



February 2010



## FOUNDATION INVESTIGATION AND DESIGN REPORT

DEEP CUT / HIGH FILL AREAS 1 TO 8  
HIGHWAY 404 EXTENSION FROM QUEENSVILLE  
SIDEROAD TO RAVENSHOE ROAD  
TOWN OF EAST GWILLIMBURY  
MINISTRY OF TRANSPORTATION, ONTARIO  
W.P. 2005-07-00

**Submitted to:**  
AECOM  
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REPORT



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## Table of Contents

### **PART A - FOUNDATION INVESTIGATION REPORT**

<b>1.0 INTRODUCTION.....</b>	<b>1</b>
<b>2.0 SITE DESCRIPTION.....</b>	<b>1</b>
<b>3.0 INVESTIGATION PROCEDURES .....</b>	<b>1</b>
<b>4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS .....</b>	<b>3</b>
4.1 Regional Geology .....	3
4.2 Subsoil Conditions.....	3
4.2.1 HIGHWAY 404 STA. 33+900 TO STA. 34+160 (HIGH FILL AREA 1).....	4
4.2.1.1 Topsoil, Organic Silt with Clay, Clayey Silt with Organics.....	4
4.2.1.2 Clayey Silt (Upper Stratum) .....	4
4.2.1.3 Silty Sand .....	4
4.2.1.4 Clayey Silt Till .....	5
4.2.1.5 Sand and Gravel.....	5
4.2.1.6 Clayey Silt (Lower Stratum) .....	5
4.2.1.7 Silty Sand to Sand and Silt .....	6
4.2.1.8 Groundwater Conditions .....	6
4.2.2 HIGHWAY 404 – STA. 34+360 TO STA. 34+600 (DEEP CUT AREA 2).....	7
4.2.2.1 Topsoil.....	7
4.2.2.2 Clayey Silt Fill .....	7
4.2.2.3 Clayey Silt Till .....	7
4.2.2.4 Silty Sand to Sand and Silt Till.....	8
4.2.2.5 Silty Sand to Sand .....	8
4.2.2.6 Clayey Silt.....	8
4.2.2.7 Groundwater Conditions .....	9
4.2.3 HIGHWAY 404 – STA. 34+780 TO STA. 34+880 (DEEP CUT AREA 3).....	9
4.2.3.1 Topsoil.....	10
4.2.3.2 Fill.....	10
4.2.3.3 Silty Sand .....	10



## FOUNDATION INVESTIGATION AND DESIGN

### DEEP CUT / HIGH FILL AREAS 1 TO 8, W.P. 2005-07-00

4.2.3.4	Clayey Silt.....	10
4.2.3.5	Sandy Silt Till.....	10
4.2.3.6	Clayey Silt.....	11
4.2.3.7	Groundwater Conditions .....	11
4.2.4	HIGHWAY 404 – STA. 35+000 TO STA. 35+150 (HIGH FILL AREA 4).....	12
4.2.4.1	Topsoil / Reworked Clayey Silt containing Organics.....	12
4.2.4.2	Clayey Silt to Silty Clay .....	12
4.2.4.3	Sandy Silt to Sand and Silt Till.....	13
4.2.4.4	Clayey Silt.....	13
4.2.4.5	Groundwater Conditions .....	14
4.2.5	HIGHWAY 404 – STA. 35+750 TO STA. 35+900 (DEEP CUT AREA 5).....	14
4.2.5.1	Topsoil, Clayey Silt with Organics.....	14
4.2.5.2	Sandy Silt with Organics.....	14
4.2.5.3	Sand and Silt .....	15
4.2.5.4	Sand and Silt Till.....	15
4.2.5.5	Clayey Silt Till .....	15
4.2.5.6	Clayey Silt.....	16
4.2.5.7	Groundwater Conditions .....	16
4.2.6	HIGHWAY 404 – STA. 36+870 TO STA. 37+150 (HIGH FILL AREA 6).....	17
4.2.6.1	Topsoil.....	17
4.2.6.2	Clayey Silt.....	17
4.2.6.3	Sandy Silt .....	18
4.2.6.4	Sand and Silt Till.....	18
4.2.6.5	Silty Sand to Sand .....	19
4.2.6.6	Silt.....	19
4.2.6.7	Clayey Silt Till .....	19
4.2.6.8	Groundwater Conditions .....	19
4.2.7	HIGHWAY 404 – STA. 37+400 TO STA. 37+760 (DEEP CUT AREA 7).....	20
4.2.7.1	Topsoil.....	20
4.2.7.2	Sand and Gravel.....	20



## FOUNDATION INVESTIGATION AND DESIGN DEEP CUT / HIGH FILL AREAS 1 TO 8, W.P. 2005-07-00

4.2.7.3	Silty Sand Till to Sand and Silt Till .....	21
4.2.7.4	Clayey Silt Till .....	21
4.2.7.5	Clayey Silt.....	21
4.2.7.6	Groundwater Conditions .....	22
4.2.8	HIGHWAY 404 – STA. 38+200 TO STA. 38+500 (HIGH FILL AREA 8) .....	22
4.2.8.1	Topsoil .....	23
4.2.8.2	Clayey Silt.....	23
4.2.8.3	Silty Clay.....	23
4.2.8.4	Silt.....	24
4.2.8.5	Sandy Silt to Sand and Silt Till.....	24
4.2.8.6	Clayey Silt Till .....	24
4.2.8.7	Groundwater Conditions .....	25
<b>5.0</b>	<b>CLOSURE.....</b>	<b>25</b>
<b>PART B - FOUNDATION DESIGN REPORT</b>		
<b>6.0</b>	<b>DISCUSSION AND ENGINEERING RECOMMENDATIONS.....</b>	<b>26</b>
6.1	General.....	26
6.2	High Fill Embankments.....	26
6.2.1	Embankment Fill Types and Benching Requirements .....	26
6.2.2	Stability .....	27
6.2.2.1	Methodology .....	27
6.2.2.2	Parameter Selection .....	27
6.2.2.3	Results of Analyses .....	28
6.2.3	Settlement.....	28
6.2.3.1	Methodology .....	28
6.2.3.2	Parameter Selection .....	29
6.2.3.3	Results of Analyses .....	30
6.2.3.4	Settlement of New Embankment Fill.....	30
6.2.4	Subgrade Preparation and Embankment Construction .....	30
6.2.4.1	Removal of Organics / Fills.....	30
6.2.4.2	Embankment Fill Placement .....	31



## FOUNDATION INVESTIGATION AND DESIGN

### DEEP CUT / HIGH FILL AREAS 1 TO 8, W.P. 2005-07-00

6.2.4.3	Control of Groundwater and Surface Water.....	31
6.3	Deep Cuts.....	31
6.3.1	Stability .....	32
6.3.1.1	Methodology .....	32
6.3.1.2	Parameter Selection .....	32
6.3.1.3	Results of Analyses .....	33
6.3.2	Design and Construction Considerations .....	33
6.3.2.1	Excavation .....	33
6.3.2.2	Obstructions (Cobbles and Boulders) .....	34
6.3.2.3	Control of Groundwater and Surface Water.....	34
7.0	CLOSURE.....	35

## REFERENCES

## LIST OF SYMBOLS AND ABBREVIATIONS

## LIST OF TABLES

Table 1 – Summary of High Fill Foundation Recommendations

Table 2 – Summary of Deep Cut Foundation Recommendations

## LIST OF DRAWINGS

Drawing 1 – Highway 404 Extension Deep Cut and High Fill Areas 1 to 8 – Index Plan

Drawing 2 – Borehole Location and Soil Strata – STA. 33+900 to STA.34+160 (Area 1)

Drawing 3 – Borehole Location and Soil Strata – STA. 34+360 to STA. 34+600 (Area 2)

Drawing 4 – Borehole Location and Soil Strata – STA. 34+780 to STA. 35+150 (Areas 3 and 4)

Drawing 5 – Borehole Location and Soil Strata – STA. 35+750 to STA. 35+900 (Area 5)

Drawing 6 – Borehole Location and Soil Strata – STA. 36+870 to STA. 37+150 (Area 6)

Drawing 7 – Borehole Location and Soil Strata – STA. 37+400 to STA. 37+760 (Area 7)

Drawing 8 – Borehole Location and Soil Strata – STA. 38+200 to STA. 38+500 (Area 8)

## LIST OF FIGURES

Figure 1 – Static Global Stability Analysis Results – High Fill Area 6

Figure 2 – Static Global Stability Analysis Results – High Fill Area 8

Figure 3 – Static Global Stability Analysis Results – Deep Cut Area 2

Figure 4 – Static Global Stability Analysis Results – Deep Cut Area 7



**LIST OF APPENDICES**

<b>APPENDIX A</b>	<b>Highway 404 – STA. 33+900 to STA. 34+160 (High Fill Area 1)</b>
	<b>Record of Boreholes and Laboratory Test Results</b>
Record of Boreholes	HD1-1 to HD1-3, C2-3 to C2-5
Figure A1	Plasticity Chart – Clayey Silt (Upper Stratum)
Figure A2	Grain Size Distribution – Clayey Silt Till
Figure A3	Plasticity Chart – Clayey Silt Till
Figure A4	Grain Size Distribution – Clayey Silt (Silty Clay Interlayer)
Figure A5	Plasticity Chart – Clayey Silt
Figure A6	Plasticity Chart – Clayey Silt (Silty Clay Interlayer)
Figure A7	Grain Size Distribution – Sand and Silt
<b>APPENDIX B</b>	<b>Highway 404 – STA. 34+360 to STA. 34+600 (Deep Cut Area 2)</b>
	<b>Record of Boreholes and Laboratory Test Results</b>
Record of Boreholes	HD2-1A/1B, HD2-2 to HD2-5
Figure B1	Grain Size Distribution – Clayey Silt Till
Figure B2	Plasticity Chart – Clayey Silt Till
Figure B3	Grain Size Distribution – Silty Sand Till to Sand and Silt Till
Figure B4	Grain Size Distribution – Clayey Silt
Figure B5	Plasticity Chart – Clayey Silt
<b>APPENDIX C</b>	<b>Highway 404 – STA. 34+780 to STA. 34+880 (Deep Cut Area 3)</b>
	<b>Record of Boreholes and Laboratory Test Results</b>
Record of Boreholes	HD3-1 to HD3-3
Figure C1	Grain Size Distribution – Sandy Silt Till
Figure C2	Grain Size Distribution – Sandy Silt Till (Clayey Silt Interlayer)
Figure C3	Grain Size Distribution – Clayey Silt
Figure C4	Plasticity Chart – Clayey Silt
<b>APPENDIX D</b>	<b>Highway 404 – STA. 35+000 to STA. 35+150 (High Fill Area 4)</b>
	<b>Record of Boreholes and Laboratory Test Results</b>
Record of Boreholes	HD4-1 to HD4-3
Figure D1	Grain Size Distribution – Silty Clay
Figure D2	Plasticity Chart – Silty Clay
Figure D3	Grain Size Distribution – Sandy Silt to Sand and Silt Till
Figure D4	Plasticity Chart – Sandy Silt Till (Clayey Silt Interlayer)
Figure D5	Grain Size Distribution – Clayey Silt
Figure D6	Plasticity Chart – Clayey Silt
<b>APPENDIX E</b>	<b>Highway 404 – STA. 35+750 to STA. 35+900 (Deep Cut Area 5)</b>
	<b>Record of Boreholes and Laboratory Test Results</b>
Record of Boreholes	HD5-1 to HD5-4
Figure E1	Grain Size Distribution – Sand and Silt



Figure E2	Grain Size Distribution – Sand and Silt Till
Figure E3	Grain Size Distribution – Clayey Silt Till
Figure E4	Plasticity Chart – Clayey Silt Till
Figure E5	Grain Size Distribution – Clayey Silt (Contains Silty Clay Interlayers)
Figure E6	Plasticity Chart – Clayey Silt

**APPENDIX F Highway 404 – STA. 36+870 to STA. 37+150 (High Fill Area 6)**

**Record of Boreholes and Laboratory Test Results**

Record of Boreholes	HD6-1 to HD6-6
Figure F1	Grain Size Distribution – Clayey Silt
Figure F2	Plasticity Chart – Clayey Silt
Figure F3	Plasticity Chart – Sandy Silt (Clayey Silt Interlayer)
Figure F4	Grain Size Distribution – Sand and Silt Till
Figure F5	Grain Size Distribution – Sand and Silt Till (Clayey Silt Interlayer)
Figure F6	Grain Size Distribution – Sand
Figure F7	Grain Size Distribution – Silt
Figure F8	Plasticity Chart – Clayey Silt Till

**APPENDIX G Highway 404 – STA. 37+400 to STA. 37+760 (Deep Cut Area 7)**

**Record of Boreholes and Laboratory Test Results**

Record of Boreholes	HD7-1 to HD7-8
Figure G1A	Grain Size Distribution – Silty Sand to Sand and Silt Till
Figure G1B	Grain Size Distribution – Silty Sand to Sand and Silt Till
Figure G2	Grain Size Distribution – Clayey Silt Till
Figure G3	Plasticity Chart – Clayey Silt Till
Figure G4	Grain Size Distribution – Clayey Silt

**APPENDIX H Highway 404 – STA. 38+200 to STA. 38+500 (High Fill Area 8)**

**Record of Boreholes and Laboratory Test Results**

Record of Boreholes	HD8-1 to HD8-7
Figure H1	Plasticity Chart – Clayey Silt (Contains Sand Interlayers)
Figure H2	Grain Size Distribution – Silty Clay
Figure H3	Plasticity Chart – Silty Clay
Figure H4	Grain Size Distribution – Silt
Figure H5	Grain Size Distribution – Sandy Silt Till
Figure H6	Plasticity Chart – Clayey Silt Till

**APPENDIX I NON-STANDARD SPECIAL PROVISIONS**

Subgrade Inspection At High Fill Embankments – Item No.  
Dewatering at Deep Cut / High Fill Areas – Item No.  
Obstructions – Item No.



# **PART A**

**FOUNDATION INVESTIGATION REPORT  
DEEP CUT / HIGH FILL AREAS 1 TO 8  
HIGHWAY 404 EXTENSION FROM QUEENSVILLE SIDEROAD TO  
RAVENSHOE ROAD  
TOWN OF EAST GWILLIMBURY  
MINISTRY OF TRANSPORTATION, ONTARIO  
W.P. 2005-07-00**





## **1.0 INTRODUCTION**

Golder Associates Ltd. (Golder) has been retained by AECOM on behalf of Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the detail design of eight (8) deep cut / high fill areas as part of the Highway 404 Extension project in East Gwillimbury, Ontario.

The terms of reference and scope of work are outlined in MTO's Request for Proposal, dated January 2008. Golder's proposal for foundation engineering services associated with the proposed deep cut / high fill areas is contained in Section 6.8 of AECOM's Technical Proposal for this assignment. The work was carried out in accordance with Golder's Supplementary Specialty Quality Control Plan for foundation engineering services for this project dated August 13, 2008.

## **2.0 SITE DESCRIPTION**

The proposed deep cut / high fill areas are located along the proposed Highway 404 extension alignment from Queensville Sideroad to Ravenshoe Road in the Town of East Gwillimbury in the Region of York. There are eight deep cut / high fill areas, designated as Areas 1 through 8 and in order of increasing chainage, along the proposed highway alignment corridor as shown on Drawing 1 following the text of this report.

The overall surface topography along the area of the proposed extension is generally flat-lying to gently sloping, with drumlins – elliptical “hills” formed by advancing glaciers during the last period of glaciation – present throughout. The Maskinonge River is located east of the proposed highway and generally runs parallel to the proposed highway alignment. The deep cut / high fill sections generally consist of open fields with localized areas of dense forest. A detailed description of each area is provided in Section 4.0.

## **3.0 INVESTIGATION PROCEDURES**

The fieldwork for the deep cut / high fill areas was carried out between February 18 and June 9, 2009, at which time forty-three boreholes were drilled at eight sites at the locations shown on Drawings 2 to 8 that follow the text of this report. The details of each investigated area are provided below:



## FOUNDATION INVESTIGATION AND DESIGN DEEP CUT / HIGH FILL AREAS 1 TO 8, W.P. 2005-07-00

Deep Cut / High Fill Area Designation	Reference Drawing	Station	Boreholes Advanced	Borehole Depth
1 (High Fill)	Dwg. 2	33+900 to 34+160	6 Boreholes (HD1-1 to HD1-3 and C2-3 to C2-5)	5.2 m to 9.8 m
2 (Deep Cut)	Dwg. 3	34+360 to 34+600	6 Boreholes (HD2-1A/1B, HD2-2 to HD2-5)	2.1 m - 6.7 m
3 (Deep Cut)	Dwg. 4	34+780 to 34+880	3 Boreholes (HD3-1 to HD3-3)	6.6 m - 6.7 m
4 (High Fill)	Dwg. 4	35+000 to 35+150	3 Boreholes (HD4-1 to HD 4-3)	5.0 m to 8.2 m
5 (Deep Cut)	Dwg. 5	35+750 to 35+900	4 Boreholes (HD5-1 to HD5-4)	5.2 m to 9.8 m
6 (High Fill)	Dwg. 6	36+870 to 37+150	6 Boreholes (HD6-1 to HD6-6)	4.2 m to 6.7 m
7 (Deep Cut)	Dwg. 7	37+400 to 37+760	8 Boreholes (HD7-1 to HD7-8)	6.6 m to 9.8 m
8 (High Fill)	Dwg. 8	38+200 to 38+500	7 Boreholes (HD8-1 to HD8-7)	1.5 m to 6.7 m

The field investigation was carried out using a track-mounted drill rig supplied and operated by Walker Drilling Ltd. of Utopia, Ontario. The boreholes were advanced using 108 mm outside diameter solid stem augers except Borehole HD8-3 which was drilled using a hand auger due to access restrictions. Soil samples were obtained at 0.75 m and 1.5 m intervals of depth using 50 mm outside diameter split-spoon samplers driven by automatic and manual cat-head hammers in accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586). Select samples of the cohesive soils were obtained using a 76 mm O.D. thin walled Shelby tube. Field vane shear tests were conducted in cohesive soils for determination of undrained shear strengths using a MTO standard 'N' size vane.

The groundwater conditions in the open boreholes were observed throughout the drilling operations and piezometers were installed in selected boreholes to monitor the groundwater level at each site. The piezometers consist of 50 mm diameter PVC pipe, with a slotted screen sealed at a select depth within the borehole. The boreholes and annulus surrounding the well pipe above the sand pack around the slotted screen were backfilled to the surface with bentonite pellets in accordance with Ontario Regulation (O.Reg.) 903 as amended by O.Reg. 372/07. The piezometer installation details and water level readings are described on the Record of Borehole sheets included in Appendices A to H that correspond to Areas 1 to 8, respectively.

The field work was supervised on a full-time basis by a member of Golder's engineering staff who arranged for service clearances, supervised the drilling, sampling and in-situ testing operations, logged the boreholes and examined and cared for the soil samples. The soil samples were identified in the field, placed in labelled containers and transported to Golder's laboratory in Mississauga for further examination and testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards as appropriate. Classification tests (water



content, Atterberg limits and grain size distribution) and organic content tests were carried out on select soil samples.

The borehole locations were surveyed in the field by J.D. Barnes Ltd. prior to drilling operations. The as-drilled borehole locations (referenced to MTM NAD83 coordinate system) and ground surface elevations (referenced to geodetic datum) are provided on the individual Record of Borehole sheets and on Drawings 2 to 8.

## **4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS**

### **4.1 Regional Geology**

The study area for this investigation lies within or near two physiographic regions, delineated in *The Physiography of Southern Ontario*<sup>1</sup> as:

- Simcoe Lowlands; and
- Peterborough Drumlin Field

The surficial soils in the Simcoe Lowlands, to the south and southeast of Lake Simcoe, consist of sands, silts and clays that were deposited within a former glacial lake. It is noted that several areas of drumlinized till break the continuity of the Simcoe Lowlands plain.

The surficial soils in the Peterborough Drumlin Field consist of sandy drumlinized till. Some of the drumlins in this area have shallow coverings of silt and fine sand of thickness between about 0.5 m and 2.5 m. "Wave-washed" drumlins, with exposed bouldery surfaces, are also present near the Simcoe Lowlands immediately south and east of Lake Simcoe. Localized deposits of silt, clay and peat are found in the low-lying areas between drumlins.

### **4.2 Subsoil Conditions**

The detailed subsurface soil and groundwater conditions encountered in the boreholes and the results of the in-situ and laboratory tests are given on the Record of Borehole sheets and laboratory test plots provided in Appendices A to H for Areas 1 to 8, respectively.

The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling, observations of drilling progress and the results of Standard Penetration Tests (SPTs). These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Subsoil conditions will vary between and beyond the borehole locations. The inferred soil stratigraphy based on the results of the boreholes is shown on Drawings 2 to 8 that follow the text of this report.

A detailed description of the site and subsurface conditions encountered in the boreholes advanced at each Deep Cut / High Fill Area is provided in the following sections.

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<sup>1</sup> Chapman, L.J and Putnam, D.F. 1984. *The Physiography of Southern Ontario, Third Edition*, Ontario Geological Survey Special Volume 2. Accompanied by Map P.2715, Scale 1:600,000.



#### **4.2.1 HIGHWAY 404 STA. 33+900 TO STA. 34+160 (HIGH FILL AREA 1)**

The proposed high fill area is located in a shallow easterly sloping valley that is currently grass covered. A tributary water course to the Maskinonge River flows from west to east at the bottom of the valley; at the time of the investigation, the valley floor was wet with localized areas of ponded and/or low flowing water. The existing ground surface at the crest of the valley is at about Elevation 256 m and the low point of the valley is at about Elevation 248 m.

In general, the subsoil conditions encountered at the site consist of a surficial layer of topsoil and organic silt or clay and clayey silt with organics, underlain by clayey silt and silty sand layers. The clayey silt and silty sand layers are underlain by a clayey silt till deposit. A clayey silt deposit containing silty clay interlayers was encountered below the clayey silt till and directly below the surficial organics at the low point of the valley. Interlayers of silty sand to sand and silt and sand and gravel were encountered throughout the clayey silt deposit.

##### **4.2.1.1 Topsoil, Organic Silt with Clay, Clayey Silt with Organics**

A surficial layer of topsoil and organic silt or clay and clayey silt with organics, was encountered in all boreholes (HD1-1 to HD1-3 and C2-3 to C2-5) in this area. The organic layer ranges from 0.7 m to 1.5 m thick with the exception of Borehole HD1-1, located near the crest of the valley, where the topsoil is 0.1 m thick. It should be noted that cobbles and boulders were observed at the ground surface throughout the site.

Standard Penetration Test (SPT) 'N' values measured within the organic layers range between 2 and 5 blows per 0.3 m of penetration, suggesting a very soft to firm consistency.

The measured water content on one sample of the organic silt with clay layer was 46 percent and two laboratory organic contents measured 6.3 percent and 7.3 percent.

##### **4.2.1.2 Clayey Silt (Upper Stratum)**

An upper stratum of clayey silt was encountered below the surficial clayey silt with organics layer in Borehole HD1-1. The top of this layer was encountered at a depth of 0.1 m below ground surface (Elevation 253.7 m) and is 1.4 m thick.

The measured SPT 'N' values within the upper stratum of clayey silt are 6 and 11 blows per 0.3 m of penetration, suggesting a firm to stiff consistency.

Atterberg limits testing carried out on one sample of the clayey silt stratum deposit measured a liquid limit of 22 percent, a plastic limit of 15 percent and corresponding plasticity index of 7 percent. The results of the Atterberg limits testing are shown on Figure A1 and indicate that the material is a clayey silt of low plasticity. The measured water content on a sample of the clayey silt is 20 percent.

##### **4.2.1.3 Silty Sand**

A deposit of silty sand was encountered below the topsoil and clayey silt with organics / organic silt with clay in Boreholes HD1-2 and HD1-3. The surface of the silty sand was encountered at depths of 0.8 m and 0.7 m below ground surface (Elevation 252.1 m to 250.4 m) and is 0.7 m and 0.8 m thick in Boreholes HD1-2 and HD1-3, respectively. Oxidation staining is present within this layer.



Two measured SPT 'N' values within the silty sand deposit are 8 blows per 0.3 m of penetration, indicating a loose relative density.

The measured water content on a sample of the silty sand is 12 percent.

#### **4.2.1.4 Clayey Silt Till**

A deposit of clayey silt till was encountered below the upper clayey silt layer in Borehole HD1-1 and below the topsoil / organic layers and silty sand layers in Boreholes C2-3, HD1-2 and HD1-3. The deposit typically contains trace to some sand and trace gravel. Oxidation staining is present within this deposit. The surface of the clayey silt till was encountered at a depth of 1.5 m below ground surface (Elevation 248.4 m to 252.3 m) and the deposit is 0.8 m to 7.2 m thick. Borehole HD1-1 was terminated within the clayey silt till deposit at a depth of 5.2 m below ground surface (Elevation 248.6 m).

The measured SPT 'N' values within the clayey silt till deposit typically range from 11 to 59 blows per 0.3 m of penetration, suggesting a stiff to hard consistency, although 'N' values of 5, 7, and 8 were measured within the upper metre of the deposit in Boreholes HD1-3, HD1-3 and C2-3. A field vane test performed within the inferred clayey silt till deposit in Borehole C2-3 exceeded the capacity of the measuring scales (i.e. undrained shear strength greater than 120 kPa) indicating a very stiff consistency.

The results of two grain size distribution tests performed on samples of the clayey silt till are shown on Figure A2.

Atterberg limits testing carried out on five samples of the clayey silt till deposit measured liquid limits ranging from 18 to 26 percent, plastic limits ranging from 12 to 17 percent, and plasticity indices ranging from 6 to 9 percent. The results of the Atterberg limits testing are shown on Figure A3 and indicate that the material is a clayey silt of low plasticity.

The measured water contents on samples of the clayey silt till range from 12 to 23 percent.

#### **4.2.1.5 Sand and Gravel**

A layer of sand and gravel, 1.1 m thick, was encountered directly below the clayey silt till in Borehole C2-3 at a depth of 2.3 m (corresponding to Elevation 247.6 m).

A measured SPT 'N' value within the sand and gravel is 27 blows per 0.15 m of penetration indicating a very dense relative density.

#### **4.2.1.6 Clayey Silt (Lower Stratum)**

A lower stratum of clayey silt was encountered below the clayey silt till in Boreholes HD1-2 and HD1-3, below the sand and gravel layer in Borehole C2-3 and below the clayey silt with organics / organic silt with clay in Boreholes C2-4 and C2-5. This stratum contains trace to some sand and interlayers of silty clay and silty sand to sand and silt. The surface of the clayey silt stratum was encountered at depths ranging from 0.9 m below ground surface at the bottom of the valley to 8.7 m below ground surface at the crest of the valley (Elevation 248.5 m to 242.4 m) and the stratum is 0.8 m to 8.9 m thick. Boreholes HD1-2, HD1-3 and C2-3 to C2-5 were terminated within this stratum at depths ranging from 5.2 m to 9.8 m below ground surface (Elevation 247.7 m to 239.3 m).



The measured SPT 'N' values within the lower stratum of clayey silt range from 13 blows per 0.3 m of penetration to 100 blows per 0.12 m of penetration, suggesting a stiff to hard consistency.

One grain size distribution test performed on a sample of the silty clay interlayer within the lower stratum of clayey silt is shown on Figure A4.

Atterberg limits tests carried out on four samples of the clayey silt deposit measured liquid limits ranging from 18 to 29 percent, plastic limits ranging from 15 to 19 percent and plasticity indices ranging from 3 to 11 percent. The results of the Atterberg limits tests are shown on Figure A5 and indicate that the material is typically a clayey silt of low plasticity and contains lenses of silt of slight plasticity. One Atterberg limits test carried out on a silty clay interlayer within the clayey silt measured a liquid limit of 37 percent, plastic limit of 17 percent and plasticity index of 20 percent. The results of the Atterberg limits test are shown on Figure A6 and indicate the interlayer is silty clay of medium plasticity.

The measured water content on samples of the lower stratum of clayey silt range from 18 to 28 percent.

#### **4.2.1.7 Silty Sand to Sand and Silt**

A layer of silty sand to sand and silt was encountered within the lower stratum of clayey silt in Boreholes C2-4 and C2-5. The top of the granular layer was encountered at a depth of 8.0 m and 7.2 m below ground surface, respectively in Boreholes C2-4 and C2-5 (corresponding to Elevation 241.3 m and 241.5 m) and is 1.1 m and

1.5 m thick. The silty sand layer in Borehole C2-4 contains cobbles and boulders as inferred from the grinding of the drill augers during advancement of the borehole.

Two SPT 'N' values measured within the silty sand to sand and silt layer are 66 and 103 blows per 0.3 m of penetration indicating a very dense relative density.

A grain size distribution test performed on a sample of the sand and silt is shown on Figure A7.

The measured water content on two samples of the granular layer is 12 and 17 percent.

#### **4.2.1.8 Groundwater Conditions**

Water levels were noted within the boreholes during and after the drilling operations. Piezometers were installed in Boreholes HD1-1, HD1-2, C2-3 and C2-4 to permit monitoring of the groundwater level. The piezometers installed in Boreholes HD1-1 and HD1-2 were sealed within the clayey silt till and clayey silt deposits and the piezometers installed in C2-3 and C2-4 were sealed within the sand and gravel layer and silty sand layer, respectively. Details of the piezometer installations are shown in the Record of Borehole sheets in Appendix A. The water levels recorded in the boreholes and piezometers are summarized below:



## FOUNDATION INVESTIGATION AND DESIGN DEEP CUT / HIGH FILL AREAS 1 TO 8, W.P. 2005-07-00

Borehole / Piezometer	Ground Surface Elevation (m)	Depth Below Ground Surface to Water Level (m)	Groundwater Level Elevation (m)	Date	Notes
HD1-1	253.8	1.0	252.8	June 12, 2009	Piezometer
HD1-2	252.9	1.1	251.8	June 12, 2009	Piezometer
HD1-3	251.1	0.9	250.2	Mar. 24, 2009	Open Borehole
C2-3	249.9	0.8	249.1	June 4, 2009	Open Borehole
C2-4	249.3	1.4	247.9	June 12, 2009	Piezometer
C2-5	248.7	0	248.7	June 3, 2009	Open Borehole

It should be noted that groundwater levels will fluctuate seasonally and are expected to rise during wet periods of the year.

### 4.2.2 HIGHWAY 404 – STA. 34+360 TO STA. 34+600 (DEEP CUT AREA 2)

The proposed deep cut area is located within an open field situated on the side of a hill that slopes downward from the west (Elevation 261 m) to the east (Elevation 254 m).

In general, the subsoil conditions encountered at the site consist of a surficial layer of topsoil, underlain by clayey silt till, underlain by a deposit of clayey silt. A deposit of sand and silt till was encountered between the clayey silt till and clayey silt deposit along the southern half of the deep cut area.

#### 4.2.2.1 Topsoil

Topsoil was encountered at the ground surface on all boreholes (designated HD2-1A, HD2-1B, HD2-2 to HD2-5) advanced at this location and ranges from 0.1 m to 0.3 m thick. Cobbles and boulders were observed at the ground surface throughout the site.

#### 4.2.2.2 Clayey Silt Fill

A layer of clayey silt fill containing organics / rootlets was encountered below the topsoil in Borehole HD2-1A, HD2-1B, HD2-4 and HD2-5. The surface of the fill was encountered at a depth of 0.3 m below ground surface (Elevation 254.0 m to 260.7 m) and the layer is 0.3 m thick.

The SPT 'N' values measured within the clayey silt fill layer ranged from 2 blows to 5 blows per 0.3 m of penetration, suggesting a very soft to firm consistency.

#### 4.2.2.3 Clayey Silt Till

A deposit of clayey silt till was encountered below the topsoil and clayey silt fill in Boreholes HD 2-1A/1B, HD2-3 and HD2-5 at depths ranging from 0.2 m to 0.6 m below ground surface (Elevation 257.7 m to 260.4 m) and is 1.3 m to 2.5 m thick. The deposit contains trace to some sand and trace gravel. Cobbles and boulders are anticipated to be present as inferred by the grinding of the augers as they advanced through this deposit.





The measured SPT 'N' values within the clayey silt till deposit range from 8 to 25 blows per 0.3 m of penetration, suggesting a firm to very stiff consistency. One SPT 'N' value of 60 blows per 0.3 m of penetration was measured in the lower portion of this deposit in Borehole HD2-1A suggesting a hard consistency.

The results of one grain size distribution test performed on a sample of the clayey silt till is shown on Figure B1.

Atterberg limits testing carried out on two samples of the clayey silt till deposit measured liquid limits of 19 and 24 percent, plastic limits of 12 and 13 percent, and a corresponding plasticity index of 6 and 11 percent. The results of the Atterberg limits testing are shown on Figure B2 and indicate that the material is a clayey silt of low plasticity.

The measured water content of two samples of the clayey silt till are 11 percent and 15 percent and are typically near the plastic limit.

#### **4.2.2.4 Silty Sand to Sand and Silt Till**

A deposit of silty sand to sand and silt till was encountered below the clayey silt till and topsoil in Boreholes HD2-1A and HD2-2. This deposit contains trace to some clay and gravel and oxidation staining is present on the surface of the fractures in this layer. Cobbles and boulders were inferred to be present throughout this stratum as indicated by the grinding of augers as they advanced through this deposit. The surface of this deposit was encountered at a depth of 3.1 m below ground surface (Elevation 258.0 m) and 0.1 m below ground surface (Elevation 259.6 m) and is 3.0 m and 4.5 m thick in Boreholes HD2-1A and HD2-2, respectively.

The measured SPT 'N' values recorded within the silty sand to sand and silt till deposit range from 12 to 102 blows per 0.3 m of penetration, indicating a compact to very dense relative density.

The results of two grain size distribution tests performed on samples of the silty sand to sand and silt till are shown on Figure B3.

The measured water content on samples of the silty sand to sand and silt till range from 8 percent to 12 percent.

#### **4.2.2.5 Silty Sand to Sand**

A layer of silty sand to sand was encountered below the clayey silt till in Borehole HD2-3 and below the sand and silt till in Borehole HD2-1A at a depth of 1.5 m below ground surface (Elevation 257.1 m) and 6.1 m below ground surface (Elevation 254.9 m), respectively. The silty sand layer is 0.8 m thick in Borehole HD2-3 and Borehole HD2-1A penetrated 0.6 m into the sand layer and was terminated at a depth of 6.7 m below ground surface (Elevation 254.3 m).

#### **4.2.2.6 Clayey Silt**

A deposit of clayey silt was encountered below the silty sand to sand and silt till, silty sand and clayey silt till in all boreholes except Borehole HD2-1A and HD2-1B. The clayey silt deposit typically contains trace sand and gravel and interlayers of silty clay and sand seams. The top of the clayey silt deposit was encountered at depths ranging from 2.3 m to 4.6 m below ground surface (Elevation 255.3 m to 251.9 m). The boreholes (HD2-2 to HD2-5) penetrated 2.0 m to 6.1 m into the clayey silt layer and were terminated at depths ranging from 6.6 m to 6.7 m below ground surface (Elevation 253.2 m to 247.6 m).





The results of two grain size distribution tests performed on samples of the clayey silt deposit are shown on Figure B4.

Atterberg limits testing carried out on three samples of the clayey silt measured liquid limits ranging from 27 to 34 percent, plastic limits ranging from 18 to 19 percent and plasticity indices ranging from 9 to 17 percent. The results of the Atterberg limits testing are shown on Figure B5 and indicate that the material is a clayey silt of low plasticity.

The measured water content on ten samples of the clayey silt deposit ranges from 10 to 27 percent.

#### **4.2.2.7 Groundwater Conditions**

Water levels were noted within the open boreholes during and upon completion of drilling operations. Piezometers were installed in Boreholes HD2-1A, HD2-1B and HD2-4 to permit monitoring of the groundwater level. The piezometer installed in Borehole HD2-1A was sealed within the sand layer and sand and silt deposit and the piezometer installed in HD2-1B was sealed within the overlying clayey silt till deposit. The piezometer installed in Borehole HD2-4 was sealed within the clayey silt deposit. Details of the piezometer installations are shown in the Record of Borehole sheets in Appendix B. The water levels recorded in the boreholes and piezometers are summarized below:

<b>Borehole / Piezometer</b>	<b>Ground Surface Elevation (m)</b>	<b>Depth Below Ground Surface to Water Level (m)</b>	<b>Groundwater Level Elevation (m)</b>	<b>Date</b>	<b>Notes</b>
HD2-1A	261.0	0.8 1.8	260.2 259.2	Apr. 2, 2009 June 12, 2009	Piezometer
HD2-1B	261.0	0.7 1.3	260.3 259.7	Apr. 2, 2009 June 12, 2009	Piezometer
HD2-2	259.7	0.9	258.8	Mar. 20, 2009	Open Borehole
HD2-3	258.6	3.1	255.5	Mar. 20, 2009	Open Borehole
HD2-4	254.3	0.2	254.1	Apr. 2, 2009	Piezometer
HD2-5	258.3	4.3	254.0	Mar. 23, 2009	Open Borehole

It should be noted that groundwater levels will fluctuate seasonally and are expected to rise during wet periods of the year.

#### **4.2.3 HIGHWAY 404 – STA. 34+780 TO STA. 34+880 (DEEP CUT AREA 3)**

The proposed deep cut area extends through an existing hydro corridor easement, along an existing residential property with associated gravel driveway / paths throughout the property. The existing ground surface is generally flat and ranges from about Elevation 256 m to 257 m.

In general, the subsoil conditions encountered at the site consist of a surficial layer of topsoil, underlain by layers of silty sand and clayey silt which resembles fill or re-worked soil at two of three borehole locations where



encountered. Underlying the silty sand, clayey silt, and fill layers, a deposit of sand and silt till was encountered, underlain by a clayey silt deposit to the bottom of the boreholes.

#### **4.2.3.1     *Topsoil***

Topsoil was encountered at the ground surface in all boreholes (HD3-1 to HD3-3) advanced in this area and cobbles and boulders were observed at the ground surface scattered throughout the site. The topsoil is 0.3 m to 0.4 m thick.

#### **4.2.3.2     *Fill***

Silty sand fill was encountered below the topsoil in Borehole HD3-1 at a depth of 0.3 m below ground surface (Elevation 256.4 m) and the fill layer is 0.5 m thick. Clayey silt fill was encountered in Borehole HD3-2 at a depth of 0.4 m below ground surface (Elevation 254.9 m) and the fill layer is 0.4 m thick. The fill typically contains organics and rootlets.

A measured SPT 'N' value within the silty sand fill is 7 blows per 0.3 m of penetration, indicating a loose relative density. A measured SPT 'N' value within the clayey silt fill is 3 blows per 0.3 m of penetration, suggesting a soft consistency.

#### **4.2.3.3     *Silty Sand***

A layer of silty sand was encountered below the topsoil in Borehole HD3-3 at a depth of 0.3 m below ground surface (Elevation 255.9 m) and is 1.2 m thick. This layer contains trace clay and trace gravel.

Two measured SPT 'N' values recorded within the silty sand layer are 6 and 13 blows per 0.3 m of penetration, indicating a loose to compact relative density. It is noted that the 'N' value of 6 was partially driven through the overlying topsoil layer.

The measured water content taken on a sample of the silty sand is 12 percent.

#### **4.2.3.4     *Clayey Silt***

An upper layer of clayey silt, trace sand, was encountered below the silty sand layer in Borehole HD3-3. The layer contains trace sand. The surface of the clayey silt layer was encountered at a depth of 1.5 m below ground surface (Elevation 254.7 m) and the layer is 0.8 m thick.

One measured SPT 'N' value within the clayey silt layer is 17 blows per 0.3 m of penetration, suggesting a very stiff consistency.

#### **4.2.3.5     *Sandy Silt Till***

A deposit of sandy silt till was encountered below the fill and clayey silt layers in all Boreholes (HD3-1 to HD3-3) advanced in this proposed deep cut area. Rootlets were present in the upper 0.6 m of this layer in Borehole HD3-1 and the deposit typically contains trace clay and gravel and interlayers of clayey silt. Oxidation staining is present on the surface of the fractures throughout the layer. Cobbles and boulders are inferred to be present as indicated by the grinding of augers as they advanced through this deposit. The surface of this deposit was encountered at a depth of 0.8 m below ground surface (Elevation 255.9 m in Borehole HD3-1 and Elevation 254.5 m in Borehole HD3-2) and is 3.8 m thick in both boreholes. The surface of the sandy silt till was



encountered below the clayey silt layer in Borehole HD3-3 at a depth of 2.3 m (Elevation 253.9 m) and was 3.2 m thick.

The measured SPT 'N' values within the sandy silt till layer range from 17 blows per 0.3 m of penetration to 84 blows per 0.15 m of penetration, indicating a compact to very dense relative density.

The results of three grain size distribution tests performed on samples of the sandy silt till are shown on Figure C1. One grain size distribution test performed on a sample of a clayey silt interlayer within the sandy silt till deposit is shown on Figure C2.

The measured water contents taken on samples of the sandy silt till ranged from 11 to 19 percent.

#### **4.2.3.6 Clayey Silt**

A lower deposit of clayey silt containing some sand and interlayers of silty clay was encountered below the sandy silt till in all boreholes advanced in this area. The surface of the clayey silt deposit was encountered at depths ranging from 4.6 m to 5.5 m below ground surface (Elevation 252.1 m to 250.7 m). Boreholes HD3-1 to HD3-3 penetrated 1.2 m to 2.1 m into this layer and were terminated at depths ranging from 6.6 m to 6.7 m below ground surface (Elevation 250.2 m to Elevation 248.6 m).

The measured SPT 'N' values within the clayey silt deposit range from 66 to 186 blows per 0.3 m of penetration, suggesting a hard consistency.

The result of one grain size distribution test performed on a sample of the clayey silt deposit is shown on Figure C3.

An Atterberg limits test carried out on a sample of the clayey silt deposit measured a liquid limit of 31 percent, a plastic limit of 16 percent and a plasticity index of 15 percent. The results of the Atterberg limits testing are shown on Figure C4 and indicate that the material is a clayey silt of low plasticity.

The measured water content on three samples of the clayey silt deposit range from 12 to 20 percent.

#### **4.2.3.7 Groundwater Conditions**

Water levels were noted within the open boreholes during and upon completion of drilling operations. A piezometer was installed (sealed) within the clayey silt deposit in Borehole HD3-1 to permit monitoring of the groundwater level. Details of the piezometer installation are shown in the Record of Borehole sheets in Appendix C. The water levels recorded in the boreholes and piezometer are summarized below:



## FOUNDATION INVESTIGATION AND DESIGN

### DEEP CUT / HIGH FILL AREAS 1 TO 8, W.P. 2005-07-00

Borehole / Piezometer	Ground Surface Elevation (m)	Depth Below Ground Surface to Water Level (m)	Groundwater Level Elevation (m)	Date	Notes
HD3-1	256.7	0.8 1.0	255.9 255.7	Apr. 2, 2009 June 12, 2009	Piezometer
HD3-2	255.3	0.9	254.4	Mar. 24, 2009	Open Borehole
HD3-3	256.2	0.6	255.6	Mar. 24, 2009	Open Borehole

It should be noted that groundwater levels will fluctuate seasonally and are expected to rise during wet periods of the year.

#### 4.2.4 HIGHWAY 404 – STA. 35+000 TO STA. 35+150 (HIGH FILL AREA 4)

The proposed high fill area extends along predominantly flat-lying fields and localized areas of dense trees along existing property lines. Holborn Road currently passes through this area in an east-west direction. The existing ground surface ranges from about Elevation 251 m at the south limit of the proposed high fill area to about Elevation 249 m at the north limit of the area.

In general, the subsoil conditions encountered at the site consist of a surficial layer of topsoil, underlain by an upper layer of clayey silt to silty clay. The clayey silt to silty clay layer is underlain by a deposit of silty sand till to sand and silt till which is underlain by a lower deposit of clayey silt.

##### 4.2.4.1 Topsoil / Reworked Clayey Silt containing Organics

A 0.3 m to 0.6 m thick layer of topsoil was encountered in Boreholes HD4-1 to HD4-3. In Borehole HD4-2 which was drilled in a farmer's field, the surficial topsoil transitioned to a reworked clayey silt containing organics.

The measured SPT 'N' values within the topsoil / reworked clayey silt ranges from 3 to 8 blows per 0.3 m of penetration, suggesting a soft to firm consistency.

##### 4.2.4.2 Clayey Silt to Silty Clay

A layer of clayey silt to silty clay was encountered below the topsoil in Boreholes HD4-1 and HD4-3 and below the reworked clayey silt containing organics in Borehole HD4-2. This layer typically contains trace to some sand, trace gravel, trace organics and rootlets. The surface of the clayey silt to silty clay layer was encountered at depths ranging from 0.3 m to 0.6 m below ground surface (Elevation 250.4 m to 248.7 m) and is 0.5 m to 1.0 m thick.

The measured SPT 'N' values within the upper clayey silt to silty clay layer ranged from 4 to 9 blows per 0.3 m of penetration, suggesting at firm to stiff consistency.

The result of one grain size distribution test performed on a sample of the silty clay from Borehole HD4-3 is shown on Figure D1.



An Atterberg limits test carried out on a sample of the silty clay measured a liquid limit of 38 percent, a plastic limit of 19 percent and a plasticity index of 19 percent. The results of the Atterberg limits testing are shown on Figure D2 and indicate that the material is a silty clay of medium plasticity.

The measured water content of three samples of the clayey silt to silty clay ranges from 16 to 37 percent.

#### **4.2.4.3 Sandy Silt to Sand and Silt Till**

A deposit of sandy silt to sand and silt till was encountered below the clayey silt to silty clay stratum in Borehole HD4-1 to HD4-3. This deposit typically contains trace to some clay and gravel and clayey silt interlayers. Oxidation staining is present in this deposit. Cobbles and boulders were also inferred to be present within this deposit as indicated by the grinding of augers as they advanced through the deposit. The surface of this deposit was encountered at depths ranging from 0.8 m to 1.5 m below ground surface (Elevation 249.5 m to 248.2 m) and the deposit is 0.8 m to 3.5 m thick. A 0.5 m thick layer of silty sand was encountered within the sand and silt till deposit in Borehole HD4-2 at a depth of 3.1 m below ground surface (Elevation 245.9 m). Borehole HD 4-3 penetrated 3.5 m into the sand and silt till deposit and was terminated at a depth of 5.0 m (Elevation 245.5 m).

The measured SPT 'N' values within the sandy silt to sand and silt till layer range from 5 blows per 0.3 m of penetration to 98 blows per 0.25 m of penetration, indicating a loose to very dense relative density.

The results of three grain size distribution tests performed on samples of the sandy silt to sand and silt till deposit are shown on Figure D3.

An Atterberg limits test carried out on a sample of a clayey silt interlayer within the silty sand to sand and silt till deposit measured a liquid limit of 17 percent, a plastic limit of 12 percent and a plasticity index of 6 percent. The results of the Atterberg limits testing are shown on Figure D4 and indicate that the interlayer is a clayey silt of low plasticity.

The measured water content of five samples of the sandy silt to sand and silt till deposit ranges from 10 to 16 percent.

#### **4.2.4.4 Clayey Silt**

A deposit of clayey silt was encountered below the sandy silt to sand and silt till in Boreholes HD4-1 and HD4-2. This deposit typically contains trace to some sand and seams of silty clay and oxidation staining is present in this layer. The surface of this layer was encountered at depths of 2.3 m and 4.1 m below ground surface (Elevation 248.7 m and 244.9 m) in Boreholes HD4-1 and HD4-2, respectively, and the boreholes penetrated 5.9 m and 1.1 m into the clayey silt deposit and were terminated within this deposit at depths of 8.2 m and 5.2 m below ground surface (Elevation 242.8 m and 243.8 m), respectively.

The measured SPT 'N' values within the clayey silt deposit range from 16 blows per 0.3 m of penetration to 100 blows per 0.15 m of penetration, suggesting a very stiff to hard consistency.

The results of two grain size distribution tests performed on samples of the clayey silt are shown on Figure D5.

An Atterberg limits test carried out on a sample of the clayey silt measured a liquid limit of 21 percent, a plastic limit of 12 percent and a plasticity index of 9 percent. The results of the Atterberg limits testing are shown on Figure D6 and indicate that the material is a clayey silt of low plasticity.



The measured water contents taken on four samples of the clayey silt ranged from 11 to 20 percent.

#### **4.2.4.5 Groundwater Conditions**

Water levels were noted in the open boreholes during and upon completion of drilling operations. A piezometer was installed (sealed) within the sand and silt till deposit in Borehole HD4-3 to permit monitoring of the groundwater level. Details of the piezometer installation are shown in the Record of Borehole sheets in Appendix D. The water levels recorded in the boreholes and piezometers are summarized below:

<b>Borehole / Piezometer</b>	<b>Ground Surface Elevation (m)</b>	<b>Depth Below Ground Surface to Water Level (m)</b>	<b>Groundwater Level Elevation (m)</b>	<b>Date</b>	<b>Notes</b>
HD4-1	251.0	1.2	249.8	Mar. 25, 2009	Open Borehole
HD4-2	249.0	5.2	243.8	June 8, 2009	Open Borehole
		1.4	247.6	June 9, 2009	Open Borehole
HD4-3	250.5	0.3	250.2	Apr 2, 2009	Piezometer
		1.2	249.3	May 20, 2009	
		1.8	248.7	June 12, 2009	

It should be noted that groundwater levels will fluctuate seasonally and are expected to rise during wet periods of the year.

#### **4.2.5 HIGHWAY 404 – STA. 35+750 TO STA. 35+900 (DEEP CUT AREA 5)**

The proposed deep cut area extends through the top of a local hill located within predominantly open fields with a forested area at the northern part of the site. The ground surface along the proposed cut ranges from about Elevation 249 m to 245 m at the end points of the cut to about Elevation 253 m at the top of the hill.

In general, the subsoil conditions consist of a surficial layer of topsoil and / or clayey silt to sandy silt with organics, underlain by deposits of sand and silt, sand and silt till and clayey silt till. The till deposits are underlain by a clayey silt deposit.

##### **4.2.5.1 Topsoil, Clayey Silt with Organics**

A 0.1 m to 0.3 m thick layer of topsoil was encountered in Boreholes HD5-2, HD5-3 and HD5-4. Borehole HD5-1 was drilled in a farm field which was recently tilled and the surficial soil consists of clayey silt with organics (reworked) to a depth of about 0.6 m. It should be noted that cobbles and boulders were observed at the ground surface throughout the site.

One measured SPT 'N' value within the layer of reworked clayey silt with organics is 4 blows per 0.3 m of penetration, suggesting a soft consistency.

##### **4.2.5.2 Sandy Silt with Organics**

A layer of sandy silt with organics and containing rootlets was encountered below the topsoil in Borehole HD5-2 and HD5-3. The sandy layer was encountered at a depth of 0.1 m (Elevation 252.0 m) and 0.3 m (Elevation 251.2 m) and is 0.7 m and 0.5 m thick in Boreholes HD5-2 and HD5-3, respectively.



Two measured SPT 'N' values within the sandy silt with organics layer were 4 and 5 blows per 0.3 m of penetration, indicating a loose relative density.

#### **4.2.5.3 Sand and Silt**

A layer of sand and silt, trace clay was encountered below the layer of sandy silt with organics in Borehole HD5-2. The surface of the sand and silt layer was encountered at a depth of 0.8 m below ground surface (Elevation 251.3 m) and the layer is 1.5 m thick.

Two measured SPT 'N' values within the sand and silt layer are 15 and 29 blows per 0.3 m of penetration, indicating a compact relative density.

The results of one grain size distribution test performed on a sample of the sand and silt are shown on Figure E1.

The measured water content taken on a sample of the sand and silt is 17 percent.

#### **4.2.5.4 Sand and Silt Till**

A deposit of sand and silt till was encountered below the layer of clayey silt with organics in Borehole HD5-1. The sand and silt till contains trace to some clay, some gravel and oxidation staining is present in this layer. Cobbles and boulders are inferred to be present within this deposit as indicated by the grinding of augers as they advanced through the deposit. The surface of the deposit was encountered at a depth of 0.6 m below ground surface (Elevation 248.8 m) and the deposit is 0.9 m thick.

One measured SPT 'N' value within the sand and silt till is 13 blows per 0.3 m of penetration, indicating a compact relative density.

The results of one grain size distribution test performed on a sample of the sand and silt till are shown on Figure E2.

The measured water content taken on a sample of the sand and silt till is 11 percent.

#### **4.2.5.5 Clayey Silt Till**

A deposit of clayey silt till was encountered below the layer of sandy silt with organics in Borehole HD5-3 and below the topsoil in Borehole HD5-4. The clayey silt till deposit contains some sand, trace to some gravel and oxidation staining is present on the surface of fractures. Cobbles and boulders were inferred to be present within this deposit as indicated by the grinding of augers and refusal to advance most of the SPT split-spoon in Borehole HD5-3. The top of the clayey silt till deposit was encountered at a depth of 0.8 m and 0.2 m below ground surface (Elevation 250.7 m and Elevation 248.7 m) and is 4.1 m and 2.1 m thick in Boreholes HD5-3 and HD5-4, respectively.

The measured SPT 'N' values within the clayey silt till generally range from 19 blows per 0.3 m of penetration to 86 blows per 0.17 m of penetration, suggesting a very stiff to hard consistency. One 'N' value of 3 was measured within the upper 0.4 m of the deposit.

The result of one grain size distribution test performed on a sample of the clayey silt till is shown on Figure E3.





Atterberg limits testing carried out on two samples of the clayey silt till measured liquid limits of 17 and 18 percent, plastic limits of 12 percent and plasticity indices of 5 and 7 percent. The results of the Atterberg limits testing are shown on Figure E4 and indicate that the material is a clayey silt of low plasticity.

The measured water content on five samples of the clayey silt till ranges from 9 to 16 percent.

#### **4.2.5.6 Clayey Silt**

A deposit of clayey silt was encountered below the sand and silt till in Borehole HD5-1, below the sand and silt layer in Borehole HD5-2 and below the clayey silt till deposit in Boreholes HD5-3 and HD5-4. The clayey silt deposit typically contains trace to some sand and interlayers of silty clay and sand seams. The top of the clayey silt deposit was encountered at depths ranging from 1.5 m to 4.9 m below ground surface (Elevation 249.8 m and 246.6 m). Boreholes HD5-1 to HD5-4 penetrated 2.9 m to 5.9 m into the clayey silt deposit and were terminated at depths ranging from 5.2 m to 9.8 m below ground surface (Elevation 244.2 m to 241.8 m).

The measured SPT 'N' values within this deposit range from 24 to 106 blows per 0.3 m of penetration, suggesting a very stiff to hard consistency.

The result of one grain size distribution test performed on a sample of the clayey silt containing a silty clay interlayer is shown on Figure E5.

