FINAL REPORT
PRELIMINARY FOUNDATION INVESTIGATION
AND DESIGN REPORT
HWY 407 EAST EXTENSION – CENTRAL SECTION (EAST PART)
SIMCOE STREET NORTH TO COURTICE ROAD
REGION OF DURHAM
W.O. 07 – 20016

Geocres Number: 30M15-108

Prepared for:

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Thurber Engineering Ltd.

EXECUTIVE SUMMARY

The proposed Highway 407 East Extension extends from the current terminus of Highway 407 at Brock Road in the City of Pickering to Highway 35/115 in the Municipality of Clarington. For the purposes of preliminary design, the project route has been divided into three sections:

- the Western Section that extends from Brock Road in the City of Pickering to Ashburn Road in the Town of Whitby. This section includes a north-south link to Highway 401, designated the West Durham Link.
- the Central Section that extends from Ashburn Road to Courtice Road in the Municipality of Clarington (subsequently divided into west and east parts for the Implementation stage).
- the Eastern Section that extends from Courtice Road to Highway 35/115 in the Municipality of Clarington. This section includes a north-south link to Highway 401, designated the East Durham Link.

A Foundation Desktop Study was previously carried out in 2008 for each section of the proposed highway extension to assess the potential geotechnical conditions affecting foundation design at the sites of individual structures in advance of site-specific field investigation. The Desktop Study was based on assessment of site geology using air-photo interpretation and hydrogeologic information, as well as borehole data obtained from previous investigations including the preliminary investigations conducted by MTO in 1994 for planning purposes. The results of the 2008 desktop study were presented in three separate reports (*"Foundation Desktop Study, Highway 407 East Extension- Western Section; Central Section; Eastern Section"*, Thurber Engineering Ltd., October 2008).

This report is one of four Preliminary Foundation Investigation and Design Reports (FIDR) subsequently prepared for the Highway 407 East Extension. The preliminary investigation and design reports provide "as near as possible" preliminary design level foundation information for environmental assessment purposes and to assist planning, selection and preliminary design of foundations for bridge, culvert and grade separation structures, as well as for deep cuts and high fill embankments. The preliminary FIDR supercedes all previous reports including the Desktop Study for the purpose of preliminary foundation design and EA submission.

This particular report addresses the east part of the Central Section, from Simcoe Street North to Courtice Road. The Western, west part of the Central, and Eastern sections are dealt with in separate reports prepared by Golder Associates Ltd. and Thurber Engineering Ltd. The technically preferred alignment of the Central Section is shown on Figure 1 following the text of this report.

The report is presented in two parts:

Part A - Preliminary Foundation Investigation Report (FIR): presents an overall description of the project, description of the regional geology/geomorphology and general groundwater conditions within the project limits, as well as site-specific subsurface and groundwater conditions at each of the proposed structures, based on the results of limited borehole investigation and laboratory testing or on the desktop study information.

Part B - Preliminary Foundation Design Report (FDR): provides project-wide engineering recommendations for preliminary design, as well as site-specific preliminary foundation recommendations for each proposed structure, culvert, deep cut and high fill site.

As per the requirements of the Request for Proposal, each highway crossing (grade separation, bridge or culvert) was characterized as requiring a low, medium or high level of investigative effort. The target levels are defined in the RFP and summarized in Section 3.0 of this report. The desired investigative effort was attempted at each site; however, the target level could not be achieved at 4 out of 15 structure sites due to restricted access to private properties (no permission to enter).

For each medium and high level site where borehole information was obtained at or near the site, an individual Preliminary Foundation Investigation and Design Report (FIDR) was prepared. Each FIDR consisted of a Preliminary Foundation Investigation Report (FIR) sheet summarizing the results of the field investigation and geotechnical laboratory testing for the site, and a Preliminary Foundation Design Report (FDR) sheet presenting site-specific preliminary foundation design recommendations. The FIR and FDR sheets are presented following the text of the report.

Where permission to enter was not granted for a site, the information presented in the desktop study was utilized and the corresponding Anticipated Foundation Conditions (AFC) sheets are included in this report. AFC sheets for sites ranking a low level of investigative effort are also included.

For deep cut and high fill sections (depth/height greater than 4.5 m), summary tables have been included that summarize the deep cut and high fill locations, depths/heights, the anticipated subsurface conditions, and preliminary geotechnical recommendations. Foundation investigations were completed at 3 out of the 10 deep cut and high fill sections. The remaining 7 sections were not investigated due to lack of permission to enter.

While the information presented in this report may be used for planning and preliminary design purposes, it is not sufficient nor intended for detail design purposes. The preliminary subsurface investigation was limited to borehole drilling within accessible parts of sites where permission to enter was granted, or to desktop study level information. Where drilling was carried out, the boreholes were not necessarily drilled at or within the footprint of the foundation elements. As well, investigation was not possible at 4 of the structure sites due to lack of permission to enter. Accordingly, further investigation at the final locations of the foundation elements, approaches, deep cut and high fill sections will be required during detail design to establish detail design level subsurface information and confirm/reassess the preliminary recommendations.

TABLE OF CONTENTS

SECTION **PAGE**

LIST OF DRAWINGS

LIST OF APPENDICES

PART A

PRELIMINARY FOUNDATION INVESTIGATION REPORT
HIGHWAY 407 EAST EXTENSION – CENTRAL SECTION (EAST PART)
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Thurber Engineering Ltd.

1.0 INTRODUCTION

This report presents the factual findings obtained from a preliminary foundation investigation carried out by Thurber Engineering Ltd. (Thurber) for the preliminary design of the proposed Highway 407 East Extension - Central Section (East Part) from Simcoe Street North in Oshawa to Courtice Road in Clarington, Ontario.

The purpose of the preliminary investigation was to explore the subsurface conditions in the vicinity of the proposed grade separation structures, bridges, culverts, deep cuts, and high fills along the alignment of the proposed highway extension and, based on the data obtained, to provide borehole location and soil strata drawings, records of boreholes, laboratory test results and written descriptions of the subsurface conditions for the investigated structures.

Thurber carried out the investigation as a sub-consultant to AECOM Canada Ltd. (Totten Sims Hubicki acting as AECOM), under the Ministry of Transportation, Ontario (MTO) Purchase Order No. 2007-E-0041. The terms of reference and scope of work for the preliminary investigation and design are outlined in MTO's Request for Proposal (RFP) for Work Order No. 07-20016.

2.0 PROJECT DESCRIPTION

The technically recommended route for the Central Section of the proposed Highway 407 East Extension consists of an approximately 16 km long highway from Ashburn Road in Whitby to Courtice Road in Clarington. Phase One of the Implementation stage is to include the west part of the Central Section, from Ashburn Road in Whitby to Simcoe Street North in Oshawa. The remaining east part of the Central Section, is an approximately 10 km long section from Simcoe Street North in Oshawa to Courtice Road in Clarington.

The proposed Highway 407 Mainline route runs primarily through farmland, crossing a number of creek valleys, tributaries, and municipal and regional roads. The mainline section crosses the Lynde, West Oshawa and Oshawa Creek valleys. The overall surface topography is gently sloping downward to the east and south towards Lake Ontario.

Along the east part of the Central Section route there are a total of 15 structure sites, where the highway crosses roads or watercourses. These consist of 12 grade separation/bridge sites and 3 culvert sites. Each site includes one or more structure depending on the configuration of the crossing (e.g. twin bridge structures, interchange ramp grade separation, etc.). The location of each structure site is shown on Figure 1 – Key Location Plan.

Each structure is designated with a prefix of 'CM' for Central Mainline and a sequential number. For multiple structures at a site, a letter is added for additional structures in the group (eg. CM-17 and CM-17b are twin overpasses at the same site). The initial structure numbering system was retained for the preliminary foundation report, however a new structure numbering system was subsequently provided by AECOM for the Environmental Assessment submission. A cross-reference of site numbers is provided in Table 1, Section 4.2.

In addition to the grade separation, bridge and culvert structures, this report also addresses deep cuts or high fills along the proposed alignment. These are defined as sections where the depth of cut or height of fill exceeds 4.5 m. The deep cut and high fill sections are summarized on Table 2 in Section 4.2.

3.0 INVESTIGATION PROCEDURES

During the Desktop Study previously carried out by Thurber, each site was categorized as requiring either a low, medium or high level of investigative effort for the preliminary foundation investigation. The level of investigative effort was assigned by using existing geological information, available boreholes from previous investigations, and site photographs taken by Thurber, and was based on the anticipated soil conditions at the site as well as the type and span length of the structure.

Based on the level of investigative effort assigned to each structure site, the proposed number of boreholes for the preliminary foundation investigation was determined as specified in the RFP and summarized below:

- Low Level Investigative Effort: no borehole investigation required;
- Medium Level Investigative Effort: two representative boreholes at the site; and
- High Level Investigative Effort: four boreholes at strategic locations at the site.

During the course of the project, several structures were added, deleted or modified , which changed the structure category, configuration and target level of investigation. The structure designation, category, location and investigative effort applied during the preliminary investigation are summarized on Table 1 in Section 4.2.

The proposed number of boreholes for the deep cut and high fill sections was based on the length of the deep cut or high fill and the availability of existing information from boreholes drilled at adjacent structures.

It was not possible to drill all of the proposed boreholes due to lack of permission to enter (PTE) private properties to access the borehole locations.

The subsurface investigations were carried out during the period of December 2007 to April 2009, during which time a total of 37 boreholes were drilled for structure sites and 4 boreholes were drilled for deep cut and high fill sections. Due to a realignment of a portion of the highway route that occurred as the design progressed, three of the structure boreholes were drilled at locations that are no longer relevant to the proposed bridge sites. The borehole locations are shown on Drawings 19-2805-10-3 to 19-2805-10-5 relative to the proposed highway alignment and structure locations provided by AECOM.

Thurber measured the borehole locations and elevations in the field using a Trimble Pathfinder ProXRT GPS unit with an accuracy of +/- 0.5 m. The northing and easting coordinates were based on MTM NAD83, with the ground surface elevations referenced to the Geodetic datum. All borehole locations were checked for the presence of underground utilities prior to drilling.

The field investigation was carried out using truck-mounted and track-mounted drill rigs supplied and operated by DBW Drilling Ltd. of Ajax, Ontario. The boreholes were advanced using solid stem augers, hollow stem augers or mud rotary drilling techniques. Soil samples were obtained at selected intervals using a split spoon sampler in accordance with the Standard Penetration Test (SPT) procedure.

The boreholes drilled for the structure sites were advanced to competent strata and generally penetrated 3 m into 'refusal' material, defined as material with a minimum SPT value of 100 blows per 0.3 m penetration. The boreholes drilled for the deep cut sections were advanced to depths of 1.5 times the depth of the cut, and the boreholes for high fill sections were advanced to depths equal to the height of the fill or to competent material. The total depth of the boreholes ranged from 6.3 m to 26.0 m below the existing ground surface.

The groundwater conditions in the open boreholes were observed throughout the drilling operations. At each structure site and deep cut section where boreholes were drilled, at least one piezometer was installed in a selected borehole to permit longer term groundwater level monitoring. The piezometers consisted of 19 to 25 mm diameter PVC pipe with a 1.5 m long slotted screen installed and enclosed in filter sand. The annular space between the piezometer pipe and borehole wall above the filter sand was backfilled with bentonite.

A total of 22 piezometers were installed as part of the subsurface investigation for this section. The locations of the piezometers are listed on Table 3 in Section 4.3. All other boreholes were backfilled with bentonite to the ground surface on completion of drilling in accordance with Ontario Regulation 903 (as amended by Ontario Regulation 372/07). After the final water level readings, all piezometers were decommissioned in accordance with Ontario Regulation 903.

Where artesian groundwater conditions were encountered in the boreholes, the artesian condition was sealed at the source; details of the artesian condition and the sealing operations are included on the Record of Borehole sheets, where applicable.

The drilling and sampling operations were supervised on a full-time basis by a member of Thurber's technical staff. The supervisor logged the boreholes and processed the recovered soil samples for transport to Thurber's laboratory for further examination and testing.

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to gradation analysis and Atterberg limits testing. The results of the drilling and laboratory testing are shown on the Record of Borehole sheets in Appendix A and on the figures in Appendix B.

4.0 SITE GEOLOGY AND STRATIGRAPHY

4.1 Regional Geology

The alignment of the proposed Highway 407 East Extension – Central Section is situated within the Regional Municipality of Durham which encompasses three major physiographic regions – the Oak Ridges Moraine, the South Slope and the Iroquois Plain, as delineated in *The Physiography of Southern Ontario* and described below:

The South Slope region: the majority of the central mainline section lies within the South Slope region and is comprised of calcareous clay till with lacustrine clay and silt reworked by glaciers, with numerous scattered drumlins and deep valley cuts caused by streams flowing towards Lake Ontario.

The Oak Ridges Moraine region: located north of the central section alignment, and is comprised predominantly of sand and gravel deposits. The Oak Ridges Moraine is a major regional aquifer and groundwater recharge area.

The Iroquois Plain region: located south of the central section alignment and extending southward to Lake Ontario. The area across the Regional Municipality of Durham is a complex mix of till plains, drumlins and areas of glaciolacustrine sediments deposited in Lake Iroquois – primarily sands, silts and gravels.

The bedrock within the project area underlies thick overburden sediments throughout the analysis area and consists of blue-grey shale of the Blue Mountain Formation and limestone from the Lindsay Formation. The bedrock is described as providing a deep aquifer unit, where groundwater flow occurs through the bedding plane fractures.

4.2 Site-Specific Descriptions and Subsurface Conditions

Table 1 summarizes the structure sites, category (i.e. underpass, overpass or culvert), location, site ranking (level of investigative effort), and boreholes advanced at or adjacent to each site as part of the current and/or past investigations. Creek and floodplain crossings are also indicated, many of which are environmentally sensitive locations that will require special consideration in this regard during preliminary design (for example, Oshawa Creek tributary crossing). The table includes the new structure numbers (as of October 2009), cross-referenced with the structure numbers used for this foundation report, and the Watercourse IDs provided by AECOM.

For all medium or high ranking sites where boreholes were drilled during the current investigation, a Preliminary Foundation Investigation Report (FIR) sheet was produced, which summarizes the results of the field investigation and geotechnical laboratory testing for each structure and includes a borehole location plan and soil strata drawing. The FIR sheets are presented following the text of the report. Following each FIR sheet is a Preliminary Foundation Design Report (FDR) sheet that includes site specific preliminary foundation recommendations for each site, referenced in Part B of this report. In the case of any structure sites that were deleted after boreholes had been drilled (for example, CM-24), the FIR and FDR sheets have been included for information purposes.

For sites where PTE could not be obtained, no boreholes were drilled. For these sites, a copy of the corresponding Anticipated Foundations Conditions (AFC) sheet from the desktop study has been included in this report for reference. AFC sheets were not available for new structures added since the desktop study, and therefore no AFC or FIDR sheets are provided for new sites without PTE. Further foundation investigation is recommended at these sites when PTE is obtained.

A summary of the soil and groundwater conditions encountered at each site, together with site-specific drawings showing the borehole locations and stratigraphic profile, are presented on the individual Preliminary FIR sheets following the text of this report.

Table 1 – Structure Summary

New Structure No.	Structure No. used for Foundation Report	Watercourse ID	Category	Location	Site Ranking	Borehole Nos.	Remarks
M-54	CM-16	CM-TA1OCW-34	Culvert	Oshawa Creek Tributary (Bridle Road)	Medium	CM16-1, CM16-2	Refer to FIDR sheet[3]
M-55	CM-17 / 17b	CM-EBOC-35	Overpass	Ritson Road and Oshawa Creek East Branch West Tributary	High	CM17-1/1a, CM17-2, CM17-3/3a, CM17-4, CM17-5, CM17b-1, CM17b-2, CM17b-3, CM17b-4	Refer to FIDR sheet
M-56	CM-18	CM-TCEBOC-36	Culvert	Oshawa Creek East Branch Tributary	Medium	CM18-1, CM18-2	Refer to FIDR sheet[3]
M-57	CM-20 / 20b	CM-TEEBOC-38	Overpass	Oshawa Creek East Branch East Tributary (Mainline)	Medium	CM20-2a, CM20b-2, CM20b-3, CM20b-4	Refer to FIDR sheet
M-58	CM-20c	CM-TEEBOC-38	Overpass	Oshawa Creek East Branch East Tributary (W-N/S Ramp)	Medium	CM20c-3	Refer to FIDR sheet
M-59	CM-21 / 21b	-	Overpass	Harmony Road	Medium	CM21-1, CM21-2, CM21b-1, CM21b-3	Refer to FIDR sheet
M-60	CM-23	-	Underpass	Winchester Road East	Medium	CM23-1, CM23-2	Refer to FIDR sheet[3]
Deleted	CM-24	-	Underpass	Townline Road	Medium	CM24-3, CM24-4	Refer to FIDR sheet – Structure deleted
M-61	CM-25 / 25b	CM-HC-54	Overpass	Harmony Creek	Medium	-	No PTE / New Structure – no Desktop (AFC) or FIDR sheet
M-62	CM-26	CM-HC-56	Culvert	Harmony Creek	Medium	-	No PTE – Refer to copy of AFC sheet from Desktop Study[3]
M-63	CM-27	-	Underpass	Langmaid Road	Medium	CM27-1, CM27-2	Refer to FIDR sheet[3]
M-64	CM-28	-	Underpass	Concession Road 6	Medium	CM28-1, CM28-2	Refer to FIDR sheet[3]
M-65	CM-29 / 29b	-	Overpass	Enfield Road	Medium	CM29-1, CM29b-1	Refer to FIDR sheet
M-66	CM-29c	-	Overpass	Enfield Road / Concession Road 6	Medium	-	No PTE / New Structure – no Desktop (AFC) or FIDR sheet
M-67	CM-29d	CM-FC-57	Overpass	Farewell Creek – Crossing Enfield Road	Medium	CM29d-1, CM29d-2	Refer to FIDR sheet
M-68	CM-29e	CM-FC-57b	Overpass	Farewell Creek – Crossing Concession Link Road	Medium	-	No PTE / New Structure – no Desktop (AFC) or FIDR sheet

[1] MTO Geocres No. 30M14-227
[2] MTO Geocres No. 30M15-85
[3] Structure category, configuration or level of investigative effort changed since Desktop Study

Table 2 summarizes the sections where the proposed highway is to be constructed in a deep cut or as a high fill. The table shows the cut (DC) or fill (HF) number, locations (station to station), maximum cut depth or fill height, and the boreholes advanced as part of the current investigation. At 7 deep cut and high fill sections, it was not possible to drill any boreholes due to lack of permission to enter (PTE) private properties. Wherever possible, borehole information from the adjacent structures has been used to provide recommendations.

The subsurface conditions at the deep cut and high fill sections are summarized in the Preliminary Foundation Investigation Report "Deep Cuts" and "High Fills" tables following the FIDR sheets for the structures. Where relevant borehole information was not available within reasonable distance from the cut/fill section, the Terrain/Drainage Maps (prepared by AECOM based on air-photo interpretation) provided in the Foundation Desktop Study and the Geologic Cross-Sections provided in the *Foundation Investigation Report For Environmental Assessment (Hydrogeology Specialty)* prepared by AECOM were used to interpret anticipated subsurface conditions.

Table 2 – Deep Cut and High Fill Summary

Deep Cut (DC) or High Fill (HF) Number	Station (From – To)	Maximum Cut Depth or Fill Height	Borehole Nos.
HF-C5	18+380 to 18+500	9	-
HF-C6	20+200 to 20+630	14	-
DC-C4	20+850 to 21+100	5.5	CCM-3
DC-C5	21+460 to 21+700	9	CCM-4
DC-C9	21+940 to 22+060	6	-
HF-C9	22+600 to 23+160	9	-
DC-C6	23+400 to 23+670	5.5	CCM-5, CCM-6
HF-C7	24+030 to 24+220	8.5	-
DC-C7	24+350 to 25+080	7	-
HF-C8	25+260 to 25+440	7	-

The detailed subsurface soil and groundwater conditions as encountered in the boreholes advanced during this investigation, and the results of geotechnical laboratory tests carried out on selected soil samples, are given on the Record of Borehole sheets included in Appendix A and on the laboratory test result figures included in Appendix B. A copy of the referenced borehole logs from the 1994 MTO investigations located along the Highway 407 alignment in this section are provided in Appendix C and approximate locations (converted to MTM NAD 83 coordinates) are shown on Drawings 19-2805-10-3 to 19-2805-10-5.

It should be noted that 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. Subsurface conditions will vary between and beyond the borehole locations.

4.3 General Groundwater Conditions

The water level was observed in open boreholes at the time of drilling, and standpipe piezometers were installed at 22 borehole locations as part of the current investigation for the project. Details of the piezometer installation and history of water levels measured in the boreholes are shown on the Record of Borehole sheets in Appendix A. Details of the site-specific groundwater conditions at each site are provided on the Preliminary FIR sheets, following the text of this report.

The groundwater levels measured in the piezometers generally range from ground surface to 11 m below ground surface, typically about 0.1 to 5.0 m below the ground surface. The most recent water levels measured in the piezometers are summarized in Table 3.

Artesian groundwater conditions were encountered during drilling at the crossing of the Oshawa Creek valley (Site CM-17/17b, Borehole CM17-5). Artesian pressure of about 3.7 m above the ground surface was observed after drilling to 20.4 m depth (Elev. 151.1 m) in a gravelly sand deposit overlain by a cohesive layer. The borehole was sealed with bentonite and cement.

An artesian condition was also encountered after advancing Borehole CM29d-2 to 25.9 m depth (Elev. 172.4 m) at the Enfield Road crossing of Farewell Creek. The groundwater level was 0.7 m above the ground surface 45 minutes after encountering the artesian zone. The borehole was sealed with bentonite and cement.

Groundwater levels are expected to fluctuate as a result of seasonal variations in precipitation and runoff.

Table 3 – Water Level Measurements

Borehole Number	Ground Surface Elevation (m)	Depth to Water Level below Ground Surface (m)	Water Level Elevation (m)	Date
CM16-2	182.4	0.9	181.5	June 4, 2009
CM17-1	173.4	1.7	171.7	July 28, 2008
CM17b-2	177.2	0.3	176.9	February 12, 2009
CM17b-3	170.7	0.1	170.6	July 28, 2008
CM17b-4	184.7	3.7	181.0	February 10, 2009
CM18-1	178.5	0.0	178.5	May 4, 2009
CM20-2a	203.9	0.4	203.5	February 12, 2009
CM20b-2	210.8	0.4	210.4	February 12, 2009
CM20c-3	203.7	1.3	202.4	June 6, 2009
CM21-2	221.1	0.1	221.0	July 28, 2008
CM21b-1	216.8	0.7	216.1	July 28, 2008
CM21b-3	218.2	0.6	217.6	February 12, 2009
CM23-2	237.2	1.8	235.4	July 21, 2009
CM23b-2	230.7	8.0	222.7	July 28, 2008
CM24-1	218.9	5.8	213.1	June 26, 2008
CM24-4	224.6	10.9	213.7	June 26, 2008
CM27-1	208.9	10.6	198.3	April 30, 2009
CM28-1	211.7	2.7	209.0	July 21, 2009
CM29b-1	204.7	4.3	200.4	August 27, 2008
CCM3	237.1	3.4	233.7	February 10, 2009
CCM4	238.4	2.9	235.5	February 12, 2009
CCM6	217.6	2.3	215.3	December 10, 2008

5.0 CLOSURE

This Preliminary Foundation Investigation Report was prepared by Mr. Mark Farrant, P.Eng. Mr. Farrant and Mr. Alastair Gorman, P.Eng. directed the field operations. The report was reviewed by Mr. Gorman and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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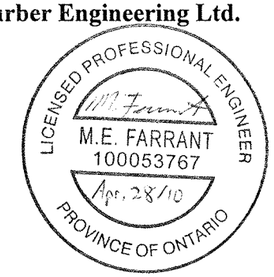
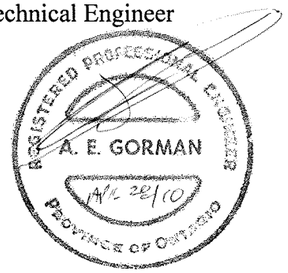
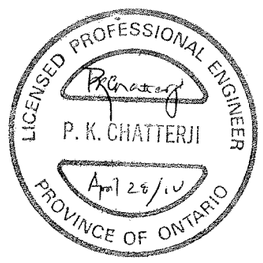


Mark Farrant, P.Eng.
Geotechnical Engineer



Alastair Gorman, P.Eng.
Associate, Senior Foundations Engineer



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Review Principal, Designated MTO Contact

PART B

PRELIMINARY FOUNDATION DESIGN REPORT
HIGHWAY 407 EAST EXTENSION – CENTRAL SECTION (EAST PART)
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6.0 ENGINEERING RECOMMENDATIONS FOR PRELIMINARY DESIGN

6.1 General

This section of the report provides preliminary geotechnical recommendations to assist selection and preliminary design of foundation systems for the proposed bridge and grade separation structures along the Highway 407 East Extension-Central Section (West Part) mainline route. Preliminary geotechnical recommendations for the design of culverts are discussed in Section 7.0. Recommendations for deep cut and high fill sections are discussed in Section 8.0.

The preliminary foundation design recommendations provided herein are based on interpretation of the factual data obtained during limited borehole investigations conducted for the current study as well as boreholes available from previous MTO investigations.

The current subsurface investigation was generally limited to borehole drilling within accessible areas of the structure sites, but not necessarily within the footprint of the foundation elements. Further investigation at the final locations of the foundation elements and approaches will be required during detail design to establish detail design level subsurface information and confirm/reassess the preliminary design recommendations.

The interpretation and recommendations are intended to provide the designers with preliminary information to assess feasible foundation alternatives for the preliminary design of the proposed structure foundations. Where provided, comments regarding construction are presented to highlight aspects which could affect the preliminary design, and for which special provisions or operational constraints could potentially be required.

6.2 Structure Foundation Recommendations

As discussed in Section 2.0, 15 bridge and grade separation structures are currently proposed for the Highway 407 central section mainline (east part). Preliminary foundation recommendations for each individual site are provided following the text of this report, in the following forms:

- Where boreholes were advanced, individual Preliminary Foundation Investigation and Design Report (FIDR) sheets were prepared, including a description of the proposed structure configuration at the time of preparation of this report. Part B of the FIDR sheets, referred to as the Preliminary Foundation Design Report (FDR), presents the preliminary foundation recommendations.
- Where borehole information to meet the desired level of investigative effort could not be obtained due to lack of permission to enter, copies of the Anticipated Foundation Conditions (AFC) sheets from the Desktop Study are presented.

The FDR sheets provide a comparison of the advantages and disadvantages of the various foundation alternatives for each site, recommendations for preliminary design of the feasible foundation types, and a recommendation regarding the preferred foundation alternative from a geotechnical viewpoint. Site-specific comments concerning the abutment type, approaches, construction considerations, and recommendations for additional work are also presented.

The following subsections of the report provide project-wide recommendations generally applicable to all structure sites, including design assumptions and limitations associated with the recommendations provided in the Preliminary Foundation Design Report sheets.

The foundation design for all highway structures must be carried out in accordance with the latest Canadian Highway Bridge Design Code (CHBDC) requirements. Design of railway grade separations must also be carried out in conformance with the local railway authority requirements and American Railway Engineering and Maintenance-of-Way Association (AREMA) code.

6.2.1 Spread Footings

Preliminary foundation recommendations for spread footings on native undisturbed soil or on a compacted Granular 'A' pad 'perched' within the structure approaches are provided where subsoil conditions are considered to be suitable for shallow foundations, as indicated on the individual Preliminary FDR sheets for each site.

For spread footings placed (or perched) within the approach embankments on a compacted Granular 'A' core, the geotechnical resistance values provided in the FDR sheets assume a minimum 2 m thickness of Granular 'A' is placed below the base of the footing. The Granular 'A' core should extend at least 1 m beyond the plan limits of the footing and be sloped no steeper than 1 Horizontal to 1 Vertical (1H:1V) in general accordance with MTO guidelines (See Figure 2). The Granular 'A' core should be compacted to 100% of its standard Proctor maximum dry density at ±2% of optimum moisture content.

Preliminary geotechnical resistance values for spread footings are provided for factored Ultimate Limit States (ULS) and at Serviceability Limit States (SLS) for 25 mm of settlement assuming a 3 m wide footing. The preliminary values are for vertical, concentric loads. In accordance with Sections 6.7.3 and 6.7.4 of the *Canadian Highway Bridge Design Code* (CHBDC 2006), the design must also account for the effects of any eccentric or inclined loads. The resistance values should be re-evaluated and modified

if necessary during detail design based on additional subsurface investigation at the locations of the foundation elements.

Resistance to lateral forces / sliding resistance between the concrete footings and the subgrade should be calculated in accordance with Section 6.7.5 of the *CHBDC (2006)*.

All footings should be provided with a minimum of 1.2 m of soil cover or equivalent thickness of insulation for frost protection (OPSD 3090.101).

6.2.2 Steel H-Piles

Preliminary recommendations for steel H-piles, assuming an HP 310 x 110 pile section, are provided on the individual Preliminary FDR sheets for sites where pile foundations are considered practical. The factored geotechnical axial resistance at Ultimate Limit States (ULS) and the geotechnical axial reaction at Serviceability Limit States (SLS) for 25 mm of displacement are provided, along with the anticipated pile depth/pile tip elevation based on the subsurface conditions encountered.

The factored ULS resistance, SLS reaction values and pile tip elevations should be re-evaluated during the detail design stage in consideration of additional subsurface data obtained during investigation at the locations of each foundation element.

The pile tip elevations are provided for preliminary estimating purposes only. The actual pile tip elevations will be controlled in the field by use of the Hiley formula. Pile installation should be in accordance with MTO's Special Provision SP903S01 and Standard Structural Drawing SS103-11 using an ultimate geotechnical resistance of two times the factored ULS design load. The pile termination or set criteria will be dependent on the pile driving hammer type, helmet, selected pile size and length of pile.

Where downdrag loads are indicated on the FDR sheets, the structural design of the piles should include a check to confirm that the factored permanent loads plus downdrag loads do not exceed the factored below-ground structural resistance of the pile at the neutral plane (CHBDC Section 6.8.4 and Commentary).

Resistance to lateral loading can be derived using vertical piles, with enhanced support offered by battered piles, if required. For vertical piles, the resistance to lateral loading will be derived solely from the soil in front of the piles, whereas battered piles derive lateral resistance from the soil in front of the piles as well as the horizontal component of the axial load present in the inclined pile. The resistance to lateral loading in front of the pile and pile group action for lateral loading if the pile spacing in the direction of loading is less than six to eight pile diameters, should be accounted for and assessed during the detail design phase of the project. For preliminary design, lateral resistance values at factored ULS and reaction values at SLS for a lateral displacement of 10 mm at the pile head for a single vertical steel H-pile embedded in typical soil profiles are provided in Table C6.4 of the CHBDC *Commentary* (2006).

All pile caps should be provided with a minimum of 1.2 m of soil cover or equivalent thickness of insulation for frost protection (OPSD 3090.101).

Where very dense or hard soils are present (SPT N-values exceeding 100 blows), pre-augering may be required to provide an adequate length of pile.

Till deposits often contain cobbles and boulders, and the potential exists that these will be encountered during pile installation. Where applicable, the piles should be reinforced with driving shoes as per OPSD 3000.100 for protection during driving. Pile installation and driving shoes should be in accordance with Special Provision SP903S01.

Where artesian groundwater conditions are present, specialized construction techniques will be required to mitigate the upward flow of water along the pile shaft. Such measures may include driving the piles within a large diameter liner filled with water to counteract artesian head, and provision of an impermeable plug and granular drainage layer. Specialized measures may also be required to minimize disturbance in sensitive wetland areas. Sites with artesian conditions should be extensively investigated and foundation installation procedures re-assessed during detail design.

6.2.3 Caissons

Preliminary foundation recommendations for caissons founded within "100-blow" deposits are provided on the individual Preliminary FDR sheets where caissons are considered to be a practical foundation alternative.

The factored geotechnical axial resistance at Ultimate Limit States (ULS) and the geotechnical axial reaction at Serviceability Limit States (SLS) for 25 mm of displacement are provided for caisson diameters equal to 1.2 and 1.5 m. The geotechnical resistance values are associated with a recommended caisson base elevation and/or embedment depth into the "100-blow" material, as the caisson will typically derive the majority of its capacity from base resistance. Shaft resistance has also been taken into account assuming permanent steel liners are required.

The factored ULS resistance and SLS reaction values should be re-evaluated during the detail design stage in consideration of additional subsurface data obtained during detailed investigation at the locations of each foundation element.

The resistance to lateral loading developed by the soils in front of the caissons (assuming vertical caissons) and the reductions due to group effects should be accounted for and assessed during the detail design phase of the project.

In general, the use of caisson foundations has not been recommended at locations where water-bearing cohesionless strata are anticipated, due to the potential for caving of the caisson sidewalls or instability or boiling at the caisson base. Where caisson foundations are considered, temporary or permanent caisson liners may be required to support cohesionless soils below the groundwater level and permit cleaning and inspection of the caisson base. Installation procedures, such as maintaining a constant head of water/drilling mud inside the caisson followed by tremied concrete placement, may also be required. Caissons should not be founded in cohesionless soils with artesian water conditions.

Where the caissons are relatively long, temporary liners may be difficult to withdraw due to the length of the liners and the typically hard/very dense nature of the "100-blow" material in which the caissons are installed. In such cases, permanent liners would be preferred for the construction of the caissons, and the reduced shaft resistance (i.e. due to the smooth liner/soil interface) has been considered in the preliminary geotechnical resistance values provided in the FDR sheets. The use of permanent liners should be re-assessed and geotechnical resistance values revised, if necessary, when the caisson installation method has been determined during detail design.

Cobbles and/or boulders may be encountered within the till deposits as indicated in the FDR sheets. Caisson drilling equipment must be capable of penetrating such obstacles, where applicable.

Pile caps for caissons, as applicable, should be provided with a minimum of 1.2 m of soil cover or equivalent thickness of insulation for frost protection (OPSD 3090.101).

6.3 Abutment and Retaining Walls

Comments regarding the suitability of conventional, semi-integral or integral abutment types at each site are presented on the Preliminary FDR sheets. Abutment walls and associated retaining/wing walls may consist of either of the following:

- Concrete retaining walls supported on spread footings or on deep foundations depending on the site-specific subsoil conditions as discussed on the FDR sheets. The preliminary foundation recommendations for this type of retaining wall can be considered similar to those provided for the structure foundation elements.

- Retained Soil System (RSS) walls founded on soils that will limit settlements to tolerable levels and provide an adequate factor of safety against global instability. In general, RSS walls should be specified to be "High Performance" and "High Appearance".

The performance of a RSS is dependent on, among other factors, the characteristics of its foundation. To provide an acceptable foundation performance, the RSS mass must be founded on competent native soils or on engineered fill consisting of OPSS Granular "A" material. Topsoil, alluvium, loose fill, and any soft/wet native material should be stripped from the footprint of the RSS. The entire block of reinforced earth must be designed against various modes of failure including sliding and overturning, and the global stability must be analyzed after the location of the wall is known.

For sites where settlement of the approach fill has been identified as a potential issue (i.e. where soft cohesive deposits were encountered), the selected wall type and impact of approach fill settlement on the retaining wall must be assessed. The preferred settlement mitigation option is site specific and should be confirmed when additional soil information and project scheduling is known during detail design.

6.4 Lateral Earth Pressures for Design

The lateral earth pressures acting on abutment walls and any associated retaining walls/wing walls will depend on the type and method of placement of the backfill materials, the nature of the soils behind the backfill, the magnitude of surcharge including construction loadings, the freedom of lateral movement of the structure, as well as the drainage conditions behind the walls.

The following general recommendations are made concerning the design of the walls. It should be noted that these recommendations and parameters assume a level backfill and ground surface behind the walls. Where there is sloping ground behind the walls, the coefficient of lateral earth pressure must be adjusted to account for the slope in accordance with Section C6.9.1 of the CHBDC (2006).

- Select free-draining granular fill meeting the specifications of Ontario Provincial Standard Specifications (OPSS 1010) Granular 'A' or Granular 'B' Type II but with less than 5 per cent passing the 200 sieve should be used as backfill behind the walls. This fill should be compacted in accordance with Special Provision SP 105S10. Backfill, subdrain and frost taper requirements must be in accordance with OPSD 3101.150 and 3121.150.

- For the case where the pressures are based on granular fill behind the wall, the following parameters may be assumed:

	GRANULAR 'A'	GRANULAR 'B' TYPE II
Soil Unit Weight:	22 kN/m^3	21 kN/m^3
Coefficients of Static Lateral Earth Pressure:		
Active, K_a	0.27	0.27
At Rest, K_o	0.43	0.43

- For the case where the pressures are based on existing materials behind the wall, the required parameters for design should be assessed on a site-by-site basis during detail design.

- If the wall support and superstructure allow lateral yielding of the abutment stem and retaining walls, active earth pressures may be used in the geotechnical design of the structure. If the abutment support does not allow lateral yielding, at-rest earth pressures should be assumed for geotechnical design. The movement to allow active pressures to develop within the backfill, and thereby assume an unrestrained structure, may be taken as:
    - Rotation of approximately 0.002 about the base of a vertical wall;
    - Horizontal translation of 0.001 times the height of the wall; or
    - A combination of both.

- A minimum compaction surcharge of 12 kPa should be included in the lateral earth pressures for the structural design of the wall stem, in accordance with Section 6.9.3 and Figure 6.6 of the CHBDC (2006). Compaction equipment should be used in accordance with SP 105S10. Other surcharge loadings should be accounted for in the design, as required.

6.5 Structure Approaches

Based on the available information provided at each site, recommendations associated with the approach stability and settlement are provided on the individual Preliminary Foundation Design Report sheets following the text of this report. The following subsections provide additional generic recommendations associated with the preliminary design and construction of the approaches.

6.5.1 Subgrade Preparation and Embankment Construction

It is recommended that all topsoil and organic material be stripped from the proposed embankment footprint. The depth and extent of stripped material should be determined during detail design when additional subsurface information is available. Particular attention will be required in low floodplain areas where thicker layers of organic/alluvial soils may be present.

After stripping of organics, the exposed subgrade should be proofrolled to identify any loose/softened areas requiring subexcavation or additional compaction prior to fill placement.

Embankment fill should be placed and compacted in accordance with MTO's SP 206S03 and SP 105S10. New embankment fill placed against existing embankment slopes or on a sloping ground surface should be benched into the existing slope in accordance with OPSD 208.010.

Where approach cuts extend below the groundwater table, the design must include measures to stabilize the cut slope face if instability is experienced. Further comments in this regard are presented in Section 8.0.

To reduce erosion of the embankment side slopes due to surface water runoff, placement of topsoil and seeding or pegged sod is recommended as soon as practicable after construction of the embankments. The erosion protection must be in accordance with OPSS 572.

6.5.2 Approach Embankment Stability

Preliminary assessment of the stability of the approach embankments at selected sites was carried out based on limit equilibrium analysis using the commercially available slope stability program GSLOPE developed by Mitre Software Inc. Bishop's modified method of slices was employed.

The analyses were based on soil profiles deduced from the current limited borehole data and existing information, and the maximum embankment heights indicated by profile and general arrangement drawings available at the time of the analysis. Approach embankment side slopes no steeper than 2H:1V, with a minimum 2 m wide mid-slope bench for embankment heights greater than 8 m, were assumed. Where designated as safe against deep-seated slope instability, a target factor of safety of 1.3 under static conditions is implied, assuming appropriate subgrade preparation and proper placement and compaction of embankment fill materials. Assessment of the overall stability of the embankment side slopes under seismic conditions is discussed in Section 6.6.

For embankment slopes higher than 8 m, the minimum requirement is to provide a 2 m wide mid-height bench in order to control surficial erosion and improve stability.

The preliminary assessment of stability of the approach slopes should be reviewed and confirmed based on the actual subsoil conditions encountered within the proposed embankment footprint during the detail design investigation. Mitigation measures to improve slope stability if required may include slope flattening, utilizing light weight fill materials, staged construction, or a combination of these options.

6.5.3 Approach Embankment Settlement

Settlement of the approach embankments will occur due to compression and consolidation of the foundation soils under the weight of the overlying fill material as well as from compression of the embankment fill itself. The total settlement within the founding soils has been estimated using elastic analysis and Terzaghi one-dimensional consolidation theory, based on the site-specific subsoil conditions deduced from the borehole data and the maximum embankment heights indicated by profile and general arrangement drawings available at the time of the analysis.

Where the estimated embankment settlement exceeds 25 mm, the computed value is indicated on the Preliminary Foundation Design Report sheet for the particular site. For preliminary design, acceptable settlement values are assumed to be less than 25 mm at or near structure locations; however, the highway design criteria will be site specific and based on maintenance considerations at the detail design stage.

The preliminary estimates do not include compression of the embankment fill itself, which would occur during and after the construction of embankment depending on the type of materials used. The magnitude of fill compression usually ranges from 1% to 2% of the height of embankment. Where granular fill is used for embankment construction, settlement of the fill itself is expected to occur during or shortly after completion of embankment construction. Non-granular earth fill or rock fill materials may exhibit additional consolidation settlement over time.

Embankment and platform width design should allow for the anticipated settlements.

Further analyses should be carried out during detail design to confirm the anticipated magnitude of settlement, assess the time rate of post-construction settlement, and develop mitigation measures such as preloading, surcharging or use of light weight fill to reduce anticipated settlements to acceptable levels where necessary.

6.6 Seismic Considerations

The peak zonal acceleration ratio for the project site is 0.05 g as per The Town of Oshawa, Ontario (CHBDC Table A3.1.1). The Site Coefficient, S, will be based on the type of soils encountered at the founding level at each site (to be determined during detailed design) in accordance with Section 4.4.6 and Table 4.4 of the CHBDC (2006).

Seismic (earthquake) loading on the abutment stem and retaining/wing wall must be considered in the design of the foundations in accordance with Sections 4 and 6 of CHBDC (2006). The walls should be designed to withstand the combined lateral loading for the appropriate static pressure conditions plus the applicable earthquake-induced dynamic earth pressure conditions (see Section 24.9 of CFEM). The static and seismic earth pressure coefficients can be determined in accordance with Sections 6.9 and 4.6.4 of the CHBDC (2006) and its Commentary.

The susceptibility to liquefaction of the soil deposits underlying the proposed embankments (and foundations) and the consequent stability of the embankments under seismic loading conditions should be assessed during the detail design stage in accordance with Sections C.4.6.2 and C.4.6.3, respectively, of the CHBDC Commentary (2006).

6.7 Construction Considerations

6.7.1 Obstructions During Pile Driving / Caisson Installation

Glacial till often contains cobbles and/or boulders that may be encountered during installation of steel piles or drilled caissons. Accordingly, pile driving shoes as per OPSD 3000.100 have been recommended for tip protection during driving in till. In addition, caisson drilling rigs must be capable of dislodging and removing cobbles and boulders. An NSSP will be required in the Contract Documents during detail design to inform the contractor of the possible presence of cobbles and boulders.

6.7.2 Excavation and Backfill

Preliminary comments regarding open-cut excavations for foundation construction are provided on a site-specific basis on the Preliminary Foundation Design Report sheets. The soil type classification as per the Occupational Health and Safety Act (OHSA), as well as the recommended maximum side slope inclination for temporary excavations, are provided for the conditions anticipated within the foundation excavations. All backfill is to be placed and compacted in accordance with SP 105S10.

6.7.3 Groundwater and Surface Water Control

The anticipated groundwater conditions and requirements for groundwater and surface water control measures at each site are presented on the Preliminary Foundation Design Report sheets. The comments regarding groundwater control are based on the groundwater levels observed in the boreholes and the anticipated excavation depth required to construct the recommended foundation type.

At locations where near surface cohesionless soils and a high water table are present, prior dewatering will be required to accommodate foundation construction in a dry condition. For footing or pile cap construction in floodplains with a high groundwater table, no excavation should be undertaken without prior dewatering. Alternatively, the excavation should be carried out within the confines of a properly designed sheet pile cofferdam. For these sites, a Non-Standard Special Provision (NSSP) will be required for inclusion in the Contract Documents.

Caissons constructed with temporary or permanent liners and founded in cohesionless subsoils subjected to unbalanced hydrostatic head will require special measures to prevent 'boiling' or basal heave of the base materials. If caisson foundations are adopted for such a site, it is recommended that a constant head of water be maintained inside the caisson liners to counterbalance the natural groundwater pressures. Concrete placement by tremie may be considered. Caissons should not be founded in cohesionless soils with artesian water conditions.

For other deep foundations installed where artesian conditions are expected, it is recommended that a sand filter, possibly in combination with a geotextile, be placed beneath the pile caps to prevent the migration of fines that may be transported along the piles or caisson liner during and after construction. Preliminary recommendations for such conditions (where considered practical) are given on the site-specific Preliminary Foundation Design report sheets. Sites with artesian conditions should be extensively investigated and foundation installation procedures re-assessed during detail design.

General site drainage should be by gravity towards an outlet at a lower elevation and/or pumping.

The need for a Permit to Take Water (PTTW) should be assessed at each specific site during detail design.

6.7.4 Protection Systems

Excavation support systems may be required for temporary roadway protection during foundation construction. The temporary excavation support system should be designed and constructed in accordance with Special Provision 105S19. In general, the lateral movement of the temporary shoring system should meet Performance Level 2 as specified in SP 105S19. Performance Level 1 may be required adjacent to railways.

6.7.5 Construction Access

Environmentally sensitive creek valley crossings have been identified during the environmental assessment of the project. Potential environmental impacts will need to be minimized during construction access in the sensitive floodplains. Specific access preparation procedures such as the use of temporary work bridges, winter construction and/or gravel roadways underlain by geosynthetics should be considered to accommodate foundation construction at these locations.

7.0 CULVERTS

All culvert sites with spans exceeding 6 m were classified as medium level effort sites. Where PTE was obtained, field investigations were conducted and FIDR sheets have been prepared.

Where PTE was not obtained, no site specific borehole investigations have been carried out, and therefore, copies of the Anticipated Foundation Conditions (AFC) sheets prepared during the Desktop Study are provided.

The AFC and FIDR sheets for the culverts are included with the FIDR sheets for the other structures at the end of this report. The preliminary project-wide recommendations presented in Section 6.0 are generally applicable to the culvert sites.

8.0 DEEP CUTS AND HIGH FILLS

8.1 General

This section of the report provides geotechnical recommendations for preliminary design of deep cuts and high fill sections where the depth/height exceeds 4.5 m. Based on the roadway profiles available at the time of analysis (February 2009), deep cuts have been identified at five locations and high fills were identified at five locations. The locations and maximum depth/height are summarized in Table 2, Section 4.2. The maximum depth of cut is in the order of 9 m and the maximum fill height is about 14 m.

The preliminary design recommendations provided herein are based on interpretation of the factual data obtained during limited borehole investigations conducted at or near the cut/fill sections as well as existing information. Where relevant borehole information was not available within reasonable distance

from the cut/fill section, the Terrain/Drainage Maps (prepared by AECOM based on air photo interpretation) provided in the Foundation Desktop Study and the Geologic Cross-Sections provided in the *Foundation Investigation Report For Environmental Assessment (Hydrogeology Specialty)* prepared by AECOM were used to interpret anticipated subsurface conditions.

The anticipated subsurface conditions at the deep cut/fill locations and preliminary recommendations for design are summarized on the "Preliminary Foundation Investigation Report - Deep Cuts" sheets and "Preliminary Foundation Investigation Report – High Fills" sheets presented following the FIDR sheets for the structures at the end of the text of this report.

The interpretation and recommendations are intended to provide the designers with preliminary information to assess design slope inclination, drainage requirements, and mitigation options for addressing potential stability or settlement issues. Where provided, comments regarding construction are presented to highlight aspects which could affect the preliminary design, and for which special provisions or operational constraints could potentially be required.

Further investigation will be required during detail design to confirm the subsurface conditions that were assumed throughout the cut/fill sections and confirm/reassess the preliminary design recommendations.

8.2 Deep Cuts

8.2.1 Stability and Drainage

Preliminary assessment of the stability of the cut slopes was carried out based on limit equilibrium analysis using the commercially available slope stability program GSLOPE developed by Mitre Software Inc. Bishop's modified method of slices was employed. Cut slopes no steeper than 2H:1V, with a minimum 2 m wide mid-slope bench for cut depths greater than 8 m, were assumed.

For preliminary design, the target factors of safety were assumed to be 1.3 for short term stability, and 1.3 and 1.5 for long term stability in cohesionless and cohesive soils, respectively.

For cut slopes deeper than 8 m, the minimum requirement is to provide a 2 m wide mid-height bench in order to control surficial erosion and improve stability. Earth cut slopes must be provided with erosion protection in accordance with OPSS 572.

Permanent drainage of the cut slope is required. Roadside ditches are expected to provide an adequate level of permanent drainage in most areas. An interceptor ditch should be provided at the top of the cut as per OPSD 200.020.

Where cut excavation extends below the measured groundwater levels in cohesionless soils, more positive measures to provide permanent slope drainage and mitigate surficial instability may be required. Measures may include provision of subdrains positioned along the toe of slope and/or along the rear of the mid-slope bench, as well as gravel sheeting or rip-rap lined channels down the slope.

Seepage and surficial instability may also be experienced from localized permeable zones/sand layers within the less permeable till soils. Determination of the frequency, extent and locations of the seepage zones from the limited borehole data is not possible. Therefore, consideration should be given to the observational approach involving examination of the cut slopes during and following construction to identify any areas of surficial instability, and providing mitigative measures such as a gravel sheeting or subdrains where required. All subdrains should be sloped on a positive grade to an outlet or pumping chamber.

The preliminary assessment of stability and drainage of the cut slopes should be reviewed and confirmed during the detail design investigation based on the subsoil conditions encountered in additional boreholes drilled within the cut sections.

8.2.2 Construction Considerations

Excavation for cut slope construction should be carried out in accordance with OPSS 206 as amended by the most recent Special Provision (SP 206S03).

Excavation in very dense/hard till deposits may be arduous and will require use of heavy duty excavators or dozers. In addition, tills often contain cobbles and boulders. The contract documents should include a NSSP to emphasize these conditions to the contractor. Selection of the method of excavation must remain the responsibility of the contractor however and be based on his equipment, experience and interpretation of the site conditions.

Temporary drainage of the cuts should be provided to maintain a relatively dry, stable excavation. Measures may include temporary drainage ditches or gravel sheeting to maintain surficial stability before permanent drainage measures are in effect.

8.3 High Fills

8.3.1 Embankment Slope Stability

Preliminary assessment of the stability of the fill embankment slopes was carried out based on limit equilibrium analysis using the commercially available slope stability program GSLOPE developed by Mitre Software Inc. Bishop's modified method of slices was employed. Embankment slopes no steeper

than 2H:1V, with a minimum 2 m wide mid-slope bench for embankment heights greater than 8 m, were assumed.

For preliminary design, the target factors of safety were assumed to be 1.3 for short term stability, and 1.3 and 1.5 for long term stability of embankments founded on cohesionless and cohesive soils, respectively.

For embankment slopes higher than 8 m, the minimum requirement is to provide a 2 m wide mid-height bench in order to control surficial erosion and improve stability. Earth fill slopes must be provided with erosion protection in accordance with OPSS 572.

Assessment of the stability of the embankment side slopes under seismic conditions should be carried out during detail design.

The preliminary assessment of stability of the embankment slopes should be reviewed and confirmed based on the actual subsoil conditions encountered within the proposed embankment footprint during the detail design investigation. Mitigation measures to improve slope stability if required may include slope flattening, utilizing light weight fill materials, staged construction, or a combination of these options.

8.3.2 Settlement

Settlement of the fill embankments will occur due to compression and consolidation of the foundation soils under the weight of the overlying fill material as well as from compression of the embankment fill itself. The total settlement within the founding soils has been estimated using elastic analysis and Terzaghi one-dimensional consolidation theory, based on the site-specific subsoil conditions deduced from the borehole data and the maximum embankment heights indicated by profile and general arrangement drawings available at the time of the analysis.

Where the estimated embankment settlement exceeds 25 mm, the computed value is indicated on the Preliminary Foundation Design Report sheet for the particular section. The settlement tolerance for embankments may range from 25 to 100 mm depending on the distance from a structure. The highway design criteria will be site specific and based on maintenance considerations at the detail design stage.

The preliminary estimates do not include compression of the embankment fill itself, which would occur during and after the construction of embankment depending on the type of materials used. The magnitude of fill compression usually ranges from 1% to 2% of the height of embankment. Where granular fill is used for embankment construction, settlement of the fill itself is expected to occur during or shortly after completion of embankment construction. Non-granular earth fill or rock fill materials may exhibit additional consolidation settlement over time.

Embankment and platform width design should allow for the anticipated settlements.

Further analyses should be carried out during detail design to confirm the anticipated magnitude of settlement, assess the time rate of post-construction settlement, and where required develop mitigation measures such as preloading, surcharging, wick drains or light weight fill to reduce anticipated settlements to acceptable levels.

8.3.3 Construction Considerations

It is recommended that all topsoil and organic material be stripped from the proposed embankment footprint. The depth and extent of stripped material should be determined during detail design when additional subsurface information is available. Particular attention will be required in low floodplain areas where thicker layers of organic/alluvial soils may be present.

After stripping of organics, the exposed subgrade should be proofrolled to identify any loose/softened areas requiring subexcavation or additional compaction prior to fill placement.

Embankment fill should be placed and compacted in accordance with SP 206S03 and SP 105S10. New embankment fill placed against existing embankment slopes or on a sloping ground surface should be benched into the existing slope in accordance with OPSD 208.010.

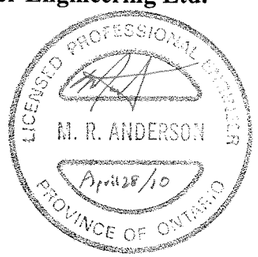
Trafficability of construction equipment may be problematic in low floodplain areas where soft/loose and organic alluvial material may be encountered and where environmental constraints are imposed on site access. Further, drainage in these areas is likely to be poor, with groundwater levels varying subject to seasonal fluctuations. The contractor must be prepared to supply equipment capable of working on this terrain and/or provide alternative measures to improve trafficability such as placement of granular pads underlain by geosynthetics in working areas.

Potential environmental impacts will need to be minimized during construction access into sensitive floodplain or wetland areas. Specific access preparation procedures such as the use of temporary work bridges, winter construction and/or gravel roadways underlain by geosynthetics should be considered.

