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**FOUNDATION INVESTIGATION REPORT
SHORT SPAN CULVERTS
HIGHWAY 3 WIDENING
GWP 315-98-00
MINISTRY OF TRANSPORTATION - SOUTHWESTERN REGION**

Submitted to:

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February 28, 2007

06-1130-177-0-5
Geocres No. 40J2-92



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1.0 INTRODUCTION

Golder Associates Ltd. (Golder Associates) has been retained by Delcan Corporation (Delcan) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out foundation investigations as part of the detail design work for GWP 315-98-00. The project involves the first phase of the reconstruction and widening of Highway 3 (Talbot Trail) between Windsor and Leamington. The project limits for GWP 315-98-00 extend along Highway 3 from just west of Essex Road 34 (Talbot Street North) easterly to just east of Essex Road 8 (Maidstone Avenue West) in Essex County, Ontario.

In conjunction with the widening, the scope of work for this project includes:

- rehabilitation or replacement of selected culverts within the project limits;
- slotted left turn lanes at all intersections;
- Revision or upgrading of illumination at four intersections;
- Revision or upgrading of traffic signals at two intersections;
- Replacement or relocation of existing traffic counting stations;
- Drainage improvements; and,
- Upgrading of existing signage.

Five structural culverts and four short span culverts are to be widened and two short span culverts replaced .

This report addresses the foundation investigation for the proposed extension of the south ends of five non-rigid frame open footing (NRFO) culverts located on Highway 3 in South Sandwich Township at Stations 18+655 and 19+245 and in Maidstone Township at Stations 12+908, 13+210 and 13+890 and the replacement of the two corrugated steel pipe (CSP) culverts located on Highway 3 in South Sandwich (SS) at Station 20+475 and in Maidstone (M) at Station 10+775. Except for the culvert at Station 13+890 M, which has a span greater than 3 metres, all other culverts are less than 3 metres in width/diameter and are considered short span culverts.

The culvert at Station 13+890 M was added to the investigation after the original proposal was submitted. The boreholes at this location provide preliminary information in the event that the project limits are extended.

The purpose of the foundation investigation is to determine the subsurface conditions at the location of the proposed works by drilling boreholes and carrying out in situ testing and laboratory testing on selected samples. The terms of reference for the scope of work are outlined in the MTO's Request for Proposal and in Golder Associates' proposal P61-3113-1 dated August 17, 2006 and our letter dated November 14, 2006. The work was carried out in accordance with our Quality Control Plan for Foundations Engineering dated September 18, 2006.

Delcan provided Golder Associates with a base plan and profile for this project in digital format which included the top elevations of the culverts.

2.0 SITE DESCRIPTION

GWP 315-98-00 extends along Highway 3 from 0.5 kilometres west of Essex Road 34 (Talbot Street North) within the Town of Tecumseh easterly to 0.6 kilometres east of Essex Road 8 (Maidstone Avenue West) in the Town of Essex. West of Manning Road, Highway 3 is within South Sandwich Township. East of Manning Road, it is within Maidstone Township. The chainage equation at Manning Road is 20+981.675 South Sandwich (SS) = 10+000.000 Maidstone (M). The west project limit is located at Station 17+700 SS and the east project limit is situated at Station 13+600 M.

The location of the project is shown on the Key Plan, Figure 1.

The land use in the vicinity of the site is predominantly agricultural. The adjacent topography is generally flat to slightly rolling with a ground surface elevation between 190 and 195 metres.

2.1 Site Geology

The site is situated on the Essex Clay Plain, a subregion of the physiographic region of southern Ontario known as the St. Clair Clay Plain.¹ This subregion is described as a bevelled till plain with little relief that has been locally smoothed by shallow deposits of lacustrine clay deposited in depressions in the till. The prevailing soil type is reported to be the Brookston clay loam.

The available surficial geology mapping for the project area indicates that the predominant surficial soils are clayey silt till.² The till is reportedly underlain by limestone, dolomite and shale of the Middle Devonian era and by dolomite of the Upper Silurian era. The overburden thickness within the project area ranges from 27 to 41 metres.³

¹ L.J. Chapman and D.F. Putnam, 1984. *The Physiography of Southern Ontario*. Third Edition. Ontario Geological Survey, Special Volume 2.

² Vagners, U. J., 1972. *Quaternary Geology of the Windsor-Essex Area (Western and Eastern Parts), Southern Ontario*. Ontario Department of Mines and Northern Affairs, Preliminary Maps P. 749 and P.750, Geological Series.

³ Vagners, U.J., Sado, E.V., and Yundt, S.E. 1973. *Drift Thickness of the Windsor-Essex Area (Western and Eastern Parts), Southern Ontario*; Ontario Division of Mines, Preliminary Maps P.814 and P.815, Drift Thickness Series.

3.0 INVESTIGATION PROCEDURES

The field work for this portion of the investigation was carried out from November 27 to December 1, 2006, at which time sixteen boreholes, numbered 101 through 116, were drilled in the areas of the proposed culvert extensions and culvert replacements. The boreholes were advanced to depths ranging from 4.4 to 5.9 metres.

The investigation for these boreholes was carried out using a Deitrich 50 track-mounted power auger supplied and operated by a specialist drilling contractor. Samples of the overburden were obtained at intervals of 0.75 metres using 50 millimetre outside diameter split spoon sampling equipment in accordance with the standard penetration test (SPT) procedures.

Groundwater conditions in the boreholes were observed throughout the drilling operations and these observations are provided on the corresponding Record of Borehole sheets. Boreholes were backfilled in accordance with current regulations, MTO recommended procedures and Ontario Regulation 128/03.

The field work was supervised on a full-time basis by an experienced member of our engineering staff who arranged for utility locates, directed the drilling, sampling and in-situ testing operations, logged the boreholes and cared for the samples obtained. The soil samples were identified in the field, placed in labelled containers and transported to Golder Associates' London laboratory for further examination and testing. Index and classification tests consisting of water content determinations, grain size distribution analyses and Atterberg limits determinations were carried out on selected samples. The results of the field and laboratory testing are given on the Record of Borehole sheets and in Appendix A.

Temporary traffic control was provided in accordance with the Ontario Traffic Manual, Temporary Conditions, Book 7, dated March 2001.

The as-drilled borehole locations and ground surface elevations are shown on the Record of Borehole sheets and on Drawing 1.

The table below summarizes the culvert locations and coordinates, ground surface elevations and depths of the associated boreholes.

| <u>BOREHOLE</u> | <u>LOCATION (m)</u> | | <u>GROUND SURFACE ELEVATION</u> | <u>BOREHOLE DEPTH</u> |
|-----------------|---------------------|----------------|---|---------------------------|
| | <u>Northing</u> | <u>Easting</u> | (m) | (m) |
| 101 | 4 672 599.3 | 274 314.0 | 192.51 | 4.42 |
| 102 | 4 672 624.8 | 274 324.6 | 193.25 | 5.94 |
| 103 | 4 671 098.6 | 275 834.3 | 193.87 | 5.18 |
| 104 | 4 671 091.7 | 275 812.2 | 193.56 | 5.18 |
| 105 | 4 670 862.2 | 276 020.4 | 193.42 | 5.18 |
| 106 | 4 670 886.1 | 276 034.8 | 194.35 | 5.94 |
| 107 | 4 670 363.2 | 276 469.5 | 193.64 | 5.18 |
| 108 | 4 670 372.5 | 276 498.1 | 194.36 | 5.94 |
| 109 | 4 672 630.0 | 274 342.6 | 192.53 | 5.18 |
| 110 | 4 673 418.1 | 273 331.6 | 190.80 | 5.18 |
| 111 | 4 674 506.2 | 271 870.7 | 190.23 | 5.94 |
| 112 | 4 674 483.9 | 271 864.6 | 189.85 | 5.18 |
| 113 | 4 674 129.2 | 272 321.7 | 190.08 | 5.18 |
| 114 | 4 674 144.7 | 272 335.2 | 190.22 | 5.18 |
| 115 | 4 673 381.0 | 273 300.7 | 191.51 | 5.18 |
| 116 | 4 673 396.5 | 273 314.2 | 191.27 | 5.18 |

The existing culverts have the following characteristics:

| STATION | DIMENSIONS (m) | TOP ELEVATION (m) | | CONSTRUCTION |
|--|---------------------|-------------------|--------|--------------|
| | | (Lt) | (Rt) | |
| South Sandwich | | | | |
| 18+655 - (Delisle Drain) | 2.45 x 1.47 x 29.91 | 189.81 | 189.83 | NRFO |
| 19+245 - (Malden Road West Drain) | 2.45 x 1.45 x 26.86 | 190.63 | 190.64 | NRFO |
| 20+475 | 0.6 x 23.73 | 191.11 | 191.08 | CSP |
| Maidstone | | | | |
| 10+775 | 1.20 x 26.54 | 191.71 | 191.74 | CSP |
| 12+908 - (Maidstone-Colchester Townline Drain) | 1.23 x 1.22 x 54.90 | 193.39 | 193.35 | NRFO |
| 13+210 - (Dooley Drain) | 1.52 x 1.55 x 25.60 | 193.60 | 193.59 | NRFO |
| 13+890 | 3.10 x 1.52 x 26.84 | 193.31 | 193.26 | NRFO |

4.0 SUBSURFACE CONDITIONS

4.1 Site Stratigraphy

The detailed subsurface soil and groundwater conditions encountered in the boreholes together with the results of the in situ and laboratory testing carried out on selected samples are given on the attached Record of Borehole sheets following the text of this report and in Appendix A. The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling and observations of drilling resistance and represent transitions between soil types rather than exact planes of geological change. Subsurface conditions will vary between and beyond the borehole locations.

In general, the boreholes drilled at the proposed culvert extensions and culvert replacements typically encountered topsoil and fill materials underlain by an extensive deposit of clayey silt till to silty clay till.

The locations of the boreholes are shown on the attached Drawing 1. A detailed description of the subsurface conditions encountered in the boreholes is provided on the Record of Borehole sheets and is summarized in the following sections.

4.1.1 Station 18+655 SS (Delisle Drain)

Boreholes 111 and 112 were drilled in the area of the proposed extension of the culvert at Station 18+655 SS.

Topsoil and Fill

Clayey topsoil layers with thicknesses of 150 and 300 millimetres were encountered at ground surface in boreholes 111 and 112, respectively.

A 0.5 metre thick layer of sand fill was encountered underlying the topsoil in borehole 111 at elevation 190.1 metres.

Clayey Silt Till

Beneath the topsoil in borehole 112 and beneath the sand fill in borehole 111, a layer of stiff to hard clayey silt till was encountered at approximately elevation 189.6 metres. The clayey silt till had N values of 10 to 50 blows per 0.3 metres with a single measured natural water content of 20 per cent. The results of a grain size analysis of a sample of the clayey silt till recovered from the standard penetration testing are presented on Figure A-2 of Appendix A. Although not

specifically encountered in the boreholes, the presence of cobbles and boulders in the till strata should be anticipated.

The clayey silt till is of low plasticity based on a single sample with plastic and liquid limits of 12 and 34 per cent, respectively, and a plasticity index of 22 per cent. The Atterberg limits data are shown on the Plasticity Chart, Figure A-4.

4.1.2 Station 19+245 SS (Malden Road West Drain)

Boreholes 113 and 114 were drilled in the area of the proposed extension of the culvert at Station 19+245 SS.

Topsoil

Clayey topsoil layers with thicknesses of 460 and 760 millimetres were encountered at ground surface in boreholes 113 and 114, respectively.