Atterberg limits testing carried out on four samples of the clayey silt measured liquid limits ranging from 29 to 36 percent, plastic limits ranging from 14 to 18 percent and plasticity indices ranging from 15 to 18 percent. The results of the Atterberg limits testing are shown on Figure E6 and indicate that the material is clayey silt with low to medium plasticity.

The measured water content of ten samples of the clayey silt ranges from 17 to 24 percent.

#### **4.2.5.7 Groundwater Conditions**

Water levels were noted within the boreholes generally during and upon completion of drilling operations. Piezometers were installed (sealed) within the clayey silt deposit containing sand seams in Boreholes HD5-2 and HD5-3 to permit monitoring of the groundwater level. Details of the well installations are shown in the Record of Borehole sheets in Appendix E. The water levels recorded in the boreholes and piezometers are summarized below:





## FOUNDATION INVESTIGATION AND DESIGN

### DEEP CUT / HIGH FILL AREAS 1 TO 8, W.P. 2005-07-00

Borehole / Piezometer	Ground Surface Elevation (m)	Depth Below Ground Surface to Water Level (m)	Groundwater Level Elevation (m)	Date	Notes
HD5-1	249.4	Dry	-	June 9, 2009	Open Borehole
HD5-2	252.1	2.7	249.4	June 12, 2009	Piezometer
HD5-3	251.5	2.9	248.6	June 12, 2009	Piezometer
HD5-4	248.9	Dry	-	June 2, 2009	Open Borehole

It should be noted that groundwater levels will fluctuate seasonally and are expected to rise during wet periods of the year.

#### 4.2.6 HIGHWAY 404 – STA. 36+870 TO STA. 37+150 (HIGH FILL AREA 6)

The proposed high fill area is situated within a gently sloping valley consisting of farm fields. The existing Boag Road (i.e. a two-lane gravel road) crosses through the area in an east-west direction at about Station 37+090. The existing ground surface ranges from about Elevation 238 m at the low point of the valley to the south of the existing Boag Road and rises to about Elevation 240 m at the south limit and about Elevation 244 m at the north limit of the valley.

In general, the subsoil conditions consist of a surficial layer of topsoil underlain by layers of clayey silt and / or sandy silt. The topsoil, clayey silt and sandy silt layers are underlain in locations by a deposit of sand and silt till or a deposit of silty sand to sand. The silty sand to sand layer is then underlain by deposits of silt or clayey silt till.

##### 4.2.6.1 Topsoil

A 0.5 m to 0.8 m thick layer of topsoil was encountered at the ground surface in Boreholes HD6-1 to HD6-6 advanced in this area. It should be noted that cobbles and boulders were observed at the ground surface throughout the site.

##### 4.2.6.2 Clayey Silt

A stratum of clayey silt was encountered below the topsoil in Boreholes HD6-2 to HD6-4 and intersecting the sandy silt and silty sand deposits in Borehole HD6-1. The clayey silt stratum contains some sand and trace gravel and in Borehole HD6-4, it contains interlayers of clay. The surface of the clayey silt stratum was encountered at depths ranging from 0.5 m to 2.3 m below ground surface (Elevation 239.3 m to 237.5 m) and its thickness ranges from about 0.7 m to 2.3 m.

The measured SPT 'N' values within the clayey silt stratum range from 4 to 49 blows per 0.3 m of penetration, suggesting a soft to hard, but generally firm, consistency.

The results of one grain size distribution test performed on a sample of the clayey silt stratum are shown on Figure F1.



An Atterberg limits test carried out on a sample of the clayey silt stratum measured a liquid limit of 24 percent, plastic limit of 16 percent and a plasticity index 8 percent. The results of the Atterberg limits testing are shown on Figure F2 and indicate that the material is a clayey silt of low plasticity. An Atterberg limits test carried out on a sample of a clay interlayer within the clayey silt stratum measured a liquid limit of 54 percent, a plastic limit of 20 percent and a plasticity index of 34 percent. The results of the Atterberg limits testing are also shown on Figure F2 and indicate that the interlayer is a clay of high plasticity.

The measured water content taken on samples of the clayey silt ranged from 15 to 20 percent and the water content taken on a sample of the clay interlayer was 40 percent.

#### **4.2.6.3 Sandy Silt**

A layer of sandy silt, trace clay and gravel and containing clayey silt seams was encountered below the topsoil in Borehole HD6-1. The surface of the sandy silt layer was encountered at a depth of 0.5 m (Elevation 239.3 m) and the thickness of the layer is 0.8 m.

Two measured SPT 'N' values within the sandy silt layer are 6 and 7 blows per 0.3 m of penetration, indicating a loose relative density.

An Atterberg limits test carried out on a sample of the sandy silt containing a clayey silt seam measured a liquid limit of 20 percent, plastic limit of 13 percent and a plasticity index of 7 percent. The results of the Atterberg limits testing are shown on Figure F3 and indicate that the seam is a clayey silt of low plasticity.

The measured water content of two samples of the sandy silt are 15 and 16 percent.

#### **4.2.6.4 Sand and Silt Till**

A deposit of sand and silt till was encountered below the clayey silt stratum in Boreholes HD6-3 and HD6-4 and below the topsoil in Boreholes HD6-5 and HD6-6. This deposit contains trace to some clay and gravel, clayey silt interlayers and cobbles and boulders were inferred to be present as indicated by the grinding of augers as they advanced through the deposit. The surface of the sand and silt till deposit was encountered at depths ranging from 0.6 m to 1.5 m below ground surface (Elevation 243.7 m to 238.3 m) and its thickness ranges from 2.3 m to 3.9 m. Boreholes HD6-5 and HD6-6 penetrated 3.6 m and 3.9 m into the deposit and were terminated at depths of 4.2 m and 4.6 m below ground surface (Elevation 240.1 m and 238.5 m), respectively.

The measured SPT 'N' values within the sand and silt till generally ranged from 20 blows per 0.3 m of penetration to 100 blows per 0.13 m of penetration, indicating a compact to very dense relative density. Two SPT 'N' values of 7 were measured within the upper 0.6 m of this deposit in Boreholes HD6-3 and HD6-4, indicating a loose relative density.

The results of two grain size distribution tests performed on samples of the sand and silt till deposit are shown on Figure F4. One grain size distribution test performed on a sample of a clayey silt interlayer within the sand and silt till deposit is shown on Figure F5.

The measured water content of nine samples of the sand and silt till deposit ranges from 7 to 15 percent.



#### **4.2.6.5 Silty Sand to Sand**

A deposit of silty sand to sand, trace clay was encountered below the clayey silt stratum in Boreholes HD6-1 and HD6-2 and below the sand and silt till in Boreholes HD6-3 and HD6-4. The surface of the silty sand to sand deposit was encountered at depths ranging from 1.5 m to 4.6 m below ground surface (Elevation 236.7 m to 235.2 m) and the deposit is 0.5 m to 3.1 m thick.

The measured SPT 'N' values within the silty sand to sand layer range from 18 to 55 blows per 0.3 m of penetration, indicating a compact to very dense relative density.

The results of two grain size distribution tests performed on samples of the sand are shown on Figure F6.

The measured water content of five samples of the silty sand to sand ranges from 14 to 20 percent.

#### **4.2.6.6 Silt**

A layer of silt containing some sand and trace clay was encountered below the silty sand deposit in Borehole HD6-2 at a depth of 4.6 m below ground surface (Elevation 233.6 m). Borehole HD6-2 penetrated 2.1 m into the silt layer and was terminated at a depth of 6.7 m below ground surface (Elevation 231.5 m).

Two measured SPT 'N' values within the silt layer are 24 and 36 blows per 0.3 m of penetration, indicating a compact to dense relative density.

The results of one grain size distribution test performed on a sample of the silt are shown on Figure F7.

#### **4.2.6.7 Clayey Silt Till**

A deposit of clayey silt till containing trace to some sand and trace gravel was encountered below the silty sand to sand deposit in Boreholes HD6-1, HD6-3 and HD6-4. The surface of the clayey silt till was encountered at depths ranging from 4.7 m to 6.4 m below ground surface (Elevation 235.2 m to 233.4 m) and the boreholes penetrated 0.2 m to 2.0 m into the clayey silt deposit and were terminated at depths ranging from 6.6 m to 6.7 m below ground surface (Elevation 233.2 m to 233.1 m).

The measured SPT 'N' values within the clayey silt till deposit range from 30 blows per 0.3 m of penetration to 152 blows per 0.28 m of penetration, suggesting a hard consistency.

An Atterberg limits test carried out on a sample of the clayey silt till measured a liquid limit of 22 percent, a plastic limit of 12 percent and a plasticity index of 10 percent. The results of the Atterberg limits testing are shown on Figure F8 and indicate that the material is a clayey silt of low plasticity.

The measured water contents taken on two samples of the clayey silt till were 9 and 15 percent.

#### **4.2.6.8 Groundwater Conditions**

Water levels were noted within the boreholes during and upon completion of drilling operations. A piezometer was installed (sealed) within the silty sand and clayey silt till deposit in Borehole HD6-3 and a piezometer was installed (sealed) within the sand and silt till deposit in Borehole HD6-6 to permit monitoring of the groundwater levels. Details of the piezometer installations are shown in the Record of Borehole sheets in Appendix F. The water levels recorded in the boreholes and piezometers are summarized below:



## FOUNDATION INVESTIGATION AND DESIGN DEEP CUT / HIGH FILL AREAS 1 TO 8, W.P. 2005-07-00

Borehole / Piezometer	Ground Surface Elevation (m)	Depth Below Ground Surface to Water Level (m)	Groundwater Level Elevation (m)	Date	Notes
HD6-1	239.8	6.3	233.5	Feb. 24, 2009	Open Borehole
HD6-2	238.2	2.8	235.4	Feb. 24, 2009	Open Borehole
HD6-3	239.9	1.8	238.1	Feb. 26, 2009	Piezometer
		1.3	238.6	Mar. 12, 2009	
		1.1	238.8	Apr. 2, 2009	
		1.3	238.6	May 20, 2009	
		1.8	238.1	June 12, 2009	
HD6-4	239.8	Dry	-	Feb. 24, 2009	Open Borehole
HD6-5	244.3	3.0	241.3	Feb. 19, 2009	Open Borehole
HD6-6	243.1	4.4	238.7	Feb. 26, 2009	Piezometer
		3.9	239.2	Mar. 12, 2009	
		2.6	240.5	Apr. 12, 2009	
		3.1	240.0	May 20, 2009	
		4.3	238.8	June 12, 2009	

It should be noted that groundwater levels will fluctuate seasonally and are expected to rise during wet periods of the year.

### 4.2.7 HIGHWAY 404 – STA. 37+400 TO STA. 37+760 (DEEP CUT AREA 7)

The proposed deep cut area extends along the top of an existing “drumlin” that is covered with trees and grassy areas. The existing ground surface ranges from about Elevation 246 m to Elevation 256 m within the limits of the deep cut area.

In general, the subsoil conditions in this area consist of a surficial layer of topsoil underlain by a silty sand to sand and silt till deposit. The silty sand to sand and silt till deposit is underlain by a deposit of clayey silt till, which is in turn underlain by a stratum of clayey silt in the northern portion of the drumlin.

#### 4.2.7.1 Topsoil

A 0.5 m to 0.8 m thick layer of topsoil was encountered at the ground surface in Boreholes HD7-1 to HD7-7 advanced within this area. Cobbles and boulders were observed at the ground surface throughout the site.

#### 4.2.7.2 Sand and Gravel

A localized layer of sand and gravel was encountered below the topsoil in Borehole HD7-2. This layer contains trace silt and contained cobbles.

One measured SPT ‘N’ value within the sand and gravel layer is 19 blows per 0.3 m of penetration, indicating a compact relative density.

The measured water content taken on a sample of the sand and gravel is 6 percent.



#### **4.2.7.3 Silty Sand Till to Sand and Silt Till**

A deposit of silty sand to sand and silt till containing trace to some clay and gravel was encountered below the sand and gravel layer in Borehole HD7-2 and below the topsoil in the remaining boreholes. Cobbles and boulders were encountered at various depths within this deposit as inferred by the grinding of augers and refusal to advance the SPT split-spoon. Silty clay seams were encountered in the lower portion of the sand and silt till deposit in Borehole HD7-2. The top of the silty sand to sand and silt till deposit was encountered at depths ranging between 0.5 m and 1.3 m below ground surface (Elevation 254.6 m to 247.3 m) and the thickness of the deposit ranges from 0.9 m to 8.6 m. Boreholes HD7-1 and HD7-2 penetrated 6.0 m and 6.4 m into this deposit and were terminated at depths of 6.6 m and 7.7 m below ground surface (Elevation 248.1 m and 248.2 m), respectively.

The measured SPT 'N' values recorded within the silty sand to sand and silt till deposit ranged from 12 blows per 0.3 m of penetration to 100 blows per 0.1 m of penetration, indicating a compact to very dense relative density. Two SPT 'N' values of 7 and 8 were measured in the upper metre of this deposit in Borehole HD7-8, directly below the topsoil.

The results of twelve grain size distribution tests performed on samples of the silty sand to sand and silt till are shown on Figures G1A and G1B.

The measured water contents of samples of the silty sand to sand and silt till ranges from 6 to 11 percent.

#### **4.2.7.4 Clayey Silt Till**

A deposit of clayey silt till was encountered below the silty sand to sand and silt till in Boreholes HD7-3 to HD7-8. This deposit typically contains some sand and trace gravel and sandy silt seams. The top of this deposit was encountered at depths ranging from 1.5 m to 9.1 m below ground surface (Elevation 250.8 m to 242.0 m). Boreholes HD7-3 to HD7-8 penetrated between 0.3 m and 2.2 m into or through this deposit and were terminated at depths ranging from 6.7 m to 9.8 m below ground surface (Elevation 246.3 m to 241.4 m).

The measured SPT 'N' values recorded within the clayey silt till range from 16 blows per 0.3 m of penetration to 118 blows per 0.2 m of penetration, suggesting a very stiff to hard consistency.

The results of two grain size distribution tests performed on samples of the clayey silt till are shown on Figure G2.

Atterberg limits testing carried out on two samples of the clayey silt till measured liquid limits of 20 percent, plastic limits of 12 percent and plasticity indices of 8 percent. The results of the Atterberg limits testing are shown on Figure G3 and indicate that the material is a clayey silt with low plasticity.

The measured water content of five samples of the clayey silt till ranged from 8 to 14 percent.

#### **4.2.7.5 Clayey Silt**

A stratum of clayey silt was encountered underlying the clayey silt till in Borehole HD7-6 at a depth of 3.1 m below ground surface (Elevation 249.3 m). Borehole HD7-6 penetrated 5.1 m into the clayey silt layer and was terminated at a depth of 8.2 m below ground surface (Elevation 244.1 m).



## FOUNDATION INVESTIGATION AND DESIGN

### DEEP CUT / HIGH FILL AREAS 1 TO 8, W.P. 2005-07-00

The measured SPT 'N' values within the clayey silt range from 19 to 57 blows per 0.3 m of penetration, indicating a very stiff to hard consistency.

The results of one grain size distribution test performed on a sample of the clayey silt are shown on Figure G4. The measured water contents taken on two samples of the clayey silt are 18 and 20 percent.

#### 4.2.7.6 Groundwater Conditions

Water levels were noted within the boreholes during and upon completion of drilling operations. Piezometers were installed to permit monitoring of the groundwater level in Boreholes HD7-1 and HD7-7 sealed within the sand and silt till deposit, in Borehole HD7-3 sealed within the clayey silt till silt deposit and in Borehole HD7-6 sealed within the clayey silt stratum. Details of the piezometer installations are shown in the Record of Borehole sheets in Appendix G. The water levels recorded in the boreholes and piezometers are summarized below:

Borehole / Piezometer	Ground Surface Elevation (m)	Depth Below Ground Surface to Water Level (m)	Groundwater Level Elevation (m)	Date	Notes
HD7-1	254.6	1.0	253.6	Mar. 19, 2009	Piezometer
		0	254.6	Apr. 2, 2009	
		1.0	253.6	Jun. 12, 2009	
HD7-2	255.9	0.7	255.2	Mar. 16, 2009	Open Borehole
HD7-3	254.5	1.4	253.1	Mar. 19, 2009	Piezometer
		0.4	254.1	Apr. 2, 2009	
		1.3	253.2	Jun. 12, 2009	
HD7-4	254.5	5.2	249.3	Mar. 17, 2009	Open Borehole
HD7-5	253.3	3.1	250.2	Mar. 17, 2009	Open Borehole
HD7-6	252.3	2.2	250.1	Mar. 19, 2009	Piezometer
		0.2	252.1	Apr. 2, 2009	
		1.3	251.0	Jun. 12, 2009	
HD7-7	251.1	2.4	248.7	Mar. 19, 2009	Piezometer
		0.8	250.3	Apr. 2, 2009	
		2.0	249.1	Jun. 12, 2009	
HD7-8	248.1	2.0	246.1	Mar. 18, 2009	Open Borehole

It should be noted that groundwater levels will fluctuate seasonally and are expected to rise during wet periods of the year.

#### 4.2.8 HIGHWAY 404 – STA. 38+200 TO STA. 38+500 (HIGH FILL AREA 8)

The proposed high fill area extends along a flat, low-lying, grassy area with dense trees located in the southern and central portions of the site. The existing ground surface ranges from about Elevation 232 m to 230 m.



In general, the subsoil conditions in this area consist of a surficial layer of topsoil underlain by strata of clayey silt to silty clay. The clayey silt and silty clay strata are underlain by a silt deposit at the southern portion of the site and by sandy silt to sand and silt till and clayey silt till at the central and northern portion of the site.

#### **4.2.8.1     *Topsoil***

A 0.2 m to 0.5 m thick layer of topsoil was encountered at the ground surface in Boreholes HD8-1 to HD8-7. Cobbles and boulders were observed at the ground surface throughout the site.

The measured water content of one sample of the topsoil is 64 percent.

#### **4.2.8.2     *Clayey Silt***

A stratum of clayey silt containing trace to some sand, trace gravel, trace organics, sand interlayers and silty sand seams was encountered below the topsoil in Boreholes HD8-1, HD8-2, HD8-5, HD8-6 and HD8-7. The surface of the clayey silt stratum was encountered at depths ranging from 0.2 m to 0.5 m below ground surface (Elevation 233.4 m to 229.6 m) and the stratum is 0.6 m to 1.2 m thick.

The measured SPT 'N' values within the clayey silt stratum range from 4 to 18 blows per 0.3 m of penetration, suggesting a firm to very stiff consistency. SPT 'N' values of 2 and 3 blows per 0.3 m of penetration were measured near the clayey silt and topsoil interface at Boreholes HD8-1, HD8-5, and HD8-7, suggesting that the surficial 0.3 m is of very soft to soft consistency.

An Atterberg limits test carried out on a sample of the clayey silt measured a liquid limit of 23 percent, a plastic limit of 18 percent and a plasticity index of 5 percent. The results of the Atterberg limits test are shown on Figure H1 and indicate that the material is a clayey silt of low plasticity.

The measured water content of three samples of the clayey silt ranges from 22 to 26 percent.

#### **4.2.8.3     *Silty Clay***

A stratum of silty clay containing trace to some sand and trace gravel was encountered below the topsoil in Boreholes HD8-3 and HD8-4 and below the clayey silt in Boreholes HD8-1, HD8-2, and HD8-5 to HD8-7. The surface of the silty clay was encountered at depths ranging from 0.3 m to 1.5 m below ground surface (Elevation 232.8 m to 228.8 m) and the stratum is 2.3 m to 4.4 m thick. Borehole HD8-3, which was drilled by hand auger equipment in an area of access restrictions for a full size drilling rig due to dense tree thickets and large trees, penetrated 1.2 m into the silty clay layer and was terminated at a depth of 1.5 m below ground surface (Elevation 229.3 m).

The measured SPT 'N' values within the silty clay layer ranged from 5 to 34 blows per 0.3 m of penetration, suggesting a firm to hard consistency. The hand auger borehole was terminated due to refusal to further hand auger advancement inferred to be on very stiff to hard consistency soil.

The results of two grain size distribution tests performed on samples of the silty clay are shown on Figure H2.

Atterberg limits testing carried out on six samples of the silty clay stratum measured liquid limits ranging from 37 to 45 percent, plastic limits ranging from 16 to 20 percent and plasticity indices ranging from 19 to 28 percent. The results of the Atterberg limits testing are shown on Figure H3 and indicate that the material is a silty clay of medium plasticity.





The measured water content of samples of the silty clay ranges from 9 to 27 percent, but is typically between 20 and 27 percent.

#### **4.2.8.4 Silt**

A deposit of silt containing trace to some clay, trace sand and seams of silty clay was encountered below the silty clay in Boreholes HD8-1 and HD8-2. The surface of this layer was encountered at depths of 3.8 m and 5.0 m below ground surface (Elevation 229.8 m and 226.1 m) in Boreholes HD8-1 and HD8-2, respectively. These boreholes penetrated 1.4 m and 1.7 m into the silt deposit and were terminated at depths of 5.2 m and 6.7 m below ground surface (Elevation 228.4 m and 224.4 m).

The measured SPT 'N' values within the silt layer range from 16 to 45 blows per 0.3 m of penetration, indicating a compact to dense relative density.

The results of two grain size distribution tests performed on samples of the silt are shown on Figure H4.

The measured water contents taken on two samples of the silt were 19 and 21 percent.

#### **4.2.8.5 Sandy Silt to Sand and Silt Till**

A deposit of sandy silt to sand and silt till containing trace to some sand and gravel was encountered below the silty clay in Boreholes HD8-4 to HD8-7. The surface of the sandy silt to sand and silt till deposit was encountered at depths ranging from 3.8 m to 4.7 m below ground surface (Elevation 226.5 m to 225.9 m) and its thickness ranges from 0.9 m to 2.0 m. Boreholes HD8-4, HD8-6 and HD8-7 penetrated 1.1 m to 2.0 m into the deposit and were terminated at depths ranging from 5.2 m to 6.7 m below ground surface (Elevation 223.9 m to Elevation 225.1 m).

The measured SPT 'N' values recorded within the sandy silt to sand and silt till deposit range from 17 to 113 blows per 0.3 m of penetration, indicating a compact to very dense relative density.

The results of one grain size distribution test performed on a sample of the sandy silt to sand and silt till are shown on Figure H5.

The measured water content of four samples of the sandy silt to sand and silt till ranges from 7 to 9 percent.

#### **4.2.8.6 Clayey Silt Till**

A stratum of clayey silt till containing trace to some sand and trace gravel was encountered below the sand and silt till deposit in Borehole HD8-5. The surface of the clayey silt till stratum was encountered at a depth of 4.7 m below ground surface (Elevation 225.6 m). Borehole HD8-5 penetrated 0.5 m into the clayey silt till and was terminated at a depth of 5.2 m below ground surface (Elevation 225.1 m).

One measured SPT 'N' value within the clayey silt till deposit is 20 blows per 0.3 m of penetration, suggesting a very stiff consistency.

An Atterberg limits test performed on one sample of the clayey silt till measured a liquid limit of 24 percent, a plastic limit of 12 percent and a plasticity index of 12 percent. The results of the Atterberg limits testing are shown on Figure H6 and indicate that the material is a clayey silt with low plasticity.

The measured water content of one sample of the clayey silt till is 17 percent.





#### **4.2.8.7 Groundwater Conditions**

Water levels were noted within the boreholes during and upon completion of drilling operations. Piezometers were installed in Borehole HD8-1 sealed within the silt and silty clay and in Borehole HD8-6 sealed within the silty clay and sand and silt till deposit. Details of the piezometer installations are shown in the Record of Borehole sheets in Appendix H. The water levels recorded in the boreholes and piezometers are summarized below:

<b>Borehole / Piezometer</b>	<b>Ground Surface Elevation (m)</b>	<b>Depth Below Ground Surface to Water Level (m)</b>	<b>Groundwater Level Elevation (m)</b>	<b>Date</b>	<b>Notes</b>
HD8-1	233.6	1.1	232.5	Mar. 19, 2009	Piezometer
		0.4	233.2	Apr. 2, 2009	
		0	233.6	Jun. 12, 2009	
HD8-2	231.1	0.3	230.8	Mar. 18, 2009	Open Borehole
HD8-3	230.8	0	230.8	Jun. 2, 2009	Open Borehole
HD8-4	230.6	0	230.6	Mar. 19, 2009	Open Borehole
HD8-5	230.3	3.8	226.5	Mar. 19, 2009	Open Borehole
HD8-6	230.3	-0.7	231.0	Apr. 2, 2009	Piezometer
		-0.2	230.5	Jun. 2, 2009	
		-0.4	230.7	Jun. 12, 2009	
HD8-7	229.9	0.8	229.1	Mar. 19, 2009	Open Borehole

It should be noted that groundwater levels will fluctuate seasonally and are expected to rise during wet periods of the year.

## **5.0 CLOSURE**

The field drilling program was supervised by Mr. Ted Beadle and Mr. Chris Radway. This Foundation Investigation Report was prepared by Mr. Ted Beadle and reviewed by Mr. Kevin Bentley, P.Eng., a Senior Geotechnical Engineer with Golder. Mr. Jorge M.A. Costa, P.Eng., a Principal of Golder and a Designated MTO Contact for Foundations carried out a quality control review of this report.



**FOUNDATION INVESTIGATION AND DESIGN  
DEEP CUT / HIGH FILL AREAS 1 TO 8, W.P. 2005-07-00**

**Report Signature Page**

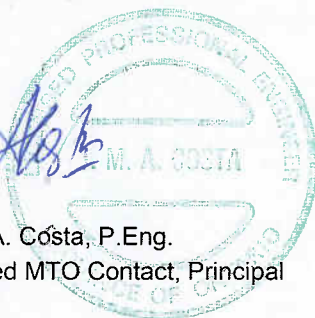
**GOLDER ASSOCIATES LTD.**

Ted Beadle  
Geotechnical Group

Kevin Bentley, P.Eng.  
Senior Geotechnical Engineer



Jorge M.A. Costa, P.Eng.  
Designated MTO Contact, Principal



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# **PART B**

**FOUNDATION DESIGN REPORT**

**DEEP CUT / HIGH FILL AREAS 1 TO 8**

**HIGHWAY 404 EXTENSION FROM QUEENSVILLE SIDEROAD TO  
RAVENSHOE ROAD**

**TOWN OF EAST GWILLIMBURY**

**MINISTRY OF TRANSPORTATION, ONTARIO**

**W.P. 2005-07-00**



## **6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS**

### **6.1 General**

This section of the report provides recommendations on the geotechnical aspects of design for the permanent deep cut and high fill sections of the proposed Highway 404 Extension from Queensville Sideroad to Ravenshoe Road. The recommendations are based on interpretation of the factual data obtained from the boreholes advanced during the subsurface investigation. The discussion and recommendations presented are intended to provide the designers with sufficient information to assess the feasible alternatives and to carry out the design of the high fill embankments and deep cut excavations. Where comments are made on construction, they are provided in order to highlight those aspects which could affect the design of the project. Those requiring information on the aspects of construction should make their own interpretation of the factual information provided as such interpretation may affect equipment selection, proposed construction methods, scheduling and the like.

It is understood that the construction of the proposed Highway 404 Extension will involve deep cuts / high fills at eight areas designated as Areas 1 to 8 as shown on Drawing 1 following the text of this report. Based on the proposed Highway 404 plan, profile and cross-section drawings provided by AECOM (dated April 21 and Nov. 26, 2009), the maximum fill height ranges from 4 m to 8 m at Areas 1, 4, 6 and 8 and the maximum cut depth ranges from 4 m to 8.5 m in Areas 2, 3, 5 and 7, as summarized below.

<b>Deep Cut / High Fill Area Designation</b>	<b>Station</b>	<b>Reference Drawing</b>	<b>Maximum Fill Height / Cut Depth</b>
1	33+900 to 34+160	2	Fill up to 8 m
2	34+360 to 34+600	3	Cut up to 8.5 m
3	34+780 to 34+880	4	Cut up to 4 m
4	35+000 to 35+150	4	Fill up to 5 m
5	35+750 to 35+900	5	Cut up to 5 m
6	36+870 to 37+150	6	Fill up to 6 m
7	37+400 to 37+760	7	Cut up to 6 m
8	38+200 to 38+500	8	Fill up to 4 m

### **6.2 High Fill Embankments**

Areas 1, 4, 6 and 8 will require high fill embankments between 4 m and 8 m above existing ground surface as part of the construction to raise the existing ground surface up to the proposed Highway 404 subgrade elevation. The following sections summarize the design and construction considerations for the high fill embankments.

#### **6.2.1 Embankment Fill Types and Benching Requirements**

It is understood that the high fill embankments are to be constructed of suitable earth fill, either from on-site deep cut excavation areas or imported from off-site. Based on the investigation performed in the deep cut areas, the subsoils available for use as embankment fill consist predominantly of silty sand to sand, silty sand till to sand and silt till and clayey silt till. These materials were encountered in the boreholes at moisture contents ranging from about 6 to 12 percent for the granular soils and 8 to 16 percent for the clayey till soils, and as such are



considered to be suitable for embankment construction. However, it is noted that the clayey silt soils present within some of the deep cut areas should be thoroughly mixed with granular soils (native silty sand to sand or imported soil meeting SP110S13, Material Specification for Aggregates, Select Subgrade Material) prior to re-use in embankment construction to avoid creating localized zones of fill that could result in differential settlement. Off-site borrow material, if required to augment the on-site material for embankment construction, should meet the requirement of OPSS 212, Construction Specification for Borrow.

All embankment fill is to be placed and compacted in accordance with SP206S03, Earth Excavation, Grading.

## **6.2.2 Stability**

### **6.2.2.1 Methodology**

Limit equilibrium slope stability analyses were performed using the commercially available software program "Slide", produced by Rocscience Inc., employing the Morgenstern-Price method of analysis to check that a minimum Factor of Safety of 1.3 is achieved for global stability of the proposed embankment height and geometry under static conditions for each high fill embankment area. This minimum Factor of Safety is considered appropriate for the embankments at these sites considering the design requirements and the available field and laboratory testing data.

### **6.2.2.2 Parameter Selection**

The subsoils and subsurface conditions encountered in each high fill embankment area vary from site to site. For the cohesionless soils, effective stress parameters were employed in the embankment stability analyses assuming drained conditions. Undrained conditions were modelled for the cohesive soils. The soil parameters were estimated from empirical correlations proposed by Kulhawy and Mayne (1990) and the CHBDC (2006) using the results of in situ Standard Penetration Tests (SPT), visual classification and the results of laboratory testing. The earth fill embankment geometry assumes side slopes no steeper than 2 horizontal: 1 vertical (2H:1V). The piezometric conditions used in the analyses are based on the highest groundwater levels noted during drilling or measured in the piezometer installations for each area.

Based on the results of the subsurface investigation and review of the profile drawings, the critical section (i.e. greatest embankment height and/or maximum thickness of soft or loose subsoils) for each high fill area was determined and the simplified soil stratigraphy and the associated strengths and unit weights were assigned for the different soil types in each critical section for each area are presented below.

Hill Fill Area	Soil Layer	Bulk Unit Weight (kN/m <sup>3</sup> )	Undrained Shear Strength (kPa)	Cohesion (c') (kPa)	Effective Friction Angle (degrees)
1 (Sta. 34+025)	Earth Fill Embankment	20	-	0	32
	Upper Clayey Silt	19	40	-	-
	Clayey Silt Till	21	100	5	32
	Lower Clayey Silt	21	200	-	-



Hill Fill Area	Soil Layer	Bulk Unit Weight (kN/m <sup>3</sup> )	Undrained Shear Strength (kPa)	Cohesion (c') (kPa)	Effective Friction Angle (degrees)
4 (Sta. 35+025)	Earth Fill Embankment	20	-	0	32
	Clayey Silt / Silty Clay	19	25	-	-
	Sand and Silt Till	21	-	0	35
	Clayey Silt	21	200	-	-
6 (Sta. 36+975)	Earth Fill Embankment	20	-	0	32
	Clayey Silt	19	25	-	-
	Sand and Silt Till	21	-	0	35
	Silty Sand to Sand / Silt	20	-	0	32
	Clayey Silt Till	21	200	-	-
8 (Sta. 38+250)	Earth Fill Embankment	20	-	0	32
	Clayey Silt	19	25	-	-
	Silty Clay	20	75	-	-
	Sandy Silt to Sand and Silt Till / Silt	21	-	0	32

### 6.2.2.3 Results of Analyses

The stability analyses performed at the critical section(s) indicates that after the completion of construction, the embankments in Areas 1, 4, 6 and 8 will have a Factor of Safety of 1.3 or greater for deep seated, global failure surfaces that would impact the operation of the roadway. Example results of two analyses, performed for Areas 6 and 8, are shown on Figures 1 and 2, respectively.

The analyses assume that all topsoil and near surface loose / soft soils containing organics and existing fill materials have been removed from the proposed new embankment footprint and the new embankment fill is properly placed and compacted as per SP206S03, Earth Excavation, Grading.

### 6.2.3 Settlement

#### 6.2.3.1 Methodology

Analyses were performed using the commercially available software program "Settle3D" produced by Rocscience Inc. and hand calculations to estimate the settlement of the foundation soils underlying the proposed 4 m to 8 m high fill embankments. A bulk unit weight of 20 kN/m<sup>3</sup> was employed for the proposed embankment fill in calculating the embankment loading on the founding subsoils.



### 6.2.3.2 Parameter Selection

Static settlement analyses were carried out for the foundation soils using the following parameters based on field and laboratory test data and accepted correlations as proposed by Kulhawy and Mayne (1990):

Hill Fill Area	Soil Layer	Thickness (m)	Bulk Unit Weight (kN/m <sup>3</sup> )	Estimated Deformation Properties
1	Firm to Stiff Upper Clayey Silt	1	19	$e_o = 0.9$ , $C_c = 0.3$ , $C_r = 0.04$ , $OCR > 1$
	Stiff to Hard Clayey Silt Till	1	21	$E' = 50$ MPa
	Hard Lower Clayey Silt	7	21	$E' = 50$ MPa
4	Firm to Stiff Clayey Silt to Silty Clay	1	19	$e_o = 1.0$ , $C_c = 0.3$ , $C_r = 0.06$ , $OCR > 1$
	Compact to Very Dense Sand and Silt Till	3	21	$E' = 50$ MPa
	Hard Clayey Silt	4	21	$E' = 50$ MPa
6	Firm Clayey Silt	1	19	$e_o = 0.9$ , $C_c = 0.3$ , $C_r = 0.04$ , $OCR < 1$
	Compact to Very Dense Sand and Silt Till	2	21	$E' = 50$ MPa
	Compact to Very Dense Silty Sand to Sand / Silt	2	20	$E' = 40$ MPa
	Hard Clayey Silt Till	5	21	$E' = 50$ MPa
8	Firm to Stiff Clayey Silt	1	19	$e_o = 0.9$ , $C_c = 0.3$ , $C_r = 0.04$ , $OCR > 1$
	Stiff to Very Stiff Silty Clay	3	20	$E' = 5$ MPa
	Compact to Very Dense Sandy Silt to Sand and Silt Till / Silt	2	21	$E' = 50$ MPa

The analyses were carried out assuming that all topsoil, clayey silt with organics, organic silt with clay, and existing fill soils have been removed from below the footprint of each embankment prior to embankment fill placement.



### **6.2.3.3 Results of Analyses**

Based on the results of the settlement analyses, the maximum total settlements are comprised of immediate settlement (i.e. settlement during or shortly after construction) due mainly to the compression of the cohesionless soil layers and overconsolidated cohesive layers and primary consolidation settlement (i.e. time-dependant settlement after construction) of slightly overconsolidated and normally consolidated cohesive soil layers. The estimated settlements for each High Fill area are summarized below.

<b>High Fill Area</b>	<b>Total Estimated Settlement (mm)</b>	<b>Initial Settlement Component (mm)</b>	<b>Primary Consolidation Settlement Component (mm)</b>
1	100	50	50
4	50	25	25
6	100	25	75
8	90	15	75

The majority (up to 90%) of the primary consolidation settlement within the cohesive subsoils below the embankments is expected to occur within the first 3 months after completion of construction of the embankments. Therefore, a preloading period of at least 3 months is required to induce the majority of settlements prior to levelling and paving operations.

Alternatively, the estimated 1 m thick layer of clayey silt to silty clay soils present at depths up to about 1.5 m below ground surface could be subexcavated to reduce the magnitude of post-construction settlements. In this case, the estimated post-construction settlements could be reduced to less than 25 mm and the preloading period is not required or it could be reduced to about 1 month in the case of High Fill Area 8. Details of the subexcavation options for each High Fill Area are summarized in Table 1 following the text of this report.

### **6.2.3.4 Settlement of New Embankment Fill**

Provided that the embankment fill material is properly placed and compacted in accordance with SP206S03, Earth Excavation and Grading, the settlement of the new embankment fill itself is expected to be less than 25 mm, and the majority of settlement will occur during or shortly after construction. It is assumed that the embankment fill will consist of suitable fill as described in Section 6.2.1.

## **6.2.4 Subgrade Preparation and Embankment Construction**

### **6.2.4.1 Removal of Organics / Fills**

Based on the borehole results, topsoil, clayey silt/sandy silt with organics, and organic silt with clay are present up to about 1.5 m below the ground surface within the proposed high fill embankment footprints. Prior to the placement of any fill for the new embankment construction, all topsoil and soils containing excessive organics should be stripped from below the proposed embankment footprints in accordance with SP206S03, Earth Excavation and Grading. Any existing fill soils with no organics that are excavated from the deep cut areas could be re-compacted as part of the new embankment fill.





#### **6.2.4.2      *Embankment Fill Placement***

After stripping, the exposed subgrade soils should be inspected by the Quality Verification Engineer (QVE) prior to placement of embankment fill, proofrolled to identify soft / loosened areas, and any poorly performing areas should be subexcavated and replaced with suitable backfill. A NSSP should be included in the Contract to address the subgrade inspection procedure prior to placement of the embankment fill and suggested wording is included in Appendix I.

Construction of the embankment or backfill for any poorly performing areas (or after sub-excavation of near surface clayey silt to silty clay layers) may be carried out using earth fill as described in Section 6.2.1.1. Fill for embankment construction below the groundwater level (such as in Areas 1 and 8) should be comprised of granular material such as Granular B, Type II (OPSS 1010, Material Specification for Aggregates) or rock fill. Construction of the fill embankment above the original ground surface (and water level) may then be continued by using conventional earth fill. If rock fill is used, a transition / filter layer of Granular B Type II (minimum 1 m thick) should be placed between the rock fill and earth fill above it to reduce the potential for loss of fines.

Embankment fill should be placed in accordance with Special Provision SP206S03, Earth Excavating and Grading. The final lift prior to placement of the granular subbase and base courses should be compacted to at least 100 percent of the standard Proctor maximum dry density of the material. Inspection and field density testing should be carried out by qualified geotechnical personnel during all engineered fill placement operations to ensure that appropriate materials are used and that adequate levels of compaction have been achieved.

#### **6.2.4.3      *Control of Groundwater and Surface Water***

Based on the borehole information, excessive groundwater is not anticipated to be encountered during construction of the high fill embankments. High Fill Areas 1 and 8 had areas of ponded water at the time of the subsurface investigation. Artesian pressures up to 0.7 m above ground surface were measured within one piezometer installed at depth within Area 8. Any groundwater seepage into the excavated areas of subgrade preparation should be able to be handled by diversion channels, perimeter ditches / trenches and pumping using sump pumps. A NSSP for dewatering during stripping and backfilling operations is included in Appendix I. Surface water should be directed away from the stripping / subexcavations at all times.

To reduce surface water erosion on the embankment side slopes, topsoil and seeding or pegged sod should be placed as soon as possible in accordance with OPSS 572, Construction Specification for Seed and Cover. If this protection is not in place before Winter, then alternate protection measures, such as covering the slope with straw or gravel sheeting, is recommended to reduce the potential for remedial works being required on the side slopes in the Spring prior to topsoil and seeding.

### **6.3      *Deep Cuts***

Area's 2, 3, 5 and 7 will require deep cut excavations as part of the lowering of the existing ground surface to meet the proposed Highway 404 subgrade elevation. The proposed maximum depth of cut is 8.5 m, 4 m, 5 m, and 6 m below existing ground surface at Areas 2, 3, 5 and 7 respectively.

The following sections summarize the design and construction considerations for the deep cut excavations.



## 6.3.1 Stability

### 6.3.1.1 Methodology

Limit equilibrium slope stability analyses were performed using the commercially available software program "Slide", produced by Rocscience Inc., employing the Morgenstern-Price method of analysis to check that a minimum Factor of Safety of 1.3 is achieved for global stability of the proposed cut slopes and geometry under static conditions. This minimum Factor of Safety is considered appropriate for the embankments at these sites considering the design requirements and the available field and laboratory testing data.

### 6.3.1.2 Parameter Selection

The subsoils and subsurface conditions encountered in each area of the deep cuts vary from site to site. For the cohesionless soils, effective stress parameters were employed in the analyses assuming drained conditions. Undrained conditions were modelled for the cohesive soils. The soil parameters were estimated from empirical correlations proposed by Kulhawy and Mayne (1990) and the CHBDC (2006) using the results of in situ Standard Penetration Tests (SPT), visual classification and the results of laboratory testing. The side slope geometry of the excavation assumes 2 horizontal: 1 vertical (2H:1V). The piezometric conditions used in the analysis are based on the highest groundwater levels noted during drilling or measured in the piezometer installations and assume a stabilized groundwater level after the proposed highway grade and ditches / subdrains have been constructed (refer to Section 6.3.2.3).

Based on the results of the subsurface investigation and review of the profile drawings, the critical section (i.e. deepest cut or cut through area of soft or loose subsoils) for each deep cut area was determined and the simplified soil stratigraphy and the associated strengths and unit weights were assigned for the different soil types in each critical section for each area as presented below.

Deep Cut Area	Soil Layer	Bulk Unit Weight (kN/m <sup>3</sup> )	Undrained Shear Strength (kPa)	Cohesion (c') (kPa)	Effective Friction Angle (degrees)
2 (Sta. 34+400)	Compact to Very Dense Silty Sand to Sand and Silt Till / Silty Sand	21	-	0	35
	Very Stiff to Hard Clayey Silt	21	200	-	-
3 (Sta.34+800)	Loose to Compact Silty Sand / Fill	20	-	0	28
	Compact to Very Dense Sandy Silt Till	21	-	0	35
	Hard Clayey Silt	21	200	-	-
5 (Sta. 35+825)	Compact Sand and Silt	20	-	0	32
	Very Stiff to Hard Clayey Silt Till	21	150	-	-
	Hard Clayey Silt	21	200	-	-



Deep Cut Area	Soil Layer	Bulk Unit Weight (kN/m <sup>3</sup> )	Undrained Shear Strength (kPa)	Cohesion (c') (kPa)	Effective Friction Angle (degrees)
7 (Sta. 35+525)	Compact to Very Dense Silty Sand to Sand and Silt Till	21	-	0	35
	Very Stiff to Hard Clayey Silt / Clayey Silt Till	21	200	-	-

### 6.3.1.3 Results of Analyses

The results of the analyses indicate that a Factor of Safety greater than 1.3 was calculated for the proposed permanent cut slopes at Area's 2, 3, 5 and 7 implementing side slopes of 2H:1V and assuming groundwater levels have stabilized after ditches and subdrains are installed. Example results of two analyses, performed at Areas 2 and 7, are shown on Figures 3 and 4, respectively. It is noted that the surficial topsoil and near surface soft / loose soils containing organics may require localized slope flattening to about 2.5H:1V or gravel sheeting.

### 6.3.2 Design and Construction Considerations

#### 6.3.2.1 Excavation

The proposed Highway 404 profile will require lowering the existing ground surface at Areas 2, 3, 5 and 7 to depths up to 8.5 m, 4 m, 5 m and 6 m respectively. Permanent and temporary excavations for the road cut will be made through the surficial topsoil, fills, clayey silt/sandy silt with organics, typically firm to very stiff clayey silt till, compact to very dense silty sand to sand and silt till, compact to dense silty sand, sand and silt, and firm to hard clayey silt soils. The groundwater levels measured in the piezometers range from ground surface to 2.9 m below existing ground surface at the deep cut areas and result in groundwater levels immediately beyond the side slopes ranging from 2.5 m to 6 m above the proposed Highway 404 subgrade level. General recommendations for deep cut areas are presented in Table 2 following the text of this report.

As a result of the existing high groundwater level relative to the proposed base of the cuts, it is recommended that the proposed Highway 404 profile be excavated and ditches and sub-drains be installed progressively as the subgrade is lowered and in advance of the final side-slopes being excavated to the design grade to allow the groundwater to drain thereby reducing the risk of surficial instability along the side-slopes and disturbance / softening of the subgrade soils. In order to allow for gravity drainage of the groundwater during the grade lowering, the excavations and ditches along Highway 404 for Areas 2, 5 and 7 should progress from north to south and excavations for Area 3 should progress from south to north.

Provided the road cut is allowed sufficient time to drain, permanent side-slopes no steeper than 2H:1V are considered adequate for the excavation provided a contingency / allowance for slope protection using gravel sheeting (minimum 0.5 m thick and as per OPSS 511, Construction Specification for Rip-Rap, Rock Protection, and Granular Sheetting) is included in the Contract. A contingency for installation of counterfort drains at localized areas of groundwater seepage along the side-slopes should also be included in the Contract.

For deep cut slopes higher than 8 m (such as in Area 2), a 2 m wide bench is required (as per OPSD 202.010, Slope Flattening) in order to control surficial erosion and improve stability.



For temporary excavations, the surficial organic and soft soils (up to 1.5 m below ground surface) are considered to be Type 3 soils and the remaining soils are considered to be Type 2 soil according to the Occupational Health and Safety Act and Regulation for Construction Projects (OHSA). As such, temporary excavations in Type 2 soils should be carried out with walls sloped to within 1.2 m of the bottom with a slope having a minimum gradient of 1H:1V provided water is allowed sufficient time to drain. Similarly, Type 3 soils should have a minimum 1H:1V gradient to the base of the excavation. If dewatering is not implemented or if sufficient time is not allowed for the native soils to drain during the grade cut, temporary side-slopes should be no steeper than 2.5H:1V.

All excavations must be carried out in accordance with the latest edition of the OHSA.

#### **6.3.2.2 Obstructions (Cobbles and Boulders)**

Cobbles and boulders were observed at the ground surface throughout the proposed high fill and deep cut areas. Further, the native silty sand to sand and silt till and clayey silt till soils at the site contain cobbles and boulders as was inferred from grinding of and refusal to advancement of the augers and SPT sampler during borehole drilling and in-situ testing.

Conventional excavation equipment should be suitable for the majority of the excavation through the subsoils on site. However, the presence of boulders may interfere with or slow the progress of stripping and excavation operations. It is recommended that a NSSP be included in the Contract Documents to alert the Contractor of these obstructions and to ensure that the Contractor is equipped to handle such obstructions. An example NSSP is included in Appendix I.

#### **6.3.2.3 Control of Groundwater and Surface Water**

The groundwater level was measured in the piezometers to range from the ground surface to about 2.9 m below ground surface at the deep cut borehole locations. The new Highway 404 subgrade profile is expected to be constructed to depths ranging from 2.5 m to 6 m below the measured groundwater level during construction at the deep cut areas.

Given the relative density and grain size distribution of the silty sand to sand and silt till, silt and sand layers, and presence of sand seams and interlayers within the clayey silt till and cohesive layers, it is considered that groundwater will drain freely from the cut slopes during construction. Highway ditches and longitudinal sub-drains should be installed to adequately draw down the water level to avoid disturbance to the proposed highway subgrade and prevent surficial sloughing of the deep cut side-slopes. Gravel sheeting will be required for slope protection in localized areas of water seepage through the sand and silt layers. If excavation operations are to progress during wet periods of the year (i.e. Spring and Fall), gravel sheeting in combination with rip-rap and/or counterfort drains may be required to control erosion due to groundwater seepage. As a result, it is recommended that excavation for the deep cuts be performed during the dry period of the year (summer months). A NSSP for dewatering during deep cut excavations is included in Appendix I.

Surface water should be directed away from the excavations at all times. An interceptor trench should be provided along the top of the cut as per OPSD 200.020, Earth / Shale Grading.



## **7.0 CLOSURE**

This Foundation Design Report was prepared by Mr. Ted Beadle, and reviewed by Mr. Kevin J. Bentley, P.Eng., a Senior Geotechnical Engineer with Golder. Mr. Jorge M. A. Costa, P.Eng., Golder's Designated MTO Contact for this project and Principal with Golder, conducted an independent quality control review of the report.



**FOUNDATION INVESTIGATION AND DESIGN  
DEEP CUT / HIGH FILL AREAS 1 TO 8, W.P. 2005-07-00**

## Report Signature Page

**GOLDER ASSOCIATES LTD.**

Ted Beadle  
Geotechnical Group

Kevin Bentley, P. Eng.  
Senior Geotechnical Engineer



Jorge M.A. Costa, P. Eng.  
Designated MTO Contact, Principal

TB/KJB/JMAC/sm/jl

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## LIST OF SYMBOLS

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

### I. GENERAL

$\pi$	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

$\gamma$	shear strain
$\Delta$	change in, e.g. in stress: $\Delta \sigma$
$\varepsilon$	linear strain
$\varepsilon_v$	volumetric strain
$\eta$	coefficient of viscosity
$\nu$	poisson's ratio
$\sigma$	total stress
$\sigma'$	effective stress ( $\sigma' = \sigma - \mu$ )
$\sigma'_{vo}$	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
$\sigma_{oct}$	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
$\tau$	shear stress
$\mu$	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
$\gamma'$	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  $\rho$ . Unit weight symbol is  $\gamma$  where  $\gamma = \rho g$  (i.e. mass density multiplied by acceleration due to gravity)

#### (a) Index Properties (continued)

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

#### (b) Hydraulic Properties

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

#### (c) Consolidation (one-dimensional)

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

#### (d) Shear Strength

$T_p, T_r$	peak and residual shear strength
$\phi'$	effective angle of internal friction
$\delta$	angle of interface friction
$\mu$	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



## LIST OF ABBREVIATIONS

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

### I. SAMPLE TYPE

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

### II. PENETRATION RESISTANCE

#### Standard Penetration Resistance (SPT), N:

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

#### Dynamic Cone Penetration Resistance; $N_d$ :

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

<b>PH:</b>	Sampler advanced by hydraulic pressure
<b>PM:</b>	Sampler advanced by manual pressure
<b>WH:</b>	Sampler advanced by static weight of hammer
<b>WR:</b>	Sampler advanced by weight of sampler and rod

#### Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm<sup>2</sup> 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	N
Relative Density	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 <sup>1</sup>
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement <sup>1</sup>
$D_R$	relative density (specific gravity, $G_s$ )
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
$SO_4$	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
$\gamma$	unit weight

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

**TABLE 1**  
**SUMMARY OF HIGH FILL FOUNDATION RECOMMENDATIONS**  
**HIGHWAY 404 EXTENSION FROM QUEENSVILLE SIDEROAD TO RAVENSHOE ROAD**  
**W.P. 2005-07-00**

<b>Hwy 404 Centreline Chainage (High Fill Area)</b>	<b>Proposed Maximum Fill Height</b>	<b>Topography and Surface Conditions</b>	<b>Organics Encountered Along Alignment<sup>1</sup></b>	<b>Recommended Embankment Fill Type and Side Slope</b>	<b>Stability / Settlement Mitigation Option<sup>1,2</sup></b>	<b>Estimated Settlement (<math>\delta</math>) During Construction<sup>3</sup></b>	<b>Estimated Post- Construction Settlement (<math>\delta</math>)</b>
Highway 404 STA 33+900 to STA 34+160 (Area 1)	High Fill (up to 8 m)	Shallow valley with wet grassy area and occasional shallow open water along valley floor where an intermittent creek flows towards Maskinonge River located east of site. Valley side slopes consist of grassy areas.	Topsoil / Organics up to about 1.5 m below ground surface.	Earth Fill with 2H : 1V side-slopes	Option 1: Strip topsoil / organics only	$\delta_{\text{Immediate}} = 50 \text{ mm}$	$\delta_{\text{Primary}} = 50 \text{ mm}$ $\delta_{\text{Primary}} < 25 \text{ mm}$ after 3 month preload
					Option 2: Sub-Excavation of upper clayey silt layer to 1.5 m depth	$\delta_{\text{Immediate}} = 50 \text{ mm}$	$\delta_{\text{Primary}} = 25 \text{ mm}$
Highway 404 STA 35+000 to STA 35+150 (Area 4)	High Fill (up to 5 m)	Flat, low-lying area in existing farm field. Southern limit consists of undulating, tree-covered terrain with an existing residence and driveway.	Topsoil / Clayey Silt containing Organics up to 0.6 m below ground surface.	Earth Fill with 2H : 1V side-slopes	Option 1: Strip Topsoil / Clayey Silt containing Organics up to 0.6 m below ground surface	$\delta_{\text{Immediate}} = 25 \text{ mm}$	$\delta_{\text{Primary}} = 25 \text{ mm}$
					Option 2: Subexcavation of firm clayey silt to silty clay up to 1.5 m below ground surface	$\delta_{\text{Immediate}} = 25 \text{ mm}$	$\delta_{\text{Primary}} = 0 \text{ mm}$
Highway 404 STA 36+870 to STA 37+150 (Area 6)	High Fill (up to 6 m)	Generally flat topography within farm fields. Existing Boag Road crosses through the site at Station 37+090. A shallow valley is located south of Boag Road that slopes west to east towards Maskinonge River.	Topsoil up to about 0.8 m below ground surface.	Earth Fill with 2H : 1V side-slopes	Option 1: Strip topsoil up to 0.8 m below ground surface	$\delta_{\text{Immediate}} = 25 \text{ mm}$	$\delta_{\text{Primary}} = 75 \text{ mm}$ $\delta_{\text{Primary}} < 25 \text{ mm}$ after 3 month preload
					Option 2: Subexcavation of soft to firm clayey silt up to 1.5 m below ground surface	$\delta_{\text{Immediate}} = 25 \text{ mm}$	$\delta_{\text{Primary}} = 0 \text{ mm}$
Highway 404 STA 38+200 to STA 38+500 (Area 8)	High Fill (up to 4 m)	Flat, low-lying area with surface cover consisting of wet grassy areas, shallow open water and gently sloping tree covered terrain sloping down towards the central and southern limits of the site.	Topsoil up to about 0.5 m below ground surface.	Earth Fill with 2H : 1V side-slopes	Option 1: Strip topsoil up to 0.5 m below ground surface	$\delta_{\text{Immediate}} = 15 \text{ mm}$	$\delta_{\text{Primary}} = 75 \text{ mm}$ $\delta_{\text{Primary}} < 25 \text{ mm}$ after 3 month preload
					Option 2: Subexcavation of soft to firm clayey silt up to 1.4 m below ground surface (Preload for 1 month)	$\delta_{\text{Immediate}} = 15 \text{ mm}$	$\delta_{\text{Primary}} = 50 \text{ mm}$ $\delta_{\text{Primary}} < 25 \text{ mm}$ after 1 month preload

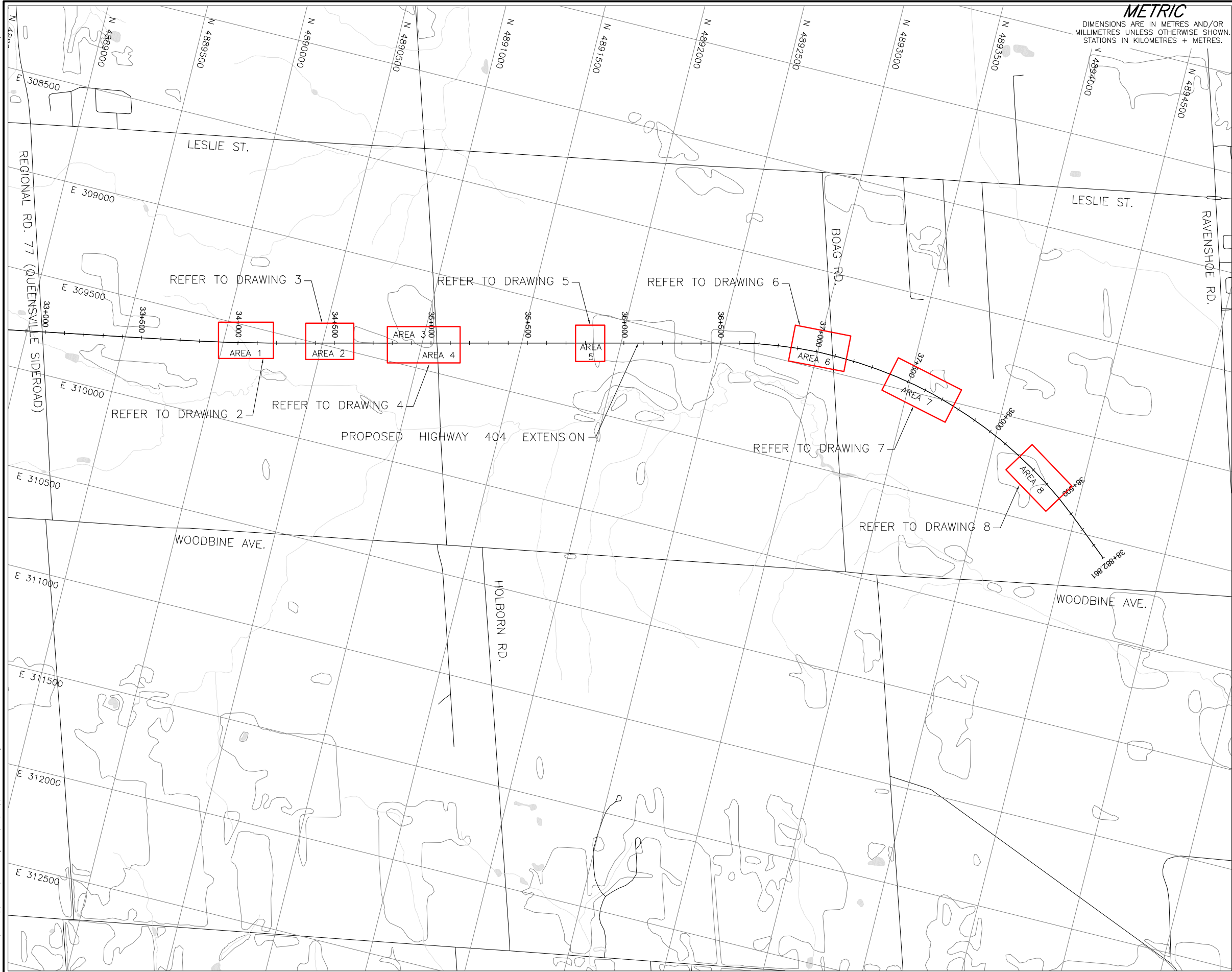
Note: <sup>1</sup> Removal of organic deposits (i.e. topsoil and/or soils containing excessive organics) is required prior to embankment construction.