9.0 CLOSURE

The Preliminary Foundation Design Report was prepared by Mr. Murray Anderson, P.Eng. and Dr. Sydney Pang, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.



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Review Principal, Designated MTO Contact

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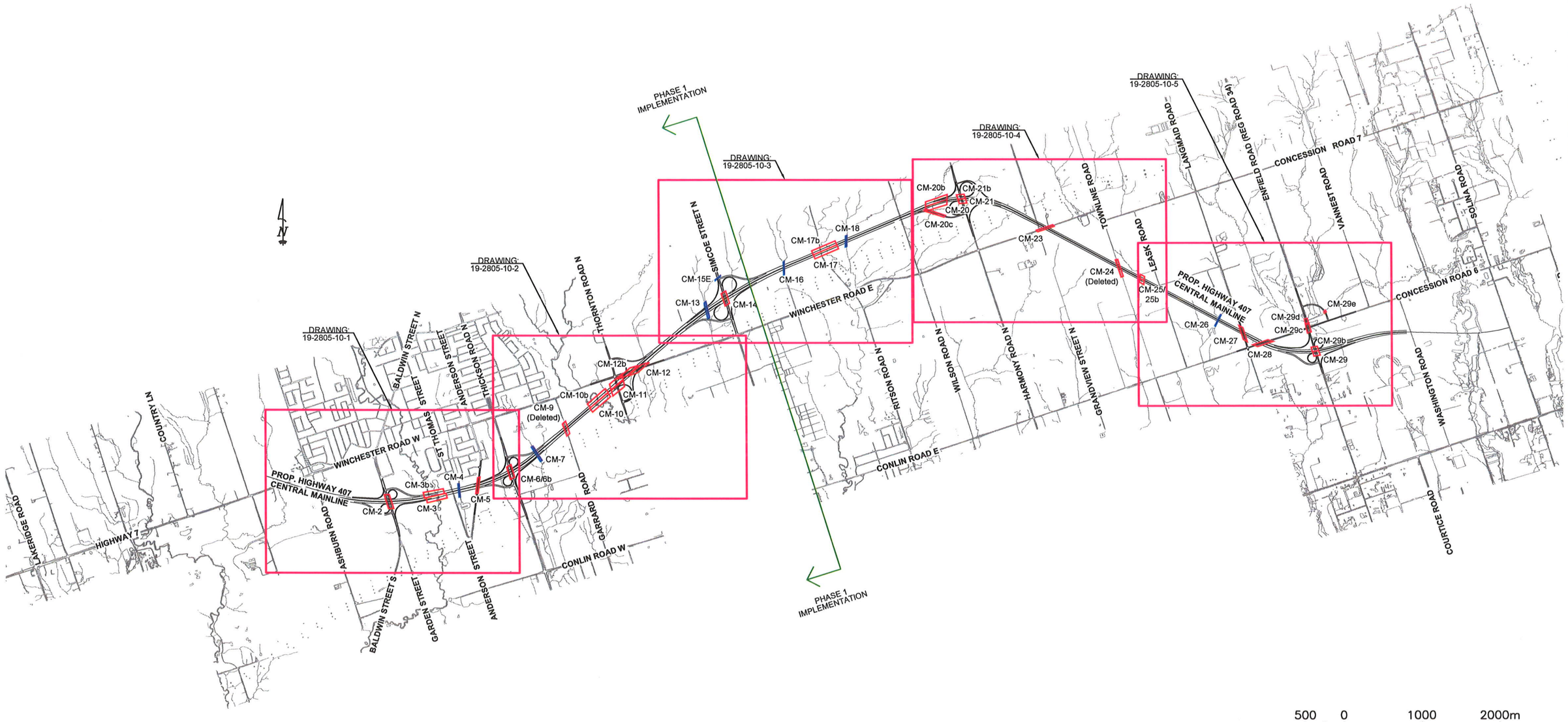

LEGEND:

- APPROXIMATE STRUCTURE LOCATION
- APPROXIMATE CULVERT LOCATION

BASE PLAN PROVIDED BY AECOM

MINISTRY OF TRANSPORTATION ONTARIO

HIGHWAY 407 EAST EXTENSION
CENTRAL SECTION
KEY LOCATION PLAN

19-2805-10

THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

ENGINEER:	DRAWN:	APPROVED:
MEF	MFA	PKC
DATE:	SCALE:	DRAWING No.
APRIL 2010	1:50000	FIGURE 1

FILENAME: D:\Drafting\19\2805\10\ted0510-BoreholePlanOverall(TSH).dwg
PLOTDATE: Apr 23, 2010 - 8:55am

LEGEND:

- BOREHOLE LOCATION (CURRENT INVESTIGATION)
- BOREHOLE LOCATION (PREVIOUS INVESTIGATION)
- APPROXIMATE STRUCTURE LOCATION
- APPROXIMATE CULVERT LOCATION

N

SIMCOE STREET N

RITSON ROAD N

WILSON ROAD N

PROPOSED HIGHWAY 407

WINCHESTER ROAD E

CM-18 Culvert
CM18–1
CM18–2

CM-17b Overpass
CM17b–4
CM17–5
CM17b–3
CM17b–1
CM17–4
CM17b–2
CM17–3/ CM17–3a
CM17–1/ CM17–1a
CM17–2
CM-17 Overpass

CM16–1
CM16–2
CM-16 Culvert

CM15e–1
CM15e–2
CM-15e Culvert

CM14–1
CM14–2
CM-14 Underpass

CM-13 Culvert

P22

160 0 200 400m

BASE PLAN PROVIDED BY AECOM

MINISTRY OF TRANSPORTATION ONTARIO

HIGHWAY 407 EAST EXTENSION
BOREHOLE LOCATION - CENTRAL MAINLINE
(SIMCOE STREET TO WILSON ROAD)

19-2805-10

THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

ENGINEER:	DRAWN:	APPROVED:
MEF	MFA	PKC
DATE:	SCALE:	DRAWING No.
APRIL 2010	1:8000	19-2805-10-3

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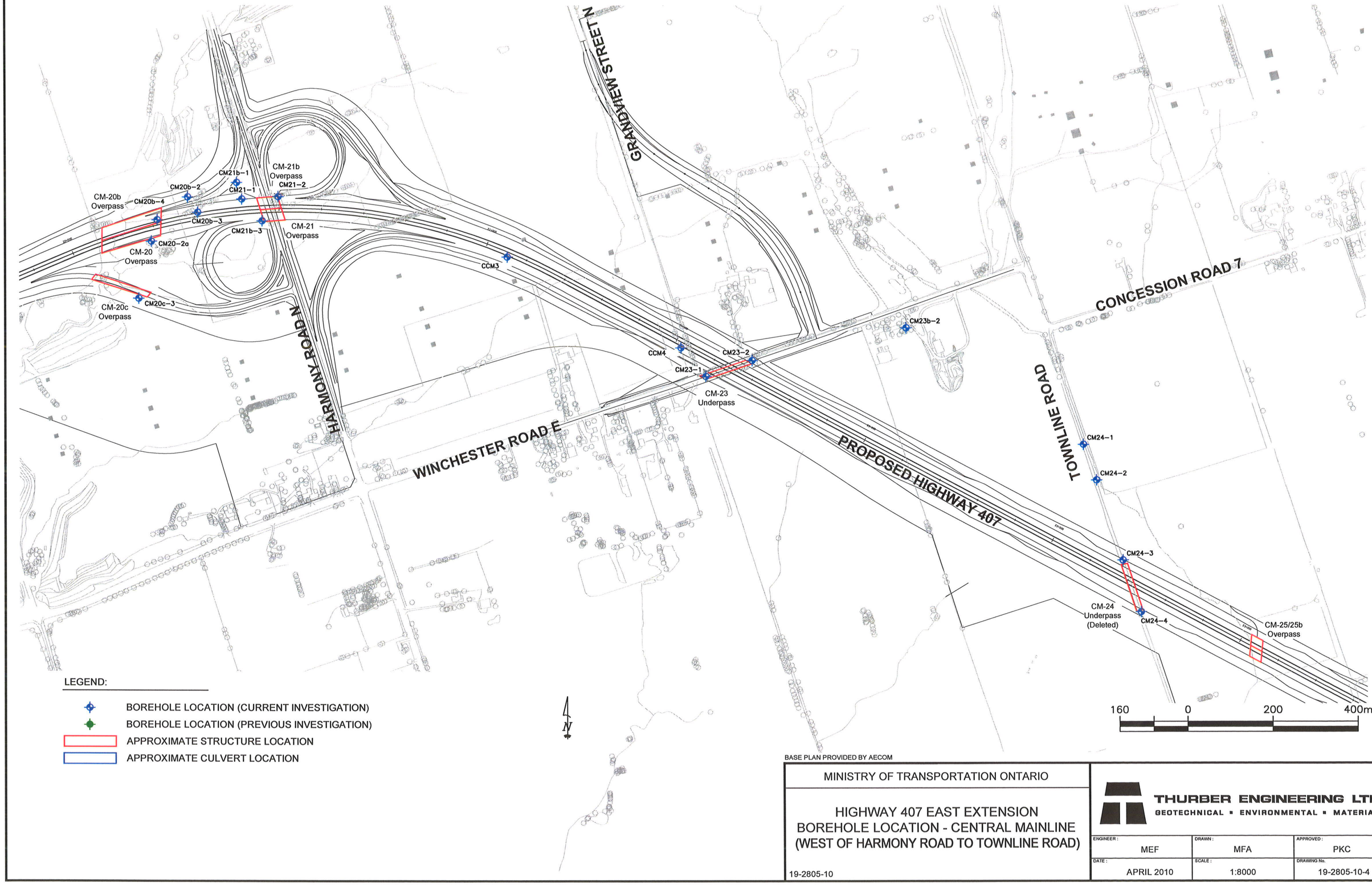

LEGEND:

- BOREHOLE LOCATION (CURRENT INVESTIGATION)
- BOREHOLE LOCATION (PREVIOUS INVESTIGATION)
- APPROXIMATE STRUCTURE LOCATION
- APPROXIMATE CULVERT LOCATION

BASE PLAN PROVIDED BY AECOM

MINISTRY OF TRANSPORTATION ONTARIO

HIGHWAY 407 EAST EXTENSION
BOREHOLE LOCATION - CENTRAL MAINLINE
(WEST OF HARMONY ROAD TO TOWNLINE ROAD)

19-2805-10

THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

ENGINEER:	DRAWN:	APPROVED:
MEF	MFA	PKC
DATE:	SCALE:	DRAWING No.
APRIL 2010	1:8000	19-2805-10-4

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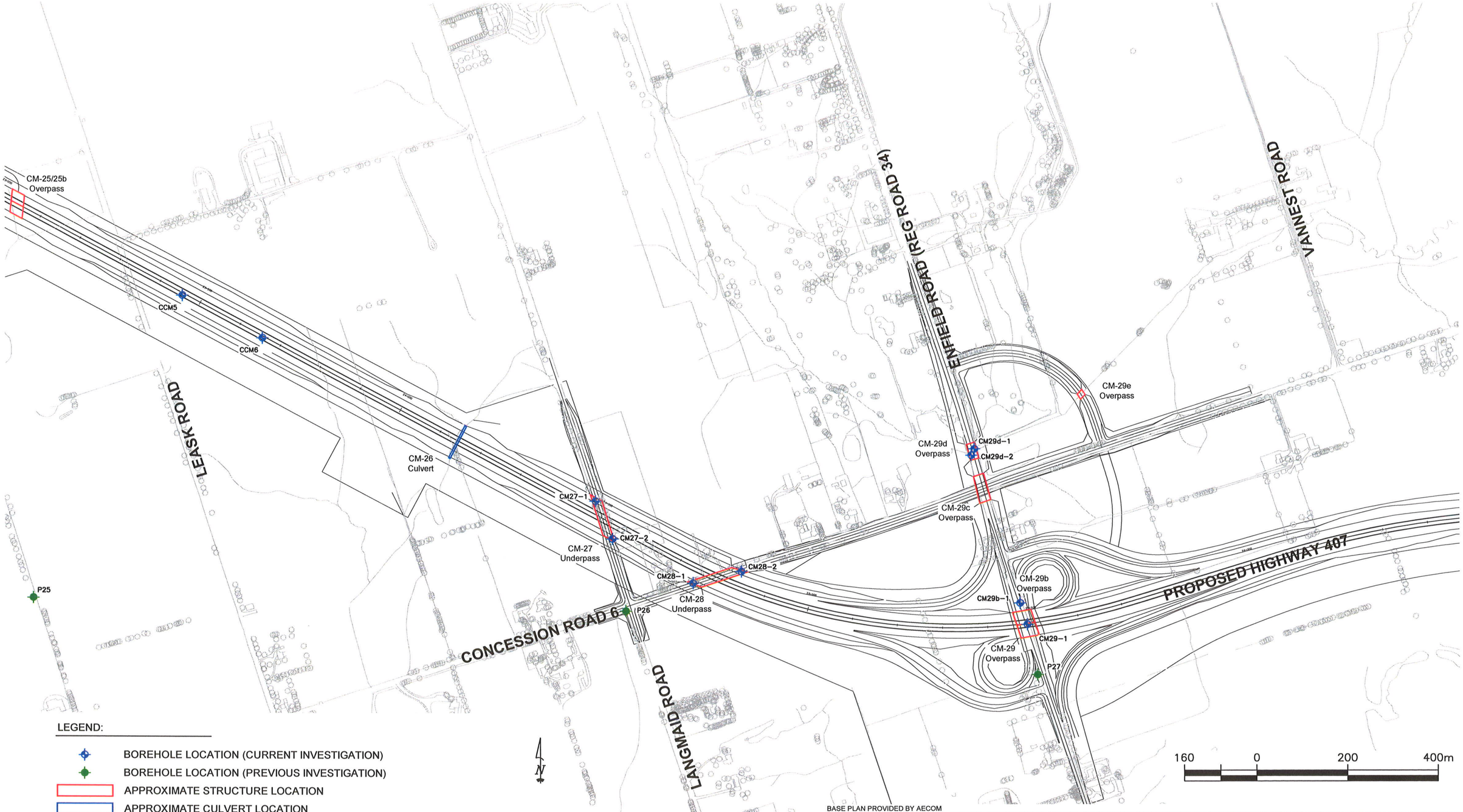


LEGEND:

- BOREHOLE LOCATION (CURRENT INVESTIGATION)
- BOREHOLE LOCATION (PREVIOUS INVESTIGATION)
- APPROXIMATE STRUCTURE LOCATION
- APPROXIMATE CULVERT LOCATION

BASE PLAN PROVIDED BY AECOM

MINISTRY OF TRANSPORTATION ONTARIO

HIGHWAY 407 EAST EXTENSION
BOREHOLE LOCATION - CENTRAL MAINLINE
(LEASK ROAD TO VANNEST ROAD)

19-2805-10

THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

ENGINEER :	DRAWN :	APPROVED :
MEF	MFA	PKC
DATE :	SCALE :	DRAWING No.
APRIL 2010	1:8000	19-2805-10-5

FILENAME: D:\Drafting\19\2805\10\ted0510-BoreholePlan(TSH).dwg
PLOTDATE: Apr 22, 2010 - 4:49pm

PRELIMINARY FOUNDATION INVESTIGATION AND DESIGN REPORT (FIDR) SHEETS

AND

ANTICIPATED FOUNDATION CONDITIONS (AFC) SHEETS

Thurber Engineering Ltd.

PART A - PRELIMINARY FOUNDATION INVESTIGATION REPORT
HWY 407 EAST EXTENSION – CENTRAL SECTION
W.O. 07 – 20016

LOCATION No:	CM-16

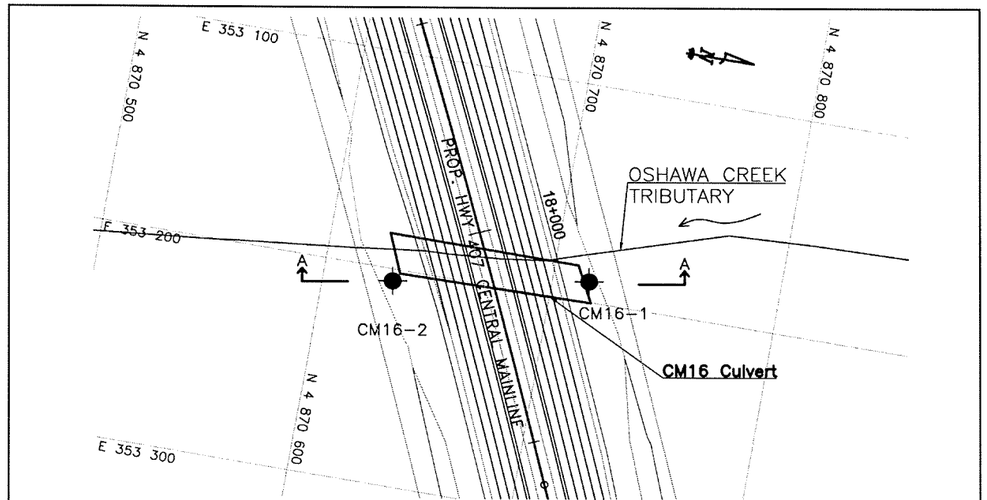
Structure Description: Highway 407 Mainline over Culvert Carrying Oshawa Creek Tributary (Bridle Road)

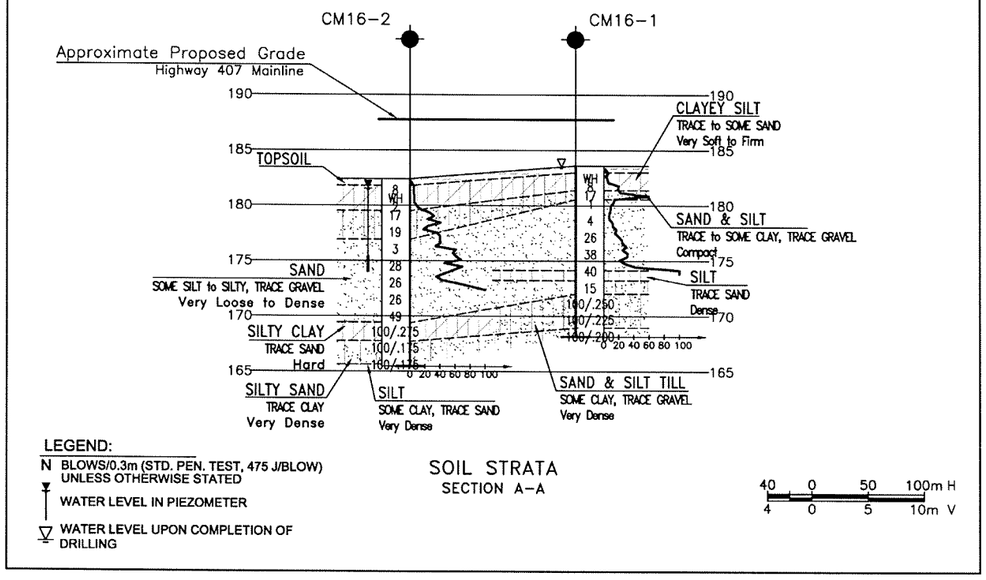
Highway 407 Proposed Grade: ~ El. 187.6 m

Existing Ground Elevation: ~ El. 182.5 to 183.0 m

Site Ranking: Medium

Station: 18+025





FOUNDATION INVESTIGATION

Site Description:

At this site, the creek flows in a north to south direction in a silty, gravelly sand alluvial plain within an area of shallow silty sand glaciolacustrine plain. Silt till ground moraine lies at depth.

Borehole Information:

Borehole No.	Borehole Location	MTM NAD 83 – Northing	MTM NAD 83 - Easting	Borehole Elevation (m)	Borehole Depth (m)
CM16-1	North Side	4 870 716.2	353 190.6	183.6	15.4
CM16-2	South Side	4 870 630.8	353 205.5	182.4	16.9

Subsurface Conditions:

- **Topsoil:** A 0.6 m thick layer of topsoil was encountered in both boreholes. The moisture content of the topsoil layer ranged between 21% and 24%. The thickness and extent of the topsoil are expected to vary between and beyond the borehole locations, and the information in this report should not be used for quantity estimating purposes.

- **Clayey Silt:** Clayey silt with trace to some sand was encountered below the topsoil. The clayey silt layer is 1.6 to 2.3 m thick, with an underside at Elev. 181.4 to 179.5 m. The consistency is very soft to firm with 'N' values ranging from 0 to 8 blows /0.3 m penetration and moisture content between 14% and 35%. A grain size distribution curve for a sample of the clayey silt is presented in Figure CM16-B1.

- **Sands and Silts:** A sequence of sands and silts with trace of gravel was encountered below the clayey silt. The combined thickness of these layers was 9.4 m, with an underside at Elev. 172.0 m in borehole CM16-1, and 10.1 m with an underside at Elev. 169.4 m in borehole CM16-2. These sands and silts are very loose to dense with 'N' values ranging from 1 to 49 blows/0.3 m penetration. Moisture contents ranged from 8% to 17%. Grain size distribution curves for samples of this soil are presented in Figure CM16-B2.

- **Sand and Silt Till:** Grey sand and silt till with some clay and trace of gravel was encountered below the upper sands and silts in borehole CM16-1. This deposit is 3 m thick, with an underside at Elev. 169.0 m. This till is very dense with 'N' values of 100 blows for less than 0.3 m penetration and with moisture content ranging between 6% and 11%. A grain size distribution curve for a sample of this soil is presented in Figure CM16-B3. Glacial tills typically contain cobbles and boulders.

- **Silty Clay:** Grey silty clay with trace of sand was found below the sands and silts in Borehole CM16-2. This clayey silt layer is 1.6 m thick with an underside at Elev. 167.8 m. This soil is hard with 'N' value of 100 blows for less than 0.3 m penetration. Measured moisture content was 9%. A grain size distribution curve for a sample of this soil is presented in Figure CM16-B4.

- **Sands and Silts:** A lower deposit of sands and silts with trace to some clay was encountered below the sand and silt till layer in borehole CM16-1, and below the silty clay layer in borehole CM16-2. The combined thickness of these layers is at least 0.8 m to at least 2.3 m, lying between Elev. 168.2 m to Elev. 165.5 m, where boreholes CM16-1 and CM16-2 where terminated. This cohesionless layer is very dense with 'N' values of 100 blows for less than 0.3 m penetration and with moisture content ranging from 12% to 17%. A grain size distribution curve for a sample of this soil is presented in Figure CM16-B5.

Groundwater Conditions:

- **BH CM16-1:** 0.0 m depth (Elev. 183.6 m) in open borehole on June 29, 2009 (unstabilized reading).
- **BH CM16-2:** 0.0 m depth (Elev. 182.4 m) in open borehole on June 26, 2009 (unstabilized reading).
  1.9 m depth (Elev. 180.5 m) in piezometer on February 12, 2009.
  0.5 m depth (Elev. 181.9 m) in piezometer on May 04, 2009.
  0.9 m depth (Elev. 181.5 m) in piezometer on June 04, 2009.

Record of Borehole Sheets – Appendix A | **Laboratory Test Results – Appendix B** | **Key Location Plan – Figure 1**

Thurber Engineering Ltd.

LOCATION No:	CM-16

FOUNDATION RECOMMENDATIONS

Note: The site specific foundation recommendations are for planning purposes only. Refer to Section 6 of the Foundation Design Report for the project-wide foundation recommendations, design assumptions and limitations.

General: An open footing concrete culvert is proposed. Retaining walls are proposed in either shoulder of Highway 407.

Foundation Option	*Advantages*	*Disadvantages*
Spread footings founded on compact sands and silts	- Conventional construction - Low cost alternative	- Dewatering will be required - Variability of surficial soils in floodplain - Scour protection is required for footings in floodplain - Sub-excavation of topsoil and native soils to construct footings
Spread Footings perched on Granular A pads	- Lower cost than deep foundations - Founding level can be adjusted - Higher bearing resistance than footings on native soil	- Dewatering will be required - Variability of surficial soils in floodplain - Scour protection is required for footings in floodplain - Sub-excavation of topsoil to construct pads
Steel H-Piles driven to very dense sand and silt till or silty sand	- Higher bearing resistance - Not affected by surficial soil variability	- Higher cost than spread footings - Sub-excavation required for pile cap construction - Unwatering may be required for pile cap construction
Caissons founded within the very dense sand and silt till or silty sand	- Higher bearing resistance - Not so affected by surficial soil variability	- Higher cost than spread footings - Unwatering may be required for pile cap construction - Require liners to address installation problems including side wall sloughing associated with cohesionless soils - Potential for base boiling

A – Spread Footings

Spread footings founded on native undisturbed compact sands and silts may be used. Footings may also be founded on compacted granular A cores in accordance with current MTO practices. The preliminary design geotechnical resistances and founding levels are as follows:

Founding Stratum	Geotechnical Resistance		Foundation Level
	Factored ULS	SLS	
Sands and Silts	300 kPa	200 kPa	At or below Elev. 177.5 m (North Side) At or below Elev. 179.0 (South Side)
Compacted Granular A	700 kPa	350 kPa	Base of Fill Pad at or below Elev. 178.0 m (North Side) Base of Fill Pad at or below Elev. 179.5 m (South Side)

B – Steel H-Piles

Steel H-piles driven to refusal within the very dense sand and silt till or silty sand may be used to provide foundation support. The preliminary design geotechnical resistances and tip elevations are as follows:

Pile	Axial Geotechnical Resistance		Downdrag Load	Anticipated Pile Tip Elevation
	Factored ULS	SLS		
HP 310 x 110	1,600 kN	1,400 kN	Not applicable	At or below Elev.170.0 m (North Side) At or below Elev. 167.0 m (South Side)

C – Caissons

Caissons are not recommended at this site due to potential installation problems related to water bearing cohesionless deposits and the associated potential of base boiling. This option therefore has not been developed.

Recommended Foundation Alternative

From a foundation engineering perspective, the recommended foundation alternative for a culvert at this site is footings founded on compacted Granular A pads. However, significant dewatering operations will be required to construct the fill pads, and therefore use of driven pile foundations should also be considered.

APPROACHES

Up to approximately 5 m of fill will be required to construct the highway mainline approaches. Retaining walls are proposed to retain the fill in either shoulder of Highway 407.

Stability

Fill embankments up to 5 m in height are anticipated to be stable at side slope inclination of 2H : 1V using SSM or granular material. Global stability of the retaining walls will need to be assessed during detail design.

Settlement

Foundation settlement will occur as fill is placed and should be completed by the end of construction. It is estimated that foundation settlement will be less than 50 mm.

• CONSTRUCTION CONSIDERATIONS

Pile Installation

During pile installation through glacially derived soils at this site, there is a low probability of encountering cobbles or boulders. Driving shoes should be fitted to the pile tips for reinforcement and enhancing seating of the piles.

Excavation

Excavations will be required for foundation construction. No excavation should be carried out in the creek valley below the water table without prior dewatering. Temporarily unsupported side slopes should not be steeper than 1H : 1V where groundwater control measures are implemented as outlined below. In accordance with the OHSA, the native silts and sands are classified as Type 3 soils above the water table and Type 4 soils below the water table.

Groundwater/Surface Water Control

Prior to any excavation, groundwater control systems such as interlocking sheetpiled enclosures and/or well points will likely be required. Diversion of stream flow and surface runoff from the excavation and pumping from carefully constructed, filtered sumps should be used to supplement the above systems. The required groundwater control systems should be further assessed during detail design.

Protection Systems

Protection systems would be required for excavations where space restrictions prohibit formation of safe side slopes. One possible system is an interlocking sheetpiled enclosure which can also be used for groundwater cutoff as outlined above. The feasibility of installing such protection system should be assessed once further subsurface investigation is carried out during detail design.

Floodplain Access

Potential environmental impacts will need to be minimized during construction access into the floodplain. Specific access preparation procedures including the use of gravel roadways underlain by geosynthetics should be considered.

• RECOMMENDATIONS FOR ADDITIONAL WORK

Further subsurface investigation, analysis and design should be carried out during detail design to confirm the subsoil conditions at the location of the culvert. As a minimum, this is likely to require additional boreholes along the culvert alignment. The feasibility and cost effectiveness of alternate dewatering systems would need to be assessed during detail design.

PART A - PRELIMINARY FOUNDATION INVESTIGATION REPORT
HWY 407 EAST EXTENSION – CENTRAL SECTION
W.O. 07 – 20016

LOCATION No:	CM-17/17b

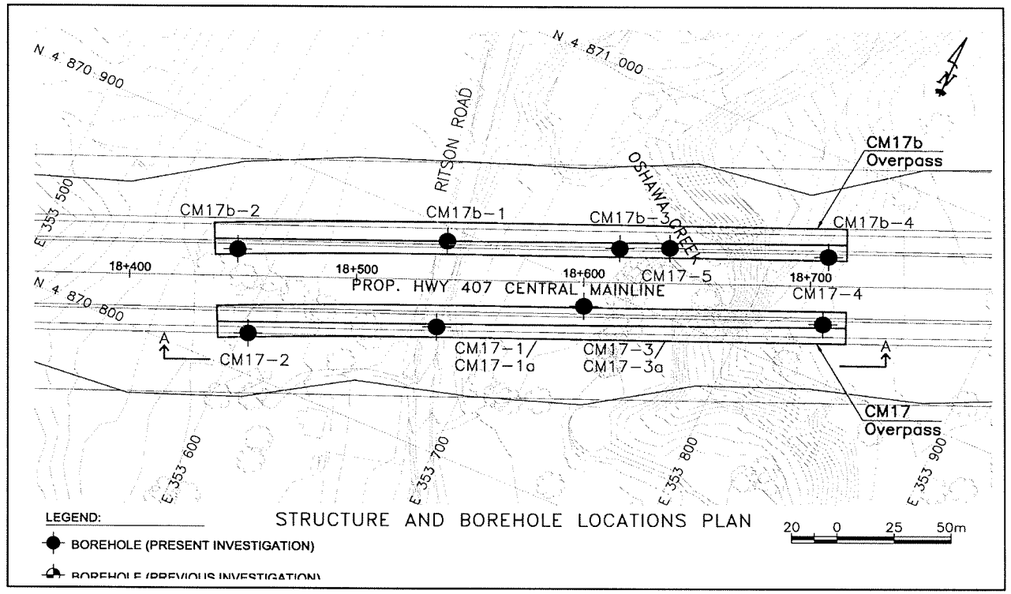
Structure Description: Overpass Highway 407 Mainline / Ritson Road and Oshawa Creek

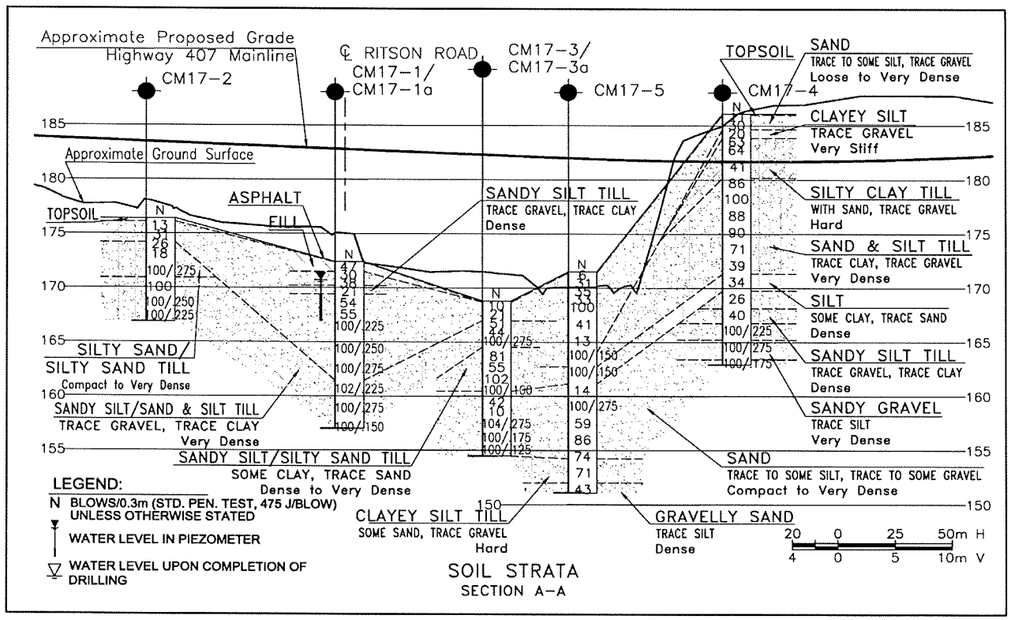
Highway 407 Proposed Grade: ~ El. 184 – 182 m

Existing Ground Elevation: ~ El. 185 - 169 m

Site Ranking: High

Station: 18+540





FOUNDATION INVESTIGATION

Site Description:

At this site, the existing Ritson Road is a four-lane, undivided paved roadway running between agricultural lands on the west side and the Oshawa Creek valley on the east side. The site is mapped as being underlain by a 250m wide band of silty, gravelly sand alluvium with some organic soils. The soil to the west changes to shallow silty sand glaciolacustrine plain. The higher ground to the east is silt till ground moraine. The relief of the alluvium is low plain, moderately to very poorly drained. The ground to the east is low plain, rolling, moderately well drained.

Borehole Information:

Borehole No.	Borehole Location	MTM NAD 83 – Northing	MTM NAD 83 - Easting	Borehole Elevation (m)	Borehole Depth (m)
CM17-1/1a	West/Centre Piers (CM17)	4 870 854.8	353 677.7	173.4	15.4
CM17-2	West Abutment (CM17)	4 870 818.0	353 603.0	176.4	9.5
CM17-3/3a	Centre/East Piers (CM17)	4 870 890.1	353 732.9	168.8	14.3
CM17-4	East Abutment (CM17)	4 870 925.2	353 832.6	186.1	23.2
CM17b-1	West/Centre Piers (CM17b)	4 870 893.4	353 665.9	174.4	20.1
CM17b-2	West Abutment (CM17b)	4 870 852.3	353 582.9	177.2	6.3
CM17b-3	Centre/East Piers (CM17b)	4 870 921.4	353 736.5	170.7	11.1
CM17b-4	East Abutment (CM17b)	4 870 955.2	353 822.1	184.7	21.7
CM17-5	East Piers	4 870 930.5	353 756.5	171.5	20.4

Subsurface Conditions:

- **Peat, Topsoil, Asphalt:** Peat and topsoil ranging between 100 and 600 mm in thickness was encountered in all except Boreholes CM17-1/1a and CM17b-1. These thicknesses may vary between and beyond borehole locations and should not be used for quantity estimating purposes. Asphalt of 75 to 135 mm in thickness was encountered at ground surface or buried within the fill in Boreholes CM17-1 and 17b-1.

- **Fill:** Existing road fill consisting mainly of sand, some gravel and trace silt, was encountered in Boreholes CM17-1 and 17b-1. The thickness of this fill ranges between 0.8 and 1.3 m. The underside of the fill varies from Elev. 172.9 to 172.5 m. Measured water contents of fill samples ranged between 2 and 6%.

- **Sands and Silts:** Layers of sands and silts were found underlying the peat/topsoil or interlayered with glacial tills in all but Borehole CM17b-2. Where encountered, these layers are between 1.1 and 15.9 m in thickness and their undersides vary between Elev. 154.2 and 174.2 m. These wet cohesionless soils are brown in colour becoming grey with depth, and are typically in a compact to dense state ('N' values from 10 to 41 blows/0.3m penetration) at shallow depths, but becoming dense to very dense with depth ('N' values up to >100 for <0.3m penetration). Figures CM17-B1 to –B4 present the grain size test results of the sand and silt samples. Measured water contents of these soils ranged between 12 and 20%.

- **Sand and Silt Till:** Deposits of glacial tills with varying proportions of sands and silts were encountered in all but Borehole CM17b-1. Boreholes CM17-1 and 17-2 were terminated within the till. The tills are brown in colour becoming grey with depth. The thickness of the till deposits varies between 1.4 and >9.7 m and the underside of the tills varies from Elev. 156.2 to 172.9 m. Typically, the tills are in a compact to dense state ('N' values of 12 to 41 blows/0.3m penetration) becoming very dense with depth ('N' values >100 blows for <0.3m penetration). Cobbles and boulders are present inherently within glacial tills. Figures CM17-B5 to –B9 present the grain size distribution curves for samples of tills. Measured water contents varied between 3% and 20%.

- **Silty Clay/Silty Clay Till:** Deposits of silty clay containing trace sand and silty clay till were encountered below the surficial sands and silts in Boreholes CM17b-1, CM17-b4 and CM17-4. The thickness of these cohesive soils is 3.4 to 3.6 m in Boreholes CM17b-4 and CM17-4, and the underside of these deposits range from 180.2 m in Borehole 17-4 to Elev. 154.2 m where Borehole 17b-1 was terminated. These soils are grey in colour and have a typically very stiff to hard consistency ('N' values of 24 blows/0.3 m penetration to >100 blows for <0.3m penetration). Figures CM17-B10 and –B11 present laboratory test results for samples of these soils. Atterberg Limits tests indicate that this soil has a low plasticity (LL=25-27, PI=13-16). Measured water contents were at 12% and 15%.

- **Clayey Silt/Clayey Silt Till:** Clayey silt and clayey silt till was encountered below, or interlyared with, the surficial sands and silts in Boreholes CM17b-2, 17b-4, 17-4, 17-5, and below the fill in Borehole CM17b-1. These soils are more than 2.0 m thick in Borehole CM17b-2 which was terminated in this till at Elev. 170.9 m. Where fully penetrated in Borehole CM17b-1, 17b-4, 17-4 and 17-5, these soils range between 0.8 and 1.3 m thick with underside elevations ranging between 183.8 and 152.0 m. The clayey silts are brown at shallow depth and have a very stiff to hard consistency ('N' value of 20 to 31 blows/0.3m penetration). At lower elevations, these soils are grey and have a hard consistency ('N' values of >100 blows for <0.3m penetration). Figure CM17-B12 presents grain size distribution curves for samples of this till. Measured water contents ranged between 8 and 18%.

- **Sandy Gravel/Gravelly Sand:** Layers of sandy gravel and gravelly sand were found underlying all of the above soils in Boreholes CM17b-4, CM17-4 and CM17-5. Where encountered, these layers are between >0.9 and >3.8 m in thickness but Boreholes CM17-5 and CM17b-4 were terminated in these deposits at Elev. 151.1 to 163.0 m. These wet cohesionless soils are grey in colour and are typically in a dense to very dense state ('N' values from 43 blows/0.3m penetration to >100 for <0.3 m penetration). Artesian groundwater pressure was encountered in this layer during the drilling of Borehole CM17-5 (see below). Figure CM17-B13 presents the grain size test results of two samples of these soils. Measured water contents of these soils ranged between 5 and 12%.

Groundwater Conditions:

- **BH CM17-1:** 1.7 m depth (Elev. 171.7 m) in piezometer on July 28, 2008.
- **BH CM17-2:** 0.3 m depth (Elev. 176.1 m) in open borehole on May 26, 2008.
- **BH CM17-3/3a:** 0.6 m depth (Elev. 168.2 m) in open borehole on March 12, 2008.
- **BH CM17b-1:** 4.7 m depth (Elev. 169.7 m) in open borehole on December 12, 2007.
- **BH CM17b-2:** 0.0 m depth (Elev. 177.2 m) in piezometer on May 26, 2008.
- **BH CM17b-3:** 0.1 m depth (Elev. 170.6 m) in open borehole on July 28, 2008.
- **BH CM17b-4:** 3.7 m depth (Elev. 180.7 m) in piezometer in February 10, 2009.
- **BH CM17-5:** 3.7 m above ground surface (Elev. 175.2 m) in open hole during drilling in December 11, 2008 (artesian conditions).

FOUNDATION RECOMMENDATIONS

Note: The site specific foundation recommendations are for planning purposes only. Refer to Section 6 of the Foundation Design Report for the project-wide foundation recommendations, design assumptions and limitations.

General: Twin four-span structures each with two abutments and three piers are proposed.

Foundation Option	*Advantages*	*Disadvantages*
Spread Footings founded on compact to dense sands and silts	- Conventional construction	- Potential variability of surficial soils; sub-excavation under the groundwater table will be required - Lower bearing resistance if founded on alluvium - Unwatering/protection systems will be required
Spread Footings perched on Granular A pads for abutments	- Lower cost than deep foundations - Minimize excavation requirements	- Higher cost than spread footings on native soils - Potential variability of surficial soils; sub-excavation of peat/topsoil and surficial, loosened/softened soils below the groundwater table will be required
Steel H-Piles driven into very dense sand and sand/silt till	- Higher bearing resistance - Permits use of integral abutments - Not affected by surficial soil variability	- Higher cost than spread footings - May encounter obstructions at some locations when driving piles - Pile embedment length will be limited in order to maintain the pile tip above the soil layer where artesian condition was encountered at ~Elev.152m
Caissons founded in very dense sand and sand/silt till	- Higher bearing resistance - Not so affected by surficial soil variability	- Higher cost than spread footings - Does not permit integral abutment design - Potential installation problems through water-bearing sands/silts, and base boiling under artesian groundwater pressures

A - Spread Footings

Spread footings may be founded on undisturbed native soils. Footings for perched abutments may be founded on compacted Granular A cores in accordance with current MTO practices. The preliminary design geotechnical resistances and founding levels are as follows:

Founding Stratum	Geotechnical Resistance		Founding Level of Fill Pad
	Factored ULS	SLS	
Silty Sand Till or Clayey Silt Till	375 kPa	250 kPa	At or below Elev. 175.0 m – West Abutments At or below Elev. 172.5 m – West/Centre Piers At or below Elev. 168.5 m – East/Centre Piers (CM17b) At or below Elev. 166.5 m – East/Centre Piers (CM17) At or below Elev. 183.0 m – East Abutment (CM17b) At or below Elev. 183.8 m – East Abutment (CM17)

Founding Stratum	Geotechnical Resistance		Founding Level of Fill Pad
	Factored ULS	SLS	
Compacted Granular A	700 kPa	350 kPa	At or below Elev. 176.5 m – West Abutment (CM17b) At or below Elev. 172.9 m – West/Centre Piers (CM17b) At or below Elev. 168.5 m – East/Centre Piers (CM17b) At or below Elev. 183.3 m – East Abutment (CM17b)
			At or below Elev. 175.0 m – West Abutment (CM17) At or below Elev. 172.5 m – West/Centre Piers (CM17) At or below Elev. 167.0 m – East/Centre Piers (CM17) At or below Elev. 185.3 m – East Abutment (CM17)

B - Steel H-Piles

Steel H-piles driven to refusal within the very dense sand and/or sand/silt till may be used to provide foundation support. However, pile tips must be maintained well above the artesian gravelly sand layer encountered at Elev. 152.0 m in Borehole CM17-5. The preliminary design geotechnical resistances and tip elevations are as follows:

Pile	Axial Geotechnical Resistance		Downdrag Load	Anticipated Pile Tip Elevation
	Factored ULS	SLS		
HP 310 x 110	1,400 kN	1,200 kN	Not Applicable	CM17b Overpass (WBL)
				Below Elev.172 m (West Abut.) / Elev.157 m (West Pier)
				Below Elev.163 m (East Pier) / Elev.166 m (East Abut.)
				CM17 Overpass (EBL)
				Below Elev.169 m (West Abut.) / Elev.162 m (West Piers)
				Below Elev.160 m (East Pier) / Elev.166 m (East Abut.)

C – Caissons

Given the artesian conditions and high potential for base boiling, and uncertainties associated with cleaning and inspecting the base, the use of caisson foundation is not recommended for this site and this option has not been developed.

Recommended Foundation Alternative

The recommended foundation alternative at this site is steel H-piles driven into the very dense sand, clayey silt till or sand/silt till. Preliminary investigation indicates that the pile tips must be maintained well above Elev. 152 m to avoid encountering artesian pressure. Extensive investigation during detailed design is recommended for designing driven pile foundation at this site.

- **ABUTMENT TYPE**

The soil conditions at this site are suitable for integral abutment design. Consideration may also be given to using conventional pile groups. Augered caissons may be considered in the floodplain in order to minimize excavation in the valley although installation difficulties as discussed previously should be expected.

- **APPROACHES**

General

Assuming that Ritson Road remains at its current grade at approximate Elev. 175 m, up to 9 m of fill will be required to construct the highway mainline west approaches. A cut of up to 13 m in height will be required at the east approaches. Removal of peat, topsoil, soft/loose alluvium and other unsuitable soils must be carried out within the footprint of the embankment prior to fill placement.

Stability

Results of preliminary global stability analysis indicate that approaches up to 10 m in height, in conjunction with a mid-height bench and a side slope inclination not steeper than 2H : 1V, would be stable (Factor of Safety > 1.3). Cut slopes at 2H : 1V with a mid-height berm should also be stable.

Settlement

Foundation settlement will occur as fill is placed. It is expected that a majority of the settlement, estimated to be up to 25 mm in magnitude, would be completed by the end of construction.

- **CONSTRUCTION CONSIDERATIONS**

Pile Installation

During pile installation, there is a low probability of encountering cobbles or boulders within the sand/silt till. For sites with artesian groundwater pressure, the use of driving shoes is not advisable. This issue must be reassessed during detailed design.

Excavation

Excavations below the groundwater level will be required to facilitate pile cap construction at the piers and abutments. Temporary unsupported side slopes should not be steeper than 1H : 1V provided that groundwater control measures are implemented as outlined below. No excavation in the creek valley should be carried out without prior unwatering. In accordance with the OHSA, native sands/silts and clayey silts above the groundwater level are classified as Type 3 soils, while sands/silts below the groundwater level are classified as Type 4 soils.

Groundwater/Surface Water Control

The groundwater table is at, or within 1 m depth below, the existing grade within the floodplain. For excavations below the groundwater level, groundwater control systems such as well points and/or interlocking sheetpiled cofferdams would be required. Diversion of surface runoff from the excavations and pumping from carefully constructed, filtered sumps may also be required to supplement the above systems. The required groundwater control system should be further assessed during detail design.

Protection Systems

Protection systems would be required at the vertically sided excavations for pile cap construction or where space restrictions prohibit formation of safe side slopes. One possible system is an interlocking sheetpiled cofferdam which can also be used for groundwater cutoff as outlined above. The feasibility of installing such protection system should be assessed once further subsurface investigation is carried out during detail design.

Floodplain Access

Potential environmental impacts will need to be minimized during construction access into the sensitive floodplain. Specific access preparation procedures including the use of gravel roadways underlain by geosynthetics should be considered.

- **RECOMMENDATIONS FOR ADDITIONAL WORK**

Further subsurface investigation, analysis and design should be carried out during detail design to confirm the subsoil conditions at the location of the bridge foundation elements. As a minimum, this will require additional boreholes at the actual abutment and pier locations, and the approaches. The global stability of the approach embankments and the foundation settlements due to fill placement should be re-evaluated during detail design. For driven pile foundations, extensive additional investigation is recommended for assessing pile geotechnical resistance, pile tip elevation and the method(s) of pile installation to address the issue of artesian groundwater pressure.

PART A - PRELIMINARY FOUNDATION INVESTIGATION REPORT
HWY 407 EAST EXTENSION – CENTRAL SECTION
W.O. 07 – 20016

LOCATION No:	CM-18

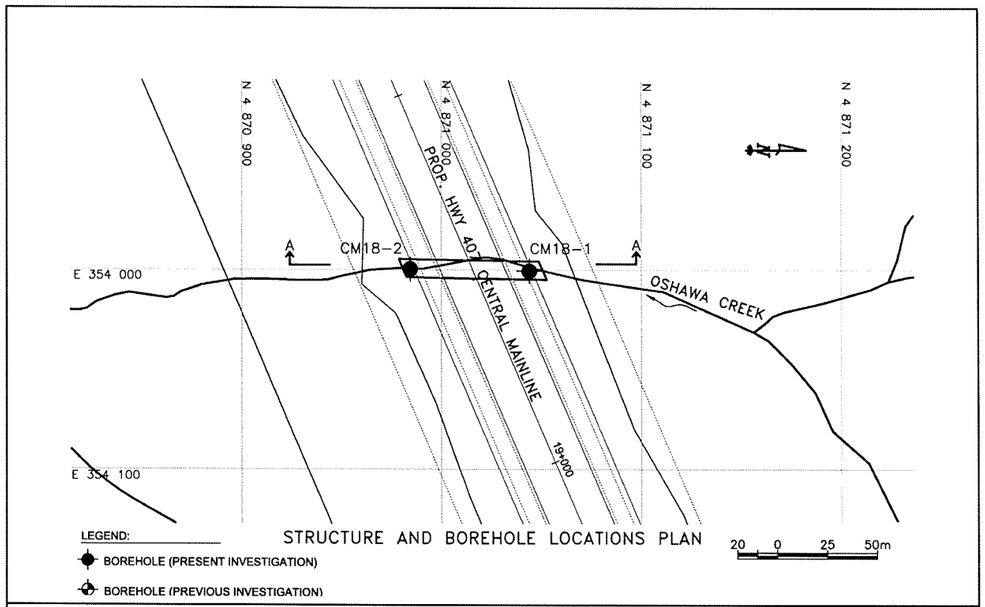
Structure Description: Culvert at Oshawa Creek East Branch Tributary

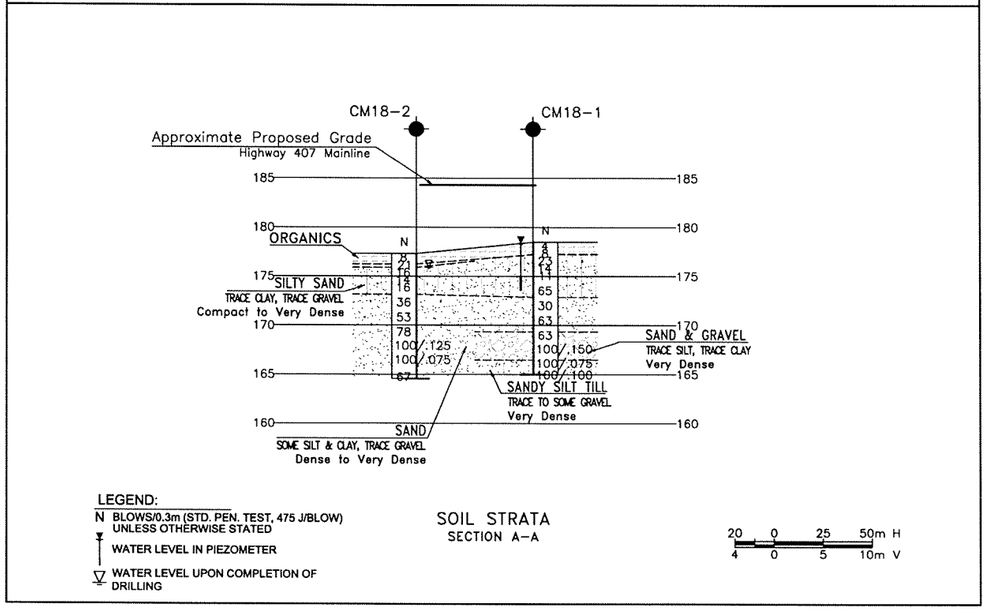
Highway 407 Proposed Grade: ~ El. 184.2 m

Existing Ground Elevation: ~ El. 177.3 to 180.0 m

Site Ranking: Medium

Station: ~ 18+890





FOUNDATION INVESTIGATION

Site Description:

At this site, the creek flows in a north-south direction in a shallow silty sand glaciolacustrine plain. Alluvial soils are present in the creek. The relief of the alluvial deposit is low, rolling, poorly drained. The higher ground to the east is composed of silt till ground moraine.

Borehole Information:

Borehole No.	Borehole Location	MTM NAD 83 – Northing	MTM NAD 83 - Easting	Borehole Elevation (m)	Borehole Depth (m)
CM18-1	North side	4 871 044.0	354 000.4	178.5	13.5
CM18-2	South side	4 870 984.5	353 999.4	177.3	12.7

Subsurface Conditions:

- **Organics:** Between 1.1 and 1.3m of organics containing roots and rootlets was encountered in both boreholes. The thickness and extent of organics are expected to vary between and beyond the borehole locations, and the information in this report should not be used for quantity estimating purposes.

- **Sand:** A 0.3m thin layer of brown sand was encountered below the organics in borehole CM18-2 only. This cohesionless soil is compact with an 'N' value of 21 blows/0.3m and a moisture content of 11%.

- **Silty Sand:** Silty sand was encountered below the organics in borehole CM18-01 and the sand layer in borehole CM18-02. The silty sand layer is 4.3 and 2.8 m thick in boreholes CM18-01 and CM18-02, with an underside at Elev. 172.9 to 173.1m. The silty sand is typically compact with 'N' values ranging from 11 to 23 blows and moisture content ranging from 8 to 19%. One 'N' value of 65 blows was obtained near the base of this unit in borehole CM18-01, indicating very a dense condition. Grain size distribution curves for samples of the silt sand are presented in Figure CM18-B1.

- **Sand:** A deposit of grey sand, trace of gravel and some silt and clay was encountered below the silty sand in both boreholes. This sand layer was 3.5 m thick, with an underside at Elev. 169.4 m in Borehole CM18-01, and greater than 8.5m thick to Elev. 164.6 m where borehole CM18-02 was terminated. This sand layer is dense to very dense with 'N' values ranging from 30 to more than 100 blows/0.3m penetration. Moisture contents ranged from 13 to 18%. Grain size distribution curves for samples of this sand are presented in Figure CM18-B2.

- **Sand and Gravel:** A deposit of grey sand and gravel, trace silt and clay, was found below the sand layer in Borehole CM18-01. This layer is 2.9 m thick with an underside at Elev. 166.5 m. This sand and gravel layer is very dense with 'N' values ranging from 63 to more than 100 blows for 0.3m penetration. Moisture contents ranged from 6 to 10%. The grain size distribution curve for a sample of this soil is presented in Figure CM18-B3.

- **Sandy Silt Till:** Grey sandy silt till, trace to some gravel was encountered below the Sand and Gravel layer in borehole CM18-01. This layer is at least 1.5 m in thickness, extending to Elev. 165.0 m where borehole CM18-01 was terminated. This sandy silt till is very dense with 'N' values of 100 blows for less than 0.3m penetration and with moisture content of about 8%. Glacial tills typically contain cobbles and boulders.

Groundwater Conditions:

- **BH CM18-1:** 1.3 m depth (Elev. 177.2 m) in piezometer on February 12, 2009.
  0.0 m depth (Elev. 178.5 m) in piezometer on May 4, 2009.
- **BH CM18-2:** 1.4 m depth (Elev. 175.9 m) in open borehole on December 05, 2008.

LOCATION No:	CM-18

FOUNDATION RECOMMENDATIONS

Note: The site specific foundation recommendations are for planning purposes only. Refer to Section 6 of the Foundation Design Report for the project-wide foundation recommendations, design assumptions and limitations.

