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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. _____

REMARKS: _____

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GEORES No
30M14-276

REPORT ON

**FOUNDATION INVESTIGATION AND DESIGN
HIGHWAY 401 AND
CARRUTHERS CREEK DRIVE INTERCHANGE
PRELIMINARY DESIGN
~~W.P. 242-86-00~~ WP 110-00-01
MINISTRY OF TRANSPORTATION, ONTARIO
CENTRAL REGION, DISTRICT 6, TORONTO**

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January 2000

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PART A

**FOUNDATION INVESTIGATION AND DESIGN
HIGHWAY 401 AND
CARRUTHERS CREEK DRIVE INTERCHANGE
PRELIMINARY DESIGN
W.P. 242-86-00**

**MINISTRY OF TRANSPORTATION, ONTARIO
CENTRAL REGION, DISTRICT 6, TORONTO**

1.0 INTRODUCTION

Golder Associates Ltd. has been retained by Totten Sims Hubicki Associates (TSH) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out a foundation investigation for the site of the proposed Highway 401 and Carruthers Creek Drive interchange. The project is part of the MTO plan to expand Highway 401 to a future Core/Distributor system, which requires modifications to several existing intersections to accommodate the Highway 401 improvements. This project addresses the preliminary design of the Carruthers Creek Drive interchange extending from the north side of the Achilles Road intersection to the northern Carruthers Creek Drive limits.

This report addresses the proposed Carruthers Creek Drive overpass, the approaches within 20 m of the structure and the proposed retaining walls along W-N/S and N/S-E Ramps. The bridge is designated as Bridge No. 6.

The purpose of this investigation is to determine the subsurface conditions at the site of the proposed overpass structure and the retaining walls by drilling boreholes, and carrying out in-situ tests and laboratory tests on selected samples. Based on our interpretation of the data obtained, recommendations on the foundation aspects of design of the proposed works are provided. Comments are also provided on anticipated construction problems where they may affect the design of the proposed overpass structure, approach embankments or retaining walls.

The proposed horizontal and vertical alignment of the proposed bridge structure and the location of the retaining wall (W-N/S and N/S-E) were provided to Golder Associates by TSH on preliminary design drawings at 1:2000 scale. A preliminary General Arrangement plan for the overpass structure was provided to us on December 8, 1999.

The terms of reference for the scope of work are outlined in our proposal letter P91-1227, dated May 28, 1999.

2.0 SITE DESCRIPTION

The site is located at the intersection of Highway 401 and Carruthers Creek Drive in the Town of Ajax. The grade of Highway 401 varies from about Elevations 96 m to 98 m and the existing highway embankment is about 2 m in height in the project area.

The ground surface varies between about Elevations 93 m and 98.5 m in the general area of the site and generally slopes to the south. There are GO Transit and CN Rail tracks located to the south and parallel to the existing Highway, with a top of railway embankment at about Elevation 96.7 m.

Outside of the existing roadways, there is a relatively thin vegetation cover consisting of bushes, trees and grass at this site.

3.0 INVESTIGATION PROCEDURES

The field work for this investigation was carried out between September 15 and 27, 1999. During this time, a total of sixteen boreholes were put down at the site at the locations shown on Drawings 1 and 2. Boreholes RW-1 through RW-9 were drilled on the south side of Highway 401 along the alignment of the proposed retaining walls. Boreholes ST-1 through ST-6 and Borehole G-13 were put down to the north of the Highway 401 in the area of the proposed bridge structure(s). The investigation was carried out using a track-mounted auger drill rig, supplied and operated by Masters Soil Investigations Ltd of Toronto.

The boreholes were advanced to depths of approximately 6.7 m to 20.6 m below the existing ground surface. The fieldwork was supervised on a full-time basis by a member of our engineering staff who located the boreholes, directed the drilling operations, logged the boreholes and samples, and carried out the in-situ testing.

In the boreholes, Standard Penetration Testing (SPT) was carried out at regular intervals of depth, and samples of the soils and rock were recovered using conventional drive open (split-spoon) sampling equipment. Bedrock was cored in NQ size in Boreholes ST-3 to ST-6. Groundwater conditions in the open holes were observed throughout the drilling operations. Piezometers were installed in selected boreholes to permit monitoring of the groundwater level at this site.

Samples of the soils encountered in the boreholes were returned to our laboratory for examination by the project engineer and for laboratory testing. The results of the laboratory classification testing on the soil samples are given on the Record of Boreholes sheets and on Figures 1 to 6.

The borehole locations were established in the field by TSH. Minor changes to some borehole locations were needed due to difficult access to the locations as staked in the field. The elevations and locations of the boreholes drilled for this investigation were provided to us by TSH. The elevations are referenced to geodetic datum. The northing and easting co-ordinates of the borehole locations are indicated on the Record of Borehole sheets and on the attached Drawings 1 and 2.

4.0 GENERAL SITE GEOLOGY AND STRATIGRAPHY

4.1 Site Geology

From published geologic information, the site is located in the physiographic region known as the Iroquois Plain. The Iroquois Plain comprises glaciolacustrine and glaciofluvial deposits of sands, silts, gravel and clays, often being stratified or layered. The deeper soil deposits overlying the bedrock are believed to have been deposited over the course of at least two glaciations and are referred to as tills. The tills consist of a heterogeneous mixture of sand, silt, clay and gravel with numerous cobbles and boulders. The bedrock is a thinly bedded, dark grey, calcareous shale of the Whitby Formation.

4.2 Site Stratigraphy

The detailed subsurface soil, bedrock and groundwater conditions encountered in the boreholes, together with the results of the laboratory tests carried out on selected samples, are given on the attached Record of Borehole / Drillhole sheets, following the text of this report. The stratigraphic boundaries shown on the borehole sheets are inferred from non-continuous sampling and therefore represent transitions between soil types rather than exact planes of geological change. Subsoil conditions will vary between and beyond the borehole locations. An interpretive model of the soil stratigraphy is shown on Drawings 1 and 2.

In summary, the soils encountered in the boreholes put down during the current investigation generally consist of relatively thin layers of topsoil and / or fill underlain by a succession of glacial till deposits. The glacial till units vary in composition from silty sand to clayey silt and extend to depths of about 15 m to 16 m beneath existing ground surface within the project area. The till units are underlain by shale bedrock of the Whitby Formation.

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

4.2.1 Topsoil

A layer of topsoil was encountered at Boreholes RW-7 through RW-9, put down on the south side of Highway 401 and at Boreholes ST-1 to ST-6 and G-13, put down to the north of Highway 401.

The thickness of the topsoil varied from approximately 150 mm to 600 mm at the borehole locations.

4.2.2 Fill Materials

Fill materials were encountered either at the surface or beneath the topsoil at Boreholes RW-1 through RW-9 put down on the south side of Highway 401 and at the location of Borehole ST-5, on the north side of the Highway. The fill materials typically consist of brown or grey, clayey silt to silty clay containing trace to some sand, trace gravel and organics. A deposit of brown sand and gravel fill was encountered at the location of Borehole RW-6.

Measured Standard Penetration Test (SPT) 'N' values within the fill materials varied from 5 blows to 135 blows per 0.3 m penetration but were generally less than 25 blows per 0.3 m penetration. Based on the SPT 'N' values and visual examination of the samples, the consistency of the clayey silt / silty clay fill materials vary between firm and hard. The sand and gravel fill encountered at Borehole RW-6 is compact.

The thickness of the fill materials, where encountered, ranged from approximately 0.45 m at Borehole RW-7 to 2.1 m at Borehole RW-1. The measured water content on selected samples of the fill varied between 7 percent and 20 percent.

4.2.3 Upper Silty Clay Till

A deposit of silty clay till containing some sand, trace to some gravel was encountered underlying the topsoil and fill materials in Boreholes ST-1 through ST-6 put down to the north of the Highway 401 alignment. Cobbles and boulders were encountered in the boreholes at different depths. The thickness of this upper silty clay till deposit ranges from approximately 1.6 m to 2.0 m in these boreholes. The silty clay till deposit is very stiff to hard with SPT 'N' values ranging from

19 blows to greater than 145 blows per 0.3 m of penetration. The base of the upper silty clay till was encountered between 2.1 m and 2.3 m depth.

Measured water contents of samples of the silty clay till deposit ranged from about 6 percent to 15 percent. The results of grain size distribution analyses of one sample of the silty clay till are shown on Figure 1.

4.2.4 Upper Clayey Silty Sand to Silty Sand Till

Beneath the upper silty clay till to the north of Highway 401 and underlying the topsoil and fills on the south side of the highway is another till deposit consisting of typically about 50 percent of coarse fractions (sand and gravel) and varying proportions of clay, typically less than 12 percent. Laboratory testing of samples of this till deposit indicated that the plasticity indices of the samples with more clay content varied from 5 percent to 12 percent, indicating that this till unit varies in composition from silty sand to clayey silty sand. SPT 'N' values ranging from 19 blows to greater than 100 blows per 0.3 m of penetration were recorded with the upper clayey silty sand to silty sand till deposit indicating that this deposit is compact to very dense and typically being very dense.

Boreholes RW-1, RW-2 and G-13 were terminated within the upper silty sand till deposit at depths that varied from 6.7 m to 8.2 m below ground surface. Interlayers of silty clay till about 0.8 m thick were encountered within the upper clayey silty sand to silty sand till stratum in Boreholes RW-1, RW-3 and RW-6. The thickness of the upper clayey silty sand to silty sand till deposit varied from approximately 0.8 m to 8.2 m at the borehole locations but was generally greater than 6 m.

Atterberg limits tests carried out on samples of this deposit indicate liquid limit ranging from approximately 15 percent to 24 percent and plastic limit ranging from about 10 percent to 17 percent. Measured water contents of samples of the silty sand till deposit generally ranged from about 5 percent to 20 percent. The results of gradation analyses of representative samples of the clayey silty sand / silty sand till are shown on Figures 2 to 5.

4.2.5 Lower Silty Clay to Clay Till

A deposit of grey, silty clay to clay till was encountered at all boreholes put down through the upper clayey silty sand to silty sand till unit. This lower silty clay till deposit contained trace to some sand and gravel as well as frequent silt partings in the eastern portion of the site. Cobbles were encountered within the lower silty clay till deposit at some borehole locations.

The lower silty clay till deposit is generally hard with SPT 'N' values ranging from 36 blows per 0.3 m penetration to greater than 100 blows per 0.15 m of penetration. The thickness of this lower silty clay till deposit varied from approximately 2.3 m to 7.9 m at the borehole locations. Boreholes RW-3, RW-4, RW-6, RW-8 and RW-9 were terminated within the lower silty clay till unit at depths that varied from 8.2 m to 12.8 m below existing ground surface.

Atterberg limits tests carried out on samples of this deposit indicate liquid limits ranging from about 41 percent to 58 percent and plastic limits ranging from 17 percent to 24 percent. These results indicate that the till deposit varies from a silty clay of medium plasticity to a clay of high plasticity. Measured water contents of samples of the lower silty clay till deposit ranged from about 6 percent to 28 percent. The results of grain size distribution tests are shown on Figure 6.

4.2.6 Lower Silty Sand Till

Underlying the upper silty clay till in Boreholes RW-7, ST-4 and ST-6 is a relatively thin deposit of silty sand till containing cobbles, trace to some gravel, and trace clay. SPT 'N' values within this lower silty sand till unit were in excess of 100 blows per 0.3 m penetration indicating that this deposit is very dense.

Borehole RW-7 was terminated within the lower silty sand till unit at a depth of approximately 10.8 m below ground surface. The thickness of the lower silty sand till varied from 0.9 m at Borehole ST-4 to in excess of 2.3 m at Borehole RW-7.

The measured water content of a sample of the lower silty sand till deposit from Borehole RW-7 was approximately 8 percent.

4.2.7 Bedrock

Shale bedrock of the Whitby Formation was encountered in Boreholes ST-1 to ST-6 and RW-5. Rock coring was carried out in Boreholes ST-3 through ST-6. Based on examination of the rock core samples, the shale bedrock is generally dark grey, thinly bedded, moderately to highly weathered, and contains occasional thin limestone interlayers. Rock Quality Designation (RQD) values measured on the rock core samples retrieved ranged between 26 percent and 62 percent indicating poor to fair quality rock mass.

The surface of the shale bedrock varied between 13.4 m and 16.4 m below ground surface, corresponding to Elevations ranging from 81.2 m to 82.6 m at the borehole locations. Boreholes RW-5 and ST-1 through ST-6 were terminated within the shale bedrock at depths of between 15.2 m and 20.6 m below ground surface.

4.3 Groundwater Conditions

Water levels were monitored in the open boreholes at the time of the field work. In addition, piezometers were installed in Boreholes RW-3, RW-5, RW-7, ST-4 and ST-5 to monitor the groundwater level at the site.

Boreholes RW-2 through RW-9, ST-1 through ST-3 and ST-6 were dry upon completion of drilling. Water was encountered at 3.9 m and 4 m depths in open Boreholes RW-1 and G-13, respectively, following completion of drilling. Measurements taken in the piezometers on October 19, 1999 indicate that the groundwater level is between 2.0 m and 5.8 m below ground surface corresponding to about Elevations 89.1 m to 93.8 m. The water level measurements are shown on the Record of Borehole sheets following the text of this report and a summary is provided in the following table.

<i>Borehole Number</i>	<i>RW-1</i>	<i>RW-2</i>	<i>RW-3</i>	<i>RW-4</i>	<i>RW-5</i>	<i>RW-6</i>	<i>RW-7</i>	<i>RW-8</i>	<i>RW-9</i>
At completion of borehole Depth (m) / Elevation (m)	3.9/91.28	dry	dry	dry	Dry	dry	dry	dry	dry
October 19, 1999 Depth (m) / Elevation (m)			5.8/89.10	-	4.07/90.50		2.03/93.75		

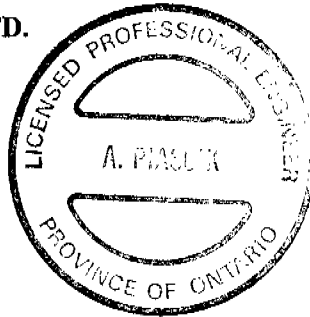
<i>Borehole Number</i>	<i>ST-1</i>	<i>ST-2</i>	<i>ST-3</i>	<i>ST-4</i>	<i>ST-5</i>	<i>ST-6</i>	<i>G-13</i>
At completion of borehole Depth (m) / Elevation (m)	dry	dry	dry	dry	dry	dry	4.0/94.32
October 19, 1999 Depth (m) / Elevation (m)				4.52/92.88	5.2/92.61		

Water levels at about Elevation 92.6 m and 92.9 m were measured in the two piezometers to the north of Highway 401. Water levels in the three piezometers installed on the south side of the highway varied from Elevation 93.8 m at the east limit and Elevation 89.1 m in the central / west portion of the project area.

It should be noted that the groundwater level is subject to seasonal fluctuations; higher groundwater level conditions might be observed after heavy rainfall or during snow melt.

GOLDER ASSOCIATES LTD.

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January 2000

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PART B

**FOUNDATION DESIGN
HIGHWAY 401 AND PICKERING BEACH
ROAD INTERCHANGE
PRELIMINARY DESIGN
W.P. 242-86-00
MINISTRY OF TRANSPORTATION, ONTARIO
CENTRAL REGION, DISTRICT 6, TORONTO**

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5.0 ENGINEERING RECOMMENDATIONS

5.1 General

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

The works described in this report are associated with the proposed overpass structure to carry Highway 401 over Carruthers Creek Drive and retaining walls along W-N/S and N/S-E Ramps to be located on the south side, between Highway 401 and the CN Railway lines.

The proposed horizontal and vertical alignment of the overpass structures and the location of the retaining walls (W-N/S and N/S-E) were provided to Golder Associates by TSH on preliminary design drawings at 1:2000 scale. A preliminary General Arrangement plan for the overpass structure was provided also to us on December 8, 1999.