<sup>2</sup> Full sub-excavation implies complete removal of soft to firm compressible cohesive deposits.

<sup>3</sup> Settlement does not include settlement of embankment fill itself.

**TABLE 2**  
**SUMMARY OF DEEP CUT FOUNDATION RECOMMENDATIONS**  
**HIGHWAY 404 EXTENSION FROM QUEENSVILLE SIDEROAD TO RAVENSHOE ROAD**  
**W.P. 2005-07-00**

<b><i>Hwy 404 Centreline Chainage (Deep Cut Area)</i></b>	<b><i>Proposed Maximum Depth of Cut</i></b>	<b><i>Topography and Surface Conditions</i></b>	<b><i>Recommended Cut Side Slope</i></b>	<b><i>Recommended Dewatering Measures</i></b>	<b><i>Other Considerations</i></b>
Highway 404 STA 34+360 to 34+600 (Area 2)	Deep Cut (up to 8.5 m)	Generally flat consisting of farm fields and localized strips of tree covered terrain along existing property boundaries.	Cut in native soils with 2H : 1V side-slopes. A 2 m wide bench is required	Excavate Hwy 404 ditch grade from north to south to allow for permanent passive drainage of groundwater prior to excavating final side-slopes. Sub-drains may be required.	Allowance for gravel sheeting (possibly in combination with counterfort trench) should be provided in the Contract. Some cobbles / boulders present within the proposed cut depth.
Highway 404 STA 34+780 to 34+880 (Area 3)	Deep Cut (up to 4 m)	Undulating terrain on top of a "rolling" hill, with grassy areas, existing residence/driveway, and pockets of tree covered terrain.	Cut in native soils with 2H : 1V side-slopes	Excavate Hwy 404 ditch grade from south to north to allow for permanent passive drainage of groundwater prior to excavating final side-slopes. Sub-drains may be required.	Allowance for gravel sheeting (possibly in combination with counterfort trench) should be provided in the Contract. Some cobbles / boulders present within the proposed cut depth.
Highway 404 STA 35+750 to 35+900 (Area 5)	Deep Cut (up to 5 m)	"Rolling" hill in farm field, dense trees located within northern half of site.	Cut in native soils with 2H : 1V side-slopes.	Excavate Hwy 404 ditch grade from north to south to allow for passive drainage of groundwater prior to excavating final side-slopes. Subdrains may be required.	Allowance for gravel sheeting (possibly in combination with counterfort trench) should be provided in the Contract. Some cobbles / boulders present within the proposed cut depth.
Highway 404 STA 37+400 to 37+760 (Area 7)	Deep Cut (up to 6 m)	"Rolling" hill consisting of grassy areas and localized tree covered areas.	Cut in native soils with 2H : 1V side-slopes.	Excavate Hwy 404 ditch grade from north to south to allow for passive drainage of groundwater prior to excavating final side-slopes. Subdrains may be required.	Allowance for gravel sheeting (possibly in combination with counterfort trench) should be provided in the Contract. Cobbles and boulders present in the majority of the proposed cut depth.



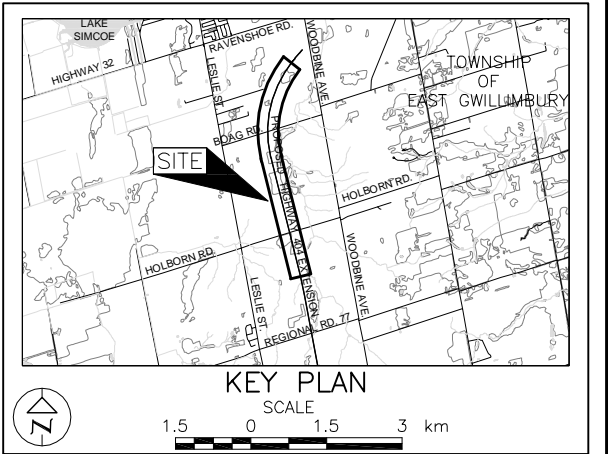
**METRIC**  
DIMENSIONS ARE IN METRES AND/OR  
MILLIMETRES UNLESS OTHERWISE SHOWN.  
STATIONS IN KILOMETRES + METRES.

CONT No.  
WP No. 2005-07-00

HIGHWAY 404 EXTENSION  
DEEP CUT AND HIGH FILL AREAS 1 to 8  
INDEX PLAN

**Golder Associates**

**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA

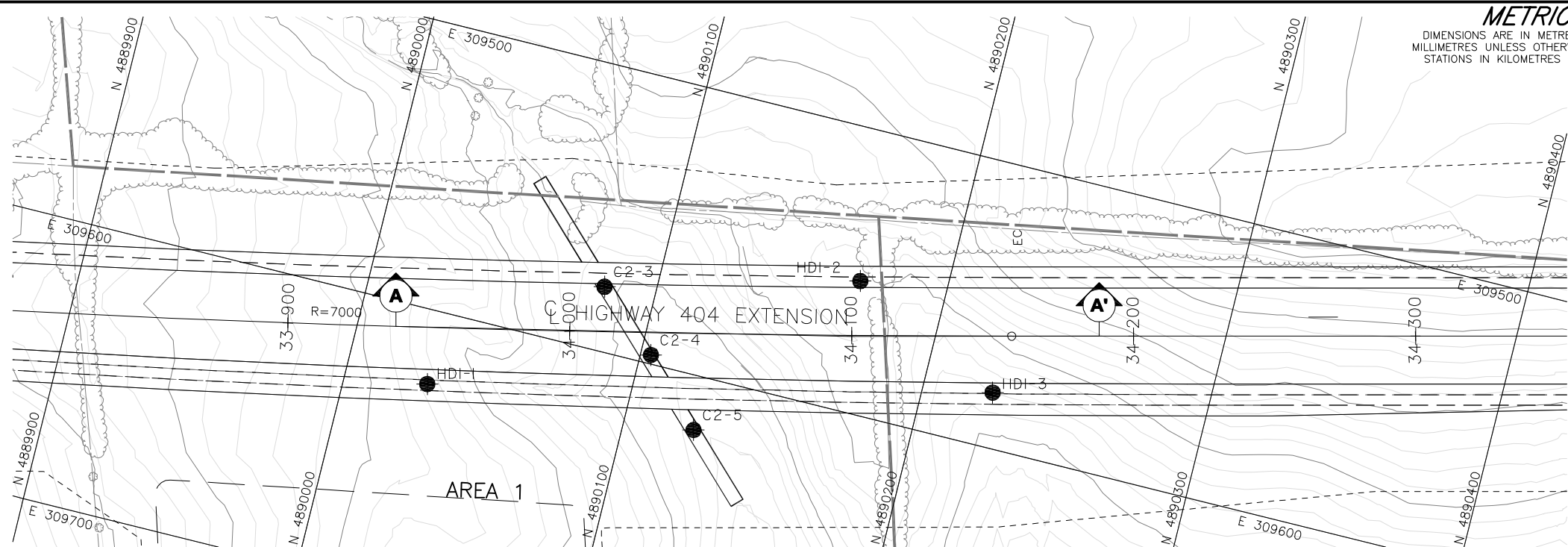


**NOTES**  
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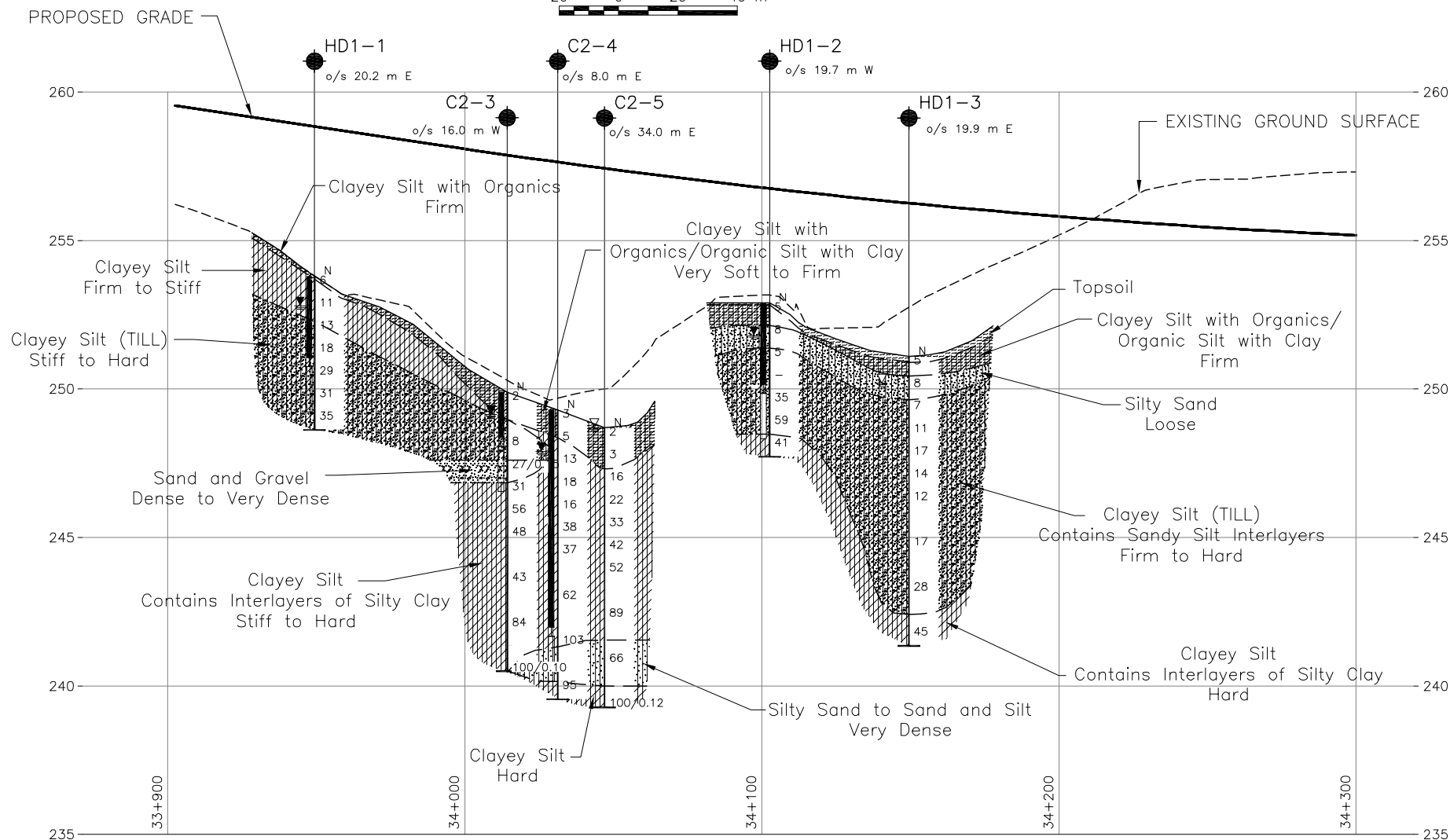
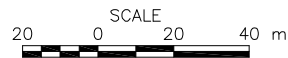
**REFERENCE**  
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NO.	DATE	BY	REVISION
Geocres No. 31D-494			
HWY. 404	PROJECT NO. 08-1111-0022		DIST.
SUBM'D.	CHKD. TB	DATE: 2/18/2010	SITE:
DRAWN: JFC/RJ	CHKD. KJB	APPD. JMAC	DWG. 1

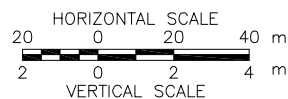




PLAN



CENTRELINE PROFILE



**METRIC**  
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CONT No.  
WP No. 2005-07-00

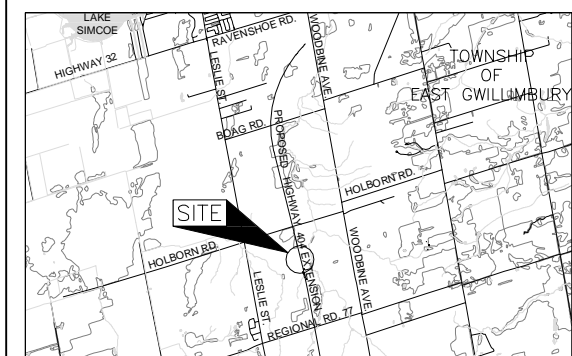


HIGHWAY 404 EXTENSION  
STA. 33+900 to STA. 34+160 (HIGH FILL AREA 1)  
BOREHOLE LOCATION AND SOIL STRATA

SHEET



**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN



SCALE  
1.5 0 1.5 3 km

LEGEND

- Borehole - Current Investigation
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated  
(Std. Pen. Test, 475 j/blow)
- WL in piezometer, measured on June 12, 2009
- WL upon completion of drilling

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
C2-3	249.9	4890085.8	309582.1
C2-4	249.3	4890107.6	309601.6
C2-5	248.7	4890128.7	309623.7
HD1-1	253.8	4890029.2	309626.0
HD1-2	252.9	4890169.4	309553.5
HD1-3	251.1	4890224.5	309580.5

NOTES

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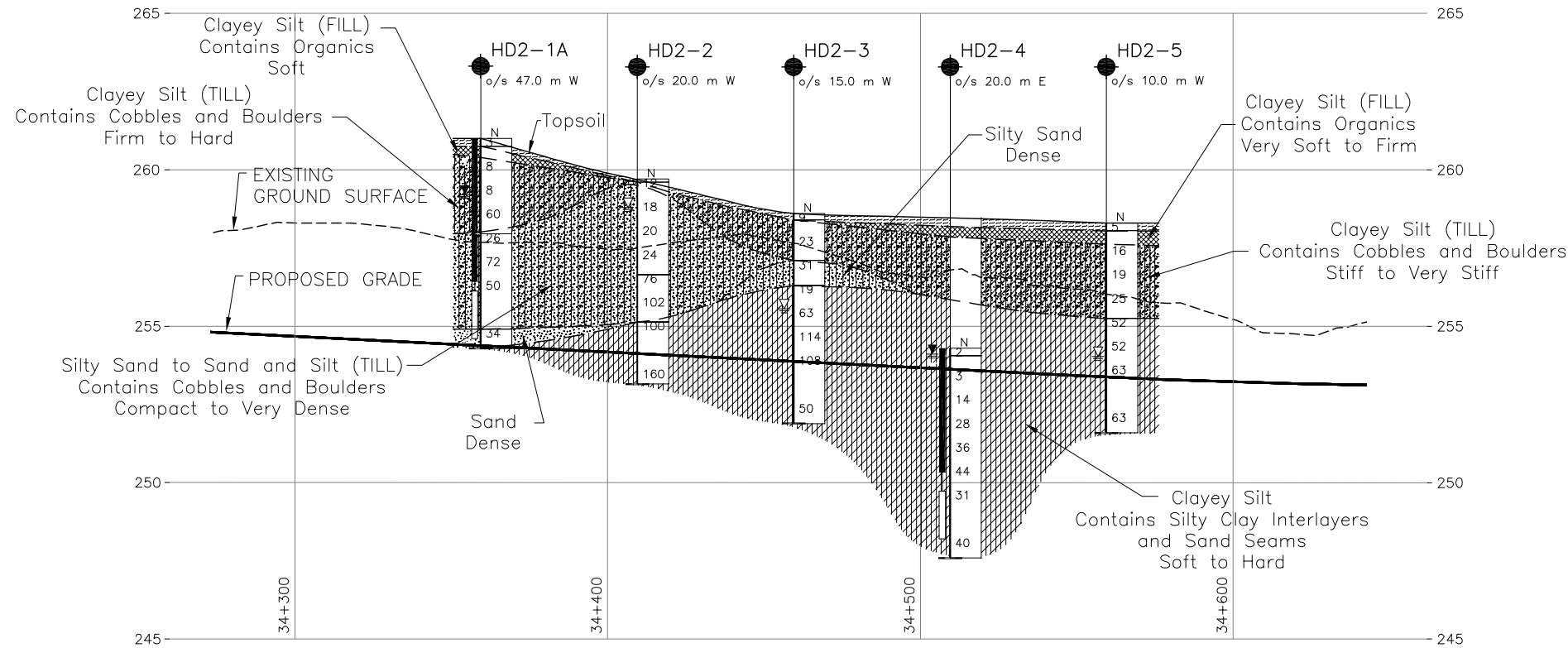
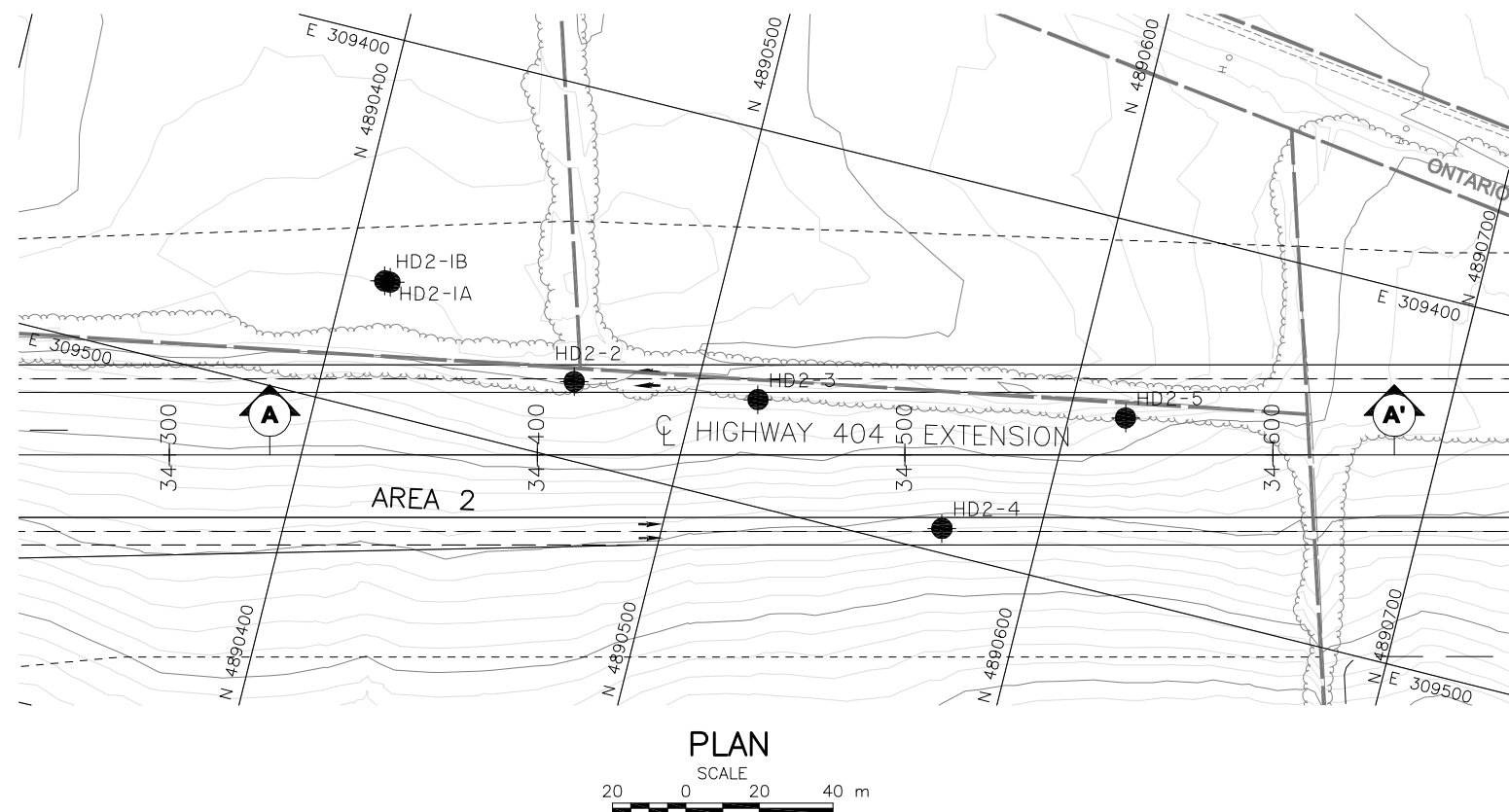
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DRAWN: JFC/RJ	CHKD. KJB	APPD. JMAC	DWG. 2



**A-A'** CENTRELINE PROFILE

HORIZONTAL SCALE  
20 0 20 40 m

VERTICAL SCALE  
2 0 2 4 m

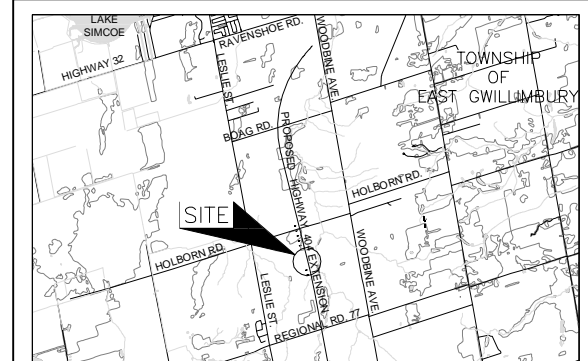
**METRIC**  
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CONT No.  
WP No. 2005-07-00

HIGHWAY 404 EXTENSION  
STA. 34+360 to STA. 34+600 (DEEP CUT AREA 2)  
BOREHOLE LOCATION AND SOIL STRATA



**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA



- LEGEND**
- Borehole - Current Investigation
  - Seal
  - Piezometer
  - N Standard Penetration Test Value
  - 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
  - WL in piezometer, measured on June 12, 2009
  - WL upon completion of drilling

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
HD2-1A	261.0	4890412.1	309464.8
HD2-1B	261.0	4890410.6	309464.8
HD2-2	259.7	4890467.2	309478.9
HD2-3	258.6	4890516.9	309471.6
HD2-4	254.3	4890573.9	309493.5
HD2-5	258.3	4890615.1	309452.3

**NOTES**

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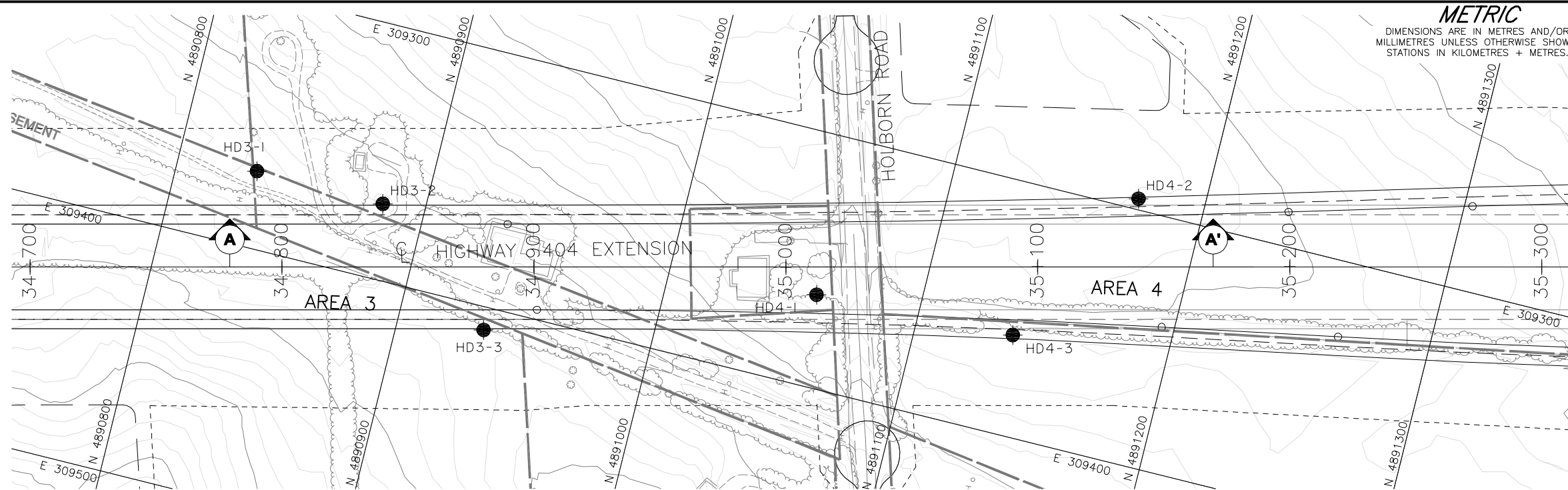
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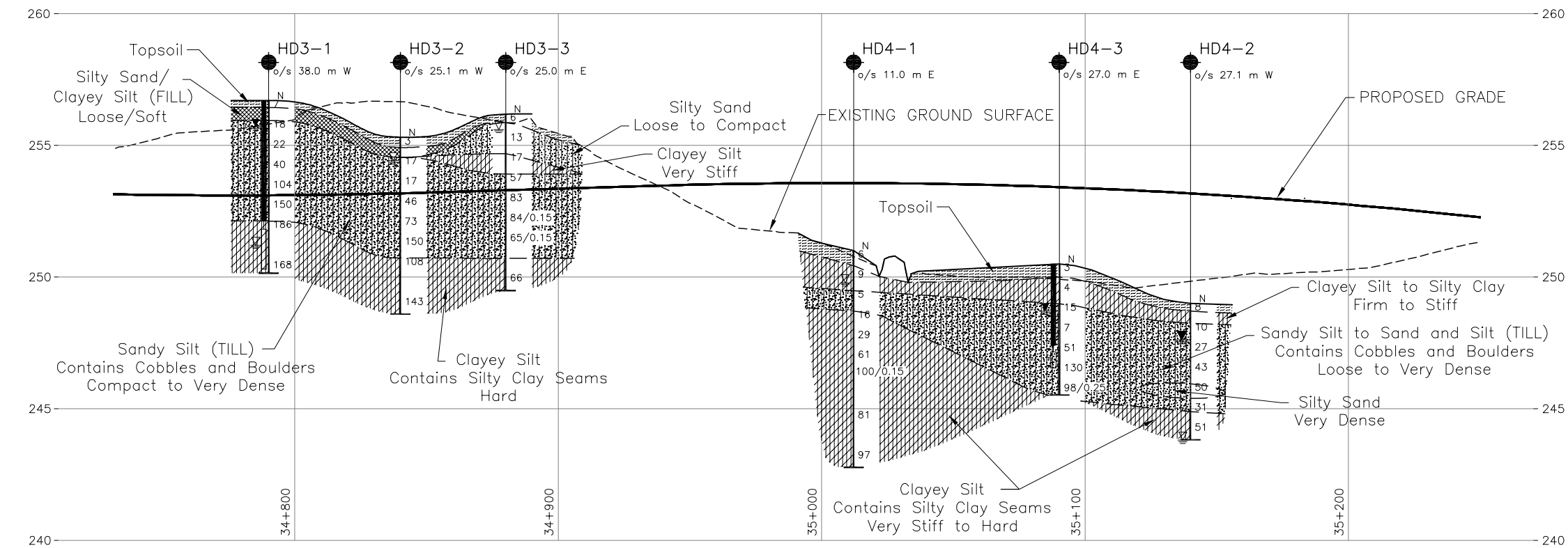
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DRAWN: JFC/RJ	CHKD. KJB	APPD. JMAC	DWG. 3





PLAN  
SCALE  
20 0 20 40 m



A-A' CENTRELINE PROFILE  
HORIZONTAL SCALE  
20 0 20 40 m  
VERTICAL SCALE  
2 0 2 4 m

**METRIC**  
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STATIONS IN KILOMETRES + METRES.

CONT No.  
WP No. 2005-07-00

HIGHWAY 404 EXTENSION  
STA. 34+780 to STA. 34+880 (DEEP CUT AREA 3)  
STA. 35+000 to STA. 35+150 (HIGH FILL AREA 4)  
BOREHOLE LOCATION AND SOIL STRATA



SHEET



**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN  
SCALE  
1.5 0 1.5 3 km

### LEGEND

- Borehole - Current Investigation
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated  
(Std. Pen. Test, 475 j/blow)
- WL in piezometer, measured on June 12, 2009
- WL upon completion of drilling

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
HD3-1	256.7	4890831.6	309369.6
HD3-2	255.3	4890883.2	309370.1
HD3-3	256.2	4890934.1	309409.0
HD4-1	251.0	4891059.0	309363.5
HD4-2	249.0	4891173.8	309295.7
HD4-3	250.5	4891138.4	309360.2

### NOTES

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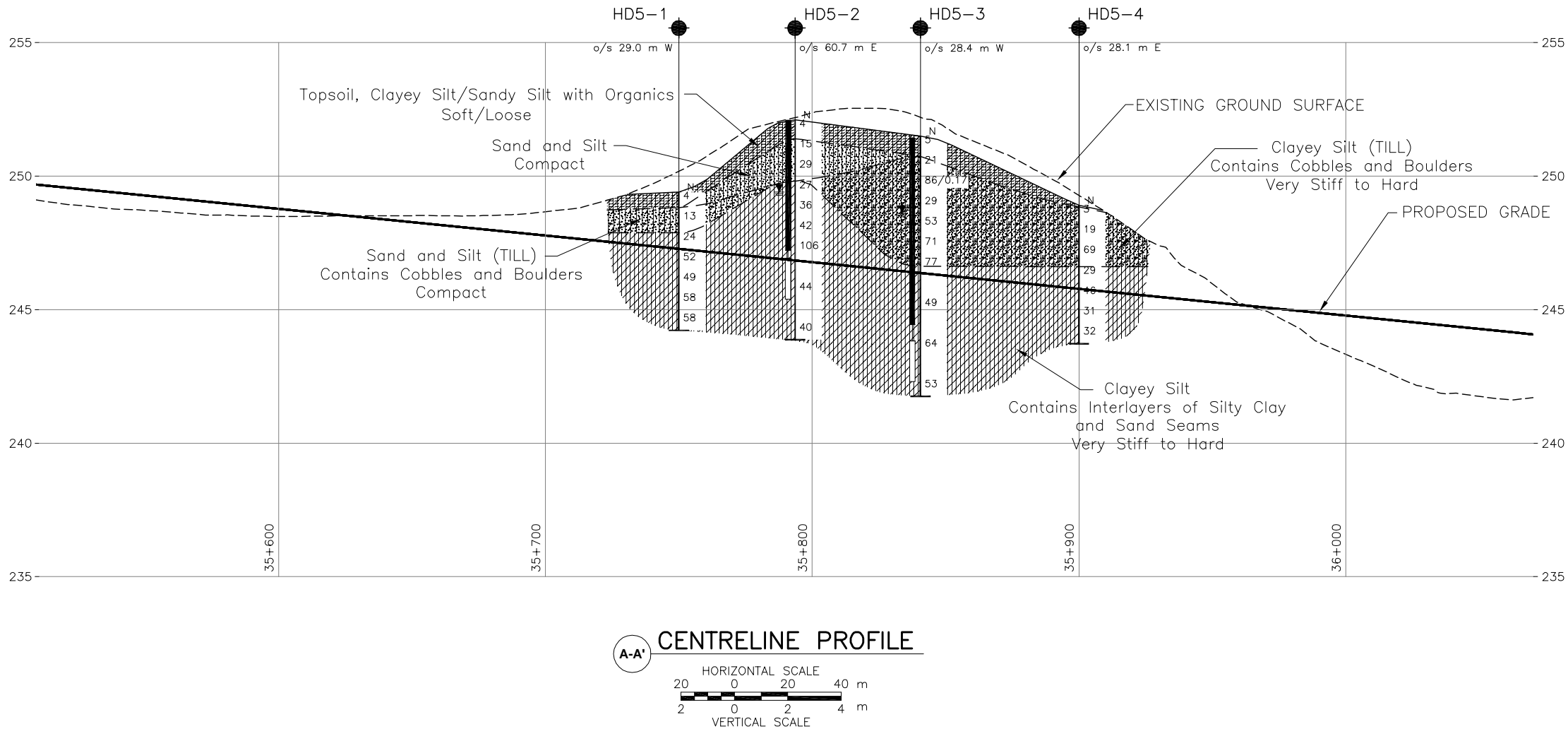
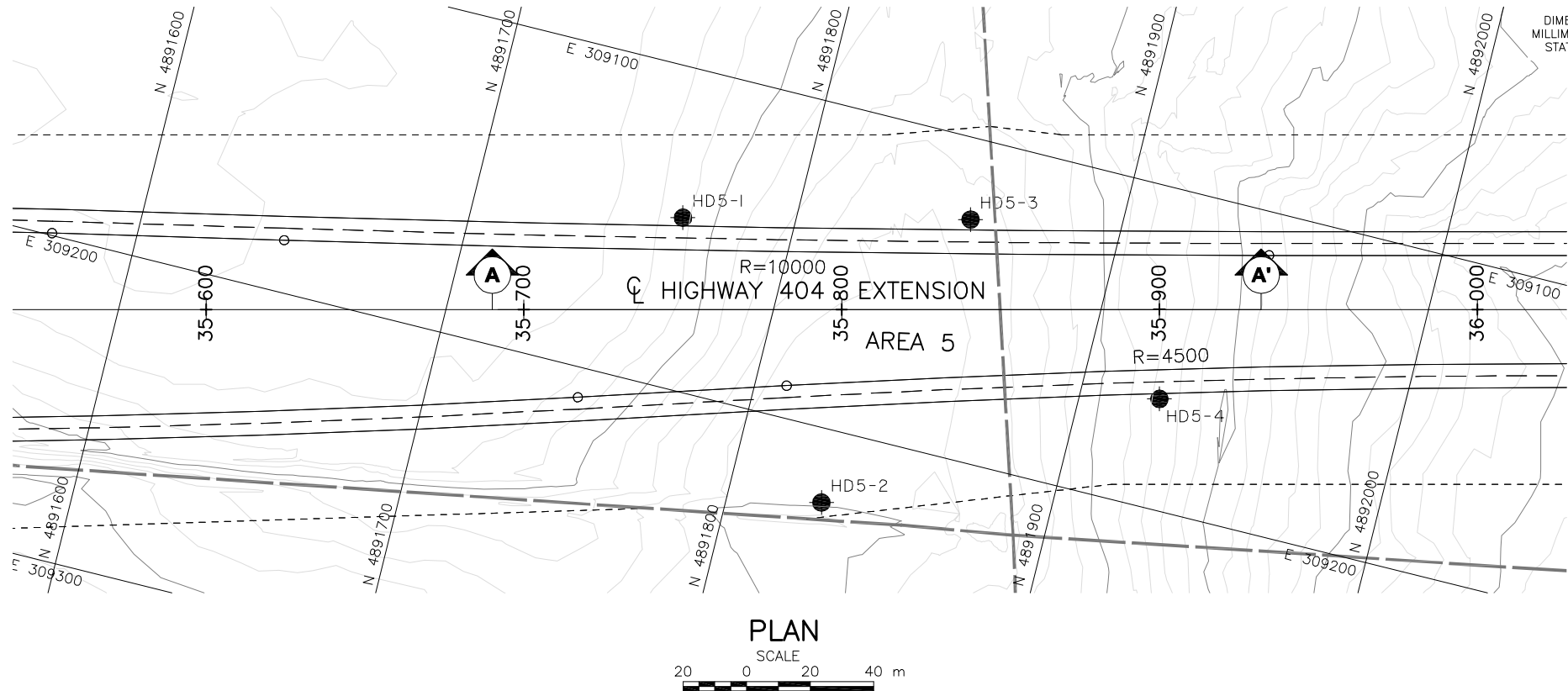
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SUBM'D.	CHKD. TB	DATE: 2/18/2010	SITE:
DRAWN: RJ/JFC	CHKD. KJB	APPD. JMAC	DWG. 4



CONT No.  
WP No. 2005-07-00

HIGHWAY 404 EXTENSION  
STA. 35+750 to STA. 35+900 (DEEP CUT AREA 5)  
BOREHOLE LOCATION AND SOIL STRATA



Golder Associates Ltd.  
MISSISSAUGA, ONTARIO, CANADA



- LEGEND
- Borehole - Current Investigation
  - Seal
  - Piezometer
  - N Standard Penetration Test Value
  - 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
  - WL in piezometer, measured on June 12, 2009
  - WL upon completion of drilling

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
HD5-1	249.4	4891765.3	309146.5
HD5-2	252.1	4891829.3	309223.0
HD5-3	251.5	4891853.3	309125.6
HD5-4	248.9	4891924.6	309165.6

**NOTES**

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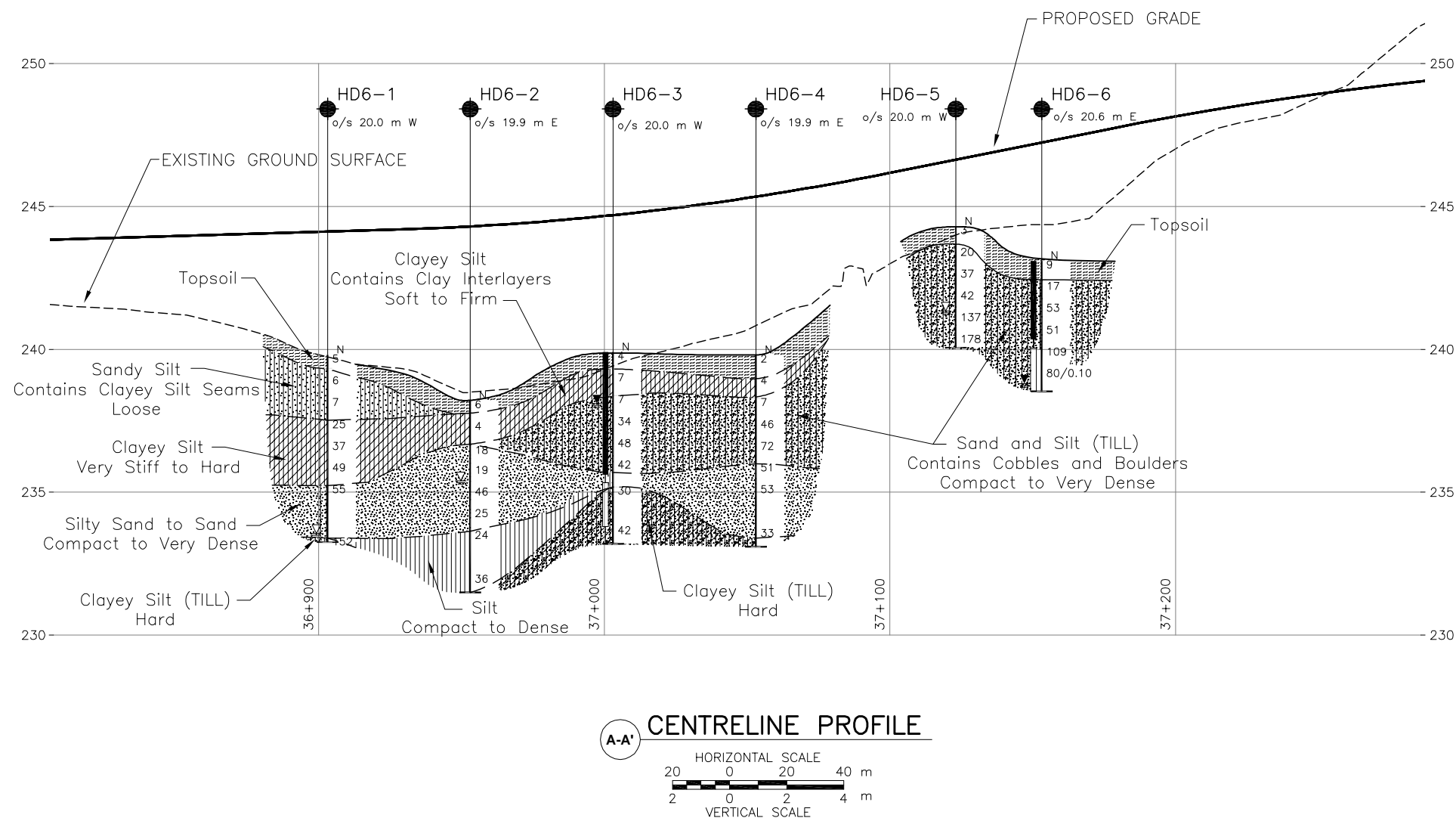
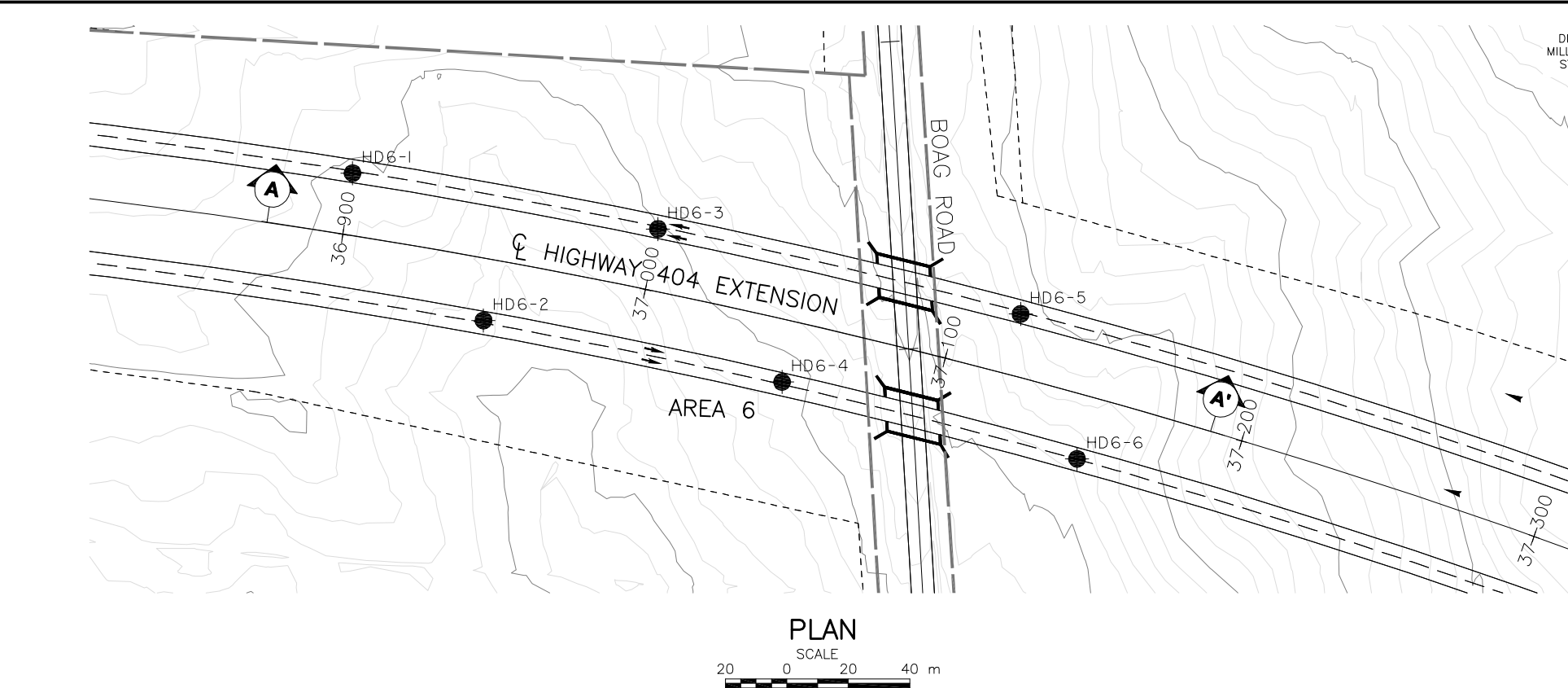
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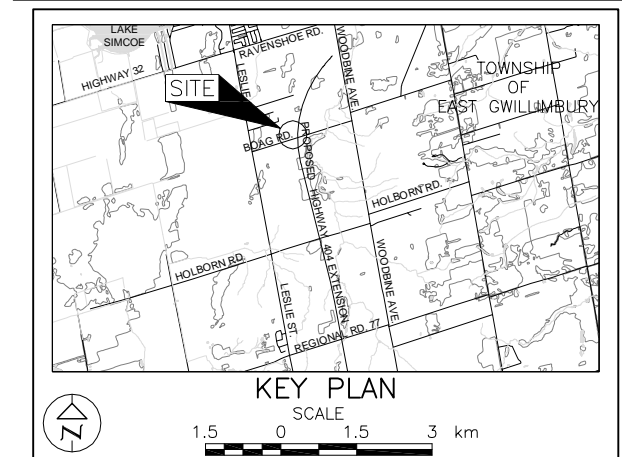
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SUBM'D.	CHKD. TB	DATE: 2/18/2010	SITE:
DRAWN: JFC/RJ	CHKD. KJB	APPD. JMAC	DWG. 5



CONT No.  
WP No. 2005-07-00

HIGHWAY 404 EXTENSION  
STA. 36+870 to STA. 37+150 (HIGH FILL AREA 6)  
BOREHOLE LOCATION AND SOIL STRATA

**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA



LEGEND				
	Borehole - Current Investigation			
	Seal			
	Piezometer			
N	Standard Penetration Test Value			
16	Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)			
	WL in piezometer, measured on June 12, 2009			
	WL upon completion of drilling			
No.	ELEVATION	CO-ORDINATES		
		NORTHING	EASTING	
HD6-1	239.8	4892891.8	308903.8	
HD6-2	238.2	4892944.6	308939.9	
HD6-3	239.9	4892992.5	308897.4	
HD6-4	239.8	4893043.6	308935.8	
HD6-5	244.3	4893113.5	308895.7	
HD6-6	243.1	4893142.7	308936.9	

**NOTES**

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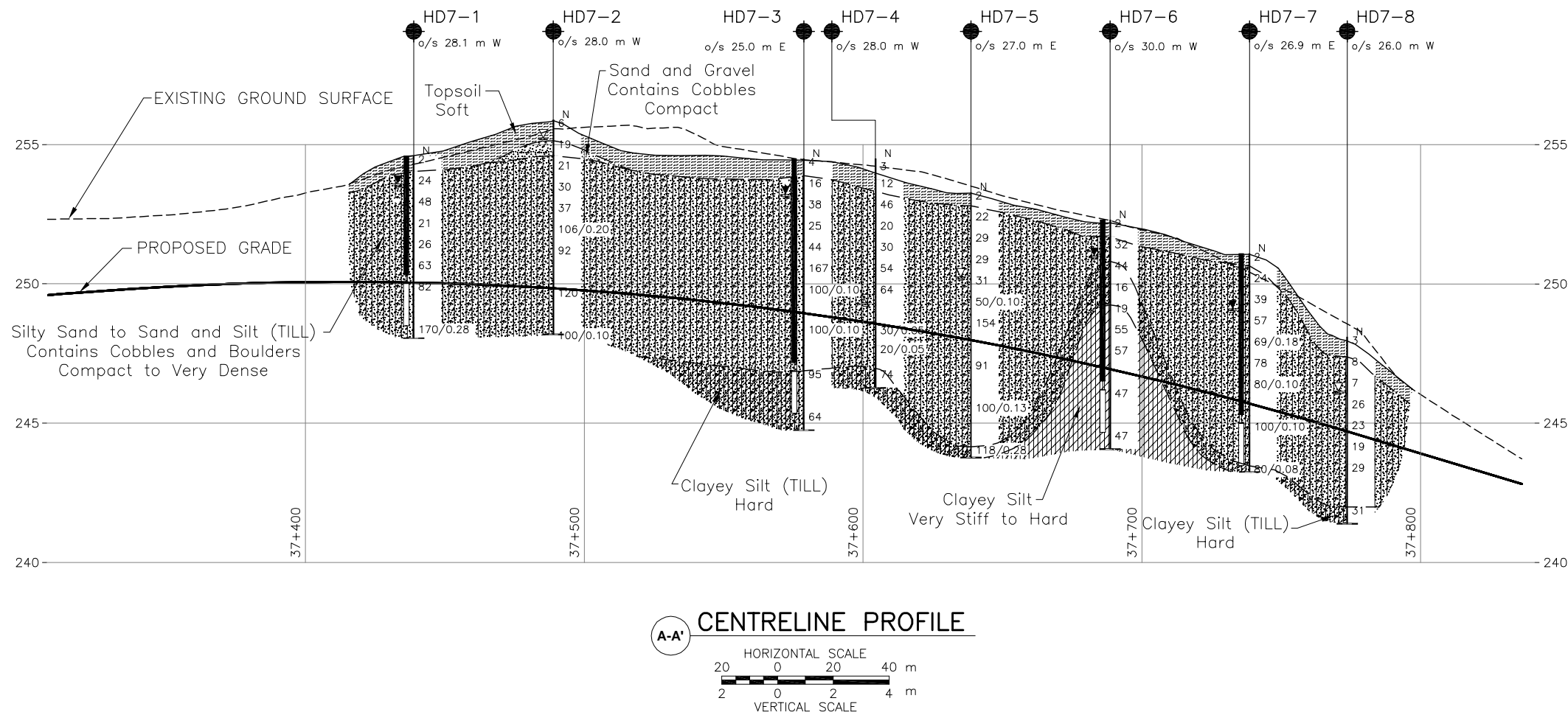
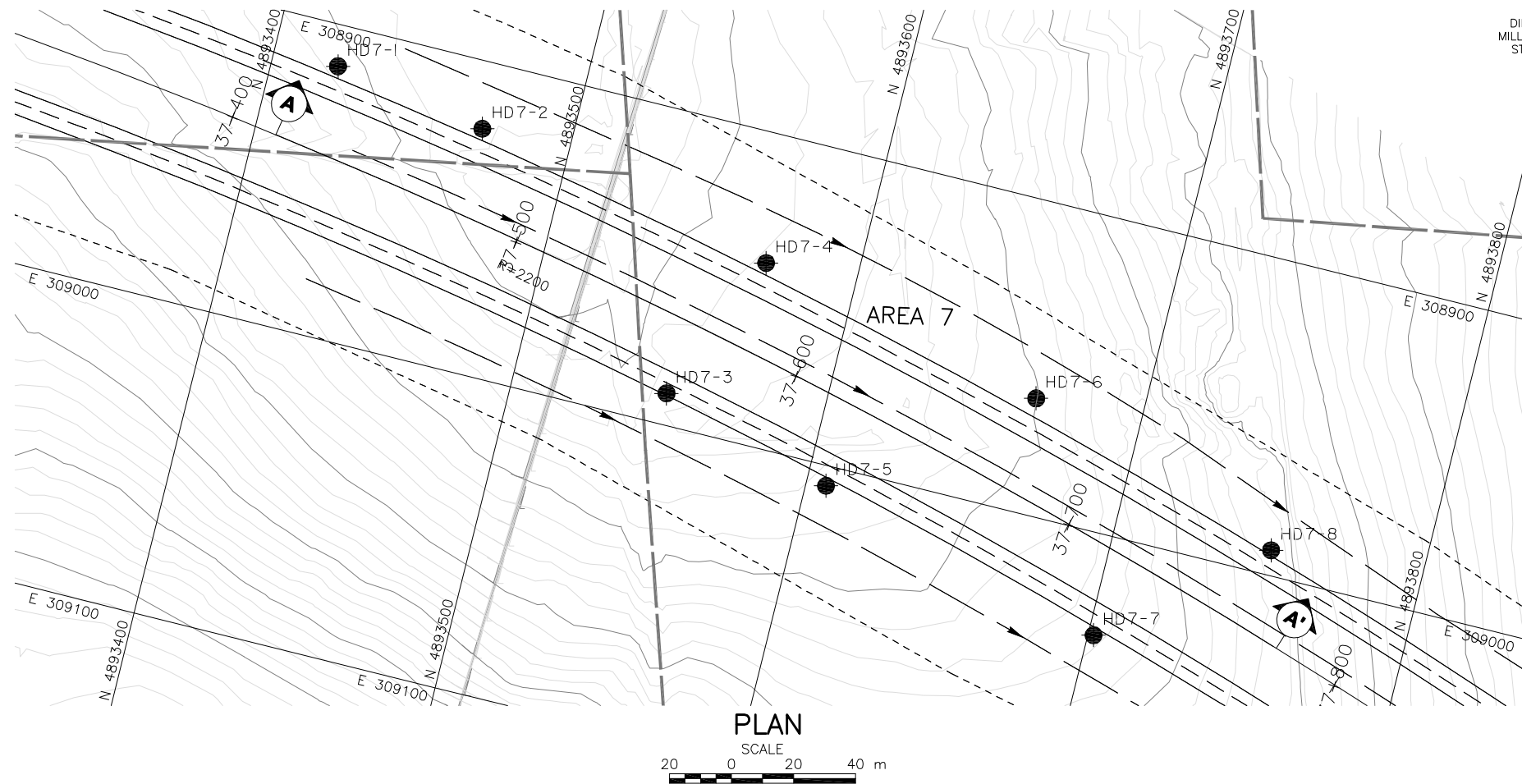
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Geores No. 31D-494			
HWY. 404	PROJECT NO. 08-1111-0022		DIST.
SUBM'D.	CHKD. TB	DATE: 2/18/2010	SITE:
DRAWN: JFC/RJ	CHKD. KJB	APPD. JMAC	DWG. 6