General : An open footing concrete culvert is proposed.

Foundation Option	*Advantages*	*Disadvantages*
Spread footings founded on compact sand or silty sand	- Conventional construction - Lower cost alternative	- Dewatering and protection (temporary shoring) systems will be required - Variability of surficial soils in floodplain - Scour protection is required for footings in floodplain - Sub-excavation of organics to construct footings
Spread Footings perched on Granular A pads	- Lower cost than deep foundations - Founding level can be adjusted	- Dewatering and protection (temporary shoring) systems will be required - Variability of surficial soils in floodplain - Scour protection is required for footings in floodplain - Sub-excavation of organics and native sands may be required to construct pads
Steel H-Piles driven to very dense sand, sand and gravel or sandy silt till	- Higher bearing resistance - Not affected by surficial soil variability	- Higher cost than spread footings - Sub-excavation of organics required - Dewatering and protection systems (temporary shoring) required for pile cap construction
Caissons founded within the very dense sand, sand and gravel or sandy silt till	- Higher bearing resistance - Not so affected by surficial soil variability	- Higher cost than spread footings - Require liners to address installation problems including side sloughing associated with cohesionless soils - Dewatering and protection systems (temporary shoring) may be required for pile cap construction - Need to dislodge and handle cobbles and boulders - Potential for base boiling

A – Spread Footings

Spread footings founded on compact sand or silty sand above high groundwater table might be used. A footing founded in compacted Granular A pad may also be used as long as the organics layer is removed. The preliminary design geotechnical resistances and founding levels are as follows:

Founding Stratum	Geotechnical Resistance		Foundation Level
	Factored ULS	SLS	
Sand or Silty Sand	350 kPa	150 kPa	At or below Elev. 176.2 (south) to 177.2 m (north)
Compacted Granular A	700 kPa	350 kPa	Fill base at or below 176.2 to 177.2 m

B – Steel H-Piles

Steel H-piles driven to refusal within very dense sand, very dense sand and gravel or very dense sandy silt till, may be used to provide foundation support. The preliminary design geotechnical resistances and tip elevations are as follows:

Pile	Axial Geotechnical Resistance		Downdrag Load	Anticipated Pile Tip Elevation
	Factored ULS	SLS		
HP 310 x 110	1600 kN	1400 kN	Not applicable	At or below Elev.167 m

C – Caissons

Caissons are not recommended at this site due to probable installation problems related to water bearing cohesionless deposits, a high groundwater table, the associated potential of base boiling, and the potential presence of cobbles and boulders in the Sand and Gravel and Sandy Silt Till.

Recommended Foundation Alternative

From a foundation engineering perspective, the recommended foundation alternative at this site is H-piles driven to refusal within the very dense sand, very dense sand and gravel or very dense sandy silt till at or below Elev.167 m. Alternatively spread footings may be used if dewatering is implemented.

- **APPROACHES**

Up to 8.0 m of fill, including removal and replacement of the organics layer, will be required to construct the highway mainline approaches.

Stability

Fill embankments up to 8.0 m in height are anticipated to be stable at side slope inclinations of 2H : 1V using SSM or better material.

Settlement

Foundation settlement will occur as fill is placed and should be completed by the end of construction. It is estimated that foundation settlement will be around 25 mm.

- **CONSTRUCTION CONSIDERATIONS**

Pile Installation

During pile installation through glacially derived soils at this site, there is a medium probability of encountering cobbles or boulders. Driving shoes should be fitted to the pile tips for reinforcement and enhancing seating of the piles.

Excavation

Excavations will be required for footing and pile cap construction. No excavation should be carried out in the floodplain below the water table without prior dewatering. Temporarily unsupported side slopes should not be steeper than 1H : 1V where groundwater control measures are implemented as outlined below. In accordance with the OHSA, sands above and below the groundwater level are classified as Type 3 and 4 soils, respectively.

Groundwater/Surface Water Control

The groundwater table is near the floodplain grade. Prior to excavations, groundwater control systems such as well points and/or interlocking sheetpiled cofferdams would be required. Diversion of stream flow and diversion of surface runoff from the excavation and pumping from carefully constructed, filtered sumps should be used to supplement the above systems. The required groundwater control systems should be further assessed during detail design.

Protection Systems

Protection systems are not expected to be required at this site.

Floodplain Access

Potential environmental impacts will need to be minimized during construction access into the floodplain. Specific access preparation procedures including the use of gravel roadways underlain by geosynthetics should be considered.

- **RECOMMENDATIONS FOR ADDITIONAL WORK**

Further subsurface investigation, analysis and design should be carried out during detail design to confirm the subsoil conditions at the location of the culvert. As a minimum, this is likely to require additional boreholes along the culvert alignment. The feasibility and cost effectiveness of alternate dewatering systems would need to be investigated.

PART A - PRELIMINARY FOUNDATION INVESTIGATION REPORT
HWY 407 EAST EXTENSION – CENTRAL SECTION
W.O. 07 – 20016

LOCATION No:	CM-20/20b

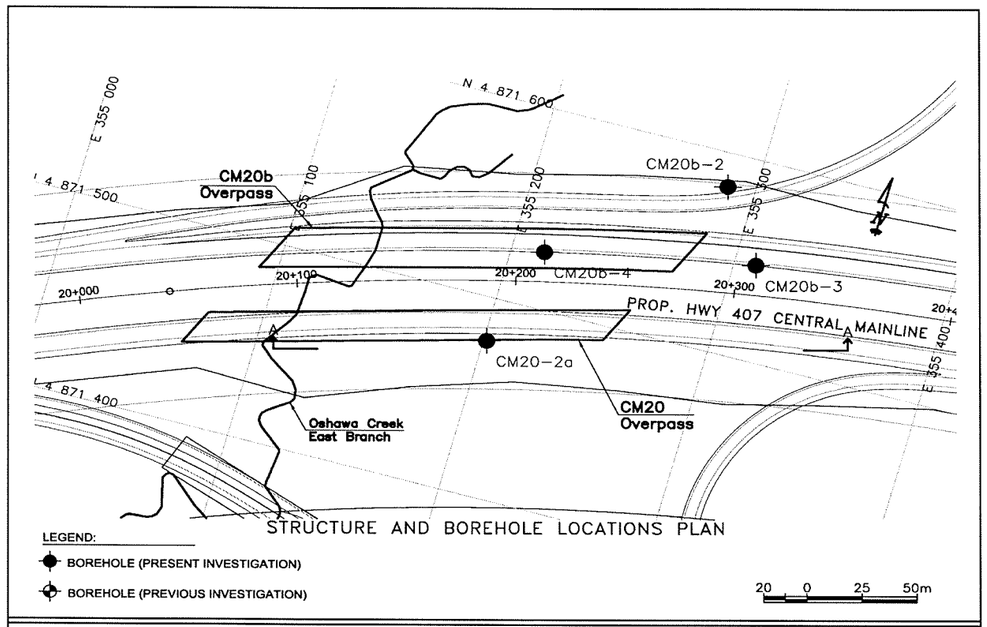
Structure Description: Overpass Highway 407 Central Mainline/Oshawa Creek Tributary & Valley

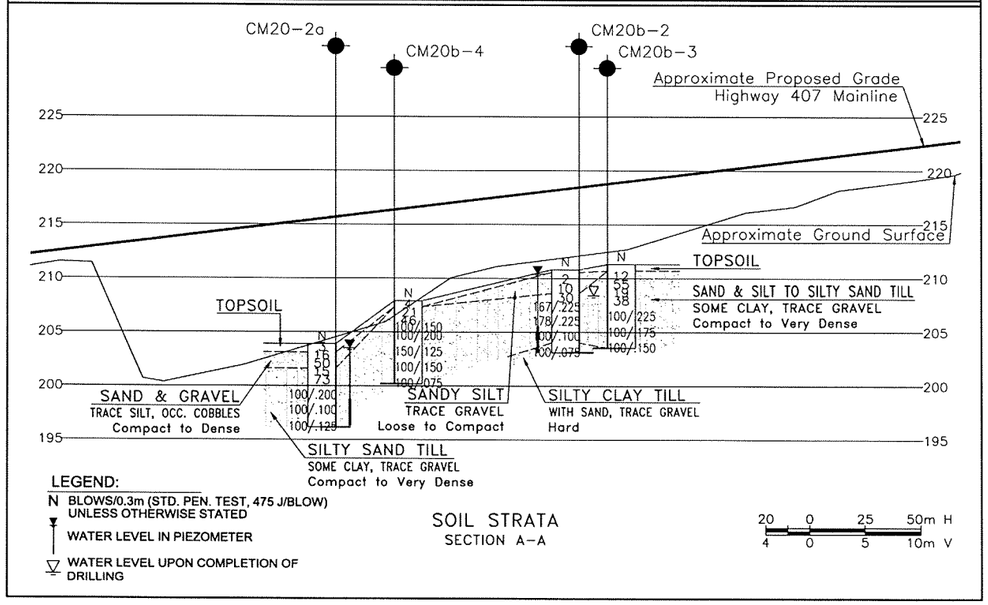
Highway 407 Proposed Grade: ~ El. 215 to 219 m

Existing Ground Elevation: ~ El. 200 m (creek level)
~ El. 210 m (west abutment)
~ El. >202 m (east abutment)

Site Ranking: Medium

Station: ~ 20+120 (at creek)





FOUNDATION INVESTIGATION

Site Description:

This site is underlain by a complex of alluvium-filled stream channels within a broader area of silt till ground moraine. The relief of the ground moraine is low to rolling and imperfectly drained. The alluvial bands are typically low plain, poorly to very poorly drained. The groundwater table is anticipated to be close to the ground surface within the valleys.

Borehole Information:

Borehole No.	Borehole Location	MTM NAD 83 – Northing	MTM NAD 83 - Easting	Borehole Elevation (m)	Borehole Depth (m)
CM20b-3	East Abutment / Approach (CM20b Overpass)	4 871 546.8	355 310.8	211.3	7.8
CM20b-2		4 871 583.0	355 287.2	210.8	7.7
CM20b-4	Piers (floodplain)(CM20b)	4 871 528.7	355 215.2	207.9	7.7
CM20-2a	Piers (floodplain) (CM20 Overpass)	4 871 478.2	355 201.5	203.9	7.7

Subsurface Conditions:

- **Topsoil:** Topsoil between 250 and 800 mm in thickness, and containing roots and trace gravel was encountered in all five boreholes. Larger thickness of topsoil was noted in the floodplain area. The thickness and extent of topsoil are expected to vary between and beyond the borehole locations, and the information in this report should not be used for quantity estimating purposes.
- **Sand and Gravel:** Sand and gravel was encountered below the topsoil in Borehole CM20-2a. The thickness of this deposit is up to 1.5 m with an underside at Elev. 201.6 m. This soil is in a compact to dense state ('N' values of 16 to 50 blows/0.3m penetration). Measured moisture contents were from 7 to 10%.
- **Sandy Silt:** Sandy silt with trace gravel was encountered below the topsoil in Borehole CM20b-2. The thickness of this deposit is 1.9 m with an underside at Elev. 208.6 m. This soil is in a very loose to compact state ('N' values of 2 and 10 blows/0.3m penetration). Measured moisture contents were from 18 to 19%.
- **Sand and Silt Till:** Sand and silt till containing some clay and trace gravel was encountered below the sandy silt in Boreholes CM20b-2 and below the topsoil in Borehole CM20b-3. This till deposit is 4.6 m thick with an underside at Elev. 204.0 m in Borehole CM20b-2. The thickness of this till deposit is more than 7.2 m with an underside below Elev. 203.5 m where Borehole CM20b-3 was terminated. The till is generally compact becoming very dense with depth ('N' values from 12 blows/0.3m penetration to >100 blows for <0.3m penetration). Glacial tills typically contain cobbles and boulders. Figure CM20/20b-B1 presents grain size test results for sand and silt till samples. Measured moisture contents of these soils ranged between 5 and 15%.
- **Silty Sand Till:** Silty sand till containing some clay and trace gravel was encountered below the surficial soils in Boreholes CM20-2a and CM20b-4. This till deposit is more than 7.1 m thick with an underside below Elev. 200.2 m in Borehole CM20b-4. The thickness of this till deposit is at least 5.4 m with an underside at Elev. 196.2 m where Borehole CM20-2a was terminated. This till is generally compact becoming very dense with depth ('N' values from 15 blows/0.3m penetration to >100 blows for <0.3m penetration). Glacial tills typically contain cobbles and boulders. Figure CM20/20b-B3 presents grain size distribution curves for samples of the silty sand till. Measured moisture contents of these soils ranged between 5% and 10%.
- **Silty Clay Till:** A deposit of grey silty clay till with sand and trace gravel was encountered below the sand and silt till in Borehole CM20b-2. Borehole CM20b-2 was terminated in this till at Elev. 203.1 m. This cohesive till has a hard consistency ('N' value of >100 for <0.3m penetration). Figure CM20/20b-B2 presents the grain size distribution curve of a sample of this till. A moisture content of about 9% was measured.

Groundwater Conditions:

- **BH CM20b-2:** 0.4 m depth (Elev. 210.4 m) in piezometer on February 12, 2009.
- **BH CM20-2a:** 0.4 m depth (Elev. 203.5 m) in piezometer on February 12, 2009.
- **BH CM20b-3:** 3.1 m depth* (Elev. 208.2 m*) in open borehole in May 26, 2008. * Unstabilized groundwater level

Record of Borehole Sheets – Appendix A | **Laboratory Test Results – Appendix B** | **Key Location Plan – Figure 1**

Thurber Engineering Ltd.

FOUNDATION RECOMMENDATIONS

Note: The site specific foundation recommendations are for planning purposes only. Refer to Section 6 of the Foundation Design Report for the project-wide foundation recommendations, design assumptions and limitations.

General : Twin three-span structures each with two abutments and two piers are proposed.

Foundation Option	*Advantages*	*Disadvantages*
Spread Footings founded on dense to very dense sand and silt till with high groundwater table (East Abutment)	- Conventional construction	- Variability of surficial soils; requires sub-excavation up to 2.2m depth to reach competent founding soils - Unwatering and protection (temporary shoring) systems will likely be required for footing construction - High abutment wall (>10m) due to the proposed highway grade
Spread Footings perched on Granular A pad (East Abutment)	- Lower cost than deep foundations - Minimize excavation requirements	- Variability of surficial soils; sub-excavation of topsoil, organics and loose soils will be required - Protection systems (temporary shoring) may be required
Steel H-Piles driven to very dense sand and silt till (East Abutment)	- Higher bearing resistance - Permits use of integral abutments - Not affected by surficial soil variability	- Higher cost than spread footings - Sub-excavation of topsoil, organics and loose soils at shallow depths for pile cap construction - Unwatering and protection (temporary shoring) systems may be required
Caissons founded within very dense sand and silt till (East Abutment)	- Higher bearing resistance - Not so affected by surficial soil variability	- Higher cost than spread footings - Does not permit integral abutment design - Potential installation problems including side sloughing, liner sealing and base boiling associated with sands and silts below the groundwater table - Need to dislodge and handle cobbles and boulders

A – Spread Footings

Spread footings may be founded on native dense to very dense sand and silt till below the groundwater table. Footings for perched abutments may be founded on compacted Granular A cores in accordance with current MTO practices. The preliminary design geotechnical resistances and founding levels are as follows:

Founding Stratum	Geotechnical Resistance		Foundation Level
	Factored ULS	SLS	
Sand and silt till	600 kPa	400 kPa	At or below Elev. 208.5 m (east abut. – CM20b Overpass) At or below Elev. 206.3 m (piers – CM20b Overpass) At or below Elev. 201.0 m (east pier – CM20 Overpass)
Compacted Granular A	700 kPa	350 kPa	Fill base at or below Elev.210.0m (east abutment – Borehole CM20b-3)

B – Steel H-Piles

Steel H-piles driven to refusal within the very dense sand and silt till may be used to provide foundation support. The preliminary design geotechnical resistances and tip elevations are as follows:

Pile	Axial Geotechnical Resistance		Downdrag Load	Anticipated Pile Tip Elevation
	Factored ULS	SLS		
HP 310 x 110	1,600 kN	1,400 kN	Not applicable	At or below Elev.205 m (east abut. - CM20b) At or below Elev.203.0 m (piers - CM20b) At or below Elev.197.5 m (east pier - CM20)

C - Caissons

Consideration may be given to using augered caissons socketted within the very dense sand and silt till. The preliminary design geotechnical resistances and base elevations for caissons extending 4 m into the very dense (N>100) sand and silt till at the plateau and developing resistance through shaft friction and a portion of end-bearing within the till are as follows:

Caisson Diameter	Axial Geotechnical Resistance		Downdrag Load (Factored ULS)	Highest Founding Level
	Factored ULS	SLS		
1.2 m	4,500 kN	3,600 kN	Not Applicable	Elev. 203 m and below floodplain level (east abutment)
1.5 m	6,500 kN	5,200 kN	Not Applicable	

Given the uncertainties associated with cleaning and inspection of the base, the above recommended values and founding levels must be reassessed during detail design (see Recommendations for Additional Work below). Given the presence of high groundwater table, water-bearing sands and silts and the potential construction difficulties below the groundwater table, the use of caisson foundations in the floodplain is not recommended at this site.

Recommended Foundation Alternative

From a foundation engineering perspective, the recommended foundation alternative at this site is steel H-piles driven to refusal in the very dense sand and silt till.

- **ABUTMENT TYPE**

The soil conditions at the east abutment are suitable for integral and semi-integral abutment design.

- **APPROACHES**

Up to 4 m of fill will be required to construct the highway mainline west approaches, and up to 15 m of fill (approximately 130 m in length) will be required to construct the east approaches.

Stability

For the west approach, fill embankments up to 8 m in height are anticipated to be stable at side slope inclinations of 2H : 1V using SSM or better material. At the east approaches, a 15 m high embankment at 2H : 1V would be stable (Factor of Safety > 1.3) provided that a 2 m wide mid-height bench is incorporated, and that all peat, topsoil and soft/loose alluvium be stripped from under the embankment footprint. Global stability for the high approach fill should be confirmed during detail design.

Settlement

Foundation settlement will occur as fill is placed and should be completed by the end of construction. It is estimated that post construction foundation settlement and fill compression should not exceed 25 and 75 mm at the west and east approaches, respectively.

- **CONSTRUCTION CONSIDERATIONS**

Pile Installation

During pile installation through glacially derived soils at this site, there is a medium probability of encountering cobbles or boulders. Driving shoes should be fitted to the pile tips for reinforcement and enhancing seating of the piles.

Excavation

Excavations will be required for pile cap and/or footing construction. Temporarily unsupported side slopes should not be steeper than 1H : 1V where groundwater control measures are implemented as outlined below. In accordance with the OHSA, sands and silts above and below the groundwater level are classified as Type 3 and Type 4 soils, respectively.

Groundwater/Surface Water Control

The groundwater table is within 0.3 m of the existing ground surface. Prior to excavations in the floodplain, groundwater control systems such as well points and/or interlocking sheetpiled cofferdams would be required. Diversion of surface runoff from the excavation and pumping from carefully constructed, filtered sumps may be used to supplement the above systems. The required groundwater control systems should be further assessed during detail design.

Protection Systems

Protection systems would be required at excavation locations where stable slopes cannot be constructed due to space limitations and where vertically sided excavations are used for footing or pile cap construction. One possible system is an interocking sheetpiled cofferdam which can also be used for groundwater cutoff as outlined above. The feasibility of installing protection systems should be assessed once further subsurface investigation is carried out during detail design.

Floodplain Access

Potential environmental impacts will need to be minimized during construction access into the sensitive floodplain. Specific access preparation procedures including the use of gravel roadways underlain by geosynthetics should be considered.

- **RECOMMENDATIONS FOR ADDITIONAL WORK**

Further subsurface investigation, analysis and design should be carried out during detail design to confirm the subsoil conditions at the location of the bridge foundation elements. As a minimum, this is likely to require additional boreholes at the actual abutment and pier locations and at the approaches. The feasibility and cost effectiveness of alternate unwatering systems would need to be investigated. Should caissons be adopted for foundation support, additional deeper boreholes will need to be drilled to obtain additional subsurface information to reassess the caisson design.

PART A - PRELIMINARY FOUNDATION INVESTIGATION REPORT
HWY 407 EAST EXTENSION – CENTRAL SECTION
W.O. 07 – 20016

LOCATION No:	CM-20c

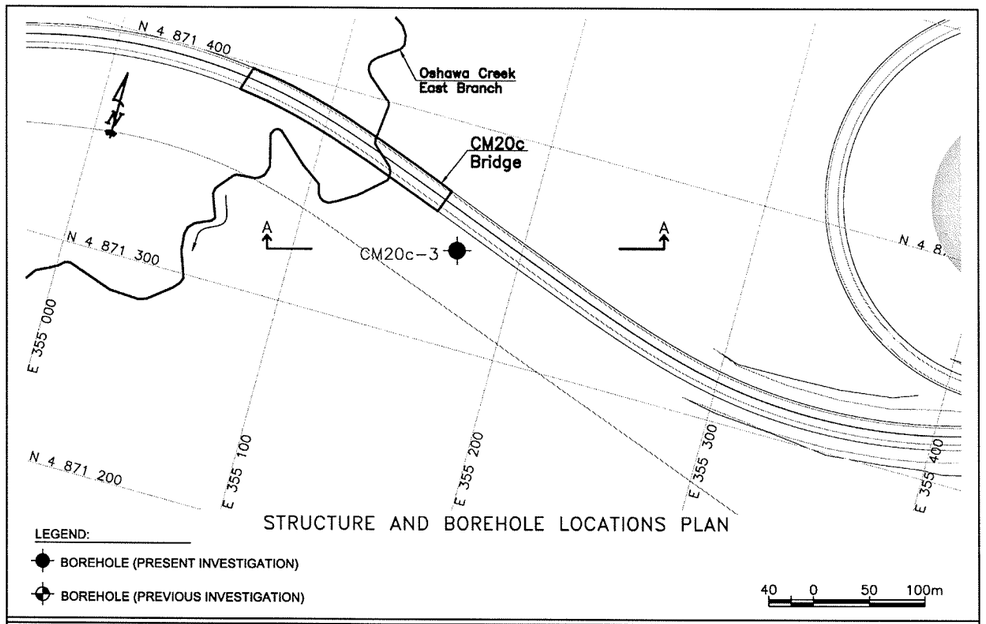
Structure Description: Highway 407E Ramp over East Branch Oshawa Creek

Highway 407 Proposed Grade: ~ El. 210

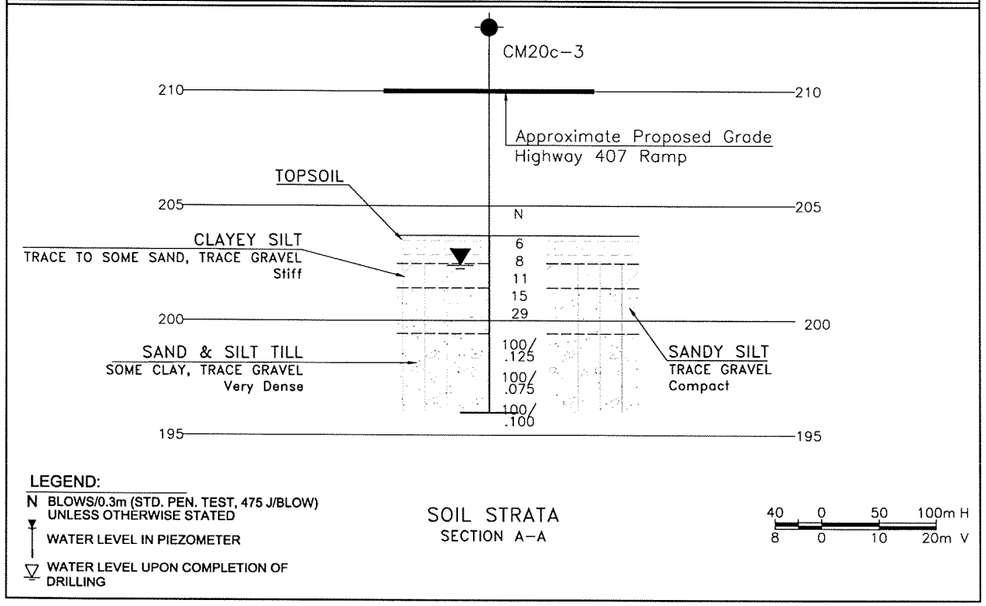
Existing Ground Elevation: ~ El. 198 m (creek level)
~ El. 208 m (west abutment)
~ El. 202 m (east abutment)

Site Ranking: Medium

Station: ~ 10+200



STRUCTURE AND BOREHOLE LOCATIONS PLAN



SOIL STRATA
SECTION A–A

FOUNDATION INVESTIGATION

Site Description:
This site is underlain by a complex of alluvium-filled stream channels within a broader area of silt till ground moraine. The relief of the grou moraine is low to rolling and imperfectly drained. The alluvial bands are typically low plain, poorly to very poorly drained. The groundwater table anticipated to be close to the ground surface within the valleys.

Borehole Information:

Borehole No.	Borehole Location	MTM NAD 83 – Northing	MTM NAD 83 - Easting	Borehole Elevation (m)	Borehole Depth (m)
CM20c	East abutment	4 871 343.4	355 171.6	203.7	7.7

Boreholes could not be drilled near the west abutment or pier locations since permission to enter these areas was not available.

Subsurface Conditions:

- **Topsoil:** 1.2m of brown topsoil was encountered in borehole CM20c-3. The thickness and extent of topsoil are expected to vary througho the area and the information in this report should not be used for quantity estimating purposes.

- **Clayey Silt:** Brown clayey silt with trace to some sand and trace gravel was encountered below the topsoil. The thickness of this deposit 1.1 m with an underside at Elev. 201.4 m. This clayey silt is stiff with an 'N' value of 11blows/0.3m penetration. Measured water content was arou 17%.

- **Sandy Silt:** Brown sandy silt with trace gravel was encountered below the clayey silt. The thickness of this deposit is 2 m with an undersi at Elev. 199.4 m. This sandy silt is compact with 'N' values of 15 and 29 blows/0.3m penetration. Measured moisture contents ranged from 14 19%.

- **Sand and Silt Till:** Brown sand and silt till with some clay and trace gravel was encountered below the sandy silt. Borehole CM20c-3 w terminated in this till at 7.7 m depth (Elev. 196.0 m). The till is very dense with 'N' values of 100 blows for less than 0.3m penetration. Measur moisture contents of these soils ranged between 6 and 12%. Glacial tills typically contain cobbles and boulders. A grain size distribution curve for sample of this till is presented in Figure CM20c-B1.

Groundwater Conditions:

- **BH CM20c-3:** 0.4 m depth (Elev. 203.3 m) in piezometer on February 12, 2009.
1.3 m depth (Elev. 202.4 m) in piezometer on May 4, 2009.
1.3 m depth (Elev. 202.4 m) in piezometer on June 6, 2009.

Record of Borehole Sheets – Appendix A | **Laboratory Test Results – Appendix B** | **Key Location Plan – Figure 1**

Thurber Engineering Ltd.

LOCATION No:	CM-20c

FOUNDATION RECOMMENDATIONS

Note: The site specific foundation recommendations are for planning purposes only. Refer to Section 6 of the Foundation Design Report for the project-wide foundation recommendations, design assumptions and limitations.

General : A three-span structure with two abutments and two piers is proposed.

Foundation Option	*Advantages*	*Disadvantages*
Spread Footings founded on compact sandy silt	- Conventional Construction - Low cost alternative	- Variability of surficial soils; requires sub-excavation up to 3.2m depth to reach competent founding soils - Dewatering and protection (temporary shoring) systems will likely be required for footing construction - Does not allow integral abutment design - Scour protection is required for footings in floodplain
Spread Footings perched on Granular A pad	- Lower cost than deep foundations - Minimize excavation requirements	- Variability of surficial soils; sub-excavation of topsoil will be required;
Steel H-Piles driven to very dense sand and silt till	- Higher bearing resistance - Permits use of integral abutments - Not affected by surficial soil variability	- Higher cost than spread footings - Sub-excavation of topsoil for pile cap construction - Unwatering and protection (temporary shoring) systems may be required
Caissons founded within very dense sand and silt till	- Higher bearing resistance - Not so affected by surficial soil variability	- Higher cost than spread footings - Does not permit integral abutment design - Require liners to address installation problems including side sloughing associated with cohesionless soils - Need to dislodge and handle cobbles and boulders - Potential for base boiling - Sub-excavation of topsoil for pile cap construction - Unwatering and protection (temporary shoring) systems may be required

A – Spread Footings

Spread footings may be founded on native compact sandy silt below the groundwater table. Footings for perched abutments may be founded on compacted Granular A cores in accordance with current MTO practices. The preliminary design geotechnical resistances and founding levels are as follows:

Founding Stratum	Geotechnical Resistance		Foundation Level
	Factored ULS	SLS	
Sandy Silt	450 kPa	300 kPa	East abutment: At or below Elev. 200.5 m
Compacted Granular A	700 kPa	350 kPa	East abutment: Fill base at or below Elev. 202.4 m

B – Steel H-Piles

Steel H-piles driven to refusal within the very dense sand and silt till may be used to provide foundation support. The preliminary design geotechnical resistances and tip elevations are as follows:

Pile	Axial Geotechnical Resistance		Downdrag Load	Anticipated Pile Tip Elevation
	Factored ULS	SLS		
HP 310 x 110	1,600 kN	1,400 kN	Not applicable	East abut: At or below Elev.197 m

C - Caissons

Caissons are not recommended at this site due to potential installation problems in cohesionless deposits in the floodplain, the associated potential of base boiling and the potential presence of cobbles and boulders in till deposits.

Recommended Foundation Alternative

From a foundation engineering perspective, the recommended foundation alternative for the east abutment at this site is steel H-piles driven to refusal in the very dense sand and silt till. Alternatively, spread footings founded on compact sandy silt may be used, provided dewatering is implemented. Additional drilling is required in the floodplain to confirm suitable foundation design which will be influenced by the depth of alluvial deposits, the depth of scour and geomorphology of the creek.

- **ABUTMENT TYPE**

The soil conditions at the east abutment are suitable for conventional, semi-integral or integral abutment design.

- **APPROACHES**

Up to 9 m of fill will be required to construct the highway ramp east approach.

Stability

For the east approach, fill embankments up to 9 m in height are anticipated to be stable at side slope inclinations of 2H : 1V using SSM or granular material.

Settlement

Foundation settlement will occur as fill is placed and should be completed by the end of construction. It is estimated that post construction foundation settlement and fill compression combined should not exceed 75 mm at the east approach.

- **CONSTRUCTION CONSIDERATIONS**

Pile Installation

During pile installation through glacially derived soils at this site, there is a medium probability of encountering cobbles or boulders. Driving shoes should be fitted to the pile tips for reinforcement and enhancing seating of the piles.

Excavation

Excavations will be required for pile cap and/or footing construction. Temporarily unsupported side slopes should not be steeper than 1H : 1V where groundwater control measures are implemented as outlined below. In accordance with the OHSA, sands and silts above and below the groundwater level are classified as Type 3 and Type 4 soils, respectively.

Groundwater/Surface Water Control

The groundwater table is within 1.3 m of the existing ground surface. Prior to excavations in the floodplain, groundwater control systems such as well points and/or interlocking sheetpiled cofferdams would be required. Diversion of surface runoff from the excavation and pumping from carefully constructed, filtered sumps may be used to supplement the above systems. The required groundwater control systems should be further assessed during detail design.

Protection Systems

Protection systems would be required at excavation locations where stable slopes cannot be constructed due to space limitations and where vertically sided excavations are used for footing or pile cap construction. Protection system will be required for foundation construction in the floodplain. One possible system is an interlocking sheetpiled cofferdam which can also be used for groundwater cutoff as outlined above. The feasibility of installing protection systems should be assessed once further subsurface investigation is carried out during detail design.

Floodplain Access

Potential environmental impacts will need to be minimized during construction access into the sensitive floodplain. Specific access preparation procedures including the use of gravel roadways underlain by geosynthetics should be considered.

- **RECOMMENDATIONS FOR ADDITIONAL WORK**

Further subsurface investigation, analysis and design should be carried out during detail design to confirm the subsoil conditions at the location of the bridge foundation elements. As a minimum, this is likely to require additional boreholes at the actual abutment and pier locations and at the approaches. Boreholes will need to be advanced below the anticipated pile tip elevations mentioned above in order to confirm the occurrence of appropriate foundation material. The feasibility and cost effectiveness of alternate unwatering systems would need to be investigated.

PART A - PRELIMINARY FOUNDATION INVESTIGATION REPORT
HWY 407 EAST EXTENSION – CENTRAL SECTION
W.O. 07 – 20016

LOCATION No:	CM-21/21b

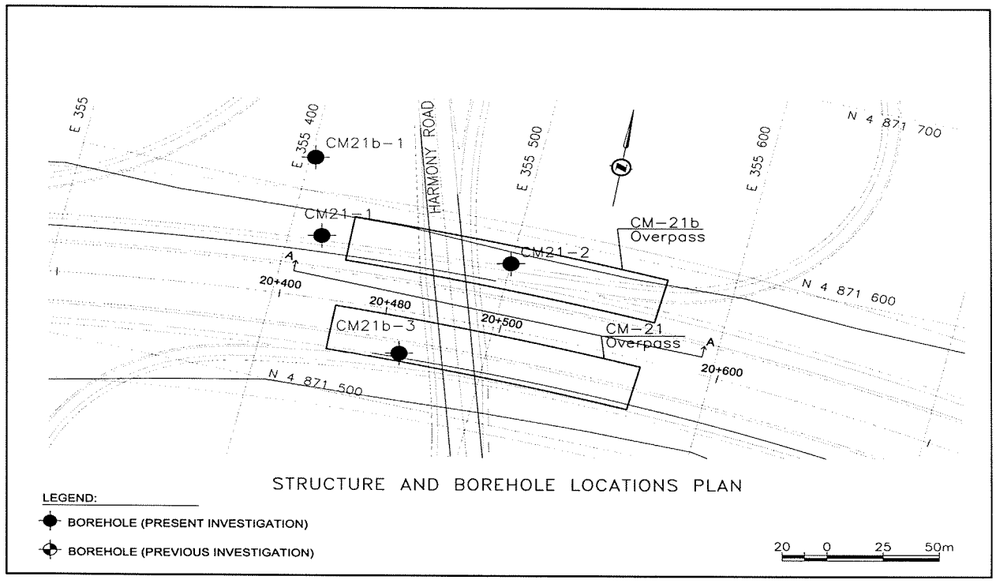
Structure Description: Overpass Highway 407 Mainline / Harmony Road North

Highway 407 Proposed Grade: ~ El. 226 – 227.5 m

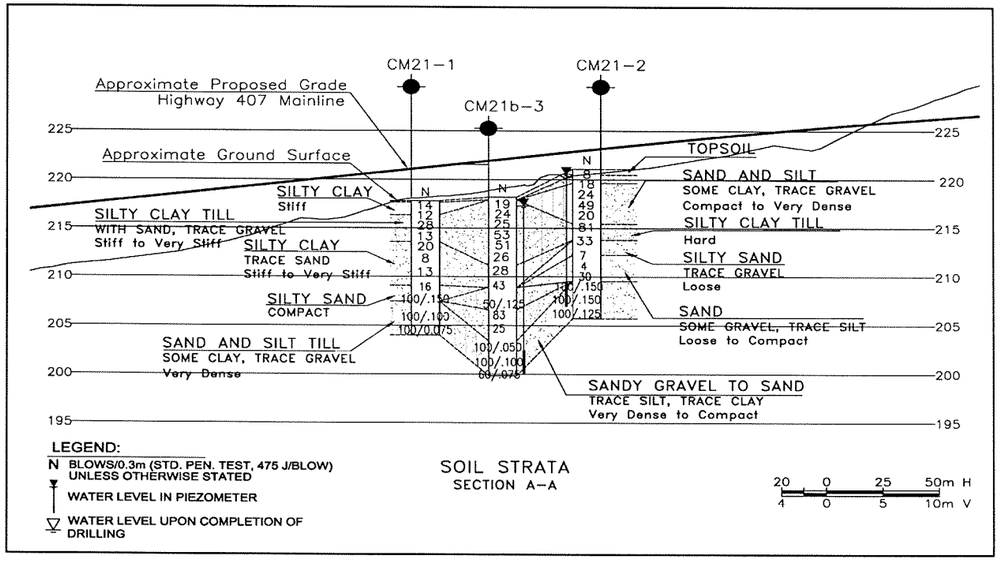
Existing Ground Elevation: ~ El. 219 – 220.5 m

Site Ranking: Medium

Station: 20+480



STRUCTURE AND BOREHOLE LOCATIONS PLAN



SOIL STRATA
SECTION A–A

20 0 25 50m H
4 0 5 10m V

FOUNDATION INVESTIGATION

Site Description:

At this site, the existing Harmony Road North is a two-lane, undivided paved road surrounded by agricultural lands. The relief is low, rolling to kettled, imperfectly to poorly drained, and is mapped as being underlain by silt till ground moraine dissected by narrow bands of alluvium.

Borehole Information:

Borehole No.	Borehole Location	MTM NAD 83 – Northing	MTM NAD 83 - Easting	Borehole Elevation (m)	Borehole Depth (m)
CM21-1	West Approaches/Abutments	4 871 578.4	355 414.6	217.8	13.8
CM21-2	East Piers/Approaches	4 871 584.2	355 499.9	221.1	15.4
CM21b-1	-	4 871 617.4	355 402.4	216.8	15.3
CM21b-3	West Piers	4 871 527.0	355 462.3	218.2	18.4

Subsurface Conditions:

- **Topsoil:** Topsoil ranging between 150 and 600 mm in thickness was encountered in all four boreholes. Topsoil thickness may vary between and beyond borehole locations, and should not be used for quantity estimating purposes.
- **Sandy Silt, Silty Sand, Sand:** Layers of sandy silt, silty sand and sand were found interlayered with the silty clay and glacial tills in all the boreholes. These layers are generally between 0.3 and 2.7 m in thickness and their underside elevations vary between 219.6 and 203.4 m. These cohesionless soils are brown in colour at shallow depth becoming grey with depth, and are typically in a loose to compact state ('N' values from 3 to 30 blows/0.3m penetration). Figures CM21-B1 and CM21–B2 present the grain size distribution curves of sand, sand and silt samples. Measured water contents of these soils ranged between 8% and 22%.
- **Silty Clay:** Deposits of silty clay were encountered in Boreholes CM21-1 and CM21b-3. Where encountered, this cohesive soil is brown in colour at shallow depth becoming grey below the groundwater level. The thickness of these cohesive deposits is between 1.2 and 4.7 m, and the underside of the layers varies from Elev. 216.4 to 208.9 m. It has a stiff to very stiff consistency ('N' values of 8 and 28 blows/0.3m penetration). Figures CM21-B3 and CM21-B4 present the grain size distribution curves and Atterberg limits results for two samples of this soil. Measured water contents varied from 17% to 22%.
- **Silty Clay Till:** Silty clay till, with sand, trace gravel and occasional cobbles, was encountered in all four boreholes. Where encountered, the thickness of this cohesive till ranges between 1.7 and 7.9 m. The underside of this till lies between Elev. 208.7 and 213.8 m. This soil has a generally brown colour becoming grey with depth, and has a typically stiff to hard consistency ('N' values from 12 to 70 blows). Figures CM21-B5 and CM21-B6 present laboratory test results for samples of the silty clay till. The Atterberg Limits tests indicate that this till has a low plasticity (LL=24 to 29, PI=11 to 15 for the silty clay matrix). Measured water contents of this till ranged from 8% to 15%.
- **Sand and Silt Till:** Sand and silt till, some clay and trace gravel, was found interlayered with the above deposits. Where fully penetrated, the thickness of the upper portion of the sand and silt till ranges from 2.3 to 4.2 m. All four boreholes were terminated within the lower portion of the till between Elev. 199.8 and 205.7 m. This cohesionless till is brown to grey in colour and contains inferred cobbles. The upper portion of the till is compact to very dense ('N' values of 18 to 81 blows/0.3m penetration), while the lower portion of the till is very dense throughout ('N' values of >100 blows for <0.3 m penetration). In Borehole CM21b-3, a 3.2 m thick layer of very dense to compact ('N' values of 83 and 25 blows) sandy gravel to sand was encountered within the till. Glacial tills inherently contain cobbles and boulders as evident from the SPTs. Figures CM21-B7 presents grain size distribution curves for samples of this till. Measured water contents typically varied between 5% and 10%.

Groundwater Conditions:

- **BH CM21-1:** 4.1 m depth (Elev. 213.7 m) in open borehole on March 6, 2008.
- **BH CM21-2:** 0.1 m depth (Elev. 221.0 m) in piezometer on July 28, 2008.
- **BH CM21b-1:** 0.7 m depth (Elev. 216.1 m) in piezometer on July 29, 2008.
- **BH CM21b-3:** 0.6 m depth (Elev. 217.6 m) in piezometer on February 12, 2009.

Record of Borehole Sheets – Appendix A **Laboratory Test Results – Appendix B** **Key Location Plan – Figure 1**

Thurber Engineering Ltd.

LOCATION No:	CM-21/21b

FOUNDATION RECOMMENDATIONS

Note: The site specific foundation recommendations are for planning purposes only. Refer to Section 6 of the Foundation Design Report for the project-wide foundation recommendations, design assumptions and limitations.

General: A multi-span structure with two abutments and piers is proposed.

Foundation Option	*Advantages*	*Disadvantages*
Spread Footings founded on stiff to hard silty clay/silty clay till, or compact to very dense sand/silt till	- Conventional construction	- Potential variability of surficial soils; sub-excavation up to 2.1 m below existing ground surface may be required - Lower bearing resistance when founded on compressible soils, e.g. west abutments - Unwatering/protection systems (temporary shoring) may be required
Spread Footings perched on Granular A pads for abutments	- Lower cost than deep foundations - Minimize excavation requirements	- Higher cost than spread footings on native soils - Potential variability of surficial soils; sub-excavation of topsoil/disturbed soils is required
Steel H-Pile driven into very dense sand and silt till	- Higher bearing resistance - Permits use of integral abutments - Not affected by surficial soil variability	- Higher cost than spread footings
Caissons founded in very dense sand and silt till	- Higher bearing resistance - Not so affected by surficial soil variability	- Higher cost than spread footings - Does not permit integral abutment design - Potential installation problems due to high groundwater level and sands/silts

A - Spread Footings

Spread footings founded on stiff to hard silty clay/silty clay till deposits, and on compact to very dense sand/silt till, may be used for closed abutments and piers. Footings for perched abutments may be founded on compacted Granular A cores in accordance with current MTO practices. The preliminary design geotechnical resistances and founding levels are as follows:

Founding Stratum	Geotechnical Resistance		Foundation Level
	Factored ULS	SLS	
Silty Clay / Silty Clay Till	300 kPa	200 kPa	At or below Elev. 216.3 m – West Abutments
Silty Clay Till / Sand/Silt Till	450 kPa	300 kPa	At or below Elev. 216.8 m – West Piers
			At or below Elev. 219.0 m – East Abutments and Piers
Compacted Granular A	700 kPa	350 kPa	Base of Fill Pad at/below Elev. 217.0 m – West Abutment
			Base of Fill Pad at/below Elev. 220.0 m – East Abutment

B - Steel H-Piles

Steel H-piles driven to refusal within the lower deposit of very dense sand and silt till may be used to provide foundation support. The preliminary design geotechnical resistances and tip elevations are as follows:

Pile	Axial Geotechnical Resistance		Downdrag Load	Anticipated Pile Tip Elevation
	Factored ULS	SLS		
HP 310 x 110	1,600 kN	1,400 kN	Not applicable	At or Below Elev.208 m – East Abutments/Piers
				At or Below Elev. 206 m – West Abutments
				At or Below Elev. 202 m – West Piers

C – Caissons

Based on the presence of water-bearing cohesionless deposits, the high groundwater table and the associated potential of base boiling, the use of caisson foundations is not recommended and the option has not been developed.

Recommended Foundation Alternative

The recommended foundation alternative at this site is steel H-piles driven into the very dense sand and silt till. Alternatively, spread footings founded on the very stiff to hard silty clay till or compact to very dense sand and silt till may be used for the piers.

- **ABUTMENT TYPE**

The soil conditions at this site are suitable for integral abutment design.

- **APPROACHES**

General

Assuming the proposed Harmony Road grade is at or below about Elev. 219 to 220 m, approximately 7 to 8 m of fill will be required to construct the highway mainline approaches. Retaining walls may be required at locations where property restrictions do not allow formation of stable permanent cut slopes.

Stability

Approach embankments up to 10 m in height are anticipated to be stable at side slope inclinations of 2H : 1V using SSM or better material.

Settlement

Foundation settlement will occur as fill is placed. It is estimated that the magnitude of such settlement would be less than 25 mm. It is expected that a majority of the settlement would be completed by the end of construction.

- **CONSTRUCTION CONSIDERATIONS**

Pile Installation

During pile installation, there is a low probability of encountering cobbles or boulders within the sand and silt till. Pile driving shoes should be fitted to the pile tips for reinforcement and to enhance seating of the piles.

Excavation

Shallow excavations below the road grade are required for footing construction. Temporary unsupported side slopes should not be steeper than 1H : 1V at this site. In accordance with the OHSA, native soils above the groundwater level are classified as Type 2 soils, while native soils below the groundwater level and all fills are classified as Type 3 soils.

Groundwater/Surface Water Control

It is anticipated that much of the water accumulation within excavations will be from surface runoff, with some contribution of seepage from the water-bearing sands and silts. Diversion of surface runoff from the excavations and pumping from carefully constructed, filtered sumps should be adequate to control the water during construction.

Protection Systems

Protection systems may be required at excavation locations where stable slopes cannot be constructed due to space limitations and where vertically sided excavations are used for footing construction. Possible systems include soldier piles and lagging, and interlocking sheetpiles. The feasibility of installing protection systems should be assessed once further subsurface investigation is carried out during detail design.

- **RECOMMENDATIONS FOR ADDITIONAL WORK**

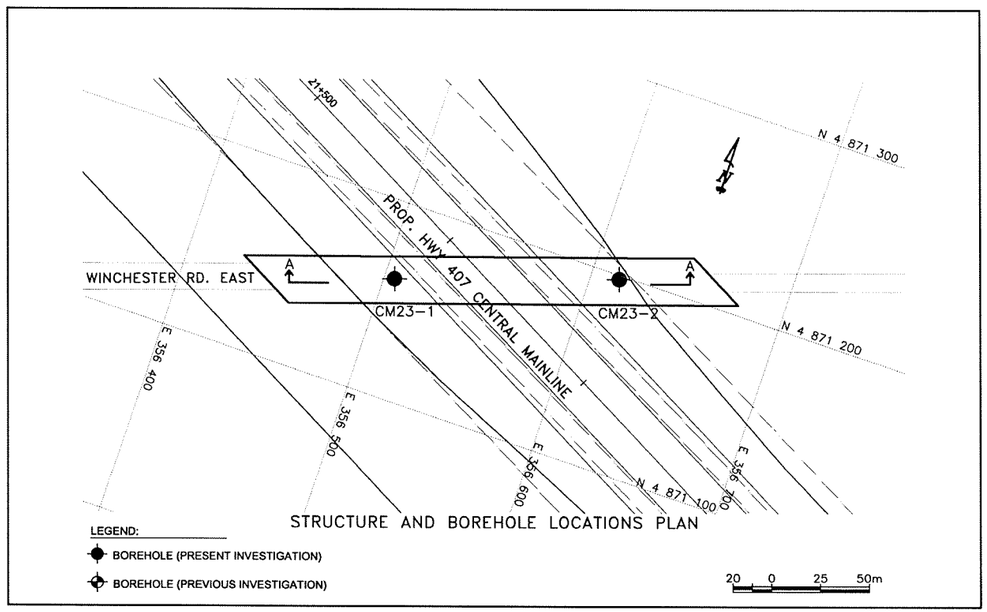
Further subsurface investigation, analysis and design should be carried out during detail design to confirm the subsoil conditions at the location of the bridge foundation elements. As a minimum, this is likely to require additional boreholes at the actual abutment and pier locations, and the approaches. The feasibility of using spread footings founded on compressible materials, such as those encountered near the west abutment, should be further assessed.

PART A - PRELIMINARY FOUNDATION INVESTIGATION REPORT
HWY 407 EAST EXTENSION – CENTRAL SECTION
W.O. 07 – 20016

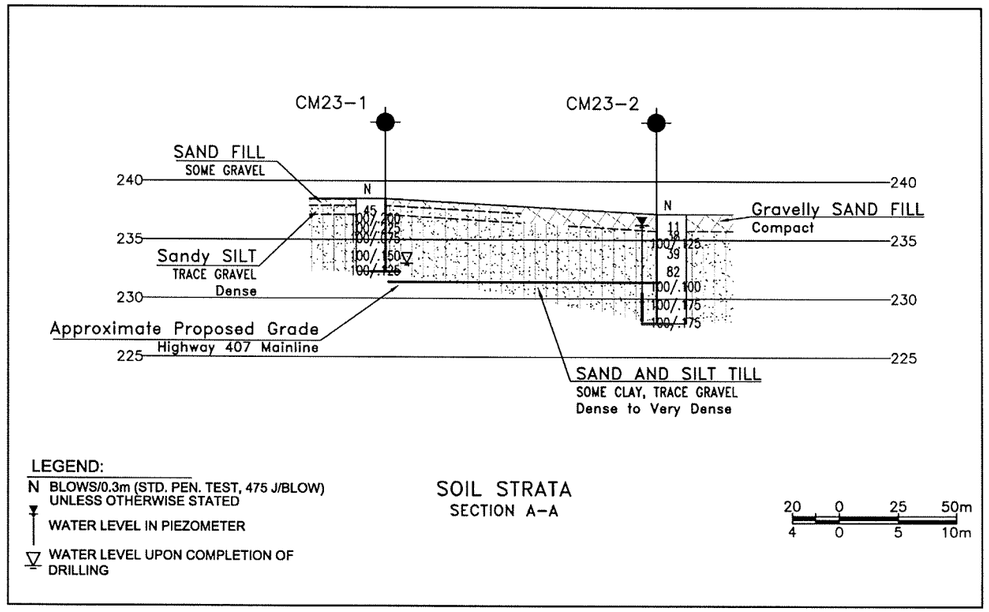
LOCATION No:	CM-23

Structure Description: Underpass Highway 407 Mainline / Winchester Road East.

Highway 407 Proposed Grade: ~ El. 231 m
Existing Ground Elevation: ~ El. 237.2 to 238.5 m
Site Ranking: Medium
Station: ~ 21+630



STRUCTURE AND BOREHOLE LOCATIONS PLAN



SOIL STRATA
SECTION A–A

FOUNDATION INVESTIGATION

Site Description:
At this site, Winchester Road East is an existing two-lane, rural undivided roadway surrounded by farmlands. The terrain is locally flat, and is mapped as silt till ground moraine. The relief is low, rolling and imperfectly drained.

Borehole Information:

Borehole No.	Borehole Location	MTM NAD 83 – Northing	MTM NAD 83 - Easting	Borehole Elevation (m)	Borehole Depth (m)
CM23-1	West side	4 871 160.7	356 505.3	238.5	6.2
CM23-2	East side	4 871 198.0	356 614.4	237.2	9.3

Subsurface Conditions:

- **Pavement Structure:** A 75 mm thick layer of asphalt underlain by a 0.5m thick layer of brown sand fill with some gravel was encountered in borehole CM23-1. The measured moisture content was around 4%.

- **Gravelly Sand Fill:** Brown gravelly sand fill was encountered to 1.4 m depth (Elev. 235.8 m) in borehole CM23-2. This cohesionless fill is compact with an 'N' value of 11 blows/0.3m penetration. Measured moisture content ranged from 3 to 14%.

- **Sandy Silt:** Brown sandy silt with trace of gravel was encountered below the pavement structure in borehole CM23-01. This layer is 0.8m thick with an underside at Elev. 237.1m. This sandy silt layer is dense with an 'N' value of 45 blows/0.3m penetration and measured moisture content of 19%.

- **Sand and Silt Till:** A deposit of brown sand and silt till with some clay and trace of gravel was encountered below the sandy silt in borehole CM23-1 and below the gravelly sand fill in borehole CM23-2. Boreholes CM-23-1 and CM23-2 were terminated in this till at 6.2 m depth (Elev. 232.3 m) and 9.3 m depth (Elev. 227.9 m) respectively. This till is dense to very dense with 'N' values ranging from 38 to more than 100 blows for less than 0.3m penetration. Moisture contents ranged from 7 to 11%. Grain size distribution curves for samples of this soil are presented in Figure CM23-B1. Glacial tills typically contain cobbles and boulders.

Groundwater Conditions:

- **BH CM23-1:** 5.5 m depth (Elev. 233 m) in open borehole on December 11, 2008 (unstabilized reading).

- **BH CM23-2:** 0.80 m depth (Elev. 236.5 m) in piezometer on December 08, 2008.
  0.95 m depth (Elev. 236.25 m) in piezometer on April 30, 2009.
  1.84 m depth (Elev. 235.36 m) in piezometer on July 21, 2009.

Record of Borehole Sheets – Appendix A | **Laboratory Test Results – Appendix B** | **Key Location Plan – Figure 1**

Thurber Engineering Ltd.

FOUNDATION RECOMMENDATIONS

Note: The site specific foundation recommendations are for planning purposes only. Refer to Section 6 of the Foundation Design Report for the project-wide foundation recommendations, design assumptions and limitations.

General : A double span structure supported by two abutments and one pier is assumed.