It is understood that the proposed overpass structure, designated as Bridge No. 6, will carry the traffic from Westbound and Eastbound Lanes of Highway 401 over Carruthers Creek Drive. Based on the preliminary General Arrangement Plan, the overpass will be constructed in stages with the ultimate structure width of about 50 m and length of 40.5 m. Stage I will involve the construction of the Westbound Lanes portion of the structure and Stage II will involve the construction of the Eastbound Lanes portion of the structure. Possible future widening of the bridge is indicated on both sides of the structure. The width of Westbound Lanes and Eastbound Lanes will be about 27.5 m and 22.5 m, respectively, where the Westbound Lanes width includes 6 m wide allowance for the S-W Ramp. The proposed Carruthers Creek Drive will be constructed in cut as deep as 8 m at the location of the bridges. The W-N/S and N/S-E access ramps will require the construction of retaining walls, which will have a maximum height of about 8.0 m.

5.2 Bridge Foundations

5.2.1 General

The till deposit underlies relatively thin layers of topsoil and / or fill across the site. The till units vary in composition from clayey silty sand / silty sand to silty clay and extend to depths of about 15 m to 16 m beneath existing ground surface within the project area. The till deposit is typically very dense or hard below 1.5 m to 2 m depth below the ground surface. The till units are underlain by shale bedrock of the Whitby Formation. The measured water level varies between Elevations 90 m and 93 m (about 4 m to 5 m below ground surface) within the site of the proposed bridge.

The native soils at relatively shallow depth are generally suitable for support of the proposed abutments on shallow foundations. Spread footings maintained above Elevation 93 m will be maintained above the groundwater level. Alternatively, consideration may be given to the use of driven piles for support of the bridge abutments if integral abutment construction is proposed. Given the hard / very dense nature of the till deposits, however, heavy driving will be encountered during pile installation and preaugering would likely be required to advance the piles.

5.2.2 Spread Footings on Native Soils

5.2.2.1 Geotechnical Resistance

The bridge abutments may be supported on spread footings placed below any fill and topsoil and founded within the undisturbed very dense clayey silty sand or silty sand till deposits. For a closed abutment bridge configuration, it is assumed that footings would be located at suitable depth below the proposed adjacent road grade. On the preliminary design drawing, the grade of Carruthers Creek Drive is shown at about Elevation 90.5 m within the overpass area. It is assumed that the highest founding level for spread footings for this option would be at about Elevation 89.0 m, about 1.5 m below the road grade and up to 4 m below the groundwater table.

For footings placed on the undisturbed clayey silty sand till at or below Elevation 89.0 m, a factored geotechnical resistance at Ultimate Limit State (ULS) of 900 kPa may be assumed for design. The geotechnical resistance at Serviceability Limit State (SLS) for 25 mm of settlement will be dependent on the actual footing size. For an assumed footing size of 10 m x 4 m for the abutments

it is calculated that the total settlement for footings under the design resistance at ULS will be less than 25 mm. For these conditions, therefore, ULS design will govern. The above bearing capacities assume that the founding soils are not disturbed / softened due to inadequate construction procedures. The above guidelines should be reviewed if the footing dimensions differ from the dimensions assumed in this report.

For an open abutment bridge configuration, spread footings perched above the proposed road grade is also an option for support of the bridge. This option may enable footing construction to be maintained above groundwater table. The design geotechnical resistance will depend on the size of the footing and the configuration (depth / setback) with respect to the front slope. Assuming that the footing is placed at the distance equal to at least two footing widths from the face of the front slope and at or below the elevation given below, the geotechnical resistance at ULS of 1,100 kPa may be used for design.

The highest founding level on native soil for "perched" abutments can be at Elevation 94 m.

The actual footing sizes, locations and elevations must be reviewed during design in relation to the subsoil conditions at the boreholes to confirm the design assumptions given.

These values are for vertical concentric loads only. Effects of load inclination and eccentricity need to be taken into account as appropriate.

5.2.2.2 Resistance to Lateral Forces

Resistance to lateral forces / sliding resistance between the concrete footings and native soils should be calculated in accordance with Section 6-8.4.3 of the OHBDC assuming the following unfactored coefficients of friction between the concrete and the founding soils:

at or above Elevation 93.5 m	-	0.55
below Elevation 93 m	-	0.43

5.2.2.3 Frost Protection

All footings should be provided with a minimum of 1.2 m of earth cover for frost protection purposes.

5.2.2.4 Construction Considerations

The proposed founding level at Elevation 89 m will be about 1.5 m to 4 m below the groundwater level as measured in piezometers. Some water inflow into footing excavations should be expected. Pumping from well-filtered sumps in the till deposit should provide sufficient groundwater control during foundation excavations.

The founding soils are sensitive to disturbance and softening due to water seepage or ponding. In addition, The excavation base will be as much as about 4 m below the groundwater level in this area and mud coat placement will be required at the base of excavation to protect the founding soils against softening due to upward water seepage. The general excavation for the footing should be carried out in narrow strips with a mud coat placed immediately after the founding level is reached and the base cleaned. Prolonged exposure without protection of the mud coat will allow the upward water seepage to soften the founding soils. The cleaned excavation base should be inspected by qualified geotechnical personnel prior to placing the mud coat. It should be noted that the water levels could be higher during wet periods of the year.

5.2.3 Piled Foundations

Consideration could be given to construction of integral abutments and supporting the structure on pile foundations. It is assumed that the design would incorporate steel H-piles placed within double CSP pipe liners with the base of the liner at about 1 m below the proposed Carruthers Creek Drive grade. The details of the integral abutment should be in accordance with the MTO Reference Report 50-96-01, "Integral Abutment Bridges". Heavy driving will be encountered for H-pile installation through the till deposits at this site and pre-augering will likely be required to allow sufficient depth / length of pile to be installed on the bedrock surface, which was encountered between Elevation 81.2 m and Elevation 82.6 m, corresponding to about 8 m to 9 m below the proposed Carruthers Creek Drive grade.

5.2.3.1 Factored Geotechnical Resistance

The following factored axial geotechnical resistances at Ultimate Limit States (ULS) may be assumed for HP 310 x 110 piles driven at this site for the driven pile lengths indicated.

<i>Driven Pile Length * (m)</i>	<i>Factored Geotechnical Resistance at ULS (kN)</i>
5	1,100
7.5	2,000 **

* Driven pile length is the length below the base of the CSP liner, which is assumed to be at about Elevation 89.5 m.

** Structural capacity for piles driven to bedrock surface.

In the case of the 5 m driven length of pile, pre-augering should only be carried out for a maximum depth of 2 m to allow for a 3 m length of pile for derivation of shaft friction.

The geotechnical resistance at ULS for piles driven to practical refusal on the moderately weathered to fresh shale bedrock at this site, which can be considered to be unyielding, will be greater than the structural capacity of the piles. The geotechnical resistance at SLS for 25 mm of settlement of the pile group will be higher than the structure capacity of the piles.

The SPT "N" values measured within the clayey silty sand / silty sand and silty clay till deposits were generally greater than 100 blows per 0.3 m of penetration and driving the piles will be difficult given the density / consistency of the soils. A heavy pile section should be considered and the tips and the tops of the piles should be reinforced to protect against damage during driving.

Some pre-augering may be required at least to provide a starting guide for pile driving. It should be noted that the pile resistances provided above assume contribution from the shaft friction as well as end bearing resistance. Pre-augering should therefore only be carried out to a depth that will still permit driving the pile at least 3 m through undisturbed till.

The steel H-piles should be driven to an initial set equal to or greater than 10 blows per 12 mm of penetration (unless abrupt peaking occurs) using a hammer with rated energy of about 50 kilojoules

but not exceeding 60 kilojoules. A final set of no less than 10 blows per 12 mm of penetration should be obtained at the maximum hammer energy. Provision should be made to re-tap all piles to confirm the set after adjacent piles have been driven. The above set criteria should be reviewed at the time of construction in light of the contractor's proposed equipment, so that over-driving and possible damage to the piles is avoided.

5.2.3.2 Resistance to Lateral Loads

The passive resistance over the length of the double pipe liner may be neglected in design. If vertical piles are to resist the lateral loading, the horizontal reaction to the pile can be calculated from the expression:

$$k_s = z \times n_h / d,$$

Where

- k_s = coefficient of horizontal subgrade reaction (MPa/m)
- d = pile diameter (m)
- n_h = constant of horizontal subgrade reaction (MPa/m)
- z = depth (m)

The constant of horizontal subgrade reaction depends on the soil type and soil density / consistency around the pile shaft. For design of resistance to lateral loads, the values (or range of values) indicated in the table below may be assumed:

<i>Elevation (m) (approximate)</i>	<i>Soil Type</i>	<i>$z \times n_h$ (MPa)</i>
Base of the double pipe liner (assumed at Elevation 89 m) to bedrock surface encountered between Elevations 81.2 m and 82.6 m	Very dense clayey silty sand / silty sand till and hard silty clay till	$z \times 10.0$

Group action for lateral loading should be considered when the pile spacing in the direction of loading is less than 6 to 8 pile diameters. Group action can be evaluated by reducing the coefficient of lateral subgrade reaction in the direction of loading by a reduction factor R as follows:

<i>Pile Spacing in Direction of Loading d = Pile Diameter</i>	<i>Subgrade Reaction Reduction Factor R</i>
8d	1.00
6d	0.70
4d	0.40
3d	0.25

5.2.3.3 Frost Protection

The pile caps should be provided with 1.2 m soil cover for frost protection.

5.3 Lateral Earth Pressure

The lateral earth pressures acting on the bridge abutment walls and on the retaining walls will depend on the type and method of placement of the backfill materials, on the nature of the soils behind the backfill, on the magnitude of surcharge including construction loadings and on subsequent movement of the structure. The following recommendations are made concerning the design of the abutment and retaining walls:

- Select free-draining granular fill such as that meeting the specifications of the Ontario Provincial Standard Specifications (OPSS) Granular A or B Type II, but with less than 5 percent passing the #200 sieve, should be used as backfill behind walls. All granular fill should be compacted in lifts of loose thickness not greater than 200 mm, to at least 95 percent of the material's Standard Proctor maximum dry density.
- Longitudinal drains and weep holes should be installed to provide drainage of the granular backfill.
- The granular fill may be placed either in a zone with width equal to at least 1.2 m behind the back of the wall stem (Case I) or within a wedge-shaped zone defined by a 60 degree line extending up and back from the bottom of the rear face of the footing (Case II).
- If the structural support allows movement of the top of the wall of at least 0.5 percent of the retained height (unrestrained structure), "active" earth pressures may be used in the geotechnical design of the structure. If the support does not allow sufficient lateral movement (restrained structure), "at rest" pressures should be assumed for geotechnical design.
- A compaction surcharge equal to 16 kPa should be included in the lateral earth pressures for the structural design of the wall stem. Other surcharge loadings should also be accounted for in the design, as required.

- For Case I, the lateral earth pressures are based on the in-situ soils (native till) and the following parameters may be assumed:

Soil Unit Weight	21 kN/m ³
Coefficient of Lateral Earth Pressure	
"active"	0.27
"at rest"	0.43

- For Case II, the lateral earth pressures are based on the granular fill as placed; the following parameters may be assumed:

	Granular A	Granular B Type II
Soil Unit Weight	22 kN/m ³	21 kN/m ³
Coefficient of Lateral Earth Pressure		
"active"	0.27	0.31
"at rest"	0.43	0.47

It should be noted that the above design parameters assume level backfill and ground surface behind the wall. Where there is sloping ground behind the wall, the coefficient of lateral earth pressure must be adjusted (increased) to account for the slope. Other aspects of the abutment granular backfill requirements with respect to sub-drains and frost taper should be in accordance with OPSD-3501.00.

5.4 Retaining Walls

5.4.1 General

Retaining walls will be required along W-N/S and N/S-E Ramps to be located on the south side of Highway 401. Based on the plan / profile information provided, it is understood that the maximum height of the wall will be about 8 m.

Two concepts could be considered for the retaining walls:

- mechanically reinforced soil retaining wall system; and
- cantilever cast-in-place concrete retaining wall.

To provide protection against frost, the backfill material to a horizontal minimum distance of 1.2 m behind the face of the wall must consist of granular fill such as OPSS Granular A or Granular B Type II. Beyond a horizontal distance of 1.2 m, the backfill may consist of granular fill or the excavated native clayey silty sand / silty sand till and silty clay till deposits.

5.4.1 Mechanically Reinforced Soil Retaining Wall System

A mechanically reinforced soil retaining wall system consists of soil reinforced with metal, plastic or fabric strips or grids integrated with suitable fill which is placed and compacted in layers. All topsoil, existing fill and loose / soft materials should be removed prior to placing the granular fill for the reinforced soil system and the granular fill material should be placed on native undisturbed soils.

A facing material, typically pre-cast concrete blocks or panels mechanically fastened to the reinforcing strips or grids is used to form the face of the reinforced soil structure and to prevent the loss of fill material.

The maximum height of the wall is anticipated to be about 8 m. The reinforced soil mass should be placed on the native, undisturbed till deposits. For the reinforced earth mass founded on dense to very dense clayey silty sand / silty sand till or hard silty clay till deposits, a factored geotechnical resistance at ULS as indicated below may be used for the design of the retaining walls along W-N/S, N/S-E Ramps. The corresponding geotechnical resistance values at SLS were computed for 25 mm settlement imposed by the reinforced soil mass of width equal to 0.7 of height of the reinforced soil mass. The angle of internal friction for the native deposits may be taken as 35°.

Average Wall Height (m)	Geotechnical Resistance (kPa)		
	ULS (Factored)	SLS (25 mm)	Founding Elevation (m)
8	600	550	Stepping up to the west (Ramp W-N/S) and east (Ramp N/S-E) from Elevations 88 m to Elevation 89 m
5	450	400	Stepping up to the west (Ramp W-N/S) and east (Ramp N/S-E) from Elevations 89 m to Elevation 93 m
2 to 3	250	200	Elevation 93 m

5.4.2 Cantilever Cast-in-Place Concrete Retaining Walls

For the cantilever wall option, the concrete walls may be supported on spread footings founded within the native, undisturbed clayey silty sand / silty sand and / or silty clay till deposits, below any topsoil and fill materials. Factored geotechnical resistance at ULS of 400 kPa can be used for design for a 3 m wide strip footing placed within the native, undisturbed clayey silty sand / silty sand and / or silty clay till deposits placed below Elevation 93 m. The total settlement induced by the SLS of 400 kPa will be less than 25 mm for a 3 m wide strip footings. Therefore, ULS conditions will govern for geotechnical resistance calculations.

The footings should be provided with a minimum of 1.2 m soil cover for frost protection.

Resistance to lateral forces / sliding resistance between the concrete footings and subsoils should be calculated in accordance with Section 6-8.4.3 of the OHBDC assuming an unfactored coefficient of friction of 0.43 between the concrete and the founding soils to calculate the resistance of the wall footing against sliding.

The bearing pressures provided are given under the assumption that the loads will be applied perpendicular to the surface of the footings. The inclination of the load should be taken into account in accordance with OHBDC when the load is not applied perpendicular to the surface of the footing.

The total settlement for footings under the design geotechnical residence at ULS will be less than 25 mm; however, the actual settlement will be dependent on the actual footing size and applied loads. The above guidelines should be reviewed if the footing dimensions differ from the dimensions assumed in this report.

5.5 Excavations and Temporary Cut Slopes

Excavations for footing construction will extend through fill and till deposit consisting of clayey silty sand, silty sand and silty clay. At the proposed bridge and retaining walls, the excavations for the footings will be up to about 8 m in depth below existing ground surface. Cobbles and boulders are inherent in the glacial deposits as encountered at this site and should be expected during

excavation. The excavation bases will be up to 4 m below the groundwater level as measured in the piezometers. Temporary open cut slopes should be maintained no steeper than 1 horizontal to 1 vertical (1H:1V). Where space restrictions dictate, the excavation could also be carried out within a fully braced excavation.