CONT No.  
WP No. 2005-07-00HIGHWAY 404 EXTENSION  
STA. 37+400 to STA. 37+760 (DEEP CUT AREA 7)  
BOREHOLE LOCATION AND SOIL STRATA

SHEET

**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA**KEY PLAN**

SCALE

1.5 0 1.5 3 km

**LEGEND**

- Borehole - Current Investigation
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL in piezometer, measured on June 12, 2009
- WL upon completion of drilling

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
HD7-1	254.6	4893421.2	308913.2
HD7-2	255.9	4893471.2	308921.5
HD7-3	254.5	4893549.4	308989.9
HD7-4	254.5	4893570.4	308941.4
HD7-5	253.3	4893606.5	309006.4
HD7-6	252.3	4893665.4	308962.7
HD7-7	251.1	4893701.8	309032.3
HD7-8	248.1	4893750.7	308991.9

**NOTES**

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

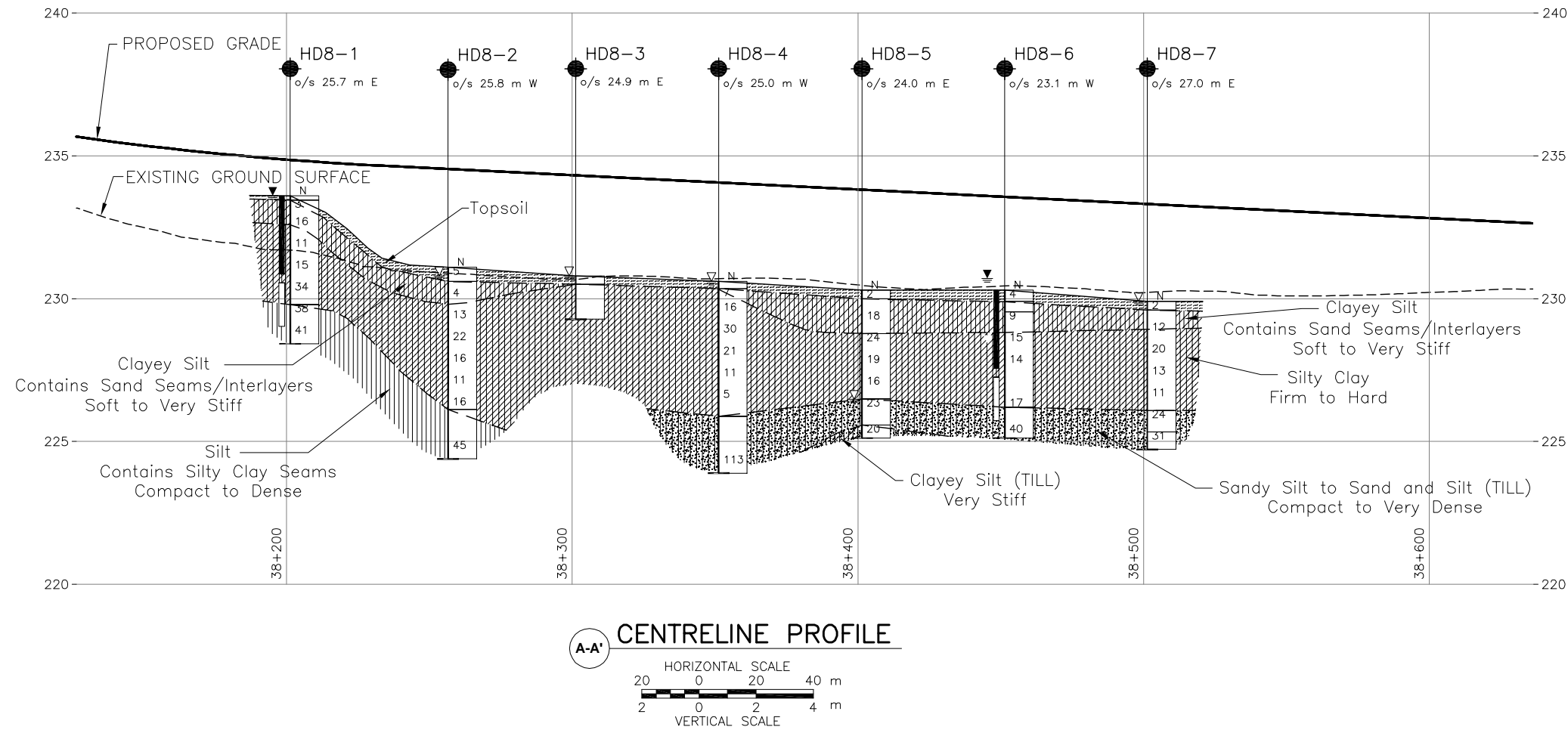
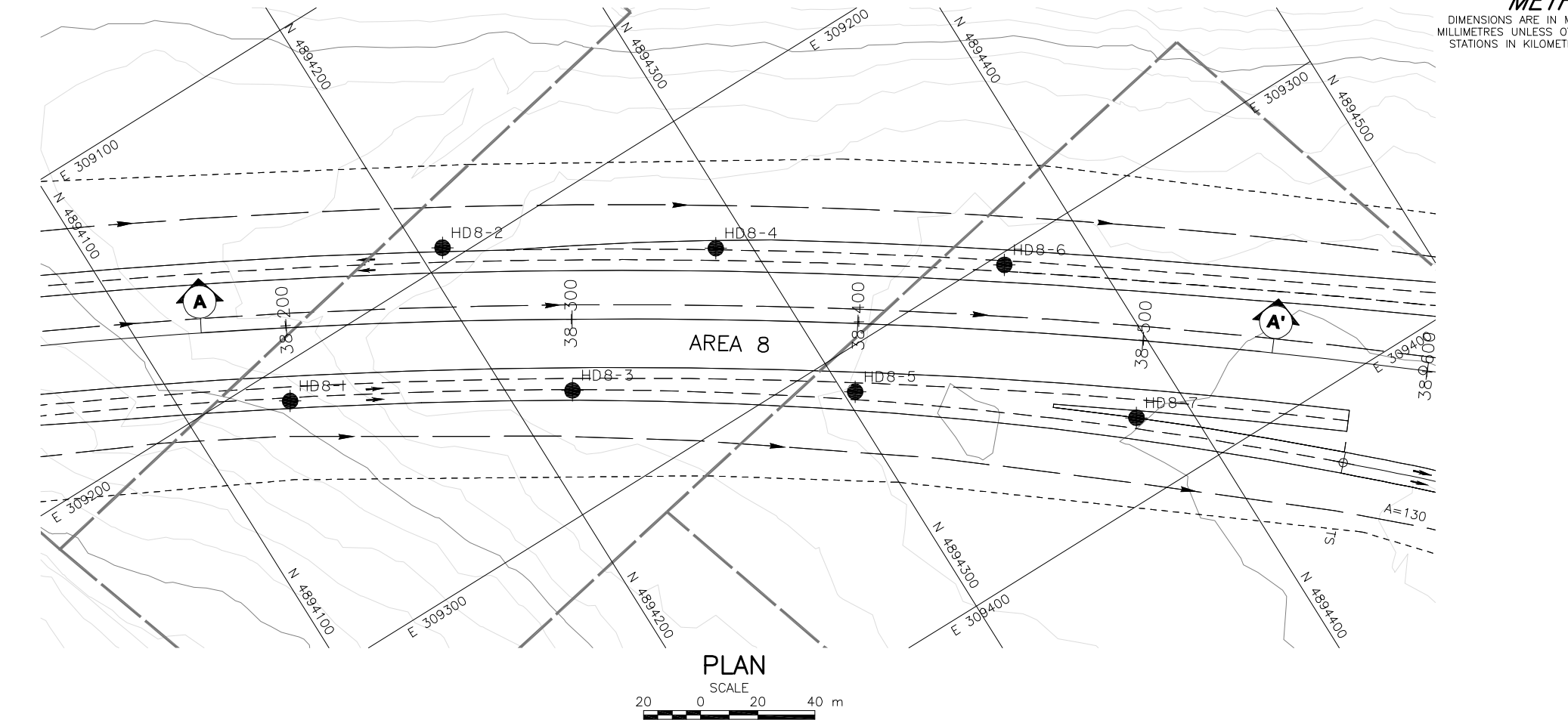
The boundaries between soil strata have been established only at borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

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

**REFERENCE**

Base plans provided in digital format by AECOM, drawing file no. "x-design 2.dwg", received, November, 04, 2008 and drawing file no. "2538-199-00-ct-xprofile.dwg", received April 21, 2009.

NO.	DATE	BY	REVISION
Geocres No. 31D-494			
HWY. 404	PROJECT NO. 08-1111-0022		DIST.
SUBM'D.	CHKD. TB	DATE: 2/18/2010	SITE:
DRAWN: JFC/RJ	CHKD. KJB	APPD. JMAC	DWG. 7

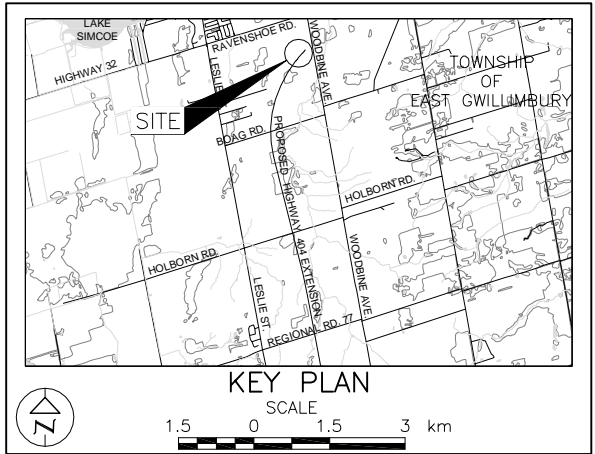


CONT No. WP No. 2005-07-00

HIGHWAY 404 EXTENSION

STA. 38+200 to STA. 38+500 (HIGH FILL AREA 8)

BOREHOLE LOCATION AND SOIL STRATA



- LEGEND**
- Borehole - Current Investigation
  - Seal
  - Piezometer
  - N Standard Penetration Test Value
  - 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
  - WL in piezometer, measured on June 12, 2009
  - WL upon completion of drilling

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
HD8-1	233.6	4894134.3	309212.1
HD8-2	231.1	4894207.9	309194.7
HD8-3	230.8	4894220.0	309261.2
HD8-4	230.6	4894289.0	309245.5
HD8-5	230.3	4894303.7	309313.9
HD8-6	230.3	4894371.6	309303.8
HD8-7	229.9	4894382.5	309373.7

**NOTES**

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

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

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

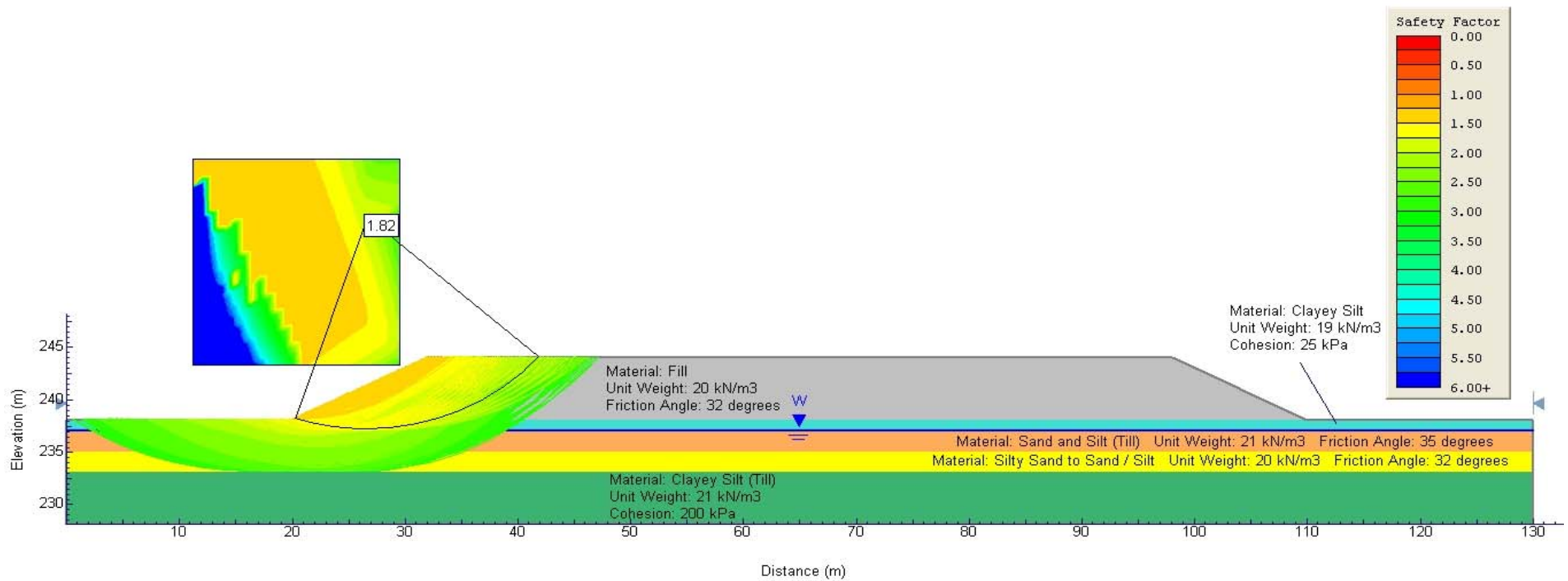
**REFERENCE**

Base plans provided in digital format by AECOM, drawing file no. "x-design 2.dwg", received, November, 04, 2008 and drawing file no. "2538-199-00-ct-xprofile.dwg", received April 21, 2009.

NO.	DATE	BY	REVISION
Geocres No. 31D-494			
HWY. 404	PROJECT NO. 08-1111-0022		DIST.
SUBM'D.	CHKD. TB	DATE: 2/18/2010	SITE:
DRAWN: JFC/RJ	CHKD. KJB	APPD. JMAC	DWG. 8

Static Global Stability Analysis Results  
High Fill - Area 6 - Station 36+975  
2H : 1V Embankment Fill Slope

Figure 1



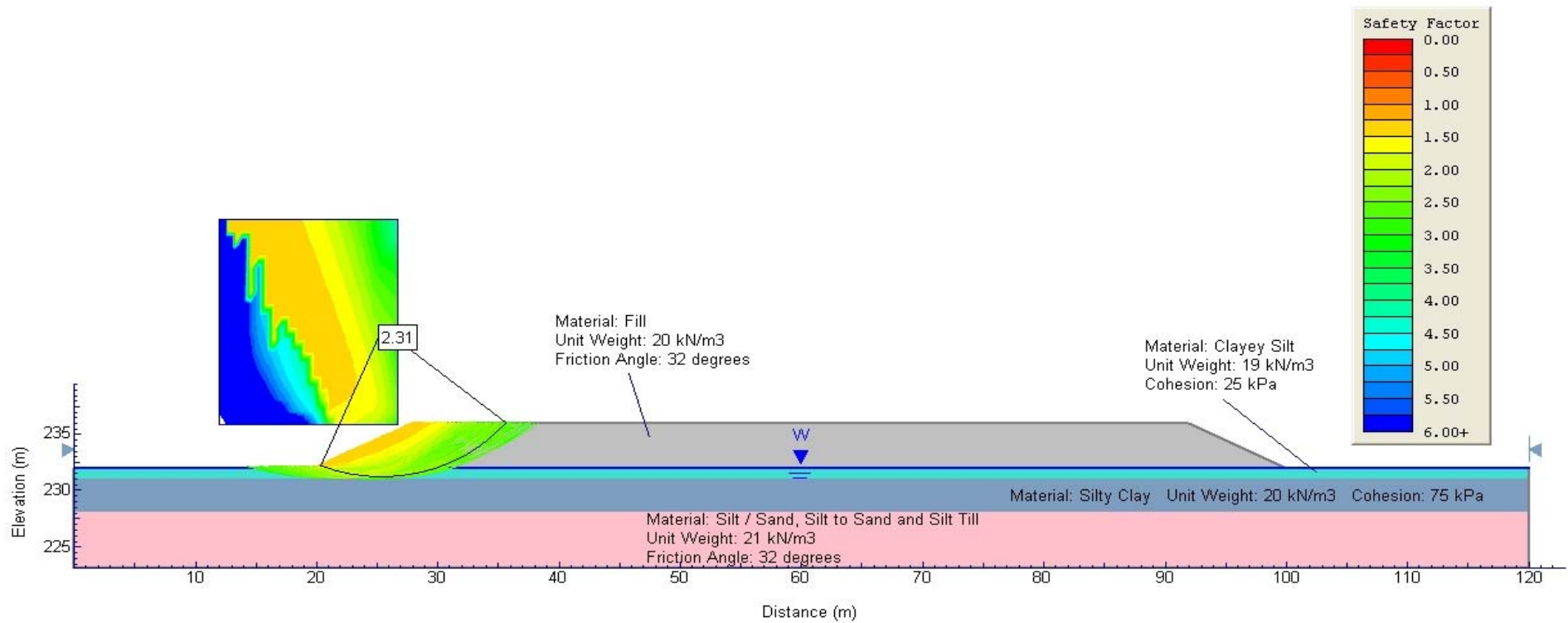
Date: Nov-09  
Project: 08-1111-0022

Golder Associates

Drawn: TB  
Checked: KJB

**Static Global Stability Analysis Results**  
**High Fill - Area 8 - Station 38+250**  
**2H : 1V Embankment Fill Slope**

**Figure 2**



Date: Nov-09  
Project: 08-1111-0022

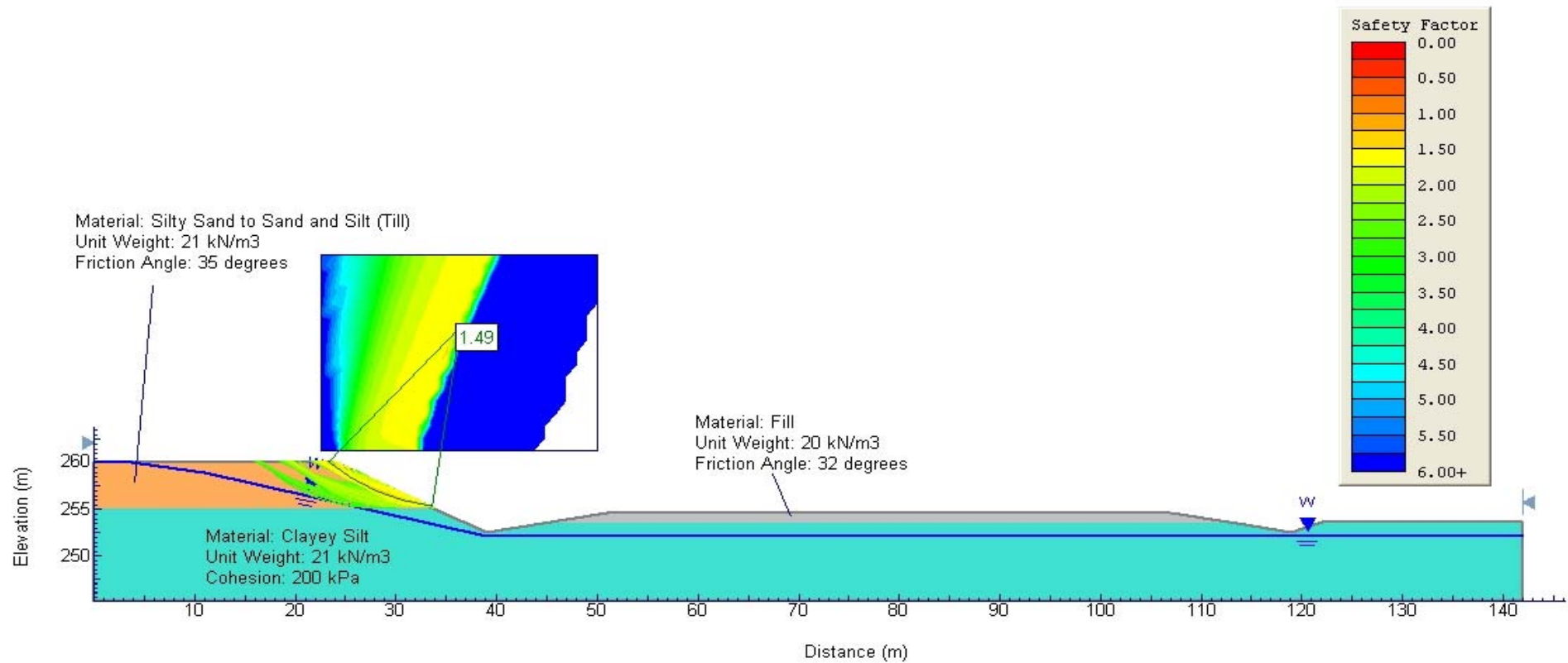
**Golder Associates**

Drawn: TB  
Checked: KJB



Static Global Stability Analysis Results  
Deep Cut - Area 2 - Station 34+400  
2H : 1V Cut Slope

Figure 3



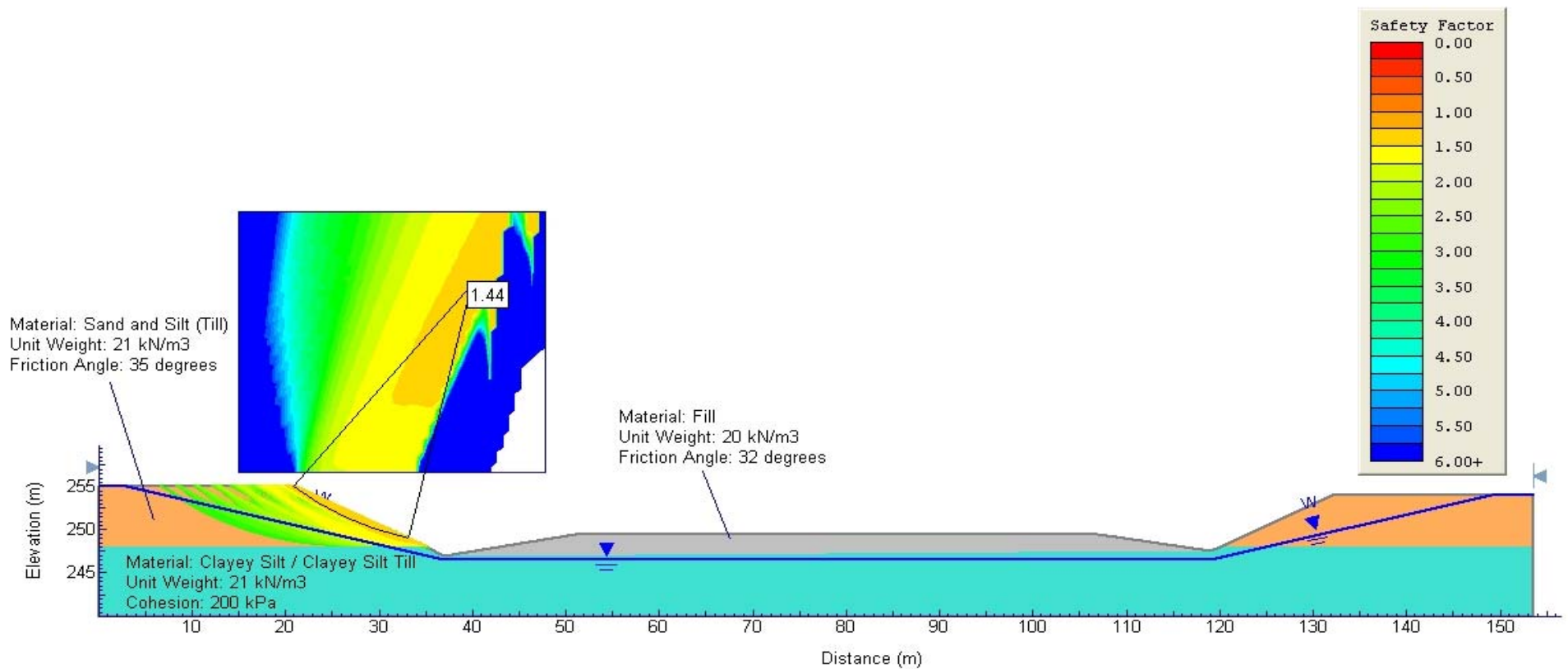
Date: Nov-09  
Project: 08-1111-0022

Golder Associates

Drawn: TB  
Checked: KJB

Static Global Stability Analysis Results  
Deep Cut - Area 7 - Station 37+525  
2H : 1V Cut Slope

Figure 4



Date: Nov-09  
Project: 08-1111-0022

Golder Associates

Drawn: TB  
Checked: KJB



# **APPENDIX A**

## **Highway 404 - STA 33+900 to STA. 34+160 (High Fill Area 1) Record of Boreholes and Laboratory Test Results**

PROJECT 08-1111-0022		<b>RECORD OF BOREHOLE No HD1-1</b>				1 OF 1 <b>METRIC</b>						
G.W.P. 2005-07-00		LOCATION N 4890029.2 ; E 309626.0				ORIGINATED BY TB						
DIST HWY 404		BOREHOLE TYPE 108 mm O.D. Solid Stem Auger				COMPILED BY SC						
DATUM Geodetic		DATE June 5, 2009				CHECKED BY KJB						
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa		WATER CONTENT (%)		
253.8	GROUND SURFACE							20 40 60 80 100	20 40 60 80 100	10 20 30		
0.1	CLAYEY SILT with organics, some sand, containing rootlets (Reworked) Dark brown Moist		1	SS	6		253					
252.3	CLAYEY SILT, trace to some sand, containing oxidation staining Firm to stiff Brown Moist		2	SS	11		252					
1.5	CLAYEY SILT, trace to some sand, trace gravel, containing oxidation staining (TILL) Stiff to hard Brown Moist		3	SS	13		251					
			4	SS	18		250					
			5	SS	29		249					
			6	SS	31							
			7	SS	35							
248.6	END OF BOREHOLE											
5.2	NOTES:  1. Water level in open borehole at a depth of 5.2 m below ground surface (Elev. 248.6 m) upon completion of drilling.  2. Water level in piezometer at a depth of 1.0 m below ground surface (Elev. 252.8 m) on June 12, 2009.											

MIS-MTO 001 08-1111-0022.GPJ GAL-MASS.GDT 2/19/10 DD/SAC

PROJECT 08-1111-0022			RECORD OF BOREHOLE No HD1-2			1 OF 1 METRIC											
G.W.P. 2005-07-00			LOCATION N 4890169.4 ;E 309553.5			ORIGINATED BY TB											
DIST HWY 404			BOREHOLE TYPE 108 mm O.D. Solid Stem Auger			COMPILED BY SC											
DATUM Geodetic			DATE June 8, 2009			CHECKED BY KJB											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W <sub>p</sub> W W <sub>L</sub> WATER CONTENT (%)			γ kN/m <sup>3</sup>	GR SA SI CL
							20 40 60 80 100	20 40 60 80 100	10 20 30								
252.9	GROUND SURFACE																
0.9	TOPSOIL																
252.1	Organic SILT with clay, some sand, containing rootlets Firm Dark brown Moist		1	SS	5		252										OC = 7.3%
0.8																	
251.4	Silty SAND, trace clay, trace gravel, containing oxidation staining Loose Brown Moist		2	SS	8		251										
1.5																	
	CLAYEY SILT, some sand, trace gravel, contains sandy silt interlayers, containing oxidation staining (TILL) Firm to hard Brown Moist		3	SS	5		250										
			4	TO	PH		250										2 28 57 13
			5	SS	35		249										
			6	SS	59		248										
248.5	CLAYEY SILT, trace to some sand Hard Grey Moist																
4.4																	
247.7			7	SS	41		248										
5.2	END OF BOREHOLE																
NOTES: 1. Water level in open borehole at a depth of 3.1 m below ground surface (Elev. 249.8 m) upon completion of drilling. 2. Water level in piezometer at a depth of 1.1 m below ground surface (Elev. 251.8 m) on June 12, 2009.																	

PROJECT 08-1111-0022		<b>RECORD OF BOREHOLE No HD1-3</b>				1 OF 1 <b>METRIC</b>								
G.W.P. 2005-07-00		LOCATION N 4890224.5 ; E 309580.5				ORIGINATED BY CR								
DIST HWY 404		BOREHOLE TYPE 108 mm O.D. Solid Stem Auger				COMPILED BY SC								
DATUM Geodetic		DATE March 24, 2009				CHECKED BY KJB								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
251.1	GROUND SURFACE													
0.0	TOPSOIL		1A	SS	5									
0.2	CLAYEY SILT with organics, some sand, trace gravel, containing rootlets		1B											
250.4	Firm Brown		2	SS	8									
0.7	Silty SAND, trace clay, trace gravel													
249.7	Loose Brown		3	SS	7									
1.5	CLAYEY SILT, some sand, trace gravel (TILL)													
	Firm to very stiff		4	SS	11									
	Brown to grey below a depth of 3.0 m													
	Moist		5	SS	17									
			6	SS	14									
			7	SS	12									
			8	SS	17									
			9	SS	28									
242.4	CLAYEY SILT, trace sand, containing interlayers of silty clay													
8.7	Hard Grey Moist		10	SS	45									
241.4														
9.8	END OF BOREHOLE													
NOTES: 1. Water level in open borehole at a depth of 0.9 m below ground surface (Elev. 250.2 m) upon completion of drilling.														

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PROJECT 08-1111-0022			RECORD OF BOREHOLE No C2-3			1 OF 1 METRIC															
G.W.P. 2005-07-00			LOCATION N 4890085.8 ; E 309582.1			ORIGINATED BY TB															
DIST HWY 404			BOREHOLE TYPE 108 mm O.D. Solid Stem Auger			COMPILED BY SC															
DATUM Geodetic			DATE June 4, 2009			CHECKED BY KJB															
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%) W <sub>p</sub> W W <sub>L</sub>			γ			GR SA SI CL		
249.9	GROUND SURFACE							20 40 60 80 100													
0.0	CLAYEY SILT with organics, some sand, trace gravel, containing rootlets and oxidation staining		1	SS	2																
249.0	Very soft to soft Dark brown to brown Moist						249														
0.9	CLAYEY SILT, some sand, trace gravel, containing oxidation staining and layers of silty sand (TILL)		2	SS	8		248														
247.6	Stiff to very stiff Brown Moist		3	SS	27/0.15		247														
2.3	SAND and GRAVEL, trace silt, trace clay Dense to very dense Brown Wet		4	SS	31		246														
246.5	CLAYEY SILT, trace to some sand, containing interlayers of silty clay Hard Brown to grey below a depth of 3.81 m Moist		5	SS	56		245														
3.4			6	SS	48		244														
			7	SS	43		243														
			8	SS	84		242														
			9	SS	100/0.1		241														
240.5	Trace to some gravel below a depth of 8.9 m																				
9.4	END OF BOREHOLE																				
NOTES:																					
1. Water level in open borehole at a depth of 0.8 m below ground surface (Elev. 249.1 m) upon completion of drilling.																					
2. Attempted to turn a vane at a depth of 0.9 m (Elev. 249.0 m) but could not be turned.																					
3. Piezometer destroyed before any water level measurements could be taken.																					

MIS-MTO 001 08-1111-0022.GPJ GAL-MISS.GDT 2/19/10 DD/SAC

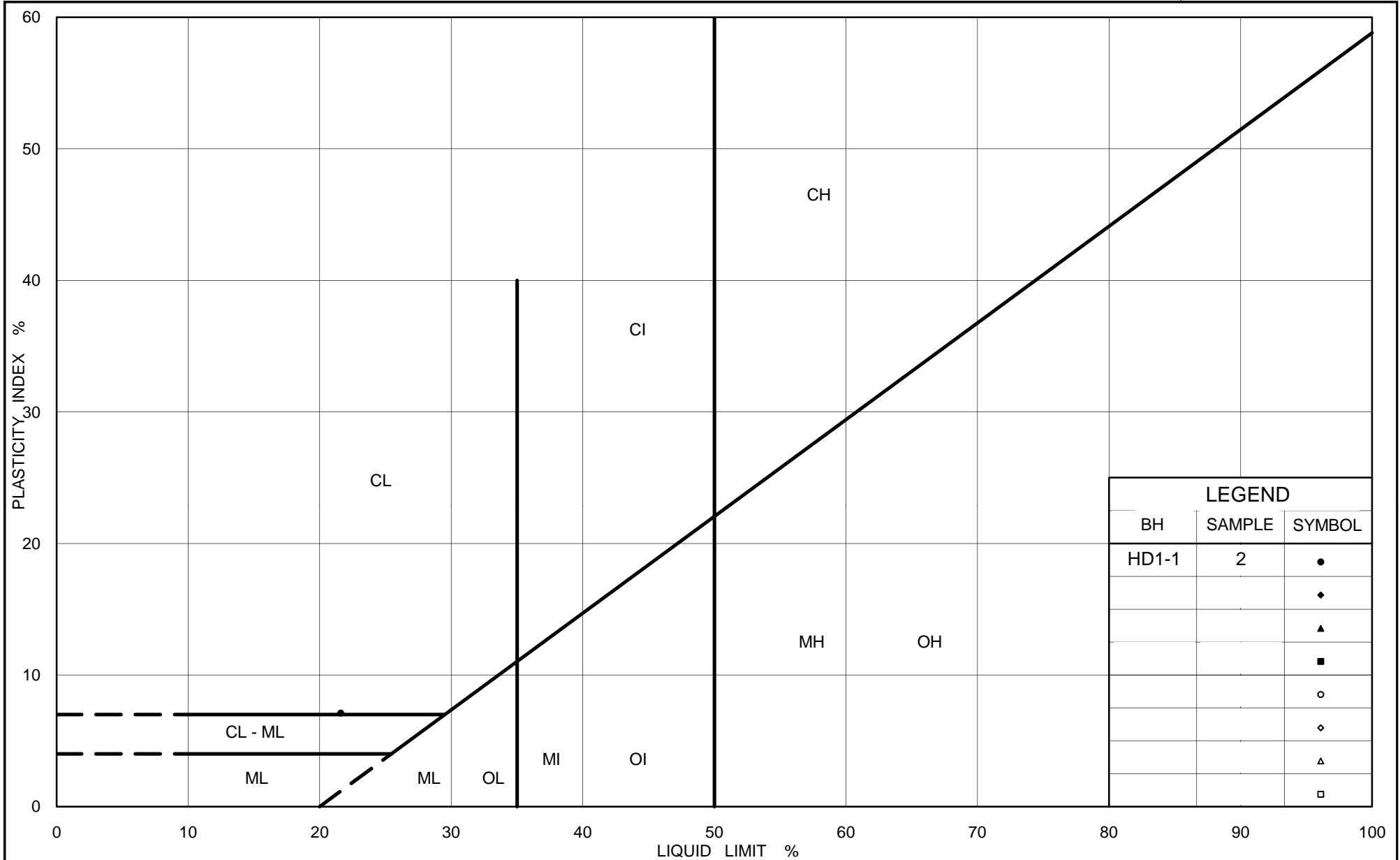


PROJECT		08-1111-0022		RECORD OF BOREHOLE No C2-4		1 OF 1 METRIC											
G.W.P.		2005-07-00		LOCATION		N 4890107.6; E 309601.6											
DIST		HWY 404		BOREHOLE TYPE		108 mm I.D. Hollow Stem Auger											
DATUM		Geodetic		DATE		June 4, 2009											
				ORIGINATED BY		TB											
				COMPILED BY		SC											
				CHECKED BY		KJB											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>	γ	GR	SA	SI	CL
249.3	GROUND SURFACE																
0.0	CLAYEY SILT with organics, trace to some sand, containing rootlets and oxidation staining Soft to firm Dark brown Moist		1	SS	3		249										
248.4			2	SS	5		248										
0.9	CLAYEY SILT, trace to some sand, containing interlayers of silty clay below 1.5 m, containing oxidation staining to 6.1 m Firm to hard Brown Moist		3	SS	13		247										
			4	SS	18		246										
			5	SS	16		245										
	Becoming grey below a depth of 3.8 m		6	SS	38		244										
			7	SS	37		243										
			8	SS	62		242										
241.3			9	SS	103		241										
8.0	Silty SAND, trace gravel, trace clay, containing cobbles and boulders Very dense Grey Wet						240										
240.2			10	SS	95												
9.1	CLAYEY SILT, trace sand Hard Grey Moist																
239.6																	
9.8	END OF BOREHOLE																
NOTES: 1. Water level in open borehole at a depth of 3.9 m below ground surface (Elev. 245.4 m) upon completion of drilling. 2. Water level in piezometer at a depth of 1.4 m below ground surface (Elev. 247.9 m) on June 12, 2009.																	

MIS-MTO 001 08-1111-0022.GPJ GAL-MISS.GDT 2/19/10 DD/SAC

PROJECT 08-1111-0022		RECORD OF BOREHOLE No C2-5		1 OF 1 METRIC								
G.W.P. 2005-07-00		LOCATION N 4890128.7 ; E 309623.7		ORIGINATED BY TB								
DIST HWY 404		BOREHOLE TYPE 108 mm O.D. Solid Stem Auger		COMPILED BY SC								
DATUM Geodetic		DATE June 3, 2009		CHECKED BY KJB								
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	"N" VALUES					
248.7	GROUND SURFACE											
0.0	Organic SILT with clay, trace to some sand, containing rootlets and oxidation staining Very soft to soft Dark brown to brown Moist		1	SS	2							
			2	SS	3							
247.2												
1.5	CLAYEY SILT, trace to some sand, containing interlayers of silty clay, containing oxidation staining to a depth of 3.1 m Very stiff to hard Brown Moist  Becoming grey at a depth of 2.7 m		3	SS	16							
			4	SS	22							
			5	SS	33							
			6	SS	42							
			7	SS	52							
			8	SS	89							
241.5												
7.2	SAND and SILT, trace clay Very dense Grey Wet		9	SS	66							
240.0												
8.7	CLAYEY SILT, trace sand Hard Grey Moist											
239.3			10	SS	100/0.12							
9.4	END OF BOREHOLE											
NOTES: 1. Water level at ground surface upon completion of drilling.												

MIS-MTO 001 08-1111-0022.GPJ GAL-MISS.GDT 2/19/10 DD/SAC



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## PLASTICITY CHART

### Clayey Silt (Upper Stratum)

Figure No. A1

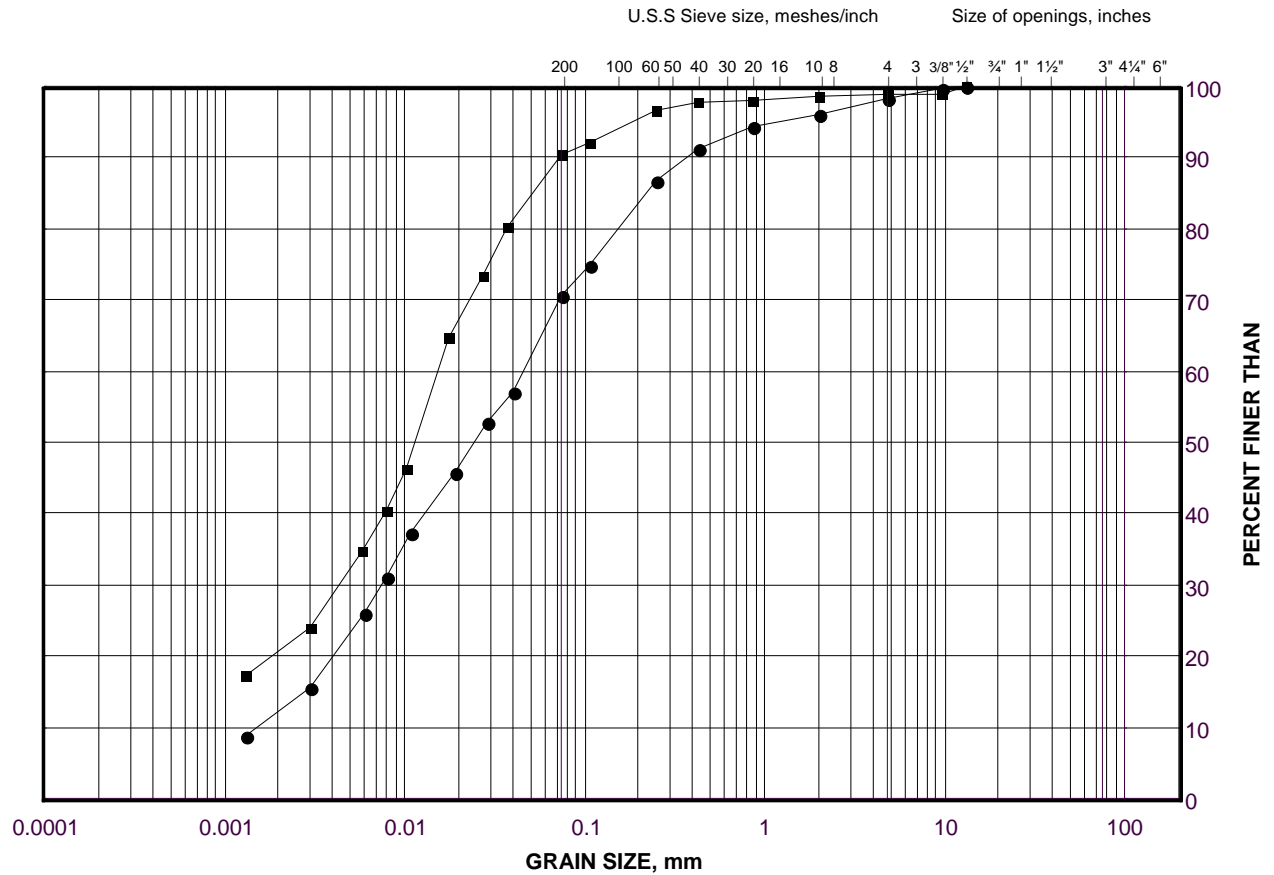
Project No. 08-1111-0022

Checked By: KJB

# GRAIN SIZE DISTRIBUTION

Clayey Silt Till

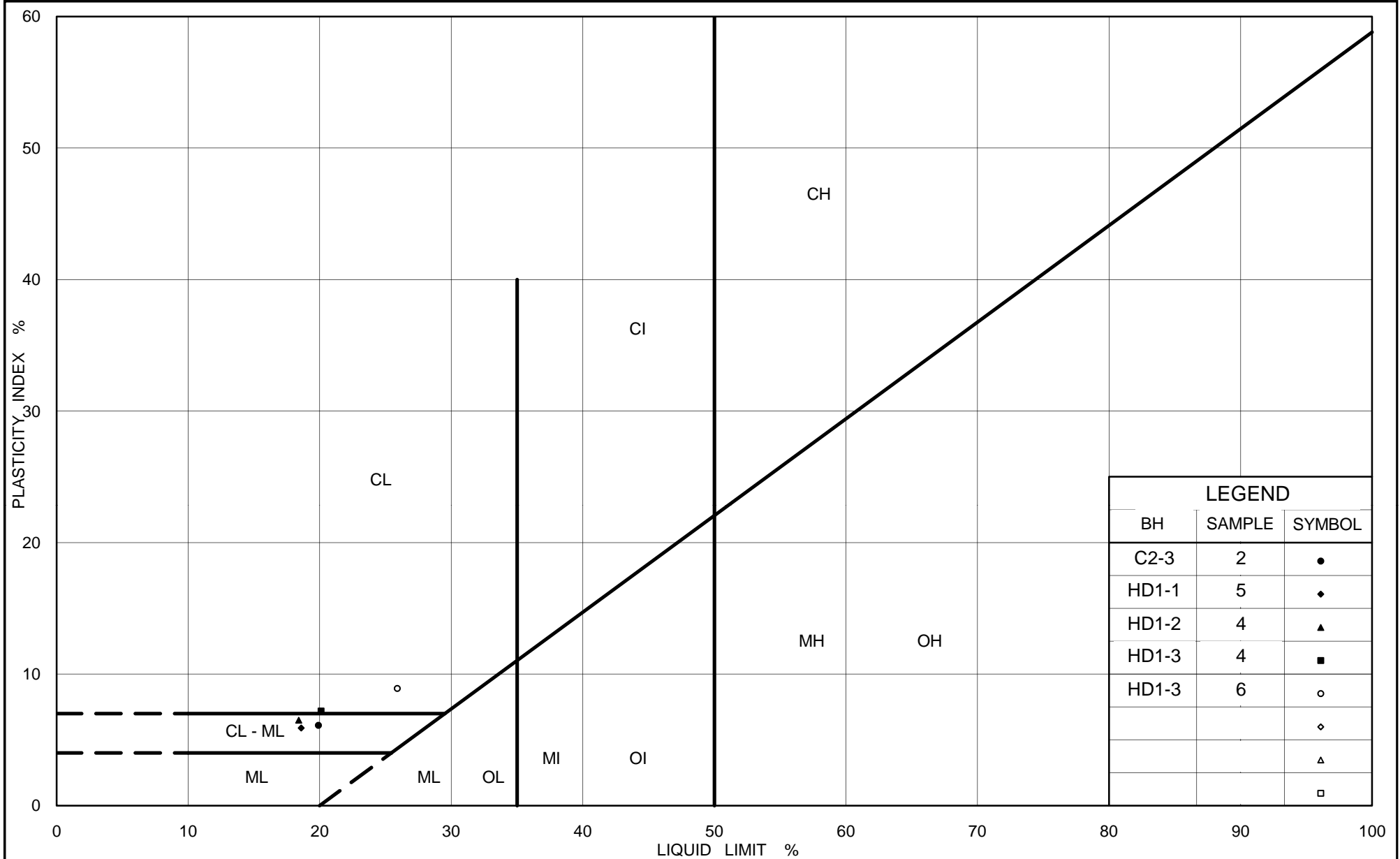
FIGURE A2



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	HD1-2	4	250.3
■	HD1-1	5	250.4



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## PLASTICITY CHART

### Clayey Silt Till

Figure No. A3

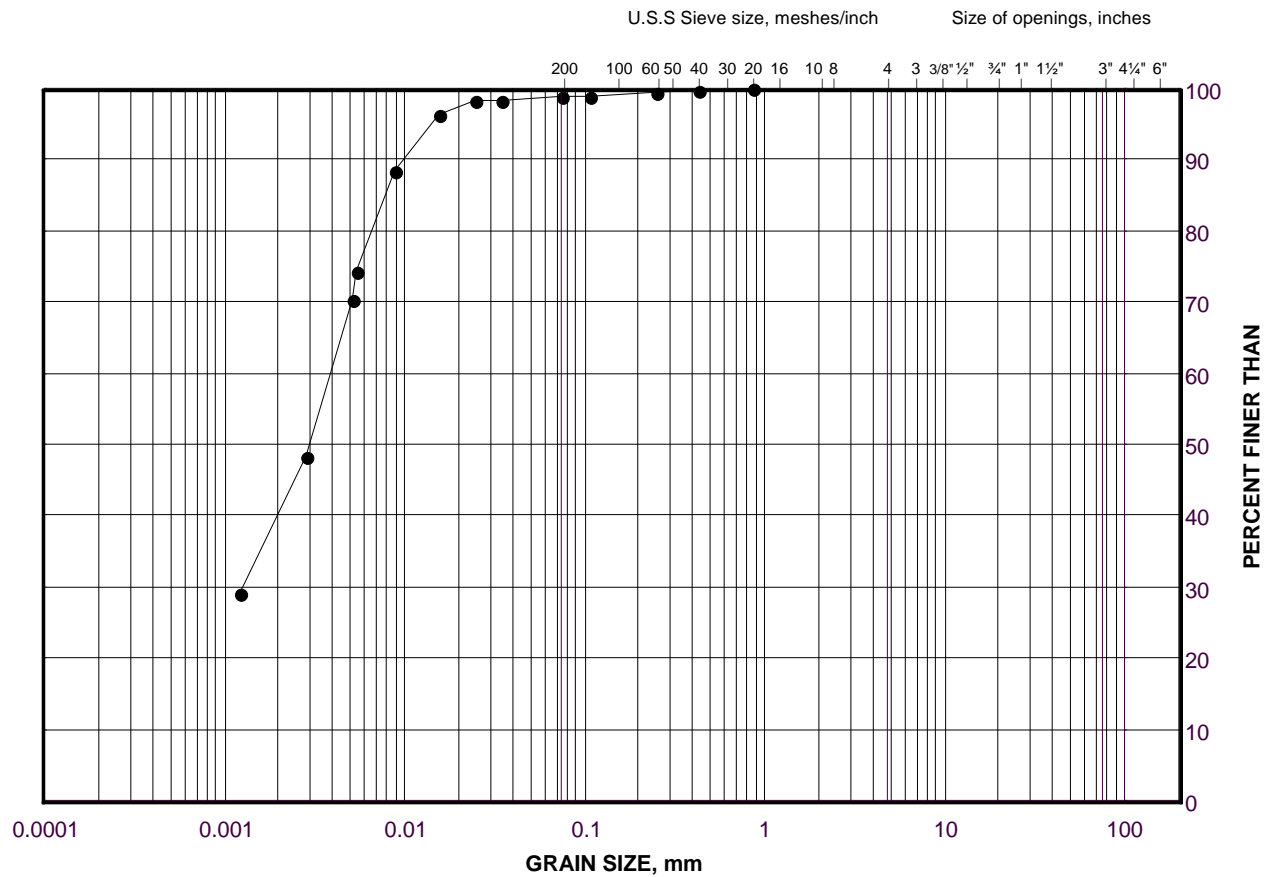
Project No. 08-1111-0022

Checked By: KJB

# GRAIN SIZE DISTRIBUTION

Clayey Silt (Silty Clay Interlayer)

FIGURE A4



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

## LEGEND

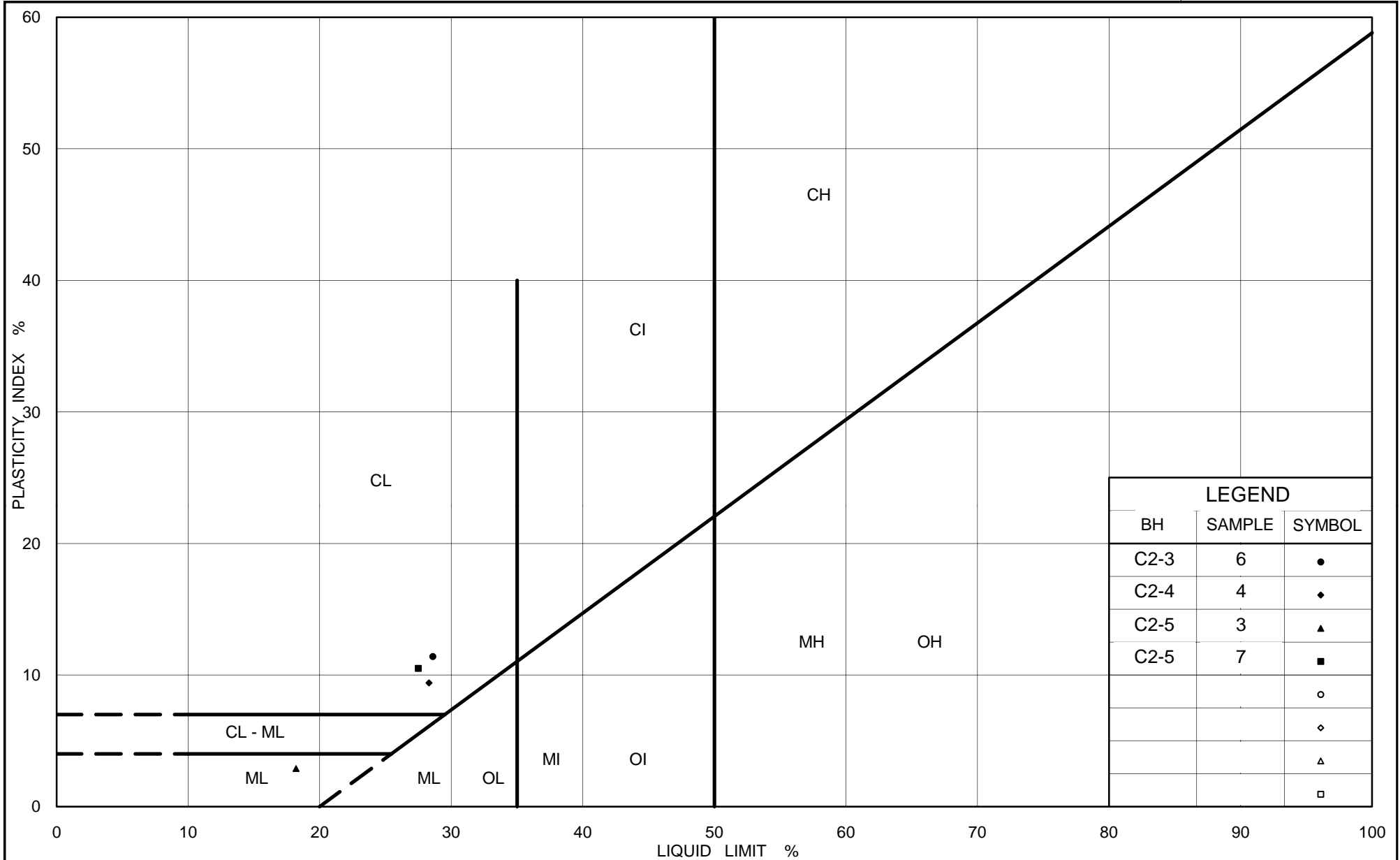
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	C2-5	7	243.8