Foundation Option	*Advantages*	*Disadvantages*
Spread footings founded on very dense sand and silt till	- Conventional construction - Low cost alternative	- Does not permit integral abutment design - Potential variability of surficial soils; footings must be extended below these soils - Unwatering will be required for footing construction
Spread Footings perched on Granular A pads	- Lower cost than deep foundations - Founding level can be adjusted	- Higher cost than spread footings on native soils - Unwatering may be required
Steel H-Pile driven into very dense sand and silt till	- Higher bearing resistance - Permits use of integral abutments - Not affected by surficial soil variability	- Higher cost than spread footings - Preaugering may be required to attain pile embedment depth
Caissons socketted in sand and silt till	- Higher bearing resistance - Not so affected by surficial soil variability	- Does not permit integral abutment design - Potential installation problems including side wall sloughing and basal instability due to water-bearing sand and silt till

A – Spread Footings

Spread footings founded on the dense sand and silt till may be used. Footings for perched abutments may be founded on compacted granular A cores in accordance with current MTO practices. The preliminary design geotechnical resistances and founding levels in spread footings in native soil are as follows:

Founding Stratum	Geotechnical Resistance		Foundation Level
	Factored ULS	SLS	
Sand and silt till	600 kPa	400 kPa	West side: At or below Elev. 237.0 m East side: At or below Elev. 235.5 m Central pier: At or below Elev. 230 m
Compacted Granular A	700 kPa	350 kPa	West side: Base of fill pad at or below Elev. 237.9 m East side: Base of fill pad at or below Elev. 235.8 m

B – Steel H-Piles

Steel H-piles driven to refusal within the very dense sand and silt till may be used to provide foundation support. The preliminary design geotechnical resistances and tip elevations are as follows:

Pile	Axial Geotechnical Resistance		Downdrag Load	Anticipated Pile Tip Elevation
	Factored ULS	SLS		
HP 310 x 110	1,600 kN	1,400 kN	Not applicable	At or Below Elev. 230 m

Preaugering may be required to attain pile embedment into the very dense 100 blow till.

C – Caissons

Based on the presence of water-bearing cohesioneless deposits and the potential construction difficulties below the water table, the use of caisson foundations is not recommended at this site and the option has not been developed.

Recommended Foundation Alternative

From a foundation engineering perspective, the recommended foundation alternative at this site is spread footings founded on very dense sand and silt till. Steel H piles are also feasible if integral abutments are desired.

- **ABUTMENT TYPE**

The soil conditions at this site are suitable for conventional, integral or semi-integral abutment design.

- **APPROACHES**

Cuts up to approximately 7.5 m deep will be required to construct the 407 mainline.

Stability

Permanent cuts up to 7.5 m in height are anticipated to be stable at side slope inclinations of 2H : 1V. A 2 m wide mid-height bench should be provided for any slopes exceeding 8 m in height. Permanent groundwater control will be required for cuts extending below the groundwater level.

Settlement

Settlements are not expected to be a concern at this site.

- **CONSTRUCTION CONSIDERATIONS**

Pile Installation

During pile installation through till deposits at this site, there is a high probability of encountering obstructions such as cobbles or boulders. Driving shoes should be fitted to the pile tips for reinforcement and enhancing seating of the piles. Preaugering may be required to attain the pile embedment depth.

Excavation

Excavations will be required for footing or pile cap construction. Temporarily unsupported side slopes should not be steeper than 1H : 1V. In accordance with the OHSA, all fills are classified as Type 3 soils. The dense sand and silt till is classified as Type 2 soil above the water table and Type 3 below the water table.

Groundwater/Surface Water Control

The groundwater table is near the ground surface at this site. Unwatering will be required for footing construction. The required groundwater control measures should be further assessed during detail design.

Protection Systems

Roadway protection may be required at some locations during construction. The feasibility of installing protection systems should be assessed once further subsurface investigation is carried out during detail design.

- **RECOMMENDATIONS FOR ADDITIONAL WORK**

Further subsurface investigation, analysis and design should be carried out during detail design to confirm the subsoil conditions at the location of the bridge. As a minimum, this is likely to require additional deeper boreholes at abutments and pier locations in order to investigate ground conditions below Elev. 228m. The feasibility and cost effectiveness of alternate unwatering systems and any need for dewatering would need to be investigated.

PART A - PRELIMINARY FOUNDATION INVESTIGATION REPORT
HWY 407 EAST EXTENSION – CENTRAL SECTION
W.O. 07 – 20016

LOCATION No:	CM-24

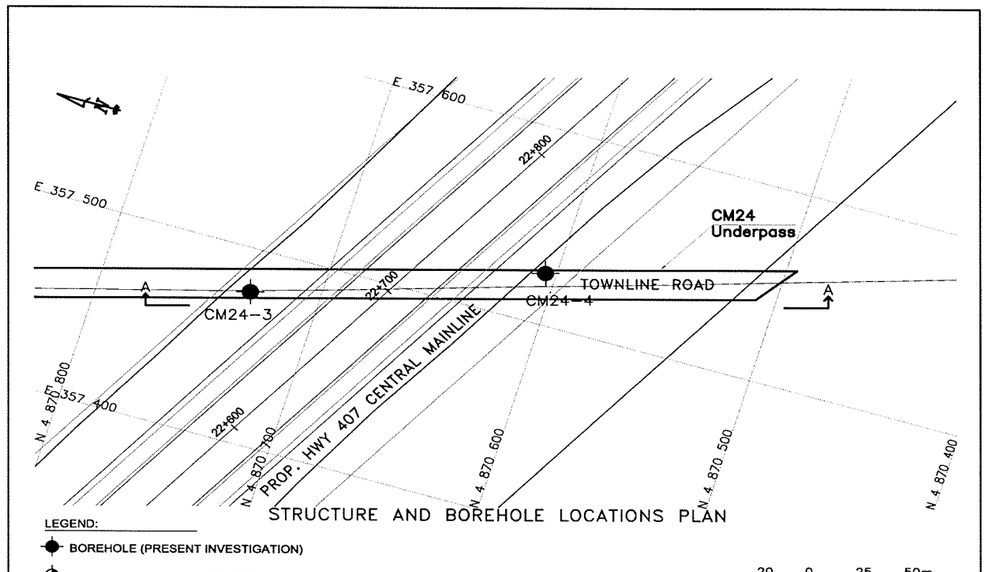
Structure Description: Flyover Highway 407 Mainline / Townline Road

Highway 407 Proposed Grade: ~ El. 228 m

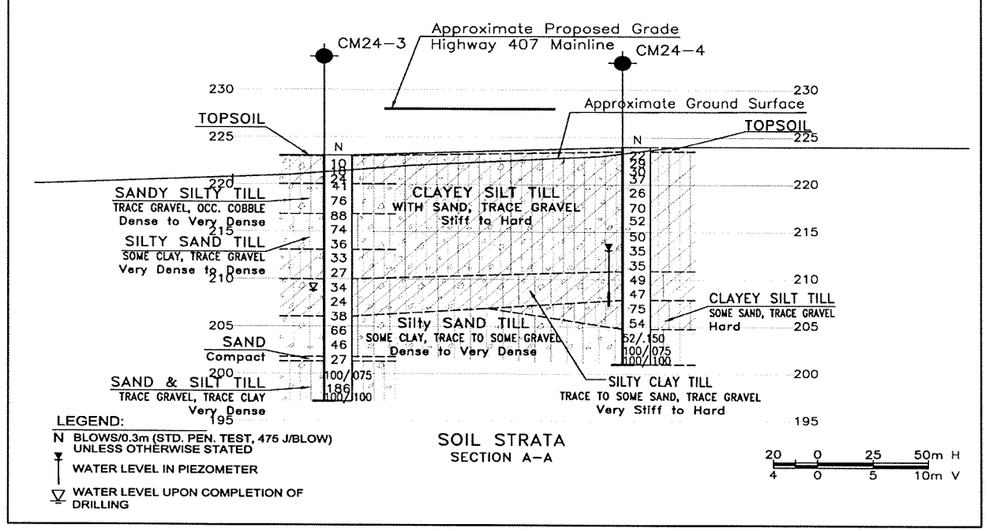
Existing Ground Elevation: ~ El. 222 - 225 m

Site Ranking: Medium

Station: 22+700



STRUCTURE AND BOREHOLE LOCATIONS PLAN



SOIL STRATA
SECTION A–A

FOUNDATION INVESTIGATION

Site Description:

At this site, the existing Townline Road is an unpaved road surrounded by agricultural lands. The relief is low, rolling and imperfectly drained, and is mapped as being underlain by silt till ground moraine.

Borehole Information:

Borehole No.	Borehole Location	MTM NAD 83 – Northing	MTM NAD 83 - Easting	Borehole Elevation (m)	Borehole Depth (m)
CM24-3	North Abutment/Approach	4 870 726.8	357 483.9	223.1	26.0
CM24-4	South Abutment/Approach	4 870 604.9	357 526.3	224.6	23.0

Subsurface Conditions:

- **Topsoil:** Topsoil ranging between 100 and 500 mm in thickness was encountered in both boreholes. Topsoil thickness may vary between and beyond borehole locations, and the information in this report should not be used for quantity estimating purposes.
- **Clayey Silt Till:** Brown to grey clayey silt till, with sand, trace gravel was encountered in both boreholes immediately below the topsoil. In Borehole 24-3, this cohesive till is interlayered with sandy silt to silty sand till. The clayey silt till has a combined thickness of 6.0 m and the underside of the lower layer is at Elev. 210.0 m. This soil has a typically stiff to very stiff consistency ('N' values from 10 to 27 blows/0.3m penetration) with occasional hard zones ('N' value of 33). In Borehole 24-4, this till is interlayered with silty clay till. It has a combined thickness of 15.6 m and an underside elevation of 205.4 m. This till is very stiff to hard throughout ('N' values from 22 to 75 blows/0.3m penetration). Figures CM24-B1 and B5 present laboratory test results for samples of the clayey silt till. The Atterberg Limits tests indicate that this till has a very low plasticity (LL=14 to 18, PI=5 to 7). Measured water contents of this till typically ranged from 8% to 12%, except at Elev. 207 to 208 m in Borehole CM24-4 where a value of 42% was recorded.
- **Sand and Silt Till Interlayers:** In Borehole CM24-3, the sand and silt till interlayers have a combined thickness of 7.0 m and an underside elevation at 213.1m. These cohesionless soils are compact to very dense ('N' values from 36 to 88 blows/0.3m penetration). Measured water contents ranged between 6% and 8%.
- **Silty Clay Till:** A deposit of silty clay till, trace to some sand, trace gravel was encountered in both boreholes. It has a thickness of 3.1 to 4.0 m and underside elevations between Elev. 206.0 and 208.4 m. This soil is grey in colour and has a typically very stiff to hard consistency ('N' values from 24 to 49 blows/0.3 m penetration). Figures CM24-B2 and B6 present laboratory test results for samples of the silty clay till. The Atterberg Limits tests indicate that this till has a low plasticity (LL=22 to 34, PI=12 to 19). Measured water contents of this till ranged from 10% to 28%.
- **Silty Sand Till:** Silty sand till with some clay and trace gravel underlies the silty clay till in both boreholes and also interlayers with the clayey silt till in Borehole CM24-3. Where fully penetrated in Borehole CM24-3, the thickness of this till is 4.2 m with an underside elevation at 201.8 m. Borehole CM24-4 was terminated within the silty sand till at Elev. 201.6 m. This cohesionless till is grey in colour and contains cobbles. The till is in a dense to very dense state ('N' values of 36 blows/0.3m penetration to >100 blows for <0.3m penetration). Glacial tills inherently contain cobbles and boulders as evident from some of the high 'N' values. Figures CM24-B3 presents the grain size distribution curves for two samples of this till. Measured water contents typically varied between 8% and 10%.
- **Sandy Silt to Sand and Silt Till:** Sandy silt to sand and silt till containing trace clay and trace gravel was found underlying the silty sand till in Borehole CM24-3. These till deposits are brown to grey in colour and contain inferred cobbles. The tills are in dense to very dense states ('N' values of 41 blows/0.3m penetration to >100 blows for 0.3m penetration). Glacial tills inherently contain cobbles and boulders as evident from the high 'N' values. Figures CM24-B4 presents grain size distribution curves for a sample of this sand and silt till. Measured water contents ranged between 6% and 8%.

Groundwater Conditions:

- **BH CM24-3:** 14.3 m depth (Elev. 208.8 m*) in open borehole on May 29, 2008.
- **BH CM24-4:** 10.9 m depth (Elev. 213.7 m) in piezometer on June 26, 2008.

* Unstabilized water level.

Record of Borehole Sheets – Appendix A | **Laboratory Test Results – Appendix B** | **Key Location Plan – Figure 1**

Thurber Engineering Ltd.

FOUNDATION RECOMMENDATIONS

Note: The site specific foundation recommendations are for planning purposes only. Refer to Section 6 of the Foundation Design Report for the project-wide foundation recommendations, design assumptions and limitations.

General: A single span structure with two abutments is proposed.

Foundation Option	*Advantages*	*Disadvantages*
Spread Footings founded on very stiff to hard clayey silt till, or dense to very dense sandy silt till	- Conventional construction	- Protection (temporary shoring) system may be Required for footing construction - Sub-excavation of topsoil/loose/soft soils is required
Spread Footings perched on Granular A pads for abutments	- Lower cost than deep foundations	- Higher cost than spread footings on native soils - Sub-excavation of topsoil/loose/soft soils is required
Steel H-Pile driven into very dense silty sand till or sand and silt till	- Higher bearing resistance - Permits use of integral abutments - Not affected by surficial soil variability	- Higher cost than spread footings
Caissons socketted in very dense silty sand till to sand and silt till	- Higher bearing resistance - Not so affected by surficial soil variability	- Higher cost than spread footings - Does not permit integral abutment design - Potential for base boiling, side sloughing and the need to dislodge cobbles and boulders

A - Spread Footings

Spread footings founded on very stiff to hard clayey silt till or dense to very dense sandy silt till may be used for closed abutments and piers. Footings for perched abutments may be founded on compacted Granular A cores in accordance with current MTO practices. The preliminary design geotechnical resistances and founding levels are as follows:

Founding Stratum	Geotechnical Resistance		Foundation Level
	Factored ULS	SLS	
Clayey Silt Till or Sandy Silt Till	525 kPa	350 kPa	At or below Elev. 220.0 m (North Abutment/Pier) At or below Elev. 223.0 m (South Abutment/Pier)
Compacted Granular A	700 kPa	350 kPa	Base of Fill Pad at/below Elev. 222.5 m (North Abutment/Pier)
			Base of Fill Pad at/below Elev. 223.8 m (South Abutment/Pier)

B - Steel H-Piles

Steel H-piles driven to refusal within the lower very dense silty sand or sand and silt till may be used to provide foundation support. The preliminary design geotechnical resistances and tip elevations are as follows:

Pile	Axial Geotechnical Resistance		Downdrag Load	Anticipated Pile Tip Elevation
	Factored ULS	SLS		
HP 310 x 110	1,600 kN	1,400 kN	Not applicable	At or Below Elev. 199 m (North Abutment/Pier)
				At or Below Elev. 203 m (South Abutment/Pier)

C – Caissons

Consideration may be given to using augered caissons socketted into the very dense silty sand or sand and silt till. The preliminary design geotechnical resistances and base elevations for caissons extended 4 m into the very dense ('N' >100 blows) till and developing resistance through shaft friction and a portion of end-bearing within the till are as follows:

Caisson Diameter	Axial Geotechnical Resistance		Downdrag Load (Factored ULS)	Highest Founding Level
	Factored ULS	SLS		
1.2 m	6,400 kN	5,000 kN	Not Applicable	Elev. 196 m (North Abutment/Pier)
1.5 m	9,000 kN	6,000 kN	Not Applicable	Elev. 198 m (South Abutment/Pier)

Given the potential for base boiling under hydrostatic pressure and uncertainties associated with cleaning and inspecting the base, the above recommended values must be reassessed during detail design.

Recommended Foundation Alternative

The recommended foundation alternative for the abutment and piers at this site is spread footings founded on the very stiff to hard silty clay till or dense to very dense sandy silt till. Consideration may be given to using footings on compacted granular pads for perched abutments. Steel H-piles driven into the very dense sand and silt till may also be considered if an integral abutment design is preferred.

- **ABUTMENT TYPE**

The soil conditions at this site are suitable for conventional, integral and semi-integral abutment design.

- **APPROACHES**

General

Assuming a proposed Highway 407 mainline grade at approximate Elev. 228 m, it is estimated that up to 10 m of fill will be required to construct the Townline Road flyover approaches.

Stability

Approach embankments up to 10 m in height are anticipated to be stable at side slope inclinations of 2H : 1V using SSM or better material.

Settlement

Foundation settlement will occur as fill is placed. It is estimated that the magnitude of such settlement would in the order of 25 mm. It is expected that a majority of the settlement would be completed by the end of construction.

- **CONSTRUCTION CONSIDERATIONS**

Pile Installation

During pile installation, there is a medium probability of encountering cobbles or boulders within the tills. Pile driving shoes should be fitted to the pile tips for reinforcement and to enhance seating of the piles.

Excavation

Shallow excavations below the road grade may be required for footing and/or pile cap construction. Temporarily unsupported side slopes should not be steeper than 1H : 1V at this site. In accordance with the OHSA, native soils above the groundwater level are classified as Type 2 soils, while native soils below the groundwater level and all fills are classified as Type 3 soils.

Groundwater/Surface Water Control

It is anticipated that much of the water accumulation within excavations will be from surface runoff, with some contribution of seepage from water perched within the sands and silts. Diversion of surface runoff from the excavations and pumping from carefully constructed, filtered sumps should be adequate to control the water during construction.

Protection Systems

Protection systems may be required at excavation locations where stable slopes cannot be constructed due to space limitations and where vertically sided excavations are used for footing construction. Possible systems include soldier piles and lagging. The feasibility of installing protection systems should be assessed once further subsurface investigation is carried out during detail design.

- **RECOMMENDATIONS FOR ADDITIONAL WORK**

Further subsurface investigation, analysis and design should be carried out during detail design to confirm the subsoil conditions at the location of the bridge foundation elements. As a minimum, this is likely to require additional boreholes at the actual abutment and pier locations, and the approaches. Should caissons be the adopted foundation option, caisson installation methods will need to be assessed and geotechnical resistances should be reassessed based on additional subsurface information.

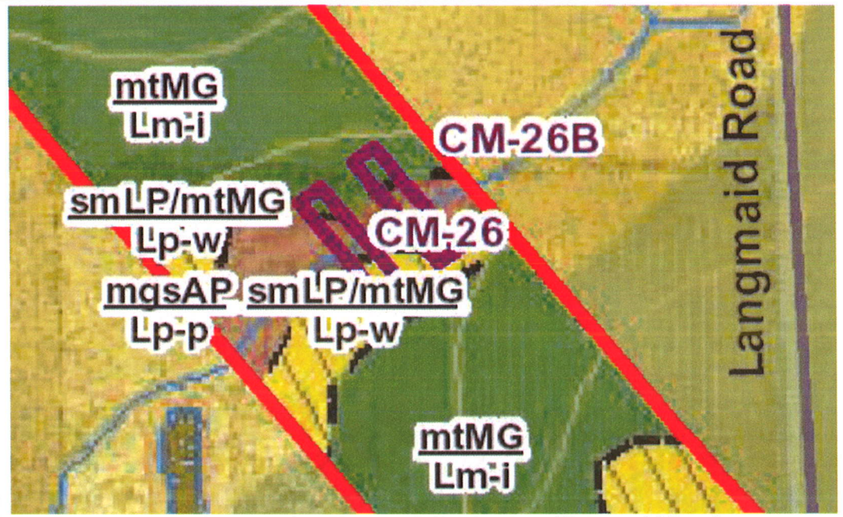
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	CM-26 CM-26b

W.O: 07-20016 **Section:** Central **Location:** Mainline at unnamed creek. **Sta.** 24+261

Original Grade: ~197 **Proposed Grade:** **Description:** Twin structures to carry Mainline over unnamed creek



Site Plan and Terrain Analysis – Unnamed Creek west of Langmaid Road

Site Photograph – facing towards culvert site from Langmaid Road

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
Boreholes: No BH at the site. BH P26, 30M15-85, lies 500m south of the site. Mapping (Central 5) shows that the site is underlain by a 20 to 50m wide band of recent alluvium with a small area of sandy silt glaciolacustrine soils to the southeast. These soils lie within a wider area of silt till ground moraine. The relief is low plain, poorly drained to well drained. BH P26 encountered: 0.0 – 9.8 Silty sand to sand silt till, very dense. 9.8 – 16.9 EOH Clayey silt some sand and gravel, till, hard **Groundwater** GWL at the creek is expected to be close to the ground surface. At the borehole, GWL was recoded at approx. 6.5mbgs. **Estimated overburden thickness – 80m**	**1. Abutments** a. Footings may be founded on compacted Granular A cores as per current MTO standard practices at assumed 3mbgs. b. For closed abutments, footings may be founded on native at assumed 3mbgs a. Factored resistance at ULS – 450 kPa b. Resistance at SLS –300 kPa c. Abutments may also be supported on HP 310X110 piles driven to refusal. a. ULS resistance – 1,600 kN b. SLS resistance – 1,400 kN d. Integral abutments are feasible. Assume 15m piles. **2. Piers** Piers may be supported using the same foundation options as for abutments.	Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better. No global stability or settlement issues are anticipated based on available information. Stripping of topsoil or other unsuitable soils will be required prior to construction.	Some dewatering may be required close to the creek. Narrow, shallow valley with no geomorphic evidence of significant valleyside instability
			Site Ranking **Foundations:** **Low** **Hydrogeology:** **Medium**

PART A - PRELIMINARY FOUNDATION INVESTIGATION REPORT
HWY 407 EAST EXTENSION – CENTRAL SECTION
W.O. 07 – 20016

LOCATION No:	CM-27

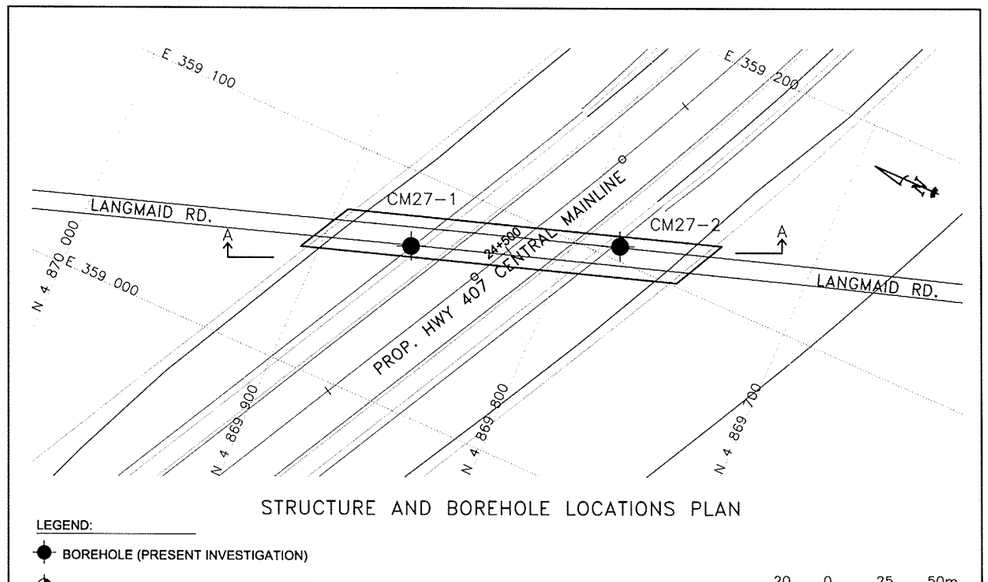
Structure Description: Underpass Highway 407E Mainline / Langmaid Road

Highway 407 Proposed Grade: ~ El. 204 m

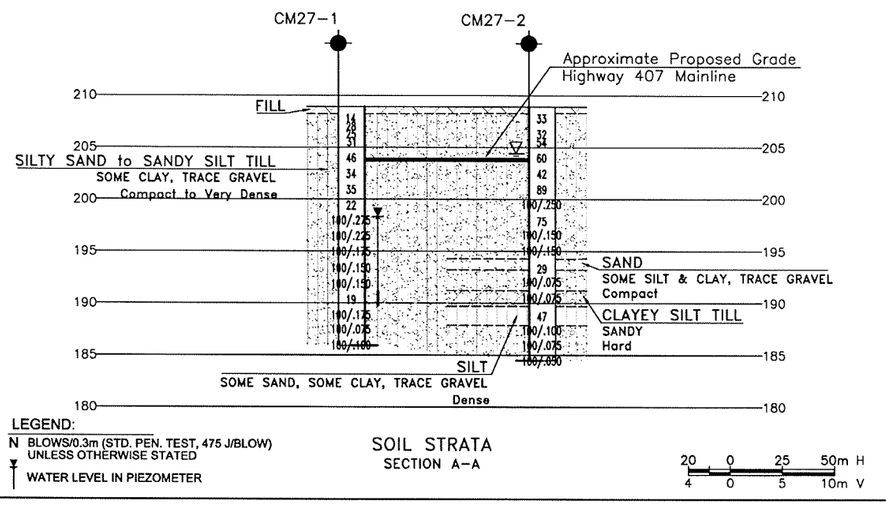
Existing Ground Elevation: ~ El. 209 m

Site Ranking: Medium

Station: ~ 24+500



STRUCTURE AND BOREHOLE LOCATIONS PLAN



SOIL STRATA
SECTION A-A

FOUNDATION INVESTIGATION

Site Description:

At this site, Langmaid Road is a two-lane, undivided rural road surrounded by farmland. Mapping shows shallow sandy silt glaciolacustrine deposits overlying silt till ground moraine. The relief is low plain, well drained.

Borehole Information:

Borehole No.	Borehole Location	MTM NAD 83 – Northing	MTM NAD 83 - Easting	Borehole Elevation (m)	Borehole Depth (m)
CM27-1	North side	4 869 863.8	359 069.1	208.9	23.0
CM27-2	South side	4 869 780.3	359 106.1	208.9	24.4

Subsurface Conditions:

- **Sand fill:** A layer of compact dark brown sand fill with trace of gravel and organics was encountered in boreholes CM27-1 and CM27-2. This sand fill layer was 0.7 m and 0.6 m thick in boreholes CM27-2 and CM27-1 respectively.

- **Silty Sand Till:** A deposit of brown to grey silty sand till with trace of gravel and occasional cobbles and boulders was encountered below the sand fill in both boreholes. This silty sand till layer was 14 m thick, with an underside at Elev. 194.3 m in borehole CM27-2. Borehole CM27-1 was terminated in this till at 23 m depth (Elev. 185.9 m). This silty sand till layer is compact to very dense with 'N' values ranging from 14 to more than 100 blows for less than 0.3m penetration. Moisture contents ranged from 8 to 17%. Grain size distribution curves for samples of this soil are presented in Figure CM27-B1. Glacial tills typically contain cobbles and boulders.

- **Sand:** A deposit of brown sand with some silt and clay was found below the silty sand till layer in borehole CM27-2. This layer is 1.1 m thick with an underside at Elev. 193.2 m. This sand layer is compact with an 'N' value of 29 blows/0.3m penetration. Moisture content was around 15%. A grain size distribution curve for a sample of this sand is presented in Figure CM27-B2.

- **Sandy Silt Till:** Brown to greyish brown sandy silt till with some clay was encountered below the sand layer in borehole CM27-2. This layer is 2 m in thickness, with an underside at Elev. 191.2 m. This sandy silt till is very dense with an 'N' value of 100 blows for less than 0.3m penetration and with moisture content of about 5%.

- **Clayey Silt Till**: Brown clayey silt till, sandy was encountered below the sandy silt till in borehole CM27-2. This clayey silt till layer is hard with an 'N' value of 100 blows for less than 0.3 m penetration and with moisture content of about 18%.

- **Silt**: Brown silt with some sand and clay was encountered below the clayey silt till in borehole CM27-2. This silt layer is dense with an 'N' value of 47 blows/0.3 m penetration and with moisture content of around 15%. A grain size distribution curve for a sample of this soil is presented in Figure CM27-B3.

- **Silt and Sand Till**: Greyish brown silt and sand till with trace of clay and gravel was encountered below the silt layer in borehole CM27-2. Borehole CM27-2 was terminated in this till at 24.4 m depth (Elev. 184.5 m). This soil is very dense with 'N' values of 100 blows for less than 0.3 m penetration and with moisture content ranging from 12 to 17%. A grain size distribution curve for a sample of this soil is presented in Figure CM27-B4.

Groundwater Conditions:

- **BH CM27-1:** 4.6 m depth (Elev.204.3 m) in piezometer on April 8, 2009.
  10.6 m depth (Elev. 198.3 m) in piezometer on April 30, 2009.
- **BH CM27-2:** 4.5 m depth (Elev. 204.4 m) in open borehole on April 2, 2009 (unstabilized reading).

Record of Borehole Sheets – Appendix A | **Laboratory Test Results – Appendix B** | **Key Location Plan – Figure 1**

Thurber Engineering Ltd.

LOCATION No:	CM-27

FOUNDATION RECOMMENDATIONS

Note: The site specific foundation recommendations are for planning purposes only. Refer to Section 6 of the Foundation Design Report for the project-wide foundation recommendations, design assumptions and limitations.

General : A double span structure on two abutments and one pier is proposed.

Foundation Option	*Advantages*	*Disadvantages*
Spread footings founded on dense silty sand till	- Conventional construction - Low cost alternative	- Variability of surficial soils - Sub-excavation of sand fill and compact till to construct footings - Does not allow integral abutment design
Spread Footings perched on Granular A pads on compact silty sand till	- Lower cost than deep foundations - Founding level can be adjusted	- Sub-excavation of sand fill to construct footings - Does not allow integral abutment design - Higher cost than spread footings on native soil
Steel H-Piles driven to very dense silty sand till	- Higher bearing Resistance - Allows integral abutment design - Not affected by surficial soil variability	- Higher cost than spread footings - Difficult driving in very dense till; may need to pre-drill
Caissons founded within the very dense silty sand till	- Higher bearing resistance - Not affected by surficial soil variability	- Higher cost than spread footings - Does not allow integral abutment design - Require liners to address installation problems including side sloughing associated with cohesionless soils - Need to dislodge and handle cobbles and boulders - Potential for base boiling

A – Spread Footings

Spread footings founded on dense native silty sand till may be used. Footings for perched abutments may be founded on compacted granular A cores in accordance with current MTO practices. The preliminary design geotechnical resistances and founding levels are as follows:

Founding Stratum	Geotechnical Resistance		Foundation Level
	Factored ULS	SLS	
Silty Sand Till	450 kPa	300 kPa	At or below Elev. 206 m
Compacted Granular A	700 kPa	350 kPa	Base of fill pad at or below Elev. 208 m

B – Steel H-Piles

Steel H-piles driven to refusal within the very dense silty sand till may be used to provide foundation support. The preliminary design geotechnical resistances and tip elevations are as follows:

Pile	Axial Geotechnical Resistance		Downdrag Load	Anticipated Pile Tip Elevation
	Factored ULS	SLS		
HP 310 x 110	1600 kN	1400 kN	Not applicable	At or below Elev.196 m

C – Caissons

Caissons are not recommended at this site due to potential installation problems related to water bearing cohesionless till deposits, the associated potential of base boiling, and the potential presence of cobbles and boulders in glacial till deposits.

Recommended Foundation Alternative

From a foundation engineering perspective, the recommended foundation alternative at this site is H piles driven to refusal within the very dense silty sand till at or below Elev. 196 m. The pier may be supported on spread footings founded on dense silty sand till

- **ABUTMENT TYPE**

The soil conditions at this site are suitable for conventional or integral abutment design.

- **APPROACHES**

Cuts up to about 6 m in height will be required to construct the highway mainline. A 2m fill is required for the Langmaid Road approaches.

Stability

Slopes up to 8 m in height are anticipated to be stable at side slope inclinations of 2H : 1V. A mid-slope bench should be provided for slopes greater than 8 m height.

Settlement

Settlement is not a concern at this site.

- **CONSTRUCTION CONSIDERATIONS**

Pile Installation

During pile installation through glacially derived soils at this site, there is a medium probability of encountering cobbles or boulders. Driving shoes should be fitted to the pile tips for reinforcement and enhancing seating of the piles. Preaugering is likely to be necessary to attain foundation embedment depth at the central pier location.

Excavation

Temporary excavations will be required for pile cap or footing construction. In accordance with the OHSA, all fills are classified as Type 3 soils. The silty sand till is classified as Type 2 soil above the water table and type 3 soil below the water table.

Groundwater/Surface Water Control

Water may accumulate in the temporary foundation excavations from surface runoff and seepage from cohesionless layers. Diversion of surface runoff from the temporary excavation and pumping from carefully constructed, filtered sumps should be adequate to control the water.

Protection Systems

Protection systems may be required at excavation locations where stable slopes cannot be constructed due to space limitations. One possible system is soldier piles and lagging. The feasibility of installing the protection system should be assessed once further subsurface investigation is carried out during detail design.

- **RECOMMENDATIONS FOR ADDITIONAL WORK**

Further subsurface investigation, analysis and design should be carried out during detail design to confirm the subsoil conditions at the location of the bridge foundation elements. As a minimum, this is likely to require additional boreholes at the pier location and at the approaches.

PART A - PRELIMINARY FOUNDATION INVESTIGATION REPORT
HWY 407 EAST EXTENSION – CENTRAL SECTION
W.O. 07 – 20016

LOCATION No:	CM-28

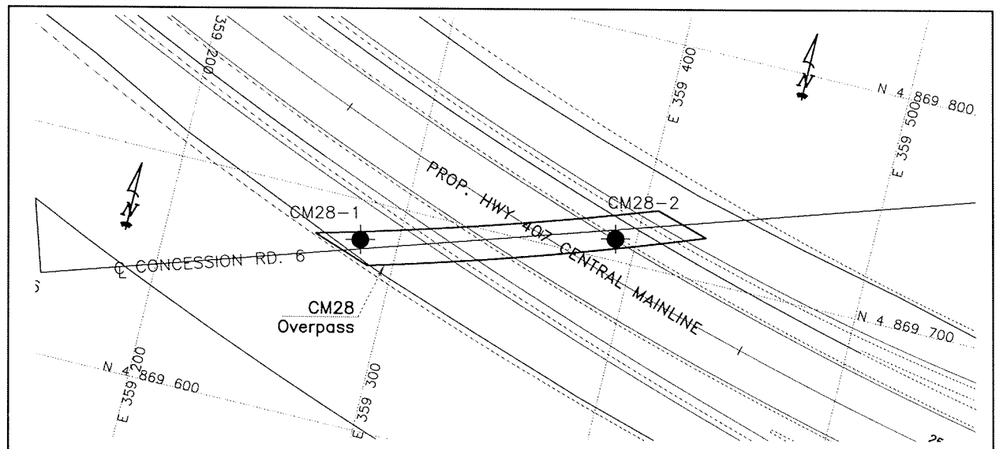
Structure Description: Underpass Highway 407 Mainline / Concession 6 Road

Highway 407 Proposed Grade: ~El. 205.5 m

Existing Ground Elevation: ~El. 212.0 m

Site Ranking: Medium

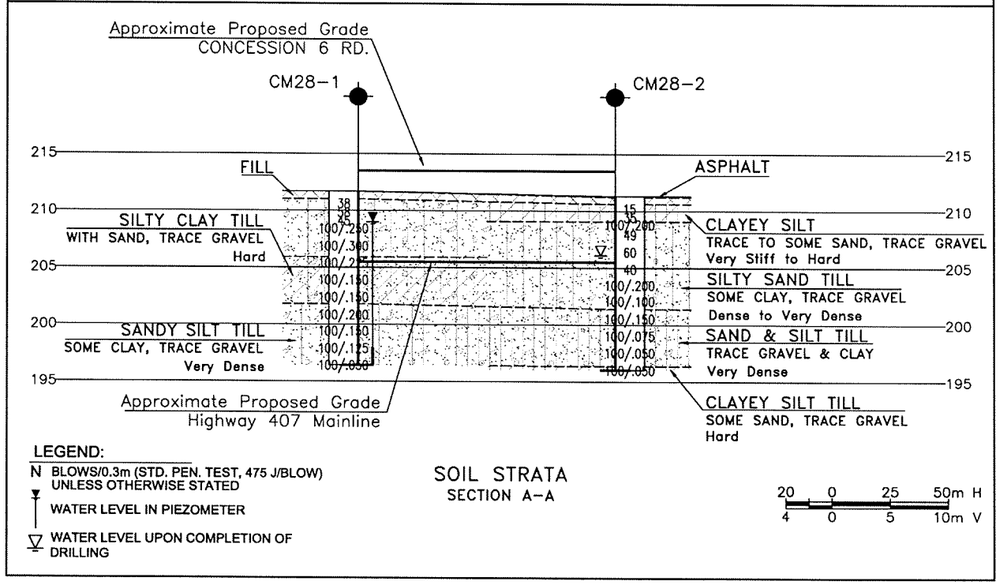
Station: ~24+785



STRUCTURE AND BOREHOLE LOCATIONS PLAN

LEGEND:
- BOREHOLE (PRESENT INVESTIGATION)
- BOREHOLE (PREVIOUS INVESTIGATION)

20 0 25 50m



LEGEND:
- N BLOWS/0.3m (STD. PEN. TEST, 475 J/BLOW) UNLESS OTHERWISE STATED
- WATER LEVEL IN PIEZOMETER
- WATER LEVEL UPON COMPLETION OF DRILLING

SOIL STRATA
SECTION A–A

20 0 25 50m H
4 0 5 10m V

FOUNDATION INVESTIGATION

Site Description:

At this site, the existing Concession 6 Road is a two-lane, undivided paved roadway. Terrain mapping shows that the site is underlain by silt till ground moraine. The relief is low, rolling and imperfectly drained.

Borehole Information:

Borehole No.	Borehole Location	MTM NAD 83 – Northing	MTM NAD 83 - Easting	Borehole Elevation (m)	Borehole Depth (m)
CM28-1	West Side	4 869 682.7	359 283.6	211.7	15.3
CM28-2	East Side	4 869 708.4	359 390.0	211.3	15.3

Subsurface Conditions:

- **Pavement Structure and Fill:** A 75 mm thick layer of asphalt pavement underlain by 0.6 m of sand fill was encountered in borehole CM28-2. BH CM28-1 encountered sand and gravel fill from the surface to 0.7 m depth. The underside of the fill varies between Elev. 211.0 m and 210.6 m.

- **Clayey Silt:** A 1.5 m thick layer of brown clayey silt with trace to some sand and trace gravel was encountered below the fill in borehole CM28-2, extending to Elev. 209.1 m. The consistency of the clayey silt is very stiff to hard with 'N' values of 15 and 35 blows/0.3 m penetration. Moisture contents ranged between 10% and 14%.

- **Silty Sand Till:** Brown to grey silty sand till with some clay and trace gravel was encountered below the fill and the clayey silt layer in boreholes CM28-1 and CM28-2 respectively. This layer is 5.1 m to 7.7 m in thickness, extending to Elev. 205.9 m to 201.4 m. This till is dense to very dense with 'N' values ranging from 38 blows/0.3 m penetration to greater than 100 blows for less than 0.3 m penetration. The moisture contents ranged from 7% to 10%. Grain size distribution curves for samples of this till are presented in Figure CM28-B1. This layer contains cobbles and boulders.

- **Silty Clay Till:** A 4.1 m thick layer of grey silty clay till with sand was encountered below the silty sand till in Borehole CM28-1. This till is hard throughout with 'N' values greater than 100 blows for less than 0.3 m penetration. The underside of this layer is at Elev. 201.8 m. Figure CM28-B2 presents a grain size distribution curve of this till. The Atterberg limit test result is presented in Figure CM28-B5. Moisture contents ranged between 8% and 10%.

- **Sandy Silt / Sand and Silt Till:** A lower deposit of sandy silt / sand and silt till with trace to some clay, trace gravel was encountered below the upper till layer in both boreholes. This layer is 5.0 m to at least 5.4 m in thickness, extending to Elev. 196.4 m where borehole CM28-1 was terminated. This grey till layer is very dense throughout with 'N' values greater than 100 blows for less than 0.3 m penetration. Figures CM28-B3 and CM28-B4 present the grain size distribution curves of this till layer. The measured water contents ranged between 6% and 13%.

- **Clayey Silt Till:** A deposit of grey clayey silt till with some sand and trace gravel, was encountered below the sand and silt till in borehole CM28-2. This layer is at least 0.4 m in thickness, extending to Elev. 196.0 m where borehole CM28-2 was terminated. This till is hard with an 'N' value greater than 100 blows for less than 0.3 m penetration.

Groundwater Conditions:

- **BH CM28-1:** 2.4 m depth (Elev. 209.3 m) in piezometer on April 13, 2009.
  3.7 m depth (Elev. 208.0 m) in piezometer on April 30, 2009.
  2.7 m depth (Elev. 209.0 m) in piezometer on July 21, 2009.
- **BH CM28-2:** 5.2 m depth (Elev. 206.1 m) in open borehole on April 09, 2009 (unstabilized reading).

Record of Borehole Sheets – Appendix A | **Laboratory Test Results – Appendix B** | **Key Location Plan – Figure 1**

Thurber Engineering Ltd.

FOUNDATION RECOMMENDATIONS

Note: The site specific foundation recommendations are for planning purposes only. Refer to Section 6 of the Foundation Design Report for the project-wide foundation recommendations, design assumptions and limitations.

General: A two span structure with two abutments and a central pier is proposed.

Foundation Option	*Advantages*	*Disadvantages*
Spread Footings founded on dense to very dense silt/sand till or hard clay till	- Conventional construction - Low cost alternative	- Does not permit integral abutment design - Potential variability of surficial soils; footings must be extended below these soils - Unwatering may be required during excavation
Spread Footings perched on Granular A pads for abutments	- Lower cost than deep foundations - Minimize excavation requirements	- Higher cost than spread footings on native soils - Sub-excavation of existing fill is required
Steel H-Piles driven to very dense silt/sand till or hard clay till	- Higher bearing resistance - Permits use of integral abutments - Not affected by surficial soil variability	- Higher cost than spread footings - Preaugering may be required to achieve adequate pile embedment
Caissons founded in very dense sand/silt till or hard silty clay till	- Higher bearing resistance - Not so affected by surficial soil variability	- Does not permit integral abutment design - Potential installation problems including basal instability due to water-bearing sands/silts

A - Spread Footings

Spread footings founded on dense to very dense silt/sand till or hard clay till may be used for the abutments and at the pier. Footings for perched abutments may be founded on compacted Granular A cores in accordance with current MTO practices. The preliminary geotechnical design resistances and founding levels for spread footings on native soils, and spread footings on compacted Granular A cores, are as follows:

Founding Stratum	Geotechnical Resistance		Foundation Level
	Factored ULS	SLS	
Silt/Sand Till Clay Till	600 kPa	400 kPa	At or below Elev. 210.5 m (west abutment) At or below Elev. 209.0 (east abutment) At or below 209.0 m (pier)
Compacted Granular A	700 kPa	350 kPa	Fill base at or below Elev. 211.0 m (west abutment) Fill base at or below Elev. 210.6 m (east abutment)

B - Steel H-Piles

Steel H-piles driven to refusal within the very dense sand/silt till or hard clay till may be used to provide foundation support. The recommended preliminary design geotechnical resistances and tip elevations are as follows:

Pile	Axial Geotechnical Resistance		Downdrag Load	Anticipated Pile Tip Elevation
	Factored ULS	SLS		
HP 310 x 110	1,600 kN	1,400 kN	Not applicable	At or below Elev. 201.0 m

Preaugering may be required to install piles to achieve adequate pile embedment in very dense or hard till.

C – Caissons

Based on the presence of water-bearing cohesionless deposits and the potential of base boiling and uncertainties associated with cleaning and inspecting the base, the use of caisson foundation is not recommended at this site and the option has not been developed.

Recommended Foundation Alternative

The recommended foundation alternative at this site is spread footings founded on dense to very dense silt/sand till or hard clay till. Steel H-piles driven into the very dense sand/silt till or hard clay till may also be considered if integral abutment design is desired.

- **ABUTMENT TYPE**

The soil conditions at this site are suitable for conventional, integral or semi-integral abutment design.

- **APPROACHES**

Highway 407 mainline will be in a 6.5 m deep cut. Up to 2 m of fill will be required at the approaches.

Stability

Approach cut and fill up to 8 m in height are anticipated to be stable at side slope inclinations of 2H : 1V. A mid-height bench should be provided for slopes higher than 8 m.

Settlement

Settlements are expected to be less than 25 mm and to occur essentially during construction.

- **CONSTRUCTION CONSIDERATIONS**

Pile Installation

During pile installation through glacially derived soils at this site, there is a high probability of encountering obstructions such as cobbles or boulders. Driving shoes should be fitted to the pile tips for reinforcement and enhancing seating of the piles. Preaugering may be required to achieve adequate pile embedment.

Excavation

Temporary excavation slopes for footing or pile cap construction should not be steeper than 1H : 1V. In accordance with OHSA the fill materials are classified as Type 3 material. The silt/sand till and clay till are Type 2 material above the water table and Type 3 soil below the water table.

Groundwater/Surface Water Control

Diversion of surface runoff from the excavation and pumping from carefully constructed, filtered sumps should be adequate to control water in foundation excavations during construction.

Protection Systems

Protection systems may be required at excavation locations where stable slopes cannot be constructed due to space limitations and where vertically sided excavations are used for footing or pile cap construction. One possible system is the use of soldier piles and lagging. The feasibility of installing protection systems should be assessed once further subsurface investigation is carried out during detail design.

- **RECOMMENDATIONS FOR ADDITIONAL WORK**

Further subsurface investigation, analysis and design should be carried out during detail design to confirm the subsoil conditions at the location of the bridge foundation elements. As a minimum, this is likely to require additional boreholes at the actual abutment and pier locations and at the approaches.

PART A - PRELIMINARY FOUNDATION INVESTIGATION REPORT
HWY 407 EAST EXTENSION – CENTRAL SECTION
W.O. 07 – 20016

LOCATION No:	CM-29/29b

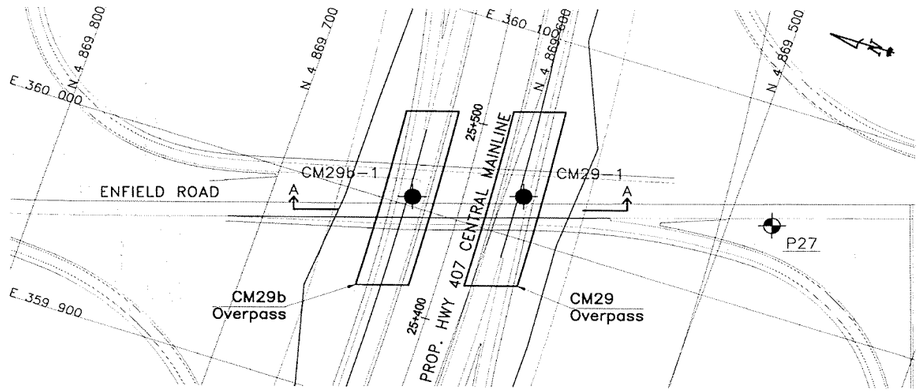
Structure Description: Overpass Highway 407 Mainline / Enfield Road

Highway 407 Proposed Grade: ~ El. 211 to 212 m

Existing Ground Elevation: ~ El. 204 to 206 m

Site Ranking: Medium

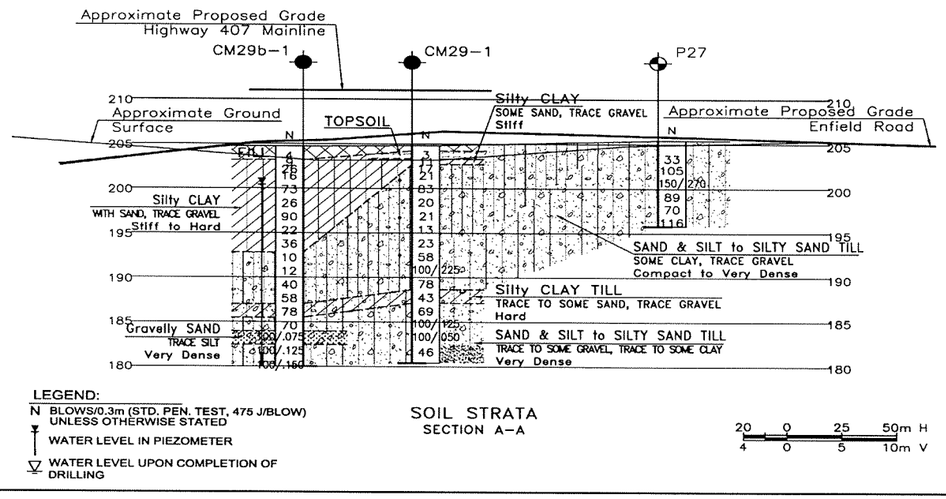
Station: 25+485



STRUCTURE AND BOREHOLE LOCATIONS PLAN

LEGEND:
- BOREHOLE (PRESENT INVESTIGATION)
- BOREHOLE (PREVIOUS INVESTIGATION)

20 0 25 50m



LEGEND:
- N BLOWS/0.3m (STD. PEN. TEST, 475 J/BLOW) UNLESS OTHERWISE STATED
- WATER LEVEL IN PIEZOMETER
- WATER LEVEL UPON COMPLETION OF DRILLING

SOIL STRATA
SECTION A–A

20 0 25 50m H
4 0 5 10m V

FOUNDATION INVESTIGATION

Site Description:

At this site, the existing Enfield Road is a two-lane, undivided paved road surrounded by agricultural lands. The terrain is relatively flat, and is mapped as being underlain by silt till ground moraine with the east ends of the structures possibly lying in the area of glaciolacustrine silt.

Borehole Information:

Borehole No.	Borehole Location	MTM NAD 83 – Northing	MTM NAD 83 - Easting	Borehole Elevation (m)	Borehole Depth (m)
CM29-1	CM29-1 Overpass	4 869 591.4	360 020.6	204.8	24.4
CM29b-1	CM29b-1 Overpass	4 869 638.7	360 004.8	204.7	24.7
P27	-	4 869 480.6	360 042.6	205.4	9.6

Subsurface Conditions:

- **Topsoil:** A 0.9 m thick layer of buried topsoil mixed with some sand and trace gravel was encountered in Borehole CM29-1. Topsoil thickness may vary between and beyond borehole locations and information in this report should not be used for quantity estimating purposes.
- **Fill:** Road embankment fill containing sand with some gravel was encountered at ground surface in Boreholes CM29-1 and CM29b-1. The fill is 0.6 to 1.5 m in thickness with underside elevations at 204.2 and 203.2 m in Boreholes CM29-1 and CM29b-1, respectively. This cohesionless fill is brown in colour and is in a loose state ('N' value of 4 blows/0.3m penetration) where measured. Measured water contents of samples of the fill were at about 3% to 4%.
- **Silty Clay:** A deposit of brown to grey silty clay was encountered in Boreholes CM29-1 and CM29b-1. The silty clay in Borehole CM29-1 is 0.6 m in thickness. In Borehole CM29b-1, the silty clay is up to 10.4 m in thickness with an underside at Elev. 192.8 m. This soil has a stiff to hard consistency ('N' valuesof 9 to 90 blows/0.3m penetration). Figures CM29-B1 and –B2 present the laboratory test results for samples of this soil. The Atterberg Limits tests indicate that this soil has a low plasticity (LL=19 to 20, PI=9). Measured water contents typically varied between 8% and 12% except in Borehole CM29-1 where a value of 22% was recorded.
- **Sand and Silt Till:** Sand and silt till of various proportions, containing some clay and trace gravel, was encountered in all three boreholes. The thickness of the cohesionless till is more than 20.8 m in Borehole CM29-1 and more than 9.6 m in Boreholes CM29b-1 and P27. All three boreholes were terminated within the till between Elev. 180.0 and 195.8 m. This cohesionless till is brown in colour becoming grey with depth and contains inferred cobbles. The upper portion of the till is typically compact to dense ('N' values of 10 to 40 blows/0.3m penetration) with occasional very dense zones. The lower portion of the till is very dense throughout ('N' values of 58 blows/0.3m penetration to >100 blows for <0.3m penetration). Glacial tills inherently contain cobbles and boulders as evident from the 'N' values. Figure CM29-B5 and CM29-B6 present grain size distribution curves for samples of this till. Measured water contents typically ranged between 8% and 15%.
- **Silty Clay Till:** A deposit of silty clay till with trace sand was encountered within the silty sand till in two boreholes. The thickness of this cohesive till is about 1.5 m with an underside at Elev. 187.1 m and 185.5 m in Boreholes CM29-1 and CM29b-1, respectively. This soil is grey in colour and has a hard consistency ('N' values of 43 and 78 blows/0.3m penetration). Figures CM29-B3 and CM29b-B4 present laboratory test results for samples of the silty clay till. The Atterberg Limits tests indicate that this till has a low plasticity (LL=26 to 30, PI=9). Measured water contents of this till ranged from 12% to 20%.
- **Gravelly Sand:** A layer of gravelly sand with trace silt was encountered within the sand and silt till in Borehole CM29b-1. The deposit is 1.6 m in thickness with an underside elevation at 182.5 m. This soil is grey in colour and is a in very dense state ('N' values of >100 blows for <0.3m penetration). A water content of about 8% was measured for a sample of this soil.

Groundwater Conditions:

- **BH CM29b-1:** 4.3 m depth (Elev. 200.4 m) in piezometer on August 27, 2008.
- **BH P27:** Dry* (below Elev. 195.8 m) in open borehole on May 30, 1994.

* Unstabilized water level.

FOUNDATION RECOMMENDATIONS

Note: The site specific foundation recommendations are for planning purposes only. Refer to Section 6 of the Foundation Design Report for the project-wide foundation recommendations, design assumptions and limitations.

General: Twin single span structures with two abutments each are proposed.

Foundation Option	Advantages	Disadvantages
Spread Footings founded on stiff to hard silty clay, or compact to very dense sand/silt till	- Conventional construction - Lower cost alternative	- Protection systems (temporary shoring) may be required - Sub-excavation up to the order of 2 m may be required to remove surficial weak soils
Spread Footings perched on Granular A pads for abutments	- Lower cost than deep foundations - Minimize excavation requirements	- Higher cost than spread footings on native soils - Potential variability of surficial soils; sub-excavation of topsoil and softened/loosened soils is required
Steel H-Pile driven into very dense sand/ silt till	- Higher bearing resistance - Permits use of integral abutments - Not affected by surficial soil variability	- Higher cost than spread footings
Caissons socketted into very dense sand/ silt till	- Higher bearing resistance - Not so affected by surficial soil variability	- Higher cost than spread footings - Does not permit integral abutment design - Potential installation problems through sands and silts below the water table - Potential for base boiling and the need to dislodge cobbles and boulders

A - Spread Footings

Spread footings founded on stiff to hard silty clay or compact to very dense sand/silt till may be used for closed abutments and piers. Footings for perched abutments may be founded on compacted Granular A cores in accordance with current MTO practices. The preliminary design geotechnical resistances and founding levels are as follows:

Founding Stratum	Geotechnical Resistance		Foundation Level
	Factored ULS	SLS	
Silty Clay	450 kPa	300 kPa	At or below Elev. 202.5 m (CM29b Overpass)
Sand/Silt Till	375 kPa	250 kPa	At or below Elev. 202.5 m (CM29 Overpass)
Compacted Granular A	700 kPa	350 kPa	Base of Fill Pad at/below Elev. 203.0 m (CM29b Overpass)
			Base of Fill Pad at/below Elev. 203.2 m (CM29 Overpass)

B - Steel H-Piles

Steel H-piles driven to refusal within the lower deposit of very dense sand and silt till may be used to provide foundation support. The preliminary design geotechnical resistances and tip elevations are as follows:

Pile	Axial Geotechnical Resistance		Downdrag Load	Anticipated Pile Tip Elevation
	Factored ULS	SLS		
HP 310 x 110	1,600 kN	1,400 kN	Not applicable	At or Below Elev.182 m (CM29b Overpass)
				At or Below Elev. 183.5 m (CM29 Overpass)

C – Caissons

Consideration may be given to using augered caissons socketted into the very dense sand and silt till. The preliminary design geotechnical resistances and base elevations for caissons extended 4 m into the very dense ('N' >100 blows) till and developing resistance through shaft friction and a portion of end-bearing within the till are as follows:

Caisson Diameter	Axial Geotechnical Resistance		Downdrag Load (Factored ULS)	Highest Founding Level
	Factored ULS	SLS		
1.2 m	6,400 kN	5,000 kN	Not Applicable	Elev. 180 m (CM29b Overpass)
1.5 m	9,000 kN	6,000 kN	Not Applicable	Elev. 183 m (CM29 Overpass)

Given the potential for base boiling under hydrostatic pressure and uncertainties associated with cleaning and inspecting the base, the above recommended values must be reassessed during detail design.