Water seepage inflow into the excavations through the sandy silty sand and silty sand will occur but is expected to be moderate, except during periods of sustained precipitation. Pumping from well-filtered sumps located at the base of the excavation within the glacial till should provide adequate groundwater control during foundation excavations. Sumps should be maintained outside the actual footing limits. Surface water run-off should be directed away from the excavations at all times.

Where space is restricted and will not permit open cuts for footing / wall construction, a temporary support system should be installed to support the sides of the excavation and permit the use of vertical cuts. The temporary support system could consist of soldier piles and lagging where the piles would be socketted into pre-augered holes extended into the very dense / hard till deposit below the excavation base. Some cobbles and boulders should be expected during augering for the soldier pile installation. Support to the soldier pile and lagging wall system could be in the form of struts and walers in the case of footing excavations or rakers and anchors in the case of retaining wall excavations.

The design of braced soldier pile and lagging walls should be based on a rectangular earth pressure distribution using the design parameters given below. Where the support to the wall is provided by anchors or rakers, the wall design should be based on a triangular earth pressure distribution using the design parameters given below. The raker / anchor support must be designed to accommodate the loads applied from pressures and surcharge pressures from area, line or point loads as well as the impact of sloping ground behind the system as may apply to the ramp retaining wall.

Unfactored triangular earth pressure distribution (p in kN/m^2 ; increasing with depth), can be calculated as follows:

where $p = K_a \gamma H$

H = the height of the excavation at any point in metres
 K_a = 0.3 for level ground behind excavation
 γ = soil unit weight = 22 kN/m³

Unfactored rectangular earth pressure distribution (p in kN/m²; constant with depth), can be calculated as follows:

where $p = K \gamma H$

H = the height of the excavation
 K = 0.4 for level ground behind excavation
 γ = soil unit weight = 22 kN/m³

Passive toe restraint to the soldier piles may be determined using a triangular pressure distribution acting over an equivalent width equal to three times the pile socket diameter. The coefficient of passive lateral earth pressure, K_p , for the socket within the very dense / hard till may be taken as 8.7.

For the bridge footing excavations and the higher sections of the walls, the soldier piles will be socketted into the very dense clayey silty sand / silty sand till deposit below the groundwater level. The soil unit weight should be taken as 22 kN/m³ and the unit weight of water should be taken as 9.8 kN/m³. A groundwater level at Elevation 93 m can be assumed at the bridge footing locations.

All excavations should be carried out in accordance with the guidelines outlined in the latest edition of the Ontario Occupational Health & Safety Act. The native soils at this site would be classified as Type I soil.

5.6 Embankment Construction

On the preliminary drawing, the proposed grade of Highway 401 is shown at Elevation 97 m, which indicates that the approach embankments would be up to 1.5 m in height.

Topsoil and fill deposits should be stripped from below the fill embankment areas and all subgrade soils proof-rolled prior to fill placement. Construction of the embankment above the prepared subgrade may be carried out using clean earth fill meeting specifications OPSS 212 or Select Subgrade Material meeting specifications with OPSS 1010, depending on material availability. All embankment fill should be placed in regular lifts with loose thickness not exceeding 300 mm, and be compacted to at least 95 percent of the material's 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. 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. The permanent soil slopes of the embankment should be maintained not steeper than 2 horizontal to 1 vertical (2H:1V). Vegetation cover should be established on all soil slopes to protect embankment fill against surficial erosion, as per OPSS 572.

The embankment subgrade soils consists of very stiff to hard silty clay till. Providing that the embankment subgrade is properly prepared, the embankment with side slopes maintained at 2 horizontal to 1 vertical would be stable. The embankment loading will result in settlement of the underlying silty clay till, however, the majority of this settlement will occur during construction and is expected to be small.

5.7 Permanent Cuts

It is understood that Carruthers Creek Drive will be formed within open cut. The permanent slopes will be up to 8 m high and typically will be formed within the very stiff to hard silty clay till or very dense clayey silty sand / silty sand till. Topsoil and surficial fill were encountered at the ground surface during borehole drilling. The groundwater table is up to 2.5 m above the proposed cut slope base / Carruthers Creek Drive grade. It is considered that permanent cuts with slopes formed not steeper than 2 horizontal to 1 vertical (2H:1V) will be stable. Drainage to the permanent slopes will be required in order to maintain the integrity of the slopes. Mid height benches should be provided for cut areas where the total slope height is 8 m or greater than 8 m.

Water seepage will be encountered through the till deposits where the permanent cut slopes extend below the groundwater table (particularly in close proximity to the bridge where the cut slopes are the deepest). The toe of the slope may be as much as 2.5 m below the groundwater table. In this regard, drainage measures are required to control and discharge the water seepage. This may be accomplished by placement of a drainage blanket on the slope in conjunction with drainage trenches discharging to the road drainage works.

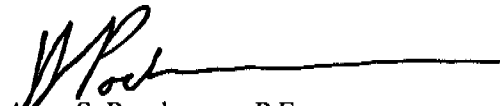
Although there was no evidence in the boreholes / soil samples of the presence of perched water tables within the boreholes, the layered nature of the soil strata is such that perched groundwater (above the general groundwater level) could occur at some times of the year. The cut slopes should be inspected by geotechnical personnel during construction and provision should be made in the contract documents for placement of additional extent of the granular blanket on the slope in the event that further drainage to the slope is required. All granular blanket material should meet the specifications for fine aggregates in accordance with OPSS 1002. Any drainage from the top of slope should be collected and carried to the toe of slope by armoured channels.

Vegetation cover should be established on all permanent cut slopes to prevent surficial erosion on the slope face.

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WORD S/FINAL.DAT/1100/991-1158/2000/91158AR1

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

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 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):

An electronic cone penetrometer with a 60° conical tip and a projected 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.

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

(a) Index Properties (con't.)

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)

(c) 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

(d) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (overconsolidated range)
C_s	swelling index
C_α	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	Overconsolidation ratio = σ'_p / σ'_{vo}

(e) 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

WEATHERING 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 texture and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	> 2 m
Thickly bedded	0.6 m to 2m
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	< 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	> 3 m
Wide	1 - 3 m
Moderately close	0.3 - 1 m
Close	50 - 300 mm
Very close	< 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	> 60 mm
Coarse Grained	2 - 60 mm
Medium Grained	60 microns - 2 mm
Fine Grained	2 - 60 microns
Very Fine Grained	< 2 microns

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

CORE CONDITION

Total Core Recovery

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 varies 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 (W.R.T.) 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 abbreviated 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

B - Bedding	P - Polished
FO - Foliation/Schistosity	S - Slickensided
CL - Cleavage	SM - Smooth
SH - Shear Plane/Zone	R - Ridged/Rough
VN - Vein	ST - Stepped
F - Fault	PL - Planar
CO - Contact	FL - Flexured
J - Joint	UE - Uneven
FR - Fracture	W - Wavy
MF - Mechanical Fracture	C - Curved
- Parallel To	
⊥ - Perpendicular To	

PROJECT 991-1158			RECORD OF BOREHOLE No RW-1			1 OF 1			METRIC								
W.P. 242-86-00			LOCATION N 4857069.50; E 343880.00			ORIGINATED BY SB											
DIST 6 HWY 401			BOREHOLE TYPE CME 55 Bombardier			COMPILED BY AMP											
DATUM Geodetic			DATE 15.9.99 - 15.9.99			CHECKED BY AMP											
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									
98.18 0.00	Clayey Silt, some sand, trace gravel and organics Firm (Fill)		1	50 DO	7	▽	98										8 44 38 10
			2	50 DO	13		97										
			3	50 DO	12												
96.05 2.13	Clayey Silty Sand, some gravel, occ. cobbles Compact to very dense Grey and brown (Till)		4	50 DO	26		96										
			5	50 DO	38		95										
			6	50 DO	38		94										
			7	50 DO	56		93										
			8	50 DO	64		92										
91.47 6.71	END OF BOREHOLE																
Note: Water level in open borehole at Elev. 94.3m upon completion of drilling.																	

ON MOT 991-1158 GPJ ON MOT GDT 30/12/99

PROJECT <u>991-1158</u>		RECORD OF BOREHOLE No RW-2		1 OF 1	METRIC
W.P. <u>242-86-00</u>		LOCATION <u>N 4857085.00; E 343927.50</u>		ORIGINATED BY <u>SB</u>	
DIST <u>6</u> HWY <u>401</u>		BOREHOLE TYPE <u>CME 55 Bombardier</u>		COMPILED BY <u>AMP</u>	
DATUM <u>Geodetic</u>		DATE <u>15.9.99 - 15.9.99</u>		CHECKED BY <u>AMP</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × REMOULDED						
95.00							20 40 60 80 100	20 40 60							
0.00	Silty Clay, some sand and gravel, trace organics and brick fragments Stiff Brown (Fill) Clayey Silty Sand with gravel, occ. cobble Compact to very dense Brown to 2.8m depth then becoming grey (Till)		1	50 DO	11										
94.39															
0.61			2	50 DO	30										
			3	50 DO	24										
			4	50 DO	30										
			5	50 DO	19										
			6	50 DO	28										
			7	50 DO	47										
			8	50 DO	47										
86.77			9	50 DO	60										
8.23	END OF BOREHOLE Note: Open hole dry on completion of drilling.														

ON MOT 991-1158.GPJ ON MOT.GDT 30/12/99

PROJECT 991-1158			RECORD OF BOREHOLE No RW-3			1 OF 1			METRIC							
W.P. 242-86-00			LOCATION N 4857100.00; E 343976.00			ORIGINATED BY SB										
DIST 6 HWY 401			BOREHOLE TYPE CME 55 Bombardier			COMPILED BY AMP										
DATUM Geodetic			DATE 15.9.99 - 15.9.99			CHECKED BY AMP										
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 (%)
94.90							20	40	60	80	100					
0.00	Silty Clay, some sand, trace gravel Very stiff Brown (Fill)		1	50 DO	18											
94.22																
0.67	Clayey Silty Sand to Silty Sand, some gravel Compact to very dense Brown to 2m depth, then becoming grey (Till)		2	50 DO	43											
			3	50 DO	29											
			4	50 DO	52											
			5	50 DO	63											
			6	50 DO	100/15											
			7	50 DO	100/15											
			8	50 DO	80/15											
			9	50 DO	142											
86.40																
8.50	Silty Clay, some sand and gravel, occ. cobbles Hard Grey (Till)		10	50 DO	100/13											
			11	50 DO	100/10											
82.40			12	50 DO	100/13											
12.50	END OF BOREHOLE															
	Note: Water level in piezometer at Elev.89.1m on Oct.19, 1999.															

ON MOT 991-1158 GPJ ON MOT.GDT 30/12/99

PROJECT <u>991-1158</u>			RECORD OF BOREHOLE No <u>RW-4</u>			1 OF 1			METRIC							
W.P. <u>242-86-00</u>			LOCATION <u>N 4857115.00; E 344023.00</u>			ORIGINATED BY <u>SB</u>										
DIST <u>6</u> HWY <u>401</u>			BOREHOLE TYPE <u>CME 55 Bombardier</u>			COMPILED BY <u>AMP</u>										
DATUM <u>Geodetic</u>			DATE <u>16.9.99 - 16.9.99</u>			CHECKED BY <u>AMP</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			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x REMOULDED								WATER CONTENT (%)
94.66								20	40	60	80	100				
0.00	Silty Clay, some sand, trace gravel Hard Brown (Fill)		1	50 DO	33											
93.96																
0.70	Clayey Silty Sand with gravel Very dense Grey (Till)		2	50 DO	149											
			3	50 DO	100/13											
			4	50 DO	100/13											
			5	50 DO	141											
			6	50 DO	100/15											
			7	50 DO	100/08											
			8	50 DO	100/15											
			9	50 DO	100/10											
86.26																
8.40	Silty Clay to Clay, some sand, trace gravel Hard Grey (Till)		10	50 DO	100/13											
		11	50 DO	84												
82.19																
12.47	END OF BOREHOLE Note: Open borehole dry on completion of drilling.	12	50 DO	100/13												

ON MOT 991-1158 GPJ ON MOT.GDT 30/12/99

PROJECT 991-1158		RECORD OF BOREHOLE No RW-5		1 OF 2	METRIC
W.P. 242-88-00		LOCATION N 4857127.00; E 344062.00		ORIGINATED BY SB	
DIST 6 HWY 401		BOREHOLE TYPE CME 55 Bombardier		COMPILED BY AMP	
DATUM Geodetic		DATE 16.9.99 - 16.9.99		CHECKED BY AMP	

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 (%)			
								20 40 60 80 100										
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x REMOULDED											
94.57																		
0.00	Silty Clay, some sand, trace gravel Hard Brown (Fill)		1	50 DO	135													
93.97			2	50 DO	100/5													
0.60	Clayey Silty Sand, some gravel Very dense Grey (Till)		3	50 DO	100/15													
			4	50 DO	100/05													
91.87			5	50 DO	100/5													
2.70	Silty Clay with sand, some gravel Hard Grey (Till)		6	50 DO	100/05													
91.07			7	50 DO	101													
3.50	Clayey Silty Sand, some gravel Very dense Grey (Till)		8	50 DO	104													
			9	50 DO	101													
			10	50 DO	165													
85.77			11	50 DO	100/15													
8.80	Silty Clay, some sand, trace gravel Hard Grey (Till)		12	50 DO	155/23													
81.17																		
13.40	Weathered, dark grey Shale Bedrock. (Whitby Formation)																	

ON MOT 991-1158 GPJ ON MOT GDT 30/12/99

Continued Next Page

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

PROJECT 991-1158				RECORD OF BOREHOLE No RW-5				2 OF 2		METRIC							
W.P. 242-86-00				LOCATION N 4857127.00; E 344062.00				ORIGINATED BY SB									
DIST 6 HWY 401				BOREHOLE TYPE CME 55 Bombardier				COMPILED BY AMP									
DATUM Geodetic				DATE 16.9.99 - 16.9.99				CHECKED BY AMP									
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					
79.33																	
15.24	END OF BOREHOLE						79										
	Note: Water level in piezometer at Elev.90.5m on Oct.19, 1999.																

ON_MOT 991-1158.GPJ ON_MOT.GDT 30/12/99

PROJECT 991-1158			RECORD OF BOREHOLE No RW-6			1 OF 1			METRIC			
W.P. 242-86-00			LOCATION N 4857142.00; E 344109.50			ORIGINATED BY SB						
DIST 6 HWY 401			BOREHOLE TYPE CME 55 Bombardier			COMPILED BY AMP						
DATUM Geodetic			DATE 17.9.99 - 17.9.99			CHECKED BY AMP						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	DYNAMIC CONE PENETRATION RESISTANCE PLOT			SHEAR STRENGTH kPa			
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w _p w w _L WATER CONTENT (%)			
95.64						20 40 60 80 100			20 40 60			UNIT WEIGHT γ kN/m ³
0.00	Sand and Gravel		1	50 DO	15							REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
95.04	Brown Compact (Fill)		2	50 DO	44							
0.60	Clayey Silty Sand, some gravel		3	50 DO	100/15							
	Dense to very dense		4	50 DO	100/15							
	Brown to grey (Till)		5	50 DO	100/15							
			6	50 DO	100/15							
			7	50 DO	100/15							
			8	50 DO	95							
			9	50 DO	129							
			10	50 DO	120							
			11	50 DO	49							
88.44	Silty Clay, trace to some sand, trace gravel		12	50 DO	68							
7.20	Hard Grey (Till)											0 3 41 56
82.84	END OF BOREHOLE											
12.80	Note: Open hole dry on completion of drilling.											