Clayey Silt Till

Beneath the topsoil in boreholes 113 and 114, a layer of stiff to hard clayey silt till was encountered at approximately elevation 189.5 metres. The clayey silt till had N values of 10 to 45 blows per 0.3 metres with a water content of 16 per cent. The results of grain size analyses of two clayey silt till samples recovered from the standard penetration testing are presented on Figure A-2. Although not specifically encountered in the boreholes, the presence of cobbles and boulders in the till strata should be anticipated.

The clayey silt till is of low plasticity based on a plastic limit of 17 per cent, liquid limits ranging from 32 to 35 per cent (with an average liquid limit of 34 per cent) and a plasticity index ranging from 16 to 18 per cent (with an average plasticity index of 17 per cent). The Atterberg limits data are shown on the Plasticity Chart, Figure A-4.

4.1.3 Station 20+475 SS

Boreholes 110, 115 and 116 were drilled in the area of the proposed replacement of the culvert at Station 20+475 SS.

Topsoil and Fill

Clayey topsoil layers with an average thickness of 150 millimetres were encountered at ground surface in boreholes 110, 115 and 116.

A 1.2 metre thick layer of clayey silt fill was encountered underlying the topsoil in borehole 116. The clayey silt fill had a standard penetration test N value of 12 blows per 0.3 metres.

Clayey Silt Till

Beneath the topsoil in borehole 110 and the fill material in borehole 116, a layer of stiff to hard clayey silt till was encountered from approximately elevation 190.7 metres in borehole 110 and elevation 190.0 metres in borehole 116. The clayey silt till had N values of 10 to 42 blows per 0.3 metres with natural water contents of 10 to 17 per cent. The results of grain size testing on samples of the clayey silt till recovered from the standard penetration testing are presented on Figure A-2. Although not specifically encountered in the boreholes, the presence of cobbles and boulders in the till strata should be anticipated.

The clayey silt till is of low to intermediate plasticity based on plastic limits ranging from 12 to 17 per cent (for an average plastic limit of 15 per cent), liquid limits ranging from 20 to 36 per cent (for an average liquid limit of 30 per cent) and plasticity indices ranging from 8 to 20 per cent (for an average plasticity index of 15 per cent). The Atterberg limits data are shown on the Plasticity Chart, Figure A-4.

Clayey Silt

A 0.8 metre thick layer of clayey silt with silt seams was encountered interlayered with the clayey silt till in borehole 110 at approximately elevation 187.9 metres. The clayey silt had an N value of 27 blows per 0.3 metres.

Silty Clay Till

Beneath the topsoil in borehole 115, a layer of very stiff to hard silty clay till was encountered at elevation 191.3 metres. The silty clay till had N values of 16 to 43 blows per 0.3 metres and a water content of 18 per cent. The results of a grain size analysis of a sample of the silty clay till recovered from the standard penetration testing are shown on Figures A-3. Although not specifically encountered in the borehole, the presence of cobbles and boulders in the till should be expected.

The silty clay till is of intermediate plasticity with plastic and liquid limits of 17 and 36 per cent, respectively, and a plasticity index of 19 per cent. The Atterberg limits data are shown on Figure A-5.

4.1.4 Station 10+775 M

Boreholes 101, 102 and 109 were drilled in the area of the proposed replacement of the culvert at Station 10+775 M.

Topsoil and Fill

Clayey topsoil layers with thicknesses of 100 to 180 millimetres were encountered at ground surface in boreholes 101 and 109.

A 0.3 metre thick layer of sand and gravel fill was encountered at ground surface in borehole 102. Below the sand and gravel fill, a 0.3 metre thick layer of sand fill was encountered at approximately elevation 193.0 metres. A 2.2 metre thick layer of clayey silt fill was encountered below the sand fill at elevation 192.7 metres. The clayey silt fill had standard penetration test N values of 8 to 15 blows per 0.3 metres.

A 0.2 metre thick buried topsoil layer was encountered within the clayey silt fill at elevation 191.8 metres in borehole 102.

Clayey Silt Till

Beneath the topsoil in boreholes 101 and 109 and the fill materials in borehole 102, a layer of stiff to hard clayey silt till was encountered from about elevation 190.5 to 192.4 metres. The clayey silt till had N values of 8 to 44 blows per 0.3 metres with water contents of 15 to 17 per cent. The results of grain size testing on samples of the clayey silt till recovered from the standard penetration testing are presented on Figure A-1. Although not specifically encountered in the boreholes, the presence of cobbles and boulders in the till strata should be anticipated.

The clayey silt till is of low plasticity based on plastic limits ranging from 14 to 17 per cent (with an average plastic limit of 16 per cent), liquid limits ranging from 33 to 35 per cent (with an average liquid limit of 34 per cent) and plasticity indices ranging from 17 to 18 per cent (with an average plasticity index of 18 per cent). The Atterberg limits data are shown on the Plasticity Chart, Figure A-4.

4.1.5 Station 12+908 M (Maidstone-Colchester Townline Drain)

Boreholes 103 and 104 were drilled in the area of the proposed extension of the culvert at Station 12+908 M.

Topsoil and Fill

Clayey topsoil with a thickness of 230 millimetres was encountered at ground surface in borehole 104.

A 0.2 metre thick layer of sand and gravel fill was encountered at ground surface in borehole 103. Below the sand and gravel fill, a 1.1 metre thick layer of clayey silt fill was encountered at elevation 193.6 metres. The clayey silt fill had a standard penetration test N value of 13 blows per 0.3 metres.

Clayey Silt Till

Beneath the topsoil in borehole 104 and the fill materials in borehole 103, a layer of stiff to hard clayey silt till was encountered from about elevation 192.5 to 193.3 metres. The clayey silt till had N values of 14 to 40 blows per 0.3 metres with a single measured water content of 17 per cent. The results of a grain size analysis of a sample of the clayey silt till recovered from the standard penetration testing are presented on Figure A-1 of Appendix A. Although not specifically encountered in the boreholes, the presence of cobbles and boulders in the till strata should be anticipated.

The clayey silt till is of low plasticity based on plastic and liquid limits of 13 and 35 per cent, respectively, and a plasticity index of 22 per cent. The Atterberg limits data are shown on the Plasticity Chart, Figure A-4.

4.1.6 Station 13+210 M (Dooley Drain)

Boreholes 105 and 106 were drilled in the area of the proposed extension of the culvert at Station 13+210 M.

Topsoil and Fill

Clayey topsoil with a thickness of 300 millimetres was encountered at ground surface in borehole 105.

A 0.8 metre thick layer of sand and gravel fill was encountered at ground surface in borehole 106. Below the sand and gravel fill, a 0.3 metre thick layer of sand fill was encountered at elevation 193.6 metres. The sand fill had a standard penetration test N value of 12 blows per 0.3 metres. A 1.0 metre thick layer of clayey silt fill was encountered below the sand fill at elevation 192.3 metres. The clayey silt fill had a standard penetration test N value of 8 blows per 0.3 metres.

Silty Clay Till

Beneath topsoil in borehole 105 and the fill materials in borehole 106, a layer of stiff to hard silty clay till was encountered from approximately elevation 192.3 to 193.1 metres. The silty clay till had N values of 9 to 32 blows per 0.3 metres with natural water contents of 16 and 17 per cent. The results of grain size testing on samples of the silty clay till recovered from the standard penetration testing are presented on Figure A-3. Although not specifically encountered in the boreholes, the presence of cobbles and boulders in the till strata should be anticipated.

The silty clay till is of intermediate plasticity based on average plastic and liquid limits of 16 and 36 per cent, respectively, and a plasticity index of 20 per cent. The Atterberg limits data are shown on the Plasticity Chart, Figure A-5.

4.1.7 Station 13+890 M

Boreholes 107 and 108 were drilled in the area of the proposed extension of the culvert at Station 13+890 M.

Topsoil and Fill

Clayey topsoil with a thickness of 150 millimetres was encountered at ground surface in borehole 107.

A 0.2 metre thick layer of sand and gravel fill was encountered at ground surface in borehole 108. Below the sand and gravel fill, a 0.9 metre thick layer of sand fill was encountered at elevation 194.2 metres. The sand fill had a standard penetration test N value of 18 blows per 0.3 metres. A 1.1 metre thick layer of clayey silt fill was encountered below the sand fill at elevation 193.3 metres. The clayey silt fill had a standard penetration test N value of 7 blows per 0.3 metres.

Silty Clay Till

Beneath the topsoil in borehole 107 and the fill materials in borehole 108, a layer of stiff to hard silty clay till was encountered from about elevation 192.2 to 193.5 metres. The silty clay till had N values of 10 to 35 blows per 0.3 metres with natural water contents of 16 to 19 per cent. The results of grain size testing on samples of the silty clay till recovered from the standard penetration testing are presented on Figure A-3. Although not specifically encountered in the boreholes, the presence of cobbles and boulders in the till strata should be anticipated.

The silty clay till is of intermediate plasticity based on plastic limits ranging from 13 to 19 per cent (with an average plastic limit of 17 per cent), liquid limits ranging from 37 to 39 per cent (with an average liquid limit of 38 per cent) and plasticity indices ranging from 19 to 26 per cent (with an average plasticity index of 21 per cent). The Atterberg limits data are shown on the Plasticity Chart, Figure A-5.

4.2 Groundwater Conditions

Groundwater conditions were observed during and on completion of drilling and sampling. Details of the groundwater conditions at each culvert location are provided on the Records of Boreholes and are discussed individually in the following paragraphs.

The groundwater levels are expected to fluctuate seasonally and are likely to be higher during periods of sustained precipitation or spring melt.

4.2.1 Station 18+655 SS (Delisle Drain)

Boreholes 111 and 112 were dry during and on completion of drilling. The long-term groundwater table based on the change in soil colour is inferred to be near elevation 188 metres. The water level at the inlet/south end of the Delisle Drain at Station 18+655 SS was measured at elevation 188.66 metres on November 30, 2006.

4.2.2 Station 19+245 SS (Malden Road West Drain)

Boreholes 113 and 114 were dry during and on completion of drilling. The closest piezometer is at the Malden Road Drain culvert at Station 19+320. The water level in borehole 11 was measured at elevation 187.4 metres on December 14, 2006 approximately two weeks after installation. The long-term groundwater table based on the change in soil colour is inferred to be near elevation 188 metres. The water level at the inlet/south end of the Malden Road West Drain culvert was measured at elevation 189.43 metres on November 30, 2006.

4.2.3 Station 20+475 SS

Boreholes 110, 115 and 116 were dry during and on completion of drilling. The long-term groundwater table based on the change in soil colour is inferred to be near elevation 189 metres. The water level in the existing culvert at Station 20+475 SS was measured at elevation 190.57 metres at the inlet/north end of the culvert on November 29, 2006 and 190.87 metres at the outlet/south end of the culvert on December 1, 2006.

4.2.4 Station 10+775 M

Boreholes 101, 102 and 109 were dry during and on completion of drilling. The long-term groundwater table based on the change in soil colour is inferred to be near elevation 190 metres. The water level at the outlet/north end of the existing culvert at Station 10+775 M was measured at elevation 191.11 metres and at the inlet/south end at elevation 191.12 metres on November 28, 2006.

4.2.5 Station 12+908 M (Maidstone - Colchester Townline Drain)

Boreholes 103 and 104 were dry during and on completion of drilling. The long-term groundwater table based on the change in soil colour is inferred to be near elevation 191 metres. The water level at the outlet/south end of the Maidstone-Colchester Townline Drain culvert was measured at elevation 192.22 metres on November 27, 2006.

4.2.6 Station 13+210 M (Dooley Drain)

Boreholes 105 and 106 were dry during and on completion of drilling. The long-term groundwater table based on the change in soil colour is inferred to be near elevation 191 metres. The water level at the outlet/south end of the Dooley Drain was measured at elevation 192.30 metres on November 28, 2006.