Recommended Foundation Alternative

The recommended foundation alternative at this site is steel H-piles driven into the very dense sand/silt till.

- **ABUTMENT TYPE**

The soil conditions at this site are suitable for conventional or integral abutment design.

- **APPROACHES**

General

Assuming the proposed Enfield Road grade is at or below about Elev. 204 to 206 m, up to 8 m of fill will be required to construct the highway mainline approaches.

Stability

Approach embankments up to 8 m in height are anticipated to be stable at side slope inclinations of 2H : 1V using SSM or better material.

Settlement

Foundation settlement will occur as fill is placed. It is estimated that the magnitude of such settlement would be less than 25 mm. It is expected that a majority of the settlement would be completed by the end of construction.

- **CONSTRUCTION CONSIDERATIONS**

Pile Installation

During pile installation, there is a medium probability of encountering cobbles or boulders within the sand and silt till. Pile driving shoes should be fitted to the pile tips for reinforcement and to enhance seating of the piles.

Excavation

Shallow excavations below the road grade are required for footing or pile cap construction. Temporarily unsupported side slopes should not be steeper than 1H : 1V at this site. In accordance with the OHSA, all native soils and fills at this site are classified as Type 3 soils.

Groundwater/Surface Water Control

It is anticipated that much of the water accumulation within footing or pile cap excavations will be from surface runoff, with some contribution of seepage from perched water in the fill or sands and silts. Diversion of surface runoff from the excavations and pumping from carefully constructed, filtered sumps are required to control the water during construction.

Protection Systems

Protection systems may be required at excavation locations where stable slopes cannot be constructed due to space limitations and where vertically sided excavations are needed for footing or pile cap construction. Possible systems include soldier piles and lagging. The feasibility of installing protection systems should be assessed once further subsurface investigation is carried out during detail design.

- **RECOMMENDATIONS FOR ADDITIONAL WORK**

Further subsurface investigation, analysis and design should be carried out during detail design to confirm the subsoil conditions at the location of the bridge foundation elements. As a minimum, this is likely to require additional boreholes at the actual abutment and pier locations, and the approaches. Caisson installation methods will need to be further assessed and the caisson geotechnical resistances should be reassessed based on additional subsurface information.

PART A - PRELIMINARY FOUNDATION INVESTIGATION REPORT
HWY 407 EAST EXTENSION – CENTRAL SECTION
W.O. 07 – 20016

LOCATION No:	CM-29d

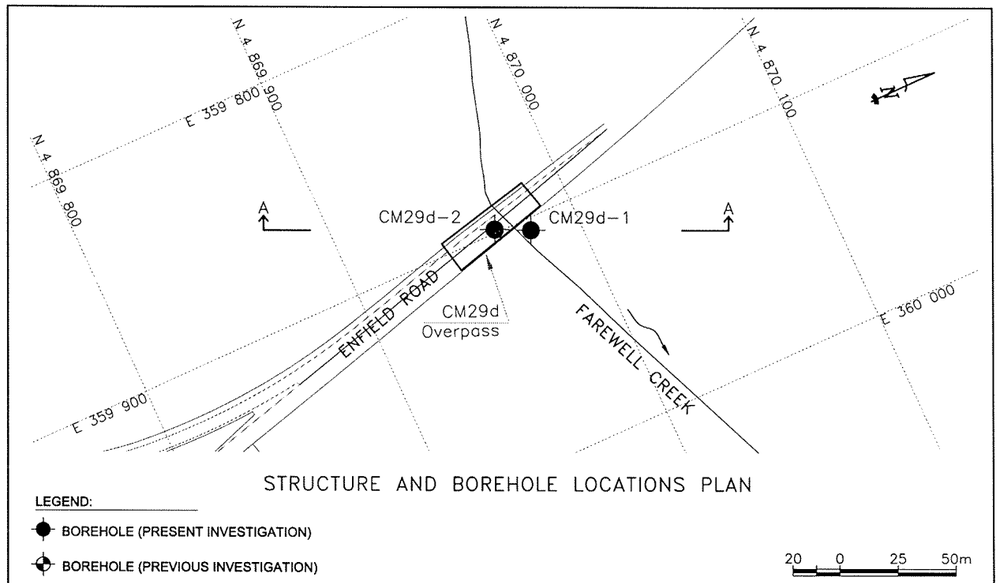
Structure Description: Enfield Road Bridge over Farewell Creek

Enfield Road Proposed Grade: ~ El. 207 m

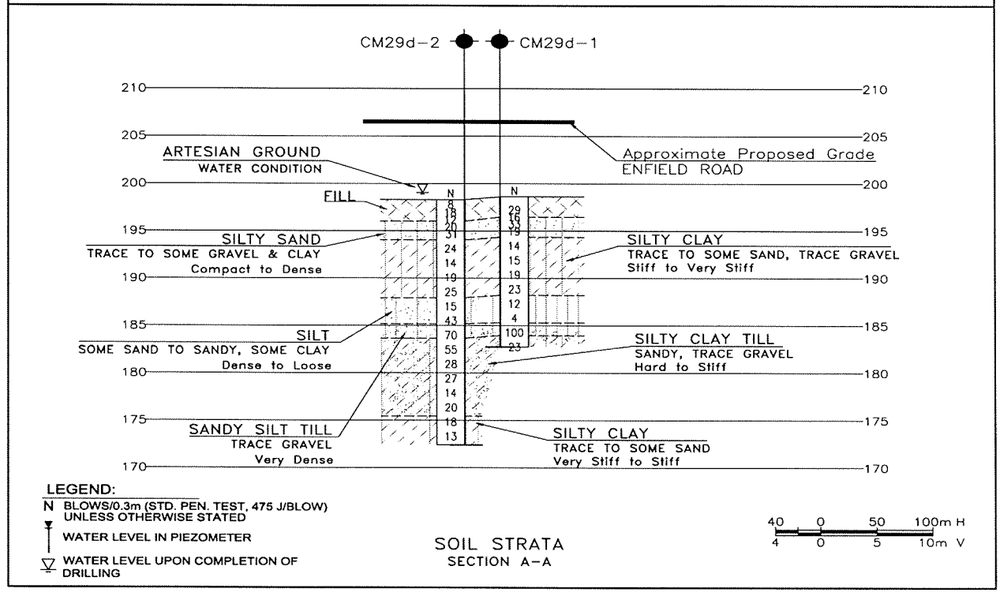
Existing Ground Elevation: ~ El. 198 to 199 m

Site Ranking: Medium

Station: ~9+625



STRUCTURE AND BOREHOLE LOCATIONS PLAN



SOIL STRATA
SECTION A–A

FOUNDATION INVESTIGATION

Site Description:

At this site, Enfield Road is an existing two-lane, rural undivided paved roadway. Farewell creek flows in a west to east direction through an existing culvert under Enfield Road. Terrain mapping shows the creek area is characterized by organics and sand, silt and gravel alluvial plain over glacial till. The local relief is low with poor drainage.

Borehole Information:

Borehole No.	Borehole Location	MTM NAD 83 – Northing	MTM NAD 83 - Easting	Borehole Elevation (m)	Borehole Depth (m)
CM29d-1	North Side	4 869 979.3	359 905.2	198.6	15.8
CM29d-2	South Side	4 869 965.2	359 898.5	198.3	25.9

Subsurface Conditions:

- **Fill:** Brown to dark brown sand to sandy silt fill was encountered from ground surface to 2.1 m and 2.3 m depths in boreholes CM29d-1 and CM29d-2. The underside of the fill varies between Elev. 196.5 m to 196.0 m. The fill is loose to compact with 'N' values ranging from 8 to 29 blows/0.3 m penetration. Moisture contents of the fill ranged between 4% and 20%.

- **Silty Sand:** A layer of greyish brown to brown silty sand, with some gravel and trace to some clay was encountered below the fill in both boreholes. The thickness of this deposit ranges between 2.0 m and 2.2 m, with underside elevations ranging from 194.0 m to 194.3 m. This layer is compact to dense with 'N' values ranging from 19 to 33 blows/0.3 m penetration. Moisture content ranges between 11% and 18%. Grain size distribution curves for samples of this soil are presented in Figure CM29d-B1.

- **Silty Clay:** Greyish brown silty clay with trace to some sand and trace gravel was encountered below the silty sand layer in both boreholes. This layer is 6.1 m thick in both boreholes with an underside at Elev. 188.2 and 187.9 m in BH CM29d-1 and BH CM29d-2, respectively. This silty clay deposit is stiff to very stiff with 'N' values ranging from 14 to 25 blows/0.3 m penetration. The measured moisture contents ranged from 13% to 21%. Grain size distribution curves for samples of this soil are presented in Figure CM29d-B2. The Atterberg limit test results are presented in Figure CM29d-B5.

- **Silt**: A 2.7 to 2.9 m thick layer of greyish brown silt, some sand to sandy, with some clay and trace gravel underlies the silty clay. The underside of this layer lies at Elev. 185.2 to 185.3 m. This silt is loose to dense with 'N' values of 4 and 43 blows/0.3 m penetration. Moisture contents ranged between 10% and 18%. Grain size distribution curves for samples of this soil are presented in Figure CM29d-B3.

- **Sandy Silt Till:** Greyish brown sandy silt till, with trace gravel was encountered below the sandy silt. This layer is 1.3 to 1.5 m in thickness, extending to Elev. 184.0 and 183.7 m. This till is very dense with 'N' values of 70 and 100 blows/0.3 m penetration. Moisture content was about 8%. Glacial tills typically contain cobbles and boulders.

- **Silty Clay Till:** A 8.3 m thick layer of greyish brown silty clay till was encountered below the sandy silt till in borehole CM29d-2. Borehole CM29d-1 was terminated in this till layer at 15.8 m depth (Elev. 182.8 m).This layer is hard to stiff with 'N' values ranging from 55 to 14 blows/0.3 m and extends to Elev. 175.4 m. Measured moisture contents ranged from 8% to 16%. Grain size distribution curves for samples of this soil are presented in Figure CM29d-B4. The Atterberg limit test results are presented in Figure CM29d-B6.

- **Silty Clay:** Grey silty clay, with trace to some sand was encountered below the silty clay till in borehole CM29d-2. . This silty clay is very stiff to stiff with 'N' values of 18 and 13 blows/0.3 m penetration. Moisture content ranged between 7% and 18%. After sampling to 25.0 m depth (Elev. 173.3 m), borehole CM29d-2 was extended to 25.9 m depth (Elev. 172.4 m), an artesian condition was encountered, and the borehole was terminated. Based on this observation, the lower boundary of the clay layer is believed to be between 25.0 and 25.9 m depth.

Groundwater Conditions:

- **BH CM29d-2:** Groundwater level at 0.74 m above ground surface (Elev. 199.04 m) 45 minutes after artesian condition encountered at 25.9 m depth (Elev. 172.4 m).

Record of Borehole Sheets – Appendix A | **Laboratory Test Results – Appendix B** | **Key Location Plan – Figure 1**

Thurber Engineering Ltd.

LOCATION No:	CM-29d

FOUNDATION RECOMMENDATIONS

Note: The site specific foundation recommendations are for planning purposes only. Refer to Section 6 of the Foundation Design Report for the project-wide foundation recommendations, design assumptions and limitations.

General: A single span structure with two abutments is proposed.

Foundation Option	*Advantages*	*Disadvantages*
Spread Footings founded on compact to dense silty sand	- Conventional construction - Low cost alternative	- Does not permit integral abutment design - Potential variability of surficial soils; footings must be extended below these soils - Temporary shoring may be required - Dewatering will be required - Scour protection will be required for the footings - Sub-excavation of existing fill, soft and organics soil is required
Spread Footings perched on Granular A pads for abutments	- Lower cost than deep foundations - Minimize excavation requirements - Higher bearing resistance than footings on native soil	- Higher cost than spread footings on native soils - Sub-excavation of existing fill, soft and organics soils is required - Dewatering may be required - Scour protection is required
Steel H-Piles driven to very stiff silty clay or silty clay till	- Permits use of integral abutments - Not affected by surficial soil variability	- Higher cost than spread footings - Pile embedment length limited in order to keep pile tips above the artesian layer - Piles may have to be driven after constructing approach fill
Caissons founded in very stiff silty clay or hard silty clay till	- Higher bearing resistance - Not so affected by surficial soil variability	- Higher cost than spread footings - Does not permit integral abutment design - Caisson embedment length and bearing resistance limited to keep caisson bases above artesian layer

A - Spread Footings

Spread footings founded on compact to dense silty sand may be used for the abutments. Footings for perched abutments may be founded on compacted Granular A cores in accordance with current MTO practices. The preliminary geotechnical design resistances and founding levels for spread footings on native soils, and spread footings on compacted Granular A cores, are as follows:

Founding Stratum	Geotechnical Resistance		Foundation Level
	Factored ULS	SLS	
Silty Sand	300 kPa	200 kPa	At or below Elev. 196.0 m
Compacted Granular A	700 kPa	350 kPa	Fill base at or below Elev. 196.0 m

B - Steel H-Piles

Steel H-piles driven within the very stiff silty clay or silty clay till may be used to provide foundation support. However, pile tips must be kept well above the artesian layer encountered at Elev. 172.4 m in BH CM29d-2. The preliminary pile design is based largely on skin friction. The preliminary design geotechnical resistances and tip elevations are as follows:

Pile	Axial Geotechnical Resistance		Downdrag Load	Anticipated Pile Tip Elevation
	Factored ULS	SLS		
HP 310 x 110	600 kN	500 kN	Not applicable	At or below Elev. 178.0 m

Note: 1. The pile tip penetration and corresponding geotechnical resistances are limited in order not to make contact with the artesian layer at Elev. 172.4 m. Higher geotechnical resistances may be achieved by driving the piles deeper to refusal. If the deeper pile penetration reaches the artesian layer, then specialized pile construction techniques will be required to mitigate the upward flow of artesian water. This may involve measures such as constructing the approach embankment first then driving piles from a higher elevation through approach embankments. Additional surface investigation including deeper boreholes is required to finalize pile design at this site.

C – Caissons

Based on the potential difficulties with installing caissons under artesian pressure conditions, uncertainties associated with cleaning and inspecting the base, and the limited bearing resistance available in the soils above the artesian zone, the use of caisson foundations is not recommended at this site and the option has not been developed.

Recommended Foundation Alternative

The recommended foundation alternative at this site is steel H-piles driven into the very stiff silty clay or silty clay till. The preliminary pile tip elevations have been set above the artesian layer. In view of the risks associated with driving piles into a layer under artesian groundwater condition, extensive additional investigation during detail design is recommended for designing pile foundation at this site.

- **ABUTMENT TYPE**

The soil conditions at this site are suitable for conventional, integral or semi-integral abutment design.

- **APPROACHES**

Approach embankments up to the order of 10 m high are anticipated.

Stability

Approach embankments up to 10 m in height are anticipated to be stable at side slope inclinations of 2H : 1V using SSM or granular material. A 2 m wide mid-height bench is required for embankment slopes higher than 8 m.

Settlement

Settlements in the order of 150 mm are expected from the 10 m high approach fills. During detail design phase, additional settlement calculations should be undertaken to determine if the approach fills should be constructed ahead of foundation construction.

- **CONSTRUCTION CONSIDERATIONS**

Pile Installation

Driving shoes should be fitted to the pile tips for reinforcement and enhancing seating of the piles.

Excavation

Temporarily unsupported side slopes should not be steeper than 1H : 1V where groundwater control measures are implemented as outlined below. In accordance with OHSA the fill materials are classified as Type 3 material. The silty sand is Type 2 material above the water table and Type 3 soil below the water table.

Groundwater/Surface Water Control

Diversion of stream flow and surface runoff from the temporary excavations for foundation construction and pumping from carefully constructed, filtered sumps should be used to control groundwater. The required groundwater control systems should be further assessed during detail design.

Protection Systems

Protection systems may be required for any vertically sided excavations for foundation construction or where space restrictions prohibit formation of safe side slopes. One possible system is soldier pile and lagging. The feasibility of installing such protection systems should be assessed once further subsurface investigation is carried out during detail design.

Floodplain Access

Potential environmental impacts will need to be minimized during construction access into the creek floodplain. Specific access preparation procedures including the use of gravel roadways underlain by geosynthetics should be considered.

- **RECOMMENDATIONS FOR ADDITIONAL WORK**

Further subsurface investigation, analysis and design should be carried out during detail design to confirm the subsoil conditions at the location of the bridge foundation elements. As a minimum, this is likely to require additional boreholes at the actual abutment locations and at the approaches. It is recommended to advance boreholes below Elev. 172.4 m to confirm depth to refusal. Artesian condition should be extensively investigated and foundation capacity and installation procedures re-assessed during detail design.

PRELIMINARY FOUNDATION INVESTIGATION REPORT
DEEP CUTS
HWY 407 EAST EXTENSION – CENTRAL SECTION (EAST PART)
W.O. 07 - 20016

Deep Cut No.	Station (From – To)	Proposed Highway Grade (m)	Maximum Cut Depth (m)	Reference Data	Subsurface Conditions	Preliminary Recommendations
Hwy 407	**Central Mainline**					
DC-C4	20+850 to 21+100	232.9 to 233.5	5.5	CCM-3	**Stratigraphy:** Very stiff to hard silty clay till to 4.1 m depth (Elev. 233.0 m), underlain by very dense sand and silt till. **Groundwater:** 3.4 m depth (Elev. 233.7 m) in piezometer on February 10, 2009.	**Design Slope Inclination**: Cut slopes up to 5.5 m high may be constructed at 2H : 1V. **Drainage**: No major groundwater issues are anticipated. Side ditches should be adequate for surface drainage. **Recommendations for Further Investigation:** Additional boreholes should be advanced to confirm the stratigraphy within the cut section.
DC-C5	21+460 to 21+700	231.1 to 231.8	9	CCM-4	**Stratigraphy:** Dense to very dense silty sand to 7.2 m depth (Elev. 231.3 m), underlain by very dense silty sand till. **Groundwater:** 2.9 m depth (Elev. 235.6 m) in piezometer on October 10, 2008. 2.9 m depth (Elev. 235.6 m) in piezometer on February 12, 2009.	**Design Slope Inclination**: Cut slopes up to 9 m high may be constructed at 2H : 1V with a 2 m wide mid-height bench on slopes exceeding 8 m in height. **Drainage**: Excavation will extend into silty sand approximately 4 m below the groundwater table. Temporary and permanent drainage measures such as interceptor drains and subdrains are likely to be required. Side ditches should be adequate for surface drainage. **Surficial Instability:** Gravel sheeting or other measures may be required to improve surficial stability in areas of persistent seepage. **Recommendations for Further Investigation:** Additional boreholes should be advanced to confirm the stratigraphy within the cut section and further assess groundwater control measures.
DC-C9	21+940 to 22+060	230.0 to 230.4	6	Desktop Study, Hydrogeology Report	**Stratigraphy:** Desktop study and hydrogeology reports indicate a clayey silt till ground moraine at this location. However in nearby Borehole CCM-4 where similar conditions were anticipated, dense to very dense silty sand was encountered to 7.2 m depth (Elev. 231.3 m), underlain by very dense silty sand till. **Groundwater:** Estimated near 3 m depth (233.0 m).	**Design Slope Inclination**: Cut slopes up to 6 m high may be constructed at 2H : 1V. **Drainage**: Excavation may extend into silty sand approximately 3 m below the groundwater table. Temporary and permanent drainage measures such as slope drains may be required. Side ditches should be adequate for surface drainage. **Surficial Instability:** Gravel sheeting or other measures may be required to improve surficial stability in areas of persistent seepage. **Recommendations for Further Investigation:** Boreholes should be advanced to confirm the stratigraphy within the cut section and further assess groundwater control measures.
DC-C6	23+400 to 23+670	212.3 to 217.1	5.5	CCM-5 CCM-6	**Stratigraphy:** Discontinous sand layer to 0.7 m depth, underlain by typically dense to very dense silty sand to sand and silt till. A 2.1 m thick layer off gravelly sand was encountered within the till at 4.9 m depth (Elev. 215.4 m) in one borehole. **Groundwater:** 2.3 m depth (Elev. 215.3 m) in piezometer on December 10, 2008.	**Design Slope Inclination**: Cut slopes up to 5.5 m high may be constructed at 2H : 1V. **Drainage**: Groundwater seepage may be encountered from more permeable zones in the till soils. Side ditches should be adequate for surface drainage. **Surficial Instability:** Gravel sheeting or other measures may be required to improve surficial stability if areas of persistent seepage are encountered. **Recommendations for Further Investigation:** Additional boreholes should be advanced to confirm the stratigraphy within the cut section.

PRELIMINARY FOUNDATION INVESTIGATION REPORT
DEEP CUTS
HWY 407 EAST EXTENSION – CENTRAL SECTION (EAST PART)
W.O. 07 - 20016

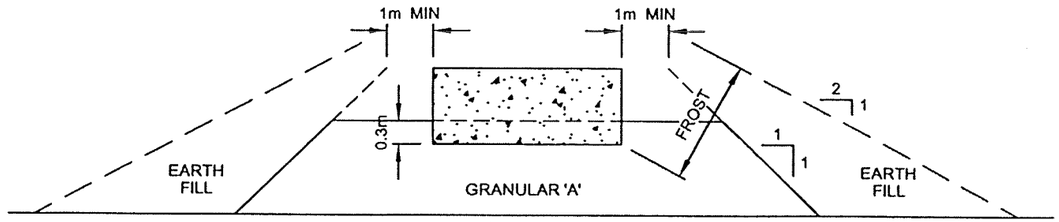
Deep Cut No.	Station (From – To)	Proposed Highway Grade (m)	Maximum Cut Depth (m)	Reference Data	Subsurface Conditions	Preliminary Recommendations
DC-C7	24+350 to 25+080	202.4 to 207.8	7	Desktop Study, Hydrogeology Report	**Stratigraphy:** Silt till ground moraine. **Groundwater:** Estimated near 6 m depth (Elev. 204.0 m).	**Design Slope Inclination**: Cut slopes up to 7 m high may be constructed at 2H : 1V. **Drainage**: No major groundwater issues are anticipated. Side ditches should be adequate for surface drainage. **Recommendations for Further Investigation:** Boreholes should be advanced to confirm the stratigraphy within the cut section.

High Fill No.	Station (From – To)	Proposed Highway Grade (m)	Maximum Fill Height (m)	Reference Data	Subsurface Conditions	Preliminary Recommendations
Hwy 407	**Central Mainline**					
HF-C5	18+380 to 18+500	184.8 to 185.5	9	Site CM-17 (BHs CM17-2 and CM17b-2)	**Stratigraphy:** 0.3 to 0.6 m of peat or topsoil, overlying compact to dense silty sand to depths of 2.2 to 2.7 m (Elev. 174.2 to 174.4 m), underlain by compact to very dense sand and silt till. **Groundwater:** 0.0 m depth (Elev. 177.2 m) in piezometer on May 26, 2008.	**Design Slope Inclination**: Fill slopes up to 9 m high may be constructed at 2H : 1V with a 2 m wide mid-height bench on slopes exceeding 8 m in height. **Stability**: No stability issues are anticipated. Existing peat and topsoil require removal. **Settlement:** No settlement issues are anticipated. **Recommendations for Further Investigation:** Additional boreholes should be advanced to confirm the stratigraphy within the fill section.
HF-C6	20+200 to 20+630	219.2 to 230.8	14	Sites CM-20 and CM-21	**Stratigraphy:** Variable stratigraphy, typically comprising compact to very dense sand and silt till and/or stiff to hard silty clay till, locally overlain by a thin (0.8 to 1.9 m) layer of sandy silt or silty clay. The till deposits contain discontinuous layers of stiff to very stiff silty clay and loose to compact sand, silty sand and sandy gravel, ranging in thickness from 0.3 to 4.7 m. **Groundwater:** 0.1 to 0.7 m depth (Elev. 210.4 to 221.0 m) in piezometers.	**Design Slope Inclination**: Fill slopes up to 14 m high may be constructed at 2H : 1V with a 2 m wide mid-height bench on slopes exceeding 8 m in height. **Stability**: No stability issues are anticipated. **Settlement:** Post-construction settlement in the order of 75 mm is anticipated under a maximum 14 m high embankment. **Mitigation Options:** Measures to minimize post-construction settlement, such as advance embankment construction (preloading) should be evaluated. **Recommendations for Further Investigation:** Additional boreholes should be advanced and laboratory testing conducted to confirm the stratigraphy, further evaluate the magnitude of anticipated settlement, and assess measures such as preloading.
HF-C9	22+600 to 23+160	221.3 to 228.4	9	Desktop Study, Hydrogeology Report	**Stratigraphy:** Silt till ground moraine with surficial alluvial deposits comprising silty gravelly sand adjacent to watercourse. **Groundwater:** Estimated near ground surface (Elev. 216.0 m).	**Design Slope Inclination**: Fill slopes up to 9 m high may be constructed at 2H : 1V with a 2 m wide mid-height bench on slopes exceeding 8 m in height. **Stability**: No stability issues are anticipated. **Settlement:** No settlement issues are anticipated. **Recommendations for Further Investigation:** Boreholes should be advanced to confirm the stratigraphy in the high fill section.
HF-C7	24+030 to 24+220	203.0 to 206.0	8.5	Desktop Study, Hydrogeology Report	**Stratigraphy:** Silt till ground moraine with surficial alluvial deposits (silty gravelly sand) and glaciolacustrine deposits (sandy silt) adjacent to watercourse. **Groundwater:** Estimated near ground surface (Elev. 196.0 m).	**Design Slope Inclination**: Fill slopes up to 8.5 m high may be constructed at 2H : 1V with a 2 m wide mid-height bench on slopes exceeding 8 m in height. **Stability**: No stability issues are anticipated. **Settlement:** No settlement issues are anticipated. **Recommendations for Further Investigation:** Boreholes should be advanced to confirm the stratigraphy in the high fill section.

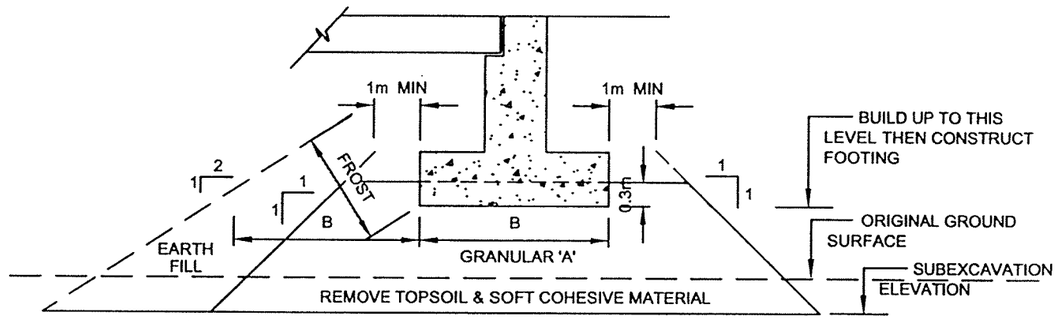
PRELIMINARY FOUNDATION INVESTIGATION REPORT
HIGH FILLS
HWY 407 EAST EXTENSION – CENTRAL SECTION (EAST PART)
W.O. 07 - 20016

High Fill No.	Station (From – To)	Proposed Highway Grade (m)	Maximum Fill Height (m)	Reference Data	Subsurface Conditions	Preliminary Recommendations
HF-C8	25+260 to 25+440	209.1 to 210.5	7	Site CM-29	**Stratigraphy:** Surficial deposits of fill, topsoil and silty clay to depths of 1.5 to 2.1 m (Elev. 202.6 to 203.2 m), underlain by compact to very dense silt and sand till, some clay to clayey. **Groundwater:** 4.3 m depth (Elev. 200.4 m) in piezometer on August 27, 2008.	**Design Slope Inclination**: Fill slopes up to 7 m high may be constructed at 2H : 1V. **Stability**: No stability issues are anticipated. **Settlement:** No settlement issues are anticipated. **Recommendations for Further Investigation:** Additional boreholes should be advanced to confirm the stratigraphy in the high fill section.

March , 2004



CROSS-SECTION



LONGITUDINAL SECTION

NOT TO SCALE

NOTES:

1. REMOVE TOPSOIL AND SOFT SILTY CLAY SUBSOIL UNDER FOOTPRINT OF COMPACTED GRANULAR 'A'.
2. PLACE GRANULAR 'A' AND EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO O.P.S.S. 501.
3. CONSTRUCT CONCRETE FOOTING.
4. PLACE REMAINDER OF GRANULAR 'A' AND EARTH FILL AS REQUIRED.
5. SOURCE M.T.C. 1982.

ENGINEER: AEG		
DRAWN: SS	ABUTMENT ON COMPACTED FILL SHOWING GRANULAR 'A' CORE	THURBER
DATE: MARCH 2009		
APPROVED: PKC		DWG. NO. FIGURE 2
SCALE: NTS		

TED35146.DWG

APPENDIX A

RECORD OF BOREHOLE SHEETS

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT[(1)] 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

1) Laboratory Triaxial Testing
2) Field Insitu Vane Testing
3) Laboratory Vane Testing
4) SPT value
5) Pocket Penetrometer

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE

SS Split Spoon Sample; WS Wash Sample; AS Auger (Grab) Sample
TW Thin Wall Shelby Tube Sample; TP Thin Wall Piston Sample
PH Sampler Advanced by Hydraulic Pressure; PM Sampler Advanced by Manual Pressure
WH Sampler Advanced by Self Static Weight; RC Rock Core; SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

$\overline{\blacktriangledown}$ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

(1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.

(2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

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THURBER

RECORD OF BOREHOLE No CM16-1 1 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 716.2 E 353 190.6 Oshawa Creek Tributary | ORIGINATED BY WB
HWY 407 | BOREHOLE TYPE Hollow Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2009.06.26 - 2009.06.29 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
183.6								20 40 60 80 100 / 40 80 120 160 200	20 40 60		
0.0	**TOPSOIL**, mixed with silty clay, some sand, some rootlets Brown		1	AS							
183.0							183				
0.6	Clayey **SILT**, some sand Very Soft to Firm Brown		1	SS	WH						
181.4			2	SS	8		182				
2.2	**SAND** and **SILT**, trace clay, trace gravel Compact Brown Moist		3	SS	17		181				8 49 35 8
180.6											
3.0	**SAND**, some silt to silty, trace gravel Very Loose to Dense Grey Wet		4	SS	1		180				
			5	SS	4		179				
			6	SS	26		178				0 75 25 (SI+CL)
			7	SS	38		177				
							176				
			8	SS	40		175				
174.2							174				
9.4	**SILT**, trace sand Dense Grey										

Continued Next Page

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

ONTMT4S 0510.GPJ 9/3/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM16-1 2 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 716.2 E 353 190.6 Oshawa Creek Tributary | ORIGINATED BY WB
HWY 407 | BOREHOLE TYPE Hollow Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2009.06.26 - 2009.06.29 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100 / 40 80 120 160 200	20 40 60		
173.2	Moist										
10.4	Silty **SAND**, trace gravel Compact Grey Moist		9	SS	15		173				1 68 31 (SI+CL)
172.0							172				
11.6	**SAND** and **SILT**, some clay, trace gravel Very Dense Grey Moist (TILL)		10	SS	100/ 0.250		171				2 44 36 18
			11	SS	100/ 0.225		170				
169.0							169				
14.6	**SAND**, trace silt Very Dense Grey Moist		12	SS	100/ 0.200						
168.2											
15.4	END OF BOREHOLE AT 15.4m. WATER LEVEL AT SURFACE UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH HOLEPLUG AND CUTTINGS TO SURFACE.										

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

ONTMT4S 0510.GPJ 9/3/09

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Ontario

THURBER

RECORD OF BOREHOLE No CM16-2 1 OF 2 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 870 630.8 E 353 205.5 Oshawa Creek Tributary ORIGINATED BY WB

HWY 407 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2009.06.24 - 2009.06.26 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
182.4								
0.0	**TOPSOIL**, mixed with silty clay, some rootlets Brown		1	AS				
181.8								
0.6	Clayey **SILT**, trace to some sand, trace gravel Very Soft to Firm Dark Brown		1	SS	8			
			2	SS	WH			
	Occasional cobbles		3	SS	2			0 16 59 25
179.5								
2.9	**SILT** and **SAND**, some clay, trace gravel Compact Grey Moist		4	SS	17			3 41 45 11
			5	SS	19			
176.9								
5.5	**SAND**, some silt, trace gravel Very Loose to Compact Brown Moist		6	SS	3			
			7	SS	28			9 77 14 (SI+CL)
			8	SS	26			

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
40 80 120 160 200

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ kN/m^3

ELEVATION SCALE: 182, 181, 180, 179, 178, 177, 176, 175, 174, 173

Continued Next Page

ONTMT4S 0510.GPJ 9/3/09

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM16-2 2 OF 2 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 870 630.8 E 353 205.5 Oshawa Creek Tributary ORIGINATED BY WB

HWY 407 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2009.06.24 - 2009.06.26 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							
	SAND, some silt to silty, trace gravel Compact to Dense Brown Moist		9	SS	26			
			10	SS	49			7 69 24 (SI+CL)
169.4								
13.0	Silty **CLAY**, trace sand Hard Grey		11	SS	100/ 0.275			0 6 62 32
167.8								
14.6	Silty **SAND**, trace clay Very Dense Grey Moist		12	SS	100/ 0.175			
165.6								
16.8	**SILT**, some clay, trace sand Very Dense Grey		13	SS	100/ 0.175			0 8 75 17
16.9	END OF BOREHOLE AT 16.9m. WATER LEVEL AT SURFACE UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH HOLEPLUG AND CUTTINGS TO SURFACE.							

WATER LEVEL READINGS (FROM PIEZOMETER CM16-2):

DATE	DEPTH (m)	ELEV. (m)
2009.02.12	1.9	180.5
2009.05.04	0.5	181.9
2009.06.09	0.9	181.5

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
40 80 120 160 200

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ kN/m^3

ELEVATION SCALE: 172, 171, 170, 169, 168, 167, 166

ONTMT4S 0510.GPJ 9/3/09

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM17-1 1 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 854.8 E 353 677.7 Ritson Road | ORIGINATED BY SLL
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2007.12.11 - 2007.12.11 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kPa: O UNCONFINED + FIELD VANE; ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
173.4															
0.0 / 0.1	**ASPHALT:** (50mm)														
	SAND, some gravel, trace silt Dark Brown Moist (FILL)		1	AS			173								
172.5															
0.9	**SAND**, some gravel, some silt Dense Brown Moist (TILL)		1	SS	47										17 66 17 (SI+CL)
			2	SS	30		172								
171.2															
2.2	Sandy **SILT**, trace gravel, trace clay Dense Brown Moist (TILL)		3	SS	38		171								
170.4															
3.0	**SAND**, some silt, trace gravel Compact to Very Dense Brown Wet		4	SS	21		170								
			5	SS	54		169								
			6	SS	55		168 167								0 80 20 (SI+CL)
			7	SS	100/ 225		166								
	becoming Grey		8	SS	100/ 250		165 164								

Continued Next Page

+ 3, × 3 Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 11/14/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM17-1 2 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 854.8 E 353 677.7 Ritson Road | ORIGINATED BY SLL
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2007.12.11 - 2007.12.11 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kPa: O UNCONFINED + FIELD VANE; ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page														
	SAND, some silt, trace gravel Very Dense Grey Wet						163								
162.5			9	SS	100/ 275										0 75 25 (SI+CL)
161.9	Sandy **SILT**, trace gravel, trace clay Very Dense Grey Moist (TILL)														
11.1	BOREHOLE CONTINUED IN CM17-1a END OF BOREHOLE AT 11.1m. Piezometer installation consists of 19 mm diameter Schedule 40 PVC pipe with a 1.52 m slotted Screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 2008.12.12 3.0 170.5 2008.01.16 2.1 171.4 2008.07.28 1.7 171.7														

+ 3, × 3 Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 11/14/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM17-1a 1 OF 2 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 870 854.8 E 353 677.7 Ritson Road ORIGINATED BY SLL

HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES

DATUM Geodetic DATE 2007.12.13 - 2007.12.13 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
173.4								20 40 60 80 100	20 40 60		
0.0	BOREHOLE CONTINUED FROM CM17-1. No Sampling until 12.2m.						173 172 171 170 169 168 167 166 165 164				

Continued Next Page

+ 3 , × 3 : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 11/14/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM17-1a 2 OF 2 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 870 854.8 E 353 677.7 Ritson Road ORIGINATED BY SLL

HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES

DATUM Geodetic DATE 2007.12.13 - 2007.12.13 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
161.2							163 162				
12.2	Sandy **SILT**, trace gravel, trace clay Very Dense Grey Moist (TILL)		1	SS	102/ 225		161 160				
			2	SS	100/ 275		159				
158.0			3	SS	100/ .150						
15.4	END OF BOREHOLE AT 15.4m. BOREHOLE OPEN TO 9.8m AND WATER LEVEL AT 5.9m UPON COMPLETION. BOREHOLE SEALED WITH BENTONITE HOLEPLUG TO 0.2m AND ASPHALT TO SURFACE.										

+ 3 , × 3 : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 11/14/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM17-2 1 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 818.1 E 353 603.0 Ritson Road | ORIGINATED BY WB
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.05.26 - 2008.05.26 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa 40 80 120 160 200 (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
176.4											
0.0 / 176.1	**PEAT**, sandy, roots		1	AS		▽			o		
0.3	Silty **SAND**, trace clay, trace gravel Compact to Dense Brown-grey Moist		1	SS	13		176		o		
174.2			2	SS	31		175		o		0 64 33 3
2.2	Silty **SAND**, trace clay, trace gravel Compact to Very Dense Grey Moist (TILL)		3	SS	26		174		o		
			4	SS	18		173		o		4 56 33 7
			5	SS	100/ 275		172		o		
170.9											
5.5	**SAND** and **SILT**, trace clay, trace gravel Very Dense Grey Moist (TILL)		6	SS	100		171		o		
							170				
			7	SS	100/ 250		169		o		6 41 44 9
							168				
166.9			8	SS	100/ 225		167		o		
9.5	END OF BOREHOLE AT 9.53m. WATER LEVEL AT 0.3m UPON COMPLETION.										

Continued Next Page

+ 3 , × 3 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 3/11/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM17-2 2 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 818.1 E 353 603.0 Ritson Road | ORIGINATED BY WB
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.05.26 - 2008.05.26 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	BOREHOLE SEALED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.										

+ 3 , × 3 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 11/14/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM17-3 1 OF 2 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 870 890.1 E 353 732.9 Ritson Road ORIGINATED BY SLL
HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2007.03.10 - 2007.03.10 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
168.8											
0.0	**TOPSOIL:** (125mm), with roots Brown Moist										
0.1	**SAND**, trace silt Compact Brown to Grey Wet		1	SS	10		168				
167.0			2	SS	21		167				
1.8	Sandy **SILT**, trace gravel Very Dense Grey Moist (TILL)		3	SS	51		166				
165.9											
3.0	Silty **SAND**, trace gravel, with sand seams Dense Grey Wet (TILL)		4	SS	44		165				3 70 27 (SI+CL)
164.6											
4.3	**SILT**, some clay, trace sand Very Dense Grey Moist (TILL)		5	SS	100/275		164				0 10 75 15
163.0											
5.8	**SAND**, some silt, trace gravel Very Dense Grey Wet		6	SS	81		163				
			7	SS	55		162				
			8	SS	102		161				1 83 16 (SI+CL)
							160				
							159				

Continued Next Page

+ 3 , × 3 Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 11/14/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM17-3 2 OF 2 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 870 890.1 E 353 732.9 Ritson Road ORIGINATED BY SLL
HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2007.03.10 - 2007.03.10 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND, some silt, trace gravel Very Dense Grey Wet		9	SS	100/100		158				
	Dense to Compact		10	SS	42		157				
							156				
154.5			11	SS	10		155				
14.3	END OF BOREHOLE AT 14.3m. BOREHOLE CONTINUED IN CM17-3a.										

+ 3 , × 3 Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 11/14/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM17-3a 1 OF 2 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 870 890.1 E 353 732.9 Ritson Road ORIGINATED BY SLL
HWY 407 BOREHOLE TYPE HW Casing COMPILED BY ES
DATUM Geodetic DATE 2008.03.12 - 2008.03.12 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
168.8											
0.0	BOREHOLE CONTINUED FROM CM17-3					▼	168				
							167				
							166				
							165				
							164				
							163				
							162				
							161				
							160				
159.7							159				
9.1	**SAND**, some silt, trace gravel Very Dense Grey		1	SS	104/ 275			o			
159.3											
9.6	Wet										
	SAND, some silt, some gravel, trace										

Continued Next Page

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

ONTMT4S 0510.GPJ 11/25/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM17-3a 2 OF 2 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 870 890.1 E 353 732.9 Ritson Road ORIGINATED BY SLL
HWY 407 BOREHOLE TYPE HW Casing COMPILED BY ES
DATUM Geodetic DATE 2008.03.12 - 2008.03.12 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	clay, with weathered shale fragments Very Dense Grey Moist (TILL)		2	SS	100/ .175		158		o		14 63 16 7
							157				
156.2			3	SS	100/ .125				o		
12.6	END OF BOREHOLE AT 12.6m. BOREHOLE OPEN TO 8.7m AND WATER LEVEL AT 0.6m UPON COMPLETION. BOREHOLE SEALED WITH BENTONITE HOLEPLUG TO 0.9m AND AUGER CUTTINGS TO SURFACE.										

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

ONTMT4S 0510.GPJ 11/25/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM17-4 1 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 925.2 E 353 832.6 Ritson Road | ORIGINATED BY SLL
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2008.12.05 - 2008.12.05 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
186.1									
0.0	**TOPSOIL**, with roots: (125mm) Black						186		
0.1	**SAND**, trace silt Compact Brown Moist		1	SS	11				
			2	SS	30		185		
184.7									
1.4	Clayey **SILT**, trace gravel Very Stiff Brown		3	SS	20				
183.8							184		
2.3	Silty **CLAY**, with sand, trace gravel Hard Brown (TILL)(CL)		4	SS	63				
			5	SS	64		183		1 26 45 28
			6	SS	41		182		
180.2							181		
5.9	**SAND** and **SILT**, trace clay, silt seams Very Dense Brown Moist (TILL)		7	SS	86		180		
			8	SS	100		179		0 43 50 7
							178		
			9	SS	88		177		

Continued Next Page

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE: 40 80 120 160 200
PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%): 20 40 60

+ ³ . × ³ : Numbers refer to Sensitivity
20 / 15 / 10 / 5 (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 3/9/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM17-4 2 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 925.2 E 353 832.6 Ritson Road | ORIGINATED BY SLL
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2008.12.05 - 2008.12.05 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page								
	SAND and **SILT**, trace clay, trace gravel Very Dense Brown Moist (TILL)		10	SS	90		176		1 49 43 7
							175		
			11	SS	71		174		
							173		
			12	SS	39		172		1 53 39 7
171.3									
14.8	**SILT**, some clay, trace sand Dense Grey Wet		13	SS	34		171		0 9 77 14
169.7							170		
16.4	**SAND**, trace to some silt Compact Grey Wet		14	SS	26		169		
168.1							168		
18.0	Sandy **SILT**, trace gravel, trace clay Dense Grey Wet (TILL)		15	SS	40				
166.7							167		
19.4	**SAND**, some gravel, some silt Very Dense Grey Moist to Wet								

Continued Next Page

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE: 40 80 120 160 200
PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%): 20 40 60

+ ³ . × ³ : Numbers refer to Sensitivity
20 / 15 / 10 / 5 (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 3/9/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No CM17-4 3 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 925.2 E 353 832.6 Ritson Road | ORIGINATED BY SLL
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2008.12.05 - 2008.12.05 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) 40 80 120 160 200	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page											
	SAND, some gravel, some silt Very Dense Grey Moist to Wet		16	SS	100/ 0.225	▽	166			o		20 63 17 (SI+CL)
165.2												
20.9	Sandy **GRAVEL**, trace silt Very Dense Grey Wet						165					
			17	SS	100/ 0.275					o		62 34 4 (SI+CL)
163.4							164					
22.7	**SAND**, some silt, trace gravel Very Dense Grey Wet											
162.9			18	SS	100/ 0.175		163			o		
23.2	END OF BOREHOLE AT 23.2m. BOREHOLE OPEN TO 21.4m AND WATER LEVEL AT 20.2m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.2m, THEN CUTTINGS TO SURFACE.											

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 3/9/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No CM17-5 1 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 930.5 E 353 756.5 Ritson Road | ORIGINATED BY SLL
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2008.12.11 - 2008.12.16 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) 40 80 120 160 200	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
171.5												
0.0	**TOPSOIL**, with roots: (100mm) Black											
0.1	**SAND**, some silt, trace gravel Loose to Compact Brown Moist		1	SS	6		171			o		
	becoming Dense		2	SS	31					o		
170.1							170					
1.4	becoming Grey Dense to Very Dense Wet		3	SS	35					o		
			4	SS	33		169			o		0 85 15 (SI+CL)
			5	SS	100					o		
							168					
			6	SS	41		167			o		
	becoming Compact		7	SS	13		166			o		4 83 13 (SI+CL)
164.0							165					
7.5	Clayey **SILT**, sandy, trace gravel Hard Grey (TILL)		8	SS	100/ 0.150		164			o		5 33 40 22
162.7							163					
8.8	Sandy **SILT**, trace clay Very Dense Grey Moist		9	SS	100/ 0.150		162			o		

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 3/9/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM17-5 2 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 930.5 E 353 756.5 Ritson Road | ORIGINATED BY SLL
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2008.12.11 - 2008.12.16 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
161.1	Continued From Previous Page										
10.4	**SAND**, some silt, trace gravel Compact to Very Dense Grey Wet		10	SS	14		161		○		
			11	SS	100/ 0.275		159		○		6 77 17 (SI+CL)
			12	SS	59		158		○		
			13	SS	86		156		○		
			14	SS	74		154		○		0 78 22 (SI+CL)
154.2 17.3	Clayey **SILT**, layered, some sand, trace gravel Hard Grey (TILL)		15	SS	71		153		○		
152.0 19.5	Gravelly **SAND**, trace silt Dense Grey						152				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 3/9/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM17-5 3 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 930.5 E 353 756.5 Ritson Road | ORIGINATED BY SLL
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2008.12.11 - 2008.12.16 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
151.1	Continued From Previous Page Wet Artesian pressure encountered		16	SS	43				○		28 68 4 (SI+CL)
20.4	END OF BOREHOLE AT 20.4m ARTESIAN PRESSURE GREATER THAN 3.7m ABOVE GROUND SURFACE. ARTESIAN PRESSURE TERMINATED BY SEALING WITH CEMENT AND BENTONITE TO SURFACE.						151				

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 3/9/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM17b-1 1 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 893.4 E 353 665.9 Ritson Road | ORIGINATED BY SLL
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2007.12.12 - 2007.12.12 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
174.4								
0.0	**ASPHALT**: (25mm)							
173.9	**SAND**, some gravel, trace silt Brown Moist (FILL)		1	AS			174	
179.8 0.6	**ASPHALT**: (75mm)							
	SAND, some gravel, trace silt Brown Moist (FILL)		1	SS	41			
172.9 1.4	Clayey **SILT**, some sand, trace gravel Very Stiff Brown (TILL)		2	SS	20		173	
172.0 2.4	Sandy **SILT**, trace clay, trace gravel Compact to Dense Brown Moist		3	SS	30		172	
171.8 2.6	**SAND**, some silt, trace gravel Compact to Very Dense Brown Moist to Wet		4	SS	27		171	4 77 19 (SI+CL)
			5	SS	26	▽	170	
			6	SS	90		169	
							168	
166.6 7.8	Sandy **SILT**, some clay Very Dense Grey Moist		7	SS	100/ 225		167	0 33 52 15
166.0 8.4	**SAND**, some silt, trace clay Very Dense Grey Wet						166	
			8	SS	100/ 250		165	
164.4								

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ kN/m^3

Continued Next Page

+ 3 × 3 Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 11/14/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM17b-1 2 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 893.4 E 353 665.9 Ritson Road | ORIGINATED BY SLL
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2007.12.12 - 2007.12.12 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							
10.0	Silty **SAND**, trace clay Dense to Very Dense Grey Wet		9	SS	47		164	0 66 32 2
			10	SS	100/ 275		163	
160.7 13.7	Sandy **SILT**, trace clay Dense to Very Dense Grey Wet		11	SS	42		162	
			12	SS	30		161	0 29 65 6
156.4 18.0	Silty **CLAY**, trace sand Hard Grey (CL)		13	SS	100/ 125		160	
			14	SS	100/ 150		159	
							158	
							157	
							156	0 2 55 43
							155	

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ kN/m^3

Continued Next Page

+ 3 × 3 Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 11/14/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM17b-1 3 OF 3 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 870 893.4 E 353 665.9 Ritson Road ORIGINATED BY SLL
HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2007.12.12 - 2007.12.12 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L: WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%): GR SA SI CL
154.2	Continued From Previous Page		15	SS	100/						
20.1	END OF BOREHOLE AT 20.1m. BOREHOLE OPEN TO 6.3m AND WATER LEVEL AT 4.7m. BOREHOLE SEALED WITH BENTONITE HOLEPLUG TO 0.2m AND ASPHALT TO SURFACE.				.175		154				

+ ^{3}, × ^{3} Numbers refer to Sensitivity (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 11/14/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM17b-2 1 OF 1 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 870 852.3 E 353 582.9 Ritson Road ORIGINATED BY WB
HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2008.05.26 - 2008.05.26 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L: WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%): GR SA SI CL
177.2											
0.0 176.6	**TOPSOIL**, silty Brown Moist						177				
0.6 174.4	Silty **SAND**, trace gravel, trace clay Compact to Dense Brown Moist (TILL)		1	SS	41		176				
			2	SS	13		175				
			3	SS	31						6 65 29 (SI+CL)
2.7 172.9	**SILT**, sandy, trace gravel Very Dense Grey Moist (TILL)		4	SS	100/ 250		174				
4.3	Clayey **SILT**, some sand, trace gravel Hard Grey (TILL)		5	SS	100/ .150		173				3 26 53 18
170.9			6	SS	100/		172				0 5 77 18
6.3	END OF BOREHOLE AT 6.30m. WATER LEVEL AT 0.60m UPON COMPLETION. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2008.07.28 0.0 177.2 2009.02.12 0.3 176.9				.200		171				

+ ^{3}, × ^{3} Numbers refer to Sensitivity (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 3/17/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM17b-3 1 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 921.4 E 353 736.5 Ritson Road | ORIGINATED BY SLL
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2007.03.12 - 2007.03.12 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
170.7											
0.0 / 170.4	**TOPSOIL:** (275mm), with roots Brown Moist										
0.3 / 169.3	**SAND**, trace gravel Compact Brown Moist		1	SS	17				o		
1.4	Silty **SAND**, trace clay, trace gravel Compact to Very Dense Brown to Grey Moist (TILL)		2	SS	12				o		
			3	SS	31				o		
			4	SS	60				o		1 65 29 5
			5	SS	60				o		
164.9 / 5.8	**SAND** and **SILT**, trace to some clay, trace gravel Very Dense Grey Moist to Wet (TILL)		6	SS	100/ .200				o		1 51 43 5
			7	SS	105/ 250				o		
			8	SS	100/ .150				o		4 40 42 14

Continued Next Page

+ 3 × 3 Numbers refer to Sensitivity — 20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 11/14/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM17b-3 2 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 921.4 E 353 736.5 Ritson Road | ORIGINATED BY SLL
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2007.03.12 - 2007.03.12 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
159.6	**SAND** and **SILT**, trace to some clay, trace gravel Very Dense Grey Moist to Wet (TILL) some gravel and weathered shale fragments		9	SS	105		160		o		
11.1	END OF BOREHOLE AT 11.1m. BOREHOLE OPEN TO 9.6m AND WATER LEVEL AT 1.6m UPON COMPLETION. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2008.04.28 0.1 170.6 2008.07.28 0.1 170.6										

+ 3 × 3 Numbers refer to Sensitivity — 20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 11/14/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM17b-4 1 OF 3 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 870 955.2 E 353 822.1 Rilson Road ORIGINATED BY SLL
HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2008.12.08 - 2008.12.09 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa 40 80 120 160 200 (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
184.7											
0.0 / 184.4	**TOPSOIL**, with roots: (250mm) Black		1	SS	8		184				
0.3	Silty **SAND** Loose to Compact Brown Moist to Wet		2	SS	13						
183.3							183				
1.4	Clayey **SILT**, trace gravel Hard Brown		3	SS	31						
182.5							182				
2.2	Silty **CLAY**, with sand, trace gravel Very Stiff to Hard Brown (TILL)(CL)		4	SS	32						2 22 44 32
			5	SS	24						
			6	SS	100/ 0.200		181				
179.1							180				
5.6	**SILT**, some clay, trace sand Very Dense Brown Moist to Wet		7	SS	100/ 0.150		179				0 8 82 10
177.8							178				
6.9	**SAND** and **SILT**, trace clay Very Dense Grey Moist to Wet (TILL)		8	SS	100/ 0.175		177				
			9	SS	100/ 0.275		176				
							175				