ON MOT 991-1158 GPJ ON MOT GOT 30/12/99

RECORD OF BOREHOLE No RW-7

1 OF 1

METRIC

PROJECT 991-1158

W.P. 242-86-00

LOCATION N 4857157.50; E 344157.00

ORIGINATED BY SB

DIST 6 HWY 401

BOREHOLE TYPE CME 55 Bombardier

COMPILED BY AMP

DATUM Geodetic

DATE 17.9.99 - 17.9.99

CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
95.78	Topsoil													
0.00	Silty Clay, trace sand and gravel		1	50 DO	5									
0.15														
95.18														
0.60	Clayey Silty Sand to Silty Sand, trace clay, trace to some gravel Dense to very dense Grey (Till)		2	50 DO	42		95							
			3	50 DO	58		94							
			4	50 DO	125		93							
			5	50 DO	90/15		92							5 55 34 6
			6	50 DO	90/15		91							
			7	50 DO	100/15		90							
89.58							89							
6.20	Silty Clay, trace to some sand, trace gravel Hard Grey (Till)		*8				88							
			9	50 DO	90/15		87							
87.28							86							
8.50	Clayey Silty Sand to Silty Sand, trace clay, trace to some gravel Dense to very dense Grey (Till)		10	50 DO	100/15		85							
84.96			11	50 DO	92/15									
10.82	END OF BOREHOLE													
	Note: Open hole dry on completion of drilling. Water level in piezometer at Elev.93.8m on Oct.19, 1999. * no recovery spoon bouncing													

ON MOT 991-1158 GPJ ON MOT.GDT 5/1/00

PROJECT <u>991-1158</u>		RECORD OF BOREHOLE No RW-8		1 OF 1	METRIC
W.P. <u>242-88-00</u>		LOCATION <u>N 4857172.50; E 344205.00</u>		ORIGINATED BY <u>SB</u>	
DIST <u>6</u> HWY <u>401</u>		BOREHOLE TYPE <u>CME 55 Bombardier</u>		COMPILED BY <u>AMP</u>	
DATUM <u>Geodetic</u>		DATE <u>17.9.99 - 17.9.99</u>		CHECKED BY <u>AMP</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE						
95.47								20 40 60 80 100							
0.00	Topsoil														
0.15	Silty Clay, trace sand and gravel, trace organics Firm to hard Brown and grey (Fill)		1	50 DO	8										
			2	50 DO	9										
			3	50 DO	35										
93.27															
2.20	Clayey Silty Sand, trace clay, trace gravel Very dense Grey (Till)		4	50 DO	100/08										
92.47															
3.00	Silty Clay, trace sand and gravel, frequent silt partings Hard Grey (Till)		5	50 DO	42										
			6	50 DO	63										
			7	50 DO	61										
			8	50 DO	95										
			9	50 DO	105										

ON MOT 991-1158.GPJ ON MOT.GDT 30/12/99

PROJECT 991-1158		RECORD OF BOREHOLE No RW-9				1 OF 1		METRIC							
W.P. 242-86-00		LOCATION N 4857187.50; E 344252.50				ORIGINATED BY SB									
DIST 6 HWY 401		BOREHOLE TYPE CME 55 Bombardier				COMPILED BY AMP									
DATUM Geodetic		DATE 19.9.99 - 19.9.99				CHECKED BY AMP									
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							
95.92 0.00	Topsoil		1	50 DO	6										
95.46 0.46	Silty Clay, some sand, trace gravel, trace organics Very stiff Brown (Fill)		2	50 DO	24										
93.82 2.10	Clayey Silty Sand, some gravel, occ. shale fragments at depth, occ. silty sand seams Dense to very dense Grey (Till)		3	50 DO	41										
			4	50 DO	127										
			5	50 DO	178/18										
			6	50 DO	106										
91.42 4.50	Silty Clay, some sand, trace gravel, occ. shale fragments at depth, occ. silty sand seam Hard Grey (Till)		7	50 DO	46										
			8	50 DO	45										
			9	50 DO	49										
87.69 8.23	END OF BOREHOLE Note: Open hole dry on completion of drilling.														


ON MOT 991-1158.GPJ ON MOT.GDT 30/12/99

PROJECT 991-1158			RECORD OF BOREHOLE No ST-1			1 OF 2		METRIC							
W.P. 242-86-00			LOCATION N 4857159.50; E 343995.50			ORIGINATED BY SB									
DIST 6 HWY 401			BOREHOLE TYPE CME 55 Bombardier			COMPILED BY AMP									
DATUM Geodetic			DATE 27.9.99 - 27.9.99			CHECKED BY AMP									
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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X REMOULDED							
96.95	Topsoil		1	50 DO	12										
96.85	Silty Clay, some sand, trace gravel Stiff to hard Brown (Till)		2	50 DO	19										
96.30			3	50 DO	65										
94.65			4	50 DO	93/15										
2.30	Clayey Silty Sand to Silty Sand, trace clay, trace to some gravel, cobbles encountered at depth Very dense Grey (Till)		5	50 DO	97/15										
			6	50 DO	100/15										
			7	50 DO	100/10										
			8	50 DO	110/15										
			9	50 DO	100/03										
88.15	Silty Clay, trace sand and gravel, frequent silt partings below 11.6m depth Hard Grey (Till)		10	50 DO	165/28										
8.80			11	50 DO	100/15										
			12	50 DO	80										
			13	50 DO	98										

ON MOT 991-1158.GPJ ON MOT.GDT 30/12/99

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+ 3 . X 3 : Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT 991-1158			RECORD OF BOREHOLE No ST-1				2 OF 2		METRIC								
W.P. 242-86-00			LOCATION N 4857159.50, E 343995.50				ORIGINATED BY SB										
DIST 6 HWY 401			BOREHOLE TYPE CME 55 Bombardier				COMPILED BY AMP										
DATUM Geodetic			DATE 27.9.99 - 27.9.99				CHECKED BY AMP										
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 (%)	
81.75								20	40	60	80	100					
15.20	Weathered, dark grey Shale. (Whitby Formation)		14	50	DO	100/15											
78.66																	
18.29	END OF BOREHOLE Note: Open hole dry on completion of drilling.																

ON MOT 991-1158 GPJ ON MOT.GDT 30/12/99

PROJECT 991-1158 RECORD OF BOREHOLE No ST-2 1 OF 2 METRIC
W.P. 242-86-00 LOCATION N 4857171.50; E 344032.50 ORIGINATED BY SB
DIST 6 HWY 401 BOREHOLE TYPE CME 55 Bombardier COMPILED BY AMP
DATUM Geodetic DATE 27.9.99 - 27.9.99 CHECKED BY AMP

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									
						20 40 60 80 100	20 40 60 80 100		20 40 60						
96.74 0.00	Topsoil		1	50 DO	5										
96.14 0.60	Silty Clay, some sand, trace gravel Very stiff to hard Brown (Till)		2	50 DO	28										
			3	50 DO	145/25										
94.54 2.20	Clayey Silty Sand to Silty Sand, trace clay, some gravel, cobbles encountered at depth Very dense Grey (Till)		4	50 DO	100/13										
			5	50 DO	100/10										
			6	50 DO	100/10										
			7	50 DO	100/15										
			8	50 DO	100/15										
			9	50 DO	175										
88.24 8.50	Silty Clay, trace sand and gravel, frequent silt partings below 11.6m depth Hard Grey (Till)		10	50 DO	92/15										
			11	50 DO	156										
			12	50 DO	67										
			13	50 DO	93										

ON MOT 991-1158.GPJ ON MOT.GDT 30/12/99

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

PROJECT 991-1158				RECORD OF BOREHOLE No ST-2				2 OF 2		METRIC						
W.P. 242-86-00				LOCATION N 4857171.50; E 344032.50				ORIGINATED BY SB								
DIST 6 HWY 401				BOREHOLE TYPE CME 55 Bombardier				COMPILED BY AMP								
DATUM Geodetic				DATE 27.9.99 - 27.9.99				CHECKED BY AMP								
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x REMOULDED					20 40 60 WATER CONTENT (%)				
81.54 15.20	Weathered, dark grey Shale. (Whitby Formation)		14	50	100	13										
							81									
							80									
							79									
78.45 18.29	END OF BOREHOLE Note: Open hole dry on completion of drilling.															

ON MOT 991-1158.GPJ ON MOT.GDT 30/12/99

PROJECT 991-1158			RECORD OF BOREHOLE No ST-3			1 OF 2		METRIC								
W.P. 242-86-00			LOCATION N 4857177.00; E 343984.00			ORIGINATED BY SB										
DIST 6 HWY 401			BOREHOLE TYPE CME 55 Bombardier			COMPILED BY AMP										
DATUM Geodetic			DATE 23.9.99 - 23.9.99			CHECKED BY AMP										
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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED								WATER CONTENT (%)
97.22								20	40	60	80	100				
0.00	Topsoil		1	50 DO	17		97									
96.92																
0.30	Silty Clay, some sand, trace gravel, occasional cobbles Hard Brown (Till)		2	50 DO	49		96									
			3	50 DO	84											
94.93							95									
2.29	Clayey Silty Sand, trace gravel, occ. clayey silt seams Very dense Grey (Till)		4	50 DO	81/15											
			5	50 DO	78/15		94									
			6	50 DO	101/15											
			7	50 DO	95/15		93									
			8	50 DO	140		92									
							91									
90.21							90									
7.01	Silty Clay, trace sand and gravel, frequent silt partings below 11.6m depth Hard Grey (Till)		9	50 DO	92											
			10	50 DO	154		89									
							88									
			11	50 DO	107		87									
			12	50 DO	41		86									
							85									
			13	50 DO	62		84									
							83									
82.28																

ON MOT 991-1158.GPJ ON MOT.GDT 30/12/99

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

PROJECT 991-1158			RECORD OF BOREHOLE No ST-3				2 OF 2		METRIC								
W.P. 242-86-00			LOCATION N 4857177.00, E 343984.00				ORIGINATED BY SB										
DIST 6 HWY 401			BOREHOLE TYPE CME 55 Bombardier				COMPILED BY AMP										
DATUM Geodetic			DATE 23.9.99 - 23.9.99				CHECKED BY AMP										
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 (%)	
								20	40	60	80	100					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X REMOULDED									
								20	40	60	80	100	20	40	60		
14.94	Weathered, dark grey Shale Bedrock. (Whitby Formation)(continued)		14	50 DO	144		82										
							81										
							80										
							79										
							78										
76.67	Bedrock cored between 16.76m and 20.55m depth. For bedrock coring details refer to Record of Drillhole ST-3.						77										
20.55	END OF BOREHOLE Note: Open hole dry during drilling through the soils.																

ON MOT 991-1158 GPJ ON MOT GDT 30/12/99

PROJECT: 991-1158

RECORD OF DRILLHOLE: ST-3

SHEET 1 OF 1

LOCATION: N 4857177.00; E 343984.00

DRILLING DATE: 23/9/99

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME 55 Bombardier

DRILLING CONTRACTOR: Master Soils Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	CORRELATION LOG															NOTES WATER LEVELS INSTRUMENTATION	
				ELEV. DEPTH (m)	RUN NO.	PENETRATION RATE (mm/min)	FLUSH % RETURN	FR-FRACTURE		F-FAULT		SM-SMOOTH		FL-FLEXURED		BC-BROKEN CORE		DIAMETRAL POINT LOAD INDEX (MPa)		
								CL-CLEAVAGE	J-JOINT	R-ROUGH	UE-UNEVEN	MB-MECH. BREAK	B-BEDDING							
								SH-SHEAR	P-POLISHED	ST-STEPPED	W-WAVY									
								VN-VEIN	S-SLICKENSIDED	PL-PLANAR	C-CURVED									
RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY k, cm/sec														
TOTAL CORE %	SOLID CORE %			TYPE AND SURFACE DESCRIPTION		k ₁	k ₂	k ₃												
15				82.22 15.00																
16		For soil description refer to Record of Borehole ST-3																		
17		Shale, dark grey, highly fractured and weathered to about 18m depth, becoming moderately weathered to fresh, fine grained, thinly bedded, occ. thin limestone layers. (Whitby Formation)		80.46 16.76																
18					1	0.2	100													
19					2	0.1	100													
20					3	0.1	100													
21		END OF HOLE		76.67 20.55																
22																				
23																				
24																				
25																				

DEPTH SCALE

1 : 50



LOGGED: SB

CHECKED: AMP

DRILLHOLE 1158BROCK GPJ GLDR CAN GDT 22/11/99 PS

PROJECT 991-1158

RECORD OF BOREHOLE No ST-4

1 OF 2

METRIC

W.P. 242-86-00

LOCATION N 4857188.20; E 344021.00

ORIGINATED BY SB

DIST 6 HWY 401

BOREHOLE TYPE CME 55 Bombardier

COMPILED BY AMP

DATUM Geodetic

DATE 22.9.98 - 22.9.99

CHECKED BY AMP

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					
97.40																	
97.10	Topsoil		1	50 DO	15		97										
0.30	Silty Clay, some sand, trace gravel, occ. cobble Very stiff to hard Brown (Till)		2	50 DO	45		96										
			3	50 DO	100/15												
95.27																	
2.13	Clayey Silty Sand, trace to some gravel, occ. clayey silt seams Very dense Grey (Till)		4	50 DO	83		95										
			5	50 DO	92/15		94										
			6	50 DO	140/23												
			7	50 DO	100/15		93										
							92										
			8	50 DO	100/15		91										
							90										
			9	50 DO	100/15		89										
							88										
			10	50 DO	100/15		87										
87.04							86										
10.36	Silty Clay, trace sand and gravel, frequent silt partings Hard Grey (Till)		11	50 DO	59		85										
			12	50 DO	36		84										
							83										
			13	50 DO	60												
82.77																	
14.63																	

ON MOT 991-1158.GPJ ON MOT.GDT 30/12/99

Continued Next Page

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

PROJECT 991-1158			RECORD OF BOREHOLE No ST-4			2 OF 2			METRIC								
W.P. 242-86-00			LOCATION N 4857188.20; E 344021.00			ORIGINATED BY SB											
DIST 8 HWY 401			BOREHOLE TYPE CME 55 Bombardier			COMPILED BY AMP											
DATUM Geodetic			DATE 22.9.99 - 22.9.99			CHECKED BY AMP											
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					
81.86 15.54	Silty Sand, trace clay, trace gravel, occ. shale fragments Very dense Grey (Till)(continued) Weathered, dark grey Shale Bedrock. (Whitby Formation)		14	50 DO	100		82										
							81										
							80										
							79										
78.20 19.20	Bedrock cored between 16.61m and 19.20m depth. For bedrock coring details refer to Record of Drillhole ST-4. END OF BOREHOLE																
	Note: Water level in piezometer at Elev.92.9m on Oct.19,1999.																