Project Number: 08-1111-0022

Checked By: KJB

**Golder Associates**

Date: 22-Oct-09



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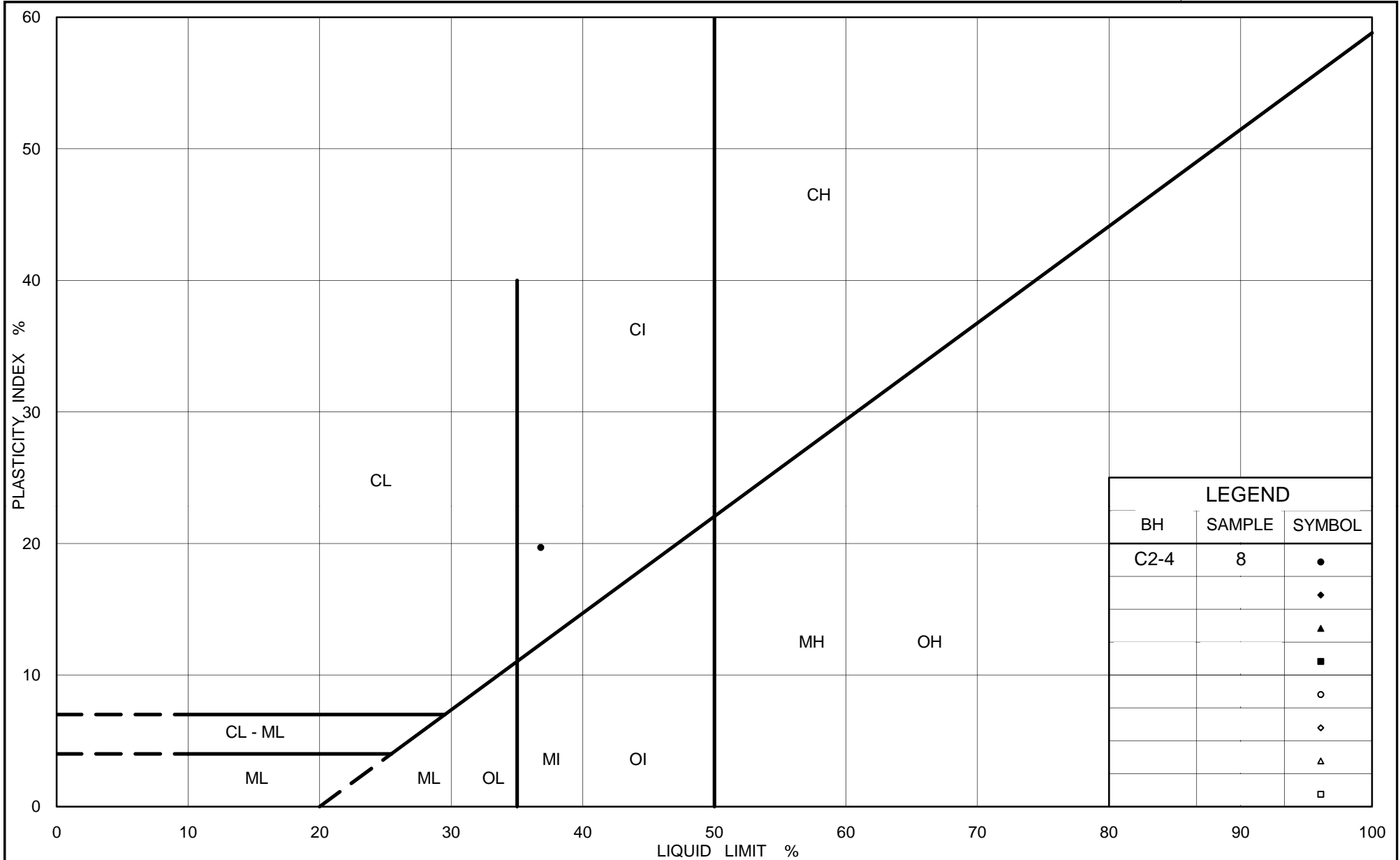
## PLASTICITY CHART

### Clayey Silt

Figure No. A5

Project No. 08-1111-0022

Checked By: KJB



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## PLASTICITY CHART

### Clayey Silt (Silty Clay Interlayer)

Figure No. A6

Project No. 08-1111-0022

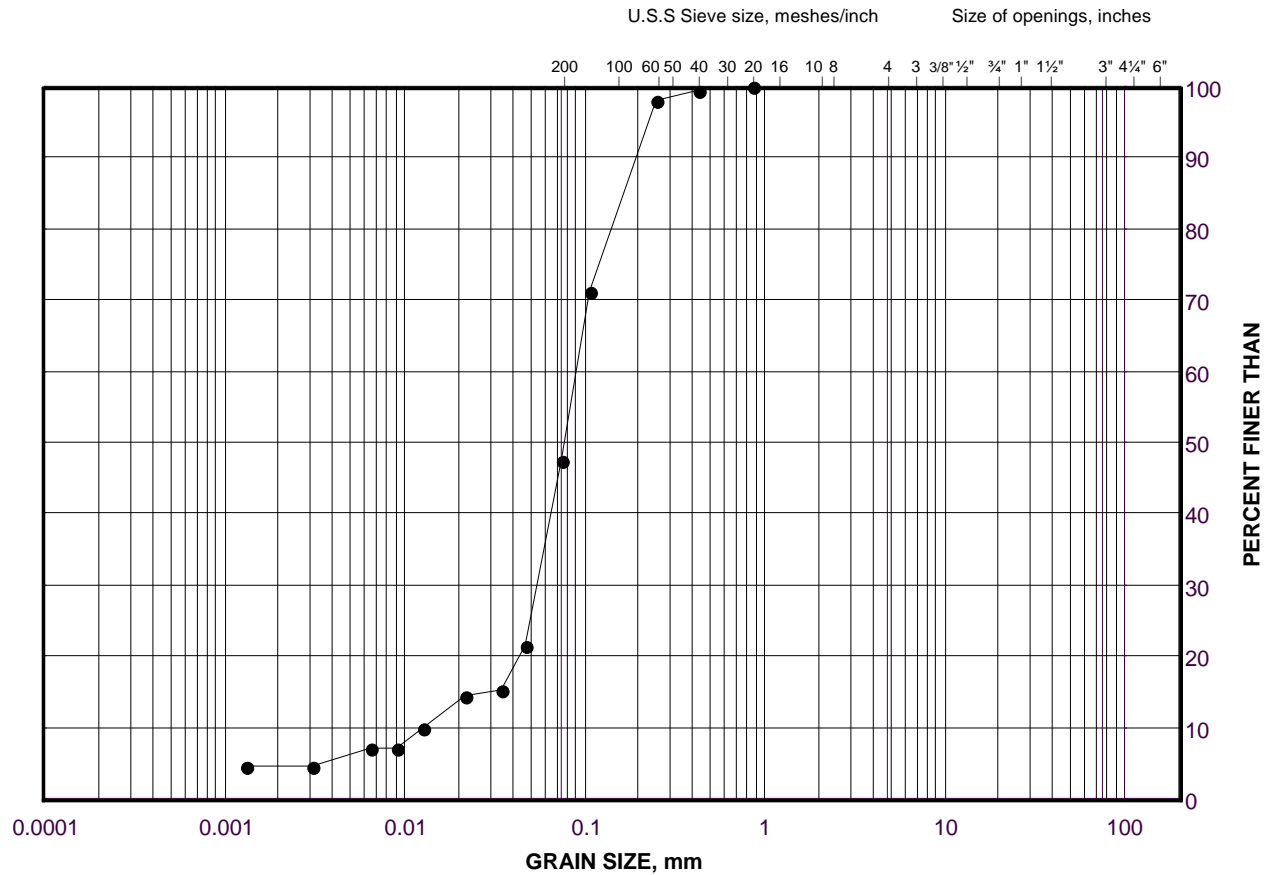
Checked By: KJB



# GRAIN SIZE DISTRIBUTION

Sand and Silt

FIGURE A7



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	C2-5	9	240.8

Project Number: 08-1111-0022

Checked By: KJB

**Golder Associates**

Date: 22-Oct-09



# **APPENDIX B**

**Highway 404 – STA. 34+360 to STA. 34+600 (Deep Cut Area 2)**  
**Record of Boreholes and Laboratory Test Results**

PROJECT		08-1111-0022		RECORD OF BOREHOLE No HD2-1A		1 OF 1		METRIC											
G.W.P.		2005-07-00		LOCATION		N 4890412.1 ; E 309464.8		ORIGINATED BY											
DIST		HWY 404		BOREHOLE TYPE		108 mm O.D. Solid Stem Auger		COMPILED BY											
DATUM		Geodetic		DATE		March 23, 2009		CHECKED BY											
TB/KJB																			
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV	DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES													
261.0	0.0	GROUND SURFACE		1A	SS	3													
		TOPSOIL		1B	SS	3													
260.4	0.6	Clayey silt, trace sand and gravel, contains organics/rootlets (FILL) Soft Brown Moist		2	SS	8													
		CLAYEY SILT, some sand, trace gravel, contains cobbles and boulders, containing oxidation staining (TILL) Firm to hard Brown Moist		3	SS	8													
				4	SS	60													
258.0	3.1	SAND and SILT, trace clay, trace gravel, containing cobbles and boulders and oxidation staining (TILL) Compact to very dense Brown to grey Moist		5	SS	26													
		Becoming grey at a depth of 4.6 m		6	SS	72													
				7	SS	50													
254.9	6.1	SAND, some silt, trace clay, trace gravel Dense Brown Wet		8	SS	34													
254.3	6.7	END OF BOREHOLE																	
NOTES: 1. Water level in open borehole at a depth of 0.9 m below ground surface (Elev. 260.1 m) upon completion of drilling. 2. Water level in piezometer at a depth of 0.8 m below ground surface (Elev. 260.2 m) on April 2, 2009. 3. Water level in piezometer at a depth of 1.8 m below ground surface (Elev. 259.2 m) on June 12, 2009.																			

MIS-MTO 001 08-1111-0022.GPJ GAL-MISS.GDT 2/19/10 DD/SAC

PROJECT 08-1111-0022		<b>RECORD OF BOREHOLE No HD2-1B</b>				1 OF 1 <b>METRIC</b>									
G.W.P. 2005-07-00		LOCATION N 4890410.6; E 309464.8				ORIGINATED BY CR									
DIST HWY 404		BOREHOLE TYPE 108 mm O.D. Solid Stem Auger				COMPILED BY SC									
DATUM Geodetic		DATE March 23, 2009				CHECKED BY TB/KJB									
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa			WATER CONTENT (%)			$\gamma$ kN/m <sup>3</sup>	GR SA SI CL
							20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>				
261.0	GROUND SURFACE														
0.0	TOPSOIL														
260.4	Clayey silt, trace sand and gravel, contains organics/rootlets (FILL) Soft Brown Moist						260								
0.6	CLAYEY SILT, some sand, trace gravel, containing cobbles, boulders and oxidation staining (TILL) Soft to hard Brown Moist						259								
258.9	END OF BOREHOLE														
2.1	NOTES: 1. Soil strata inferred from Borehole HD2-1A. 2. Water level in open borehole at a depth of 0.9 m below ground surface (Elev. 260.1 m) upon completion of drilling. 3. Water level in piezometer at a depth of 0.7 m below ground surface (Elev. 260.3 m) on April 2, 2009. 4. Water level in piezometer at a depth of 1.3 m below ground surface (Elev. 259.7 m) on June 12, 2009.														

MIS-MTO 001 08-1111-0022.GPJ GAL-MISS.GDT 2/19/10 DD/SAC

PROJECT 08-1111-0022		RECORD OF BOREHOLE No HD2-2				1 OF 1 METRIC									
G.W.P. 2005-07-00		LOCATION N 4890467.2 ; E 309478.9				ORIGINATED BY CR									
DIST _____ HWY 404		BOREHOLE TYPE 108 mm O.D. Solid Stem Auger				COMPILED BY SC									
DATUM Geodetic		DATE March 20, 2009				CHECKED BY TB/KJB									
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa							
259.7	GROUND SURFACE														
0.0	TOPSOIL		1A		12										
	Silty SAND, trace clay, trace gravel, containing oxidation staining (TILL) Compact Brown Moist to wet below a depth of 1.1 m		1B	SS											
			2	SS	18										
			3	SS	20										
			4	SS	24										
256.7															
3.1	SAND and SILT, trace to some clay and gravel, containing cobbles and oxidation staining (TILL) Very dense Brown Moist		5	SS	76										
			6	SS	102										
255.1															
4.6	CLAYEY SILT, some sand, trace gravel, contains sand seams Hard Grey Moist		7	SS	100/0.10										
253.2			8	SS	160										
6.6	END OF BOREHOLE														
NOTES:  1. Water level in open borehole at a depth of 0.9 m below ground surface (Elev. 258.8 m) upon completion of drilling.															

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○<sup>3</sup>% STRAIN AT FAILURE

MIS-MTO 001 08-1111-0022.GPJ GAL-MISS.GDT 2/19/10 DD/SAC

PROJECT		08-1111-0022		<b>RECORD OF BOREHOLE No HD2-4</b>				1 OF 1 <b>METRIC</b>						
G.W.P.		2005-07-00		LOCATION		N 4890573.9; E 309493.5		ORIGINATED BY CR						
DIST		HWY 404		BOREHOLE TYPE		108 mm O.D. Solid Stem Auger		COMPILED BY SC						
DATUM		Geodetic		DATE		March 23, 2009		CHECKED BY TB/KJB						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
254.3 0.0	GROUND SURFACE TOPSOIL		1A	SS	2									
253.7 0.6	Clayey silt, trace sand and gravel, contains organics/rootlets (FILL) Very soft to soft Brown Moist		1B	SS	2									
	CLAYEY SILT, some sand, containing interlayers of silty clay and sand seams, contains oxidation staining Soft to hard Brown Moist		2	SS	3									
			3	SS	14									
			4	SS	28									
			5	SS	36									
			6	SS	44									
			7	SS	31									
			8	SS	40									
247.6 6.7	END OF BOREHOLE													
NOTES: 1. Water level in open borehole at a depth of 0.8 m below ground surface (Elev. 253.5 m) upon completion of drilling. 2. Water level in piezometer at a depth of 0.2 m below ground surface (Elev. 254.1 m) on April 2, 2009. 3. Piezometer noted as destroyed on June 12, 2009.														

MIS-MTO 001 08-1111-0022.GPJ GAL-MASS.GDT 2/19/10 DD/SAC

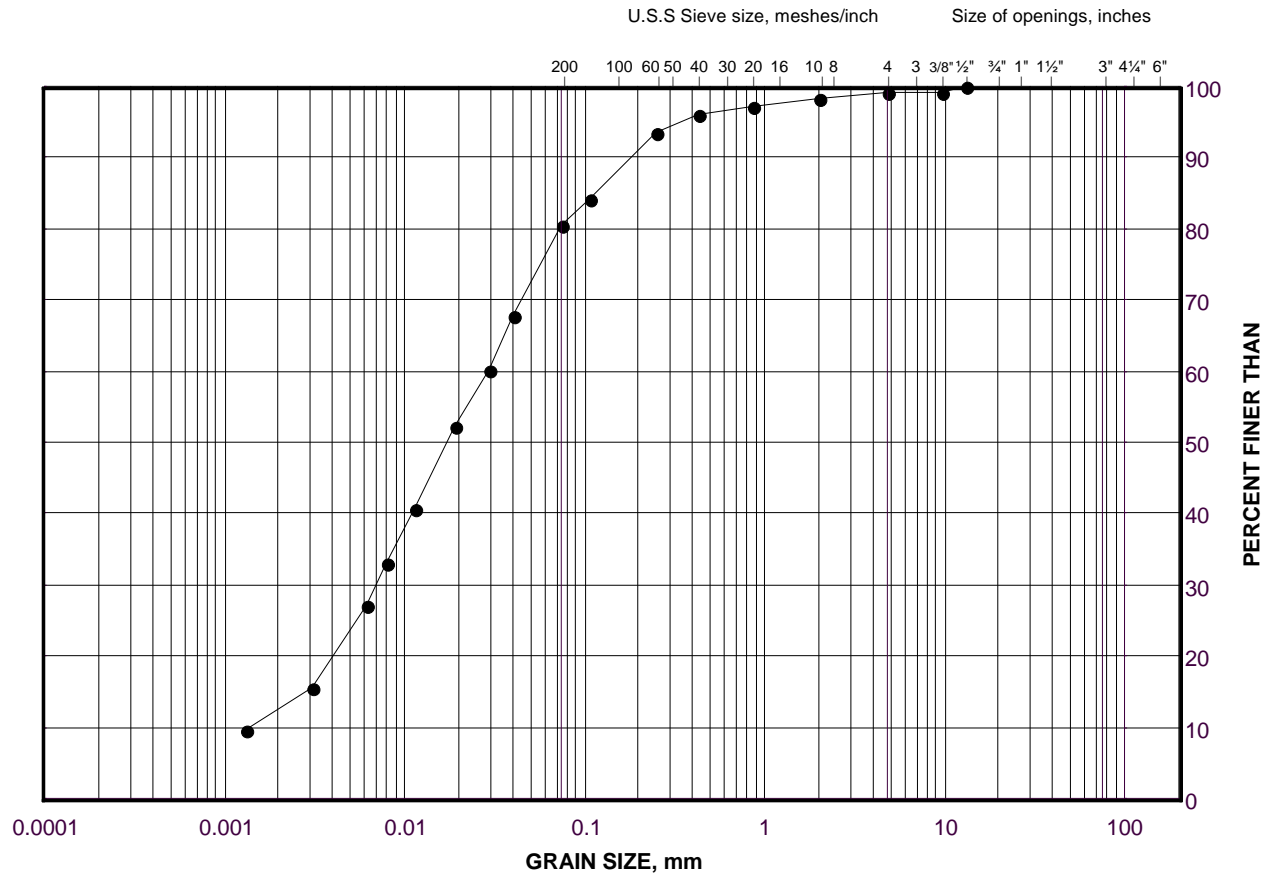
PROJECT 08-1111-0022		RECORD OF BOREHOLE No HD2-5		1 OF 1 METRIC																
G.W.P. 2005-07-00		LOCATION N 4890615.1 ; E 309452.3		ORIGINATED BY CR																
DIST HWY 404		BOREHOLE TYPE 108 mm O.D. Solid Stem Auger		COMPILED BY SC																
DATUM Geodetic		DATE March 23, 2009		CHECKED BY TB/KJB																
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ	GR SA SI CL			
							20 40 60 80 100	○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× REMOULDED	W <sub>p</sub>	W	W <sub>L</sub>						
258.3	GROUND SURFACE																			
0.0	TOPSOIL		1A	SS	5		258													
257.7	Clayey silt, trace sand and gravel, contains organics (FILL) Firm Brown Moist		1B	SS																
0.6			2	SS	16		257													
	CLAYEY SILT, some sand, trace gravel, containing oxidation staining (TILL) Very stiff Brown Moist		3	SS	19															
			4	SS	25		256													
255.3																				
3.1	CLAYEY SILT, trace sand, containing sand seams and oxidation staining Hard Brown Moist		5	SS	52		255													
			6	SS	52		254													
	Becoming grey below a depth of 4.6 m		7	SS	63		253													
251.6			8	SS	63		252													
6.7	END OF BOREHOLE																			
NOTES:																				
1. Water level in open borehole at a depth of 4.3 m below ground surface (Elev. 254.0 m) upon completion of drilling.																				



# GRAIN SIZE DISTRIBUTION

Clayey Silt Till

FIGURE B1



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

## LEGEND

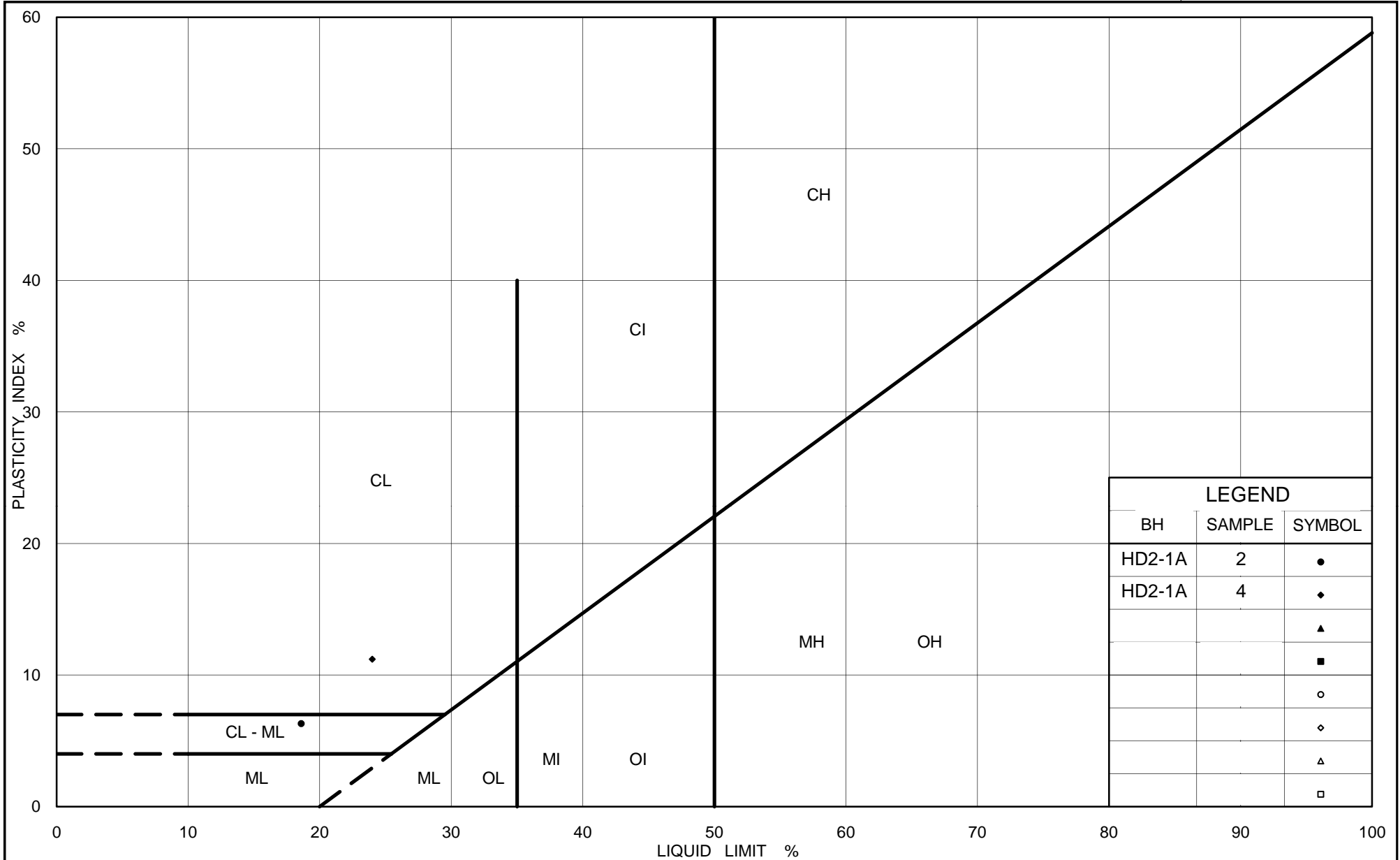
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	HD2-5	4	255.7

Project Number: 08-1111-0022

Checked By: KJB

**Golder Associates**

Date: 22-Oct-09



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## PLASTICITY CHART

### Clayey Silt Till

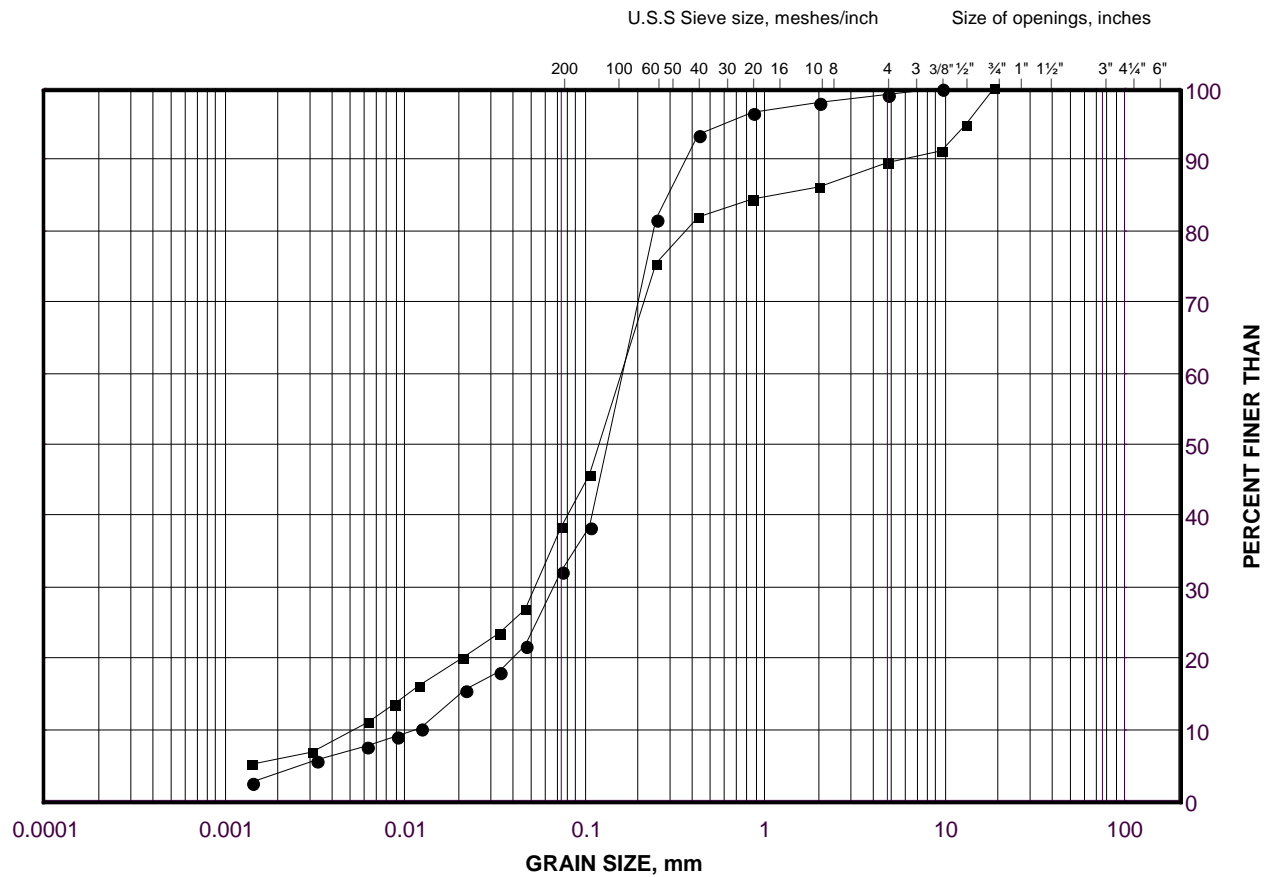
Figure No. B2

Project No. 08-1111-0022

Checked By: KJB

## Silty Sand Till to Sand and Silt Till

FIGURE B3



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	HD2-2	3	257.9
■	HD2-2	5	256.3

Project Number: 08-1111-0022

Checked By: KJB

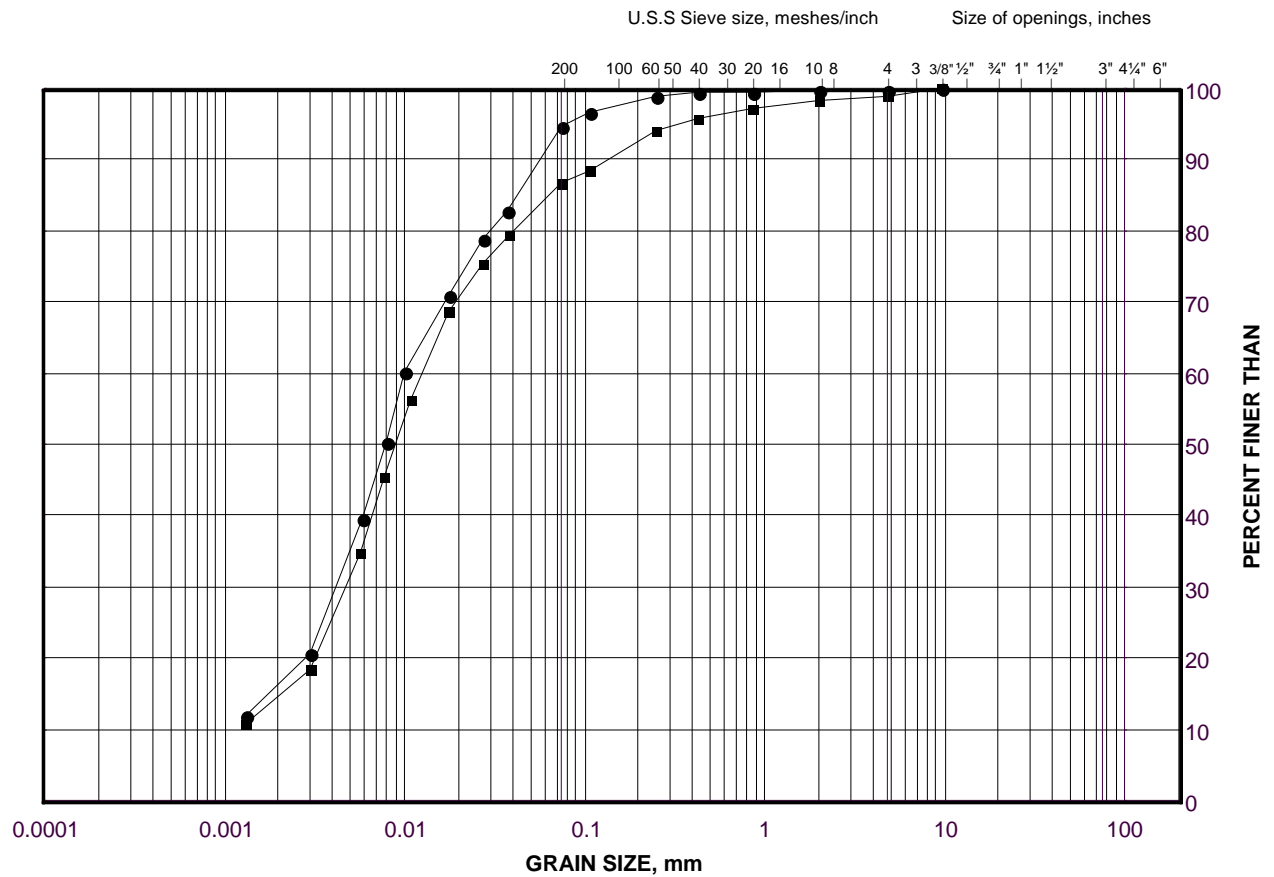
## Golder Associates

Date: 23-Oct-09

# GRAIN SIZE DISTRIBUTION

Clayey Silt

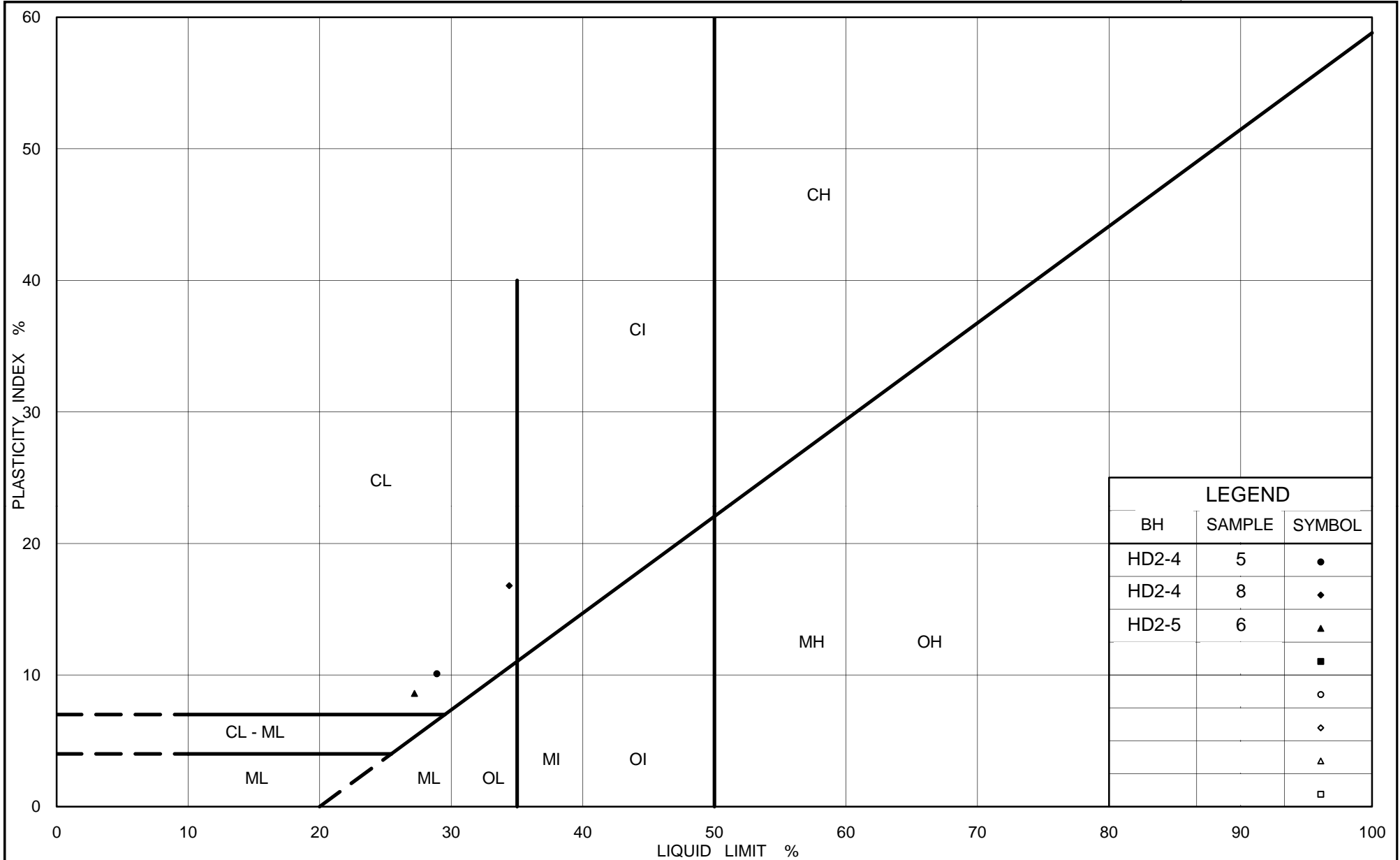
FIGURE B4



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	HD2-3	4	256.0
■	HD2-3	6	254.5



Ministry of Transportation

Ontario

## PLASTICITY CHART

### Clayey Silt

Figure No. B5

Project No. 08-1111-0022

Checked By: KJB



# **APPENDIX C**

**Highway 404 – STA. 34+780 to STA. 34+880 (Deep Cut Area 3)**  
**Record of Boreholes and Laboratory Test Results**

PROJECT		08-1111-0022		RECORD OF BOREHOLE No HD3-1		1 OF 1 METRIC											
G.W.P.		2005-07-00		LOCATION		N 4890831.6; E 309369.6											
DIST		HWY 404		BOREHOLE TYPE		108 mm O.D. Solid Stem Auger											
DATUM		Geodetic		DATE		March 24, 2009											
ORIGINATED BY		CR		COMPILED BY		SC											
CHECKED BY		TB/KJB															
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>	γ	GR	SA	SI	CL
256.7	GROUND SURFACE																
0.0	TOPSOIL		1A	SS	7												
0.3	Silty sand, trace clay, trace gravel (FILL)		1B														
255.9	Loose Brown Moist		2	SS	18		256										
0.8	Sandy SILT, trace clay, trace gravel, containing cobbles and boulders, rootlets present to a depth of 1.4 m, containing interlayers of clayey silt and oxidation staining (TILL) Compact to very dense Brown Moist		3	SS	22		255										
			4	SS	40		254							1	29	66	4
			5	SS	104		253										
			6	SS	150		252							2	25	59	14
252.1	CLAYEY SILT, some sand, containing seams of silty clay Hard Grey Moist		7	SS	186		251										
4.6			8	SS	168												
250.2	END OF BOREHOLE																
6.6	NOTES: 1. Water level in open borehole at a depth of 5.5 m below ground surface (Elev. 251.2 m) upon completion of drilling. 2. Water level in piezometer at a depth of 0.8 m below ground surface (Elev. 255.9 m) on April 2, 2009. 3. Water level in piezometer at a depth of 1.0 m below ground surface (Elev. 255.7 m) on June 12, 2009.																

MIS-MTO 001 08-1111-0022.GPJ GAL-MISS.GDT 2/19/10 DD/SAC



PROJECT 08-1111-0022		RECORD OF BOREHOLE No HD3-2				1 OF 1 METRIC											
G.W.P. 2005-07-00		LOCATION N 4890883.2; E 309370.1				ORIGINATED BY CR											
DIST HWY 404		BOREHOLE TYPE 108 mm O.D. Solid Stem Auger				COMPILED BY SC											
DATUM Geodetic		DATE March 24, 2009				CHECKED BY TB/KJB											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
255.3	GROUND SURFACE																
0.0	TOPSOIL		1A	SS	3												
254.9			1B														
254.5	Clayey silt, trace sand, trace gravel, containing organics and rootlets (FILL) Soft Brown Wet		2	SS	17												
0.8																	
	Sandy SILT, trace clay, trace gravel, containing cobbles and boulders and layers of clayey silt, containing oxidation staining to a depth of 4.6 m (TILL) Compact to very dense Brown Moist		3	SS	17												
			4	SS	46												
			5	SS	73												
			6	SS	150												
250.7																	
4.6	CLAYEY SILT, some sand, containing seams of silty clay Hard Grey Moist		7	SS	108												
			8	SS	143												
248.6																	
6.7	END OF BOREHOLE																
	NOTES:  1. Water level in open borehole at a depth of 0.9 m below ground surface (Elev. 254.4 m) upon completion of drilling.																

MIS-MTO 001 08-1111-0022.GPJ GAL-MISS.GDT 2/19/10 DD/SAC

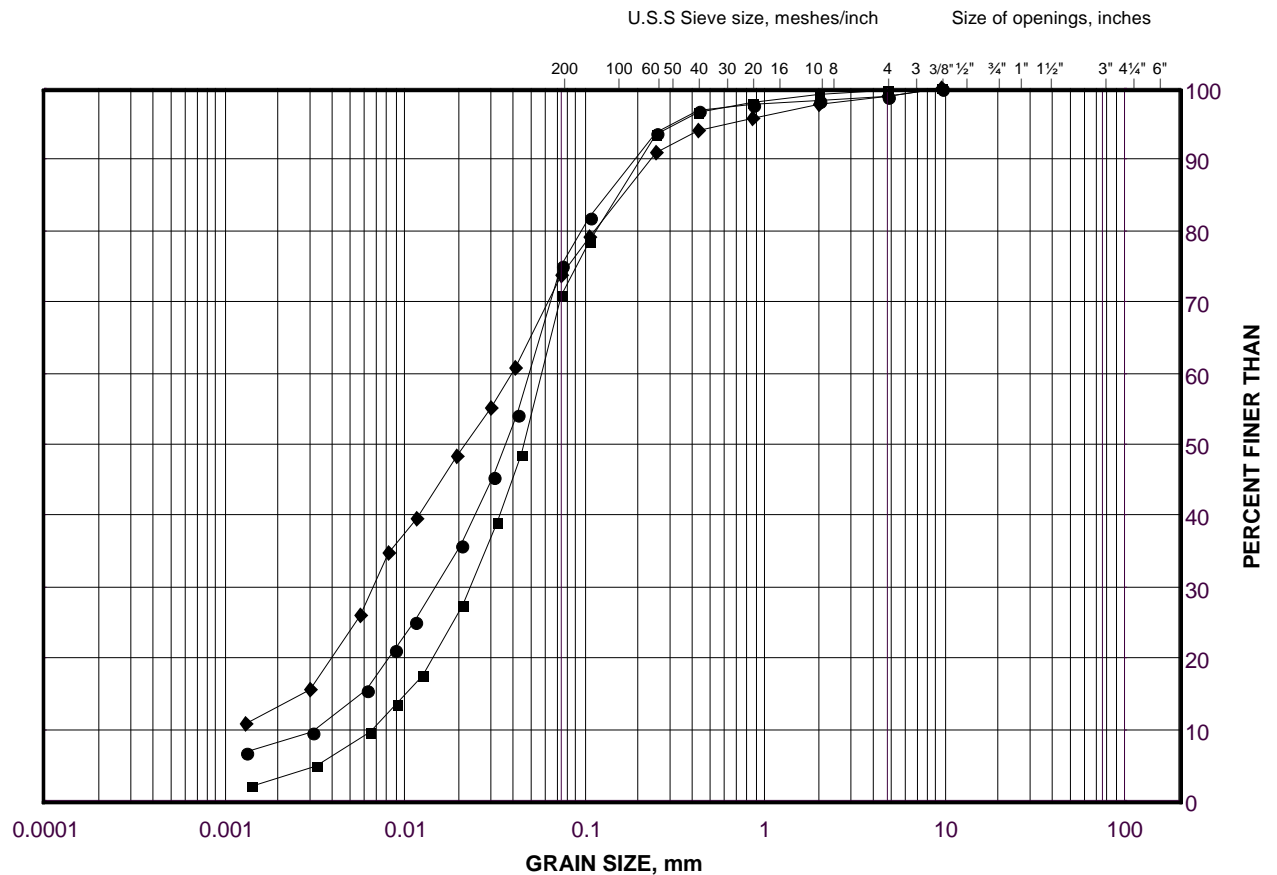
PROJECT 08-1111-0022		RECORD OF BOREHOLE No HD3-3		1 OF 1 METRIC																
G.W.P. 2005-07-00		LOCATION N 4890934.1 ; E 309409.0		ORIGINATED BY CR																
DIST HWY 404		BOREHOLE TYPE 108 mm O.D. Solid Stem Auger		COMPILED BY SC																
DATUM Geodetic		DATE March 24, 2009		CHECKED BY TB/KJB																
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		ELEVATION SCALE	SHEAR STRENGTH kPa			WATER CONTENT (%)			γ						
256.2	GROUND SURFACE							20 40 60 80 100	○ UNCONFINED	+	FIELD VANE	W <sub>p</sub>	W	W <sub>L</sub>						
0.0	TOPSOIL		1A	SS	6		256		● QUICK TRIAXIAL	×	REMOULDED									
255.9			1B																	
0.3	Silty SAND, trace clay, trace gravel Loose to compact Brown Wet		2	SS	13		255													
254.7																				
1.5	CLAYEY SILT, trace sand Very stiff Brown Moist		3	SS	17		254													
253.9																				
2.3	Sandy SILT, trace to some clay, trace gravel, containing cobbles and boulders (TILL) Very dense Brown Moist		4	SS	57		253													
			5	SS	83															
			6	SS	84/0.15		252													
			7	SS	85/0.15															
							251													
250.7																				
5.5	CLAYEY SILT, some sand, containing seams of silty clay Hard Grey Moist		8	SS	66		250													
249.5																				
6.7	END OF BOREHOLE																			
NOTES:																				
1. Water level in open borehole at a depth of 0.6 m below ground surface (Elev. 255.6 m) upon completion of drilling.																				

MIS-MTO 001 08-1111-0022.GPJ GAL-MASS.GDT 2/19/10 DD/SAC

# GRAIN SIZE DISTRIBUTION

Sandy Silt Till

FIGURE C1



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	HD3-3	4	253.6
■	HD3-1	4	254.1
◆	HD3-1	6	252.6

Project Number: 08-1111-0022

Checked By: KJB

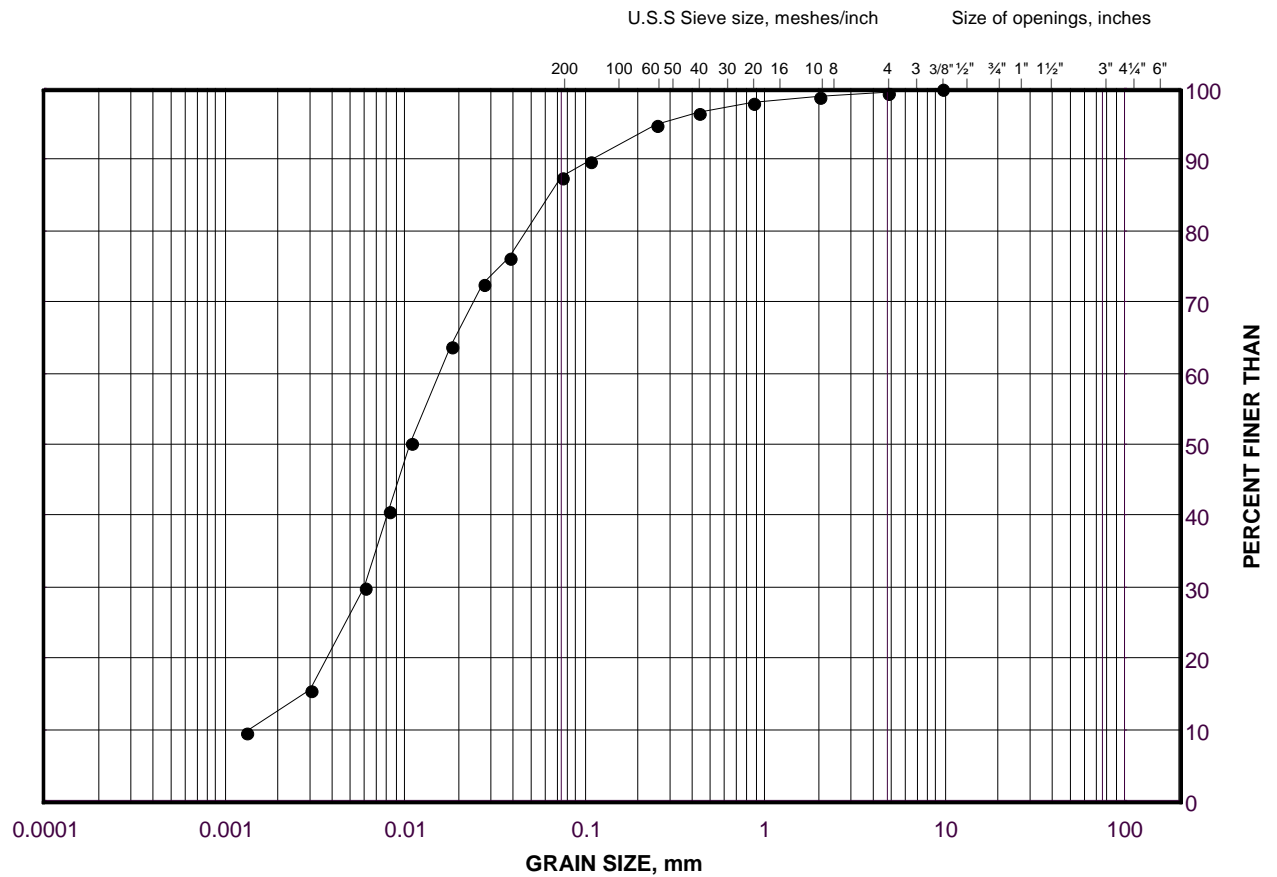
**Golder Associates**

Date: 23-Oct-09

# GRAIN SIZE DISTRIBUTION

Sandy Silt Till (Clayey Silt Interlayer)

FIGURE C2



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	HD3-2	3	253.5

Project Number: 08-1111-0022

Checked By: KJB

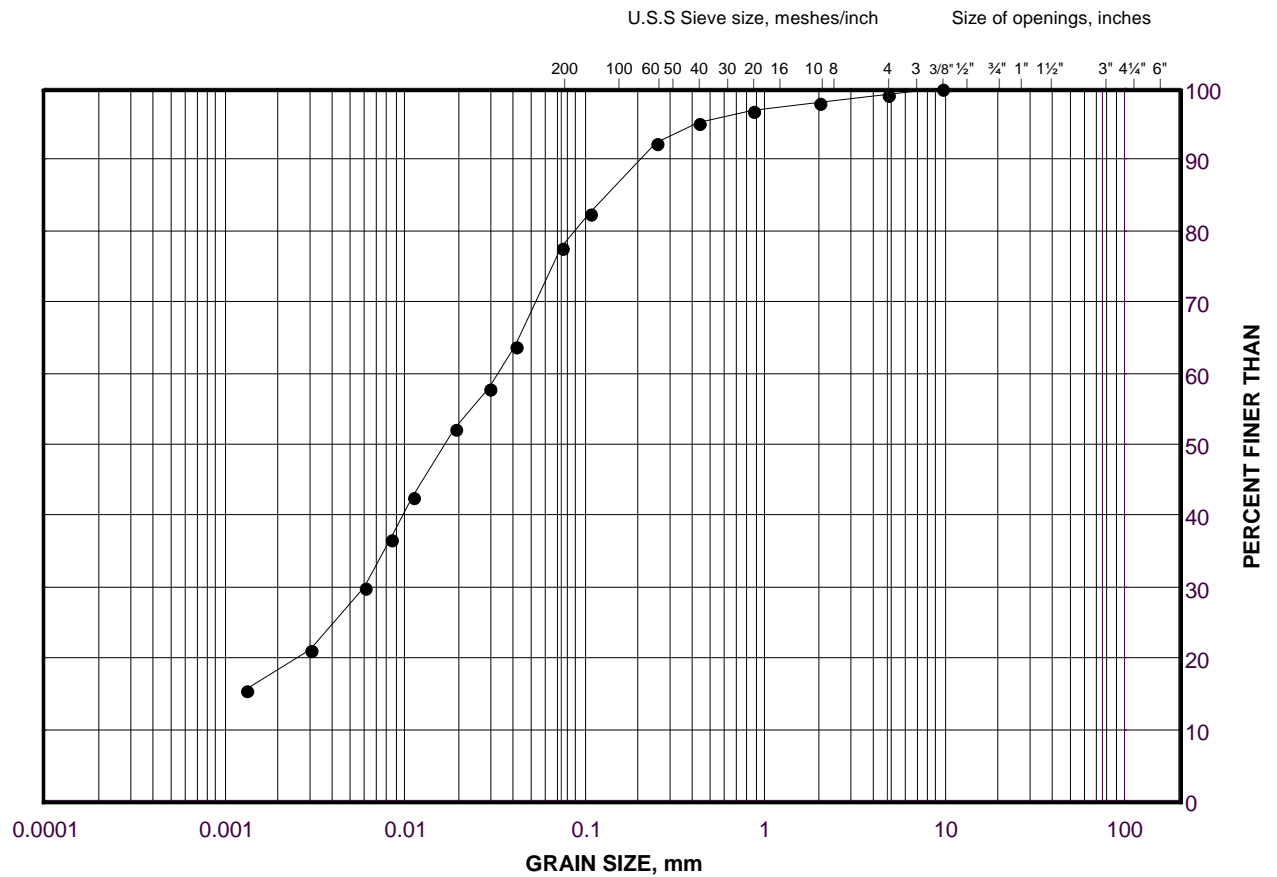
**Golder Associates**

Date: 23-Oct-09

# GRAIN SIZE DISTRIBUTION

Clayey Silt

FIGURE C3



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

## LEGEND

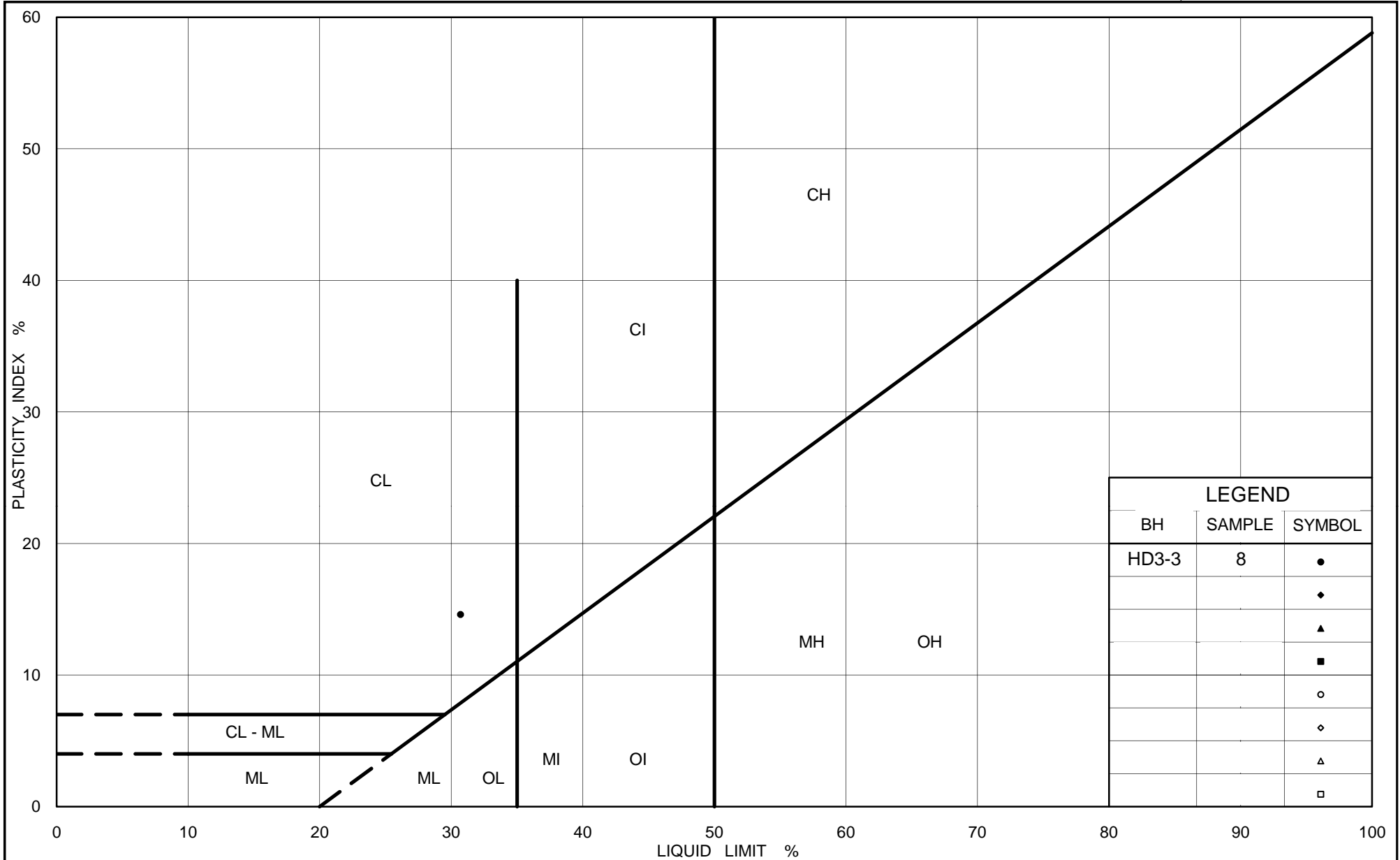
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	HD3-2	7	250.4

Project Number: 08-1111-0022

Checked By: KJB

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Date: 23-Oct-09



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## PLASTICITY CHART

### Clayey Silt

Figure No. C4

Project No. 08-1111-0022

Checked By: KJB



# **APPENDIX D**

## **Highway 404 - STA. 35+000 to STA. 35+150 (High Fill Area 4) Record of Boreholes and Laboratory Test Results**

[illegible]

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○<sup>3</sup>% STRAIN AT FAILURE



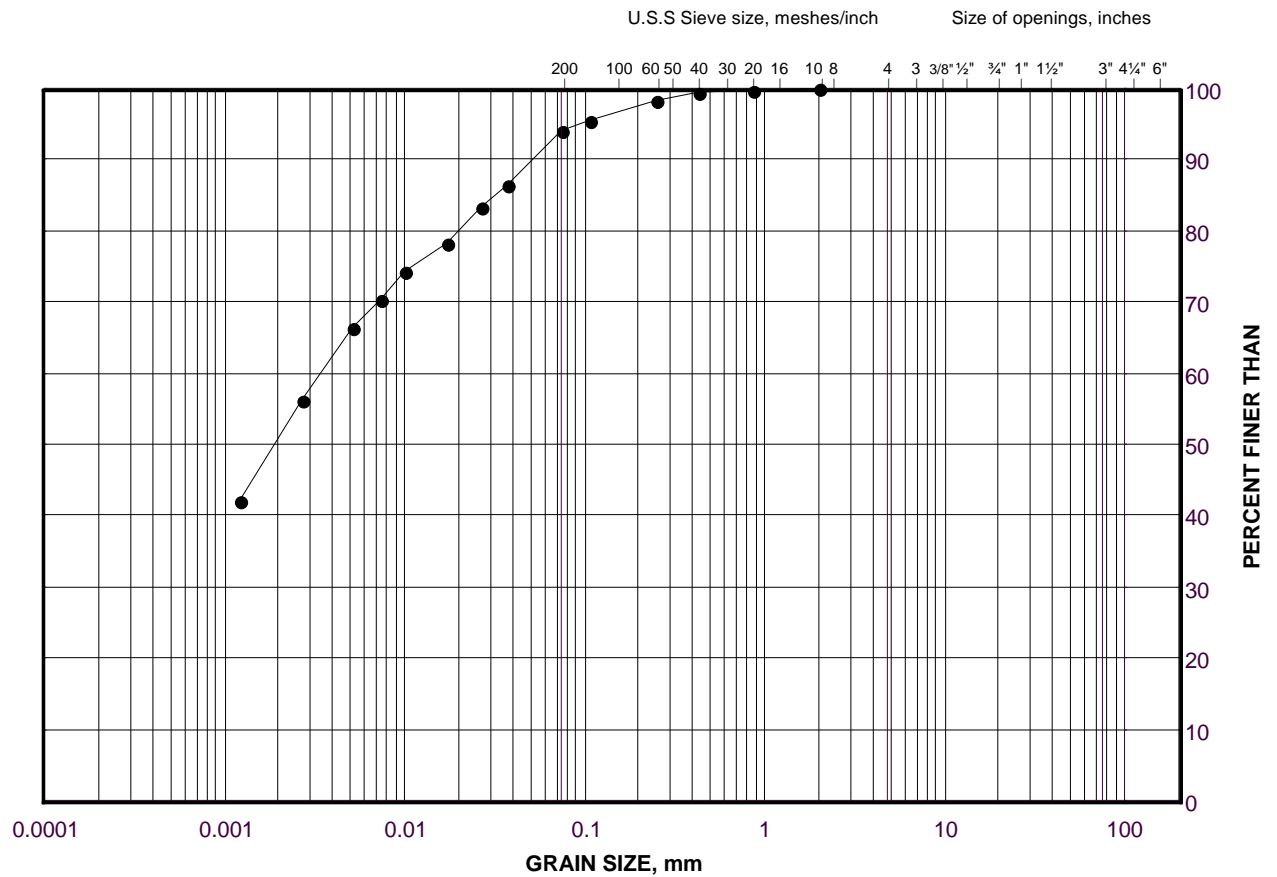
PROJECT 08-1111-0022		RECORD OF BOREHOLE No HD4-2				1 OF 1 METRIC							
G.W.P. 2005-07-00		LOCATION N 4891173.8 ; E 309295.7		ORIGINATED BY TB									
DIST HWY 404		BOREHOLE TYPE 108 mm O.D. Solid Stem Auger		COMPILED BY SC									
DATUM Geodetic		DATE June 8, 2009		CHECKED BY KJB									
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	W <sub>p</sub> W W <sub>L</sub>	γ	GR SA SI CL		
249.0	GROUND SURFACE												
0.0	TOPSOIL to CLAYEY SILT, some sand, trace gravel, containing organics and rootlets (Reworked)		1A	SS	8								
0.3	Stiff		1B										
248.2	Dark brown												
0.8	Moist		2	SS	10								
	CLAYEY SILT, trace to some sand, trace gravel												
	Stiff												
	Brown		3	SS	27								
	Moist												
	Sandy SILT to SAND and SILT, trace clay, trace gravel, containing cobbles and boulders, containing clayey silt interlayers (TILL)												
	Compact to dense												
246.0	Brown												
3.1	Moist												
	Silty SAND, trace clay		5	SS	50								
245.4	Dense												
3.6	Brown												
	Moist												
244.9	SAND and SILT, trace clay, trace gravel, containing cobbles and boulders (TILL)		6A	SS	31								
4.1	Dense												
	Brown												
	Moist												
243.8	CLAYEY SILT, trace to some sand, containing oxidation staining		6B										
5.2	Hard												
	Brown												
	Moist		7	SS	51								
	END OF BOREHOLE												
NOTES: 1. Water level in open borehole at a depth of 5.2 m below ground surface (Elev. 243.8 m) upon completion of drilling. 2. Water level in open borehole at a depth of 1.4 m below ground surface (Elev. 247.6 m) on June 9, 2009.													