Continued Next Page

+ ^{3}, × ^{3} : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 3/9/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM17b-4 2 OF 3 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 870 955.2 E 353 822.1 Rilson Road ORIGINATED BY SLL
HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2008.12.08 - 2008.12.09 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa 40 80 120 160 200 (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND and **SILT**, trace clay Very Dense Grey Moist to Wet (TILL)		10	SS	57		174				0 51 40 9
			11	SS	42		173				
			12	SS	72		172				0 24 66 10
169.8							171				
14.9	**SAND**, trace to some silt Very Dense Grey Wet		13	SS	60		170				0 88 12 (SI+CL)
167.6			14	SS	35		169				
17.1	Sandy **SILT**, trace clay Dense Grey Wet						168				0 22 74 4
166.4							167				
18.3	Sandy **SILT**, trace gravel Very Dense Grey Moist (TILL)		15	SS	100/ 0.250		166				
165.0							165				
19.7	Sandy **GRAVEL**, trace silt Very Dense										

Continued Next Page

+ ^{3}, × ^{3} : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 3/9/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM17b-4 3 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 955.2 E 353 822.1 Ritson Road | ORIGINATED BY SLL
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2008.12.08 - 2008.12.09 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) (40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Sandy **GRAVEL**, trace silt Very Dense Grey Wet		16	SS	100/ 0.225		164				
163.0			17	SS	100/ 0.225				o		
21.7	END OF BOREHOLE AT 21.7m. BOREHOLE OPEN TO 17.7m AND WATER LEVEL AT 12.3m UPON COMPLETION OF DRILLING. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2008.12.10 13.5 171.2 2009.02.10 3.7 181.0										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 3/9/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM18-1 1 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 871 044.0 E 354 000.4 | ORIGINATED BY SLL
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2008.12.04 - 2008.12.04 | CHECKED BY LT

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (40 80 120 160 200) O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
178.5										
0.0	**ORGANICS** with roots and rootlets, mixed with sand Firm Black Moist		1	SS	4					
177.2			2	SS	8					
1.3	Silty **SAND**, trace gravel, trace clay Compact to Very Dense Grey Wet		3	SS	23					
			4	SS	14					
			5	SS	11					2 64 28 6
			6	SS	65					
172.9										
5.6	**SAND**, some silt and clay, trace gravel Dense to Very Dense Grey Wet		7	SS	30					2 86 12 (SI+CL)
			8	SS	63					0 82 18 (SI+CL)
169.4										
9.1	**SAND** and **GRAVEL**, trace silt and clay Very Dense Grey Wet		9	SS	63					46 47 7 (SI+CL)

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM18-1 2 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 871 044.0 E 354 000.4 | ORIGINATED BY SLL
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2008.12.04 - 2008.12.04 | CHECKED BY LT

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (40 80 120 160 200) O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page									
166.5	**SAND** and **GRAVEL**, trace silt and clay Very Dense Grey Wet		10	SS	100/ 0.150					
12.0	Sandy **SILT**, trace to some gravel Very Dense Grey Moist (TILL)		11	SS	100/ 0.175					
165.0			12	SS	100/ 0.100					
13.5	END OF BOREHOLE AT 13.5m. BOREHOLE OPEN TO 5.0m AND WATER LEVEL AT 2.0m UPON COMPLETION OF DRILLING. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. 2009.02.12 1.3 177.2 2009.05.04 0.0 178.5									

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 5/26/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM18-2 1 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 984.5 E 353 999.4 | ORIGINATED BY SLL
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2008.12.04 - 2008.12.05 | CHECKED BY LT

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
177.3							177	
0.0	**ORGANICS** with some clay, black with roots and rootlets Firm		1	SS	8			
176.2			2	SS	21		176	
1.1	**SAND**, trace silt Compact Brown Moist					▽		
175.9			3	SS	16			2 57 33 8
1.4	Silty **SAND**, trace clay, trace gravel Compact Brown to Grey Moist		4	SS	14		175	
			5	SS	16			1 62 31 6
173.1							174	
4.2	**SAND**, trace gravel, some silt and clay Dense to Very Dense Grey Wet		6	SS	36		173	
	With sandy silt seams		7	SS	53		172	3 80 17 (SI+CL)
			8	SS	78		171	
			9	SS	100/ 0.125		170	
							169	3 73 19 5
							168	

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
SHEAR STRENGTH kPa 40 80 120 160 200
○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE
PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60
UNIT WEIGHT γ kN/m^3

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 5/26/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM18-2 2 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 984.5 E 353 999.4 | ORIGINATED BY SLL
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2008.12.04 - 2008.12.05 | CHECKED BY LT

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							
	SAND, some silt and clay, trace gravel Very Dense Grey Wet		10	SS	100/ 0.175		167	
164.6			1.5	SS	67		166	
12.7	END OF BOREHOLE AT 12.7m. BOREHOLE CAVED TO 5.0m AND WATER LEVEL AT 1.4m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.6m, THEN CUTTINGS TO SURFACE.						165	

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
SHEAR STRENGTH kPa 40 80 120 160 200
○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE
PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60
UNIT WEIGHT γ kN/m^3

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 5/26/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM20-2a 1 OF 1 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 871 478.2 E 355 201.5 Oshawa Creek East | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2009.02.02 - 2009.02.02 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)	SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
203.9															
0.0	**TOPSOIL** Soft to Firm Brown		1	SS	3										
203.1															
0.8	**SAND** and **GRAVEL**, trace silt, occasional cobbles and organics Compact to Dense Brown Wet		2	SS	16		203								
			3	SS	50		202								
201.6															
2.3	Silty **SAND**, trace gravel, some clay Compact to Very Dense Brown Wet to Moist (TILL)		4	SS	15		201								
			5	SS	73		200								2 50 31 17
			6	SS	100/ 0.200		199								
			7	SS	100/ 0.100		198								1 45 34 20
196.2							197								
7.7	END OF BOREHOLE AT 7.7m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2009.02.12 0.4 203.5		8	SS	100/ 0.125										

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 3/12/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM20b-2 1 OF 1 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 871 583.0 E 355 287.2 Oshawa Creek East | ORIGINATED BY SLL
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.03.07 - 2008.03.07 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)	SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
210.8															
0.0	**TOPSOIL**, with roots: (250mm) Brown Moist														
210.6															
0.3	Sandy **SILT**, trace gravel Loose to Compact Brown Moist to Wet		1	SS	2		210								
			2	SS	10		209								
208.6															
2.2	**SAND** and **SILT**, some clay, trace gravel Dense to Very Dense Grey Moist (TILL)		3	SS	30		208								
			4	SS	167/ .225		207								2 46 35 17
			5	SS	178/ .225		206								
			6	SS	100/ .100		205								2 48 40 10
204.0															
6.8	Silty **CLAY**, with sand, trace gravel Hard Grey (TILL)						204								
203.1			7	SS	100/ .075										3 28 36 33
7.7	END OF BOREHOLE AT 7.7m. BOREHOLE OPEN AND WATER LEVEL AT 0.5m UPON COMPLETION. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2008.03.12 0.3 210.5 2009.02.12 0.4 210.4														

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 3/12/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM20b-3 1 OF 1 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 871 546.8 E 355 310.8 Oshawa Creek East | ORIGINATED BY WB
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.05.26 - 2008.05.26 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
211.3											
0.0 / 210.7	**TOPSOIL**, trace gravel, trace clay Brown Moist		1	AS							
0.6	**SAND** and **SILT**, some clay, trace gravel Compact to Very Dense Brown (TILL)		1	SS	12		211				
			2	SS	55		210				8 40 37 15
			3	SS	19		209				
			4	SS	38	▽	208				2 52 33 13
	Very Dense		5	SS	100/ .225		207				
			6	SS	100/ .175		206 205				6 42 33 19
							204				
203.5 / 7.8	END OF BOREHOLE AT 7.8m. WATER LEVEL AT 3.1m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.		7	SS	100/ .150						

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

ONTMT4S 0510.GPJ 12/9/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM20b-4 1 OF 1 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 871 528.7 E 355 215.2 Oshawa Creek East | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2009.02.02 - 2009.02.02 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
207.9											
0.0 / 207.3	**TOPSOIL** Soft Brown		1	SS	4						
0.6	Silty **SAND**, some clay, trace gravel, occasional organics Compact to Very Dense Brown Wet to Moist (TILL)		2	SS	21		207				
			3	SS	46		206				2 50 30 18
			4	SS	100/ 0.150						
			5	SS	100/ 0.200		205				
	becoming grey		6	SS	150/ 0.125		204 203				1 49 30 20
	occasional cobbles and boulders		7	SS	100/ 0.150		202 201				
200.2 / 7.7	END OF BOREHOLE AT 7.7m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.		8	SS	100/ 0.075						

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

ONTMT4S 0510.GPJ 3/9/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM20c-3 1 OF 1 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 871 343.4 E 355 171.6 Oshawa Creek East | ORIGINATED BY LH

HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES

DATUM Geodetic | DATE 2009.01.30 - 2009.01.30 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) 40 80 120 160 200	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
203.7											
0.0	**TOPSOIL** Brown		1	SS	6						
202.5			2	SS	8		203				
1.2	Clayey **SILT**, trace to some sand, trace gravel, trace oxide staining, occasional cobbles Stiff Brown		3	SS	11		202				
201.4											
2.3	Sandy **SILT**, trace gravel, trace oxide staining Compact Brown Wet		4	SS	15		201				
			5	SS	29		200				
199.4											
4.3	**SAND and SILT**, some clay, trace gravel, occasional cobbles Very dense Brown Moist (TILL)		6	SS	100/ .125		199				
							198				4 44 36 16
			7	SS	100/ .075		197				
196.0			8	SS	100/ .100						
7.7	END OF BOREHOLE AT 7.7m. Piezometer installation consists of 25mm diameter schedule 40 PVC pipe with a 1.52m slotted screen.										

WATER LEVEL READINGS:

DATE	DEPTH (m)	ELEV. (m)
2009.02.12	0.4	203.3
2009.05.04	1.3	202.4
2009.06.06	1.3	202.4

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity

$15 \oplus^{20}_{10} 5$ (%) STRAIN AT FAILURE

ONTMTAS 0510.GPJ 8/21/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM21-1 1 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 871 578.4 E 355 414.6 Harmony Road | ORIGINATED BY SLL
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.03.06 - 2008.03.06 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
217.8								20 40 60 80 100	20 40 60		
0.0	**TOPSOIL**, trace roots: (150mm)										
0.2	Brown Moist										
	Silty **CLAY** Stiff Brown Moist		1	SS	14		217				
216.4											
1.4	Silty **CLAY**, with sand, trace gravel Stiff to Very Stiff Brown Moist (TILL)(CL)		2	SS	12		216				
			3	SS	28		215				
			4	SS	13		214				2 31 39 28
213.8											
4.0	Silty **CLAY**, trace sand Stiff Grey (CL)		5	SS	20	▽	213				
			6	SS	8		212				
			7	SS	13		211				
							210				0 6 38 56
209.1											
8.7	Silty **SAND** Compact Grey Wet		8	SS	16		209				
							208				

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 10/14/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM21-1 2 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 871 578.4 E 355 414.6 Harmony Road | ORIGINATED BY SLL
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.03.06 - 2008.03.06 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
207.5											
10.3	**SAND** and **SILT**, some clay, trace gravel Very Dense Grey Moist (TILL)		9	SS	100/ .150		207				3 50 36 11
	occasional inferred cobbles at 12.3 to 12.5m		10	SS	100/ .100		206				
204.0			11	SS	100/ .075		205				
13.8	END OF BOREHOLE AT 14.1m. BOREHOLE OPEN TO BOTTOM AND WATER LEVEL AT 4.1m UPON COMPLETION. BOREHOLE SEALED WITH BENTONITE HOLEPLUG TO SURFACE.										

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 9/19/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM21-2 1 OF 2 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 871 584.2 E 355 499.9 Harmony Road ORIGINATED BY SLL

HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES

DATUM Geodetic DATE 2008.03.07 - 2008.03.07 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100) O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
221.1											
0.0	**TOPSOIL**, with roots and rootlets: (600mm) Brown Moist						221				
220.5											
0.6	Sandy **SILT**, some clay, trace gravel Loose Brown Wet		1	SS	8		220		o		
219.6											
1.4	**SAND** and **SILT**, some clay, trace gravel Compact to Very Dense Brown Moist (TILL)		2	SS	18		219		o		
			3	SS	24				o		
			4	SS	49		218		o		4 41 38 17
	becoming Grey		5	SS	81		217		o		
215.4							216				
5.6	Silty **CLAY**, with sand , trace gravel Hard Grey (TILL)(CL)		6	SS	33		215		o⊢		1 22 38 39
213.8							214				
7.3	Silty **SAND**, trace gravel Loose Grey Wet		7	SS	7		213		o		
212.2											
8.8	**SAND**, some gravel, trace silt Loose to Compact Grey Wet		8	SS	4		212		o		14 79 7 (SI+CL)

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 9/19/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM21-2 2 OF 2 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 871 584.2 E 355 499.9 Harmony Road ORIGINATED BY SLL

HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES

DATUM Geodetic DATE 2008.03.07 - 2008.03.07 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100) O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND, some gravel, trace silt Loose to Compact Grey Wet		9	SS	30		211		o		
209.6							210				
11.5	**SAND** and **SILT**, some clay, trace gravel Very Dense Grey Moist (TILL)		10	SS	100/ .150		209		o		3 40 45 12
			11	SS	100/ .150		208		o		
							207				
205.7			12	SS	100/ .125		206		o		
15.4	END OF BOREHOLE AT 15.4m. BOREHOLE OPEN TO 14.0m AND WATER LEVEL AT 2.9m UPON COMPLETION. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.37m slotted screen. WATER LEVEL READINGS; DATE DEPTH (m) ELEV. (m) 2008.03.12 7.0 214.1 2008.07.28 0.1 221.0										

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 9/19/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM21b-1 1 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 871 617.4 E 355 402.4 Harmony Road | ORIGINATED BY SLL
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.03.06 - 2008.03.06 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
216.8						
0.0	**TOPSOIL**, with roots: (150mm)					
0.2	Brown Moist					
	Silty **CLAY**, with sand, trace gravel, occasional cobbles Hard Brown (TILL)(CL)	1	SS	49		
		2	SS	35		
		3	SS	70		
		4	SS	68		2 31 40 27
		5	SS	49		
		6	SS	14		1 21 37 41
	becoming Stiff to Very Stiff	7	SS	25		
208.7						
8.1	**SAND** and **SILT**, trace clay Very Loose Grey Wet	8	SS	3		0 40 52 8

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DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

ELEVATION SCALE: 216 215 214 213 212 211 210 209 208 207

+ ³, × ³ : Numbers refer to Sensitivity
15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 9/19/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM21b-1 2 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 871 617.4 E 355 402.4 Harmony Road | ORIGINATED BY SLL
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.03.06 - 2008.03.06 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page					
206.6						
10.2	**SAND** and **SILT**, some clay, trace gravel Very Dense Grey Moist (TILL)	9	SS	100/.225		
204.7						
12.0	**SAND**, trace silt Compact Grey Wet	10	SS	100/.125		
204.4						
12.3	**SAND** and **SILT**, some clay, trace gravel Very Dense Grey Moist (TILL)	11	SS	100/.100		1 47 37 15
201.4		12	SS	100/.100		
15.3	END OF BOREHOLE AT 15.3m. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2008.03.12 7.7 209.1 2008.07.29 0.7 216.1					

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

ELEVATION SCALE: 206 205 204 203 202

+ ³, × ³ : Numbers refer to Sensitivity
15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 9/29/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM21b-3 1 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 871 527.0 E 355 462.3 Harmony Road | ORIGINATED BY WB
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.05.27 - 2008.05.27 | CHECKED BY MEF

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
218.2										
0.0 / 217.9	**TOPSOIL**		1	AS			218			
0.3	Silty **CLAY**, with sand, trace gravel Very Stiff to Hard Brown to Grey (TILL)		1	SS	19					
			2	SS	24		217			
			3	SS	25		216			
	50 mm thick sand layer		4	SS	53		215			
			5	SS	51		214			2 21 38 39
			6	SS	26		213			
211.2							212			
7.0	Silty **CLAY**, trace sand Very Stiff Grey		7	SS	28		211			0 9 25 66
208.9							210			
9.3	**SAND** and **SILT**, trace gravel, trace clay Very Dense Grey Moist; (TILL)		8	SS	43		209			9 49 35 7

Continued Next Page

+ ³ . × ³ : Numbers refer to Sensitivity (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 3/17/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM21b-3 2 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 871 527.0 E 355 462.3 Harmony Road | ORIGINATED BY WB
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.05.27 - 2008.05.27 | CHECKED BY MEF

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page									
	SAND and **SILT**, trace gravel, trace clay Very Dense Grey Moist (TILL)		9	SS	50/125		208			
206.6							207			
11.6	Sandy **GRAVEL**, trace silt, trace clay Very Dense Grey Wet (TILL)		10	SS	83		206			
204.9							205			
13.3	**SAND**, some gravel, trace siltl Compact Brown to Grey Moist		11	SS	25		204			18 78 4 (SI+CL)
203.4							203			2 37 43 18
14.8	**SAND** and **SILT**, some clay, trace gravel Very Dense Grey (TILL)		12	SS	100/.050		202			
			13	SS	100/.100		201			
199.8			14	SS	60/.075		200			
18.4	END OF BOREHOLE AT 18.36 m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2008.07.28 0.5 217.7 2009.02.12 0.6 217.6									

+ ³ . × ³ : Numbers refer to Sensitivity (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 3/17/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No CM23-1 1 OF 1 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 871 160.7 E 356 505.3 | ORIGINATED BY WB
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2008.12.11 - 2008.12.11 | CHECKED BY LT

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
238.5									
0.0	**ASPHALT** (75mm)		1	AS					
0.1	**SAND**, some gravel Brown Moist (FILL)								
237.9			1	SS	45				
0.6	Sandy **SILT**, trace gravel Dense Brown Moist								
237.1			2	SS	100/ 0.200				2 45 36 17
1.4	**SAND** and **SILT**, some clay, trace gravel Very Dense Brown Moist (TILL)		3	SS	100/ 0.225				
			4	SS	100/ 0.075				
			5	SS	100/ 0.150	▽			5 43 36 16
232.3			6	SS	100/ 0.125				
6.2	END OF BOREHOLE AT 6.2m. WATER LEVEL AT 5.5m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH HOLEPLUG, CUTTING AND CAPPED WITH ASPHALT TO SURFACE.								

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE: 40 80 120 160 200
PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%): 20 40 60

ONTMT4S 0510.GPJ 8/6/09

$+^3, \times^3$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No CM23-2 1 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 871 198.0 E 356 614.4 | ORIGINATED BY WB
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2008.12.08 - 2008.12.08 | CHECKED BY LT

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
237.2									
0.0	Gravelly **SAND** Compact Brown Moist (FILL)		1	AS					
235.8			1	SS	11				
1.4	**SAND** and **SILT**, some clay, trace gravel Dense to Very Dense Brown Moist (TILL)		2	SS	38	▽			
			3	SS	100/ 0.125				
			4	SS	39				3 44 35 18
			5	SS	82				
			6	SS	100/ 0.100				
			7	SS	100/ 0.175				1 42 39 18
227.9			8	SS	100/ 0.175				
9.3	END OF BOREHOLE AT 9.3m. WATER LEVEL AT 4.0m UPON COMPLETION OF DRILLING. Piezometer installation consists of								

Continued Next Page

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE: 40 80 120 160 200
PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%): 20 40 60

ONTMT4S 0510.GPJ 7/24/09

$+^3, \times^3$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM23-2 2 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 871 198.0 E 356 614.4 | ORIGINATED BY WB
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2008.12.08 - 2008.12.08 | CHECKED BY LT

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa 40 80 120 160 200 (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
	Continued From Previous Page										
	19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										
	WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2009.02.12 0.80 236.50 2009.04.30 0.95 236.25 2009.07.21 1.84 235.36										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 7/24/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM23b-2 1 OF 2 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 871 274.8 E 356 976.8 ORIGINATED BY SLL
HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2008.03.19 - 2008.03.19 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (40 80 120 160 200) O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
230.7											
0.0	**TOPSOIL**, some peat, with roots: (175mm) Brown Moist										
0.2	Clayey **SILT**, some sand, trace gravel Firm to Very Stiff Brown (TILL)		1	SS	8		230				
			2	SS	14		229				
			3	SS	25		228				
227.7											
3.0	**SAND** and **SILT**, some clay, trace gravel, with sand seams Compact to Very Dense Brown Moist (TILL)		4	SS	25		227				2 47 38 13
			5	SS	102		226				
225.2											
5.5	Silty **CLAY**, some sand Hard Grey (TILL)(CL)		6	SS	31		225				0 15 38 47
			7	SS	100/ .125		224				
							223				
222.4											
8.3 222.2	**BOULDER** (225mm)						222				
8.5	Sandy **SILT**, trace gravel, occasional cobbles and boulders Very Dense Grey Moist (TILL)		8	SS	100/ .125		221				

Continued Next Page

+ ^{3}, × ^{3} : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 3/19/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM23b-2 2 OF 2 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 871 274.8 E 356 976.8 ORIGINATED BY SLL
HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2008.03.19 - 2008.03.19 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (40 80 120 160 200) O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
220.3											
10.4	Silty **SAND**, some gravel, trace clay Very Dense Grey Moist (TILL)		9	SS	100/ .150		220				13 58 23 6
219.8											
10.8	END OF BOREHOLE AT 10.8m. BOREHOLE OPEN AND DRY UPON COMPLETION. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE / DEPTH (m) / ELEV. (m): 2008.03.20 Dry -; 2008.04.28 8.2 222.5; 2009.07.28 8.0 222.7										

+ ^{3}, × ^{3} : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 3/19/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM24-1 1 OF 3 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 870 999.6 E 357 392.3 Townline Road ORIGINATED BY JM
HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2008.03.14 - 2008.03.14 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa 40 80 120 160 200 (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
218.9											
0.0	**TOPSOIL**, with roots: (150mm) Brown Moist										
0.2	Sandy **SILT**, trace clay, trace gravel Loose Brown Moist		1	SS	4		218				
217.2											
1.7	Clayey **SILT** and **SAND**, trace gravel Stiff to Hard Light Brown to Grey (TILL)(CL-ML)		2	SS	14		217				
			3	SS	31		216				1 33 45 21
			4	SS	44						
			5	SS	33		214				
			6	SS	43		213				
211.7							212				
7.2	Silty **CLAY**, some sand to sandy, trace gravel, occasional cobbles Hard to Very Stiff Grey (TILL)(CL)		7	SS	36		211				
			8	SS	28		210				
							209				

Continued Next Page

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

ONTMT4S 0510.GPJ 3/19/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM24-1 2 OF 3 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 870 999.6 E 357 392.3 Townline Road ORIGINATED BY JM
HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2008.03.14 - 2008.03.14 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa 40 80 120 160 200 (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **CLAY**, some sand to sandy, trace gravel, occasional cobbles Hard to Very Stiff Grey (TILL)(CL)		9	SS	16		208				0 21 38 41
206.7							207				
12.2	Silty **SAND**, some clay, trace gravel, trace cobbles Very Dense Grey Moist (TILL) cobble at 12.34m		10	SS	53		206				7 48 33 12
205.6							205				
13.3	Silty **CLAY**, trace sand Stiff Grey (TILL)		11	SS	12		204				
204.1							203				
14.8	Silty **SAND**, trace gravel, trace clay Compact to Very Dense Grey Moist (TILL)		12	SS	27		202				9 48 43 (SI+CL)
			13	SS	100/.250		201				
			14	SS	100		200				
198.9			15	SS	100/		199				

Continued Next Page

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

ONTMT4S 0510.GPJ 3/19/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM24-1 3 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 999.6 E 357 392.3 Townline Road | ORIGINATED BY JM
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.03.14 - 2008.03.14 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
19.9	END OF BOREHOLE AT 19.9m. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2008.03.20 13.9 205.0 2008.06.26 5.8 213.1 2008.06.26 Piezometer Decomissioned				.125						

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

ONTMT4S 0510.GPJ 3/17/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM24-2 1 OF 4 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 915.6 E 357 422.8 Townline Road | ORIGINATED BY JM
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.03.17 - 2008.03.18 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
219.4											
0.0	**TOPSOIL**, with roots: (150mm) Brown Moist						219				
0.2	Sandy **SILT**, trace clay, trace gravel, trace roots Loose Brown Moist		1	SS	4				○		
217.6							218				
1.8	Clayey **SILT** and **SAND**, trace gravel Stiff to Very Stiff Brown (TILL)(CL-ML)		2	SS	12				○		
			3	SS	13		217		○		
			4	SS	18		216		○		4 40 39 17
			5	SS	24		215		○		
			6	SS	23		214		○		
			7	SS	28		213		⊕		3 40 41 16
210.8							212				
8.7	Silty **CLAY**, some sand to sandy, trace gravel Very Stiff Grey (TILL)(CL)		8	SS	21		211				
							210		○		

Continued Next Page

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

ONTMT4S 0510.GPJ 3/19/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM24-2 2 OF 4 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 870 915.6 E 357 422.8 Townline Road ORIGINATED BY JM
HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2008.03.17 - 2008.03.18 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **CLAY**, some sand to sandy, trace gravel Very Stiff Grey (TILL)(CL)						209				
			9	SS	28						2 18 36 44
			10	SS	23		207				
206.2											
13.3	Sandy **SILT**, trace clay, trace gravel Very Dense Grey Moist (TILL)		11	SS	100/ .125		206				
204.1							205				
15.4	Silty **CLAY**, trace sand Very Stiff Grey (TILL)		12	SS	20		204				0 8 44 48
203.1											
16.3	Silty **SAND**, trace clay, trace gravel Compact to Very Dense Grey Moist (TILL)		13	SS	16		203				
			14	SS	70		201				5 57 31 7
200.4											
19.1	**SILT**, some sand, some clay, trace gravel Very Dense to Dense Grey Moist (TILL)						200				

Continued Next Page

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

ONTMT4S 0510.GPJ 3/19/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM24-2 3 OF 4 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 870 915.6 E 357 422.8 Townline Road ORIGINATED BY JM
HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2008.03.17 - 2008.03.18 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILT, some sand, some clay, trace gravel Very Dense to Dense Grey Moist (TILL)		15	SS	100/ 250		199				
			16	SS	31		198				1 13 74 12
196.6							197				
22.9	Silty **SAND**, trace gravel Very Dense Grey Moist (TILL)		17	SS	100/ .125		196				
			18	SS	51		195				
194.0							194				
25.5	Silty **SAND**, trace gravel Very Dense Grey Moist		19	SS	100/ .075		193				
192.5											
26.9	Sandy **SILT**, some clay, trace gravel Very Dense Grey Moist (TILL)		20	SS	100/ .075		192				
190.4							191				
29.0	BOREHOLE ENDED AT 29.0m. BOREHOLE OPEN TO 16.5m AND WATER LEVEL AT 1.1m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.5m AND AUGER		21	SS	100/ .075						

Continued Next Page

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

ONTMT4S 0510.GPJ 3/19/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM24-2 4 OF 4 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 870 915.6 E 357 422.8 Townline Road ORIGINATED BY JM

HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES

DATUM Geodetic DATE 2008.03.17 - 2008.03.18 CHECKED BY MEF

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED + FIELD VANE; ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES					GR SA SI CL
	Continued From Previous Page									
	CUTTINGS TO SURFACE.									

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 3/17/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM24-3 1 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 726.8 E 357 483.9 Townline Road | ORIGINATED BY ES
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.05.29 - 2008.05.29 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
223.1											
0.0	**TOPSOIL:** (100mm)						223				
0.1	Clayey **SILT**, with sand, trace gravel, mixed with topsoil Stiff to Very Stiff Brown Moist (TILL)		1	AS							
			1	SS	10		222				
			2	SS	18		221				
			3	SS	24						5 28 45 22
220.1							220				
3.0	Sandy **SILT**, trace gravel, occasional cobble, occasional oxide staining Dense to Very Dense Brown Moist (TILL)		4	SS	41						
			5	SS	76		219				
	Augers grinding at 5.3 to 5.6m						218				
216.9	Augers grinding at 6.2 to 6.5m						217				
6.2	Silty **SAND**, some clay, trace gravel Very Dense to Dense Grey Moist (TILL)		6	SS	88						
			7	SS	74		216				6 47 28 19
			8	SS	36		215				
213.1							214				

Continued Next Page

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM24-3 2 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 726.8 E 357 483.9 Townline Road | ORIGINATED BY ES
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.05.29 - 2008.05.29 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
10.0	Clayey **SILT**, with sand, trace gravel Hard to Very Stiff Grey Moist (TILL)						213				
			9	SS	33		212				
			10	SS	27		211				2 37 39 22
210.0							210				
13.1	Silty **CLAY**, trace sand, trace to occasional gravel Hard to Very Stiff Grey Moist (TILL)		11	SS	34	▽	209				
			12	SS	24		208				0 7 33 60
							207				
206.0			13	SS	38		206				
17.1	Silty **SAND**, some clay, some gravel Dense to Very Dense Grey Moist (TILL)										
			14	SS	66		205				10 47 32 11
							204				

Continued Next Page

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

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No CM24-3 3 OF 3 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 870 726.8 E 357 483.9 Townline Road ORIGINATED BY ES
HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2008.05.29 - 2008.05.29 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page								
	Silty **SAND**, some clay, some gravel Dense Grey Moist (TILL)		15	SS	46		203		
201.8							202		
21.3 / 201.3	**SAND**, fine grained Compact Grey		16	SS	27				
21.8	Moist						201		
	SAND and **SILT**, trace gravel, trace clay Very Dense Grey Moist (TILL)		17	SS	100/ .075		200		
			18	SS	186		199		4 50 39 7
197.1			19	SS	100/ .100		198		
26.0	END OF BOREHOLE AT 26.0m. BOREHOLE OPEN AND WATER LEVEL AT 14.3m UPON COMPLETION. BOREHOLE SEALED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.								

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100
PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

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+ ³, × ³: Numbers refer to Sensitivity
20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No CM24-4 1 OF 3 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 870 604.9 E 357 526.3 Townline Road ORIGINATED BY WB
HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY ES
DATUM Geodetic DATE 2008.05.28 - 2008.05.28 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
224.6									
0.0 / 224.1	**TOPSOIL**, trace clay, trace gravel Brown Moist		1	AS					
0.5	Clayey **SILT**, with sand, trace gravel Very Stiff to Hard Brown to Grey Moist (TILL)		1	SS	22		224		
			2	SS	29		223		
			3	SS	30		222		0 44 39 17
			4	SS	37		221		
			5	SS	26		220		
			6	SS	70		219		7 40 39 14
			7	SS	52		218		
			8	SS	50		217		3 41 36 20
							216		
							215		

Continued Next Page

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100
PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

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+ ³, × ³: Numbers refer to Sensitivity
20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No CM24-4 2 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 604.9 E 357 526.3 Townline Road | ORIGINATED BY WB
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.05.28 - 2008.05.28 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page														
	Clayey **SILT**, with sand, trace gravel Hard Grey Moist (TILL)														
			9	SS	35		214		○						
							213								
			10	SS	35		212		○						
211.5															
13.1	Silty **CLAY**, some sand, trace gravel Hard Grey Moist (TILL)														
			11	SS	49		211		○						
							210								
			12	SS	47		209		⊢●						2 24 34 40
208.4															
16.2	Clayey **SILT**, some sand, trace gravel Hard Grey Moist (TILL)														
			13	SS	75		208		○						
							207								
			14	SS	54		206		○						
205.4															
19.2	Silty **SAND**, some clay, trace gravel Very Dense Grey Moist (TILL)						205								

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 12/1/08

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No CM24-4 3 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 604.9 E 357 526.3 Townline Road | ORIGINATED BY WB
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.05.28 - 2008.05.28 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page														
	Silty **SAND**, some clay, trace gravel Very Dense Grey Moist (TILL)		15	SS	52/ .150		204								2 54 33 11
			16	SS	100/ .075		203								
201.6							202								
23.0	END OF BOREHOLE AT 23.0m. WATER LEVEL AT 12.8m UPON COMPLETION. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen.		17	SS	100/ .100										

WATER LEVEL READINGS:

DATE	DEPTH (m)	ELEV. (m)
2008.06.26	10.9	213.7
2008.06.26	decomissioned	

+³, ×³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 12/1/08

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No CM27-1 1 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 863.8 E 359 069.1 Langmaid Drive | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY SLL
DATUM Geodetic | DATE 2008.04.02 - 2009.04.07 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
208.9											
0.0	**SAND**, fine grained, trace gravel and organics Compact Dark Brown Moist to Wet (FILL)		1	GS							
208.2 0.7	Silty **SAND**, trace gravel, occasional cobble and boulder Compact to Very Dense Brown to Grey Moist to Wet (TILL)		2	SS	14		208	○			
			3	SS	28		207	○			
			4	SS	25			○			3 49 34 14
	Some Clay		5	SS	31		206	○			
			6	SS	46		205	○			
			7	SS	34		204	○			
	Some gravel and clay						203	○			
			8	SS	35		202	○			14 46 27 13
							201	○			
			9	SS	22		200	○			
							199				

Continued Next Page

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

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No CM27-1 2 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 863.8 E 359 069.1 Langmaid Drive | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY SLL
DATUM Geodetic | DATE 2008.04.02 - 2009.04.07 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **SAND**, trace gravel Very Dense Brown to Grey Moist to Wet (TILL)		10	SS	100/ .275		198	○			
	Some clay, trace of gravel		11	SS	100/ .225		197	○			6 49 31 14
			12	SS	100/ .175		196				
			13	SS	100/ .150		195	○			
			14	SS	100/ .150		194	○			
							193				
							192	○			
			15	SS	19		191	○			
							190				
							189				

Continued Next Page

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM27-1 3 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 863.8 E 359 069.1 Langmaid Drive | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY SLL
DATUM Geodetic | DATE 2008.04.02 - 2009.04.07 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100; 40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										4 45 32 19
	Silty **SAND**, some clay, trace gravel Very Dense Brown to Grey Moist to Wet (TILL)		16	SS	100/ .175		188				
			17	SS	100/ .075		187				
185.9			18	SS	100/ .100		186				
23.0	END OF BOREHOLE AT 23.0m. WATER LEVEL AT 4.6m UPON COMPLETION. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2009.04.08 4.6 204.3 2009.04.30 10.6 198.3										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\oplus$ (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 7/23/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM27-2 1 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 780.3 E 359 106.1 Langmaid Drive | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2009.03.31 - 2009.04.02 | CHECKED BY LT

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100; 40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
208.9											
0.0	**SAND**, fine grained, trace gravel and organics Compact Dark Brown Moist to Wet (FILL)		1	SS							
208.3											
0.6	Silty **SAND**, some clay, trace gravel, occasional cobble and boulder Dense to Very Dense Brown Moist to Wet (TILL)		2	SS	33		208				
			3	SS			207				
			4	SS	32		206				
			5	SS	54		205				2 48 36 14
			6	SS	60		204				
			7	SS	42		203				
			8	SS	89		202				
			9	SS	100/ 250		201				5 55 29 10
							200				
							199				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\oplus$ (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 7/23/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM27-2 2 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 780.3 E 359 106.1 Langmaid Drive | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2009.03.31 - 2009.04.02 | CHECKED BY LT

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **SAND**, some clay, trace gravel, occasional cobble obstacle Very Dense Brown Moist to Wet (TILL)										
			10	SS	75		198				
			11	SS	100/ .150		197				
			12	SS	100/ .150		196				
194.3							195				
14.6	**SAND**, some silt and clay, trace gravel Compact Brown Moist						194				
193.2			13	SS	29						4 80 16 (SI+CL)
15.7	Sandy **SILT**, some clay, trace gravel Very Dense Brown to Greyish Brown Moist (TILL)						193				
			14	SS	100/ .075		192				
191.2											
17.7	Clayey **SILT**, sandy Hard Brown (TILL)						191				
			15	SS	100/ .075		190				1 18 66 15
189.7											
19.2	**SILT**, some sand, some clay, trace gravel Dense Brown Moist to Wet						189				

Continued Next Page

ONTMT4S 0510.GPJ 7/23/09

+ 3 , × 3 : Numbers refer to Sensitivity (20 / 15 ⊕ 5 / 10) (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM27-2 3 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 780.3 E 359 106.1 Langmaid Drive | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2009.03.31 - 2009.04.02 | CHECKED BY LT

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILT, some sand, some clay, trace gravel Dense Brown Moist to Wet		16	SS	47						
187.9											
21.0	**SILT** and **SAND**, trace clay, trace gravel, clayey silt layers Very Dense Greyish Brown Moist to Wet (TILL)		17	SS	100/ .100		188				
			18	SS	100/ .075		187				1 41 50 8
			19	SS	100/ .050		186				
184.5							185				
24.4	END OF BOREHOLE AT 24.4m. BOREHOLE OPEN AND WATER LEVEL AT 4.5m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.										

ONTMT4S 0510.GPJ 7/23/09

+ 3 , × 3 : Numbers refer to Sensitivity (20 / 15 ⊕ 5 / 10) (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM28-1 1 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 682.7 E 359 283.6 Conc. 6 Road | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY SLL
DATUM Geodetic | DATE 2009.04.13 - 2009.04.13 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
211.7											
0.0	**SAND** and **GRAVEL**, trace organics material Brown Moist (FILL)		1	GS							
211.0							211				
0.7	Silty **SAND**, some clay, occasional cobbles and boulders Dense to Very Dense Brown to Grey Moist (TILL)		2	SS	38						
			3	SS	58		210				
			4	SS	45		209				0 54 33 13
			5	SS	100/ .250						
							208				
			6	SS	100/ .300		207				
							206				
205.9											
5.8	Silty **CLAY**, with sand, trace gravel Hard Grey (TILL)(CL)		7	SS	100/ .225		205				4 52 28 16
			8	SS	100/ .150		204				
							203				
			9	SS	100/ .150		202				
201.8											

Continued Next Page

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

ONTMT4S 0510.GPJ 7/27/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM28-1 2 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 682.7 E 359 283.6 Conc. 6 Road | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY SLL
DATUM Geodetic | DATE 2009.04.13 - 2009.04.13 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
9.9	Sandy **SILT**, some clay, trace gravel Very Dense Grey Moist (TILL)		10	SS	100/ .200		201				
			11	SS	100/ .150		200				5 34 44 17
							199				
			12	SS	100/ .125		198				
							197				
196.4											
15.3	END OF BOREHOLE AT 15.3m. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen.		13	SS	100/ .050						

WATER LEVEL READINGS:

DATE	DEPTH (m)	ELEV. (m)
2009.04.13	2.4	209.3
2009.04.30	3.7	208.0
2009.07.21	2.7	209.0

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

ONTMT4S 0510.GPJ 7/21/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM28-2 1 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 708.4 E 359 390.0 Conc. 6 Road | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY SLL
DATUM Geodetic | DATE 2009.04.09 - 2009.04.09 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (40 80 120 160 200) O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
211.3											
0.0	**ASPHALT**, (75mm)										
0.1	**SAND**, some gravel, trace rootlets Compact Brown		1	GS			211				
210.6	Moist										
0.7	(FILL)										
	Clayey **SILT**, trace to some sand, trace gravel, trace rootlets, topsoil stained Very Stiff to Hard Brown		2	SS	15				o		
			3	SS	35		210		o		
209.1											
2.2	Silty **SAND**, some clay, trace gravel, with silty sand seams Dense to Very Dense Brown to Grey Moist to Wet (TILL)		4	SS	100/ .200		209		o		
			5	SS	49		208		o		5 50 27 18
			6	SS	60	▽	207		o		
			7	SS	40		206		o		
			8	SS	100/ .200		205		o		5 57 27 11
	with silty clay pockets						204				
			9	SS	100/ .100		203		o		
201.4							202				

Continued Next Page

+ 3 , × 3 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 7/21/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM28-2 2 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 708.4 E 359 390.0 Conc. 6 Road | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY SLL
DATUM Geodetic | DATE 2009.04.09 - 2009.04.09 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (40 80 120 160 200) O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
9.9	**SAND** and **SILT**, trace gravel and clay Very Dense Grey Wet (TILL)		10	SS	100/ .150		201		o		3 50 42 5
			11	SS	100/ .075		200		o		
			12	SS	100/ .050		199				
							198				
196.4							197				
14.9	Clayey **SILT**, some sand, trace gravel Hard Grey (TILL)		13	SS	100/ .050				o		
196.0											
15.3	END OF BOREHOLE AT 15.3m. BOREHOLE OPEN AND WATER LEVEL AT 5.2m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.15m AND COLD PATCH ASPHALT TO SURFACE.										

+ 3 , × 3 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 7/21/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM29-1 1 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 591.4 E 360 020.6 Enfield Road | ORIGINATED BY WB
HWY 407 | BOREHOLE TYPE Solid Stem Augers/Hollow Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.08.11 - 2008.08.14 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
204.8											
0.0 / 204.2	**SAND**, some gravel Brown Moist (FILL)								○		
0.6 / 203.3	**TOPSOIL**, some sand, trace gravel Very Loose Brown Moist		1	SS	3		204		○		
1.5 / 202.6	Silty **CLAY**, some sand, trace gravel Stiff Grey		2	SS	11		203		○		
2.1	**SAND** and **SILT**, some clay, trace gravel Compact Brown Moist to wet (TILL)		3	SS	17		202		○		2 48 38 12
			4	SS	21				○		
200.5 / 4.3	Very Dense		5	SS	83		201		○		
199.3 / 5.5	becoming Grey		6	SS	20		200		○		3 48 35 14
			7	SS	21		199		○		
			8	SS	13		198		○		3 50 34 13
							197				
							196				
							195				

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity 20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 11/19/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM29-1 2 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 591.4 E 360 020.6 Enfield Road | ORIGINATED BY WB
HWY 407 | BOREHOLE TYPE Solid Stem Augers/Hollow Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.08.11 - 2008.08.14 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
194.4											
10.4	Silty **SAND**, some clay, trace gravel Compact to Very Dense Grey Moist (TILL)		9	SS	23		194		○		
			10	SS	58		193		○		
			11	SS	100/225		192				8 52 30 10
	inferred cobbles		12	SS	78		191		○		
188.6							190				
16.2	Silty **CLAY**, trace sand Hard Grey (TILL)(CL)		13	SS	43		189		○		0 7 44 49
187.1							188				
17.7	Silty **SAND**, some gravel, trace clay Very dense Grey Moist (TILL)		14	SS	69		187		○		
			15	SS	100/		186				
							185		○		

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity 20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 11/19/08

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No CM29-1 3 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 591.4 E 360 020.6 Enfield Road | ORIGINATED BY WB
HWY 407 | BOREHOLE TYPE Solid Stem Augers/Hollow Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.08.11 - 2008.08.14 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **SAND**, some gravel, trace clay Very dense Grey Moist (TILL)				.125						12 50 29 9
			16	SS	100/ .050		184				
	trace Gravel Dense		17	SS	46		183				3 57 35 6
							182				
180.4							181				
24.4	END OF BOREHOLE AT 24.4m. COBBLE LODGED INSIDE HOLLOW STEM AUGERS ON 2008.08.14, COULD NOT CONTINUE DRILLING. BOREHOLE SEALED WITH BENTONITE TO SURFACE.										

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

ONTMT4S 0510.GPJ 11/27/08

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No CM29b-1 1 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 638.7 E 360 004.8 Enfield Road | ORIGINATED BY WB
HWY 407 | BOREHOLE TYPE Hollow Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.08.26 - 2008.08.27 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
204.7											
0.0	**SAND**, some gravel Loose Brown Moist (FILL)		1	SS	4		204				
203.2											
1.5	Silty **CLAY** with sand, trace gravel Stiff to Hard Brown (CL)		2	SS	9		203				
			3	SS	26		202				1 40 37 22
			4	SS	16						
			5	SS	73		201				
			6	SS	26		200				
			7	SS	90		199				3 45 36 16
	Grey						198				
			8	SS	22		197				
							196				
							195				

Continued Next Page

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

ONTMT4S 0510.GPJ 11/27/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM29b-1 2 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 638.7 E 360 004.8 Enfield Road | ORIGINATED BY WB
HWY 407 | BOREHOLE TYPE Hollow Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.08.26 - 2008.08.27 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **CLAY** with sand, trace gravel Stiff to Hard Grey (CL)										
			9	SS	36		194				4 37 32 27
192.8											
11.9	Silty **SAND**, some clay, trace gravel Compact to Very Dense Grey Moist to Wet (TILL)		10	SS	10		193				
							192				
			11	SS	12		191				4 54 32 10
			12	SS	40		190				
							189				
			13	SS	58		188				
187.0											
17.7	Silty **CLAY**, some sand, trace gravel Hard Grey (TILL)(CL)										
			14	SS	78		187				1 16 42 41
185.5							186				
19.2	**SAND** and **SILT**, some clay, trace gravel Very Dense Grey Moist: (TILL)						185				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 11/19/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM29b-1 3 OF 3 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 638.7 E 360 004.8 Enfield Road | ORIGINATED BY WB
HWY 407 | BOREHOLE TYPE Hollow Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.08.26 - 2008.08.27 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND and **SILT**, some clay, trace gravel Very Dense Grey Moist (TILL)		15	SS	70						
184.0							184				
20.7	Gravelly **SAND**, trace silt Very dense Grey Wet		16	SS	100/.075						
182.5							183				
22.3	**SAND** and **SILT**, some clay, trace gravel Very Dense Grey Moist to wet (TILL)		17	SS	100/.125		182				5 46 38 12
							181				
180.0			18	SS	100/.150						
24.7	END OF BOREHOLE AT 24.7m. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2008.08.27 4.3 200.4 2008.10.10 POSSIBLY DESTROYED										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 11/27/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM29d-1 1 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 979.3 E 359 905.2 Enfield Road | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2009.03.20 - 2009.03.20 | CHECKED BY LT

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
198.6											
0.0	**SAND**, fine grained, trace gravel Compact Brown Moist to Wet (FILL)		1	AS			198				
197.2			2	SS	29						
1.4	Sandy **SILT**, trace gravel, trace wood fibers and organics Compact Dark Greyish Wet (FILL)		3	SS	16		197				
196.5											
2.1	Silty **SAND**, some clay, some gravel Dense to Compact Greyish Brown Saturated		4	SS	33		196				
			5	SS	19		195				20 44 23 13
194.3											
4.3	Silty **CLAY**, trace to some sand, trace gravel Firm to Very Stiff Greyish Brown (CL)		6	SS	14		194				
			7	SS	15		193				0 3 54 43
							192				
			8	SS	19		191				
							190				
			9	SS	23		189				

Continued Next Page

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

ONTMT4S 0510.GPJ 8/5/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM29d-1 2 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 869 979.3 E 359 905.2 Enfield Road | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2009.03.20 - 2009.03.20 | CHECKED BY LT

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
188.2											
10.4	Silty **CLAY**, trace to some sand, trace gravel Firm to Very Stiff Brown (CL)						188				
	SILT, some sand, some clay, with silty clay layers Compact to Loose Greyish Brown Saturated		10	SS	12		187				
185.3											
13.3	Sandy **SILT**, trace gravel, occasional cobble Very Dense Greyish Brown Saturated (TILL)		11	SS	4		186				0 11 68 21
			12	SS	100		185				
184.0											
14.6	Silty **CLAY**, sandy, trace gravel Very Stiff Greyish Brown (TILL)						184				
			13	SS	23		183				2 29 33 36
182.8											
15.8	END OF BOREHOLE AT 15.8m. BOREHOLE BACKFILLED WITH BENTONITE AND CUTTINGS TO SURFACE.										

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

ONTMT4S 0510.GPJ 8/14/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No CM29d-2 1 OF 3 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 869 965.2 E 359 898.5 Enfield Road ORIGINATED BY LH
HWY 407 BOREHOLE TYPE Solid Stem Augers & Wash Boring COMPILED BY SN
DATUM Geodetic DATE 2009.03.25 - 2009.03.27 CHECKED BY LT

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
198.3								20 40 60 80 100 / 40 80 120 160 200	20 40 60		
0.0	**SAND**, trace gravel Loose to Compact Dark Brown Moist to Wet (FILL)		1	SS	8		198				
	Mixed with clayey silt layers, trace organics		2	SS	18		197				
196.0			3	SS	12		196				
2.3	Silty **SAND**, some gravel, trace clay Compact to Dense Brown Wet to Saturated		4	SS	20						
194.0			5	SS	31		195				10 48 37 5
4.3	Silty **CLAY**, some sand, trace gravel Stiff to Very Stiff Greyish Brown (CL)		6	SS	24		194				
	Sand seams, fissures filled with sand and gravel		7	SS	14		192				
			8	SS	19		191				1 11 40 48
	Gravelly sand layers Silt seams		9	SS	25		189				

Continued Next Page

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

ONTMT4S 0510.GPJ 8/17/09

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No CM29d-2 2 OF 3 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 869 965.2 E 359 898.5 Enfield Road ORIGINATED BY LH
HWY 407 BOREHOLE TYPE Solid Stem Augers & Wash Boring COMPILED BY SN
DATUM Geodetic DATE 2009.03.25 - 2009.03.27 CHECKED BY LT

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100 / 40 80 120 160 200	20 40 60		
187.9	Silty **CLAY**, trace sand, trace gravel Stiff to Very Stiff Greyish Brown (CL)						188				
10.4	Sandy **SILT**, some clay, trace gravel Compact to Dense Greyish Brown Saturated		10	SS	15		187				
185.2			11	SS	43		186				1 26 56 17
13.1	Sandy **SILT**, trace gravel, occasional cobble Very Dense Greyish Brown Saturated (TILL)		12	SS	70		185				
183.7							184				
14.6	Silty **CLAY**, sandy, trace gravel Hard to Stiff Greyish Brown (TILL)(CL)		13	SS	55		183				
			14	SS	28		182				6 34 31 29
			15	SS	27		180				
							179				

Continued Next Page

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

ONTMT4S 0510.GPJ 8/14/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CM29d-2 3 OF 3 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 869 965.2 E 359 898.5 Enfield Road ORIGINATED BY LH

HWY 407 BOREHOLE TYPE Solid Stem Augers & Wash Boring COMPILED BY SN

DATUM Geodetic DATE 2009.03.25 - 2009.03.27 CHECKED BY LT

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) (40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty CLAY, sandy, trace gravel Stiff to Very Stiff Greyish Brown (TILL)(CL)		16	SS	14		178		o		
							177				
			17	SS	20				o		
175.4							176				
22.9	Silty CLAY, trace to some sand Very Stiff to Stiff Grey		18	SS	18		175		o		
	with silty sand seams		19	SS	13		174		o		
173.3											
25.0	ARTESIAN CONDITION ENCOUNTERED AFTER EXTENDING CASING TO 25.9m. AFTER 45min, WATER IN CASING AT 0.74m ABOVE GROUND SURFACE. ARTESIAN CONDITION SEALED AND BOREHOLE BACKFILLED TO SURFACE WITH BENTONITE USING REVERSE AUGER ROTATION.										