ON MOT 991-1158 GPJ ON MOT.GDT 30/12/99

PROJECT: 991-1158

RECORD OF DRILLHOLE: ST-4

SHEET 1 OF 1

LOCATION: N 4857188.20; E 344021.00

DRILLING DATE: 23/9/99

DATUM: Geodetic

INCLINATION: -90°

AZIMUTH: —

DRILL RIG: CME 55 Bombardier

DRILLING CONTRACTOR: Master Soils Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No	PENETRATION RATE (mm/min)	FLUSH % RETURN	FR-FRACTURE		F-FAULT	SM-SMOOTH	FL-FLEXURED	BC-BROKEN CORE	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION			
								CL-CLEAVAGE		J-JOINT	R-ROUGH	UE-UNEVEN	MB-MECH. BREAK					
								SH-SHEAR		P-POLISHED	ST-STEPPED	W-WAVY	B-BEDDING					
								VN-VEIN		S-SLICKENSIDED	PL-PLANAR	C-CURVED						
								RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY k, cm/sec				
								TOTAL CORE %	SOLID CORE %			DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	10	5	1	0	
15				82.40				100	100	100	100	100	100					
				15.00														
16		Borehole continued For soil description refer to Record of Borehole ST-4																
				80.79														
17		Shale, dark grey, moderately weathered, fine grained, thinly bedded, occ. thin limestone layers. (Whitby Formation)		16.81	1		100											
18					2		100											
19				78.20														
		END OF HOLE		19.20														
20																		
21																		
22																		
23																		
24																		
25																		

DEPTH SCALE

1 : 50



LOGGED: SB

CHECKED: AMP

DRILLHOLE 1158 ROCK GPJ GLDR CAN GDT 22/11/99 PS

PROJECT 991-1158		RECORD OF BOREHOLE No ST-5		1 OF 2	METRIC
W.P. 242-86-00		LOCATION N 4857194.10; E 343973.00		ORIGINATED BY SB	
DIST 6 HWY 401		BOREHOLE TYPE CME 55 Bombardier		COMPILED BY AMP	
DATUM Geodetic		DATE 20.9.99 - 20.9.99		CHECKED BY AMP	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)	
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × REMOULDED							
97.81	Topsoil		1	50 DO	10											
0.10	Silty Clay, some sand, some gravel, trace organics. (FILL)		2	50 DO	31											
97.21	Silty Clay, some sand, trace gravel, occ. cobble Very stiff to hard Brown and grey (Till)		3	50 DO	25											
0.60			4	50 DO	96											
95.51	Clayey Silty Sand to Silty Sand, trace clay, trace to some gravel, occ. sandy silt and clayey silt seams, cobbles encountered with depth Very dense Grey (Till)		5	50 DO	172											
2.30			6	50 DO	63											
			7	50 DO	178											
			8	50 DO	100											
			9	50 DO	100											
			10	50 DO	100											
88.01	Silty Clay, trace sand, trace gravel, frequent silt partings Hard Grey (Till)		11	50 DO	173											
9.80			12	50 DO	100/15											
			13	50 DO	156											

Continued Next Page

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

ON MOT 991-1158.GPJ ON MOT.GDT 30/12/99

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

ON_MOT 991-1158.GPJ ON_MOT.GDT 30/12/99

PROJECT: 991-1158

RECORD OF DRILLHOLE: ST-5

SHEET 1 OF 1

LOCATION: N 4857194.10; E 343973.00

DRILLING DATE: 20/9/99

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME 55 Bombardier

DRILLING CONTRACTOR: Master Soils Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (mm/min)	FLUSH % RETURN	FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN	F-FAULT J-JOINT P-POLISHED S-SLICKENSIDED	SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR	FL-FLEXURED UE-UNEVEN W-WAVY C-CURVED	BC-BROKEN CORE MB-MECH. BREAK B-BEDDING	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
15				82.81 15.00										
16		For soil description refer to Record of Borehole ST-5												
17		Shale, dark grey, highly to moderately weathered, fine grained, thinly bedded, occ. thin limestone layers. (Whitby Formation)		81.05 16.76	1		100							
18														
19					2		100							
20		END OF HOLE		78.30 19.51										
21														
22														
23														
24														
25														

DEPTH SCALE

1 : 50



LOGGED: SB

CHECKED: AMP

DRILLHOLE 1158 ROCK GPJ GLDR CAN GDT 22/11/99 PS

ON MOT 991-1158.GPJ ON MOT.GDT 5/1/00

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

PROJECT 991-1158				RECORD OF BOREHOLE No ST-6				2 OF 2		METRIC					
W.P. 242-86-00				LOCATION N 4857208.00; E 344010.00				ORIGINATED BY SB							
DIST 6 HWY 401				BOREHOLE TYPE CME 55 Bombardier				COMPILED BY AMP							
DATUM Geodetic				DATE 21.9.99 - 21.9.99				CHECKED BY AMP							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa 20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x REMOULDED							
82.34 15.20	Silty Sand, trace gravel, trace clay Very dense Grey (Till)		14	50 DO	133		82								
81.14 16.40	Weathered, dark grey Shale Bedrock. (Whitby Formation)						81								
							80								
							79								
78.49 19.05	Bedrock cored between 16.76m and 19.05m depth. For bedrock coring details refer to Record of Drillhole ST-6 END OF BOREHOLE														
	Note: Open hole dry on completion of drilling through the soils.														

ON MOT 991-1158.GPJ ON MOT.GDT 5/100

PROJECT: 991-1158

RECORD OF DRILLHOLE: ST-6

SHEET 1 OF 1

LOCATION: N 4857206.00; E 344010.00

DRILLING DATE: 22/9/99

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME 55 Bombardier

DRILLING CONTRACTOR: Master Soils Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (mm/min)	COLOUR % RETURN	FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN	F-FAULT J-JOINT P-POLISHED S-SUCKENSIDED	SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR	FL-FLEXURED UE-UNEVEN W-WAVY C-CURVED	BC-BROKEN CORE MB-MECH. BREAK B-BEDDING	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
15				82.54 15.00										
16		For soil description refer to Record of Borehole ST-6												
17		Shale, dark grey, moderately weathered, fine grained, thinly bedded, occ. thin limestone layers. (Whitby Formation)		80.78 16.76	1		100							
18					2		100							
19		END OF HOLE		78.49 19.05										
20														
21														
22														
23														
24														
25														

DEPTH SCALE

1 : 50



LOGGED: SB

CHECKED: AMP

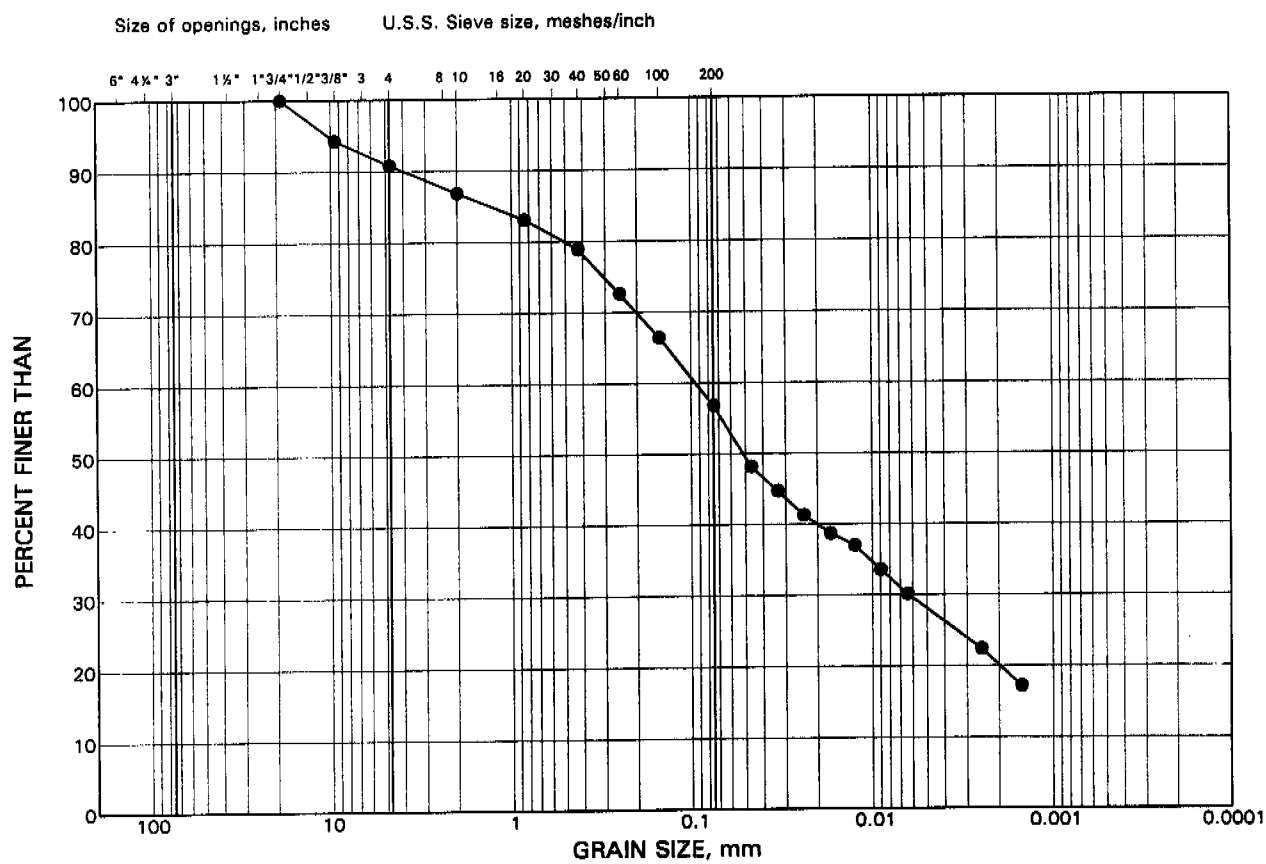
DRILLHOLE 1158 ROCK GPJ GLOR CAN GDT 22/11/99 PS

PROJECT 991-1158			RECORD OF BOREHOLE No G-13				1 OF 1		METRIC						
W.P. 242-86-00			LOCATION N 4857263.00; E 343953.00				ORIGINATED BY SB								
DIST 6 HWY 401			BOREHOLE TYPE CME 55 Bombardier				COMPILED BY AMP								
DATUM Geodetic			DATE 21.9.99 - 21.9.99				CHECKED BY AMP								
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							
98.32								20 40 60 80 100							
98.09	Topsoil		1	50 DO	12		98								
0.23	Clayey Silty Sand to Silty Sand, trace clay, trace to some gravel, cobbles encountered with depth Very dense Brown to 2.1m depth, then grey (Till)		2	50 DO	75		97								
			3	50 DO	95		96								
			4	50 DO	82		95								
			5	50 DO	60/13		94								
			6	50 DO	80/05		93								
			7	50 DO	150/10		92								
			8	50 DO	60/05		91								
90.55			9	50 DO	80/15										
7.77	END OF BOREHOLE Note: Water level in open hole at 4m depth on completion of drilling.														

ON MOT 991-1158.GPJ ON MOT.GDT 30/12/99

OVERSIZE DRAWING(S)

FIGURE 1



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

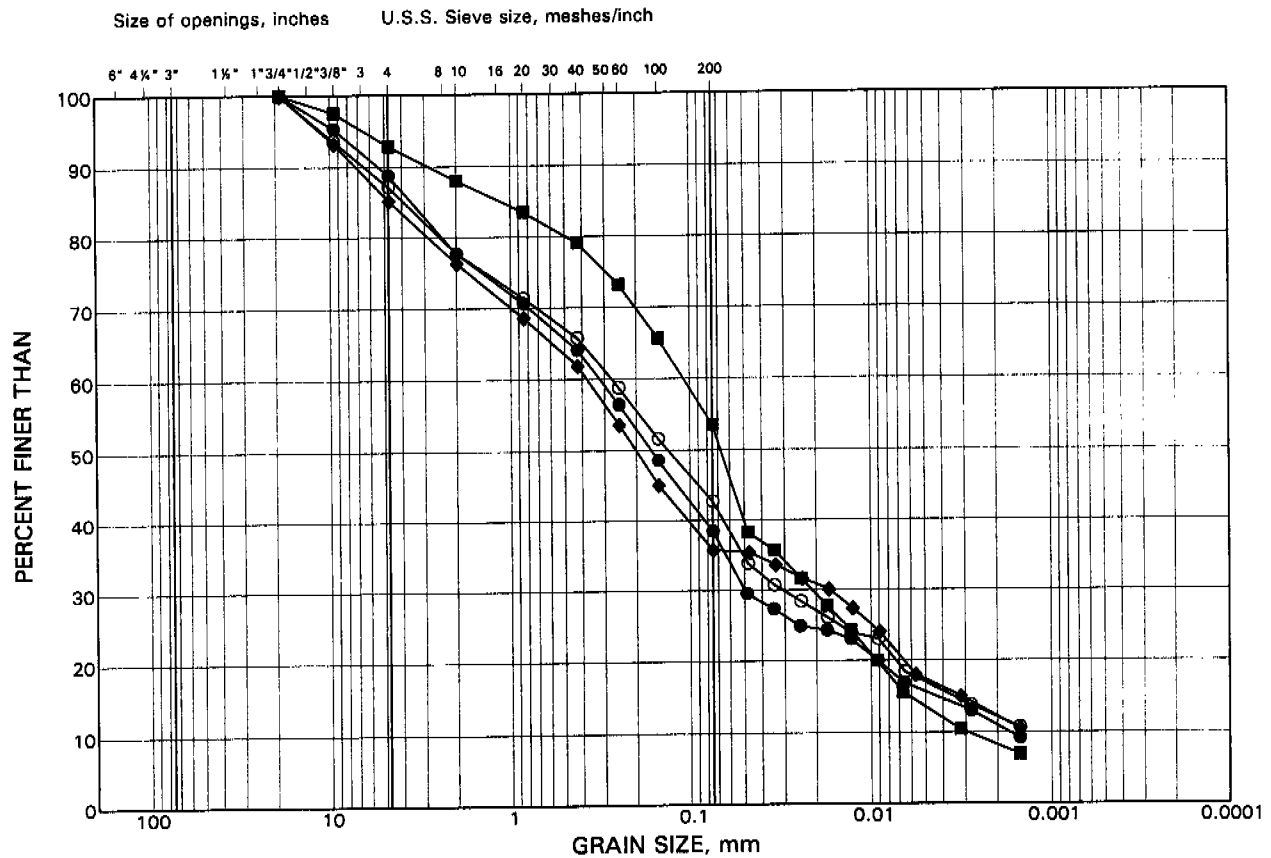
LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	RW5	5	95.2

GRAIN SIZE DISTRIBUTION

Clayey Silty Sand (Till)

FIGURE 2



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

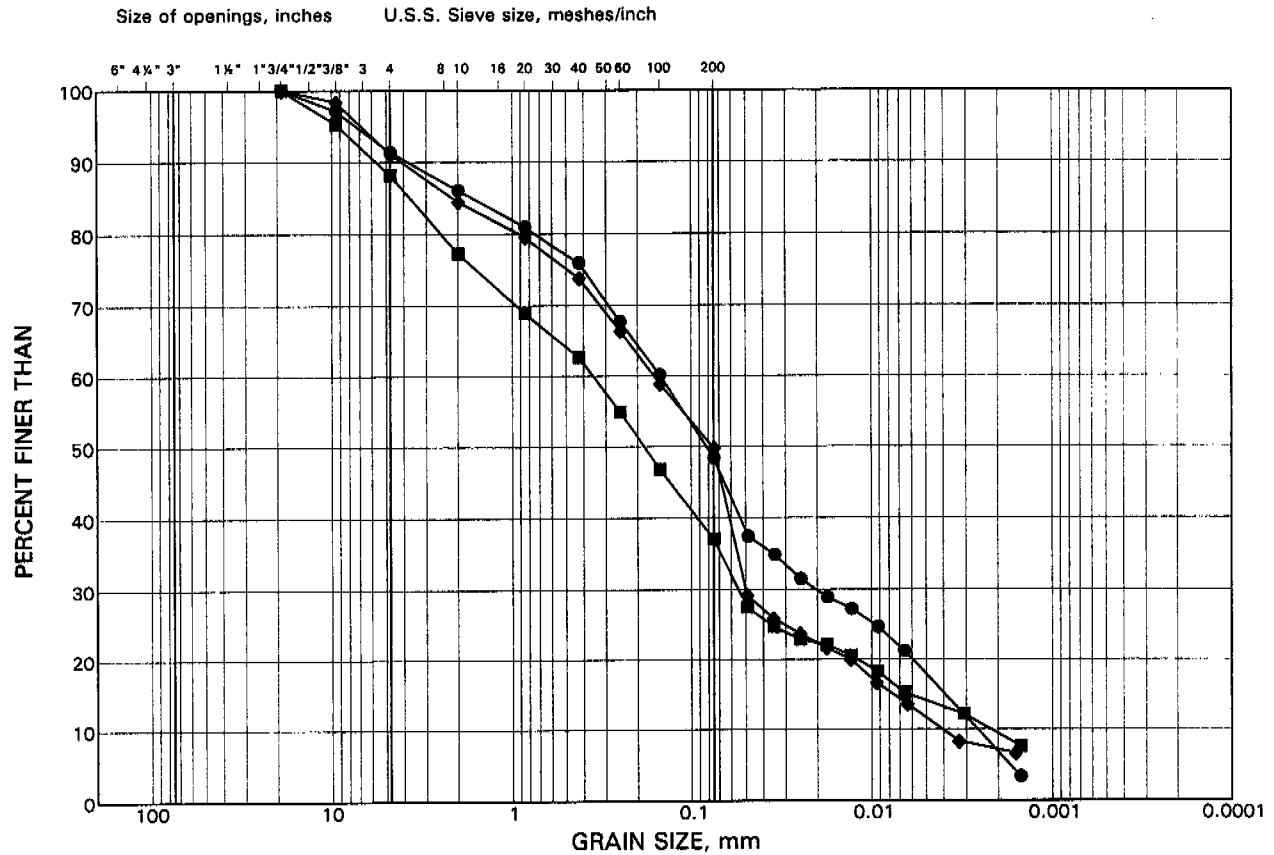
LEGEND

SYMBOL	BOREHOLE	SAMPLE ELEVATION(m)
●	ST-3	5 94.1
■	ST-4	5 92.3
◆	ST-5	8 91.6
○	ST-6	6 93.6

GRAIN SIZE DISTRIBUTION

Clayey Silty Sand (Till)