PROJECT		08-1111-0022		<b>RECORD OF BOREHOLE No HD4-3</b>				1 OF 1 <b>METRIC</b>									
G.W.P.		2005-07-00		LOCATION		N 4891138.4 ;E 309360.2		ORIGINATED BY CR									
DIST		HWY 404		BOREHOLE TYPE		108 mm O.D. Solid Stem Auger		COMPILED BY SC									
DATUM		Geodetic		DATE		March 25, 2009		CHECKED BY TB/KJB									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
250.5	GROUND SURFACE																
0.0	TOPSOIL		1A	SS	3												
250.0			1B														
0.5	SILTY CLAY, trace to some sand, trace gravel, trace rootlets Firm Brown Wet		2	SS	4												0 6 44 50
249.0																	
1.5	SAND and SILT, trace to some clay and gravel, containing cobbles and boulders and oxidation staining (TILL) Loose to very dense Brown Moist to wet		3	SS	15												8 35 46 11
			4	SS	7												
			5	SS	51												11 34 49 6
			6	SS	130												
			7	SS	98/0.25												
245.5	END OF BOREHOLE																
5.0	NOTES:  1. Water level in open borehole at a depth of 1.2 m below ground surface (Elev. 249.3 m) upon completion of drilling.  2. Water level in piezometer at a depth of 0.3 m below ground surface (Elev. 250.2 m) on April 2, 2009.  3. Water level in piezometer at a depth of 1.2 m below ground surface (Elev. 249.3 m) on May 20, 2009.  4. Water level in piezometer at a depth of 1.8 m below ground surface (Elev. 248.7 m) on June 12, 2009.																

# GRAIN SIZE DISTRIBUTION

Silty Clay

FIGURE D1



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

## LEGEND

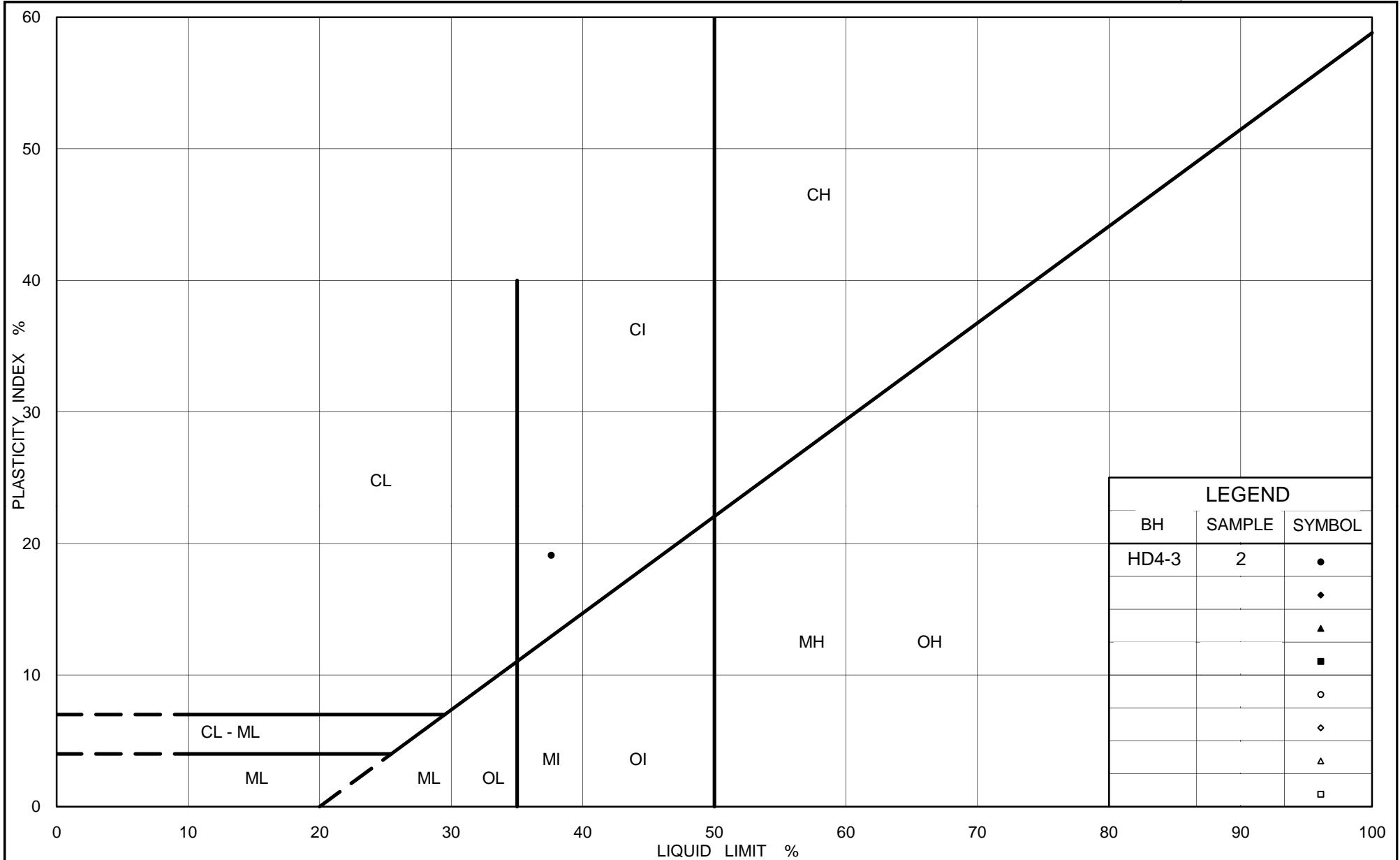
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	HD4-3	2	249.4

Project Number: 08-1111-0022

Checked By: KJB

**Golder Associates**

Date: 23-Oct-09



Ministry of Transportation

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## PLASTICITY CHART Silty Clay

Figure No. D2

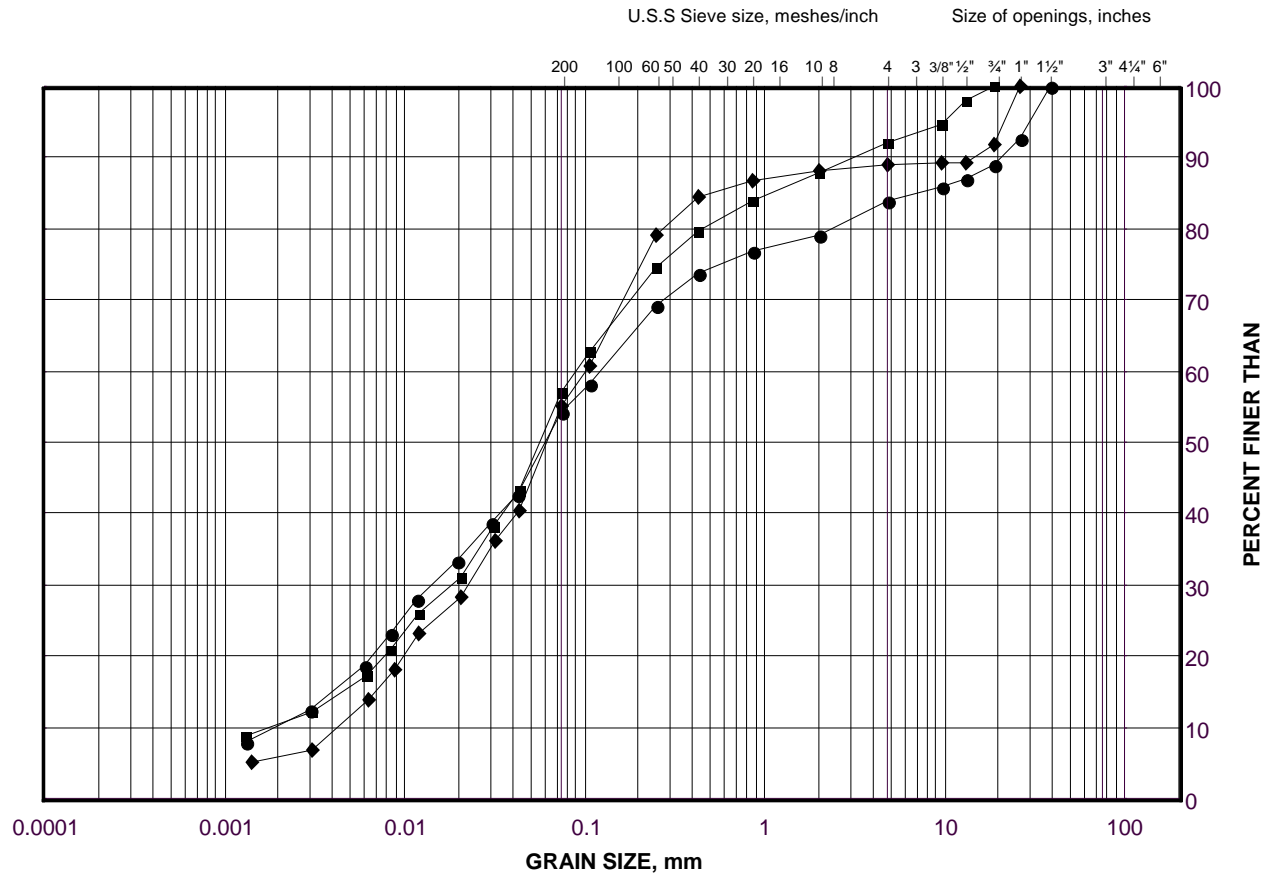
Project No. 08-1111-0022

Checked By: KJB

# GRAIN SIZE DISTRIBUTION

Sandy Silt to Sand and Silt Till

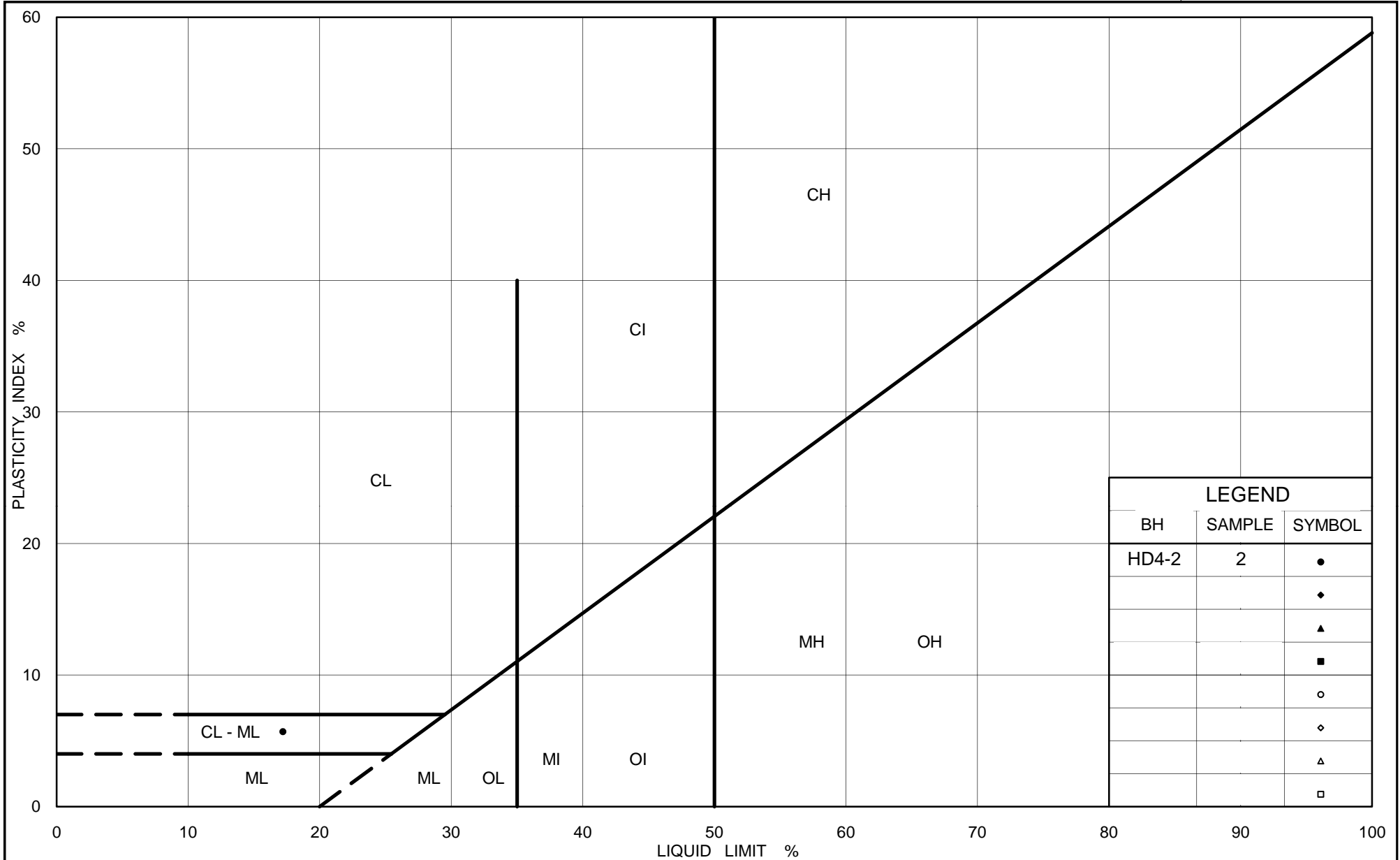
FIGURE D3



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	HD4-2	2	247.9
■	HD4-3	3	248.7
◆	HD4-3	5	247.1



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# PLASTICITY CHART Sandy Silt Till (Clayey Silt Interlayer)

Figure No. D4

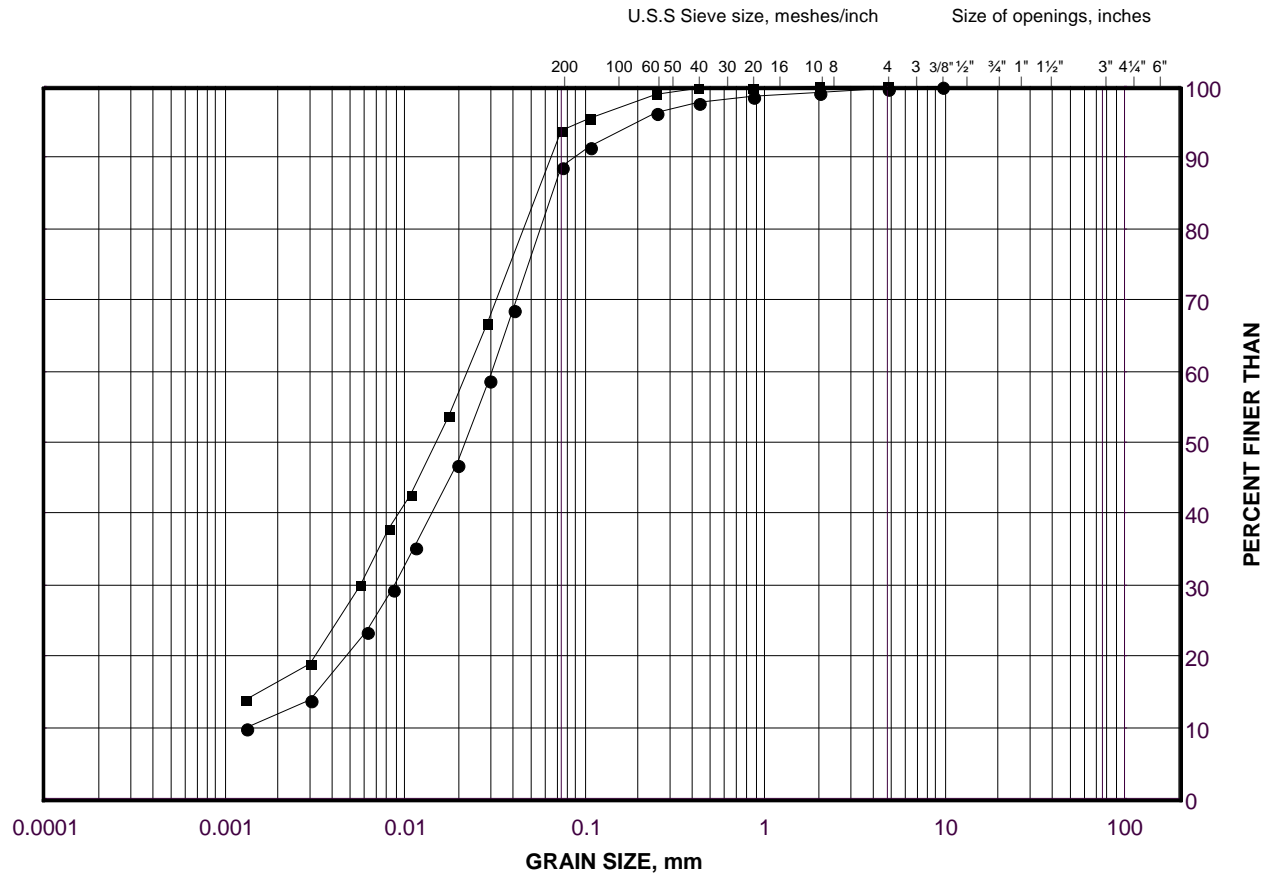
Project No. 08-1111-0022

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# GRAIN SIZE DISTRIBUTION

Clayey Silt

FIGURE D5



## LEGEND

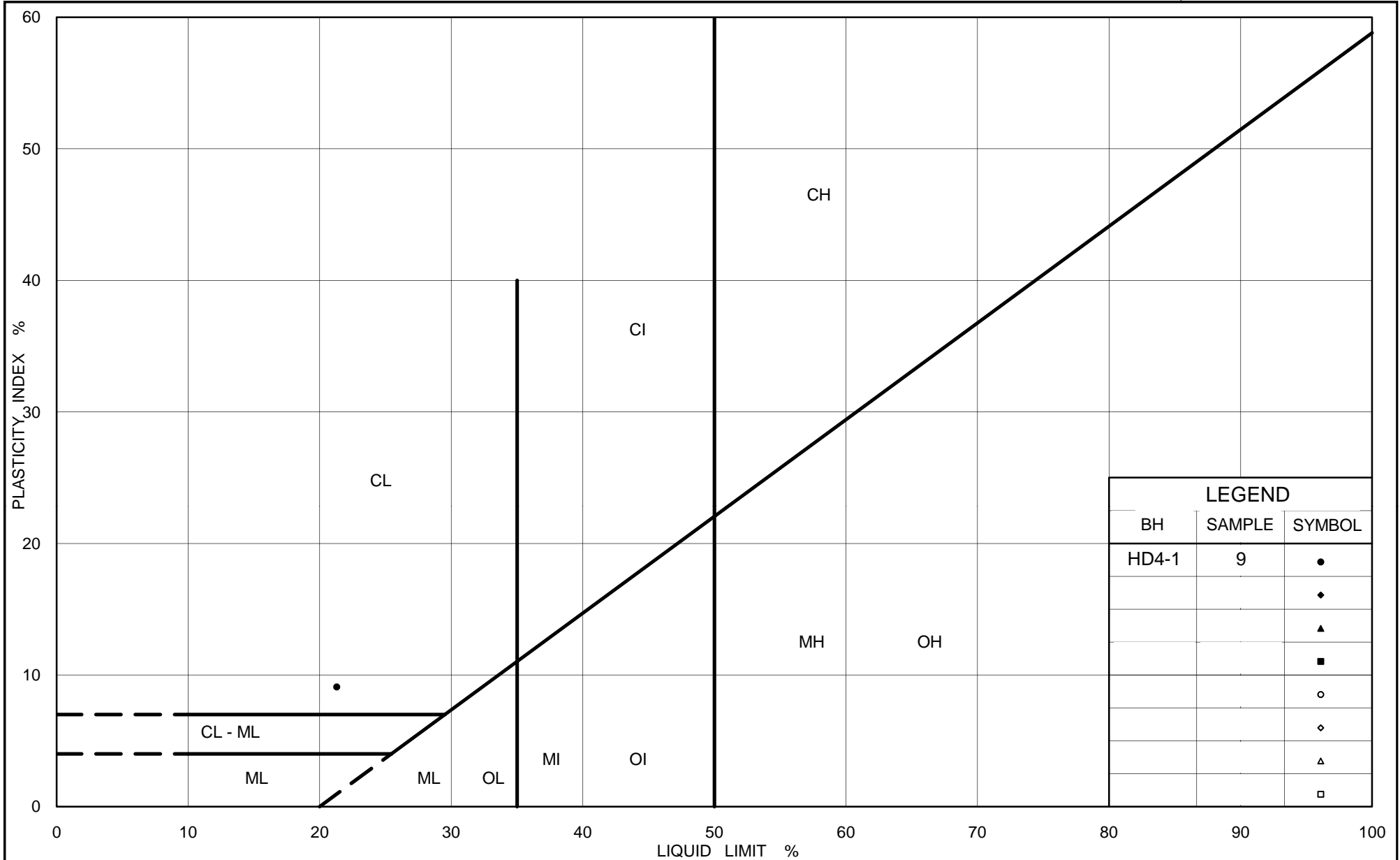
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	HD4-1	4	248.4
■	HD4-1	6	246.9

Project Number: 08-1111-0022

Checked By: KJB

**Golder Associates**

Date: 23-Oct-09



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## PLASTICITY CHART

### Clayey Silt

Figure No. D6

Project No. 08-1111-0022

Checked By: KJB





# **APPENDIX E**

## **Highway 404 - STA. 35+750 to STA. 35+900 (Deep Cut Area 5) Record of Boreholes and Laboratory Test Results**


PROJECT 08-1111-0022		<b>RECORD OF BOREHOLE No HD5-1</b>				1 OF 1 <b>METRIC</b>											
G.W.P. 2005-07-00		LOCATION N 4891765.3 ; E 309146.5				ORIGINATED BY TB											
DIST HWY 404		BOREHOLE TYPE 108 mm O.D. Solid Stem Auger				COMPILED BY SC											
DATUM Geodetic		DATE June 9, 2009				CHECKED BY KJB											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
249.4	GROUND SURFACE																
0.0	CLAYEY SILT with organics, some sand, containing rootlets (Reworked)		1A	SS	4												
248.8	Soft to firm Dark brown Moist		1B														
0.6																	
	SAND and SILT, some gravel, trace to some clay, containing oxidation staining, cobbles and boulders (TILL)		2	SS	13												
247.9	Compact Moist		3	SS	24												
1.5																	
	CLAYEY SILT, trace to some sand, containing interlayers of silty clay, containing oxidation staining to a depth of 3.05 m		4	SS	52												
	Very stiff to hard Brown to grey Moist																
			5	SS	49												
			6	SS	58												
			7	SS	58												
244.2	END OF BOREHOLE																
5.2	NOTES:  1. Borehole open and dry upon completion of drilling.																

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PROJECT 08-1111-0022			RECORD OF BOREHOLE No HD5-2			1 OF 1 METRIC											
G.W.P. 2005-07-00			LOCATION N 4891829.3 ; E 309223.0			ORIGINATED BY TB											
DIST HWY 404			BOREHOLE TYPE 108 mm O.D. Solid Stem Auger			COMPILED BY SC											
DATUM Geodetic			DATE June 9, 2009			CHECKED BY KJB											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ kN/m³	GR SA SI CL
							20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>	10 20 30					
252.1	GROUND SURFACE						252										
0.0	TOPSOIL																
0.1	Sandy SILT with organics, trace clay, contains rootlets		1	SS	4												
251.3	Very loose to loose																
0.8	Dark brown Moist		2	SS	15		251									0 35 57 8	
	SAND and SILT, trace clay, contains wet sand seams																
	Compact		3	SS	29												
	Brown Moist						250										
249.8	CLAYEY SILT, some sand, trace gravel, containing interlayers of silty clay and seams of fine sand, containing oxidation staining to a depth of 3.81 m		4	SS	27												
2.3	Very stiff to hard						249										
	Brown Moist		5	SS	36												
	Becoming grey below a depth of 4.2 m		6	SS	42		248									0 1 50 49	
			7	SS	106												
							247										
			8	SS	44		246										
							245										
243.9	END OF BOREHOLE		9	SS	40		244										
8.2	NOTES: 1. Water level in piezometer at a depth of 2.7 m below ground surface (Elev. 249.4 m) on June 12, 2009.																

PROJECT		RECORD OF BOREHOLE		No HD5-3		1 OF 1		METRIC											
G.W.P.		LOCATION		N 4891853.3; E 309125.2		ORIGINATED BY		TB											
DIST		HWY		BOREHOLE TYPE		COMPILED BY		SC											
DATUM		DATE		June 8, 2009		CHECKED BY		KJB											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa			WATER CONTENT (%)			γ			GR SA SI CL		
251.5	GROUND SURFACE							20 40 60 80 100			10 20 30								
0.0	TOPSOIL		1A	SS	5		251												
0.3	Sandy SILT with organics, trace clay, contains rootlets		1B	SS															
250.7	Loose Brown Moist		2	SS	21														
0.8	CLAYEY SILT, some sand, trace to some gravel, containing interlayers of sandy silt, containing cobbles, boulders and oxidation staining (TILL) Very stiff to hard Brown Moist		3	SS	86/0.17		250												
			4	SS	29		249										7 28 54 11		
			5	SS	53		248												
			6	SS	71		247												
246.6	CLAYEY SILT, trace to some sand, containing interlayers of silty clay Hard Grey Moist		7	SS	77		246												
4.9	Containing seams of wet sand below a depth of 6 m		8	SS	49		245												
			9	SS	64		244												
			10	SS	53		243												
241.8	END OF BOREHOLE						242												
9.8	NOTES: 1. Water level in open borehole at a depth of 5.2 m below ground surface (Elev. 246.3 m) upon completion of drilling. 2. Water level in piezometer at a depth of 2.9 m below ground surface (Elev. 248.6 m) on June 12, 2009.																		

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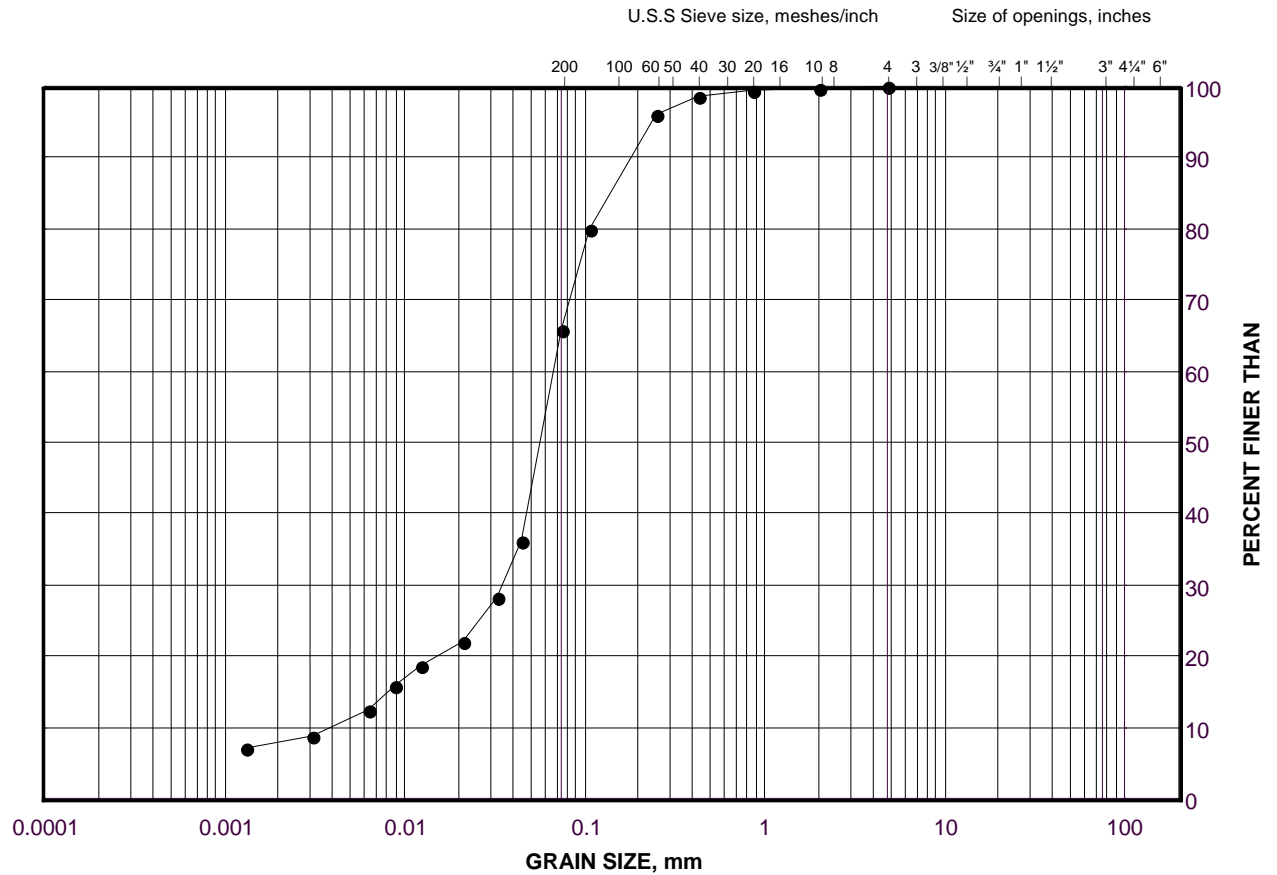
PROJECT		08-1111-0022		<b>RECORD OF BOREHOLE No HD5-4</b>				1 OF 1 <b>METRIC</b>														
G.W.P.		2005-07-00		LOCATION		N 4891924.6 ; E 309165.6		ORIGINATED BY TB														
DIST		HWY 404		BOREHOLE TYPE		108 mm O.D. Solid Stem Auger		COMPILED BY SC														
DATUM		Geodetic		DATE		June 2, 2009		CHECKED BY KJB														
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)							
248.9	GROUND SURFACE																					
0.0	TOPSOIL																					
0.2	CLAYEY SILT, some sand, trace gravel, containing cobbles, boulders and oxidation staining (TILL) Soft to hard Brown Moist		1	SS	3		248															
			2	SS	19																	
			3	SS	69																	
246.6															247							
2.3	CLAYEY SILT, trace to some sand, containing interlayers of silty clay and sand seams Very stiff to hard Brown to grey Moist		4	SS	29																	
			5	SS	46																	
			6	SS	31																	
		7	SS	32	245																	
243.7	END OF BOREHOLE						244															
5.2	NOTES:  1. Borehole open and dry upon completion of drilling.																					

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# GRAIN SIZE DISTRIBUTION

Sand and Silt

FIGURE E1



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	HD5-2	2	251.0

Project Number: 08-1111-0022

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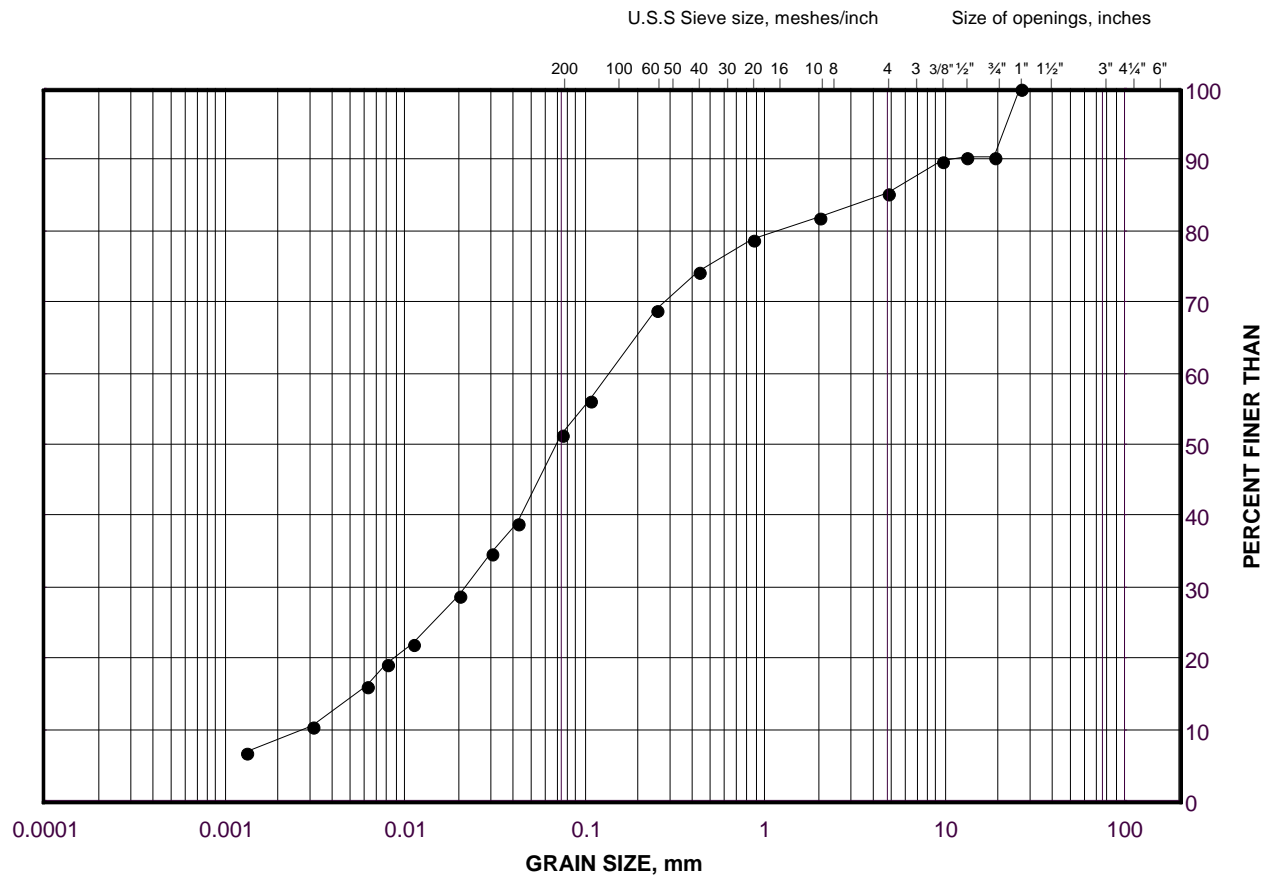
**Golder Associates**

Date: 27-Oct-09

# GRAIN SIZE DISTRIBUTION

Sand and Silt Till

FIGURE E2



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	HD5-1	2	248.3

Project Number: 08-1111-0022

Checked By: KJB

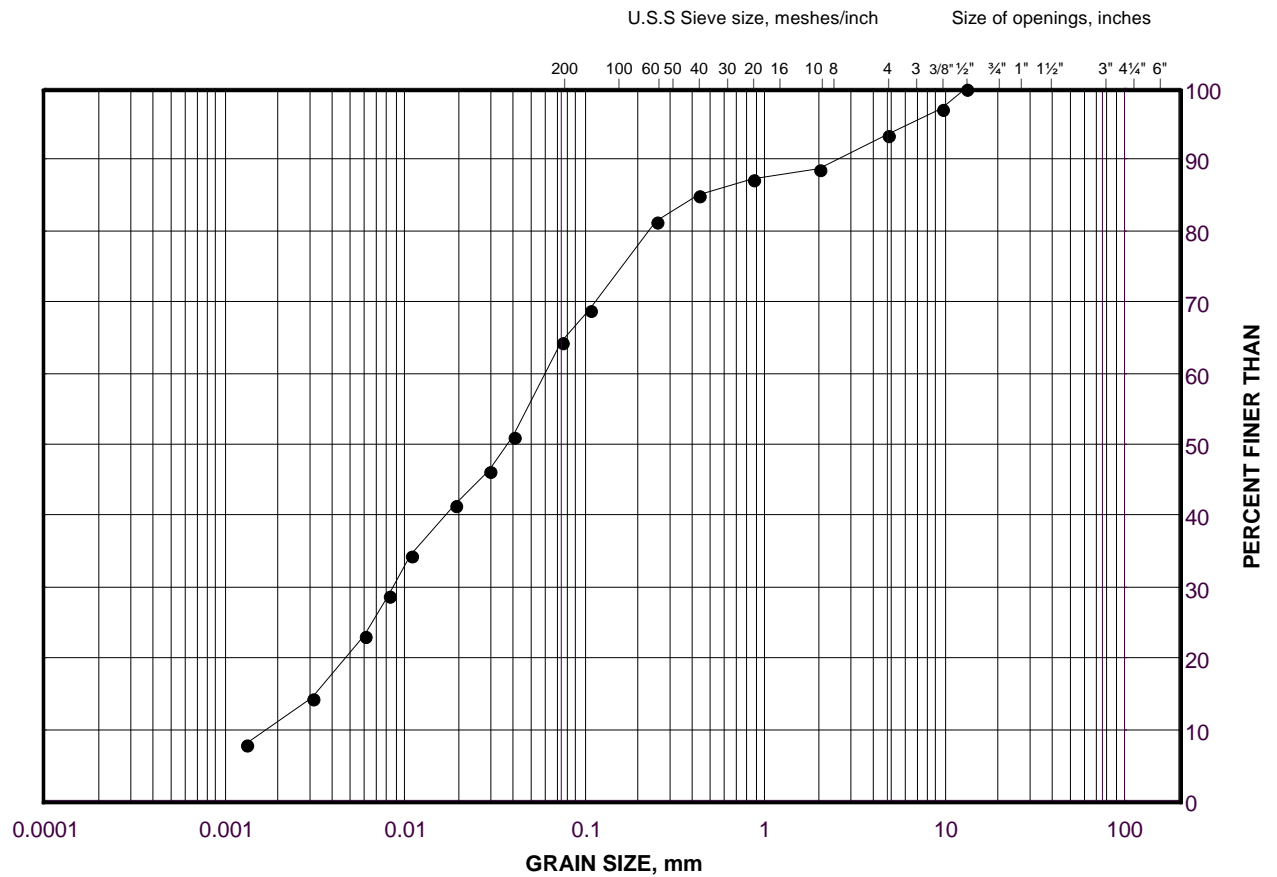
**Golder Associates**

Date: 27-Oct-09

# GRAIN SIZE DISTRIBUTION

Clayey Silt Till

FIGURE E3



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	HD5-3	4	248.9

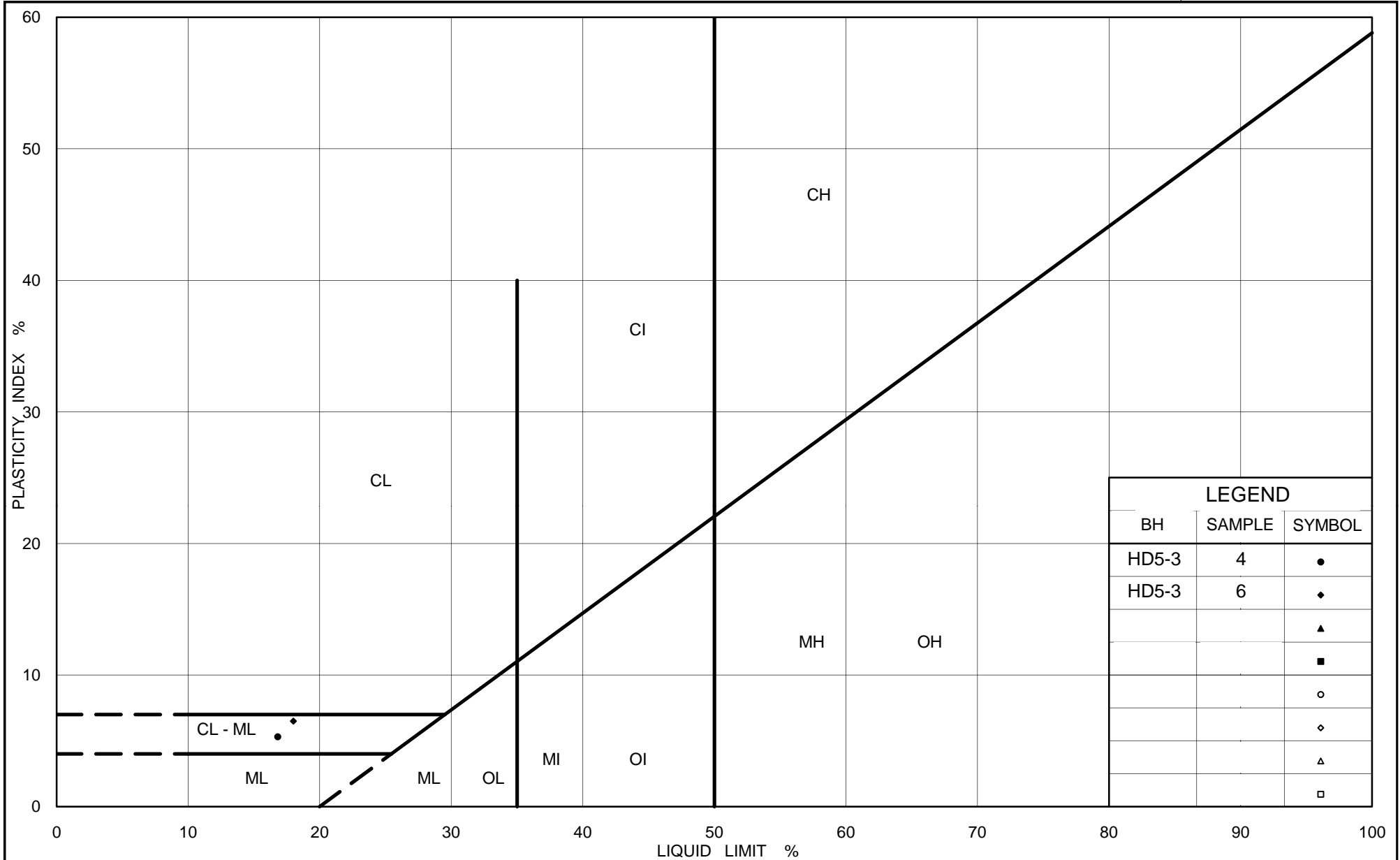
Project Number: 08-1111-0022

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## PLASTICITY CHART

### Clayey Silt Till

Figure No. E4

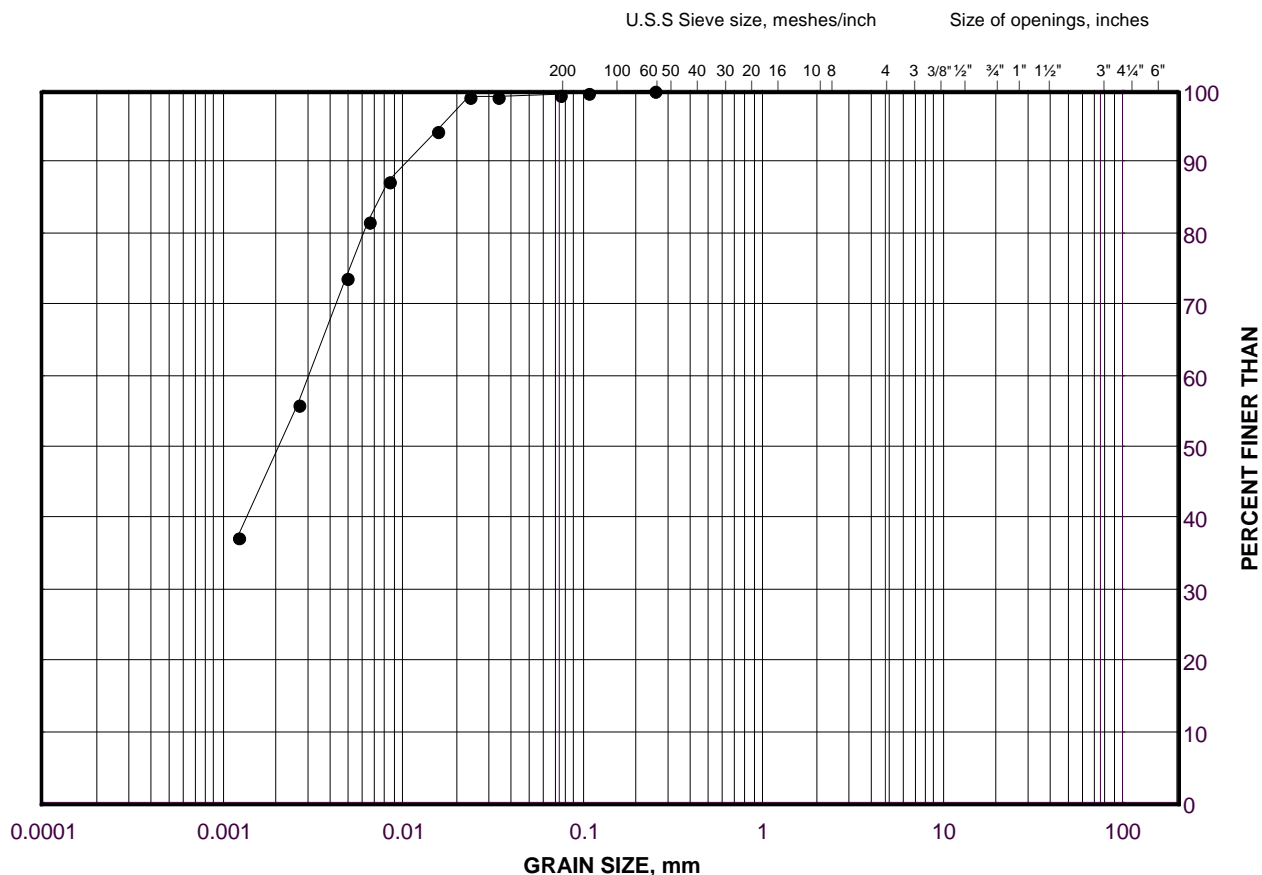
Project No. 08-1111-0022

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# GRAIN SIZE DISTRIBUTION

Clayey Silt (Contains Silty Clay Interlayers)

FIGURE E5



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

## LEGEND

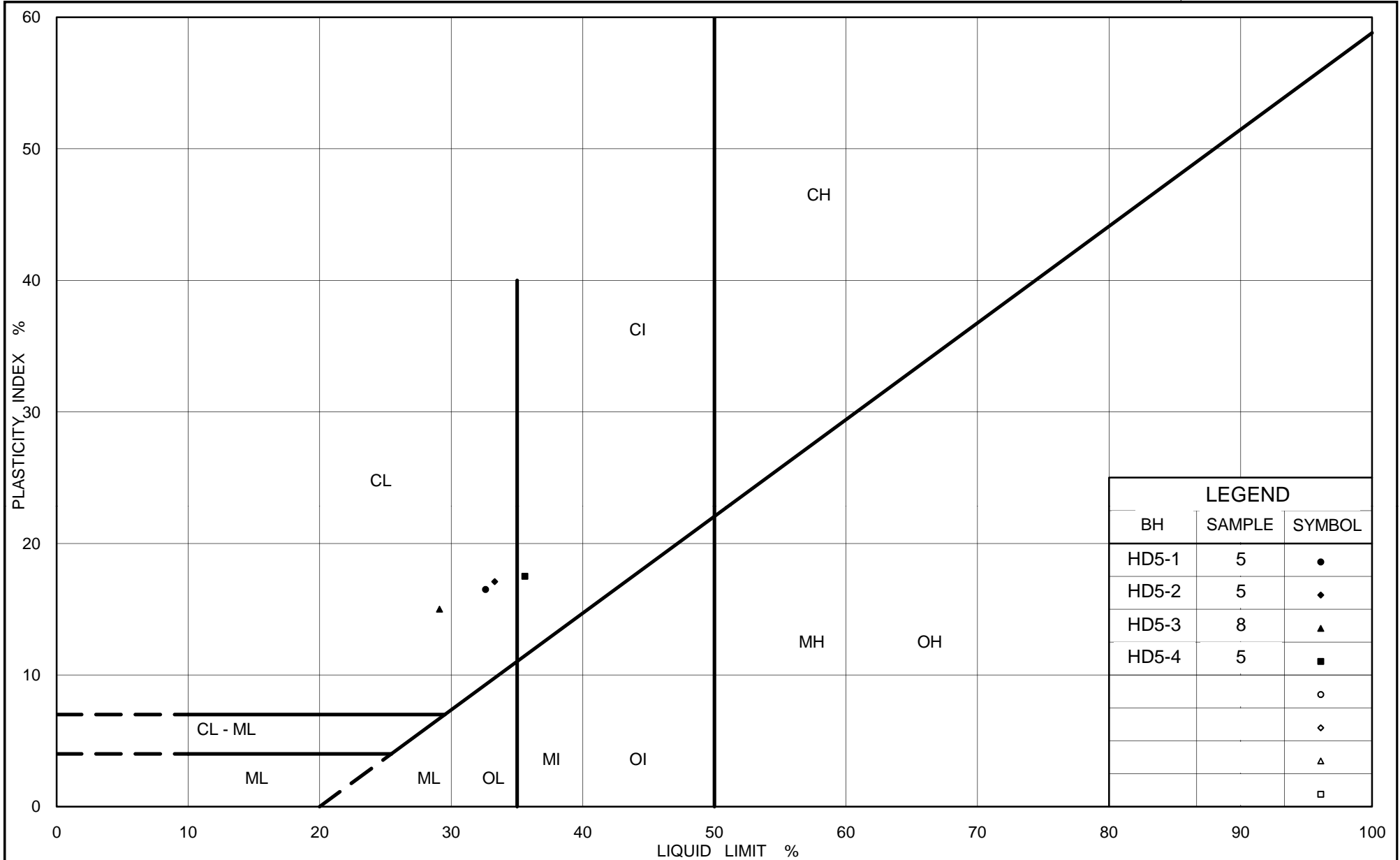
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	HD5-2	5	248.7

Project Number: 08-1111-0022

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Date: 27-Oct-09



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## PLASTICITY CHART Clayey Silt

Figure No. E6

Project No. 08-1111-0022

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# **APPENDIX F**

**Highway 404 - STA. 36+870 to STA. 37+150 (High Fill Area 6)**  
**Record of Boreholes and Laboratory Test Results**

PROJECT <u>08-1111-0022</u>			<b>RECORD OF BOREHOLE No HD6-1</b>			1 OF 1 <b>METRIC</b>		
G.W.P. <u>2005-07-00</u>			LOCATION <u>N 4892891.8 ; E 308903.8</u>			ORIGINATED BY <u>TB</u>		
DIST <u>          </u> HWY <u>404</u>			BOREHOLE TYPE <u>108 mm O.D. Solid Stem Auger</u>			COMPILED BY <u>SC</u>		
DATUM <u>Geodetic</u>			DATE <u>February 24, 2009</u>			CHECKED BY <u>TT/KJB</u>		

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	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						20	40	60
239.8	GROUND SURFACE																			
0.0	TOPSOIL		1A	SS	5															
239.3			1B																	
0.5	Sandy SILT, trace clay and gravel, containing clayey silt seams, trace organics to a depth of 0.8 m Loose Light brown Moist		2	SS	6															
			3	SS	7															
237.5																				
2.3	CLAYEY SILT, trace sand Very stiff to hard Brown Moist		4	SS	25															
			5	SS	37															
			6	SS	49															
235.2																				
4.6	Silty SAND, trace clay Very dense Brown Wet		7	SS	55															
233.4			8	SS	152/0.28															
6.6	CLAYEY SILT, some sand, trace gravel (TILL) Hard Grey Wet  END OF BOREHOLE  NOTES:  1. Water level in open borehole at a depth of 6.3 m below ground surface (Elev. 233.5 m) upon completion of drilling.																			