+ ³ , × ³ : Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 8/14/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CCM-03 1 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 871 442.0 E 356 038.8 | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.12.18 - 2008.12.18 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
237.1											
0.0	**TOPSOIL**, mixed with clay Very Soft Brown		1	SS	2		237				
236.5											
0.6	Silty **CLAY**, sandy, trace gravel, occasional sandy silt inclusions, occasional cobbles or boulders Very Stiff to Hard Brown (TILL)(CL)		2	SS	24		236				
			3	SS	49		235				7 39 31 23
			4	SS	100		234				
			5	SS	100/ 0.275	▼					5 29 30 36
233.0							233				
4.1	**SAND** and **SILT**, some clay, trace gravel, occasional silty sand inclusions Very dense Greyish Brown Damp (TILL)		6	SS	100/ 0.200		232				
			7	SS	100/ 0.125		231				
							230				
			8	SS	100/ 0.150		229				6 46 30 18
			9	SS	100/ 0.100		228				

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 3/5/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CCM-03 2 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 871 442.0 E 356 038.8 | ORIGINATED BY LH
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY ES
DATUM Geodetic | DATE 2008.12.18 - 2008.12.18 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND and **SILT**, some clay, trace gravel, occasional silty sand layers Very dense Greyish Brown Damp (TILL)		10	SS	100/ 0.100		227				
224.8							226				
12.3	END OF BOREHOLE AT 12.3m. Piezometer installation consists of 25mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2009.02.10 3.4 233.7		11	SS	100/ 0.100		225				

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 3/5/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CCM-04 1 OF 2 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 871 228.2 E 356 446.9 ORIGINATED BY MEF
HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2008.10.01 - 2008.10.01 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (40 80 120 160 200) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
238.5											
0.0 / 0.1	**TOPSOIL:** (125mm), silty Brown										
	Silty **SAND**, trace gravel Dense to Very Dense Brown Dry to Damp		1	SS	5		238				
			2	SS	41						
			3	SS	100		237				6 60 34 (SI+CL)
	becoming Wet		4	SS	85		236				
			5	SS	100/ .200		235				
			6	SS	100/ .225		234				1 63 36 (SI+CL)
			7	SS	100/ .175		233				
							232				
231.3 / 7.2	Silty **SAND**, some clay, trace gravel, occasional cobbles Very Dense Grey Dry (TILL)		8	SS	100/ .100		231				1 48 33 18
							230				
229.2 / 9.3	END OF BOREHOLE AT 9.3m. BOREHOLE OPEN TO 3.0m, WET AT 3.0m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe										

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity (%) STRAIN AT FAILURE (15, 20, 10, 5)

ONTMT4S 0510.GPJ 3/5/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CCM-04 2 OF 2 METRIC

G.W.P. W.O. 07-20016 LOCATION N 4 871 228.2 E 356 446.9 ORIGINATED BY MEF
HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2008.10.01 - 2008.10.01 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (40 80 120 160 200) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2008.10.10 2.9 235.6 2009.02.12 2.9 235.6										

$+^3$, $\times^3$: Numbers refer to Sensitivity (%) STRAIN AT FAILURE (15, 20, 10, 5)

ONTMT4S 0510.GPJ 3/5/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CCM-05 1 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 317.0 E 358 159.8 | ORIGINATED BY SLL
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2008.12.02 - 2008.12.02 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) (40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
220.3											
0.0	**TOPSOIL**: (150mm) Black										
0.2	**SAND**, trace gravel, trace silt Compact Brown Moist		1	SS	14		220				
219.6											
0.7	Silty **SAND**, trace clay, trace gravel Dense to Very Dense Brown Moist to Wet (TILL)		2	SS	33		219				
			3	SS	56						3 65 25 7
			4	SS	100/ 0.225		218				
			5	SS	102		217				
			6	SS	108		216				21 66 13 (SI+CL)
215.4											
4.9	Gravelly **SAND**, some silt, trace clay Very Dense Grey Moist (TILL)		7	SS	~~100/~~ 0.025		215				
213.3							214				
7.0	**SAND** and **SILT**, some clay, trace gravel Hard Grey (TILL)(CL-ML)		8	SS	100/ ~~0.225~~		213				
							212				
			9	SS	100/ 0.200		211				6 43 36 15

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 3/5/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CCM-05 2 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 317.0 E 358 159.8 | ORIGINATED BY SLL
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2008.12.02 - 2008.12.02 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) (40 80 120 160 200)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page						210				
209.5			10	SS	100/						
10.8	END OF BOREHOLE AT 10.8m. BOREHOLE BACKFILLED WITH BENTONITE TO SURFACE.				0.125						

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 3/5/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CCM-06 1 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 223.2 E 358 336.2 | ORIGINATED BY SLL
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2008.12.02 - 2008.12.02 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa 40 80 120 160 200 (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
217.6											
0.0	**TOPSOIL** Black		1	SS	7						
216.9							217				
0.7	**SAND** and **SILT**, some clay, trace gravel Compact to Very Dense Brown Moist (TILL)		2	SS	11						
			3	SS	100/ 0.250		216				2 46 39 13
			4	SS	100		215				
			5	SS	100/ 0.275		214				
	becoming Grey		6	SS	75		213				3 47 36 14
			7	SS	67		212				
			8	SS	110		211				2 42 36 18
			9	SS	68		210				
207.6							209				
9.8	END OF BOREHOLE AT 9.8m.						208				

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 3/5/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CCM-06 2 OF 2 METRIC

G.W.P. W.O. 07-20016 | LOCATION N 4 870 223.2 E 358 336.2 | ORIGINATED BY SLL
HWY 407 | BOREHOLE TYPE Solid Stem Augers | COMPILED BY AN
DATUM Geodetic | DATE 2008.12.02 - 2008.12.02 | CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa 40 80 120 160 200 (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page BOREHOLE OPEN AND WATER LEVEL AT 3.8m UPON COMPLETION OF DRILLING. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2008.12.10 2.3 215.3										

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 0510.GPJ 3/5/09

APPENDIX B

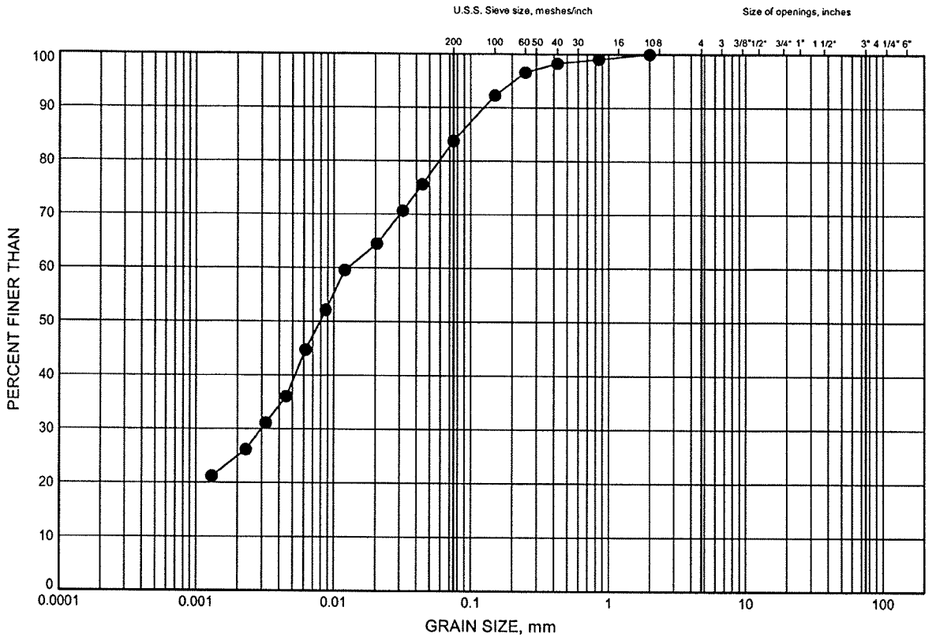
LABORATORY TEST RESULTS

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM16-B1

CLAYEY SILT



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM16-2	2.59	179.81

GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 9/3/09

W.P.# W.O. 07-20016
Prepared By AN
Checked By LT

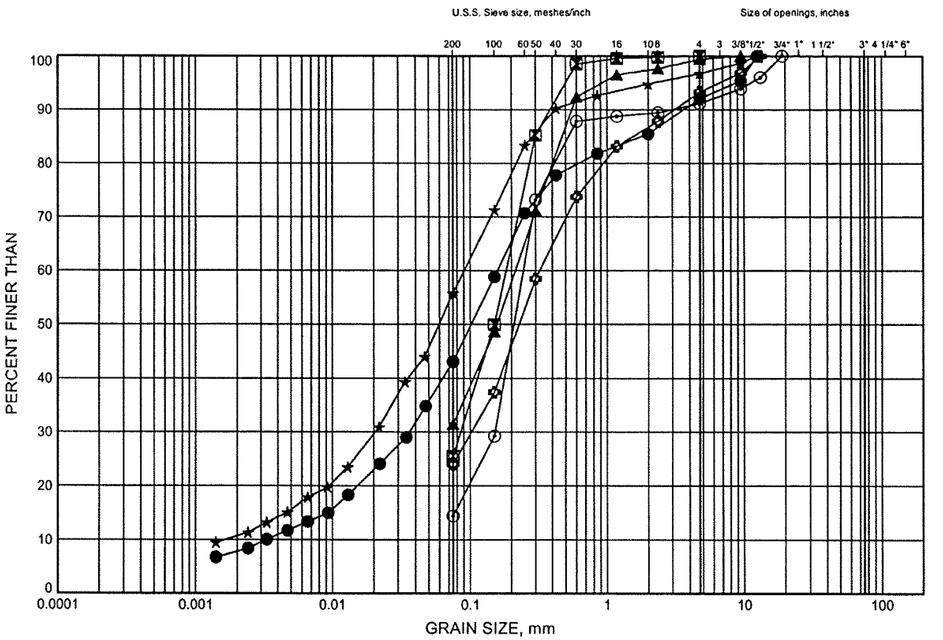
THURBER

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM16-B2

SANDS & SILTS



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM16-1	2.59	181.01
⊠	CM16-1	6.40	177.20
▲	CM16-1	10.97	172.63
★	CM16-2	3.35	179.05
⊙	CM16-2	7.92	174.48
✪	CM16-2	12.50	169.90

GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 9/3/09

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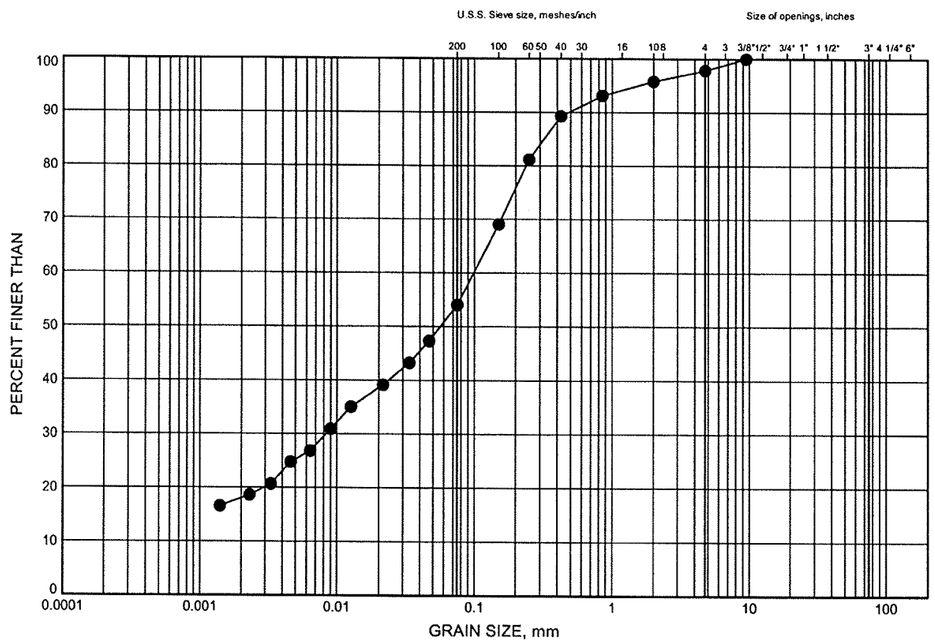
Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM16-B3

SAND & SILT TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM16-1	12.40	171.20

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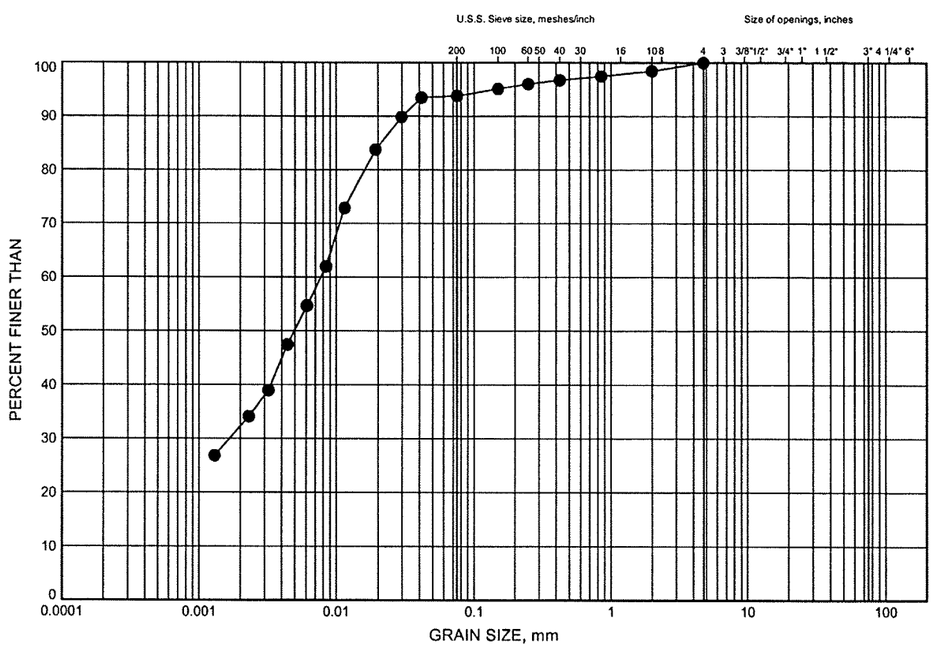
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 9/3/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM16-B4

SILTY CLAY



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM16-2	13.85	168.55

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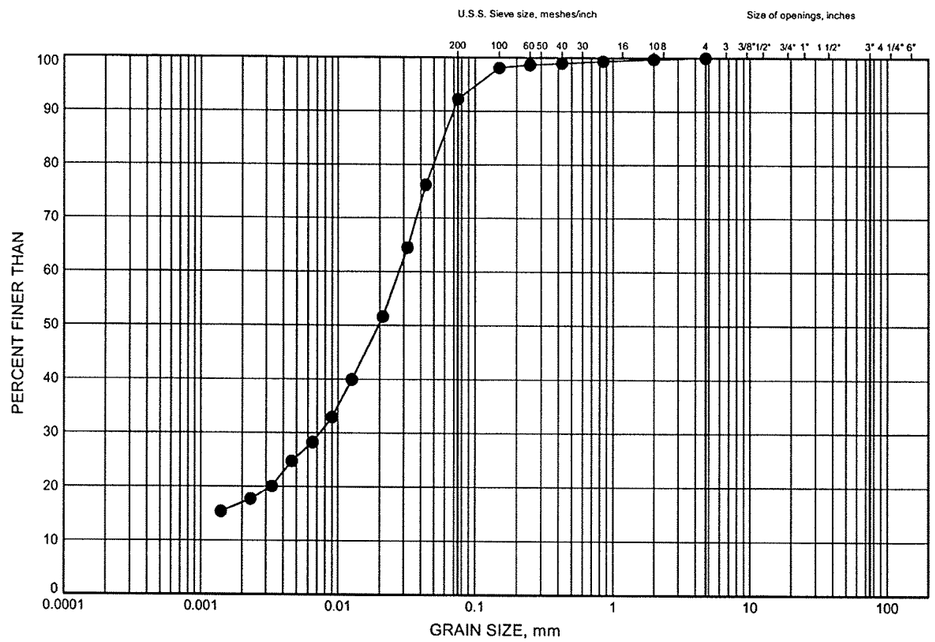
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 9/3/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM16-B5

SILT



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM16-2	16.86	165.54

W.P.# W.O. 07-20016

Prepared By AN

Checked By LT

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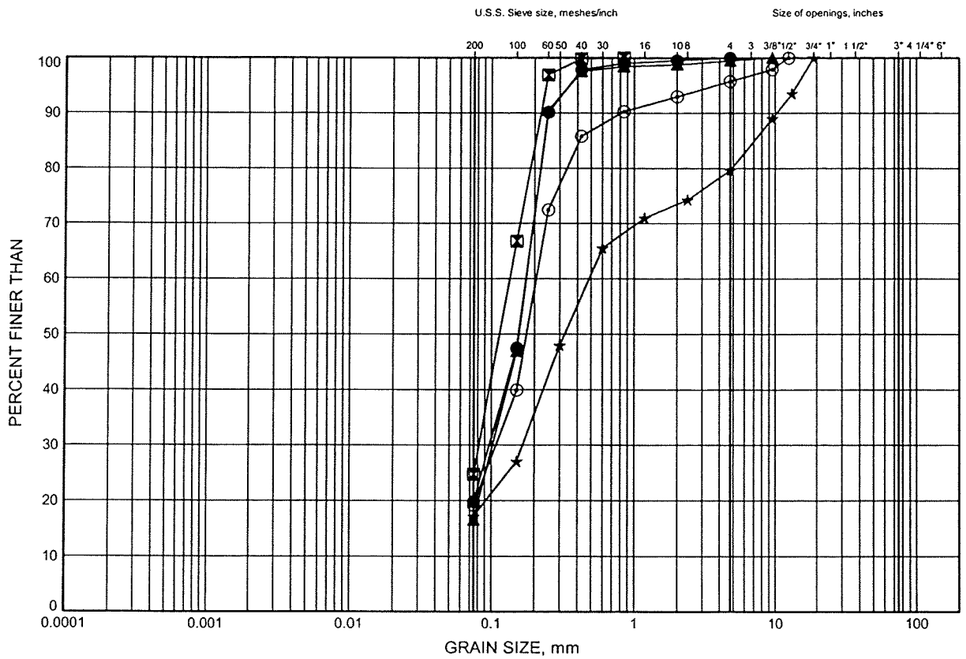
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 9/3/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM17-B1

SAND



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM17-1	6.38	167.05
⊠	CM17-1	10.82	162.60
▲	CM17-3	9.33	159.50
★	CM17-4	20.03	166.07
⊙	CM17b-1	3.35	171.03

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Prepared By MFA
Checked By SKP

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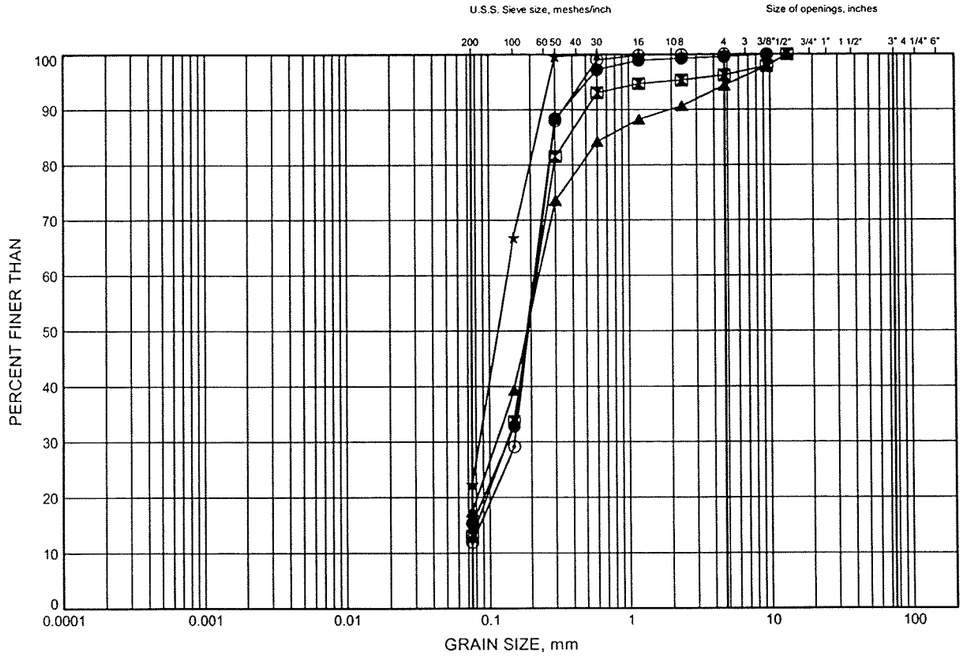
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 3/9/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM17-B2

SAND



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM17-5	2.59	168.91
⊠	CM17-5	6.40	165.10
▲	CM17-5	12.41	159.09
★	CM17-5	17.07	154.43
⊙	CM17b-4	15.54	169.16

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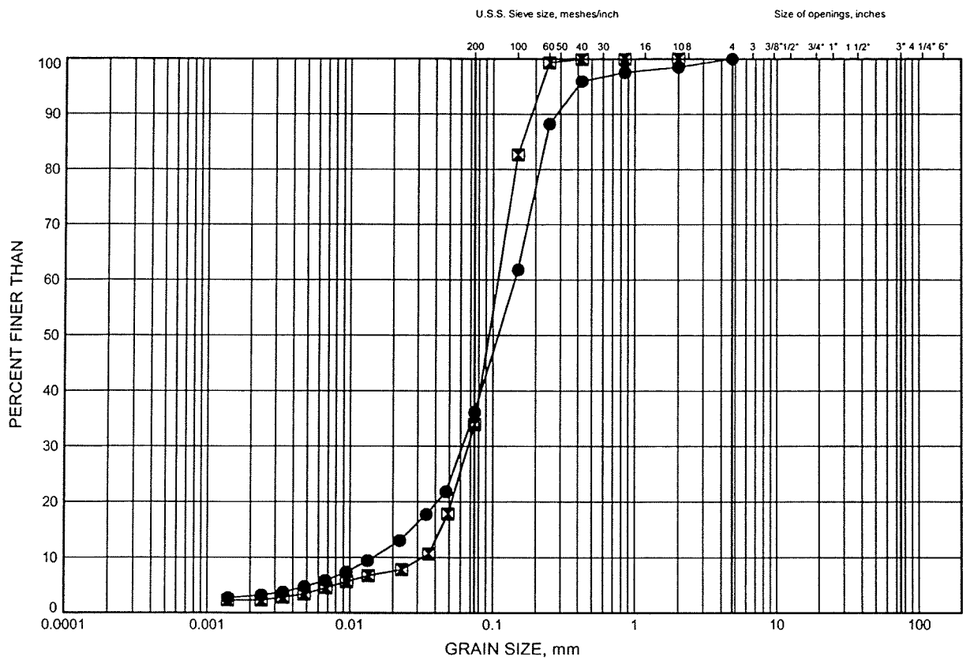
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 3/9/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM17-B3

SILTY SAND



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM17-2	1.83	174.57
⊠	CM17b-1	10.96	163.42

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Prepared By MFA
Checked By SKP

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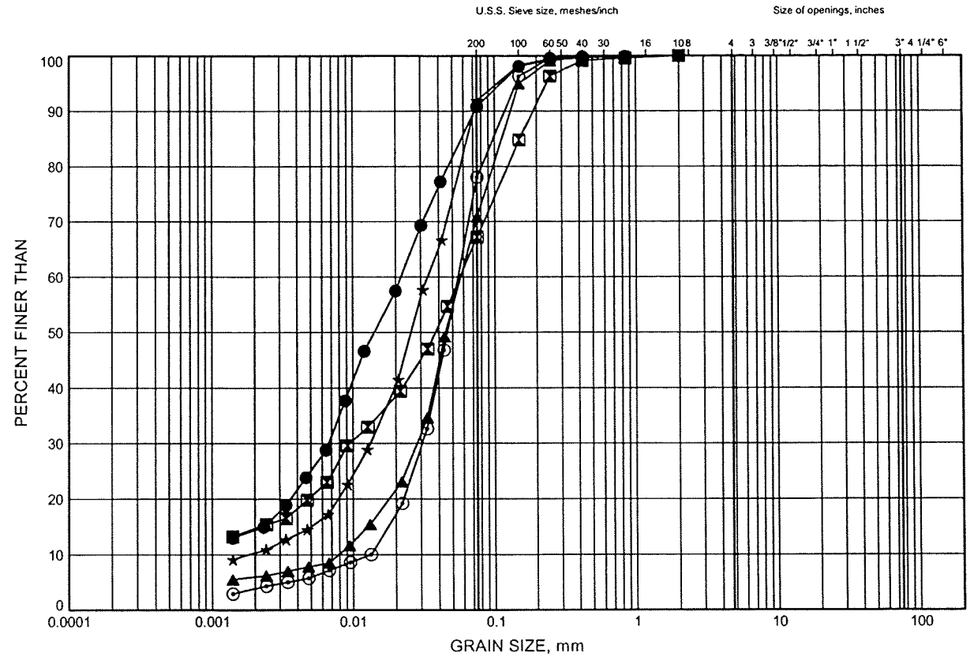
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 3/9/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM17-B4

SILT TO SANDY SILT



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM17-4	15.54	170.56
⊠	CM17b-1	7.91	166.47
▲	CM17b-1	14.01	160.38
★	CM17b-4	6.17	178.53
⊙	CM17b-4	17.07	167.63

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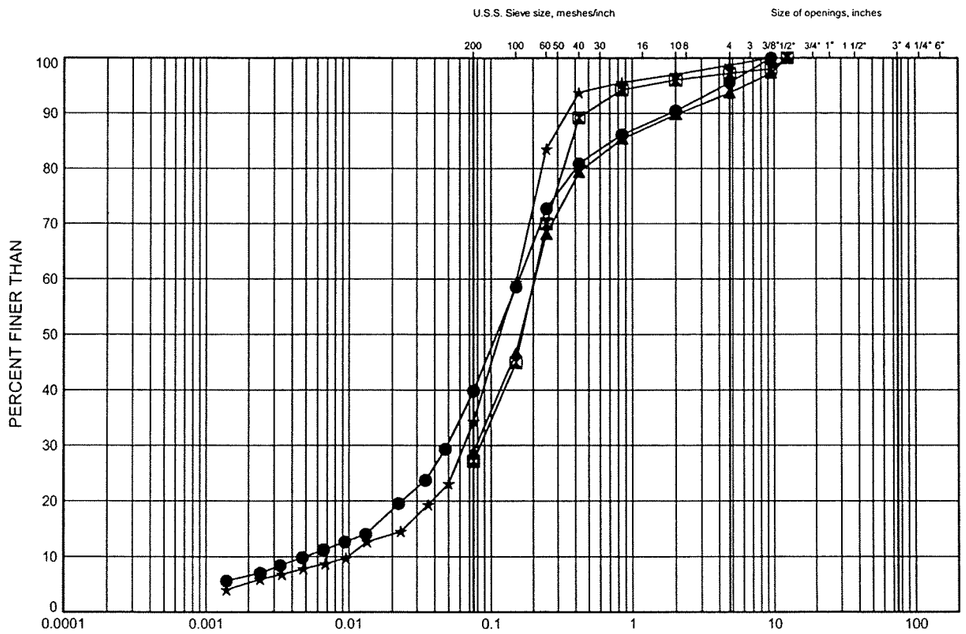
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 3/9/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM17-B5

SILTY SAND TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM17-2	3.35	173.05
⊠	CM17-3	3.35	165.48
▲	CM17b-2	2.59	174.58
★	CM17b-3	3.35	167.35

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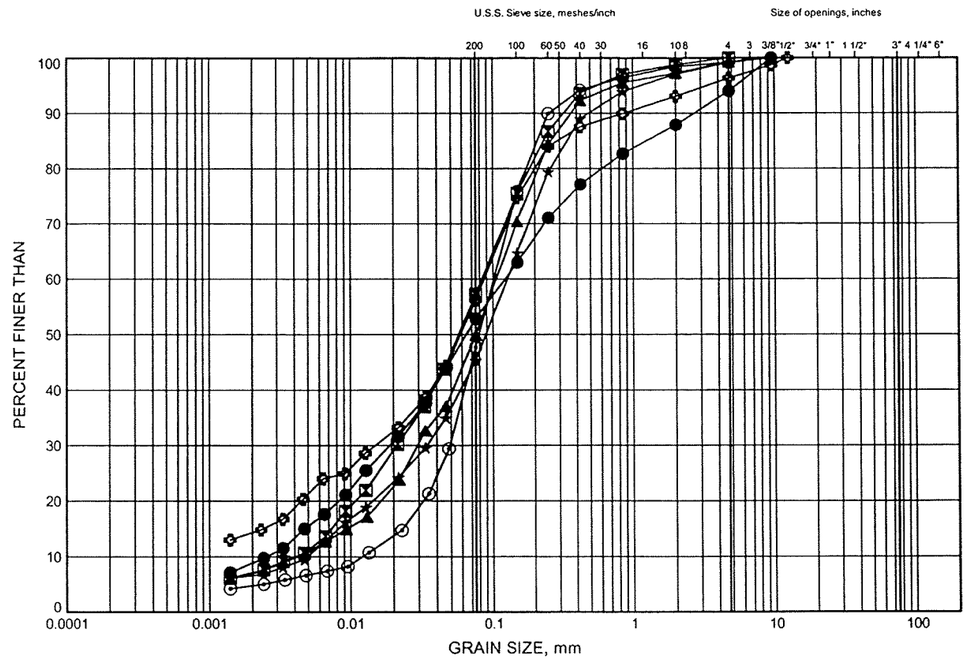
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 3/9/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM17-B6

SAND AND SILT TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM17-2	7.81	168.59
⊠	CM17-4	7.85	178.25
▲	CM17-4	10.95	175.15
★	CM17-4	14.02	172.08
⊙	CM17b-3	6.27	164.43
✪	CM17b-3	9.30	161.41

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Prepared By MFA
Checked By SKP

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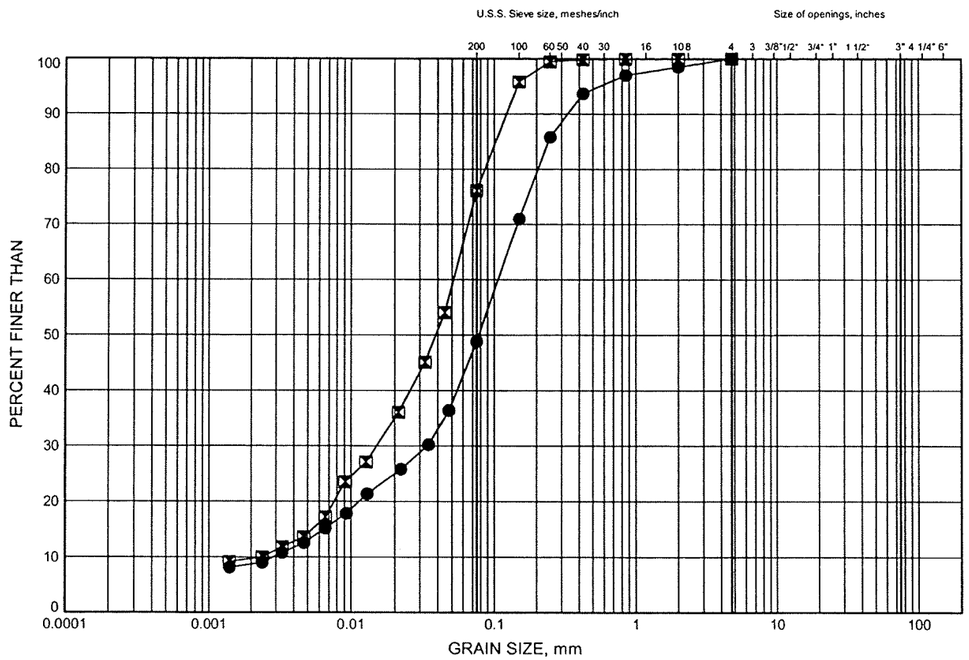
Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM17-B7

SAND AND SILT TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM17b-4	10.97	173.73
⊠	CM17b-4	14.02	170.68

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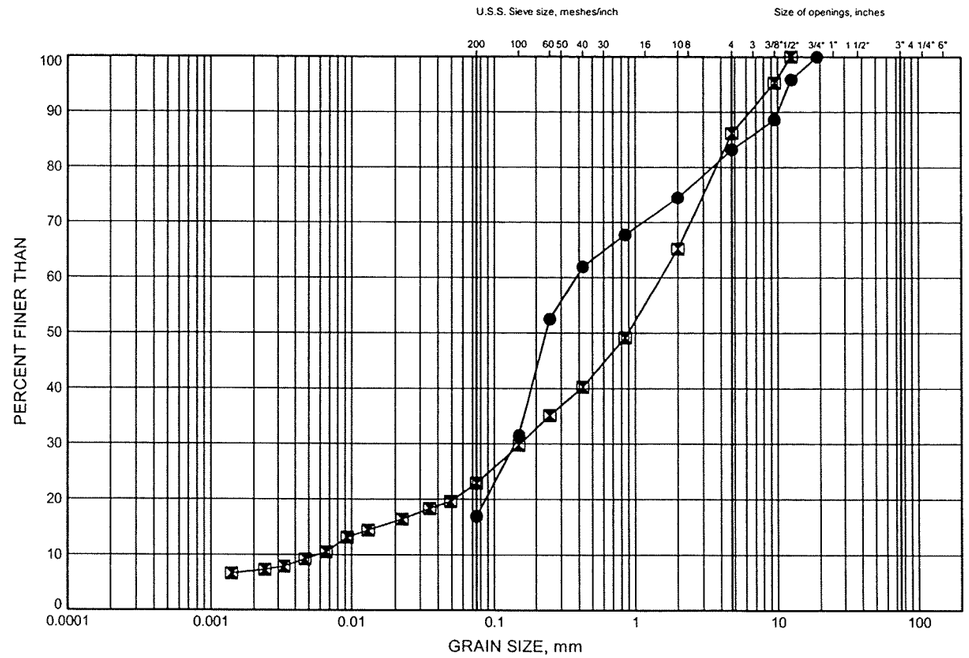
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 3/9/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM17-B8

SAND TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM17-1	1.07	172.36
⊠	CM17-3a	10.76	158.07

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Prepared By MFA
Checked By SKP

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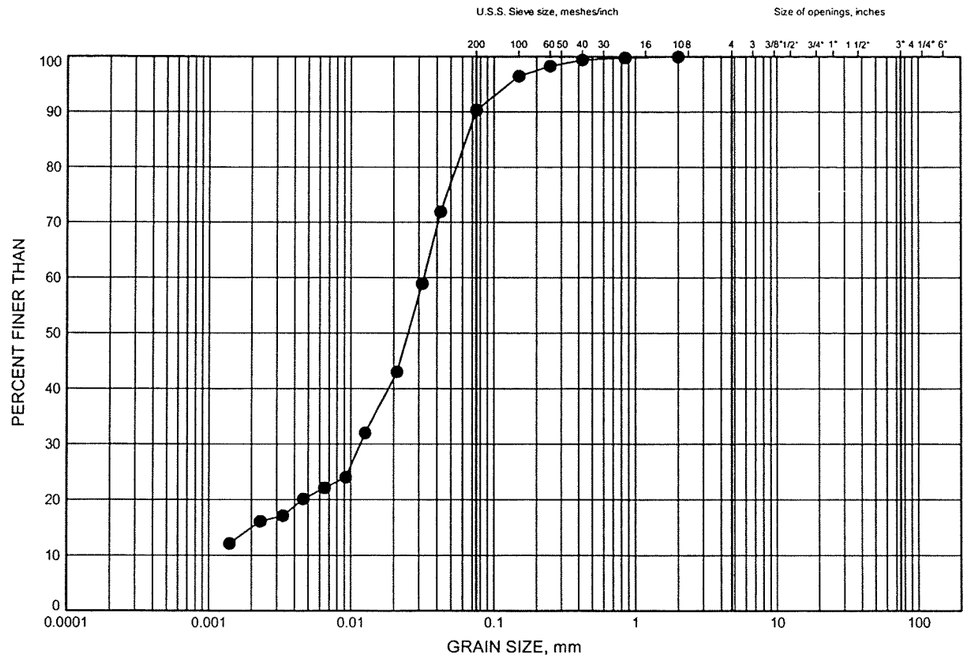
Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM17-B9

SILT TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM17-3	4.79	164.04

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Prepared By MFA
Checked By SKP

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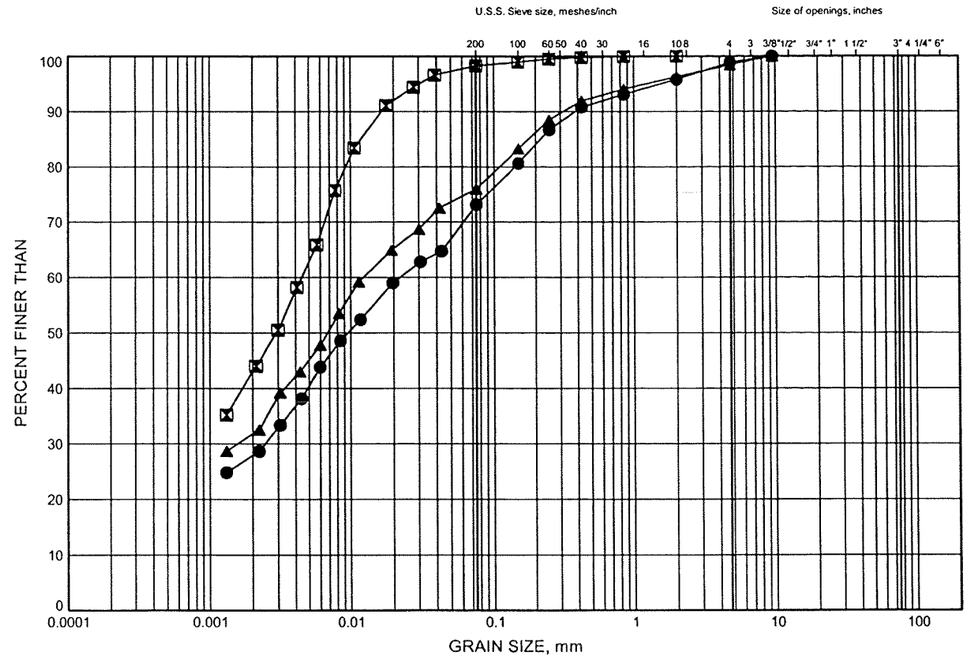
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 3/9/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM17-B10

SILTY CLAY / SILTY CLAY TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM17-4	3.34	182.76
⊠	CM17b-1	18.44	155.94
▲	CM17b-4	2.59	182.11

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Prepared By MFA
Checked By SKP

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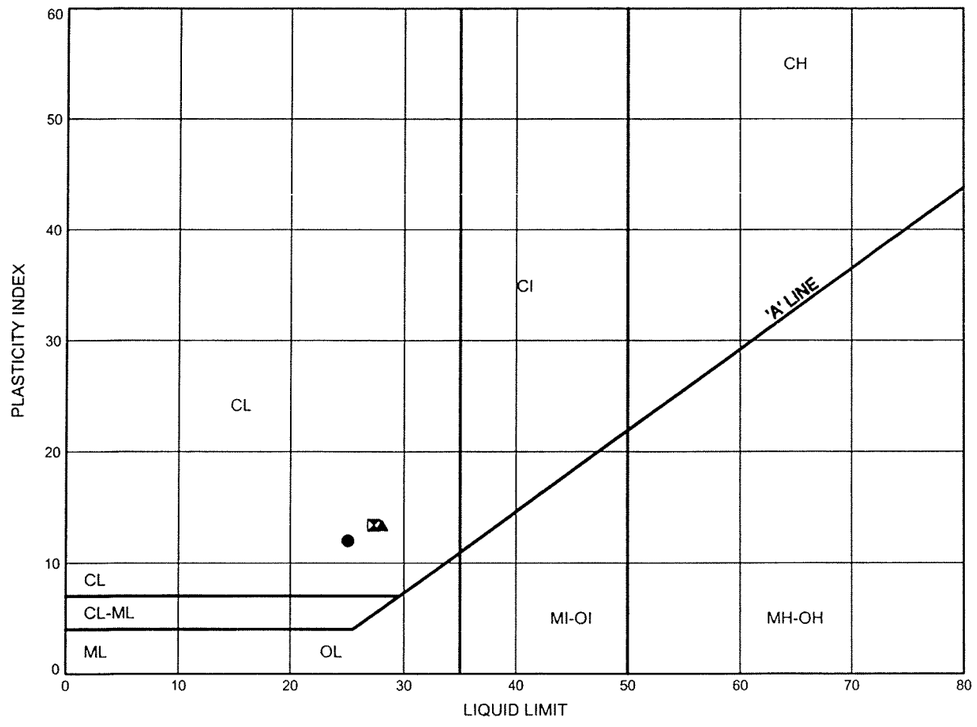
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 3/9/09

Hwy 407 East Extension - Central Section

ATTERBERG LIMITS TEST RESULTS

FIGURE CM17-B11

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	CM17-4	3.34	182.76
⊠	CM17b-1	18.44	155.94
▲	CM17b-4	2.59	182.11

Date March 2009

Project W.O. 07-20016

THURBER

Prep'd MFA

Chkd. SKP

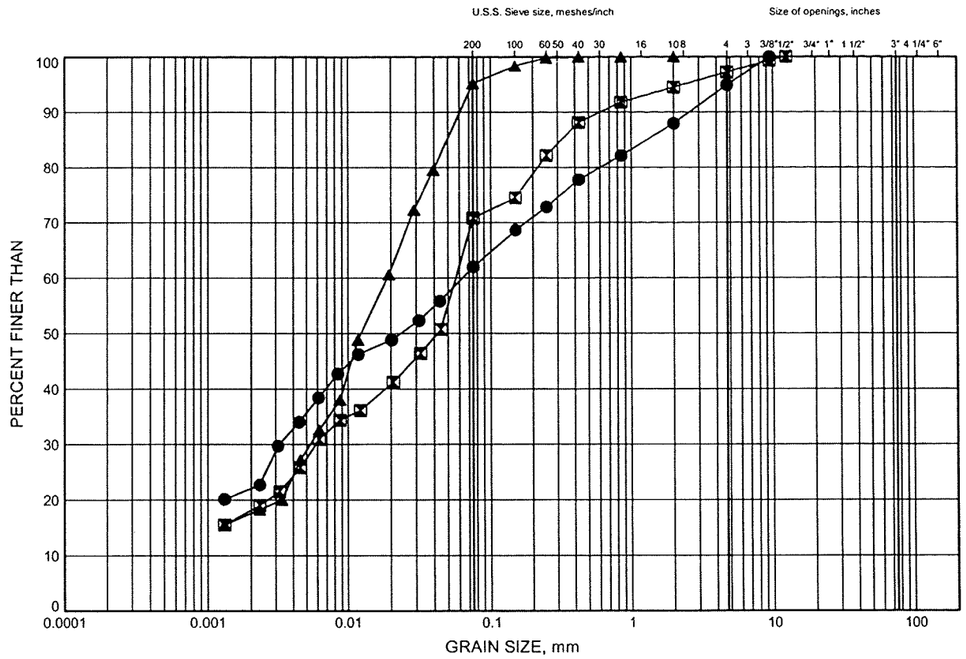
THURBALT 0510.GPJ 3/9/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM17-B12

CLAYEY SILT TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM17-5	7.70	163.80
⊠	CM17b-2	4.65	172.52
▲	CM17b-2	6.19	170.99

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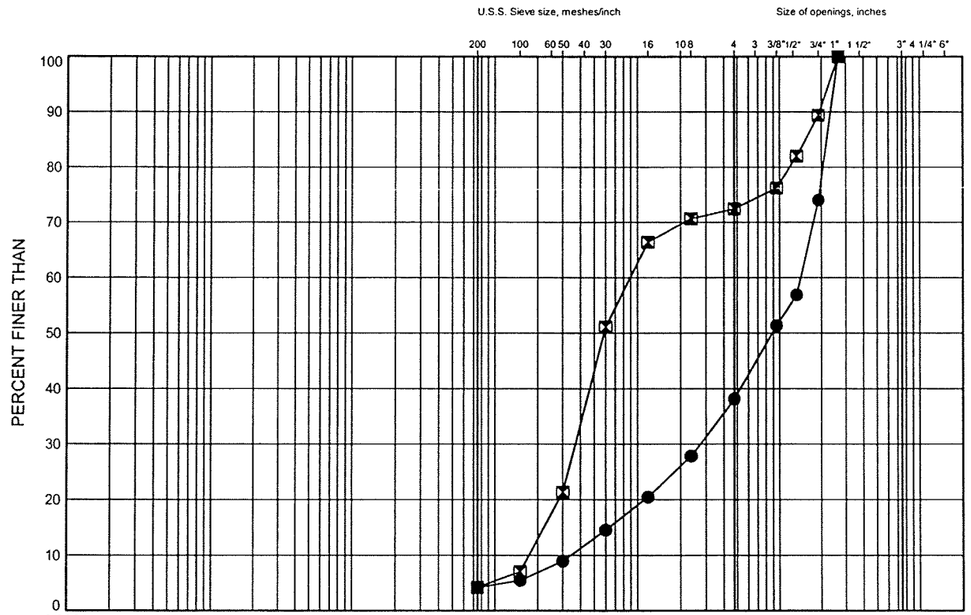
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 3/9/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM17-B13

SANDY GRAVEL TO GRAVELLY SAND



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM17-4	21.54	164.56
⊠	CM17-5	20.12	151.38

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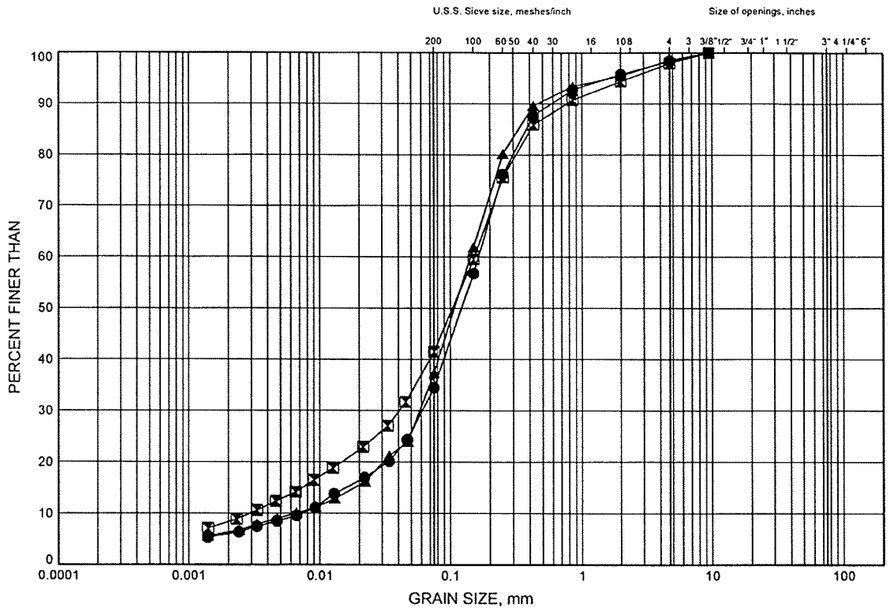
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 3/9/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM18-B1

SILTY SAND



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM18-1	3.35	175.15
⊠	CM18-2	1.83	175.47
▲	CM18-2	3.35	173.95

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Prepared By AN
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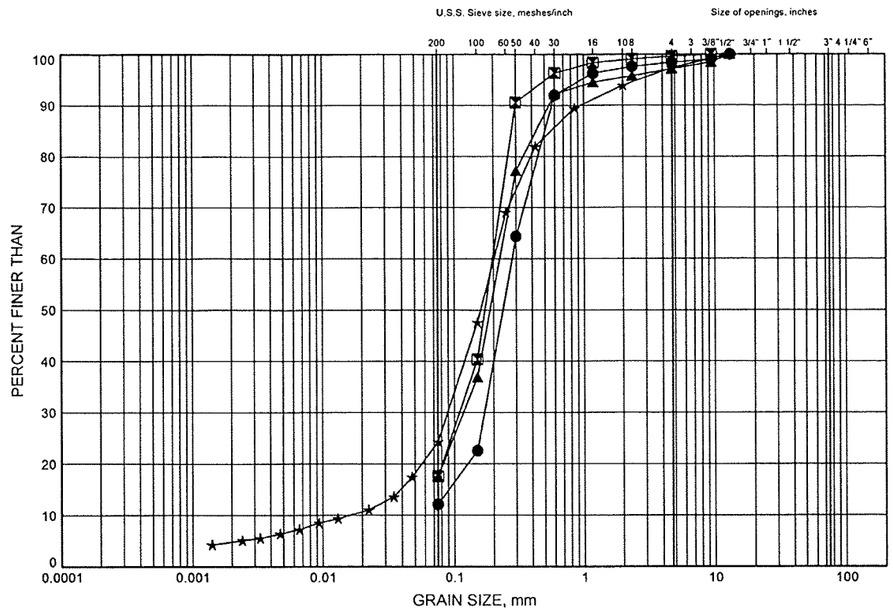
Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM18-B2

SAND



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM18-1	6.40	172.10
⊠	CM18-1	8.15	170.35
▲	CM18-2	6.40	170.90
★	CM18-2	9.28	168.02

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Prepared By AN
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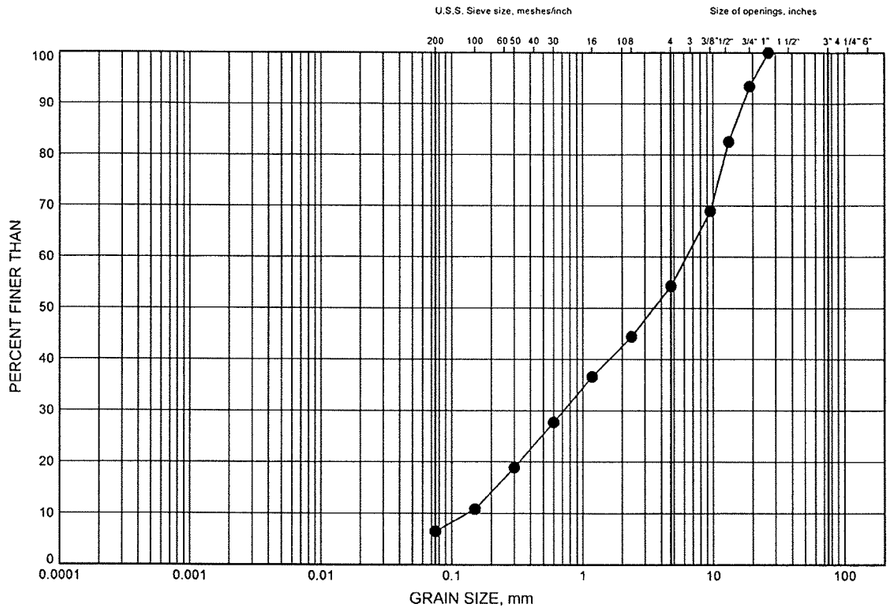
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 5/26/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM18-B3

SAND and GRAVEL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM18-1	9.42	169.08

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Prepared By AN
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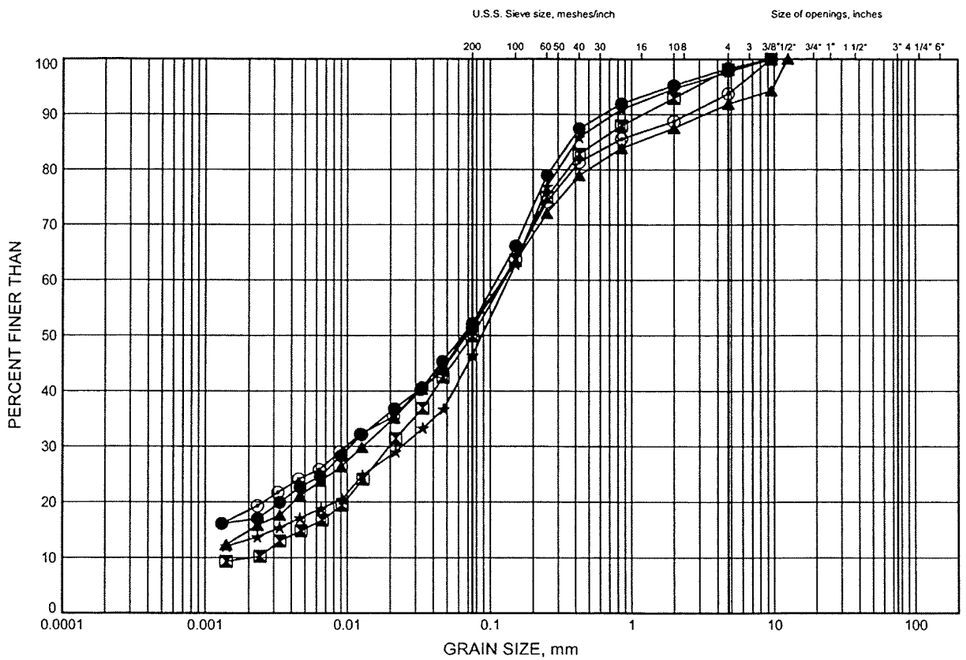
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 5/26/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM20/20b-B1

SAND AND SILT TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM20b-2	3.28	207.54
⊠	CM20b-2	6.14	204.67
▲	CM20b-3	1.83	209.49
★	CM20b-3	3.35	207.96
⊙	CM20b-3	6.40	204.92

W.P.# W.O. 07-20016
Prepared By AN
Checked By SKP

THURBER

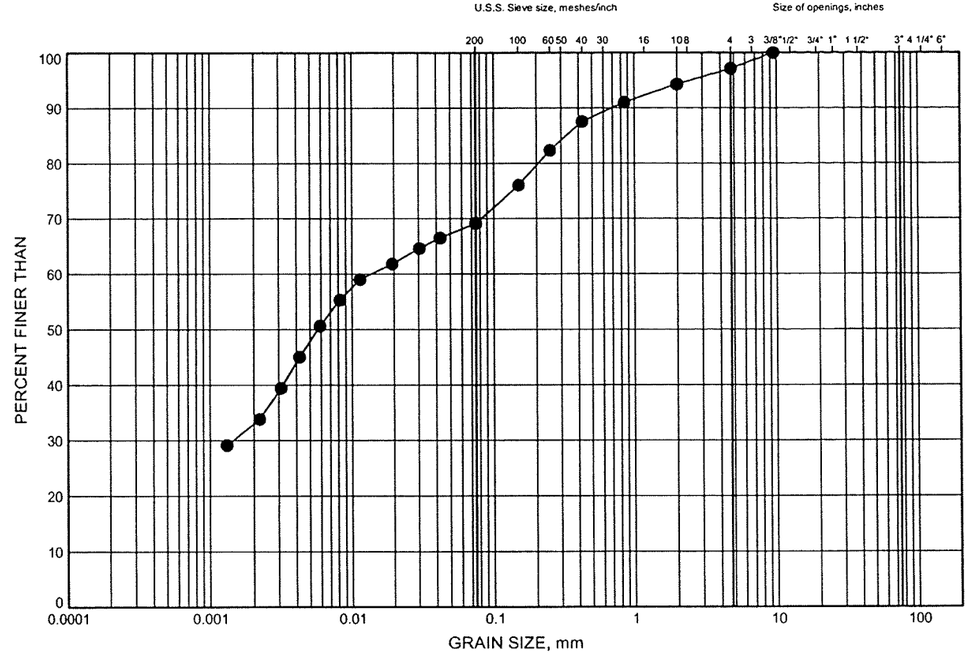
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 3/12/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM20/20b-B2

SILTY CLAY TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM20b-2	7.66	203.16

W.P.# W.O. 07-20016
Prepared By MFA
Checked By SKP

THURBER

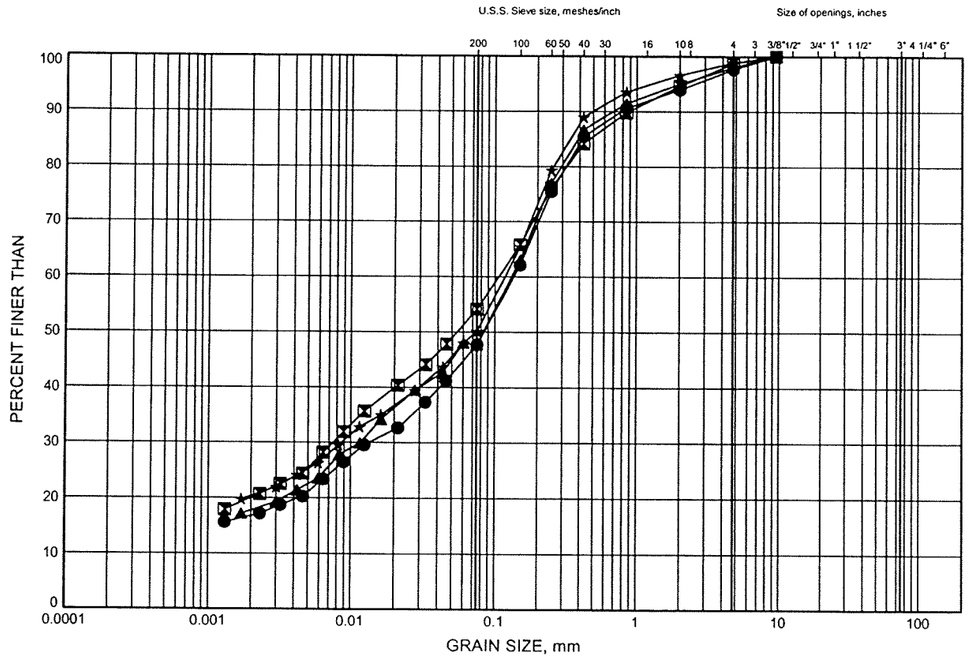
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 3/9/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM20/20b-B3

SILTY SAND TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM20-2a	3.35	200.55
⊠	CM20-2a	6.14	197.76
▲	CM20b-4	1.83	206.07
★	CM20b-4	4.71	203.19