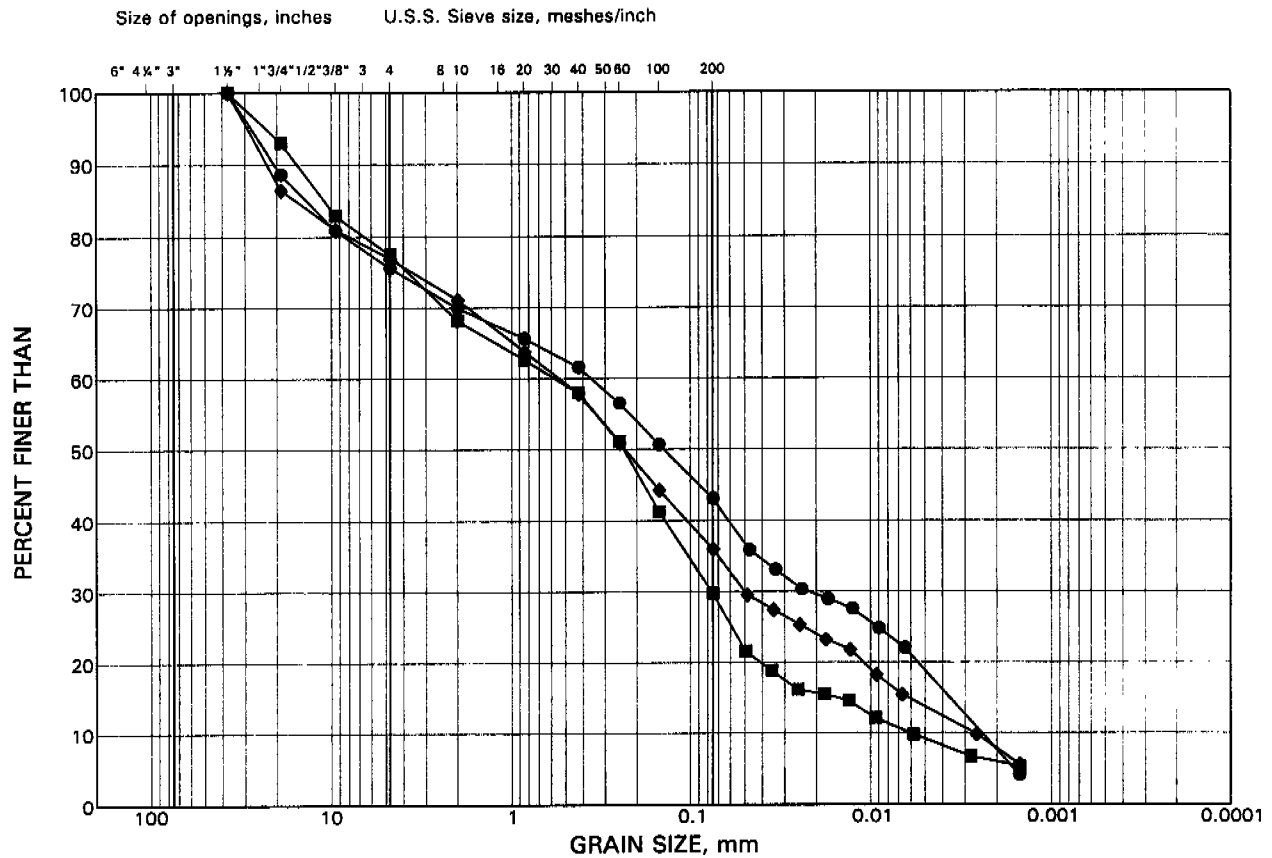
FIGURE 3



GRAIN SIZE DISTRIBUTION

Clayey Silty Sand with Gravel (Till)

FIGURE 4



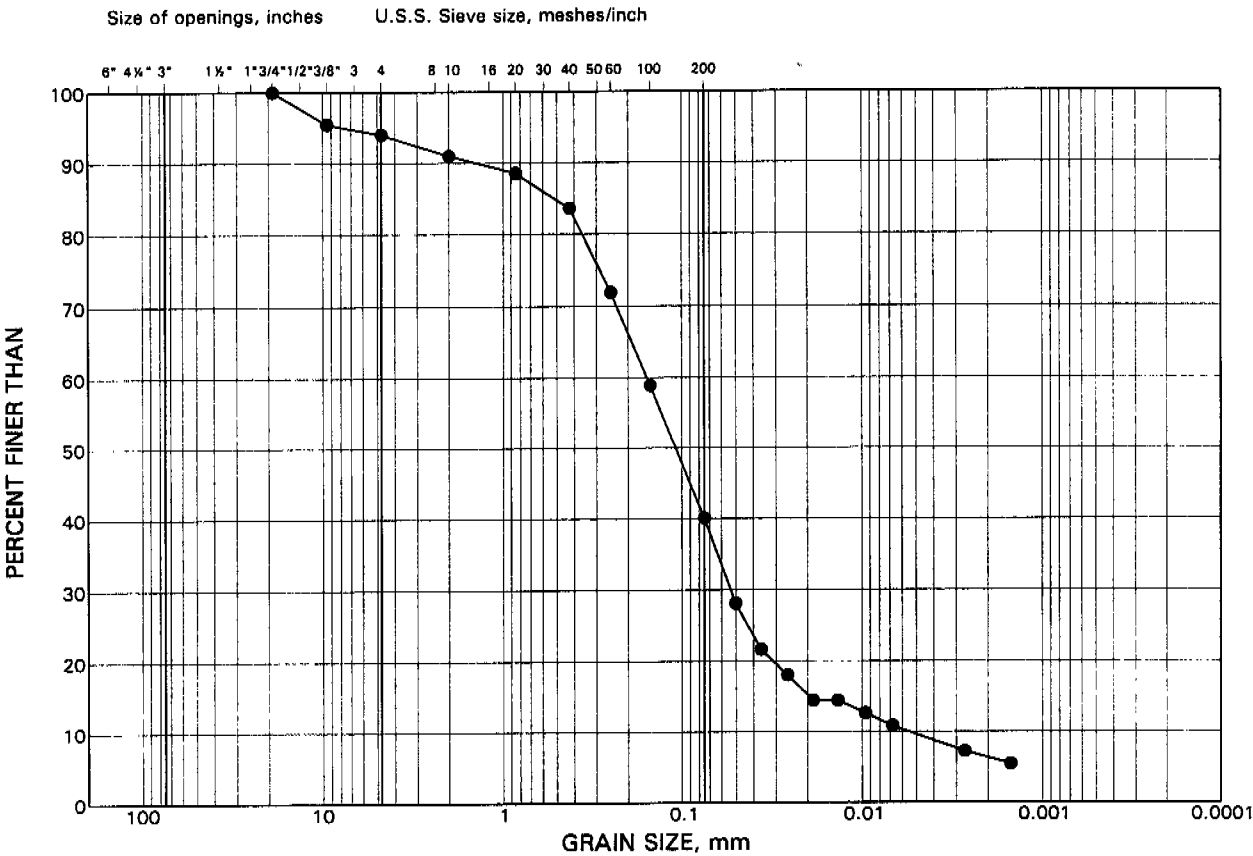
LEGEND

SYMBOL	BOREHOLE	SAMPLE ELEVATION(m)
●	RW2	6 90.8
■	RW4	5 91.3
◆	ST-2	7 92.1

GRAIN SIZE DISTRIBUTION

Silty Sand (Till)

FIGURE 5



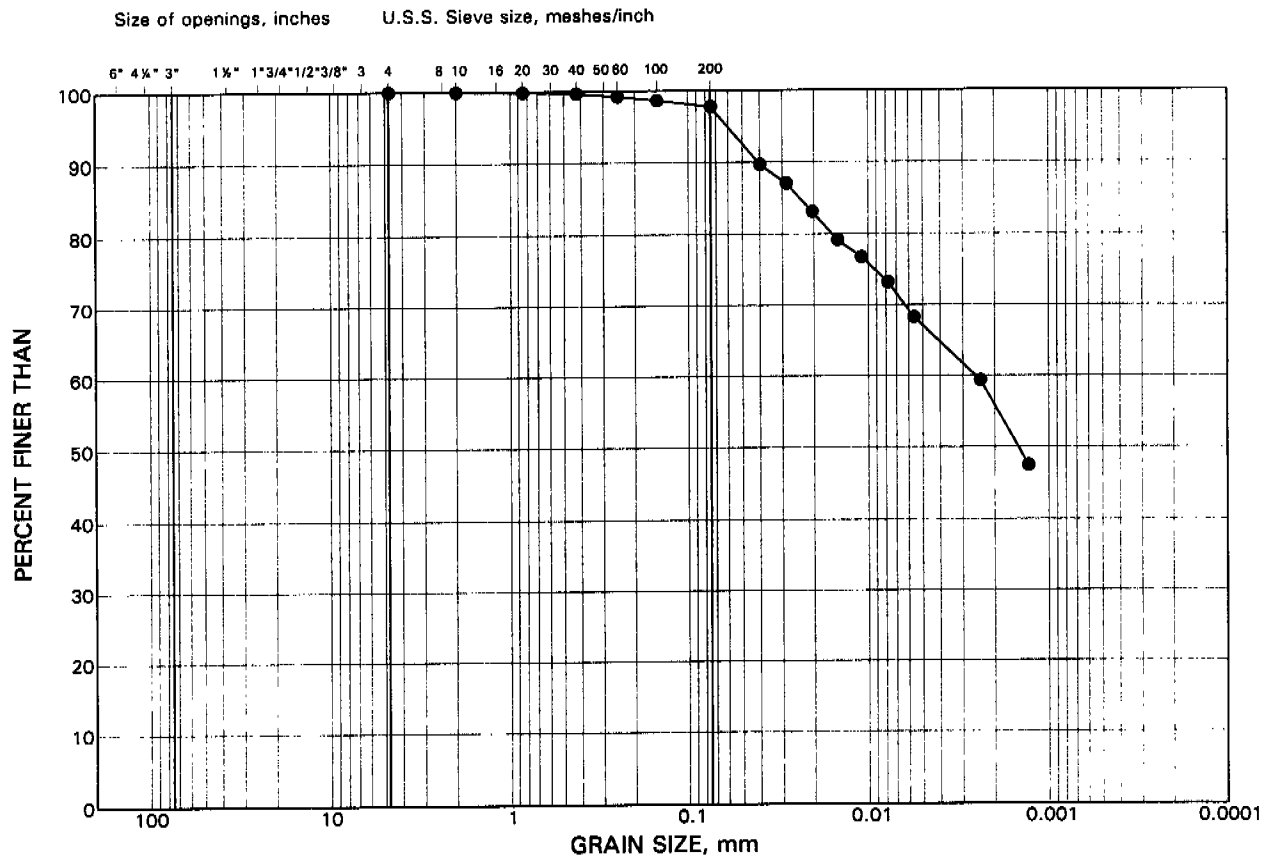
COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE ELEVATION(m)
•	RW7	5 92.7

GRAIN SIZE DISTRIBUTION Clay (Till)

FIGURE 6

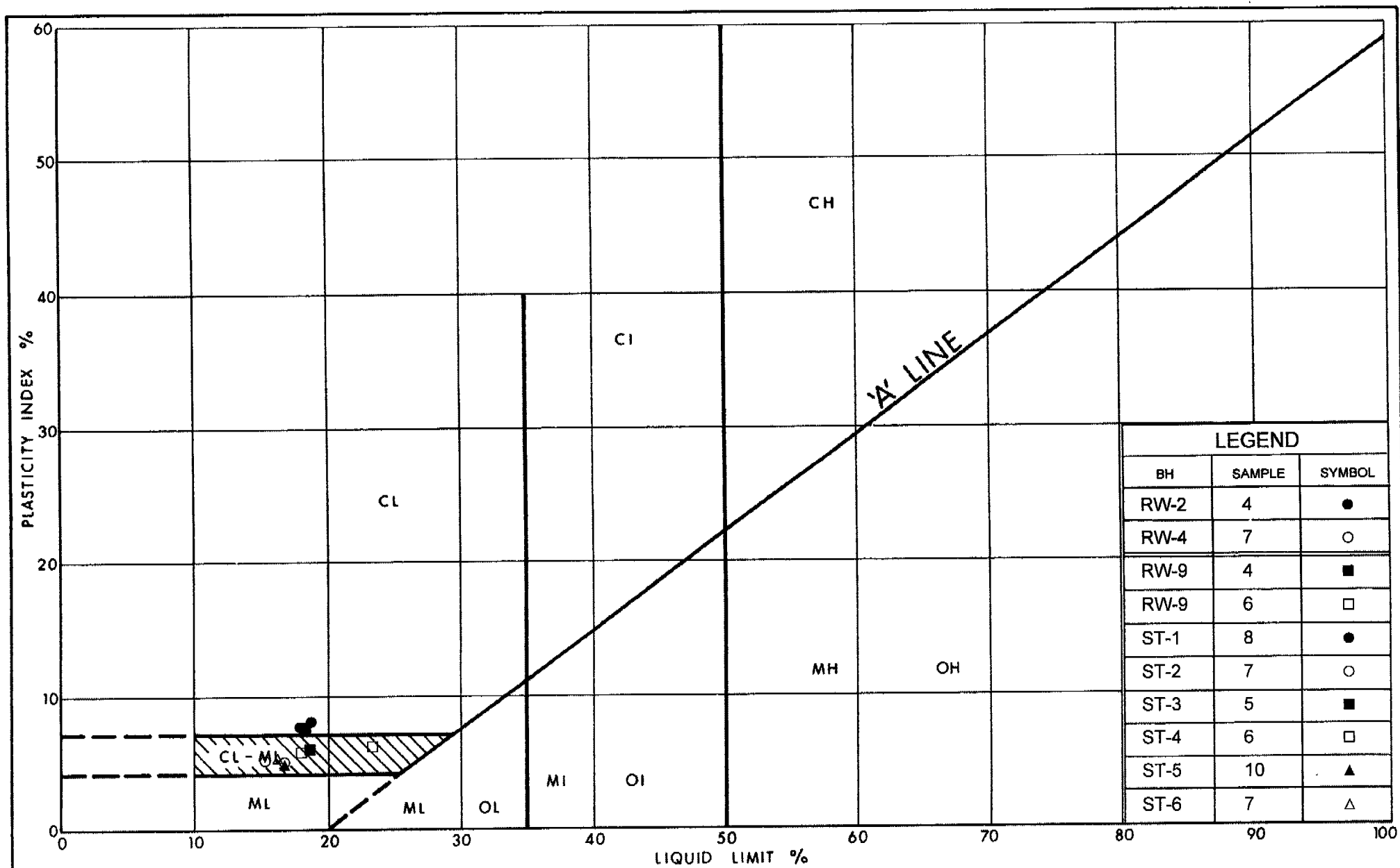


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL BOREHOLE SAMPLE ELEVATION(m)