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PROJECT		08-1111-0022		RECORD OF BOREHOLE No HD6-2				1 OF 1		METRIC								
G.W.P.		2005-07-00		LOCATION		N 4892944.6 ; E 308939.9		ORIGINATED BY		TB								
DIST		HWY 404		BOREHOLE TYPE		108 mm O.D. Solid Stem Auger		COMPILED BY		SC								
DATUM		Geodetic		DATE		February 24, 2009		CHECKED BY		TT/KJB								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
238.2	GROUND SURFACE							20	40	60	80	100						
0.0	TOPSOIL		1A	SS	6		238											
237.7	CLAYEY SILT, some sand, trace gravel, trace organics and rootlets to a depth of 0.8 m		1B															
0.5	Firm Brown Moist		2	SS	4		237											
236.7	SAND, some silt		3	SS	18		236											
1.5	Compact to dense Brown Moist		4	SS	19		235											
			5	SS	46		234											
			6	SS	25		233											
233.6	SILT, some sand, trace clay		7	SS	24		232											
4.6	Compact to dense Brown Wet		8	SS	36													
231.5	END OF BOREHOLE																	
6.7	NOTES: 1. Water level in open borehole at a depth of 2.8 m below ground surface (Elev. 235.4 m) upon completion of drilling.																	

PROJECT		08-1111-0022		<b>RECORD OF BOREHOLE No HD6-3</b>		1 OF 1 <b>METRIC</b>										
G.W.P.		2005-07-00		LOCATION		N 4892992.5 ; E 308897.4										
DIST		HWY 404		BOREHOLE TYPE		108 mm O.D. Solid Stem Auger										
DATUM		Geodetic		DATE		February 24, 2009										
						ORIGINATED BY TB										
						COMPILED BY SC										
						CHECKED BY TT/KJB										
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60	80
239.9	GROUND SURFACE															
0.0	TOPSOIL Soft		1	SS	4											
239.3																
0.6	CLAYEY SILT, some sand, trace gravel Firm Brown Moist		2	SS	7											
238.4																
1.5	SAND and SILT, trace to some clay, trace gravel, containing cobbles and boulders (TILL) Loose to dense Brown Moist to wet		3	SS	7											
			4	SS	34											
			5	SS	48											
			6	SS	42											
235.7																
4.2	Silty SAND, trace clay Dense Brown Wet															
235.2																
4.7	CLAYEY SILT, trace sand, trace gravel (TILL) Hard Grey Moist		7	SS	30											
			8	SS	42											
233.2																
6.7	END OF BOREHOLE															
NOTE: 1. Water level in open borehole at a depth of 6.0 m below ground surface (Elev. 233.9 m) upon completion of drilling. 2. Water level in piezometer at a depth of 1.8 m below ground surface (Elev. 238.1 m) on February 26, 2009. 3. Water level in piezometer at a depth of 1.3 m below ground surface (Elev. 238.6 m) on March 12, 2009. 4. Water level in piezometer at a depth of 1.1 m below ground surface (Elev. 238.8 m) on April 2, 2009. 5. Water level in piezometer at a depth of 1.3 m below ground surface (Elev. 238.6 m) on May 20, 2009. 6. Water level in piezometer at a depth of 1.8 m below ground surface (Elev. 238.1 m) on June 12, 2009.																

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PROJECT 08-1111-0022		RECORD OF BOREHOLE No HD6-4		1 OF 1 METRIC													
G.W.P. 2005-07-00		LOCATION N 4893043.6 ; E 308935.8		ORIGINATED BY TB													
DIST HWY 404		BOREHOLE TYPE 108 mm O.D. Solid Stem Auger		COMPILED BY SC													
DATUM Geodetic		DATE February 24, 2009		CHECKED BY TT/KJB													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ kN/m <sup>3</sup>	GR SA SI CL
								20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>					
239.8	GROUND SURFACE																
0.0	TOPSOIL Soft		1	SS	2												
239.0							239										
0.8	CLAYEY SILT, some sand, trace gravel, contains interlayers of clay		2	SS	4												
238.3	Soft to firm																
1.5	Brown Moist		3	SS	7		238										
	SAND and SILT, trace clay, trace gravel, containing cobbles and boulders (TILL)																
	Loose to very dense		4	SS	46		237										
	Brown Moist																
			5	SS	72												
236.0							236										
3.8	SAND, trace to some silt, trace clay		6	SS	51												
	Dense to very dense																
	Brown Moist		7	SS	53		235										
							234										
233.4	Becoming wet below a depth of 6.1 m		8	SS	33												
233.1	CLAYEY SILT, some sand, trace gravel (TILL)																
6.7	Hard Grey Moist																
	END OF BOREHOLE																
NOTES:																	
1. Borehole open and dry upon completion of drilling.																	



PROJECT 08-1111-0022		RECORD OF BOREHOLE No HD6-5				1 OF 1 METRIC										
G.W.P. 2005-07-00		LOCATION N 4893113.5; E 308895.7				ORIGINATED BY TB										
DIST _____ HWY 404		BOREHOLE TYPE 108 mm O.D. Solid Stem Auger				COMPILED BY SC										
DATUM Geodetic		DATE February 19, 2009				CHECKED BY TT/KJB										
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
244.3	GROUND SURFACE															
0.0	TOPSOIL		1	SS	3											
243.7																
0.6	SAND and SILT, some gravel, trace clay, containing cobbles and boulders (TILL) Compact to very dense Brown Moist		2	SS	20											22 25 49 4
			3	SS	37											
			4	SS	42											
			5	SS	137											
			6	SS	100/0.13											
240.1	END OF BOREHOLE															
4.2	NOTES:  1. Water level in open borehole at 3.0 m below ground surface (Elev. 241.3 m) upon completion of drilling.															

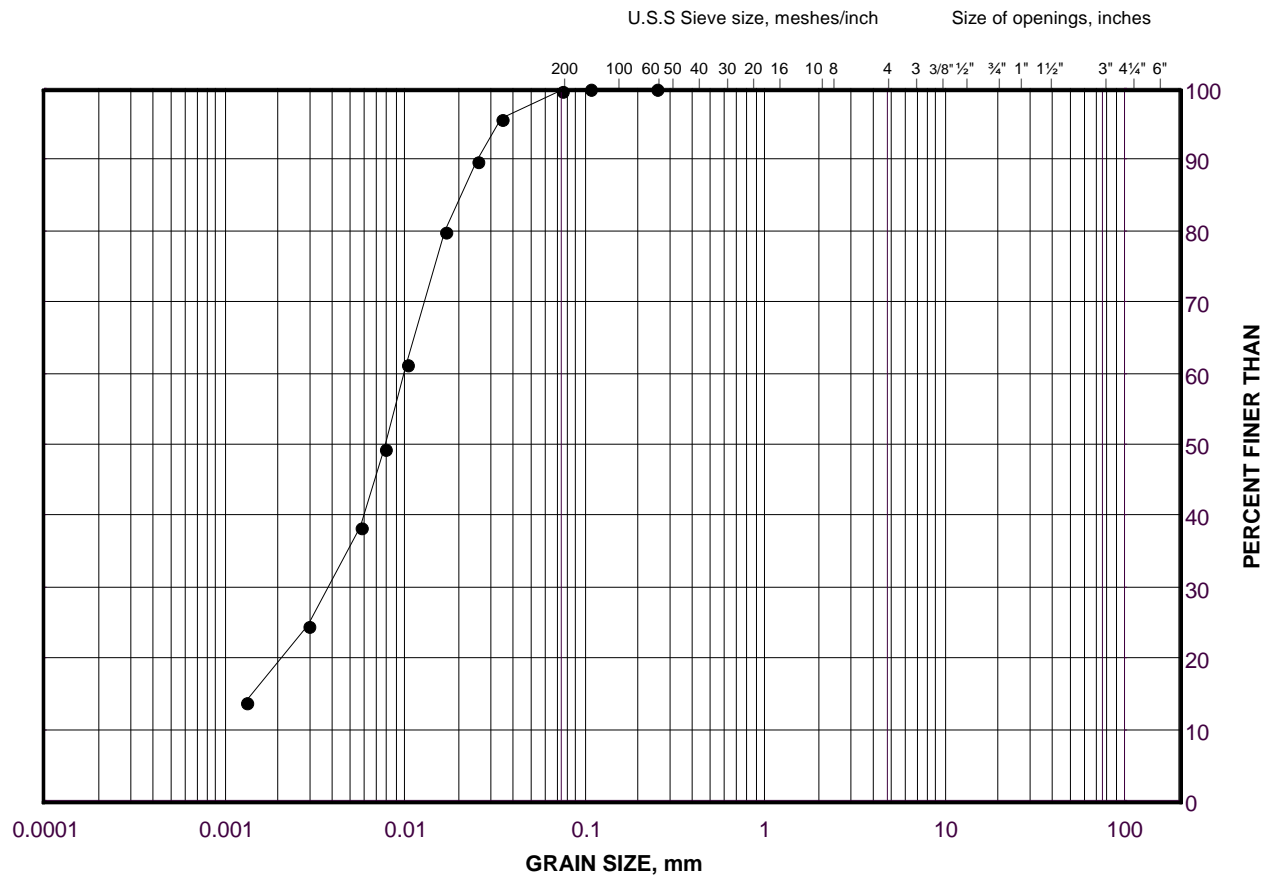
PROJECT 08-1111-0022		RECORD OF BOREHOLE No HD6-6				1 OF 1 METRIC											
G.W.P. 2005-07-00		LOCATION N 4893142.7 ; E 308936.9				ORIGINATED BY TB											
DIST HWY 404		BOREHOLE TYPE 108 mm O.D. Solid Stem Auger				COMPILED BY SC											
DATUM Geodetic		DATE February 18, 2009				CHECKED BY TT/KJB											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>	γ	GR	SA	SI	CL
243.1 0.0	GROUND SURFACE TOPSOIL		1	SS	9		243										
242.4 0.7	SAND and SILT, trace to some clay, trace gravel, containing cobbles and boulders and interlayers of clayey silt (TILL) Compact to very dense Brown Moist		2	SS	17		242										
			3	SS	53		241										
			4	SS	51		240										
			5	SS	109		239										
			6	SS	80/0.10												
238.5 4.6		END OF BOREHOLE															
NOTES:																	
1. Borehole dry upon completion of drilling.																	
2. Water level in piezometer at a depth of 4.4 m below ground surface (Elev. 238.7 m) on February 26, 2009.																	
3. Water level in piezometer at a depth of 3.9 m below ground surface (Elev. 239.2 m) on March 12, 2009.																	
4. Water level in piezometer at a depth of 2.6 m below ground surface (Elev. 240.5 m) on April 2, 2009.																	
5. Water level in piezometer at a depth of 3.1 m below ground surface (Elev. 240.0 m) on May 20, 2009.																	
6. Water level in piezometer at a depth of 4.3 m below ground surface (Elev. 238.8m) on June 12, 2009.																	

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# GRAIN SIZE DISTRIBUTION

Clayey Silt

FIGURE F1



## LEGEND

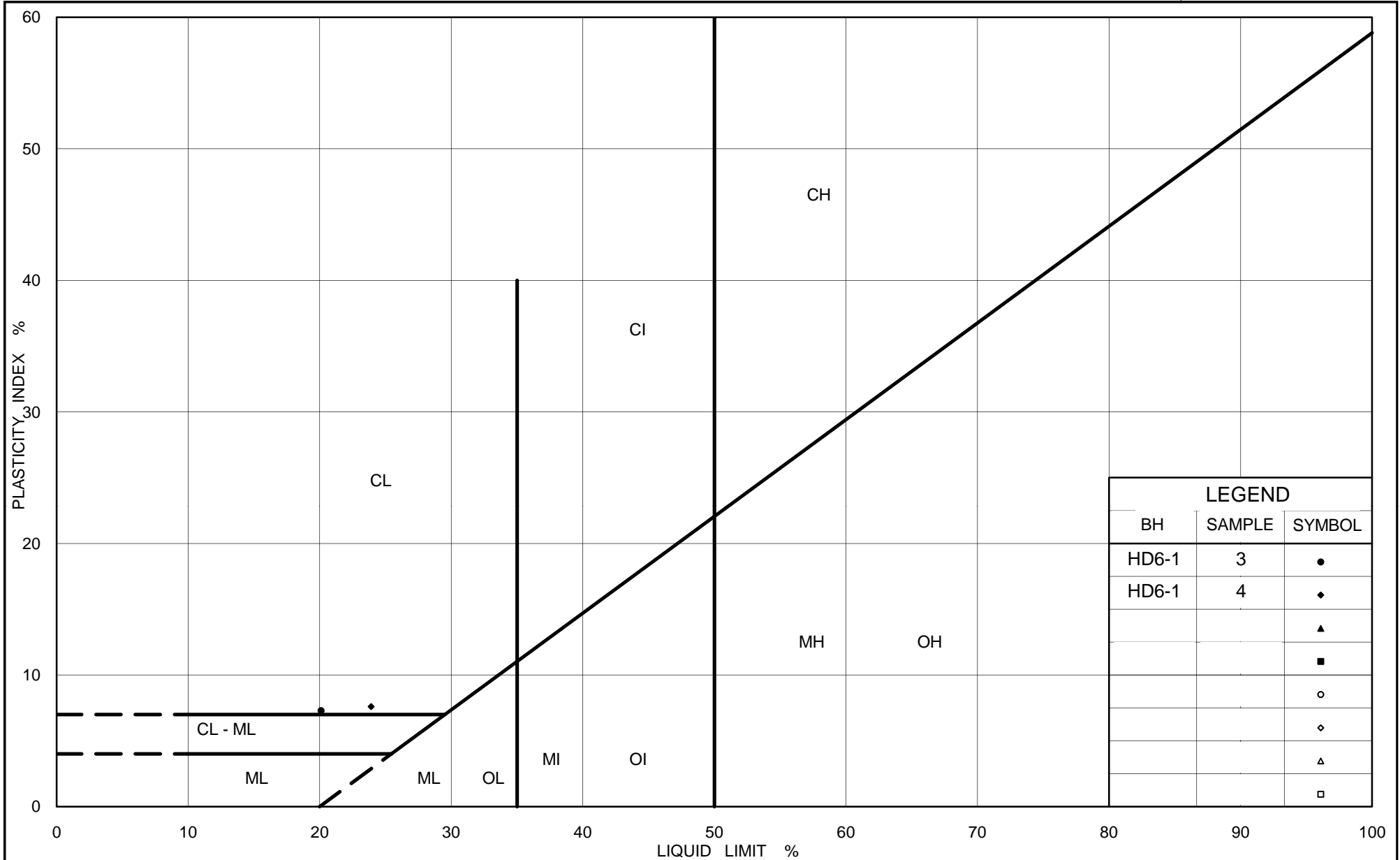
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	HD6-1	4	237.3

Project Number: 08-1111-0022

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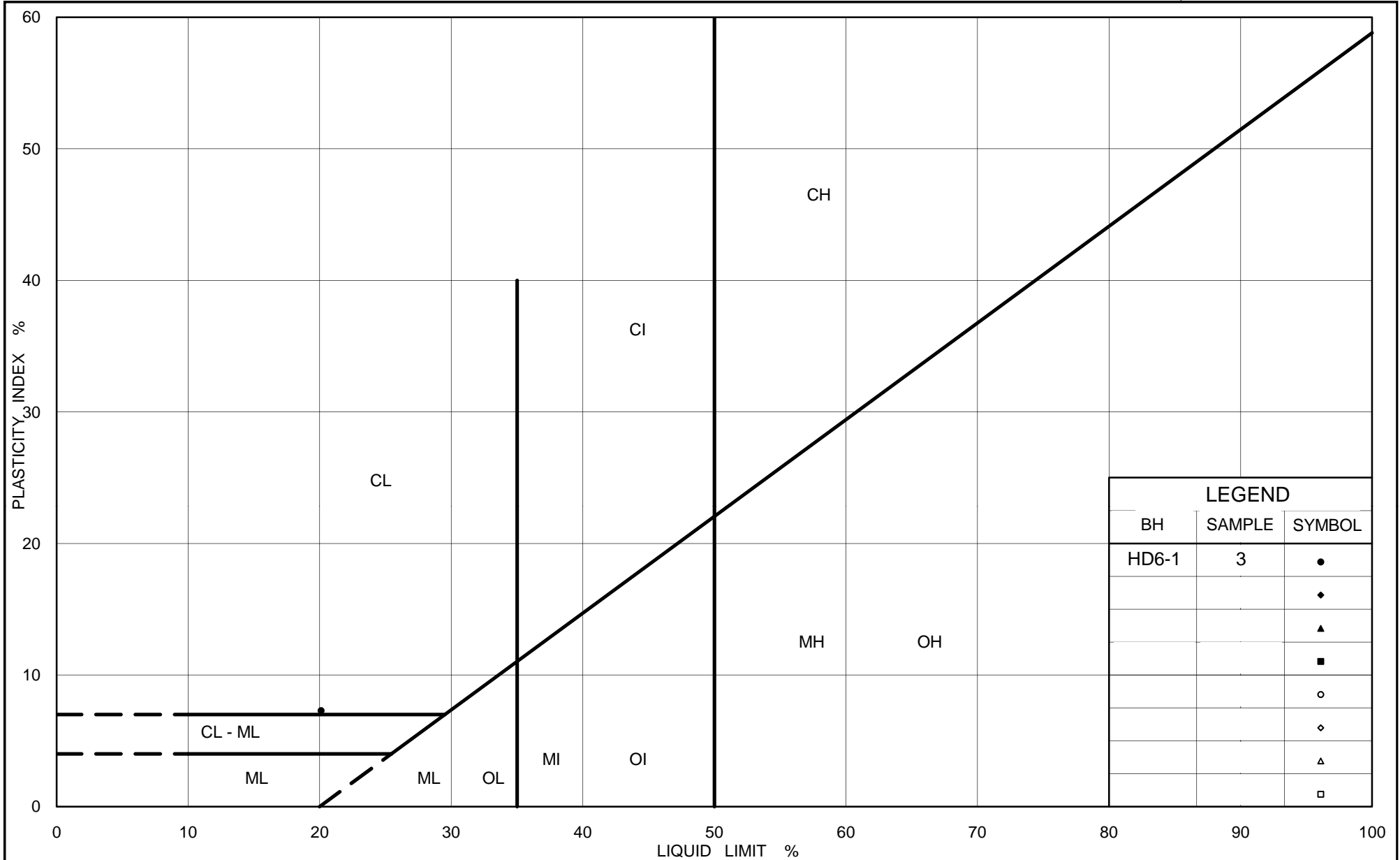
## PLASTICITY CHART

### Clayey Silt

Figure No. F2

Project No. 08-1111-0022

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## PLASTICITY CHART

### Sandy Silt (Clayey Silt Interlayer)

Figure No. F3

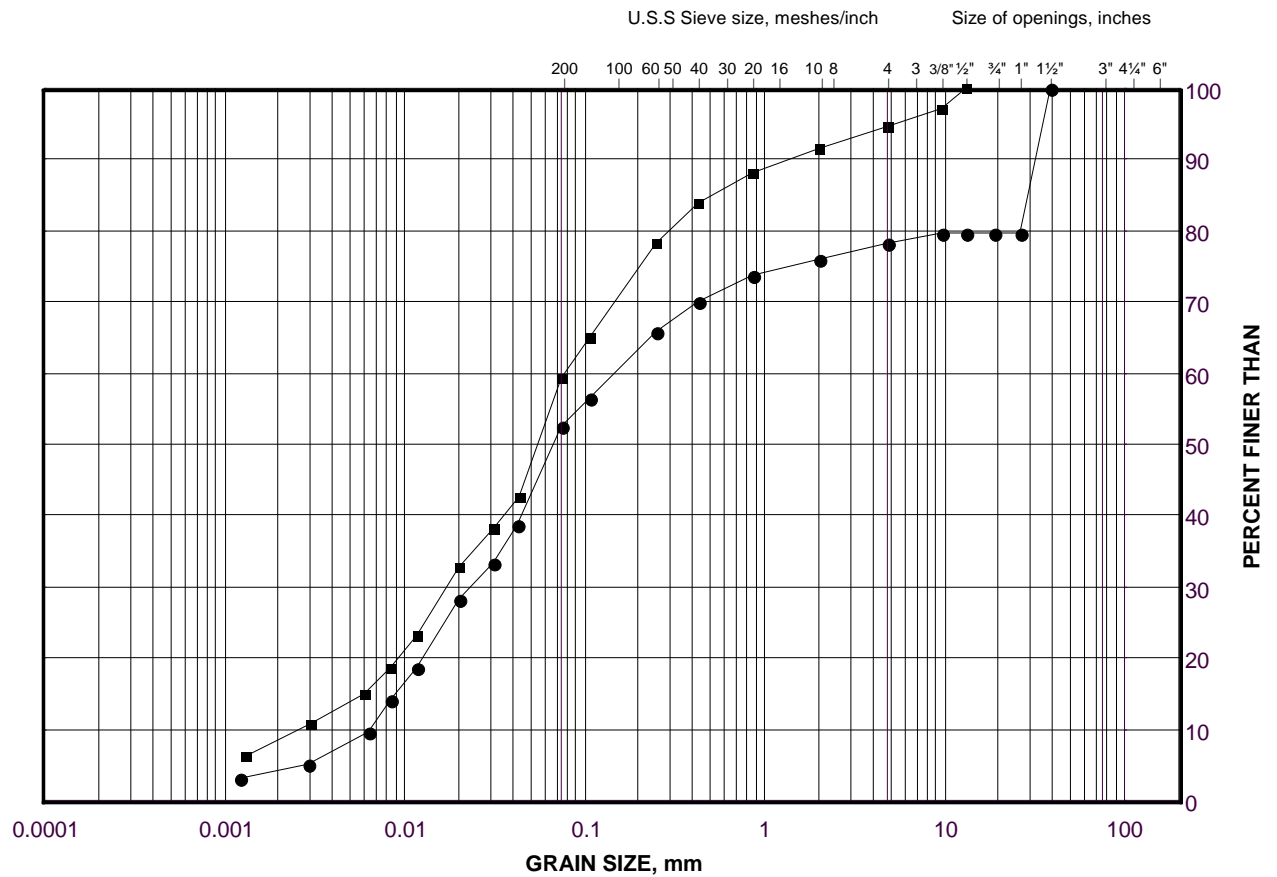
Project No. 08-1111-0022

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# GRAIN SIZE DISTRIBUTION

Sand and Silt Till

FIGURE F4



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

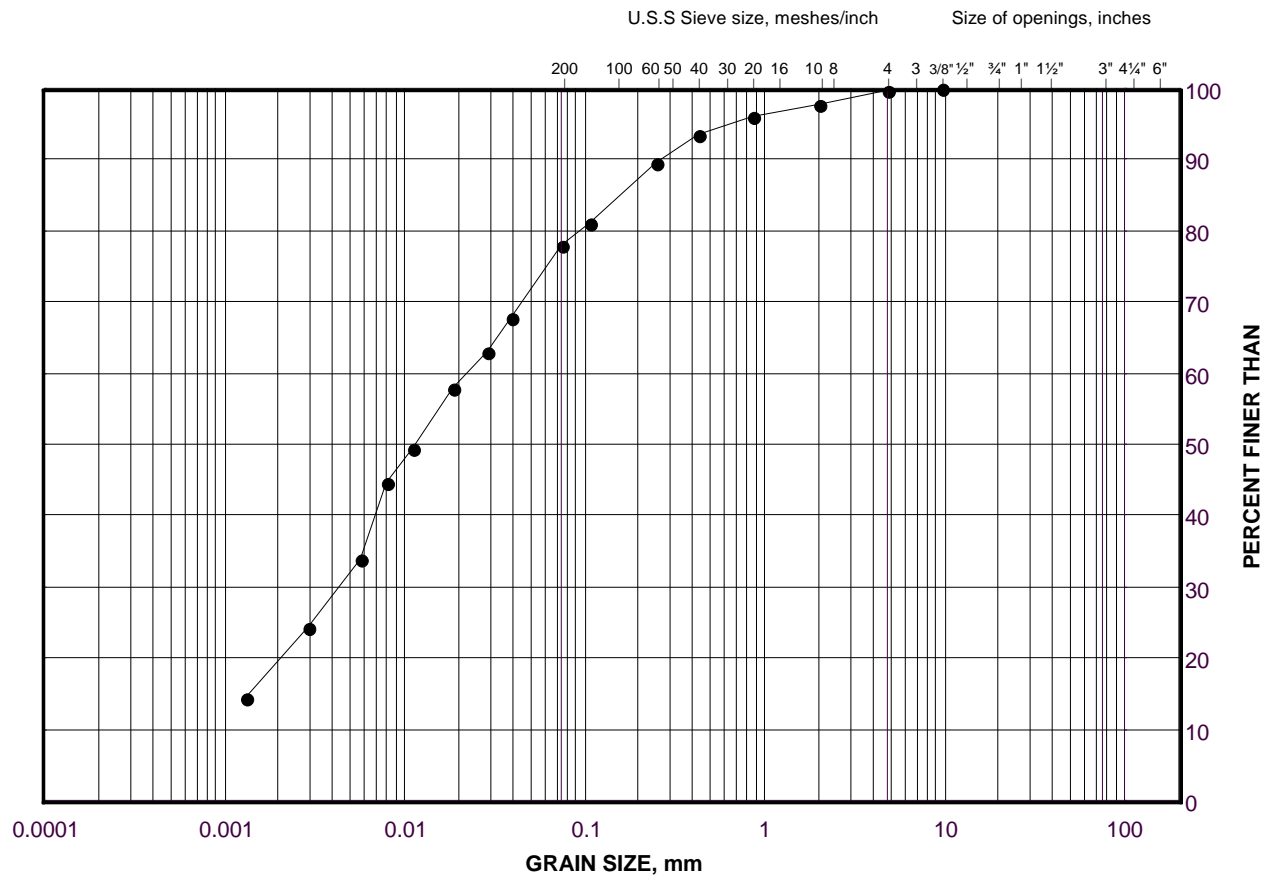
## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	HD6-5	2	243.2
■	HD6-3	5	236.5

# GRAIN SIZE DISTRIBUTION

Sand and Silt Till (Clayey Silt Interlayer)

FIGURE F5



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	HD6-6	4	240.5

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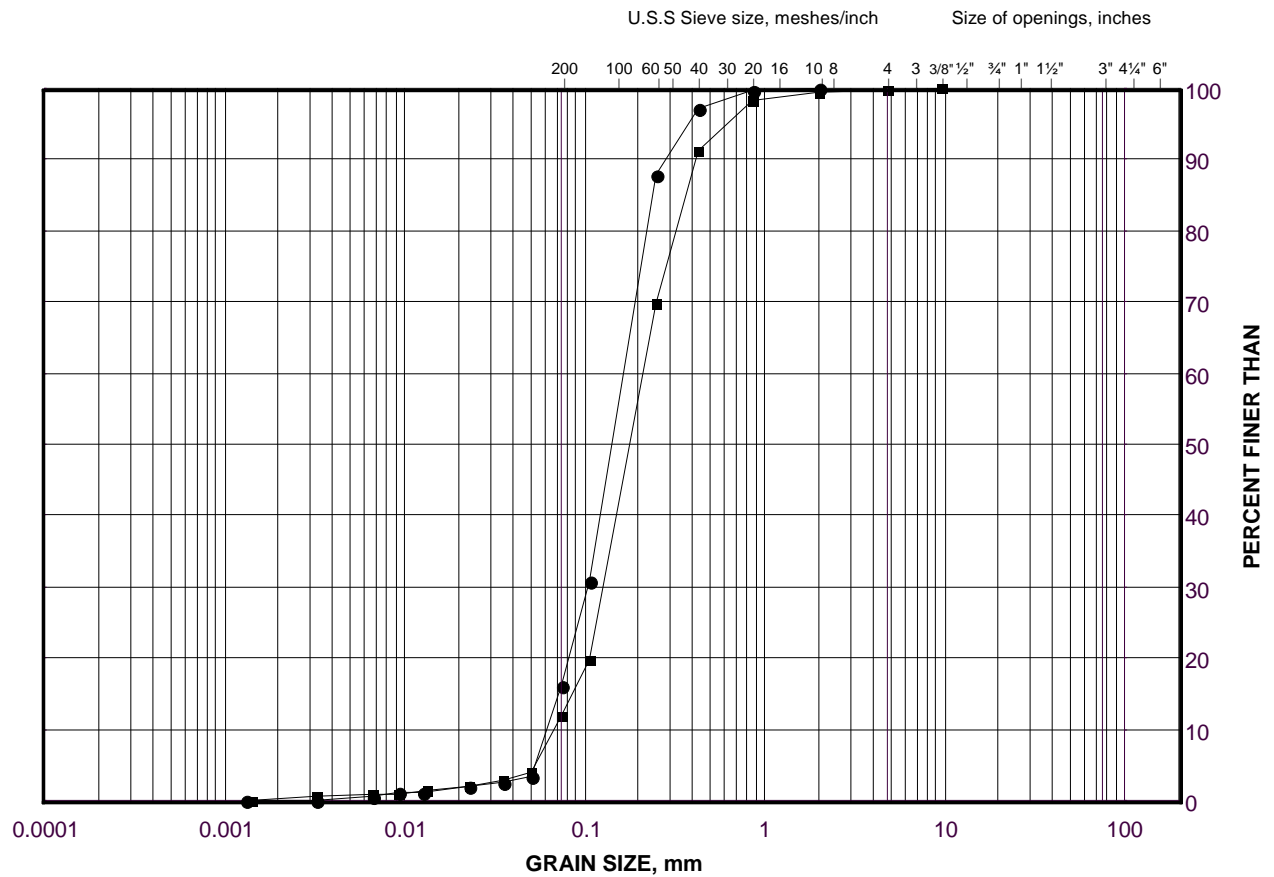
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# GRAIN SIZE DISTRIBUTION

Sand

FIGURE F6



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

## LEGEND

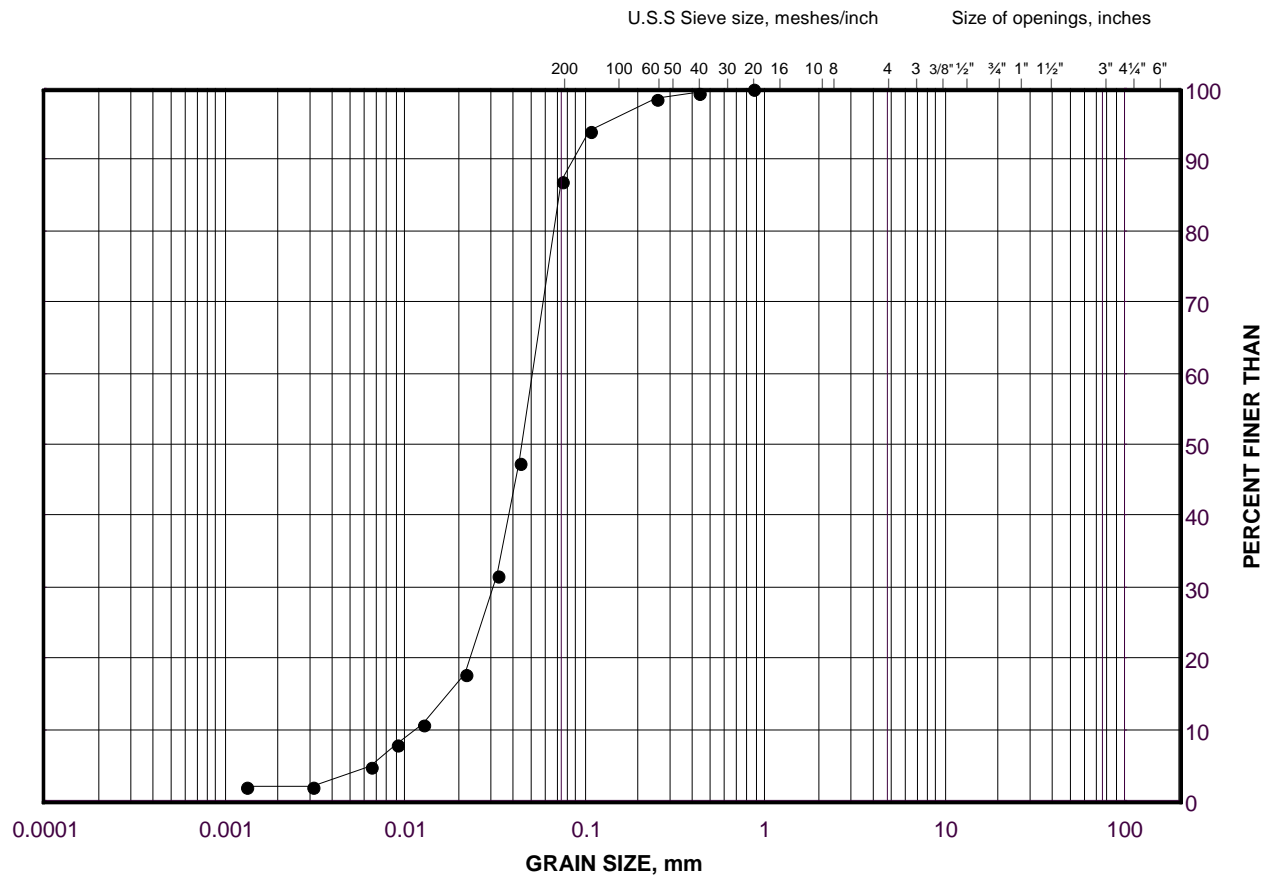
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	HD6-2	4	235.6
■	HD6-4	7	234.9



# GRAIN SIZE DISTRIBUTION

Silt

FIGURE F7



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

## LEGEND

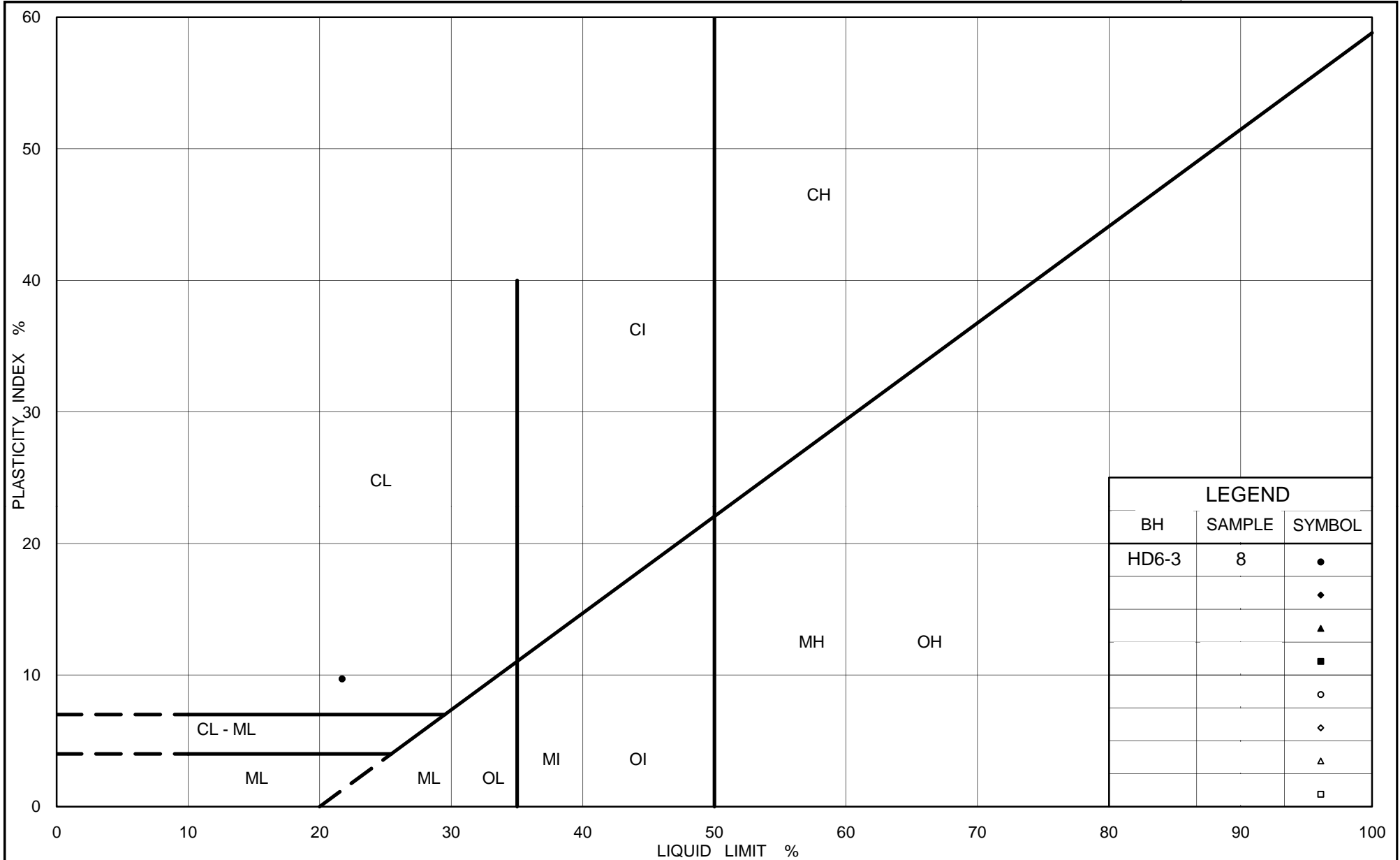
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	HD6-2	7	233.3

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## PLASTICITY CHART

### Clayey Silt Till

Figure No. F8

Project No. 08-1111-0022

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# **APPENDIX G**

## **Highway 404 - STA. 37+400 to STA. 37+760 (Deep Cut Area 7) Record of Boreholes and Laboratory Test Results**

PROJECT 08-1111-0022		RECORD OF BOREHOLE No HD7-1				1 OF 1 METRIC										
G.W.P. 2005-07-00		LOCATION N 4893421.2; E 308913.2				ORIGINATED BY TB										
DIST HWY 404		BOREHOLE TYPE 108 mm O.D. Solid Stem Auger				COMPILED BY SC										
DATUM Geodetic		DATE March 16, 2009				CHECKED BY AM/KJB										
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
254.6	GROUND SURFACE						20	40	60	80	100					
0.0	TOPSOIL Soft		1	SS	2											
254.0						254										
0.6	SAND and SILT, trace to some gravel, trace to some clay, containing cobbles and boulders (TILL) Compact to very dense Brown Moist		2	SS	24											
						253										
			3	SS	48											
						252										
			4	SS	21											
						251										
			5	SS	26											
						250										
			6	SS	63											
						249										
	Containing silty clay seams below a depth of 4.6 m		7	SS	82											
248.1	Becoming grey below a depth of 6.2 m		8	SS	70/0.2											
6.6	END OF BOREHOLE															
NOTES:																
1. Water level in open borehole at a depth of 1.8 m below ground surface (Elev. 252.8 m) upon completion of drilling.																
2. Water level in piezometer at a depth of 1.0 m below ground surface (Elev. 253.6 m) on March 19, 2009.																
3. Water level in piezometer at ground surface on April 2, 2009.																
4. Water level in piezometer at a depth of 1.0 m below ground surface (Elev. 253.6 m) on June 12, 2009.																

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PROJECT		08-1111-0022		<b>RECORD OF BOREHOLE No HD7-2</b>		1 OF 1 <b>METRIC</b>										
G.W.P.		2005-07-00		LOCATION		N 4893471.2; E 308921.5										
DIST		HWY 404		BOREHOLE TYPE		108 mm O.D. Solid Stem Auger										
DATUM		Geodetic		DATE		March 16, 2009										
				ORIGINATED BY		TB										
				COMPILED BY		SC										
				CHECKED BY		AM/KJB										
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
255.9	GROUND SURFACE															
0.0	TOPSOIL Firm		1	SS	6											
255.1																
0.8	SAND and GRAVEL, trace silt, containing cobbles		2	SS	19											
254.6	Compact Brown Wet															
1.3	SAND and SILT, trace to some clay and gravel, containing cobbles and boulders (TILL)		3	SS	21											
	Compact to very dense Brown Moist		4	SS	30											
			5	SS	37											
			6	SS	106/0.20											
			7	SS	92											
	Becoming grey below a depth of 6.1 m		8	SS	120											
248.2	END OF BOREHOLE		9	SS	100/0.10											
7.7	NOTES:															
	1. Groundwater seepage noted at a depth of 0.8 m below ground surface (Elev. 255.1 m) during drilling operations.															
	2. Water level in open borehole at a depth of 0.7 m below ground surface (Elev. 255.2 m) upon completion of drilling.															

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PROJECT 08-1111-0022		RECORD OF BOREHOLE No HD7-3				1 OF 1 METRIC								
G.W.P. 2005-07-00		LOCATION N 4893549.4 ; E 308989.9				ORIGINATED BY TB								
DIST HWY 404		BOREHOLE TYPE 108 mm O.D. Solid Stem Auger				COMPILED BY SC								
DATUM Geodetic		DATE March 16, 2009				CHECKED BY AM/KJB								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
254.5	GROUND SURFACE							20 40 60 80 100	20 40 60 80 100	10 20 30				
0.0	TOPSOIL Soft		1	SS	4									
253.9							254							
0.6	SAND and SILT, trace to some clay and gravel, containing cobbles and boulders (TILL) Compact to very dense Brown Moist		2	SS	16		253							
			3	SS	38									
			4	SS	25		252							7 35 50 8
			5	SS	44		251							
			6	SS	167		250							
			7	SS	100/0.1		249							
			8	SS	100/0.1		248							
246.9							247							
7.6	CLAYEY SILT, some sand, trace gravel, contains sandy silt seams (TILL) Hard Grey Moist		9	SS	95		246							1 34 53 12
			10	SS	64		245							
244.8														
9.8	END OF BOREHOLE													
NOTES: 1. Water level in open borehole at a depth of 1.0 m below ground surface (Elev. 253.5 m) upon completion of drilling. 2. Water level in piezometer at a depth of 1.4 m below ground surface (Elev. 253.1 m) on March 19, 2009. 3. Water level in piezometer at a depth of 0.4 m below ground surface (Elev. 254.1 m) on April 2, 2009. 4. Water level in piezometer at a depth of 1.3 m below ground surface (Elev. 253.2 m) on June 12, 2009.														

MIS-MTO 001 08-1111-0022.GPJ GAL-MISS.GDT 2/19/10 DD/SAC

PROJECT		08-1111-0022		RECORD OF BOREHOLE No HD7-4		1 OF 1 METRIC					
G.W.P.		2005-07-00		LOCATION N 4893570.4 ; E 308941.4		ORIGINATED BY TB					
DIST		HWY 404		BOREHOLE TYPE 108 mm O.D. Solid Stem Auger		COMPILED BY SC					
DATUM Geodetic				DATE March 17, 2009		CHECKED BY AM/KJB					
SOIL PROFILE		SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	W <sub>p</sub> W W <sub>L</sub>	γ	GR SA SI CL
254.5	GROUND SURFACE										
0.0	TOPSOIL Soft		1	SS	3		254				
253.7											
0.8	SAND and SILT, trace to some clay and gravel, containing cobbles and boulders (TILL) Compact to very dense Brown Moist		2	SS	12		253				8 44 41 7
			3	SS	46						
			4	SS	20		252				
			5	SS	30		251				
	Becoming grey below a depth of 4.6 m		6	SS	54		250				5 36 46 13
			7	SS	64		249				
	Cobble/boulder inferred at a depth of 6.1 m (Elev. 248.4 m)		8	SS	30/0.05		248				
247.8											
6.7	CLAYEY SILT, some sand, trace gravel (TILL) Hard Grey Moist		9	SS	20/0.05		247				
			10	SS	74						
246.3											
8.2	END OF BOREHOLE										
NOTES:  1. Water level in open borehole at a depth of 5.2 m below ground surface (Elev. 249.3 m) upon completion of drilling.											

PROJECT 08-1111-0022		RECORD OF BOREHOLE No HD7-5				1 OF 1 METRIC											
G.W.P. 2005-07-00		LOCATION N 4893606.5 ; E 309006.4				ORIGINATED BY TB											
DIST HWY 404		BOREHOLE TYPE 108 mm O.D. Solid Stem Auger				COMPILED BY SC											
DATUM Geodetic		DATE March 17, 2009				CHECKED BY AM/KJB											
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								WATER CONTENT (%)	
253.3	GROUND SURFACE						20	40	60	80	100						
0.0	TOPSOIL Soft		1	SS	2												
252.8	SAND and SILT, trace to some clay and gravel, containing cobbles and boulders (TILL) Compact to very dense Brown Moist  Cobble/boulder inferred at a depth of 3.8 m (Elev. 249.5 m)  Becoming grey below a depth of 6.1 m		2	SS	22												
0.5			3	SS	29												
			4	SS	29												
			5	SS	31												
			6	SS	50/0.10												
			7	SS	154												
			8	SS	91												
			9	SS	100/0.13												
			10	SS	118/0.23												
244.2		CLAYEY SILT, some sand, trace gravel (TILL) Hard Grey Moist															
243.8	END OF BOREHOLE																
9.5	NOTES:  1. Ground water seepage noted at a depth of 2.4 m below ground surface (Elev. 250.9 m) during drilling operations..  2. Water level in open borehole at a depth of 3.1 m below ground surface (Elev. 250.2 m) upon completion of drilling.																

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PROJECT		08-1111-0022		RECORD OF BOREHOLE No HD7-6				1 OF 1 METRIC						
G.W.P.		2005-07-00		LOCATION		N 4893665.4 ; E 308962.7		ORIGINATED BY TB						
DIST		HWY 404		BOREHOLE TYPE		108 mm O.D. Solid Stem Auger		COMPILED BY SC						
DATUM		Geodetic		DATE		March 17, 2009		CHECKED BY AM/KJB						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
252.3	GROUND SURFACE													
0.0	TOPSOIL Soft		1	SS	2									
251.7														
0.6	SAND and SILT, trace to some clay and gravel (TILL) Dense Brown Moist		2	SS	32									
250.8														
1.5	CLAYEY SILT with sand, trace gravel (TILL) Very stiff to hard Brown Moist		3	SS	44									
			4	SS	16									
249.3														
3.1	CLAYEY SILT, trace sand Very stiff to hard Brown Moist		5	SS	19									
			6	SS	55									
	Becoming grey below a depth of 4.6 m		7	SS	57									
			8	SS	47									
			9	SS	47									
244.1														
8.2	END OF BOREHOLE													
NOTES: 1. Water level in open borehole at a depth of 2.8 m below ground surface (Elev. 249.5 m) upon completion of drilling. 2. Water level in piezometer at a depth of 2.2 m below ground surface (Elev. 250.1 m) on March 19, 2009. 3. Water level in piezometer at a depth of 0.2 m below ground surface (Elev. 252.1 m) on April 2, 2009. 4. Water level in piezometer at a depth of 1.3 m below ground surface (Elev. 251.0 m) on June 12, 2009.														

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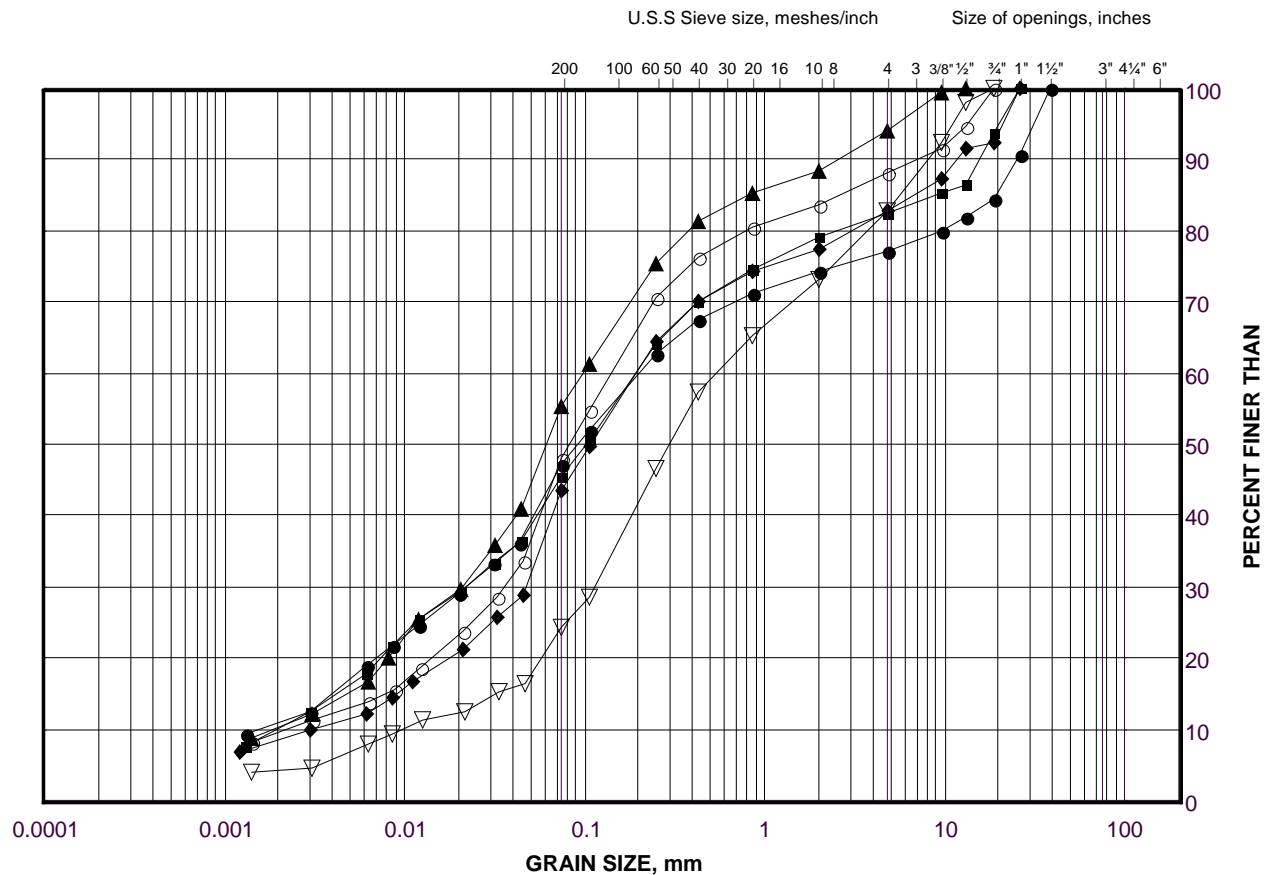
PROJECT 08-1111-0022		RECORD OF BOREHOLE No HD7-7				1 OF 1 METRIC											
G.W.P. 2005-07-00		LOCATION N 4893701.8 ; E 309032.3				ORIGINATED BY TB											
DIST HWY 404		BOREHOLE TYPE 108 mm O.D. Solid Stem Auger				COMPILED BY SC											
DATUM Geodetic		DATE March 18, 2009				CHECKED BY AM/KJB											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa		WATER CONTENT (%)			γ	GR SA SI CL			
							20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>						
251.1	GROUND SURFACE						251										
0.0	TOPSOIL Soft		1	SS	2												
250.6																	
0.5	SAND and SILT, trace to some clay and gravel, containing cobbles and boulders (TILL) Compact to very dense Brown Moist		2	SS	24		250										23 30 36 11
			3	SS	39		249										
			4	SS	57		248										
	Cobble/boulder inferred at a depth of 3.1 m (Elev. 248.0 m)		5	SS	69/0.18		247										
			6	SS	78		246										
	Cobble/boulder inferred at a depth of 4.6 m (Elev. 246.5 m)		7	SS	80/0.10		245										6 39 45 10
			8	SS	100/0.10		244										
243.5			9	SS	80/0.08												
7.9	CLAYEY SILT, some sand, trace gravel, containing cobbles and boulders (TILL) Hard Grey Moist END OF BOREHOLE																
NOTES: 1. Water level in open borehole at a depth of 7.9 m below ground surface (Elev. 243.2 m) upon completion of drilling. 2. Water level in piezometer at a depth of 2.4 m below ground surface (Elev. 248.7 m) on March 19, 2009. 3. Water level in piezometer at a depth of 0.8 m below ground surface (Elev. 250.3 m) on April 2, 2009. 4. Water level in piezometer at a depth of 2.0 m below ground surface (Elev. 249.1 m) on June 12, 2009.																	