4.2.7 Station 13+890 M

Boreholes 107 and 108 were dry during and on completion of drilling. The long-term groundwater table based on the change in soil colour is inferred to be near elevation 191 metres. The water level at the outlet/south end of the existing culvert at Station 13+890 M was measured at elevation 191.96 metres on November 28, 2006.

5.0 MISCELLANEOUS

The investigation was carried out using equipment supplied and operated by London Soil Test Limited which is an Ontario Ministry of Environment licensed well contractor. The field operations were supervised by Mr. Mike Arthur under the direction of Mr. David J. Mitchell. The laboratory testing was carried out at Golder Associates' London laboratory under the direction of Mr. Chris M. Sewell. The laboratory is an accredited participant in the MTO Soil and Aggregate Proficiency Program and is certified by the Canadian Council of Independent Laboratories for testing of Types C and D aggregates. This report was prepared by Ms. Dirka U. Prout, P. Eng. under the direction of the Project Manager, Mr. Philip R. Bedell, P. Eng. This report was reviewed by Mr. Fintan J. Heffernan, P. Eng., the Designated MTO Contact and Quality Control Auditor for this assignment.

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CAB/DUP/PRB/FJH/cr
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LIST OF ABBREVIATIONS

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

I. SAMPLE TYPE

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

III. SOIL DESCRIPTION

(a) Cohesionless Soils

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

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

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

Consistency

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

(b) Cohesive Soils

Dynamic Cone Penetration Resistance; N_d :

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

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

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

IV. SOIL TESTS

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

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

LIST OF SYMBOLS

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

I. General

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

II. STRESS AND STRAIN

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

III. SOIL PROPERTIES

(a) Index Properties

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

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

(d) Shear Strength

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

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

| | | | | | | | |
|-------------------------------------|--|--|--|------------------------------|--|---------------|--|
| PROJECT <u>06-1130-177</u> | | RECORD OF BOREHOLE No 101 | | 1 OF 1 | | METRIC | |
| G.W.P. <u>315-98-00</u> | | LOCATION <u>N 4672599.3 ; E 274314.0</u> | | ORIGINATED BY <u>MA</u> | | | |
| DIST <u> </u> HWY <u>3</u> | | BOREHOLE TYPE <u>Power Auger, Solid Stem</u> | | COMPILED BY <u>LMK</u> | | | |
| DATUM <u>GEODETIC</u> | | DATE <u>November 27, 2006</u> | | CHECKED BY <u> </u> | | | |

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT | | | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | | |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|--|--|--|--|---|----|----|--------------------------------------|---|----|----|----|----|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | WATER CONTENT (%) | | | | GR | SA | SI | CL | |
| | | | | | | | | | | | | | 20 | 40 | 60 | | | | | | 80 |
| 192.51 | GROUND SURFACE | | | | | | | | | | | | | | | | | | | | |
| 0.10 | TOPSOIL, clayey Brown CLAYEY SILT, trace sand, trace gravel (TILL) Stiff to Hard Brown becoming Grey at about elev. 188.9m | | | | | | | | | | | | | | | | | | | | |
| | | | 1 | SS | 11 | | | | | | | | | | | | | | | | |
| | | | 2 | SS | 19 | | | | | | | | | | | | | | | | |
| | | | 3 | SS | 35 | | | | | | | | | | | | | | | | |
| | | | 4 | SS | 35 | | | | | | | | | | | | | | | | |
| | | | 5 | SS | 28 | | | | | | | | | | | | | | | | |
| 188.09 | END OF BOREHOLE | | | | | | | | | | | | | | | | | | | | |
| 4.42 | Borehole dry during drilling November 27, 2006. | | | | | | | | | | | | | | | | | | | | |

ONL_MTO 06-1130-177-EE.GPJ LDN_MTO.GDT 2/28/07

| | | | | | | | |
|-------------------------------------|--|--|--|------------------------------|--|---------------|--|
| PROJECT <u>06-1130-177</u> | | RECORD OF BOREHOLE No 102 | | 1 OF 1 | | METRIC | |
| G.W.P. <u>315-98-00</u> | | LOCATION <u>N 4672624.8 ;E 274324.6</u> | | ORIGINATED BY <u>MA</u> | | | |
| DIST <u> </u> HWY <u>3</u> | | BOREHOLE TYPE <u>Power Auger, Solid Stem</u> | | COMPILED BY <u>LMK</u> | | | |
| DATUM <u>GEODETIC</u> | | DATE <u>November 27, 2006</u> | | CHECKED BY <u> </u> | | | |

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT NATURAL LIMIT MOISTURE CONTENT LIQUID LIMIT | | | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|--|----|----|----|----|---|----------------|---|--------------------------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | WATER CONTENT (%) | | | | |
| | | | | | | | | ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE | 20 | 40 | 60 | 80 | 100 | w _p | w | | |
| 193.25 | GROUND SURFACE | | | | | | | | | | | | | | | | |
| 0.00 | FILL, sand and gravel Grey | | | | | | | | | | | | | | | | |
| 0.28 | FILL, sand, trace silt, some gravel | | | | | | | | | | | | | | | | |
| 0.56 | FILL, clayey silt, trace gravel, trace topsoil Very Stiff Brown | | 1 | SS | 15 | | | | | | | | | | | | |
| 191.79 | | | | | | | | | | | | | | | | | |
| 1.46 | TOPSOIL, clayey Brown | | 2 | SS | 8 | | | | | | | | | | | | |
| 1.62 | FILL, clayey silt, trace gravel, trace organic material Stiff Grey | | | | | | | | | | | | | | | | |
| 190.51 | | | 3 | SS | 12 | | | | | | | | | | | | |
| 2.74 | CLAYEY SILT, trace sand, trace gravel (TILL) Very Stiff to Hard Brown becoming Grey at about elev. 188.4m | | 4 | SS | 35 | | | | | | | | | | | | |
| | | | 5 | SS | 44 | | | | | | | | | | | | |
| | | | 6 | SS | 37 | | | | | | | | | | | | |
| | | | 7 | SS | 18 | | | | | | | | | | | | |
| 187.31 | | | | | | | | | | | | | | | | | |
| 5.94 | END OF BOREHOLE Borehole dry during drilling November 27, 2006. | | | | | | | | | | | | | | | | |

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| | | | | | |
|-------------------------------------|--|--|--|------------------------------|--|
| PROJECT <u>06-1130-177</u> | | RECORD OF BOREHOLE No 103 | | 1 OF 1 METRIC | |
| G.W.P. <u>315-98-00</u> | | LOCATION <u>N 4671098.6 ; E 275834.3</u> | | ORIGINATED BY <u>MA</u> | |
| DIST <u> </u> HWY <u>3</u> | | BOREHOLE TYPE <u>Power Auger, Solid Stem</u> | | COMPILED BY <u>LMK</u> | |
| DATUM <u>GEODETIC</u> | | DATE <u>November 27, 2006</u> | | CHECKED BY <u> </u> | |

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT NATURAL LIMIT MOISTURE LIQUID CONTENT LIMIT | | | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|--|----|----|-----|--|---|--|--|--------------------------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | WATER CONTENT (%) | | | | |
| | | | | | | | | ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE | | | | | w _p w w _L | | | | |
| 193.87 | GROUND SURFACE | | | | | | 20 | 40 | 60 | 80 | 100 | | | | | | |
| 0.00 | FILL, sand and gravel, trace topsoil Brown | | | | | | | | | | | | | | | | |
| 0.24 | FILL, clayey silt, trace sand, trace gravel, trace organic material Stiff Brown | | 1 | SS | 13 | | | | | | | | | | | | |
| 192.50 | | | | | | | | | | | | | | | | | |
| 1.37 | CLAYEY SILT, trace sand, trace gravel (TILL) Very Stiff to Hard Brown becoming Grey at about elev. 189.5m | | 2 | SS | 19 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | 3 | SS | 32 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | 4 | SS | 40 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | 5 | SS | 39 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | 6 | SS | 26 | | | | | | | | | | | | |
| 188.69 | | | | | | | | | | | | | | | | | |
| 5.18 | END OF BOREHOLE Borehole dry during drilling November 27, 2006. | | | | | | | | | | | | | | | | |

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|-------------------------------------|--|--|--|------------------------------|--|
| PROJECT <u>06-1130-177</u> | | RECORD OF BOREHOLE No 104 | | 1 OF 1 METRIC | |
| G.W.P. <u>315-98-00</u> | | LOCATION <u>N 4671091.7 ; E 275812.2</u> | | ORIGINATED BY <u>MA</u> | |
| DIST <u> </u> HWY <u>3</u> | | BOREHOLE TYPE <u>Power Auger, Solid Stem</u> | | COMPILED BY <u>LMK</u> | |
| DATUM <u>GEODETIC</u> | | DATE <u>November 27, 2006</u> | | CHECKED BY <u> </u> | |

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT NATURAL LIMIT MOISTURE CONTENT LIQUID LIMIT | | | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|--|--|--|--|---|----|----|--------------------------------------|---|----|----|----|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | WATER CONTENT (%) | | | | GR | SA | SI | CL |
| | | | | | | | | | | | | | 20 | 40 | 60 | | | | | |
| 193.56 | GROUND SURFACE | | | | | | | | | | | | | | | | | | | |
| 0.00 | TOPSOIL, clayey Brown | | | | | | | | | | | | | | | | | | | |
| 0.23 | CLAYEY SILT, trace sand, trace gravel (TILL) Stiff to Hard Brown becoming Grey at about elev. 190.0m | | | | | | | | | | | | | | | | | | | |
| | | | 1 | SS | 14 | | | | | | | | | | | | | | | |
| | | | 2 | SS | 16 | | | | | | | | | | | | | | | |
| | | | 3 | SS | 37 | | | | | | | | | | | | | | | |
| | | | 4 | SS | 36 | | | | | | | | | | | | | | | |
| | | | 5 | SS | 18 | | | | | | | | | | | | | | | |
| | | | 6 | SS | 17 | | | | | | | | | | | | | | | |
| 188.38 | END OF BOREHOLE | | | | | | | | | | | | | | | | | | | |
| 5.18 | Borehole dry during drilling November 27, 2006. | | | | | | | | | | | | | | | | | | | |

| | | | | | |
|-------------------------------------|--|----------------------------------|--|--------|---------------|
| PROJECT <u>06-1130-177</u> | | RECORD OF BOREHOLE No 105 | | 1 OF 1 | METRIC |
| G.W.P. <u>315-98-00</u> | LOCATION <u>N 4670862.2 ; E 276020.4</u> | ORIGINATED BY <u>MA</u> | | | |
| DIST <u> </u> HWY <u>3</u> | BOREHOLE TYPE <u>Power Auger, Solid Stem</u> | COMPILED BY <u>LMK</u> | | | |
| DATUM <u>GEODETIC</u> | DATE <u>November 28, 2006</u> | CHECKED BY <u> </u> | | | |

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | | |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|---|---|----------------|---|---|----|----|----|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | W _p | W | W _L | | GR | SA | SI | CL | |
| | | | | | | | | 20 | 40 | 60 | 80 | 100 | | | | | | | | | |
| 193.42 | GROUND SURFACE | | | | | | | | | | | | | | | | | | | | |
| 0.00 | TOPSOIL, clayey Brown | | | | | | | | | | | | | | | | | | | | |
| 0.30 | SILTY CLAY, trace sand, trace gravel (TILL) Stiff to Hard Brown becoming Grey at about elev. 190.5m | | | | | | | | | | | | | | | | | | | | |
| | | 1 | SS | 11 | | | | | | | | | | | | | | | | | |
| | | 2 | SS | 9 | | | | | | | | | | | | | | | | | |
| | | 3 | SS | 30 | | | | | | | | | | | | | | | | | |
| | | 4 | SS | 28 | | | | | | | | | | | | | | | | | |
| | | 5 | SS | 15 | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | 6 | SS | 14 | | | | | | | | | | | | | | | | |
| 188.24 | END OF BOREHOLE | | | | | | | | | | | | | | | | | | | | |
| 5.18 | Borehole dry during drilling November 28, 2006. | | | | | | | | | | | | | | | | | | | | |