• RW6 9 87.8



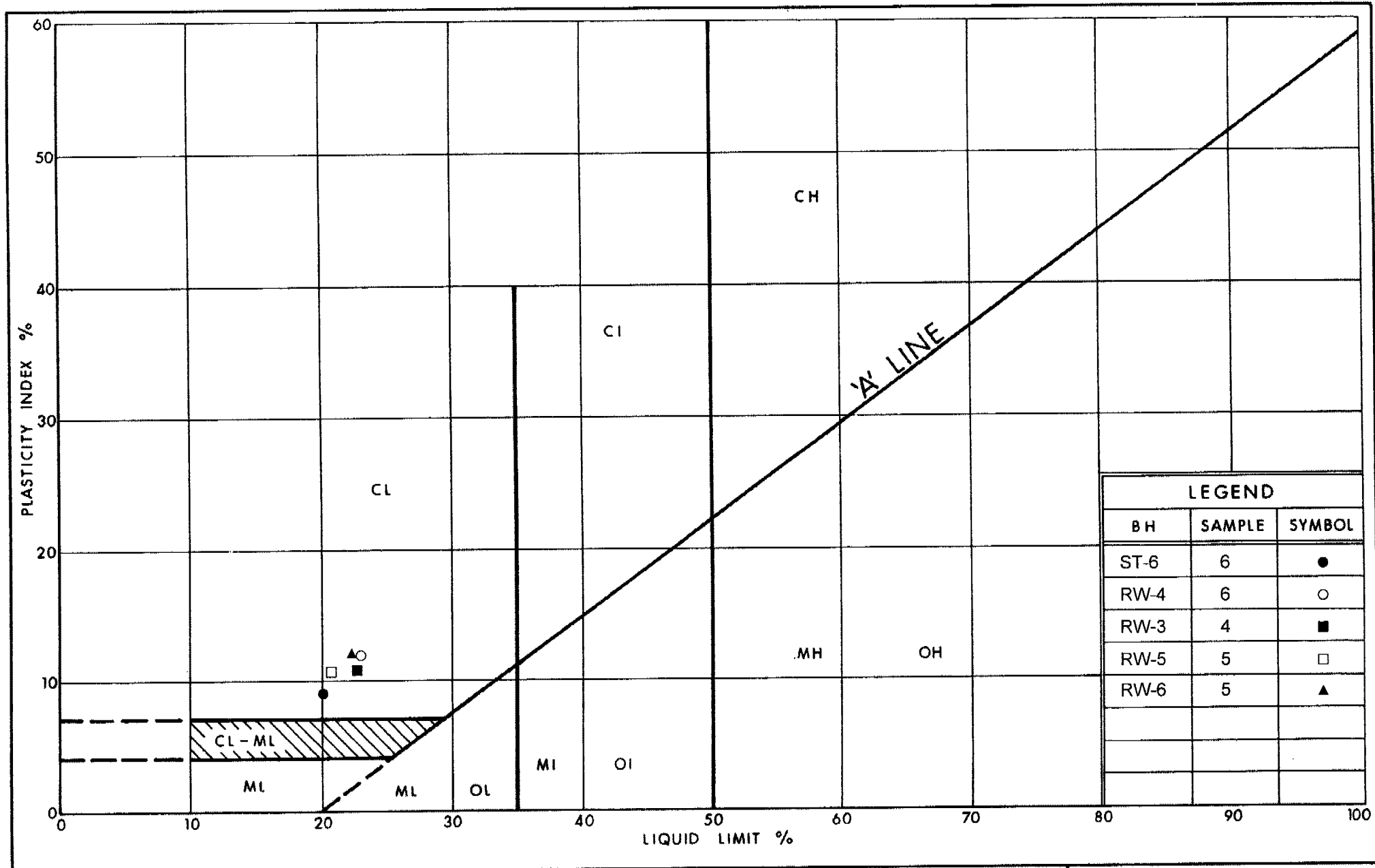
Ministry of
Transportation
Ontario

PLASTICITY CHART Clayey Silty Sand (Till)

FIG No 7

W P 242-86-00

PROJECT No 991-1158



Ontario

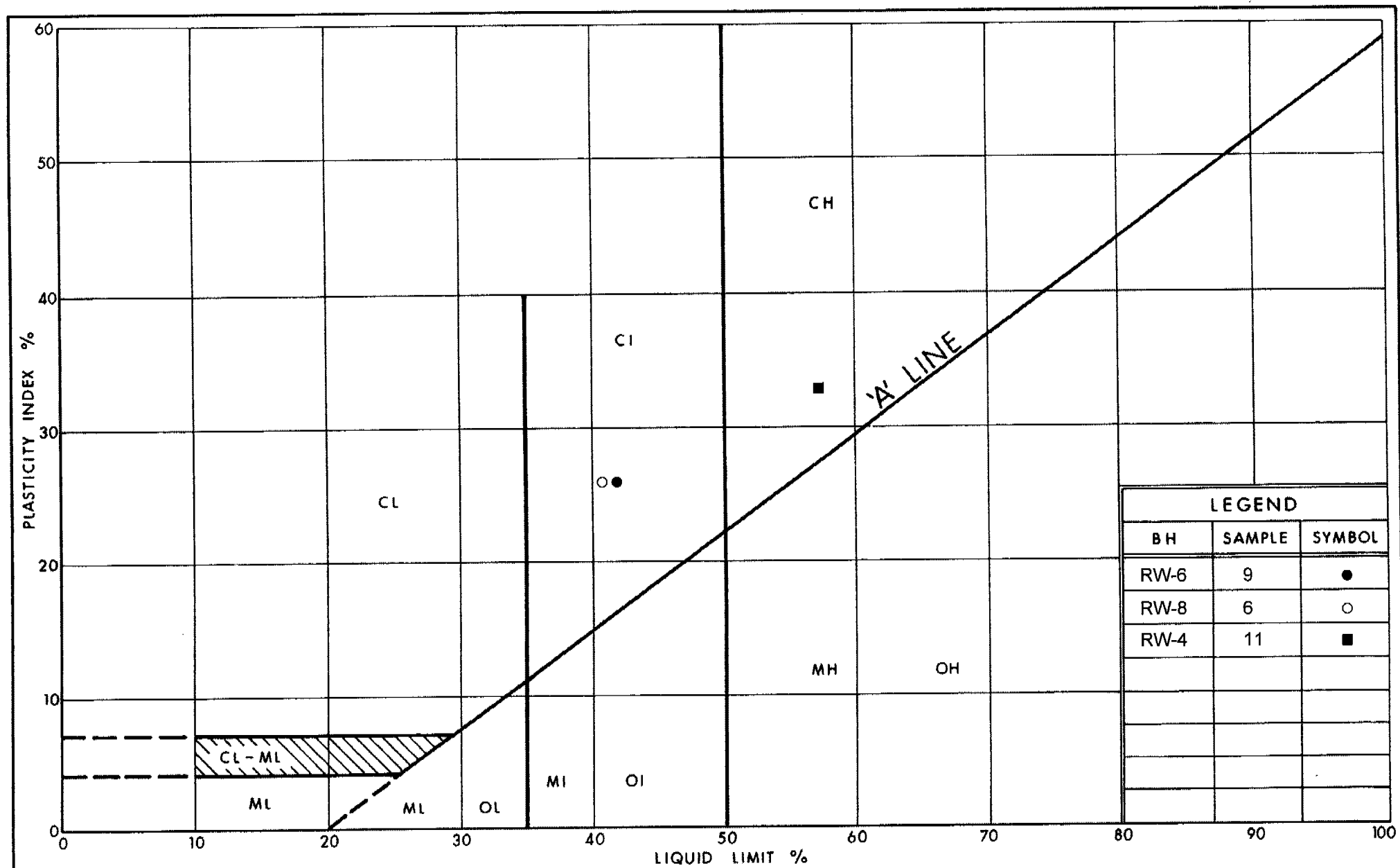
Ministry of
Transportation

PLASTICITY CHART Silty Clay (Till)

FIG No 8

W P 242-86-00

PROJECT No 991-1158



Ontario

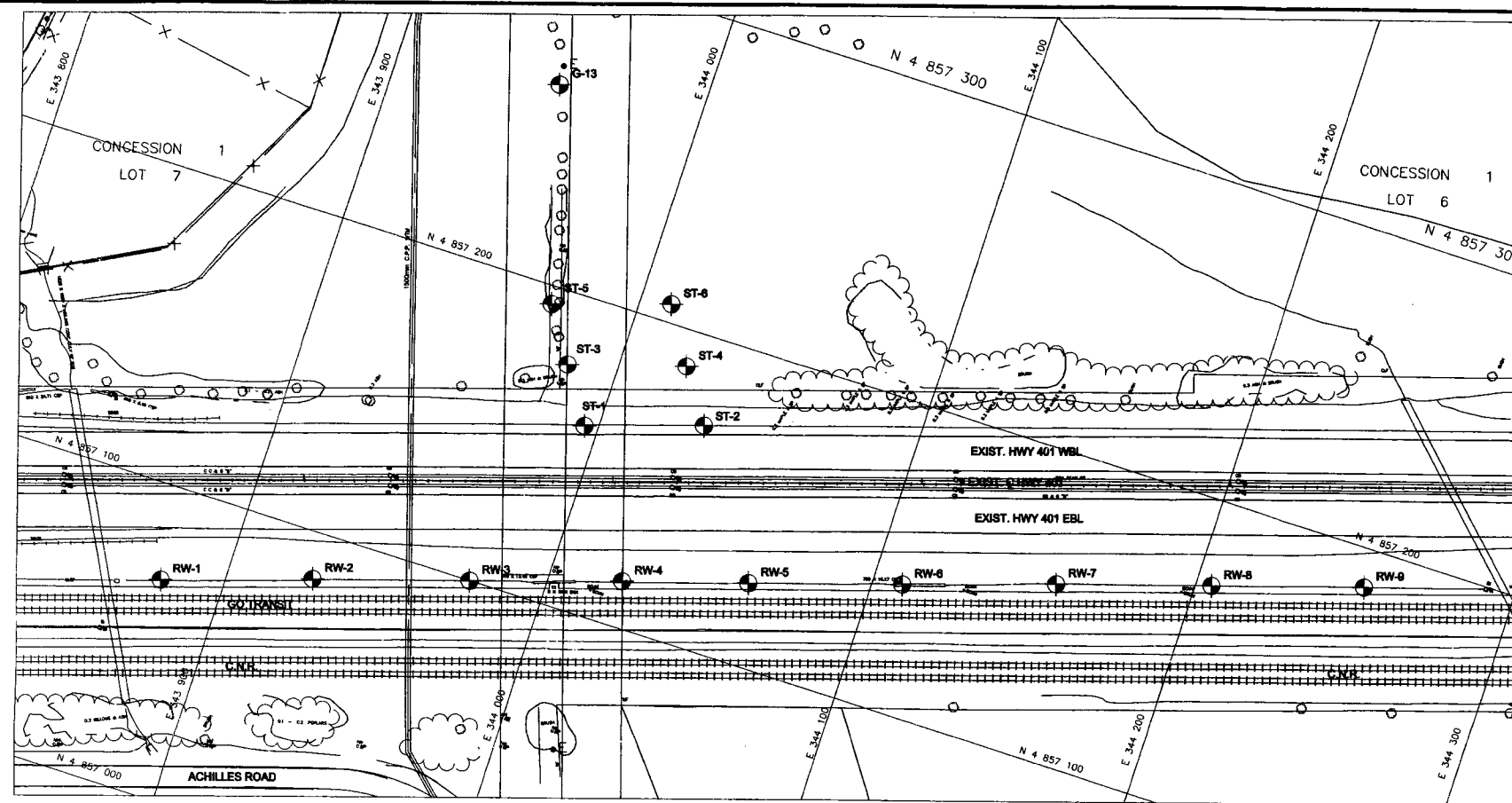
Ministry of
Transportation

PLASTICITY CHART Silty Clay to Clay

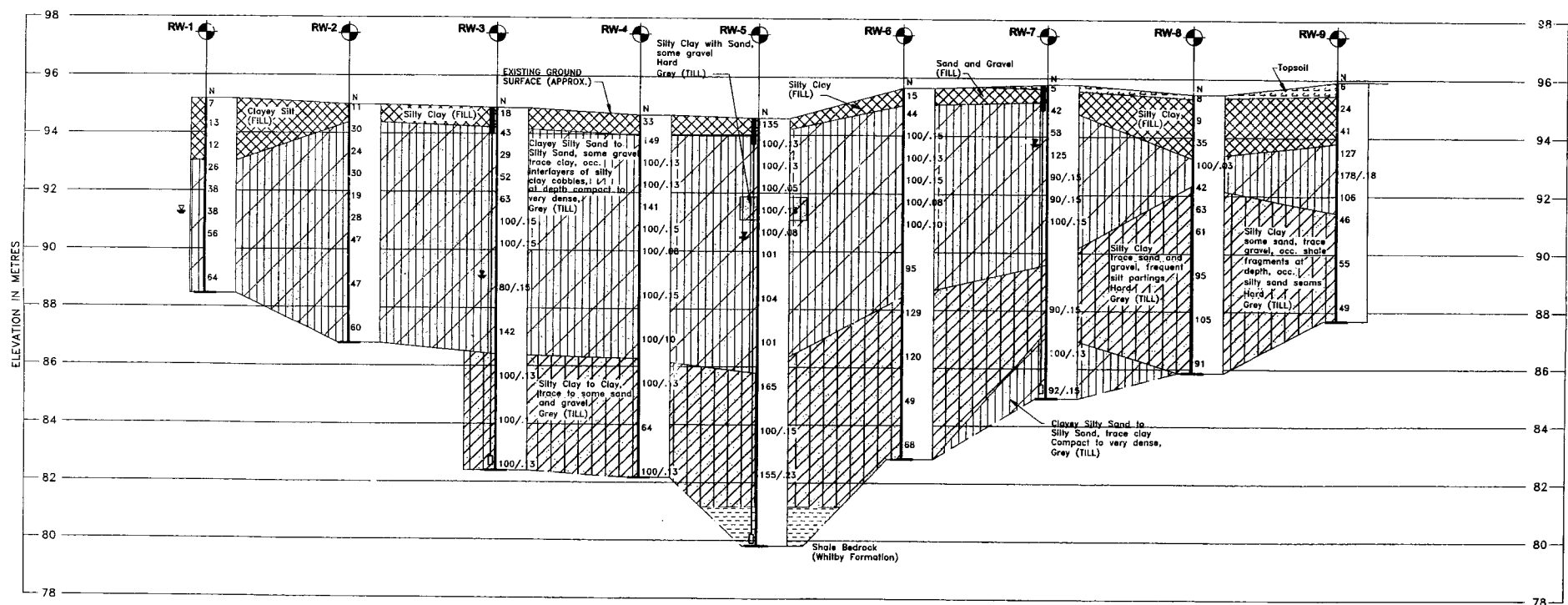
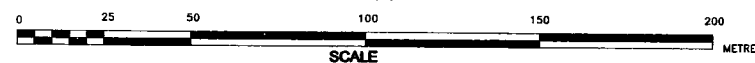
FIG No 9