PROJECT 08-1111-0022		RECORD OF BOREHOLE No HD7-8				1 OF 1 METRIC											
G.W.P. 2005-07-00		LOCATION N 4893750.7 ; E 308991.9				ORIGINATED BY TB											
DIST HWY 404		BOREHOLE TYPE 108 mm O.D. Solid Stem Auger				COMPILED BY SC											
DATUM Geodetic		DATE March 18, 2009				CHECKED BY AM/KJB											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)
248.1	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL Soft		1	SS	3												
247.3																	
0.8	SAND and SILT, trace to some clay and gravel, containing cobbles and boulders (TILL) Loose to compact Brown Moist		2	SS	8												
			3	SS	7												
			4	SS	26												
			5	SS	23												
			6	SS	19												
243.5																	
4.6	Silty SAND, some gravel, trace clay, containing cobbles and boulders (TILL) Compact Brown Wet		7	SS	29												
242.0																	
6.1	CLAYEY SILT, some sand, trace gravel (TILL) Hard Grey Moist		8	SS	31												
241.4																	
6.7	END OF BOREHOLE																
NOTES:																	
1. Water level in open borehole at a depth of 2.0 m below ground surface (Elev. 246.1 m) upon completion of drilling.																	

# GRAIN SIZE DISTRIBUTION

Silty Sand to Sand and Silt Till

FIGURE G1A



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	HD7-7	2	250.0
■	HD7-8	3	246.3
◆	HD7-5	4	250.7
▲	HD7-7	6	247.0
▽	HD7-8	7	243.2
○	HD7-5	8	246.9

Project Number: 08-1111-0022

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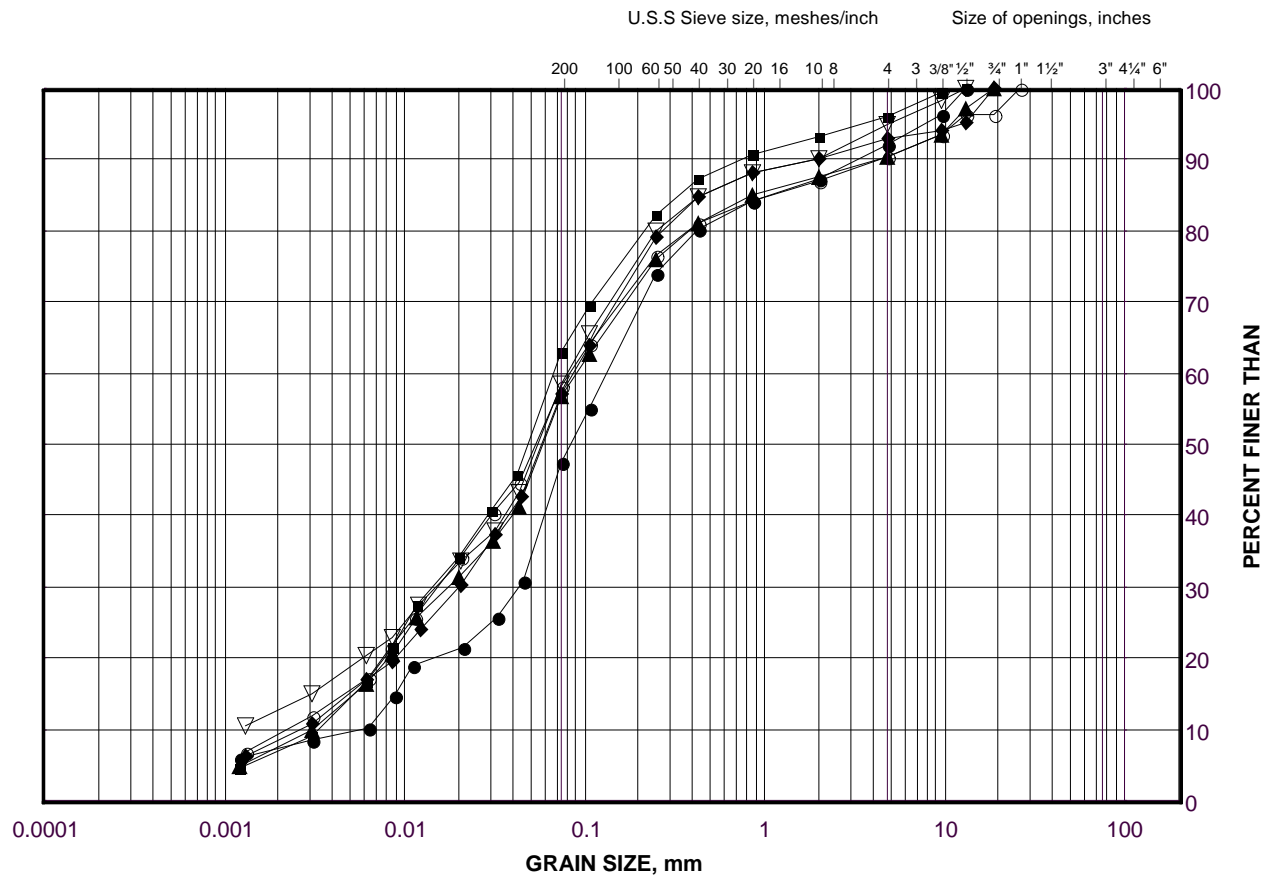
**Golder Associates**

Date: 28-Oct-09

# GRAIN SIZE DISTRIBUTION

Silty Sand to Sand and Silt Till

FIGURE G1B



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	HD7-4	2	253.4
■	HD7-2	3	254.1
◆	HD7-3	4	251.9
▲	HD7-1	5	251.2
▽	HD7-4	6	250.4
○	HD7-2	6	251.9

Project Number: 08-1111-0022

Checked By: KJB

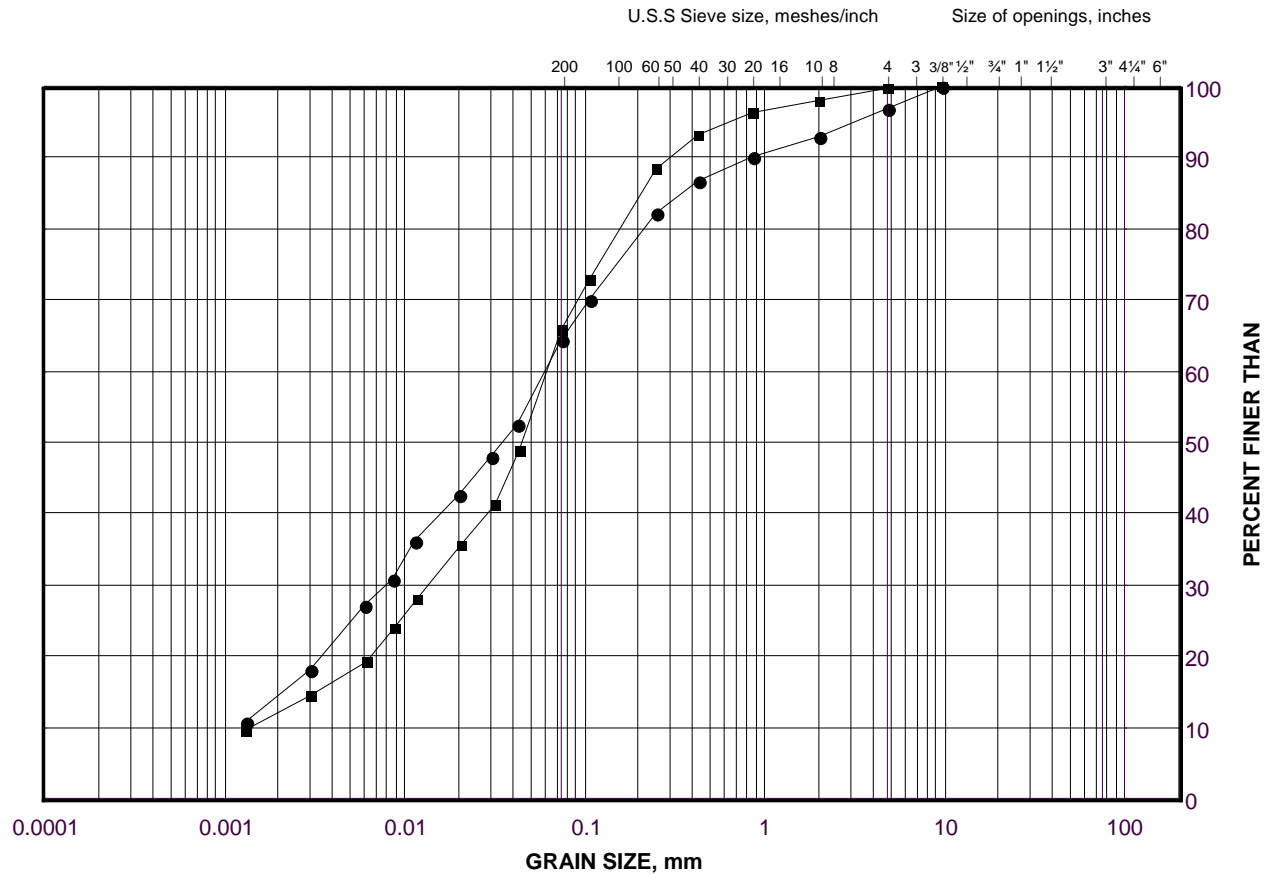
**Golder Associates**

Date: 28-Oct-09

# GRAIN SIZE DISTRIBUTION

Clayey Silt Till

FIGURE G2



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

## LEGEND

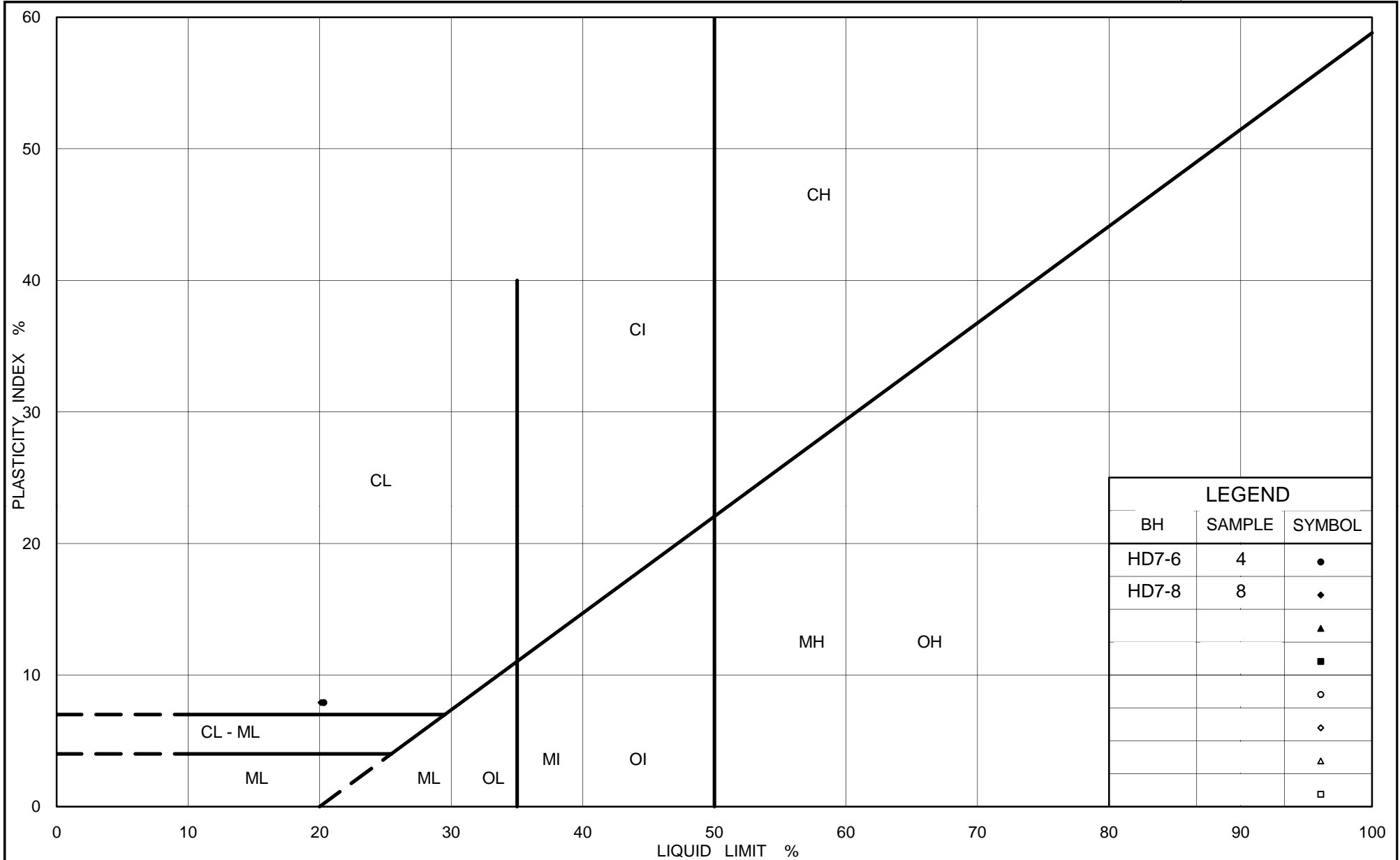
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	HD7-6	3	250.5
■	HD7-3	9	246.6

Project Number: 08-1111-0022

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Date: 28-Oct-09



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Ontario

## PLASTICITY CHART

### Clayey Silt Till

Figure No. G3

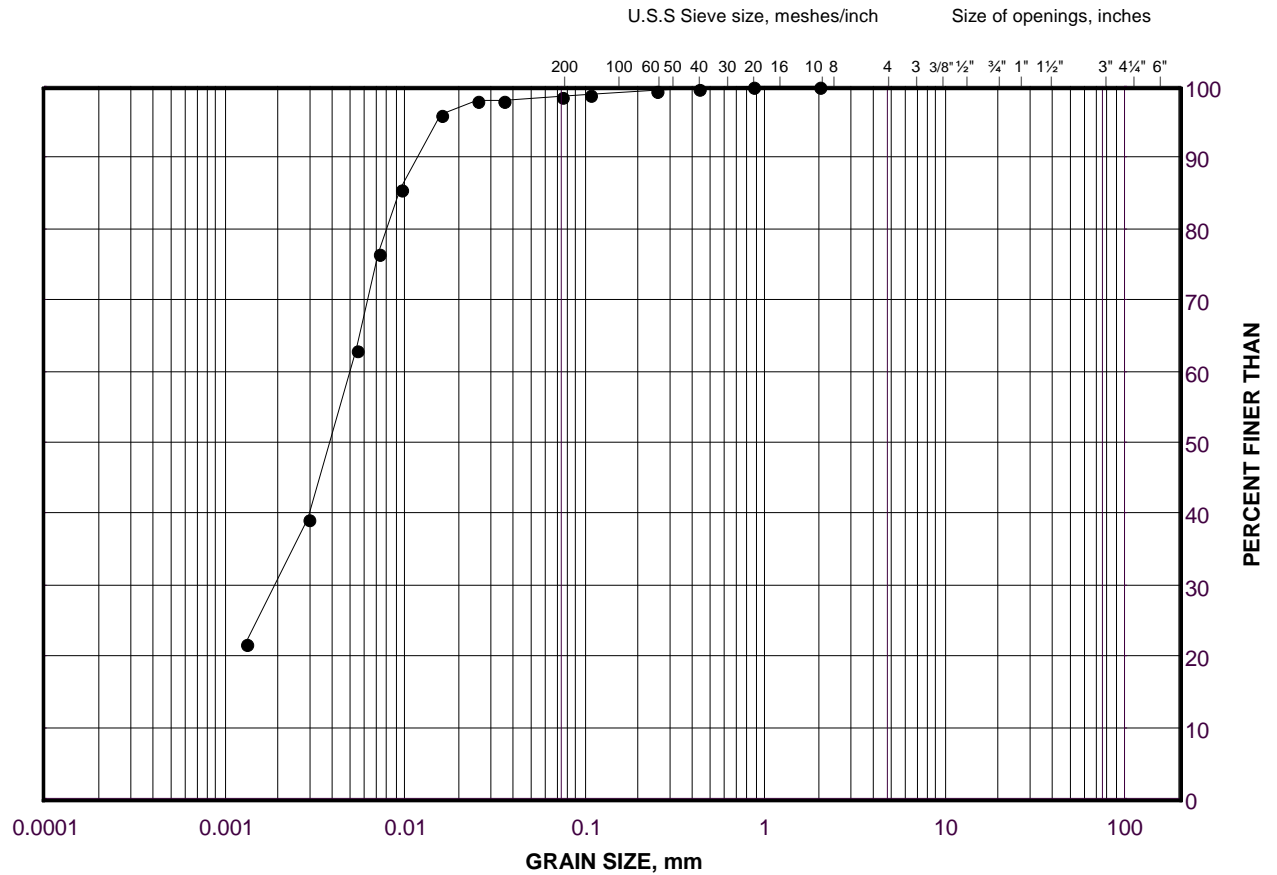
Project No. 08-1111-0022

Checked By: KJB

# GRAIN SIZE DISTRIBUTION

Clayey Silt

FIGURE G4



## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	HD7-6	8	245.9

Project Number: 08-1111-0022

Checked By : KJB

**Golder Associates**

Date: 28-Oct-09





# **APPENDIX H**

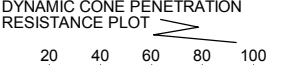
**Highway 404 - STA. 38+200 to STA. 38+500 (High Fill Area 8)**  
**Record of Boreholes and Laboratory Test Results**

PROJECT 08-1111-0022		RECORD OF BOREHOLE No HD8-1				1 OF 1 METRIC							
G.W.P. 2005-07-00		LOCATION N 4894134.3; E 309212.1				ORIGINATED BY TB							
DIST HWY 404		BOREHOLE TYPE 108 mm O.D. Solid Stem Auger				COMPILED BY SC							
DATUM Geodetic		DATE March 18, 2009				CHECKED BY AM/KJB							
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>	γ	GR SA SI CL
233.6	GROUND SURFACE												
0.0	TOPSOIL												
0.2	CLAYEY SILT, trace to some sand, trace organics		1	SS	3		233						
232.8	Soft Brown Moist		2	SS	16		232					42	
0.8	SILTY CLAY, trace to some sand, trace gravel		3	SS	11		231						
	Very stiff to hard Brown Moist		4	SS	15		230						
			5	SS	34		229						
229.8	SILT, trace sand, containing silty clay seams		6	SS	38								
3.8	Dense Brown Moist to wet		7	SS	41								
228.4	END OF BOREHOLE												0 2 86 12
5.2	NOTES:												
	1. Groundwater seepage encountered at a depth of 0.9 m below ground surface (Elev. 232.7 m).												
	2. Water level in open borehole at a depth of 4.0 m below ground surface (Elev. 229.6 m) upon completion of drilling.												
	3. Water level in piezometer at a depth of 1.1 m below ground surface (Elev. 232.5 m) on March 19, 2009.												
	4. Water level in piezometer at a depth of 0.4 m above ground surface (Elev. 233.2) on April 2, 2009.												
	5. Water level in piezometer at ground surface on June 12, 2009.												

PROJECT		08-1111-0022		RECORD OF BOREHOLE No HD8-2		1 OF 1		METRIC								
G.W.P.		2005-07-00		LOCATION		N 4894207.9; E 309194.7		ORIGINATED BY								
DIST		HWY 404		BOREHOLE TYPE		108 mm O.D. Solid Stem Auger		COMPILED BY								
DATUM		Geodetic		DATE		March 18, 2009		CHECKED BY								
AM/KJB																
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60	80
231.1	GROUND SURFACE															
0.0	TOPSOIL Firm		1	SS	5											
230.6																
0.5	CLAYEY SILT, trace to some sand, trace gravel, trace organics Soft to firm Brown Moist		2	SS	4											
229.7																
1.4	SILTY CLAY, trace to some sand, trace gravel Stiff to very stiff Brown Moist		3	SS	13											
			4	SS	22											
			5	SS	16											
			6	SS	11											
			7A	SS	16											
			7B	SS	16											
226.1	SILT, trace to some clay, trace sand, containing silty clay seams Compact to dense Grey Moist															
5.0																
	Becoming wet below a depth of 6.1 m		8	SS	45											
224.4																
6.7	END OF BOREHOLE															
	NOTES: 1. Water level in open borehole at a depth of 0.3 m below ground surface (Elev. 230.8 m) upon completion of drilling.															

PROJECT 08-1111-0022		<b>RECORD OF BOREHOLE No HD8-3</b>				1 OF 1 <b>METRIC</b>							
G.W.P. 2005-07-00		LOCATION N 4894220.0 ; E 309261.2				ORIGINATED BY TB							
DIST _____ HWY 404		BOREHOLE TYPE Hand Auger				COMPILED BY SC							
DATUM Geodetic		DATE June 2, 2009				CHECKED BY KJB							
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa		WATER CONTENT (%)			
230.8	GROUND SURFACE							20 40 60 80 100	○ UNCONFINED + FIELD VANE	W <sub>p</sub>	W	W <sub>L</sub>	
0.0	TOPSOIL							20 40 60 80 100	● QUICK TRIAXIAL × REMOULDED				
230.5													
0.3	SILTY CLAY, trace sand Grey Moist						230						
			1	AS	-								
229.3													
1.5	END OF BOREHOLE HAND AUGER REFUSAL												
NOTES: 1. Water level in open borehole at ground surface (Elev. 230.8 m) upon completion of drilling. 2. Hole drilled using a hand auger.													

PROJECT 08-1111-0022			RECORD OF BOREHOLE No HD8-4			1 OF 1 METRIC															
G.W.P. 2005-07-00			LOCATION N 4894289.0 ; E 309245.5			ORIGINATED BY TB															
DIST HWY 404			BOREHOLE TYPE 108 mm O.D. Solid Stem Auger			COMPILED BY SC															
DATUM Geodetic			DATE March 19, 2009			CHECKED BY AM/KJB															
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ					
230.6	GROUND SURFACE							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W <sub>p</sub> W W <sub>L</sub> 10 20 30			kN/m <sup>3</sup>			GR SA SI CL		
0.0	TOPSOIL																				
0.3	SILTY CLAY, trace to some sand, trace gravel Firm to very stiff Brown Moist		1	SS	7		230														
			2	SS	16																
			3	SS	30		229														
	Becoming grey below a depth of 2.3 m		4	SS	21		228														
			5	SS	11		227														
			6	SS	5																
225.9	SAND and SILT, trace clay, trace gravel (TILL) Very dense Grey Moist		7	TO	PH		226														
4.7							225														
			8	SS	113		224														
223.9	END OF BOREHOLE																				
6.7	NOTES:  1. Water level in open borehole at ground surface upon completion of drilling.  2. Attempted to push a Shelby Tube at 4.6 m depth but effective refusal was achieved in Sand and Silt (till) at 4.7 m depth.																				

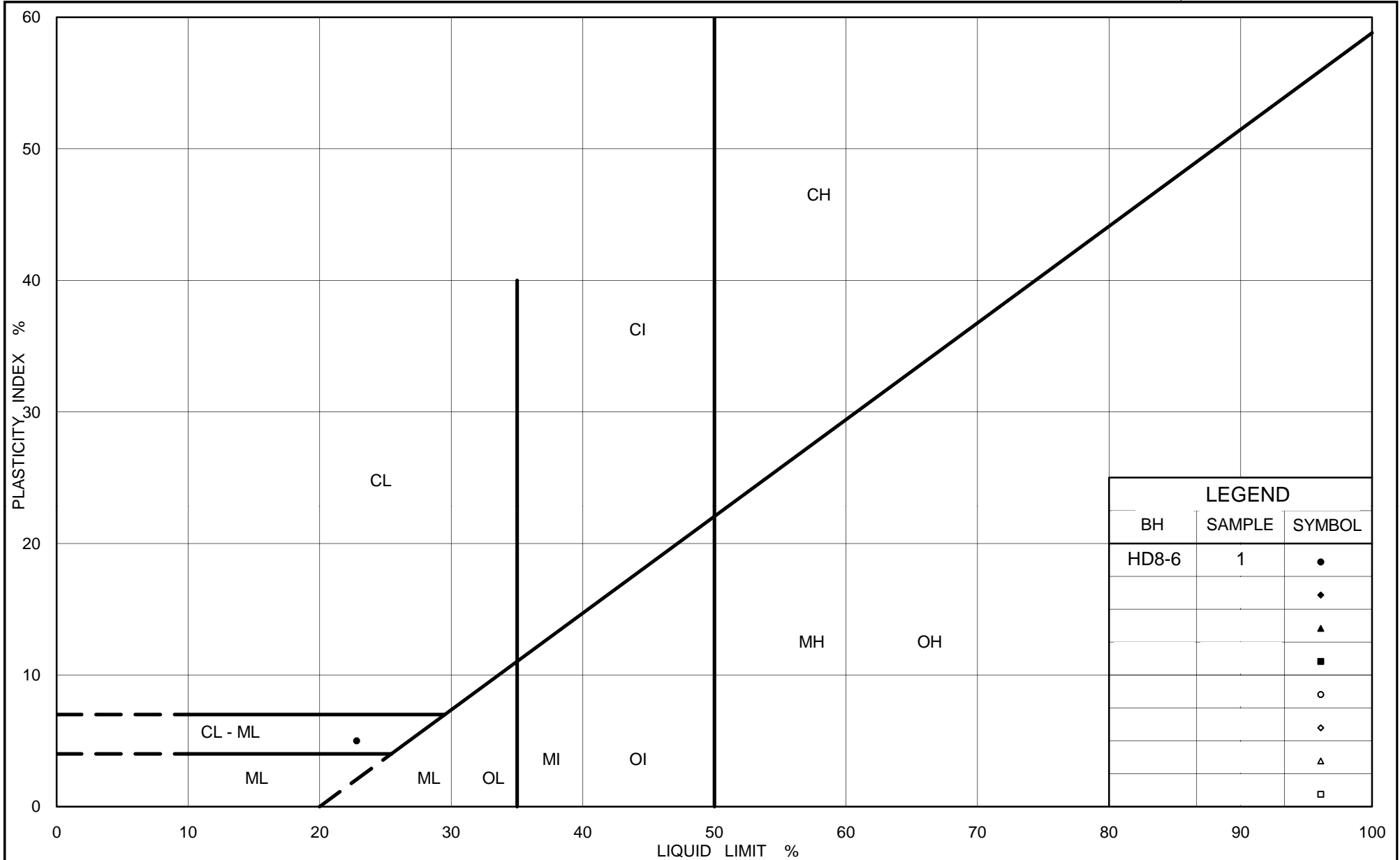
PROJECT 08-1111-0022			RECORD OF BOREHOLE No HD8-5			1 OF 1 METRIC					
G.W.P. 2005-07-00			LOCATION N 4894303.7 ; E 309313.9			ORIGINATED BY TB					
DIST HWY 404			BOREHOLE TYPE 108 mm O.D. Solid Stem Auger			COMPILED BY SC					
DATUM Geodetic			DATE March 19, 2009			CHECKED BY AM/KJB					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT  SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	PLASTIC LIMIT W <sub>p</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub> WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
230.3	GROUND SURFACE										
0.0	TOPSOIL										
0.3	CLAYEY SILT, some sand, trace gravel Soft to very stiff Brown Moist		1	SS	2		230				
			2	SS	18		229				
228.8	SILTY CLAY, trace sand, trace gravel Very stiff Brown Moist Becoming grey below a depth of 2.3 m.		3	SS	24		228				
			4	SS	19		227				
			5	SS	16		226				
226.5	SAND and SILT, trace clay, trace gravel (TILL) Compact Grey Moist		6	SS	23						
225.6	CLAYEY SILT, trace to some sand, trace gravel (TILL) Very stiff Grey Moist		7	SS	20						
225.1	END OF BOREHOLE										
5.2											
NOTES: 1. Water level in open borehole at a depth of 3.8 m below ground surface (Elev. 226.5 m) upon completion of drilling.											

PROJECT		08-1111-0022		RECORD OF BOREHOLE No HD8-6				1 OF 1 METRIC						
G.W.P.		2005-07-00		LOCATION		N 4894371.6; E 309303.8		ORIGINATED BY TB						
DIST		HWY 404		BOREHOLE TYPE		108 mm O.D. Solid Stem Auger		COMPILED BY SC						
DATUM		Geodetic		DATE		March 19, 2009		CHECKED BY AM/KJB						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
230.3	GROUND SURFACE													
0.0	TOPSOIL													
229.9			1	SS	4									
0.4	CLAYEY SILT, some sand, trace gravel, contains sand interlayers													
	Soft to stiff		2	SS	9									
	Brown													
	Moist													
228.8														
1.5	SILTY CLAY, trace to some sand, trace gravel													
	Stiff		3	SS	15									
	Brown													
	Moist													
	Becoming grey below a depth of 2.3 m		4	SS	14									
			5	TO	PH									
226.2														
4.1	SAND and SILT, trace clay, trace gravel (TILL)		6	SS	17									
	Compact to dense													
	Grey													
	Moist													
225.1			7	SS	40									
5.2	END OF BOREHOLE													
NOTES: 1. Groundwater seepage noted at a depth of 0.6 m (Elev. 229.7 m). 2. Water level in open borehole at a depth of 1.9 m below ground surface (Elev. 228.4 m) upon completion of drilling. 3. Water level in piezometer at 0.7 m above ground surface (Elev. 231.0 m) on April 2, 2009. 4. Water level in piezometer at 0.2 m above ground surface (Elev. 230.5 m) on June 2, 2009. 5. Water level in piezometer at 0.4 m above ground surface (Elev. 230.7 m) on June 12, 2009.														

PROJECT		08-1111-0022		RECORD OF BOREHOLE No HD8-7				1 OF 1		METRIC								
G.W.P.		2005-07-00		LOCATION		N 4894382.5 ; E 309373.7		ORIGINATED BY		TB								
DIST		HWY 404		BOREHOLE TYPE		108 mm O.D. Solid Stem Auger		COMPILED BY		SC								
DATUM		Geodetic		DATE		March 19, 2009		CHECKED BY		AM/KJB								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
229.9	GROUND SURFACE																	
0.0	TOPSOIL																	
0.3	CLAYEY SILT, some sand, trace gravel, containing silty sand seams, containing rootlets		1	SS	2	▽												
228.9	Soft to stiff																	
1.0	Brown Moist		2	SS	12													
	SILTY CLAY, some sand, trace gravel																	
	Stiff to very stiff																	
	Brown Moist		3	SS	20													
			4	SS	13													
	Becoming grey below a depth of 3.0 m		5	SS	11													
226.1	Sandy SILT, trace to some clay and gravel (TILL)																	
3.8	Compact Grey Wet		6	SS	24													
			7	SS	31													
224.7	END OF BOREHOLE																	
5.2	NOTES:																	
	1. Water level at ground surface upon completion of drilling.																	
	2. Water level in open borehole at a depth of 0.8 m below ground surface (Elev. 229.1 m) by end of day March 19, 2009.																	

MIS-MTO 001 08-1111-0022.GPJ GAL-MISS.GDT 2/19/10 DD/SAC





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# PLASTICITY CHART Clayey Silt (Contains Sand Interlayers)

Figure No. H1

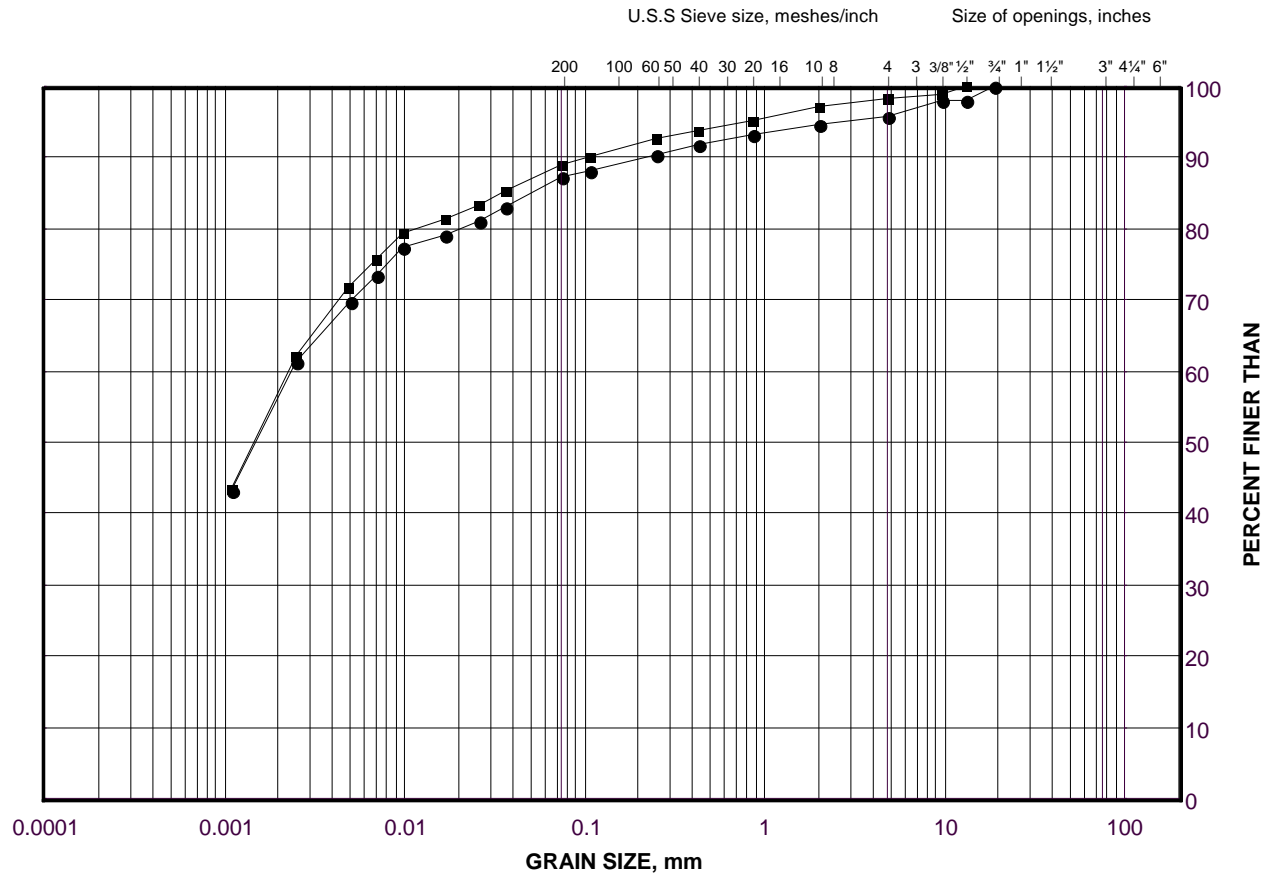
Project No. 08-1111-0022

Checked By: KJB

# GRAIN SIZE DISTRIBUTION

Silty Clay

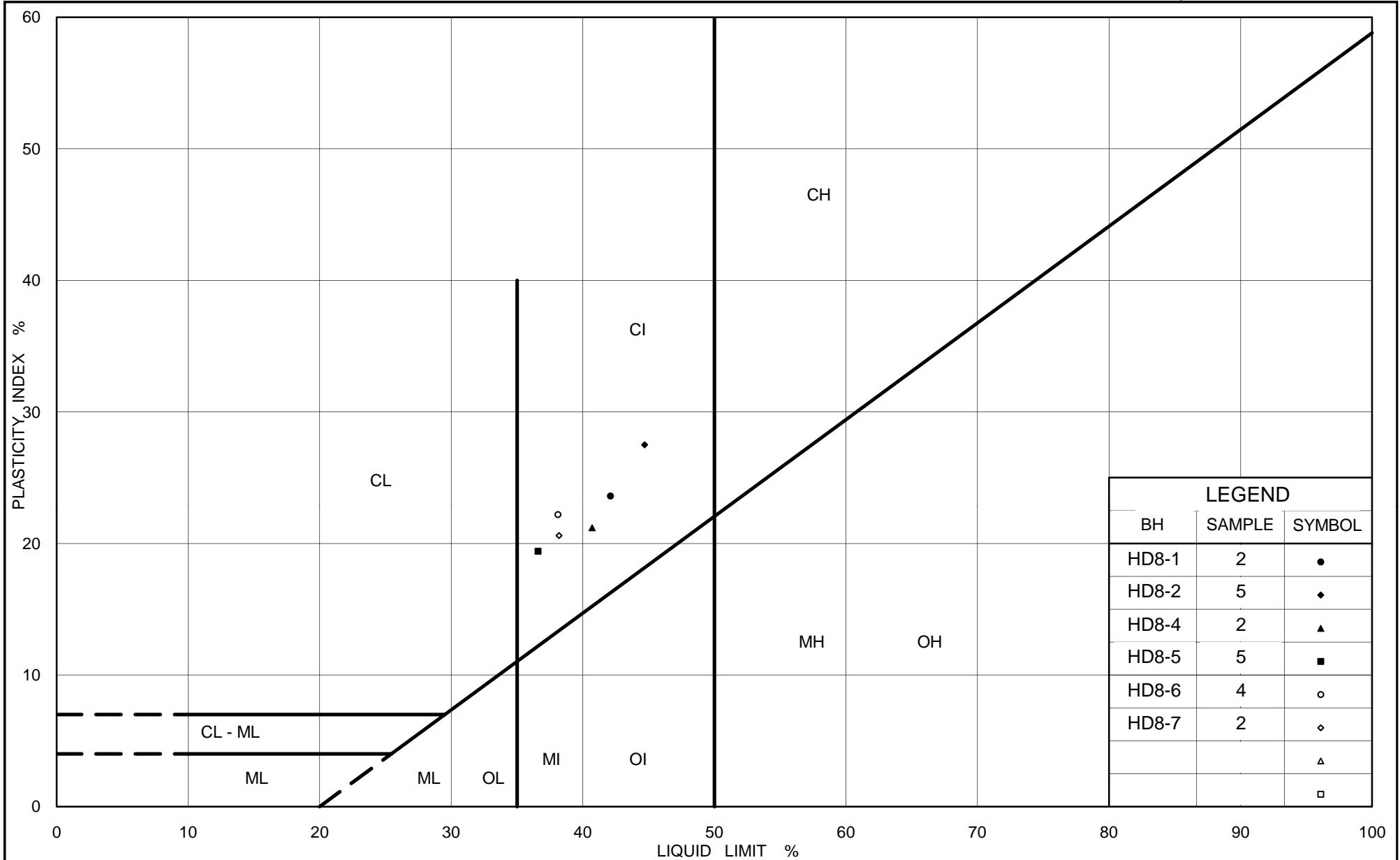
FIGURE H2



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	HD8-4	2	229.5
■	HD8-6	4	227.7



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## PLASTICITY CHART

### Silty Clay

Figure No. H3

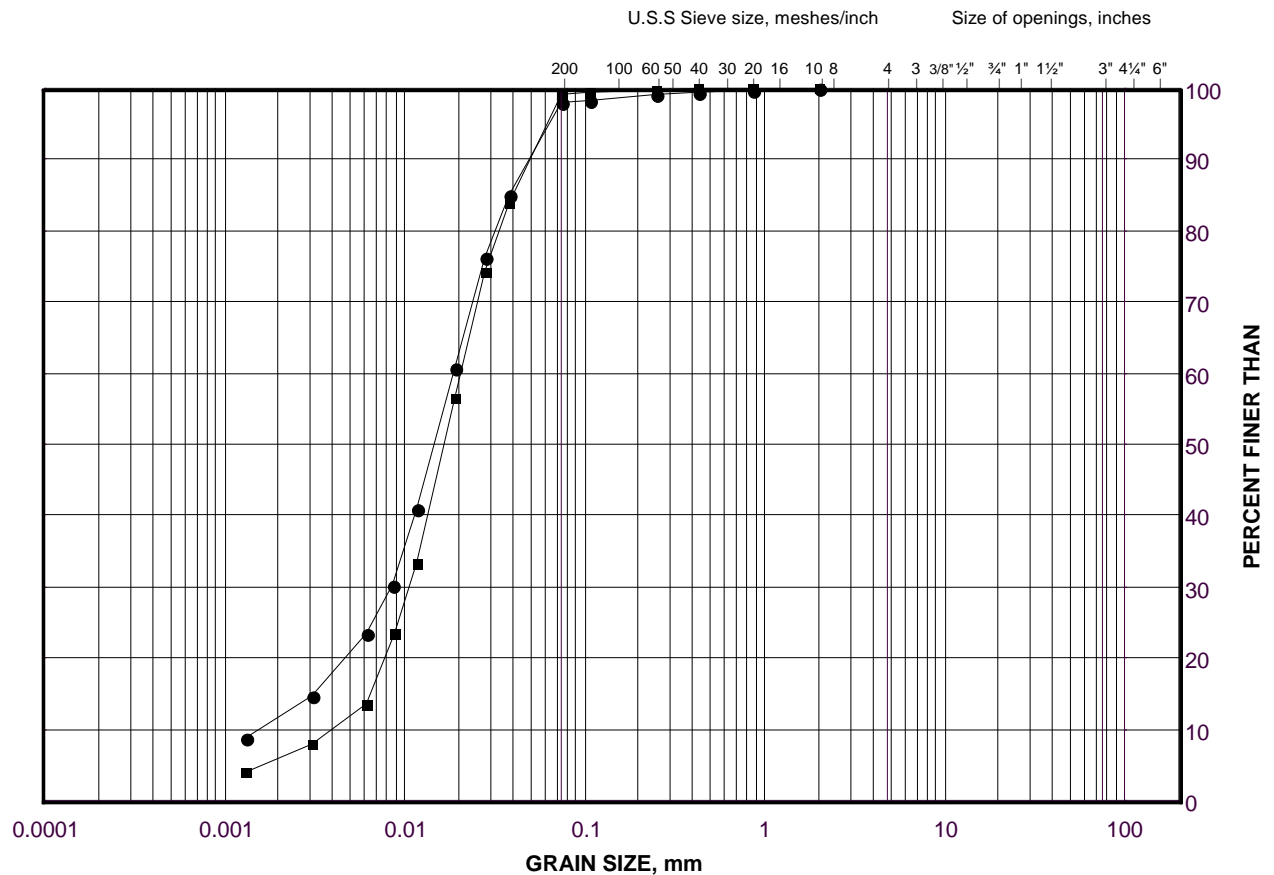
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# GRAIN SIZE DISTRIBUTION

Silt

FIGURE H4



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	HD8-1	7	228.7
■	HD8-2	8	224.7

Project Number: 08-1111-0022

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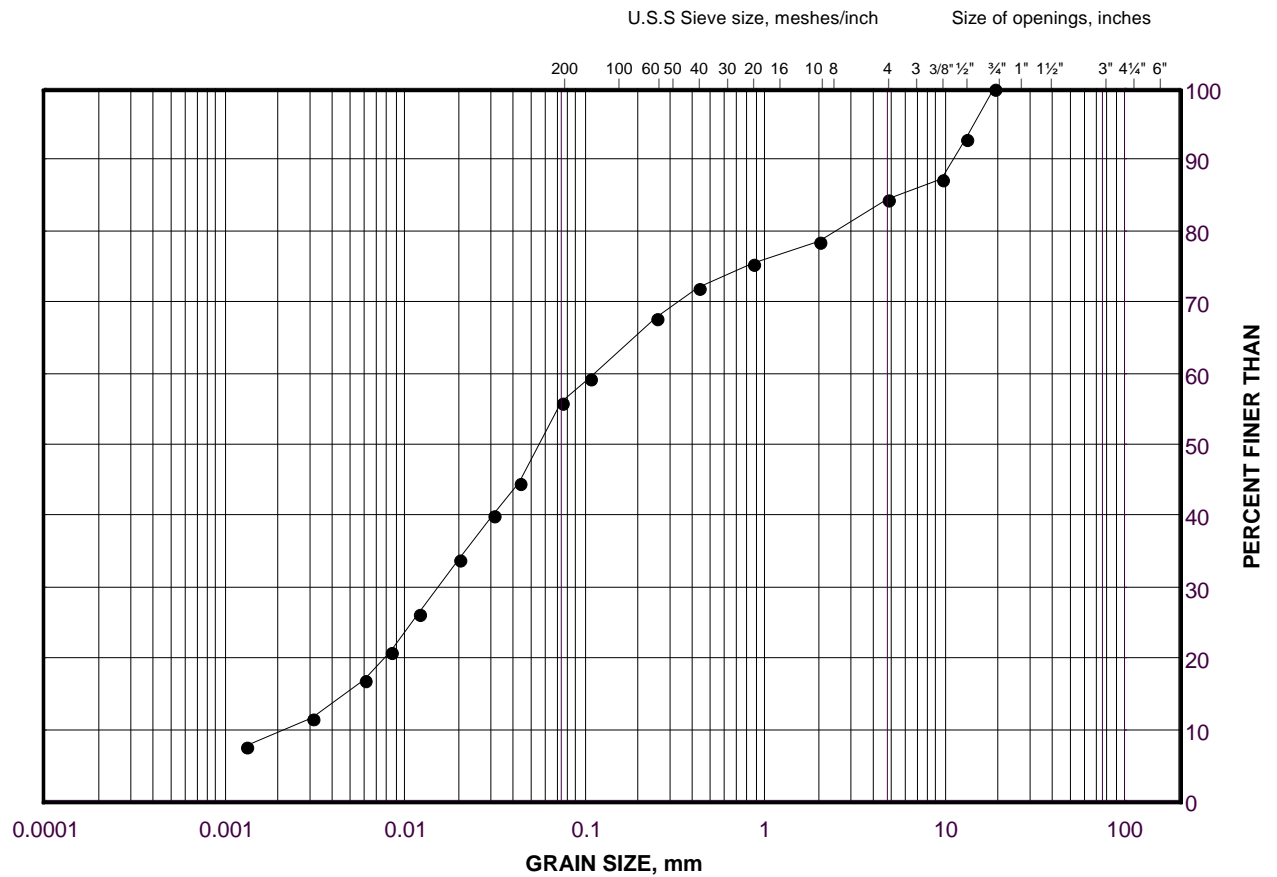
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Date: 28-Oct-09

# GRAIN SIZE DISTRIBUTION

Sandy Silt Till

FIGURE H5



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

## LEGEND

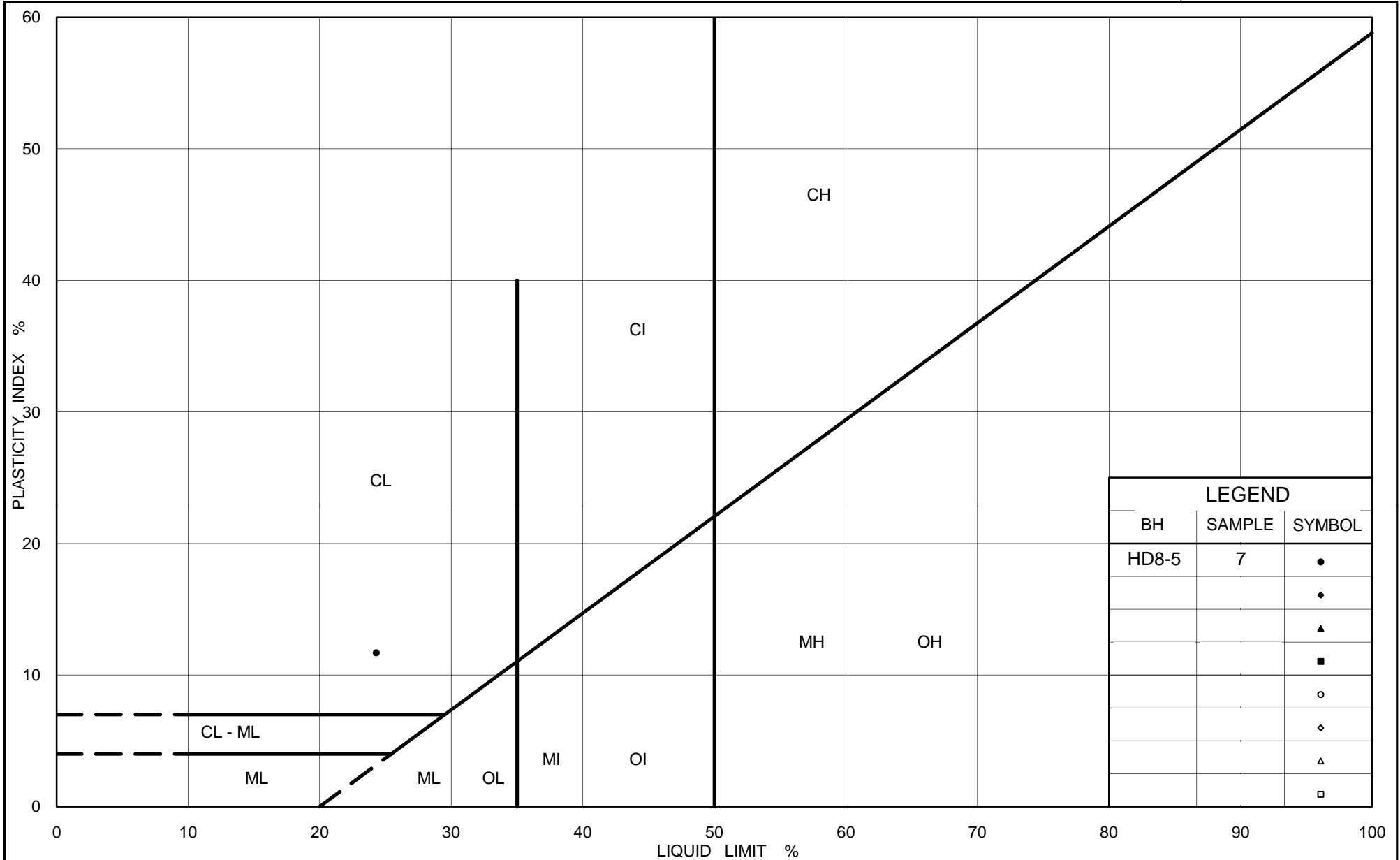
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	HD8-7	7	225.0

Project Number: 08-1111-0022

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**Golder Associates**

Date: 28-Oct-09



LEGEND		
BH	SAMPLE	SYMBOL
HD8-5	7	•
		◆
		▲
		■
		○
		◇
		△
		□



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## PLASTICITY CHART

### Clayey Silt Till

Figure No. H6

Project No. 08-1111-0022

Checked By: KJB



# **APPENDIX I**

## **NON-STANDARD SPECIAL PROVISIONS**

## **SUBGRADE INSPECTION AT HIGH FILL EMBANKMENTS - Item No.**

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### **Non-Standard Special Provision**

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High Fill Embankment Areas are located between Stations 33+900 to 34+160 (High Fill Area 1), 35+000 to 35+150 (High Fill Area 4), 36+870 to 37+150 (High Fill Area 6), and 38+200 to 38+500 (High Fill Area 8).

The measured depth of topsoil or soils containing organics that are to be stripped generally ranges from 0.7 m to 1.5 m at High Fill Area 1, 0.3 m to 0.6 m at High fill Area 4, 0.5 m to 0.8 m at High Fill Area 6, and 0.2 m to 0.5 m at High Fill Area 8. The plan limits of areas to be stripped are provided elsewhere in the Contract.

After stripping, the exposed subgrade soil shall be inspected by the Quality Verification Engineer (QVE) prior to placement of embankment fill, proofrolled to identify soft / loosened areas, and any poorly performing areas should be subexcavated and replaced with suitable backfill.

### ***Basis of Payment***

Payment at the lump sum contract price for this tender item shall be full compensation for all labour, equipment and materials for completion of the work.

### **END OF SECTION**



## DEWATERING AT DEEP CUT / HIGH FILL AREAS - Item No.

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Non-Standard Special Provision

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### Scope

**Deep Cut Areas** – The contractor shall be alerted that the groundwater level at Deep Cut Area 2 (Station 34+360 to 34+600), Area 3 (Station 34+780 to 34+880), Area 5 (Station 35+750 to 35+900), and Area 7 (Station 37+400 to 37+760) was measured to range from the ground surface to 2.9 m below ground surface. It is estimated that the new Highway 404 subgrade profile will be constructed to depths ranging from 2.5 m to 6 m below the groundwater levels measured in the piezometers installed at the deep cut areas in June 2009. The cut slopes consist of water-bearing silty sand to sand and silt till, silt and sand layers, and clayey silt / cohesive deposits containing sand interlayers / seams. Dewatering ahead of deep cut excavations will be required and the excavation shall be kept stable during the work. It is considered that a combination of ditches and sub-drains installed progressively as the subgrade is lowered and in advance of the final side-slopes being excavated to the design grade is required to allow the groundwater to drain sufficiently ahead of the permanent excavation. If excavation operations are to progress during wet periods of the year (i.e. Spring and Fall), gravel sheeting (minimum 0.5 m thick and as per OPSS 511) in combination with rip-rap and/or counterfort drains may be required to control erosion due to groundwater seepage.

**High Fill Areas** – The contractor shall be alerted that the shallow groundwater level at High Fill Area 1 (Station 33+900 to 34+160), Area 4 (Station 35+000 to 35+150), Area 6 (Station 36+870 to 37+150), and Area 8 (Station 38+200 to 38+500) was measured to range from the ground surface to 4.4 m below ground surface. High Fill Areas 1 and 8 had areas of ponded water at the time of the subsurface investigation in June and March 2009. It is estimated that stripping up to 1.5 m below existing ground surface may be required to remove topsoil / surficial organics at the high fill areas as indicated elsewhere in the Contract. Temporary dewatering will be required and the temporary excavation shall be kept stable during the work in order to allow for stripping and compaction of suitable backfill soils in the dry. It is considered that any groundwater seepage into excavated areas of subgrade preparation can be handled by diversion channels, perimeter ditches / trenches and pumping using sump pumps.

### Basis of Payment

Payment at the contract price for the above tender item shall be full compensation for all labour, equipment and materials required to do the work.

### END OF SECTION

**OBSTRUCTIONS - Item No.**

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**Non-Standard Special Provision**

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The native silty sand to sand and silt till and clayey silt till soils present at the high fill and deep cut areas contains cobbles and boulders as indicated in the Record of Borehole sheets. Consideration of the presence of these obstructions must be made in the selection of appropriate equipment and procedures for sub-excavation at the high fill areas and for permanent excavation at the deep cut areas.

***Basis of Payment***

Payment at the lump sum contract price for this tender item shall be full compensation for all labour, equipment and materials for completion of the work.

**END OF SECTION**

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[solutions@golder.com](mailto:solutions@golder.com)  
[www.golder.com](http://www.golder.com)

**Golder Associates Ltd.**  
**2390 Argentia Road**  
**Mississauga, Ontario, L5N 5Z7**  
**Canada**  
**T: +1 (905) 567 4444**