ONL_MTO 06-1130-177-EE.GPJ LDN_MTO.GDT 2/28/07

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|--------------------------------|--|--|--|-------------------------|---------------|
| PROJECT 06-1130-177 | | RECORD OF BOREHOLE No 106 | | 1 OF 1 | METRIC |
| G.W.P. 315-98-00 | | LOCATION N 4670886.1 ; E 276034.8 | | ORIGINATED BY MA | |
| DIST _____ HWY 3 | | BOREHOLE TYPE Power Auger, Solid Stem | | COMPILED BY LMK | |
| DATUM GEODETIC | | DATE November 28, 2006 | | CHECKED BY _____ | |

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | PLASTIC LIMIT NATURAL MOISTURE LIQUID CONTENT LIMIT | | | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|--------------|------------------|---|----------------|----|--------------------------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | WATER CONTENT (%) | | | | |
| | | | | | | | | ○ UNCONFINED | + FIELD VANE | ● QUICK TRIAXIAL | × LAB VANE | W _p | W | | |
| 194.35 | GROUND SURFACE | | | | | | 20 | 40 | 60 | 80 | 100 | 10 | 20 | 30 | |
| 0.00 | FILL, sand and gravel, trace silt Grey | | | | | | | | | | | | | | |
| 193.59 | | | | | | | | | | | | | | | |
| 0.76 | FILL, sand, trace silt Compact Brown | | 1 | SS | 12 | | | | | | | | | | |
| 1.06 | FILL, clayey silt, trace sand, trace gravel, trace topsoil Stiff Brown | | 2 | SS | 8 | | | | | | | | | | |
| 192.25 | | | | | | | | | | | | | | | |
| 2.10 | SILTY CLAY, trace sand, trace gravel (TILL) Very Stiff to Hard Brown becoming Grey at about elev. 190.8m | | 3 | SS | 18 | | | | | | | | | | |
| | | | 4 | SS | 31 | | | | | | | | | | |
| | | | 5 | SS | 32 | | | | | | | | | | |
| | | | 6 | SS | 18 | | | | | | | | | | |
| | | | 7 | SS | 16 | | | | | | | | | | |
| 188.41 | | | | | | | | | | | | | | | |
| 5.94 | END OF BOREHOLE Borehole dry during drilling November 28, 2006. | | | | | | | | | | | | | | |

| | | | | | | | |
|-------------------------------------|--|--|--|------------------------------|--|---------------|--|
| PROJECT <u>06-1130-177</u> | | RECORD OF BOREHOLE No 107 | | 1 OF 1 | | METRIC | |
| G.W.P. <u>315-98-00</u> | | LOCATION <u>N 4670363.2 ; E 276469.5</u> | | ORIGINATED BY <u>MA</u> | | | |
| DIST <u> </u> HWY <u>3</u> | | BOREHOLE TYPE <u>Power Auger, Solid Stem</u> | | COMPILED BY <u>LMK</u> | | | |
| DATUM <u>GEODETIC</u> | | DATE <u>November 28, 2006</u> | | CHECKED BY <u> </u> | | | |


| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT w _p | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w _L | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL | | |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|--------------|------------------------------------|-------------------------------------|-----------------------------------|--|--|-------------------|------------|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | WATER CONTENT (%) | |
| | | | | | | | | ○ UNCONFINED | + FIELD VANE | | | | | | ● QUICK TRIAXIAL | × LAB VANE |
| 193.64 | GROUND SURFACE | | | | | | | | | | | | | | | |
| 0.00 | TOPSOIL, clayey Brown | | | | | | | | | | | | | | | |
| 0.15 | SILTY CLAY, trace sand, trace gravel (TILL) Stiff to Hard Brown becoming Grey at about elev. 190.6m | | 1 | SS | 10 | | | | | | | | | | | |
| | | | 2 | SS | 18 | | | | | | | | | | | |
| | | | 3 | SS | 35 | | | | | | | | | | | |
| | | | 4 | SS | 29 | | | | | | | | | | | |
| | | | 5 | SS | 17 | | | | | | | | | | | |
| | | | 6 | SS | 16 | | | | | | | | | | | |
| 188.46 | END OF BOREHOLE | | | | | | | | | | | | | | | |
| 5.18 | Borehole dry during drilling November 28, 2006. | | | | | | | | | | | | | | | |

ONL_MTO 06-1130-177-EE.GPJ LDN_MTO.GDT 2/28/07

| | | | | | |
|----------------------------|--|--|--|-------------------------|---------------|
| PROJECT 06-1130-177 | | RECORD OF BOREHOLE No 108 | | 1 OF 1 | METRIC |
| G.W.P. 315-98-00 | | LOCATION N 4670372.5 ; E 276498.1 | | ORIGINATED BY MA | |
| DIST HWY 3 | | BOREHOLE TYPE Power Auger, Solid Stem | | COMPILED BY LMK | |
| DATUM GEODETIC | | DATE November 28, 2006 | | CHECKED BY | |

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT NATURAL LIQUID MOISTURE LIMIT CONTENT LIMIT | | | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|--|----|----|----|-----|---|---|----------------|--------------------------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | WATER CONTENT (%) | | | | |
| | | | | | | | | ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE | | | | | W _p | W | W _L | | |
| 194.36 | GROUND SURFACE | | | | | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 0.00 | FILL, sand and gravel Grey | | | | | | 194 | | | | | | | | | | |
| 0.21 | FILL, sand, trace silt, some gravel Compact Brown | | | | | | | | | | | | | | | | |
| 193.29 | | | 1 | SS | 18 | | | | | | | | | | | | |
| 1.07 | FILL, clayey silt, trace sand, trace gravel, trace topsoil Stiff to Firm Brown | | 2 | SS | 7 | | 193 | | | | | | | | | | |
| 192.23 | | | | | | | | | | | | | | | | | |
| 2.13 | SILTY CLAY, trace sand, trace gravel (TILL) Stiff to Hard Brown becoming Grey at about elev. 190.0m | | 3 | SS | 12 | | 192 | | | | | | | | | 4 | 17 43 36 |
| | | | 4 | SS | 31 | | 191 | | | | | | | | | | |
| | | | 5 | SS | 29 | | 190 | | | | | | | | | | |
| | | | 6 | SS | 19 | | | | | | | | | | | 0 | 15 46 39 |
| | | | | | | | | | | | | | | | | | |
| 188.42 | | | 7 | SS | 14 | | 189 | | | | | | | | | | |
| 5.94 | END OF BOREHOLE Borehole dry during drilling November 28, 2006. | | | | | | | | | | | | | | | | |

| | | | | | | | |
|-------------------------------------|--|--|--|------------------------------|--|---------------|--|
| PROJECT <u>06-1130-177</u> | | RECORD OF BOREHOLE No 109 | | 1 OF 1 | | METRIC | |
| G.W.P. <u>315-98-00</u> | | LOCATION <u>N 4672630.0 ; E 274342.6</u> | | ORIGINATED BY <u>MA</u> | | | |
| DIST <u> </u> HWY <u>3</u> | | BOREHOLE TYPE <u>Power Auger, Solid Stem</u> | | COMPILED BY <u>LMK</u> | | | |
| DATUM <u>GEODETIC</u> | | DATE <u>November 28, 2006</u> | | CHECKED BY <u> </u> | | | |

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT | | | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | | |
|---------------|--|---|---------|------|------------|----------------------------|-----------------|---|--|--|--|--|---|----|----|--------------------------------------|---|----|----|----|----|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | WATER CONTENT (%) | | | | GR | SA | SI | CL | |
| | | | | | | | | | | | | | 20 | 40 | 60 | | | | | | 80 |
| 192.53 | GROUND SURFACE | | | | | | | | | | | | | | | | | | | | |
| 0.00 | TOPSOIL, clayey Brown | | | | | | | | | | | | | | | | | | | | |
| 0.18 | CLAYEY SILT, trace sand, trace gravel (TILL) Stiff to Hard Brown becoming Grey at about elev. 188.8m |  | | | | | | | | | | | | | | | | | | | |
| | | | 1 | SS | 8 | | | | | | | | | | | | | | | | |
| | | | 2 | SS | 8 | | | | | | | | | | | | | | | | |
| | | | 3 | SS | 36 | | | | | | | | | | | | | | | | |
| | | | 4 | SS | 43 | | | | | | | | | | | | | | | | |
| | | | 5 | SS | 25 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | 6 | SS | 20 | | | | | | | | | | | | | | | | |
| 187.35 | END OF BOREHOLE | | | | | | | | | | | | | | | | | | | | |
| 5.18 | Borehole dry during drilling November 28, 2006. | | | | | | | | | | | | | | | | | | | | |

ONL_MTO 06-1130-177-EE.GPJ LDN_MTO.GDT 2/28/07

| | | | | | |
|-------------------------------------|--|--|--|------------------------------|--|
| PROJECT <u>06-1130-177</u> | | RECORD OF BOREHOLE No 110 | | 1 OF 1 METRIC | |
| G.W.P. <u>315-98-00</u> | | LOCATION <u>N 4673418.1 ; E 273331.6</u> | | ORIGINATED BY <u>MA</u> | |
| DIST <u> </u> HWY <u>3</u> | | BOREHOLE TYPE <u>Power Auger, Solid Stem</u> | | COMPILED BY <u>LMK</u> | |
| DATUM <u>GEODETIC</u> | | DATE <u>November 29, 2006</u> | | CHECKED BY <u> </u> | |

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT NATURAL LIMIT MOISTURE LIQUID CONTENT LIMIT | | | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | | |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|-------------------------------|--|--|--|---|--|--|--------------------------------------|---|----|----|----|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | WATER CONTENT (%) | | | | GR | SA | SI | CL | |
| | | | | | | | | ○ UNCONFINED + FIELD VANE | ● QUICK TRIAXIAL × LAB VANE | | | | | | | | | | | | |
| 190.80 | GROUND SURFACE | | | | | | | | | | | | | | | | | | | | |
| 0.00 | TOPSOIL, clayey Brown | | | | | | | | | | | | | | | | | | | | |
| 0.15 | CLAYEY SILT, trace sand, trace gravel (TILL) Stiff to Hard Brown | | 1 | SS | 10 | | | | | | | | | | | | | | | | |
| | | | 2 | SS | 35 | | | | | | | | | | | | | | | | |
| | | | 3 | SS | 40 | | | | | | | | | | | | | | | | |
| 187.90 | | | | | | | | | | | | | | | | | | | | | |
| 2.90 | CLAYEY SILT, trace sand, trace gravel with silt seams Very stiff Grey | | 4 | SS | 27 | | | | | | | | | | | | | | | | |
| 187.14 | | | | | | | | | | | | | | | | | | | | | |
| 3.66 | CLAYEY SILT, trace sand, trace gravel (TILL) Very Stiff Grey | | 5 | SS | 18 | | | | | | | | | | | | | | | | |
| | | | 6 | SS | 21 | | | | | | | | | | | | | | | | |
| 185.62 | | | | | | | | | | | | | | | | | | | | | |
| 5.18 | END OF BOREHOLE Borehole dry during drilling November 29, 2006. | | | | | | | | | | | | | | | | | | | | |

| | | | | | |
|-------------------------------------|--|----------------------------------|--|--------|---------------|
| PROJECT <u>06-1130-177</u> | | RECORD OF BOREHOLE No 111 | | 1 OF 1 | METRIC |
| G.W.P. <u>315-98-00</u> | LOCATION <u>N 4674506.2 ; E 271870.7</u> | ORIGINATED BY <u>MA</u> | | | |
| DIST <u> </u> HWY <u>3</u> | BOREHOLE TYPE <u>Power Auger, Solid Stem</u> | COMPILED BY <u>LMK</u> | | | |
| DATUM <u>GEODETIC</u> | DATE <u>November 30, 2006</u> | CHECKED BY <u> </u> | | | |