W P 242-86-00

PROJECT No 991-1158



PLAN



SECTION ALONG C OF RETAINING WALL



METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DIST 6 HWY 401
CONT. No.
WP No. 242-86-00

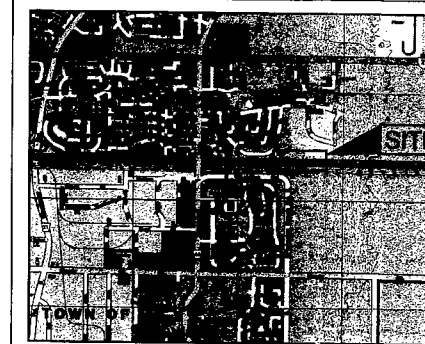


HIGHWAY 401 - RAMP AREA
BOREHOLE LOCATIONS & SOIL STRATA

SHEET



Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN

LEGEND

- Borehole
- Seal
- Piezometer
- N Standard Penetration Test value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- WL in piezometer on Oct. 19, 1999
- WL during drilling

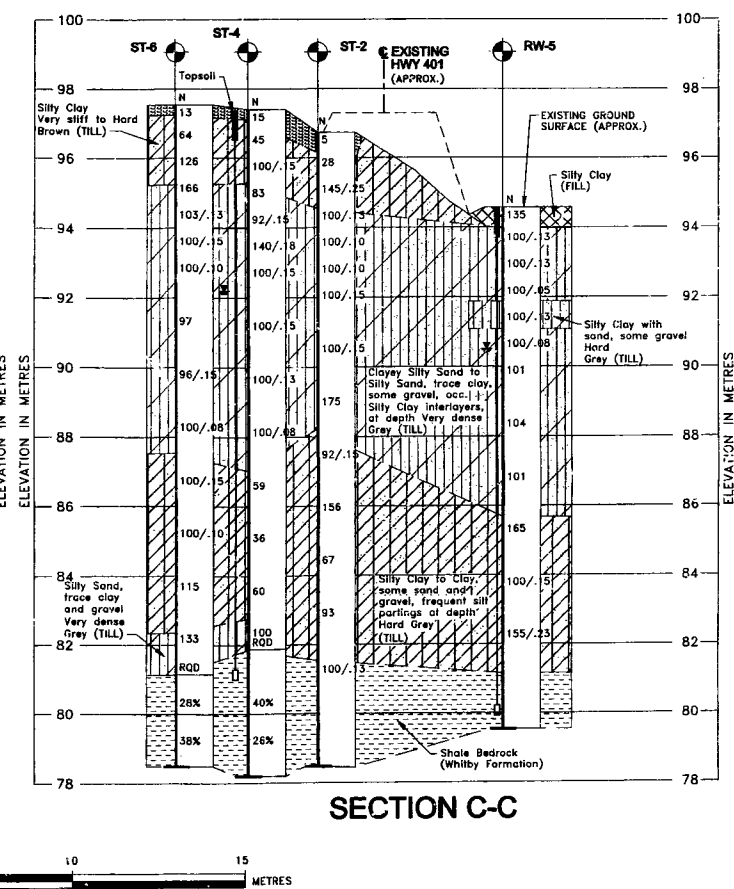
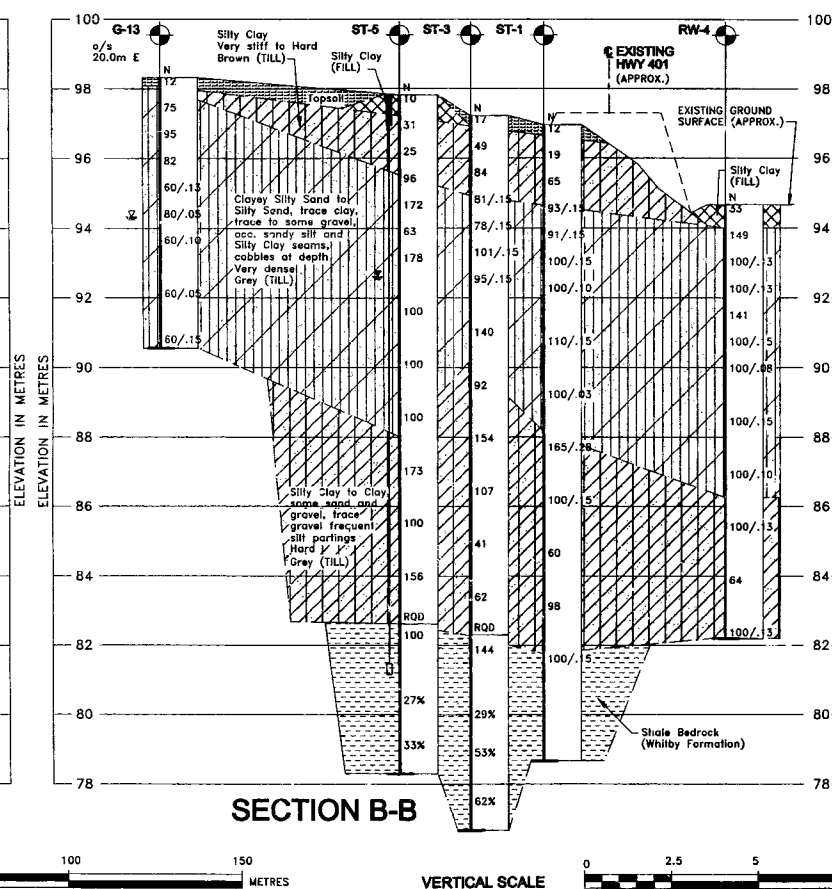
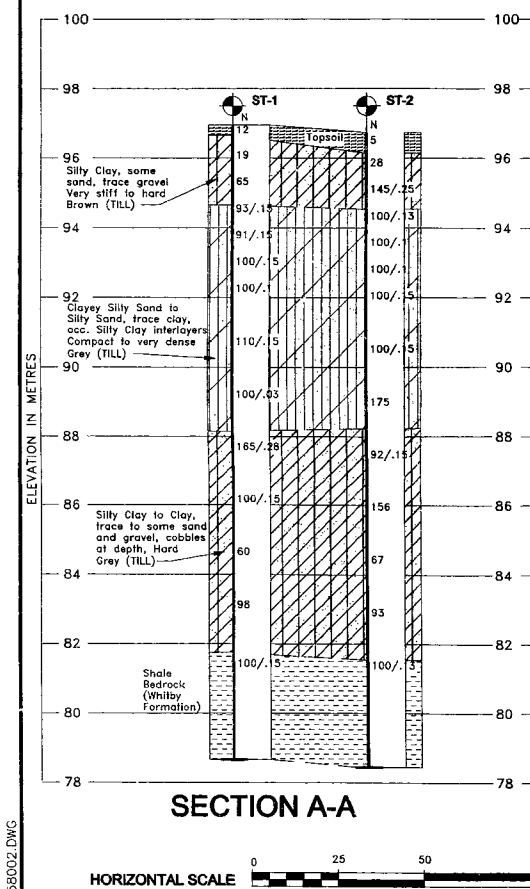
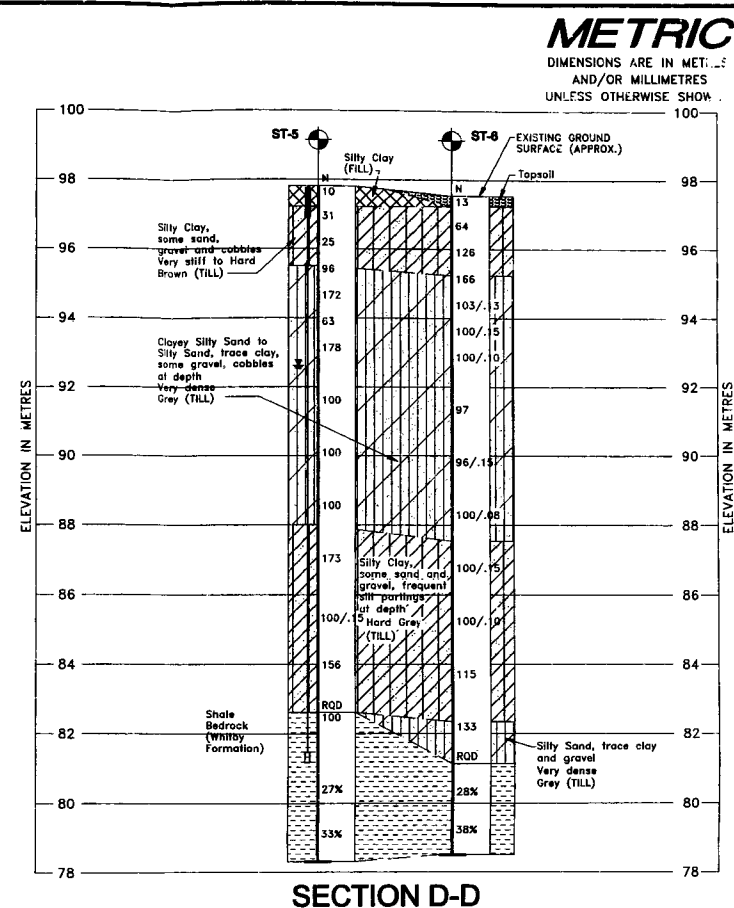
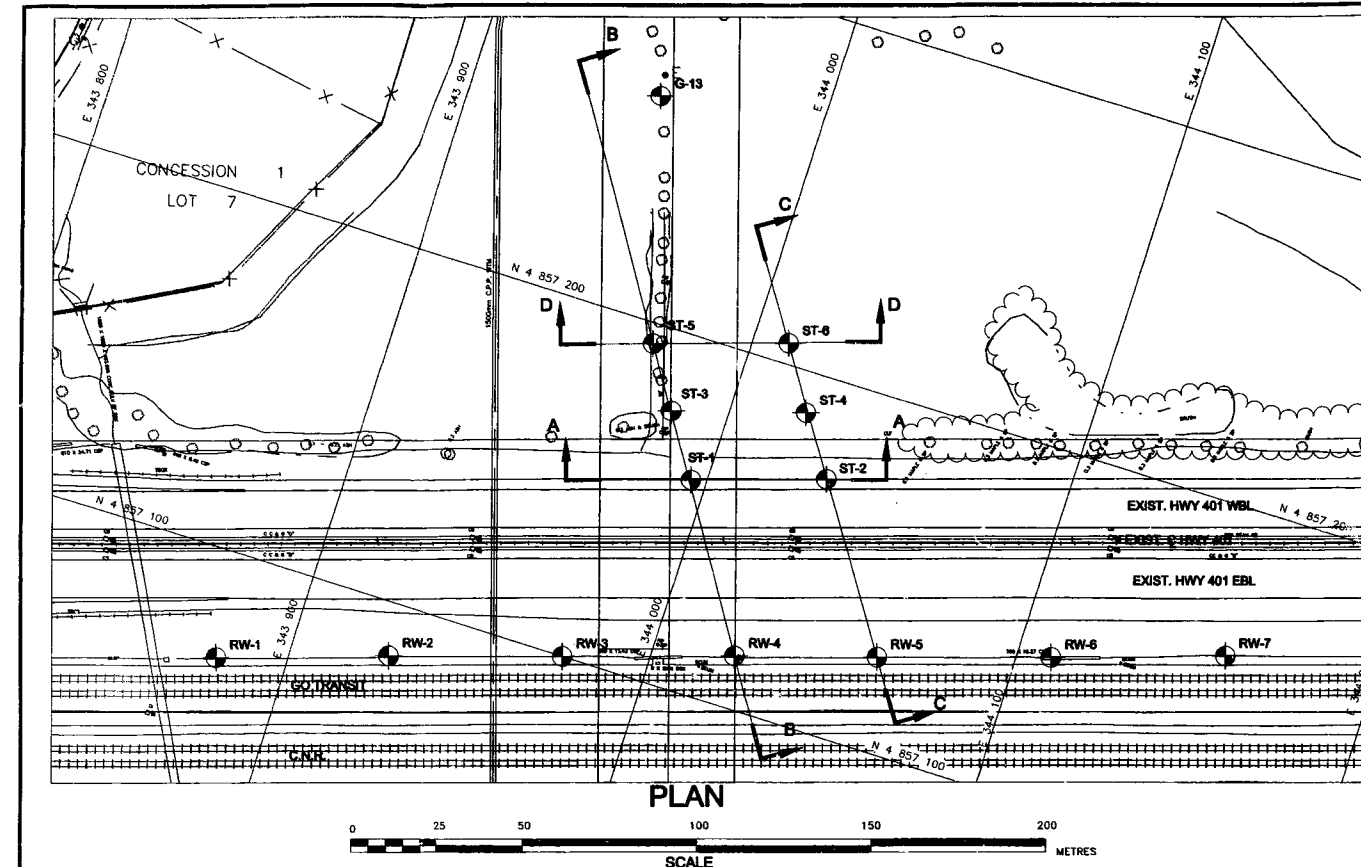
No.	ELEVATION	LOCATION	
		NORTHING	EASTING
G-13	98.32	4857263.0	343953.0
RW-1	95.18	4857069.5	343880.0
RW-2	95.00	4857085.0	343927.5
RW-3	94.90	4857100.0	343976.0
RW-4	94.66	4857115.0	344023.0
RW-5	94.57	4857127.0	344062.0
RW-6	95.64	4857142.0	344109.5
RW-7	95.78	4857157.5	344157.0
RW-8	95.47	4857172.5	344205.0
RW-9	95.92	4857187.5	344252.5
ST-1	96.95	4857159.5	343995.5
ST-2	96.74	4857171.5	344032.5
ST-3	97.22	4857177.0	343984.0
ST-4	97.40	4857188.2	344021.0
ST-5	97.81	4857194.1	343973.0
ST-6	97.54	4857206.0	344010.0

NOTES

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

NO.	DATE	BY	REVISION

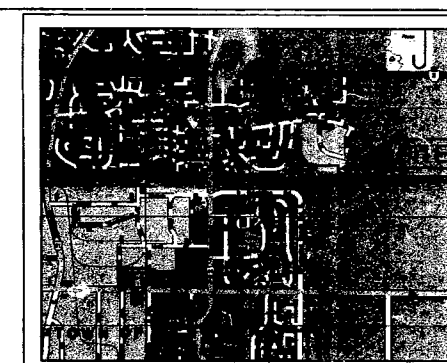
Geocres No.	
HWY. No. 401	PROJECT NO.: 991-1158
SUBM'D. AMP	CHKD: DATE: 1999 10 07
DRAWN: JFC	CHKD. AMP APPD. DWG. 1



DIST 6 HWY 401
CONT. No.
WP No. 242-86-00

HIGHWAY 401
CARRUTHERS CR. DRIVE OVERPASS
BOREHOLE LOCATIONS & SOIL STRATA

Golder Associates
Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN

- LEGEND**
- Borehole
 - Seal
 - Piezometer
 - N Standard Penetration Test value
 - 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
 - 100% Rock Quality Designation (RQD)
 - WL in piezometer on Oct. 19, 1999
 - WL during drilling

No.	ELEVATION	NORTHING	EASTING
G-13	98.32	4857263.0	343953.0
RW-4	94.66	4857115.0	344023.0
RW-5	94.57	4857127.0	344062.0
ST-1	96.95	4857159.5	343995.5
ST-2	96.74	4857171.5	344032.5
ST-3	97.22	4857177.0	343984.0
ST-4	97.40	4857138.2	344021.0
ST-5	97.81	4857194.1	343973.0
ST-6	97.54	4857206.0	344010.0

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

NO.	DATE	BY	REVISION

Geocres No.	
HWY. No. 401	PROJECT NO.: 991-1158
SUBM'D. AMP	CHKD: DATE: 1999 10 07
DRAWN: JFC	CHKD. AMP APPD. DWG. 2