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT NATURAL LIMIT MOISTURE CONTENT LIQUID LIMIT | | | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | | |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|--|----|----|----|----|---|----------------|---|--------------------------------------|---|----|----|----|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | WATER CONTENT (%) | | | | GR | SA | SI | CL | |
| | | | | | | | | ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE | 20 | 40 | 60 | 80 | 100 | w _p | w | | w _L | | | | |
| 190.23 | GROUND SURFACE | | | | | | | | | | | | | | | | | | | | |
| 0.00 | TOPSOIL, clayey Brown | | | | | | | | | | | | | | | | | | | | |
| 0.15 | FILL, sand, trace gravel, trace silt Brown | | | | | | | | | | | | | | | | | | | | |
| 189.56 | CLAYEY SILT, trace sand, trace gravel (TILL) Stiff to Hard Brown becoming Grey at about elev. 186.6m | | 1 | SS | 11 | | | | | | | | | | | | | | | | |
| 0.67 | | | 2 | SS | 15 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | 3 | SS | 39 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | 4 | SS | 50 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | 5 | SS | 26 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | 6 | SS | 18 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | 7 | SS | 16 | | | | | | | | | | | | | | | | |
| 184.29 | END OF BOREHOLE | | | | | | | | | | | | | | | | | | | | |
| 5.94 | Borehole dry during drilling November 30, 2006. | | | | | | | | | | | | | | | | | | | | |

| | | | | | | | |
|-------------------------------------|--|--|--|------------------------------|--|---------------|--|
| PROJECT <u>06-1130-177</u> | | RECORD OF BOREHOLE No 112 | | 1 OF 1 | | METRIC | |
| G.W.P. <u>315-98-00</u> | | LOCATION <u>N 4674483.9 ; E 271864.6</u> | | ORIGINATED BY <u>MA</u> | | | |
| DIST <u> </u> HWY <u>3</u> | | BOREHOLE TYPE <u>Power Auger, Solid Stem</u> | | COMPILED BY <u>LMK</u> | | | |
| DATUM <u>GEODETIC</u> | | DATE <u>November 30, 2006</u> | | CHECKED BY <u> </u> | | | |

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|--|--|--|--|---|--|--|---|---|----|----|----|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | WATER CONTENT (%) | | | | GR | SA | SI | CL |
| | | | | | | | | | | | | | | | | | | | | |
| 189.85 | GROUND SURFACE | | | | | | | | | | | | | | | | | | | |
| 0.00 | TOPSOIL, clayey Brown | | | | | | | | | | | | | | | | | | | |
| 0.30 | CLAYEY SILT, trace sand, trace gravel (TILL) Stiff to Hard Brown becoming Grey at about elev. 186.3m | | 1 | SS | 10 | | | | | | | | | | | | | | | |
| | | | 2 | SS | 14 | | | | | | | | | | | | | | | |
| | | | 3 | SS | 41 | | | | | | | | | | | | | | | |
| | | | 4 | SS | 32 | | | | | | | | | | | | | | | |
| | | | 5 | SS | 23 | | | | | | | | | | | | | | | |
| | | | 6 | SS | 17 | | | | | | | | | | | | | | | |
| 184.67 | END OF BOREHOLE | | | | | | | | | | | | | | | | | | | |
| 5.18 | Borehole dry during drilling November 30, 2006. | | | | | | | | | | | | | | | | | | | |

ONL_MTO 06-1130-177-EE.GPJ LDN_MTO.GDT 2/28/07

| | | | | | |
|-------------------------------------|--|--|--|------------------------------|---------------|
| PROJECT <u>06-1130-177</u> | | RECORD OF BOREHOLE No 113 | | 1 OF 1 | METRIC |
| G.W.P. <u>315-98-00</u> | | LOCATION <u>N 4674129.2 ; E 272321.7</u> | | ORIGINATED BY <u>MA</u> | |
| DIST <u> </u> HWY <u>3</u> | | BOREHOLE TYPE <u>Power Auger, Solid Stem</u> | | COMPILED BY <u>LMK</u> | |
| DATUM <u>GEODETIC</u> | | DATE <u>November 30, 2006</u> | | CHECKED BY <u> </u> | |

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | | PLASTIC LIMIT NATURAL LIQUID | | | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | | |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|--|----|----|----|-----|--|------------------------------------|---|----------------|-------------------------|---|----|----|----|----|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | w _p | w | w _L | | | | | | |
| | | | | | | | | ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE | | | | | | | | | | | | | | |
| 190.08 | GROUND SURFACE | | | | | | | 20 | 40 | 60 | 80 | 100 | | | | | | | GR | SA | SI | CL |
| 0.00 | TOPSOIL, clayey Brown | | | | | | 190 | | | | | | | | | | | | | | | |
| 189.62 | | | | | | | | | | | | | | | | | | | | | | |
| 0.46 | CLAYEY SILT, trace sand, trace gravel (TILL) Stiff to Hard Brown becoming Grey at about elev. 187.0m | | 1 | SS | 10 | | 189 | | | | | | | | | | | | 6 | 20 | 42 | 32 |
| | | | 2 | SS | 29 | | | | | | | | | | | | | | | | | |
| | | | 3 | SS | 45 | | 188 | | | | | | | | | | | | | | | |
| | | | 4 | SS | 27 | | | | | | | | | | | | | | | | | |
| | | | 5 | SS | 27 | | 187 | | | | | | | | | | | | | | | |
| | | | 6 | SS | 17 | | | | | | | | | | | | | | | | | |
| 184.90 | | | | | | | 186 | | | | | | | | | | | | | | | |
| 5.18 | END OF BOREHOLE Borehole dry during drilling November 30, 2006. | | | | | | 185 | | | | | | | | | | | | | | | |

ONL_MTO 06-1130-177-EE.GPJ LDN_MTO.GDT 2/28/07

| | | | | | |
|-------------------------------------|--|--|--|------------------------------|--|
| PROJECT <u>06-1130-177</u> | | RECORD OF BOREHOLE No 114 | | 1 OF 1 METRIC | |
| G.W.P. <u>315-98-00</u> | | LOCATION <u>N 4674144.7 :E 272335.2</u> | | ORIGINATED BY <u>MA</u> | |
| DIST <u> </u> HWY <u>3</u> | | BOREHOLE TYPE <u>Power Auger, Solid Stem</u> | | COMPILED BY <u>LMK</u> | |
| DATUM <u>GEODETIC</u> | | DATE <u>November 30, 2006</u> | | CHECKED BY <u> </u> | |

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT NATURAL LIQUID MOISTURE LIMIT CONTENT LIMIT | | | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | | |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|---|---|----------------|--------------------------------------|---|----|----|----|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | WATER CONTENT (%) | | | | GR | SA | SI | CL | |
| | | | | | | | | 20 | 40 | 60 | 80 | 100 | w _p | w | w _L | | | | | | |
| 190.22 | GROUND SURFACE | | | | | | | | | | | | | | | | | | | | |
| 0.00 | TOPSOIL, clayey Brown | | | | | | 190 | | | | | | | | | | | | | | |
| 189.46 | | | | | | | | | | | | | | | | | | | | | |
| 0.76 | CLAYEY SILT, trace sand, trace gravel (TILL) Stiff to Hard Brown becoming Grey at about elev. 187.2m | | 1 | SS | 12 | | 189 | | | | | | | | | | | | | | |
| | | | 2 | SS | 26 | | | | | | | | | | | | | | | | |
| | | | 3 | SS | 42 | | 188 | | | | | | | | | | | | | | |
| | | | 4 | SS | 33 | | 187 | | | | | | | | | | | | | | |
| | | | 5 | SS | 20 | | | | | | | | | | | | | | | | |
| | | | 6 | SS | 17 | | 186 | | | | | | | | | | | | | | |
| 185.04 | END OF BOREHOLE | | | | | | | | | | | | | | | | | | | | |
| 5.18 | Borehole dry during drilling November 30, 2006. | | | | | | | | | | | | | | | | | | | | |

| | | | | | | | |
|-------------------------------------|--|--|--|------------------------------|--|---------------|--|
| PROJECT <u>06-1130-177</u> | | RECORD OF BOREHOLE No 115 | | 1 OF 1 | | METRIC | |
| G.W.P. <u>315-98-00</u> | | LOCATION <u>N 4673381.0 ; E 273300.7</u> | | ORIGINATED BY <u>MA</u> | | | |
| DIST <u> </u> HWY <u>3</u> | | BOREHOLE TYPE <u>Power Auger, Solid Stem</u> | | COMPILED BY <u>LMK</u> | | | |
| DATUM <u>GEODETIC</u> | | DATE <u>December 1, 2006</u> | | CHECKED BY <u> </u> | | | |

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT NATURAL LIMIT MOISTURE CONTENT LIQUID LIMIT | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | | |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|----|---|-------------------------------|-------------------|---|---|----|----|----|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | W _p | W | W _L | | GR | SA | SI | CL | |
| | | | | | | | | ○ UNCONFINED + FIELD VANE | 20 | 40 | 60 | 80 | 100 | ● QUICK TRIAXIAL × LAB VANE | WATER CONTENT (%) | | | | | | |
| 191.51 | GROUND SURFACE | | | | | | | | | | | | | | | | | | | | |
| 0.00 | TOPSOIL, clayey Brown | | | | | | | | | | | | | | | | | | | | |
| 0.20 | SILTY CLAY, trace sand, trace gravel (TILL) Very Stiff to Hard Brown becoming Grey at about elev. 187.1m | | 1 | SS | 16 | | | | | | | | | | | | | | | | |
| | | | 2 | SS | 17 | | | | | | | | | | | | | | | | |
| | | | 3 | SS | 31 | | | | | | | | | | | | | | | | |
| | | | 4 | SS | 43 | | | | | | | | | | | | | | | | |
| | | | 5 | SS | 31 | | | | | | | | | | | | | | | | |
| | | | 6 | SS | 20 | | | | | | | | | | | | | | | | |
| 186.33 | END OF BOREHOLE | | | | | | | | | | | | | | | | | | | | |
| 5.18 | Borehole dry during drilling December 1, 2006. | | | | | | | | | | | | | | | | | | | | |

ONL_MTO 06-1130-177-EE.GPJ LDN_MTO.GDT 2/28/07

RECORD OF BOREHOLE No 116

1 OF 1

METRIC

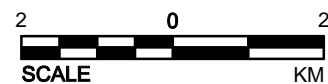
PROJECT 06-1130-177
G.W.P. 315-98-00 LOCATION N 4673396.5 ; E 273314.2 ORIGINATED BY MA
DIST HWY 3 BOREHOLE TYPE Power Auger, Solid Stem COMPILED BY LMK
DATUM GEODETIC DATE December 1, 2006 CHECKED BY

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|---|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | 20 | 40 | 60 | 80 | 100 | | |
| 191.27 | GROUND SURFACE | | | | | | | | | | | | | |
| 0.10 | TOPSOIL, clayey Brown | | | | | | 191 | | | | | | | |
| | FILL, clayey silt, trace sand, trace gravel and clay tile Stiff Brown | | 1 | SS | 12 | | 190 | | | | | | | |
| 189.96 | | | | | | | | | | | | | | |
| 1.31 | CLAYEY SILT, trace sand, trace gravel (TILL) Very Stiff to Hard Brown becoming Grey at about elev. 188.3m | | 2 | SS | 20 | | 189 | | | | | | | |
| | | | 3 | SS | 36 | | | | | | | | | |
| | | | 4 | SS | 42 | | 188 | | | | | | | |
| | | | 5 | SS | 27 | | | | | | | | | |
| | | | 6 | SS | 20 | | 187 | | | | | | | |
| 186.09 | END OF BOREHOLE | | | | | | | | | | | | | |
| 5.18 | Borehole dry during drilling December 1, 2006. | | | | | | | | | | | | | |




NOTE

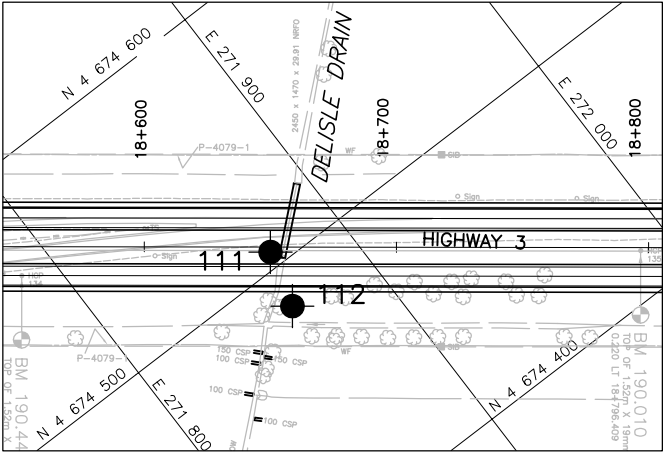
SS = TOWNSHIP OF SANDWICH SOUTH
M = TOWNSHIP OF MAIDSTONE



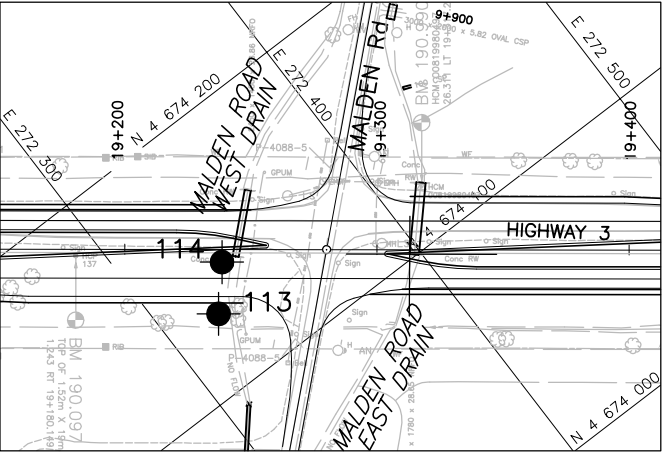
NOTE

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

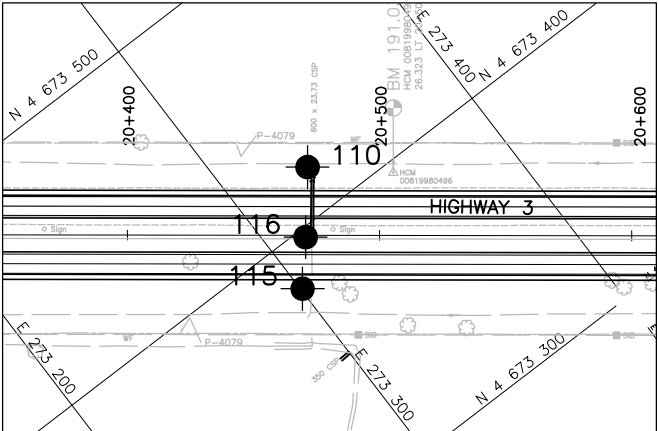
| | | | | | |
|---|--|--|-----|--------------------------|-----------------|
| PROJECT | | SHORT SPAN CULVERTS HIGHWAY 3 WIDENING GWP 315-98-00 | | | |
| TITLE | | KEY PLAN | | | |
|  Golder Associates LONDON, ONTARIO | | PROJECT No. 06-1130-177-0-5 | | FILE No. 061130177-EE001 | |
| | | CADD | WDF | Jan 09/07 | SCALE AS SHOWN |
| | | CHECK | | | REV. 0 |
| | | | | | FIGURE 1 |



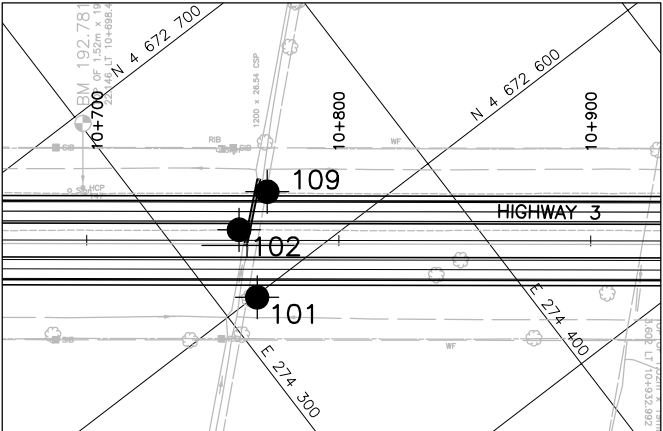
PLAN 18+655 SS
SCALE 0 25 m



PLAN 19+245 SS
SCALE 0 25 m

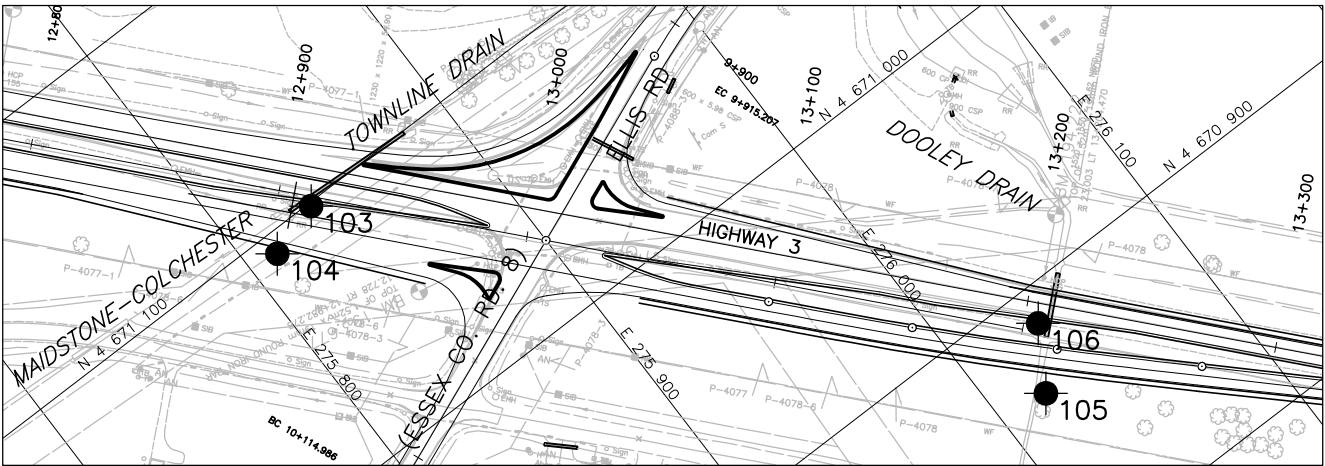


PLAN 20+475 SS
SCALE 0 25 m

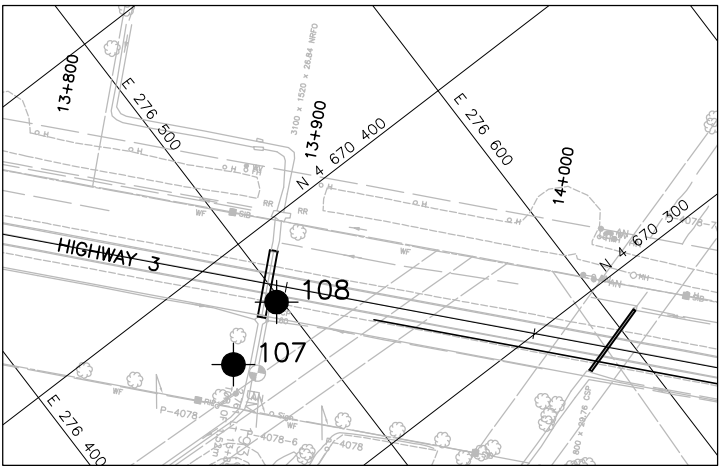


PLAN 10+775 M
SCALE 0 25 m

NOTE
SS = TOWNSHIP OF SANDWICH SOUTH
M = TOWNSHIP OF MAIDSTONE



PLAN 12+908 M and 13+210 M
SCALE 0 25 m



PLAN 13+890 M
SCALE 0 25 m

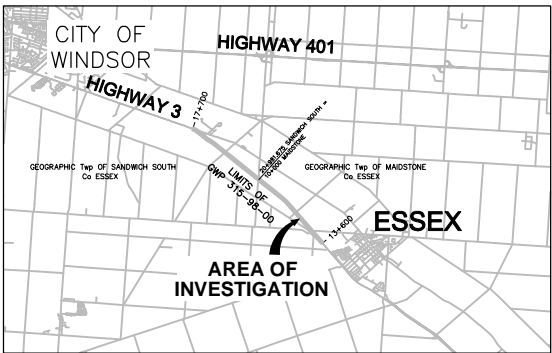
METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
WP No. 315-98-00

SHORT SPAN CULVERTS
HIGHWAY 3
BOREHOLE LOCATIONS



Golder Associates Ltd.
LONDON, ONTARIO, CANADA



KEY PLAN
SCALE 0 3000m

LEGEND

● Borehole - Current Investigation

| No. | ELEVATION | CO-ORDINATES (MTM Zone 11) | |
|-----|-----------|----------------------------|-----------|
| | | NORTHING | EASTING |
| 101 | 192.51 | 4 672 599.3 | 274 314.0 |
| 102 | 193.25 | 4 672 624.8 | 274 324.6 |
| 103 | 193.87 | 4 671 098.6 | 275 834.3 |
| 104 | 193.56 | 4 671 091.7 | 275 812.2 |
| 105 | 193.42 | 4 670 862.2 | 276 020.4 |
| 106 | 194.35 | 4 670 886.1 | 276 034.8 |
| 107 | 193.64 | 4 670 363.2 | 276 469.5 |
| 108 | 194.36 | 4 670 372.5 | 276 498.1 |
| 109 | 192.53 | 4 672 630.0 | 274 342.6 |
| 110 | 190.80 | 4 673 418.1 | 273 331.6 |
| 111 | 190.23 | 4 674 506.2 | 271 870.7 |
| 112 | 189.85 | 4 674 483.9 | 271 864.6 |
| 113 | 190.08 | 4 674 129.2 | 272 321.7 |
| 114 | 190.22 | 4 674 144.7 | 272 335.2 |
| 115 | 191.51 | 4 673 381.0 | 273 300.7 |
| 116 | 191.27 | 4 673 396.5 | 273 314.2 |

NOTES

This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

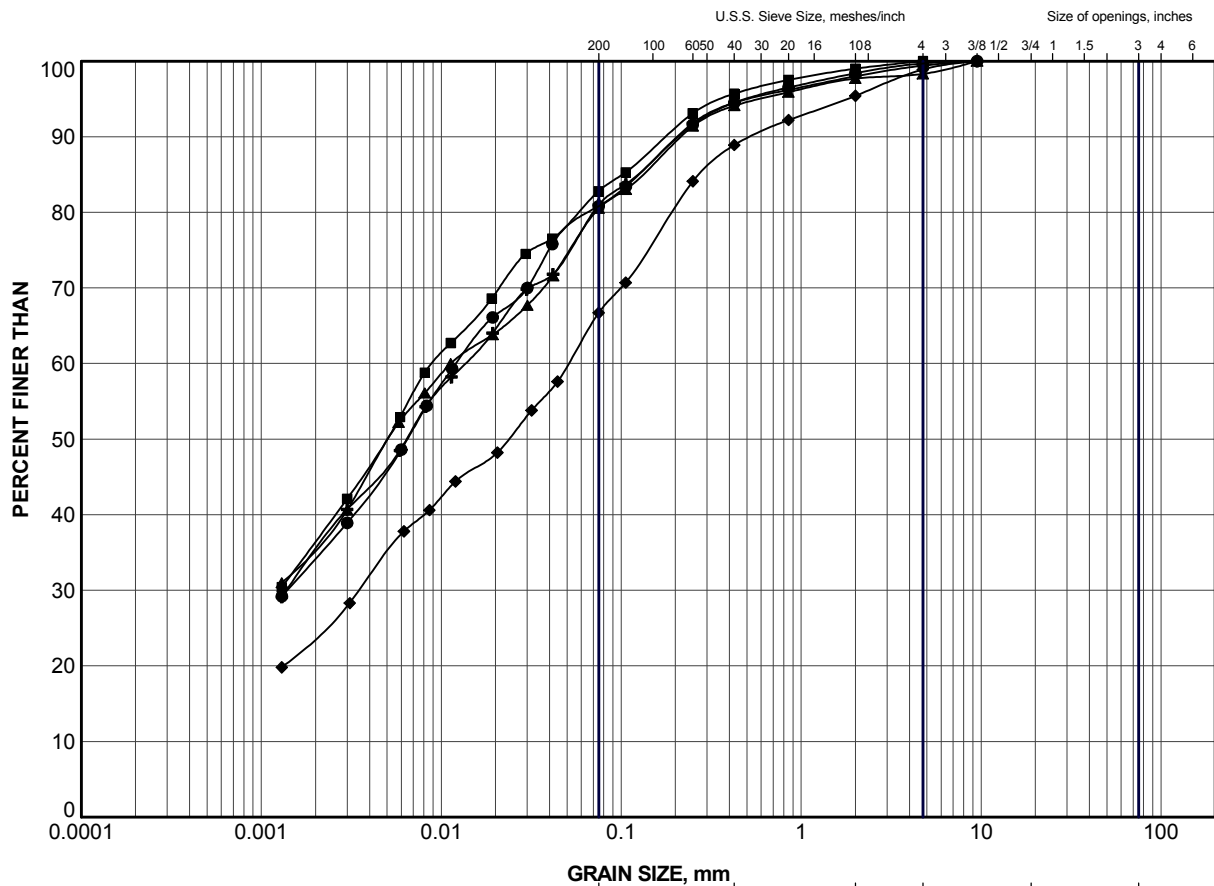
The boundaries between soil strata have been established only at borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REFERENCE

Base plans provided in digital format by DELCAN.

| | | | |
|------------------|------|-------------|-----------------|
| | | | |
| | | | |
| NO. | DATE | BY | REVISION |
| Geocres No. | | 40J2-92 | |
| HWY. | 3 | PROJECT NO. | 06-1130-177-0-5 |
| DIST. | | | |
| SUBM'D. | DUP | CHKD. | CAB |
| DATE: Feb. 15/07 | | SITE: | |
| DRAWN: | WDF | CHKD. | APPD. |
| DWG. | | 1 | |


APPENDIX A
LABORATORY TEST DATA

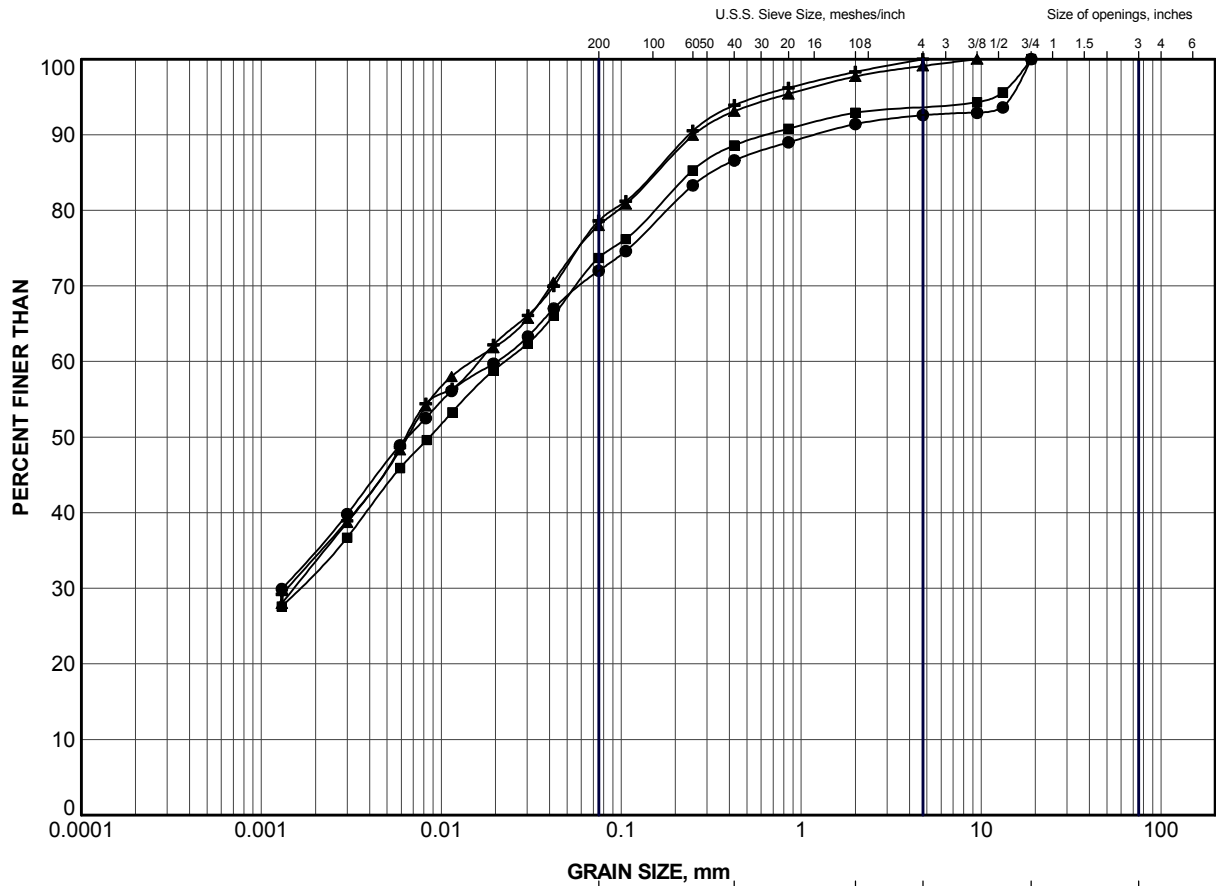


| GRAVEL SIZE, mm | | | | | | |
|-----------------|-----------|--------|--------|-------------|--------|-------------|
| CLAY AND SILT | fine | medium | coarse | fine | coarse | Cobble Size |
| | SAND SIZE | | | GRAVEL SIZE | | |

LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEV (m) |
|--------|----------|--------|----------|
| ● | 101 | 4 | 189.2 |
| ■ | 102 | 6 | 188.5 |
| ▲ | 103 | 3 | 191.4 |
| + | 109 | 4 | 189.3 |
| ◆ | 110 | 5 | 186.8 |


| | | | | | |
|---|--|--|--|-----------------------------|--|
| PROJECT | | SHORT SPAN CULVERTS HIGHWAY 3 WIDENING GWP 315-98-00 | | | |
| TITLE | | GRAIN SIZE DISTRIBUTION CLAYEY SILT (TILL) | | | |
| PROJECT No. | | 06-1130-177 | | FILE No. 06-1130-177-EE.GPJ | |
| DRAWN | | WDF | | Jan 02/07 | |
| CHECK | | | | | |
|  Golder Associates LONDON, ONTARIO | | FIGURE A-1 | | | |

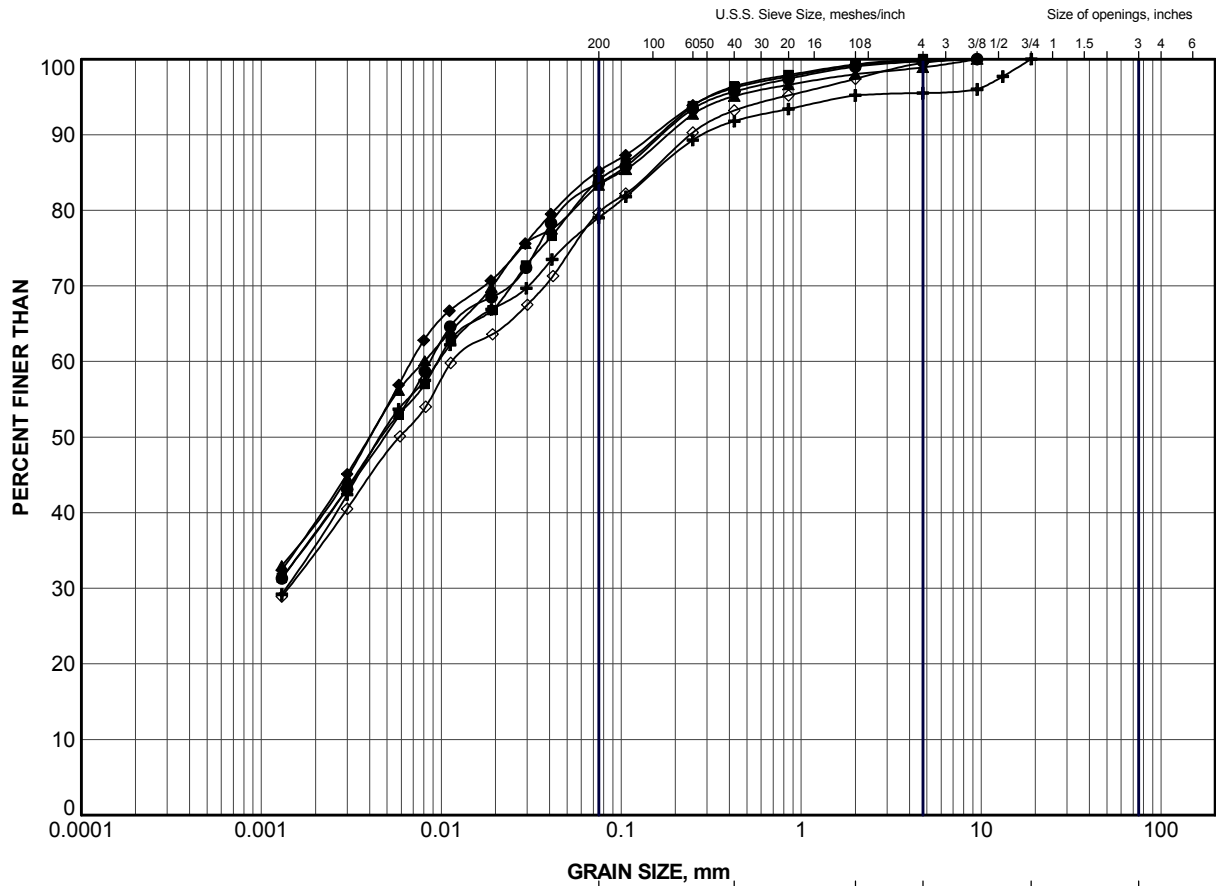


| | | | | | | |
|---------------|---------------|--------|--------|-----------------|--------|-------------|
| CLAY AND SILT | SAND SIZE, mm | | | GRAVEL SIZE, mm | | Cobble Size |
| | fine | medium | coarse | fine | coarse | |
| | SAND SIZE | | | GRAVEL SIZE | | |

LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEV (m) |
|--------|----------|--------|----------|
| ● | 111 | 6 | 185.4 |
| ■ | 113 | 2 | 188.3 |
| ▲ | 114 | 4 | 186.9 |
| + | 116 | 3 | 188.8 |


| | | | | | | |
|---|--|--|-------------|-----------|--------------------|-----|
| PROJECT | | SHORT SPAN CULVERTS HIGHWAY 3 WIDENING GWP 315-98-00 | | | | |
| TITLE | | GRAIN SIZE DISTRIBUTION CLAYEY SILT (TILL) | | | | |
|  Golder Associates LONDON, ONTARIO | | PROJECT No. | 06-1130-177 | FILE No. | 06-1130-177-EE.GPJ | |
| | | DRAWN | WDF | Jan 10/07 | SCALE | N/A |
| | | CHECK | | | REV. | |
| | | FIGURE A-2 | | | | |

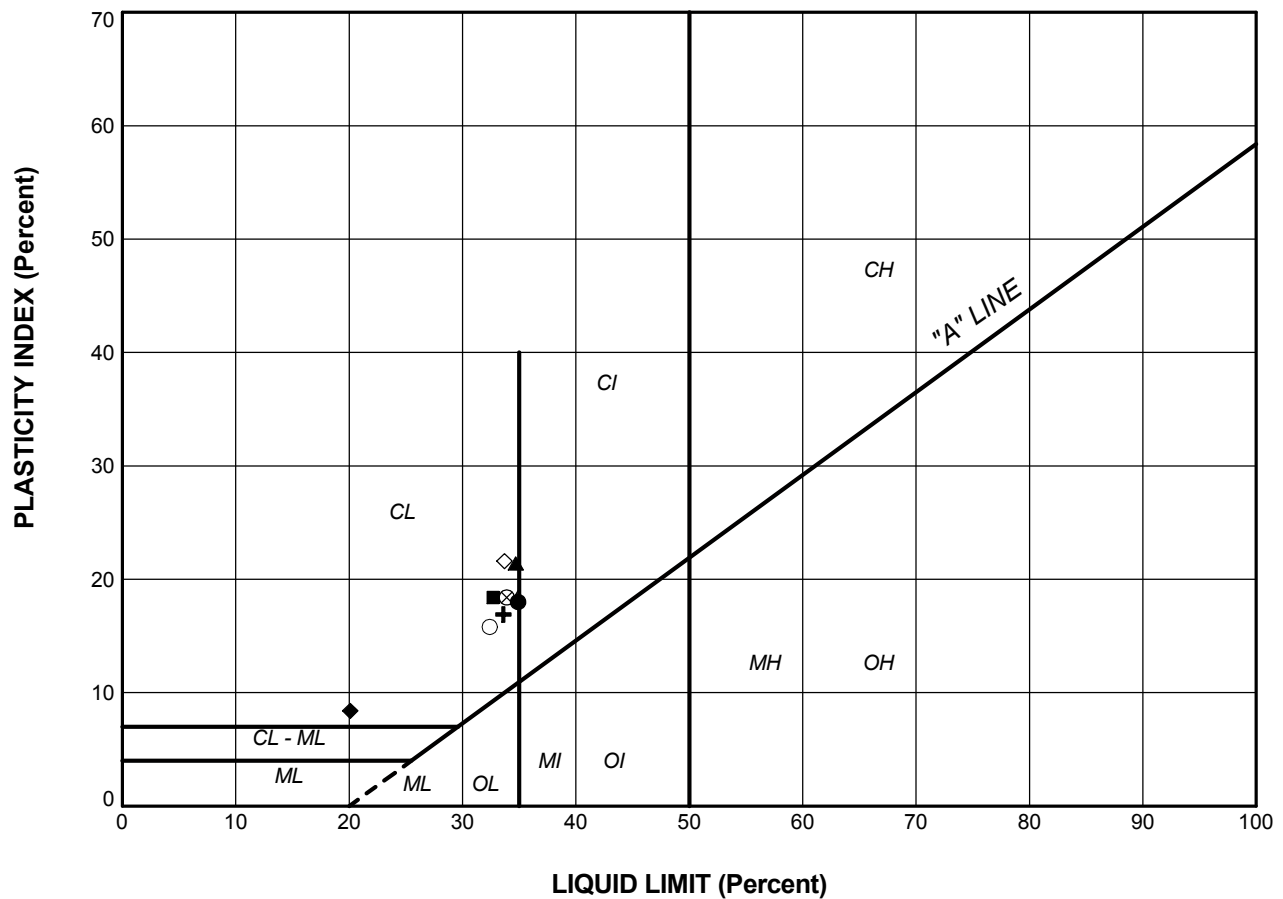


| | | | | | | |
|---------------|---------------|--------|--------|-------------|--------|----------------|
| CLAY AND SILT | SAND SIZE, mm | | | | | Cobble Size |
| | fine | medium | coarse | fine | coarse | |
| | SAND SIZE | | | GRAVEL SIZE | | |

LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEV (m) |
|--------|----------|--------|----------|
| ● | 105 | 3 | 190.9 |
| ■ | 106 | 5 | 190.3 |
| ▲ | 107 | 3 | 191.1 |
| + | 108 | 3 | 191.8 |
| ◆ | 108 | 6 | 189.6 |
| ◇ | 115 | 5 | 187.5 |

| | | | | | |
|---|--|--|--|-----------------------------|--|
| PROJECT | | SHORT SPAN CULVERTS HIGHWAY 3 WIDENING GWP 315-98-00 | | | |
| TITLE | | GRAIN SIZE DISTRIBUTION SILTY CLAY (TILL) | | | |
| PROJECT No. | | 06-1130-177 | | FILE No. 06-1130-177-EE.GPJ | |
| DRAWN | | WDF | | Jan 10/07 | |
| CHECK | | | | | |
|  Golder Associates LONDON, ONTARIO | | FIGURE A-3 | | | |

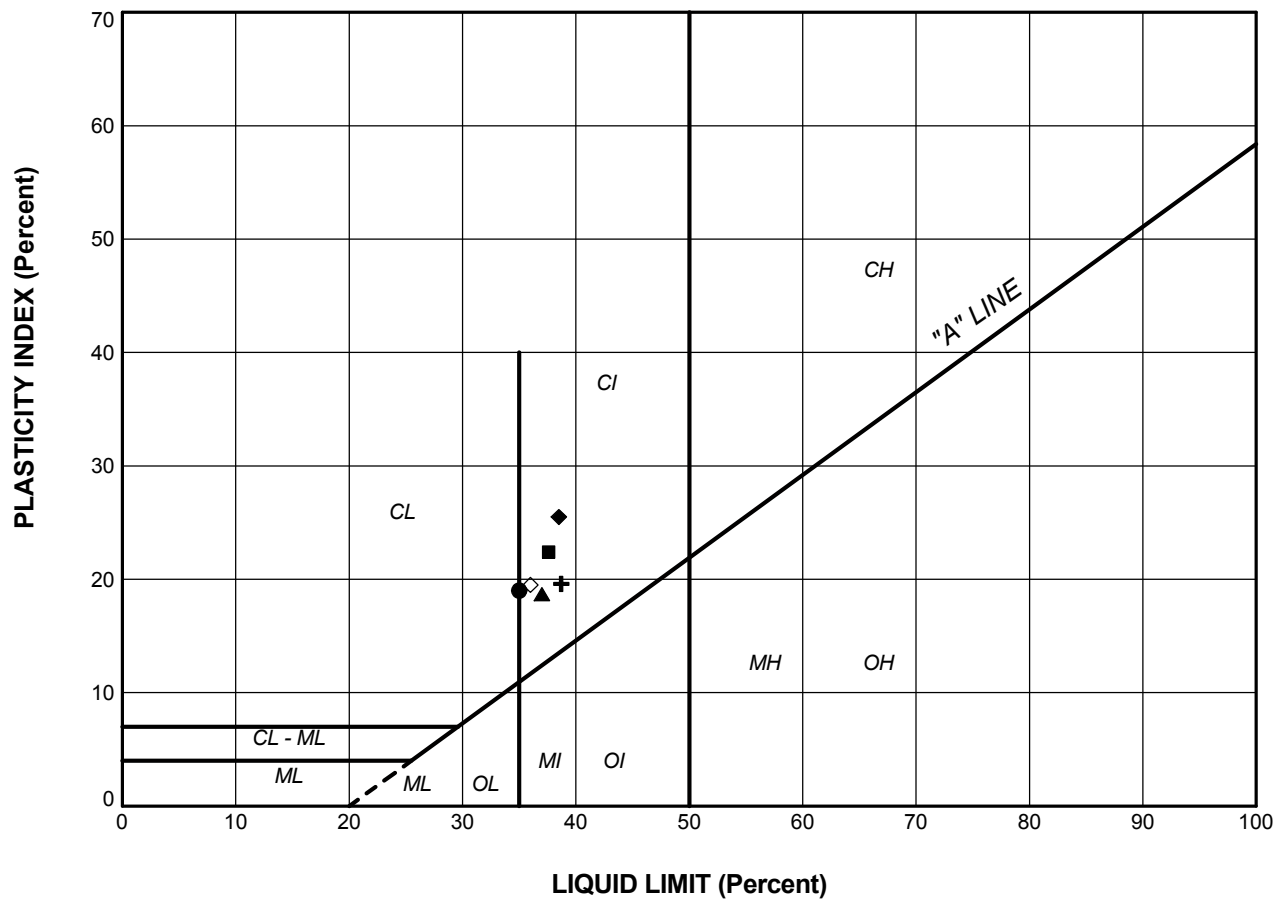



LEGEND

| SYMBOL | BOREHOLE | SAMPLE | LL(%) | PL(%) | PI |
|--------|----------|--------|-------|-------|------|
| ● | 101 | 4 | 34.9 | 16.9 | 18.0 |
| ■ | 102 | 6 | 32.7 | 14.3 | 18.4 |
| ▲ | 103 | 3 | 34.7 | 13.3 | 21.4 |
| + | 109 | 4 | 33.6 | 16.7 | 16.9 |
| ◆ | 110 | 5 | 20.1 | 11.7 | 8.4 |
| ◇ | 111 | 6 | 33.7 | 12.1 | 21.6 |
| ○ | 113 | 2 | 32.4 | 16.6 | 15.8 |
| △ | 114 | 4 | 34.9 | 16.5 | 18.4 |
| ⊗ | 116 | 3 | 33.9 | 15.5 | 18.4 |

| | | | |
|-------------------------|-----|--|-------------------|
| PROJECT | | SHORT SPAN CULVERTS HIGHWAY 3 WIDENING GWP 315-98-00 | |
| TITLE | | PLASTICITY CHART CLAYEY SILT (TILL) | |
| PROJECT No. 06-1130-177 | | FILE No. 06-1130-177-EE.GPJ | |
| DRAWN | WDF | Jan 10/07 | SCALE N/A REV. |
| CHECK | | | FIGURE A-4 |
| | | | |





| | | | |
|--|-------------|--|--------------------|
| PROJECT | | SHORT SPAN CULVERTS HIGHWAY 3 WIDENING GWP 315-98-00 | |
| TITLE | | PLASTICITY CHART SILTY CLAY (TILL) | |
| PROJECT No. | 06-1130-177 | FILE No. | 06-1130-177-EE.GPJ |
| DRAWN | WDF | Jan 10/07 | SCALE N/A |
| CHECK | | | REV. |
|  Golder Associates LONDON, ONTARIO | | | FIGURE A-5 |