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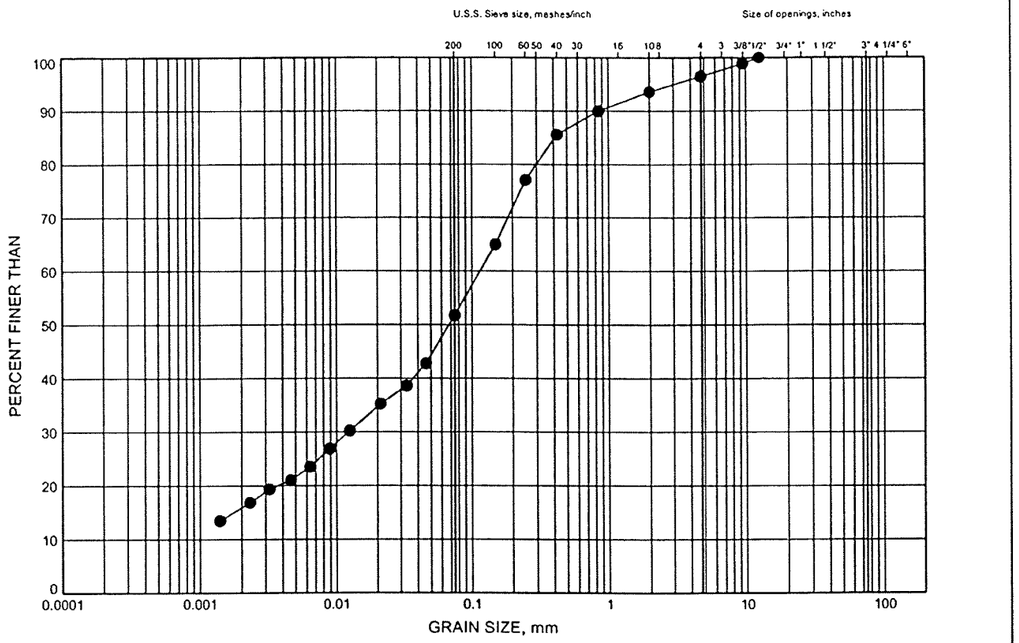
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 3/9/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM20c-B1

SAND AND SILT TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM20c-3	6.13	197.57

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Prepared By AN
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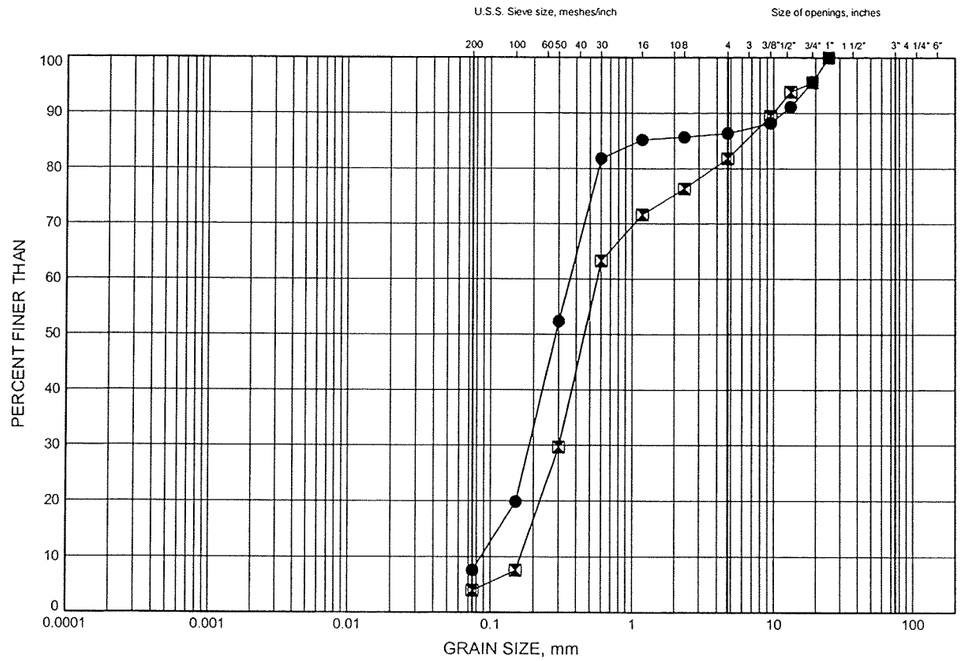
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 8/14/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM21-B1

SAND



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM21-2	9.45	211.63
⊠	CM21b-3	14.02	204.18

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Prepared By AW
Checked By SKP

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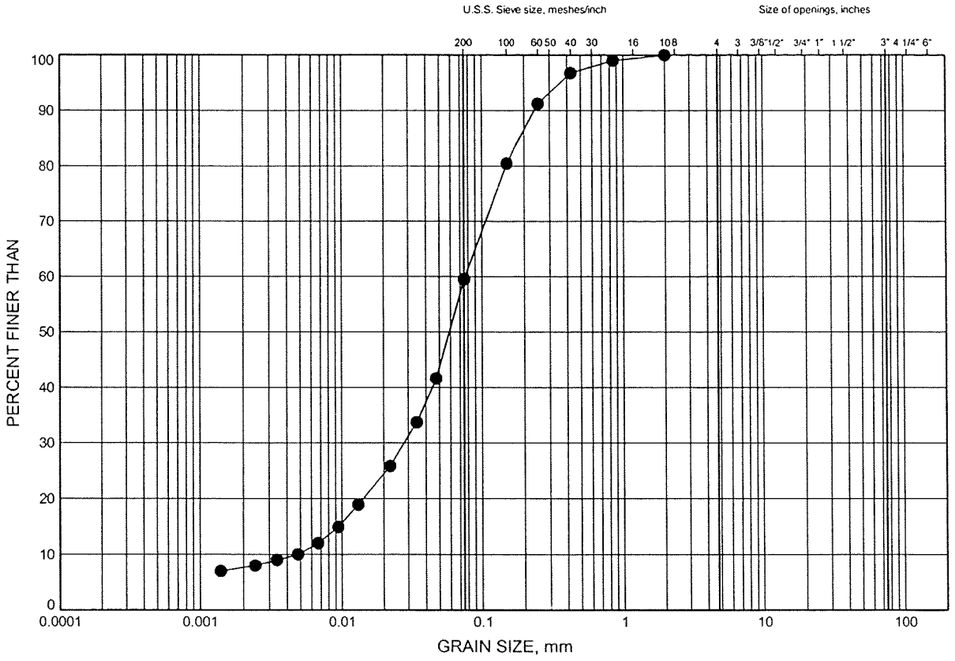
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 9/29/08

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM21-B2

SAND AND SILT



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM21b-1	8.18	208.60

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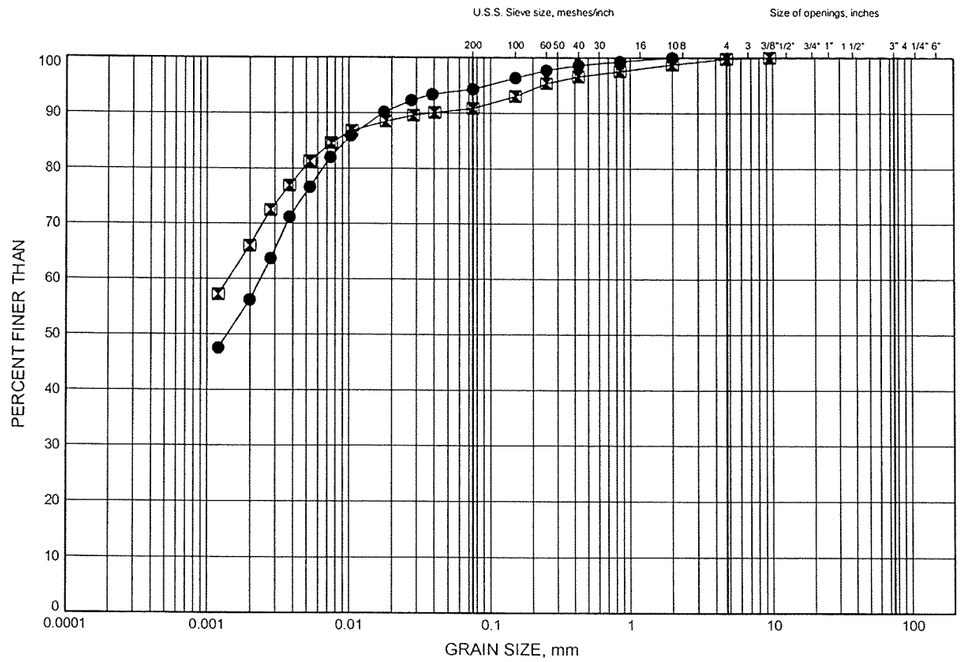
Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM21-B3

SILTY CLAY



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM21-1	7.92	209.88
⊠	CM21b-3	7.92	210.28

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Prepared By AW
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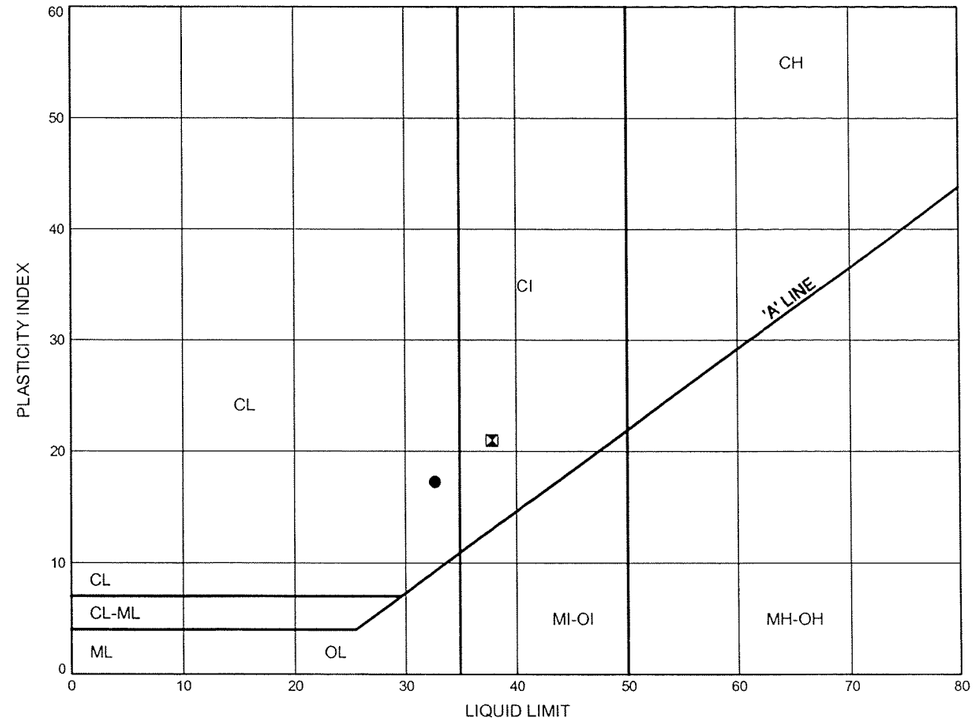
GR-AIN SIZE DISTRIBUTION - THURBER .0510.GPJ 9/29/08

Hwy 407 East Extension - Central Section

ATTERBERG LIMITS TEST RESULTS

FIGURE CM21-B4

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	CM21-1	7.92	209.88
⊠	CM21b-3	7.92	210.28

Date September 2008
Project W.O. 07-20016

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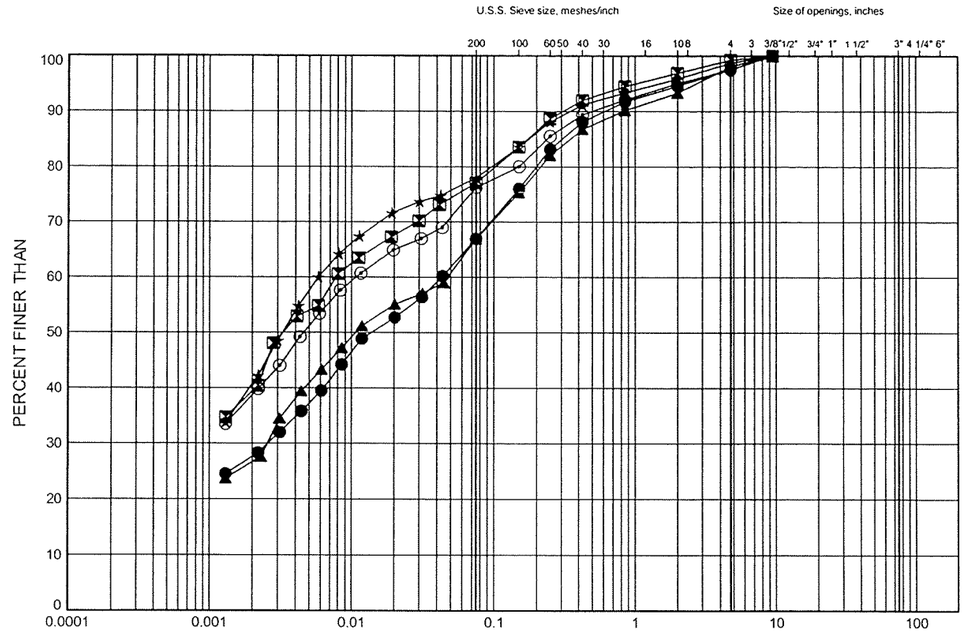
THURBALT 0510.GPJ 9/29/08

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM21-B5

SILTY CLAY TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM21-1	3.35	214.45
⊠	CM21-2	6.40	214.68
▲	CM21b-1	3.32	213.47
☆	CM21b-1	6.40	210.38
⊙	CM21b-3	4.88	213.32

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Prepared By AW
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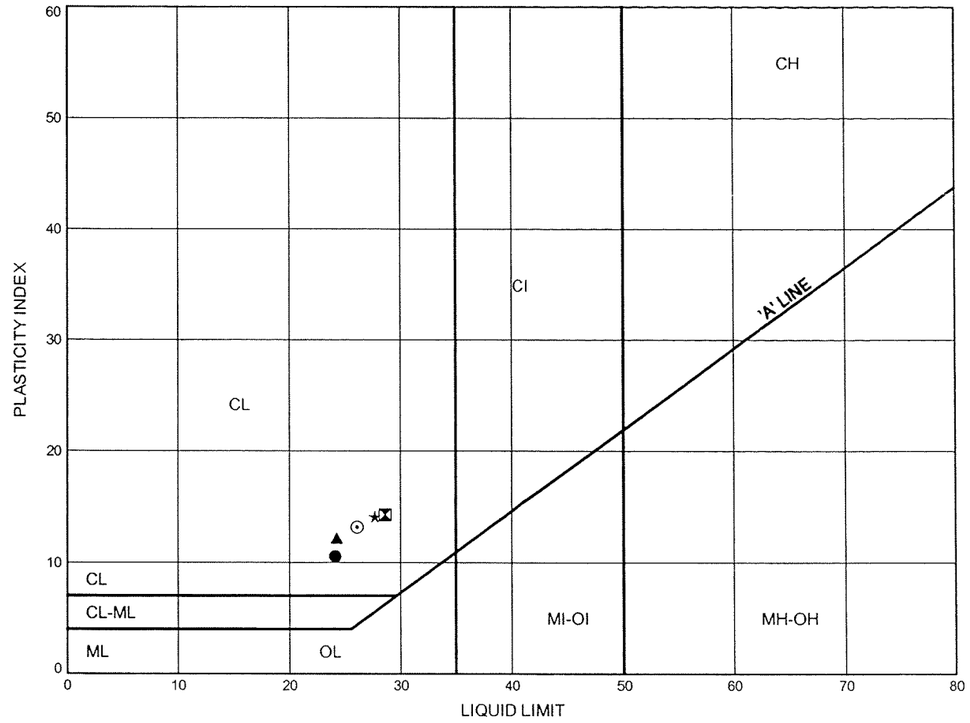
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 9/29/08

Hwy 407 East Extension - Central Section

ATTERBERG LIMITS TEST RESULTS

FIGURE CM21-B6

SILTY CLAY TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	CM21-1	3.35	214.45
⊠	CM21-2	6.40	214.68
▲	CM21b-1	3.31	213.47
★	CM21b-1	6.40	210.38
⊙	CM21b-3	4.88	213.32

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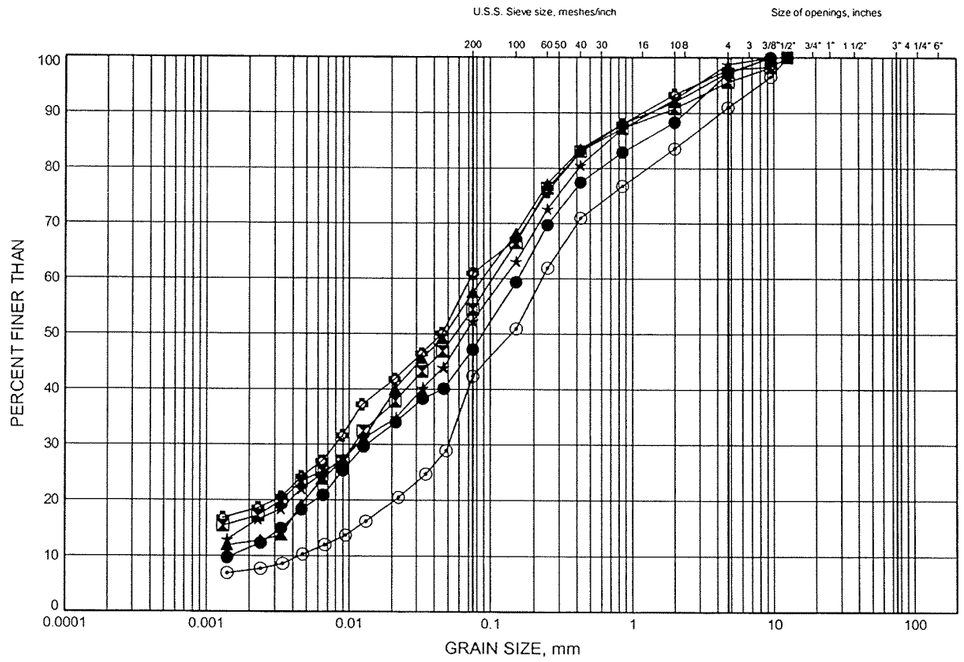
THURBALT 0510.GPJ 9/29/08

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM21-B7

SAND AND SILT TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM21-1	10.74	207.06
⊠	CM21-2	3.35	217.73
▲	CM21-2	12.27	208.81
☆	CM21b-1	13.77	203.01
⊙	CM21b-3	9.53	208.68
✪	CM21b-3	15.26	202.94

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Prepared By AW
Checked By SKP

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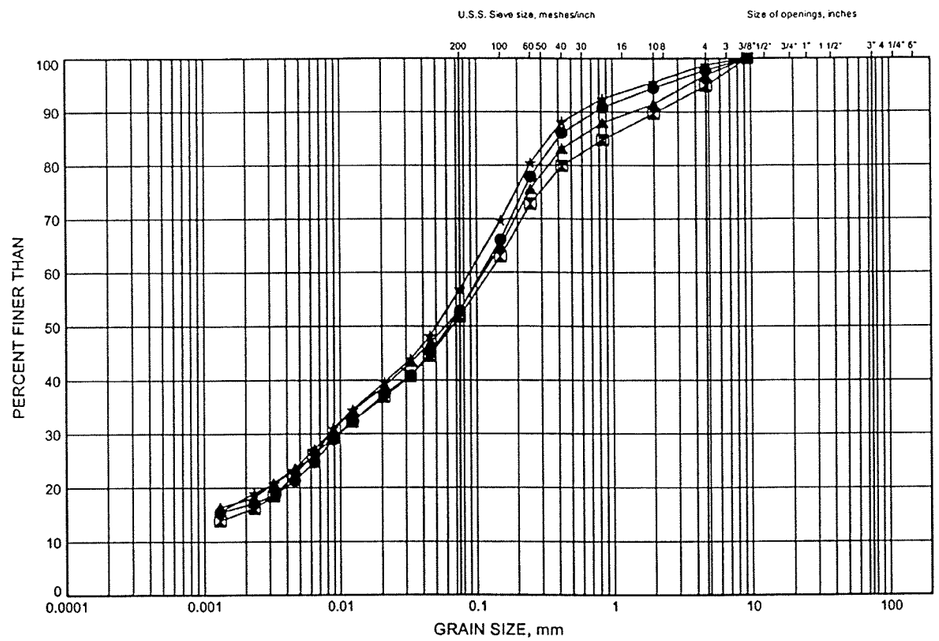
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 9/29/08

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM23-B1

SAND & SILT TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM23-1	2.59	235.91
⊠	CM23-1	4.65	233.85
▲	CM23-2	3.35	233.85
★	CM23-2	7.71	229.49

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Prepared By AN
Checked By GFA

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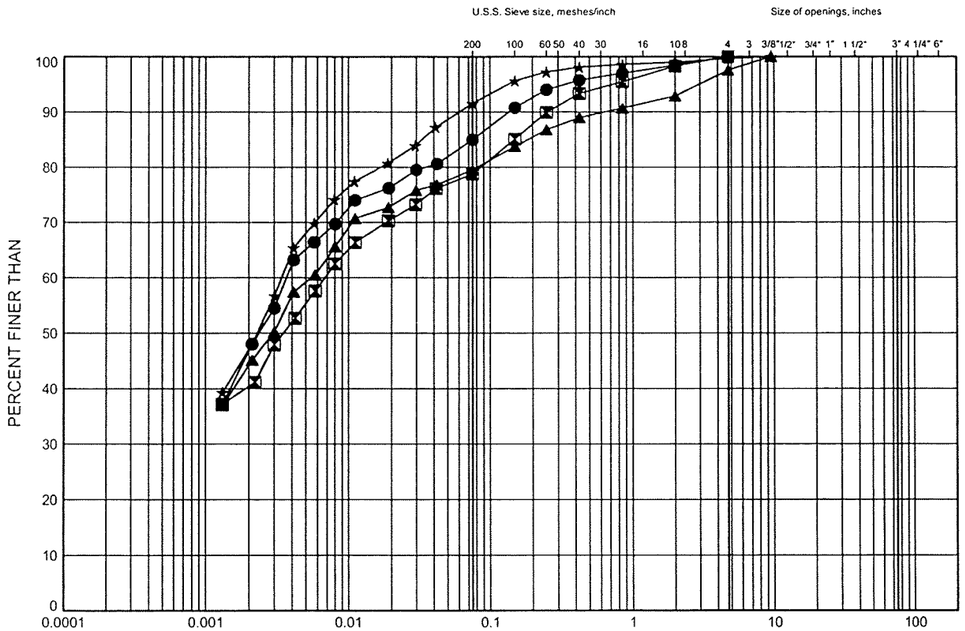
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 5/21/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM23b/24-B1

SILTY CLAY TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM23b-2	6.40	224.27
⊠	CM24-1	10.97	207.91
▲	CM24-2	10.97	208.47
★	CM24-2	15.62	203.83

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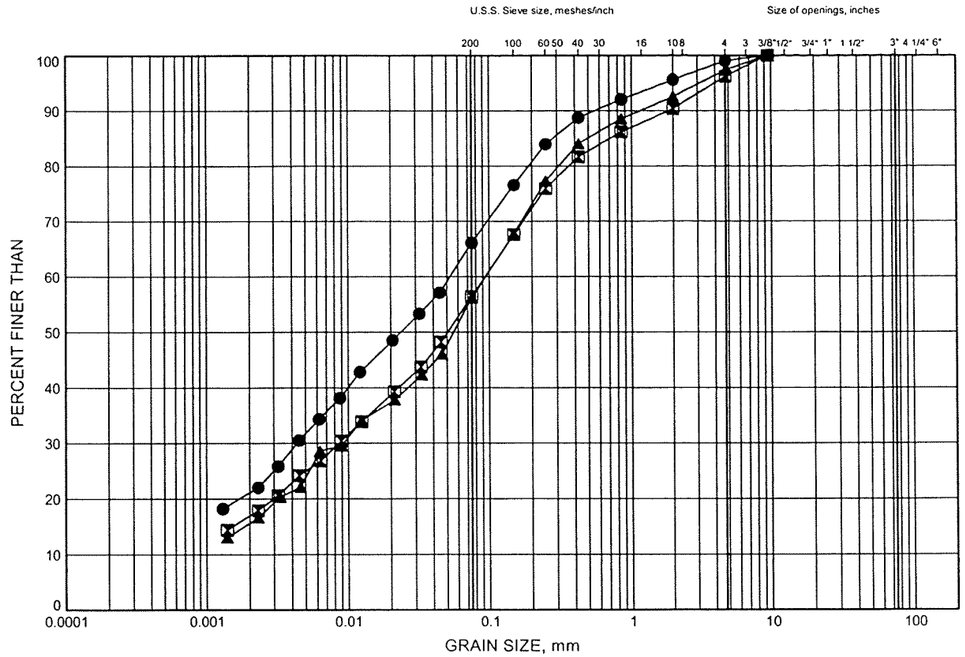
Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM23b/24-B2

CLAYEY SILT & SAND TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM24-1	3.35	215.53
⊠	CM24-2	3.35	216.09
▲	CM24-2	7.92	211.52

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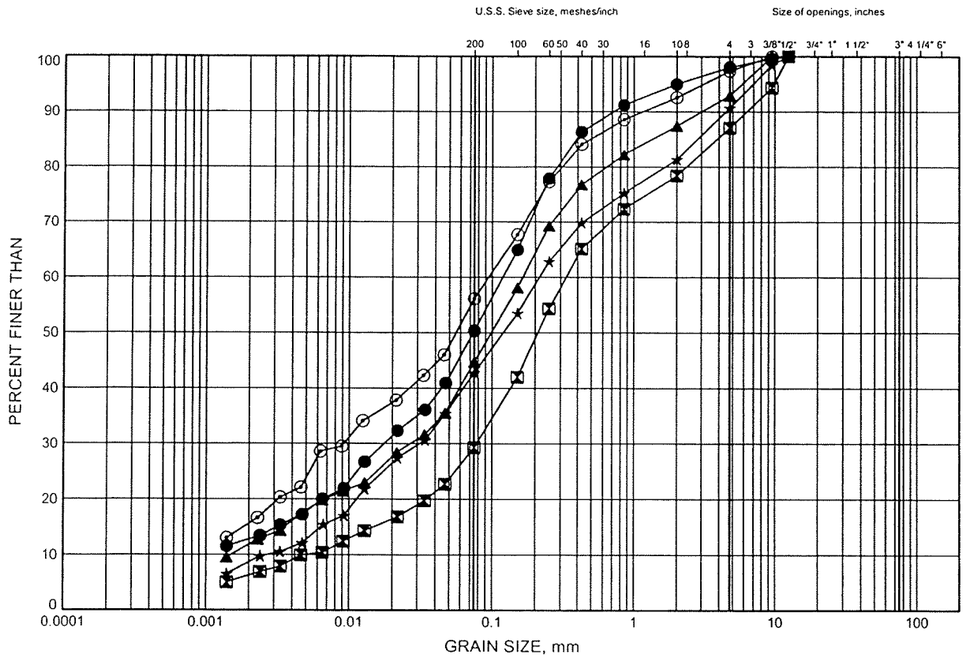
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 3/19/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM23b/24-B3

SAND & SILT TILL to SITY SAND TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM23b-2	3.35	227.32
⊠	CM23b-2	10.73	219.94
▲	CM24-1	12.50	206.38
★	CM24-1	15.98	202.90
⊙	CM24-2	7.92	211.52

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Prepared By AN
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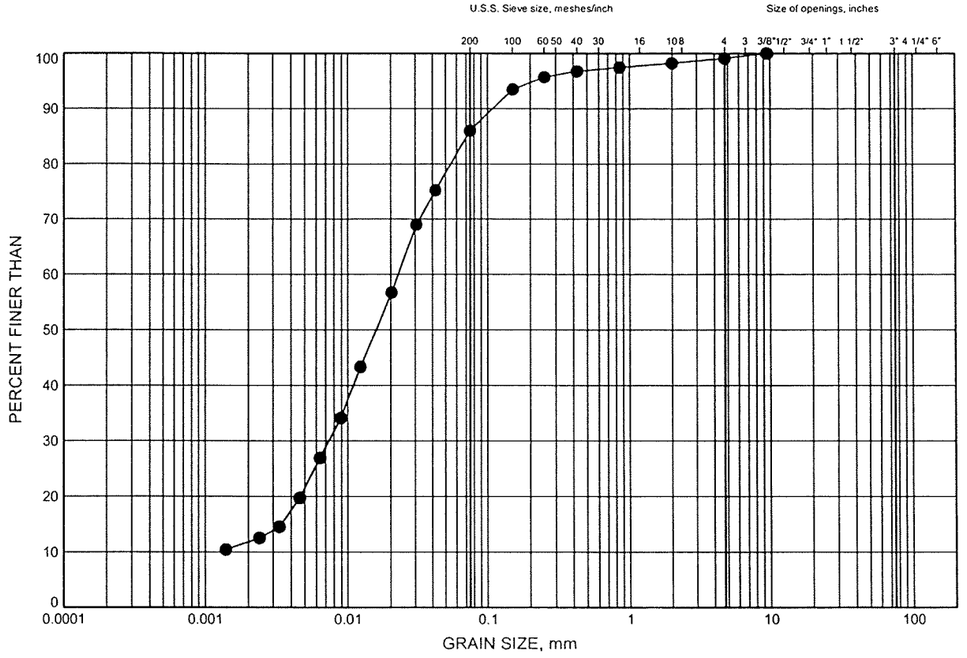
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 3/19/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM23b/24-B4

SILT TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM24-2	21.64	197.81

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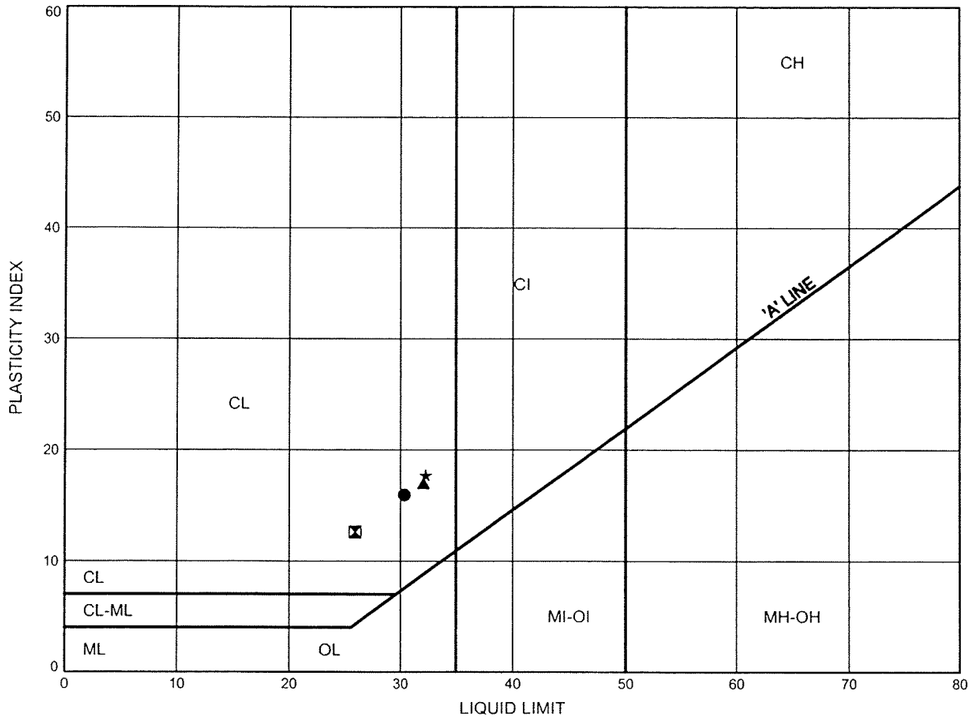
Hwy 407 East Extension - Central Section

ATTERBERG LIMITS TEST RESULTS

FIGURE CM23b/24-B5

SILTY CLAY TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	CM23b-2	6.40	224.27
⊠	CM24-1	10.97	207.91
▲	CM24-2	10.97	208.47
★	CM24-2	15.62	203.83

Date March 2009

Project W.O. 07-20016

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Chkd. MEF

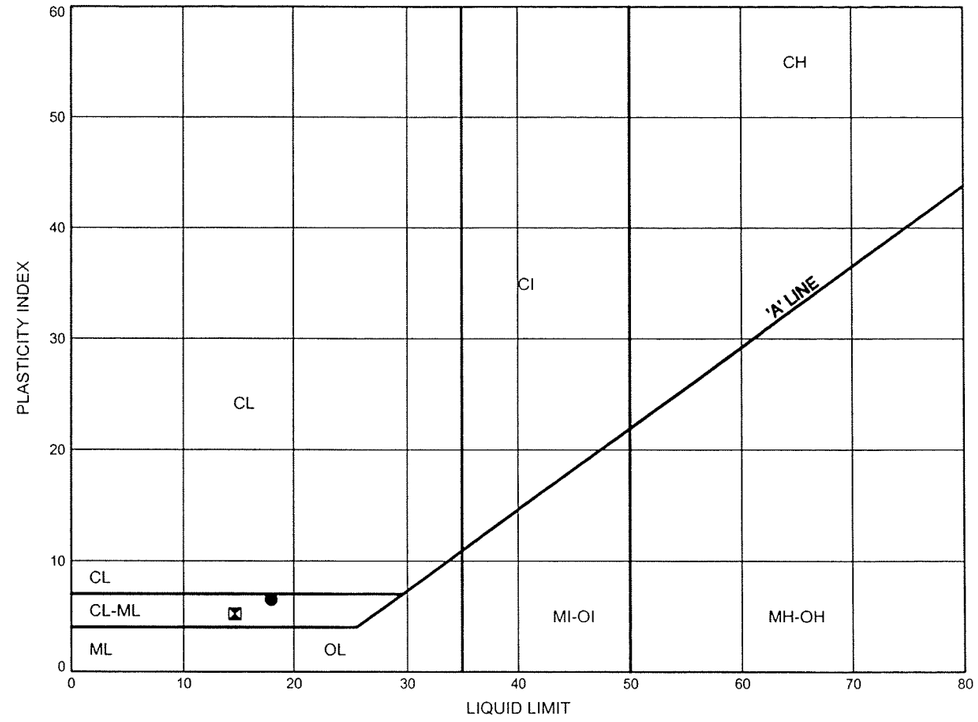
THURBALT 0510.GPJ 3/19/09

Hwy 407 East Extension - Central Section

ATTERBERG LIMITS TEST RESULTS

FIGURE CM23b/24-B6

CLAYEY SILT & SAND TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	CM24-1	3.35	215.53
⊠	CM24-2	7.92	211.52

Date March 2009

Project W.O. 07-20016

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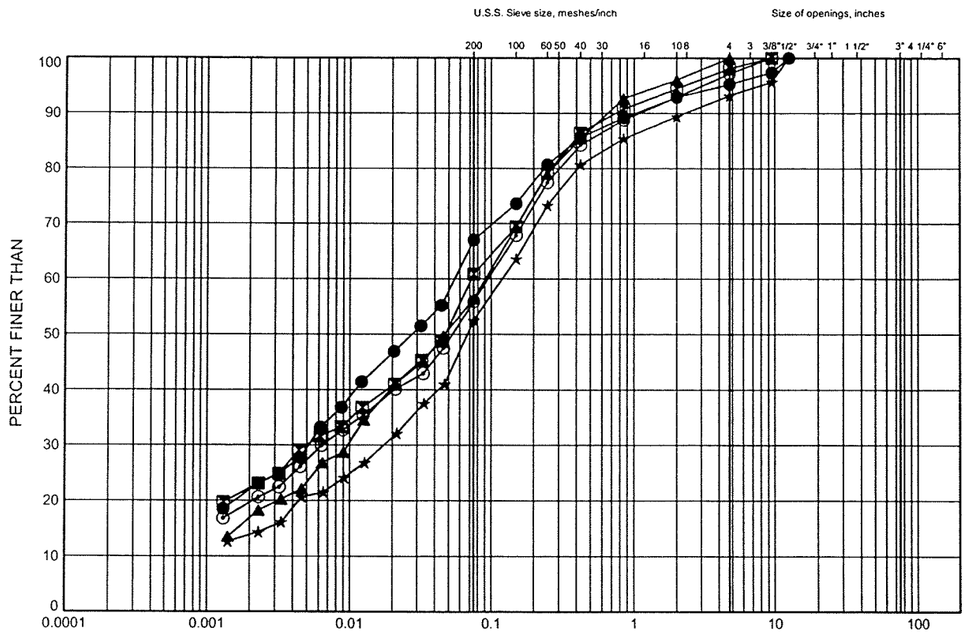
THURBALT 0510.GPJ 3/19/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM24-B1

CLAYEY SILT TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM24-3	2.59	220.51
⊠	CM24-3	12.50	210.60
▲	CM24-4	2.59	222.01
★	CM24-4	6.40	218.20
⊙	CM24-4	7.92	216.68

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Prepared By MFA
Checked By SKP

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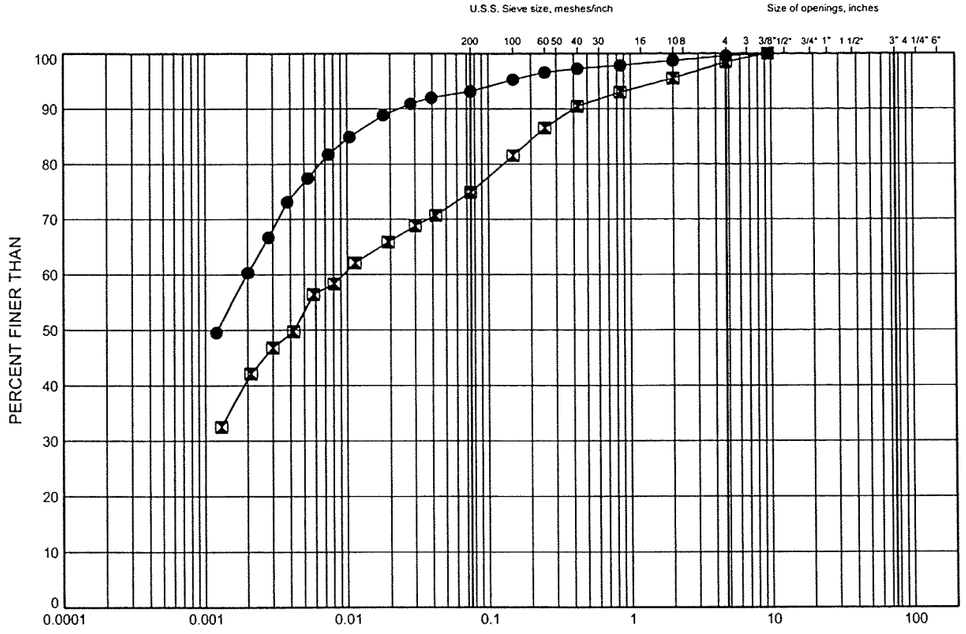
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 12/1/08

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM24-B2

SILTY CLAY TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM24-3	15.54	207.56
⊠	CM24-4	15.54	209.06

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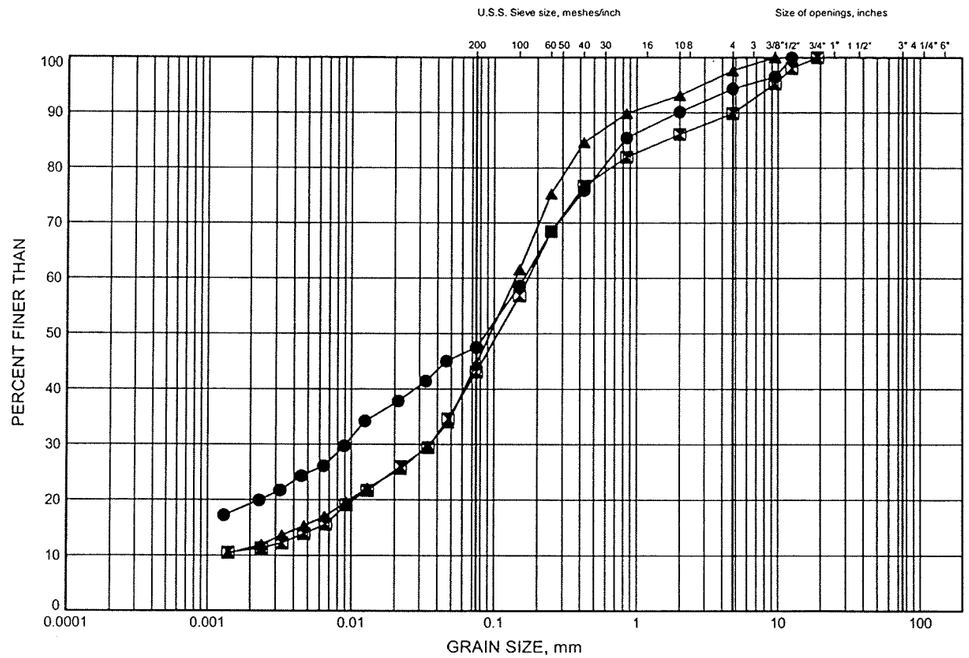
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 12/1/08

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM24-B3

SILTY SAND TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM24-3	7.92	215.18
⊠	CM24-3	18.59	204.51
▲	CM24-4	20.04	204.56

GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 12/1/08

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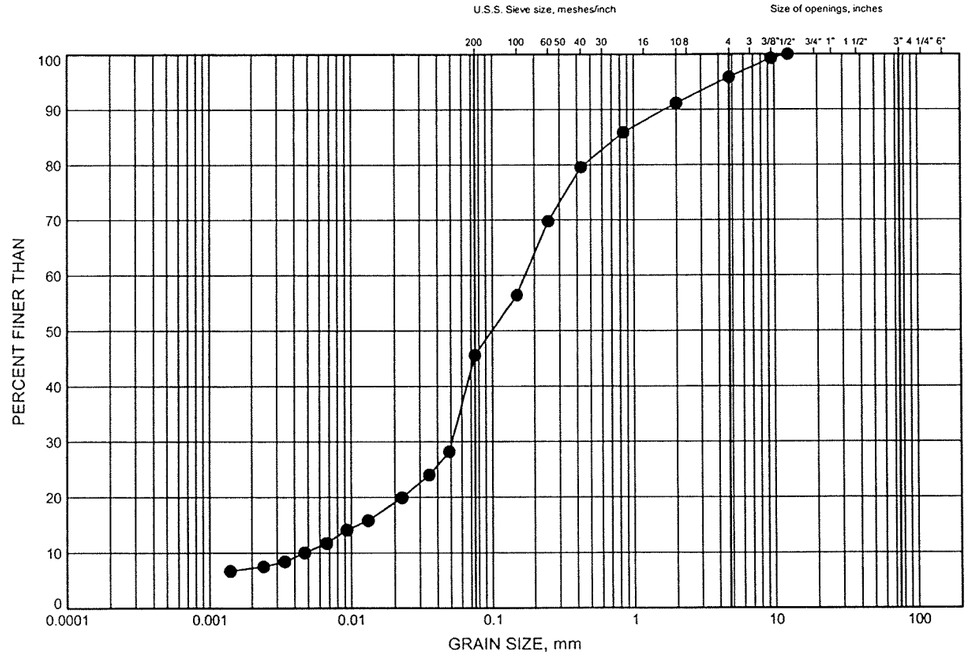
Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM24-B4

SAND AND SILT TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM24-3	24.69	198.41

GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 12/1/08

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Checked By SKP

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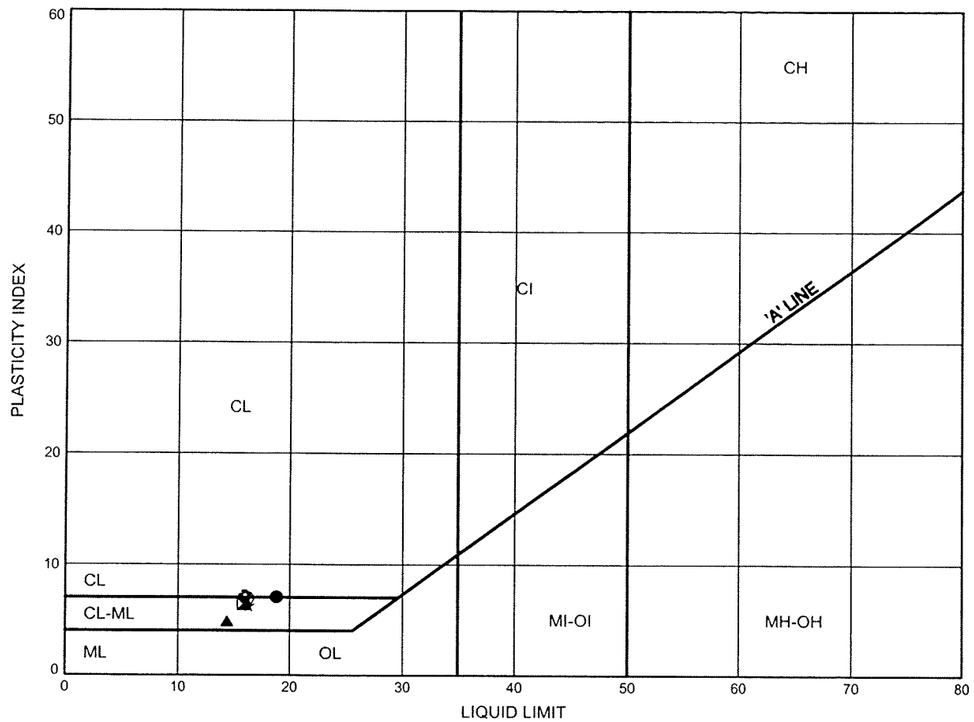
Hwy 407 East Extension - Central Section

ATTERBERG LIMITS TEST RESULTS

FIGURE CM24-B5

CLAYEY SILT TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	CM24-3	2.59	220.51
⊠	CM24-3	12.50	210.60
▲	CM24-4	1.83	222.77
★	CM24-4	2.59	222.01
⊙	CM24-4	6.39	218.21
✿	CM24-4	7.92	216.68

Date December 2008

Project W.O. 07-20016

THURBER

Prep'd MFA

Chkd. SKP

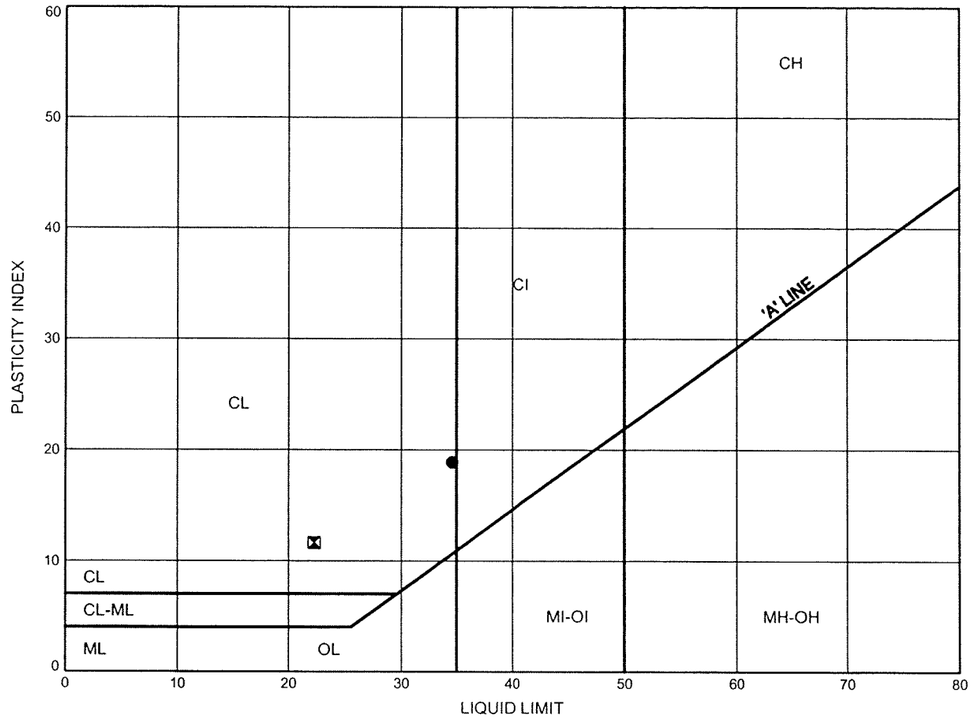
THURBALT 0510.GPJ 12/9/08

Hwy 407 East Extension - Central Section

ATTERBERG LIMITS TEST RESULTS

FIGURE CM24-B6

SILTY CLAY TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	CM24-3	15.54	207.56
⊠	CM24-4	15.54	209.06

Date December 2008

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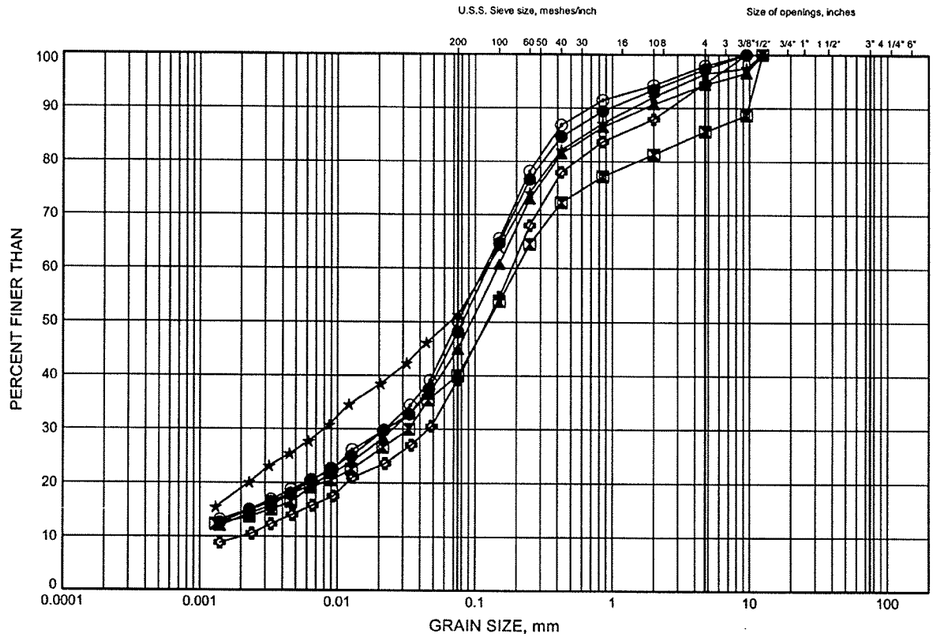
THURBALT 0510.GPJ 12/9/08

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM27-B1

SILTY SAND TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM27-1	2.59	206.29
⊠	CM27-1	7.92	200.96
▲	CM27-1	12.23	196.65
★	CM27-1	19.98	188.90
⊙	CM27-2	3.35	205.56
✿	CM27-2	7.92	200.99

W.P.# W.O. 07-20016
Prepared By AN
Checked By GFA

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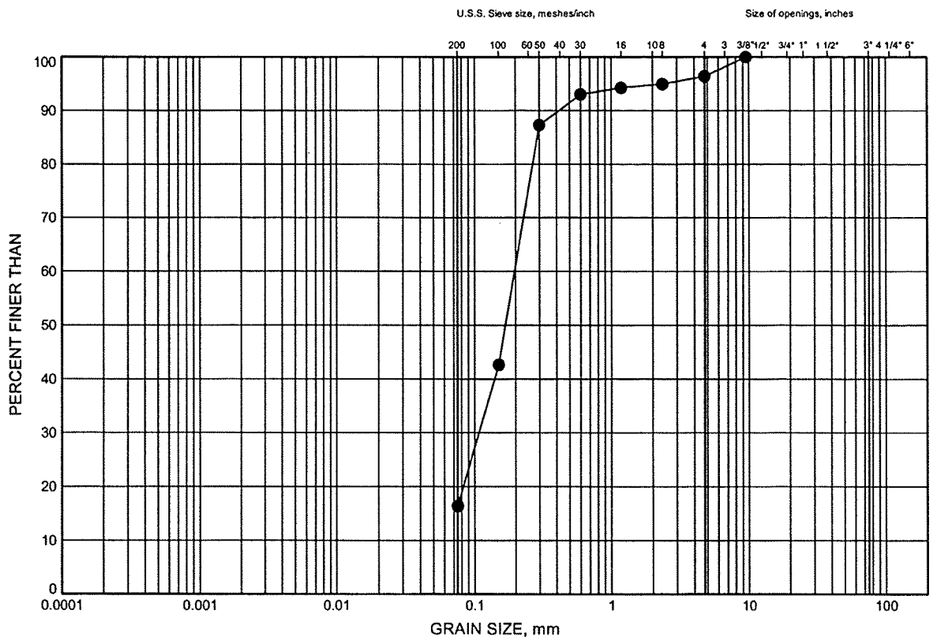
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 7/20/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM27-B2

SAND



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM27-2	15.47	193.45

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Prepared By AN
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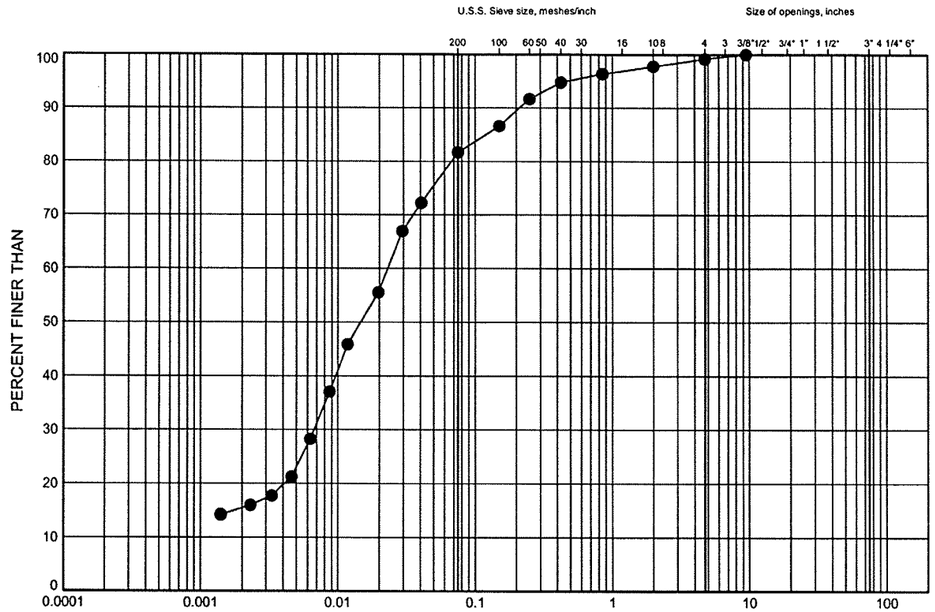
Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM27-B3

SILT



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM27-2	19.24	189.67

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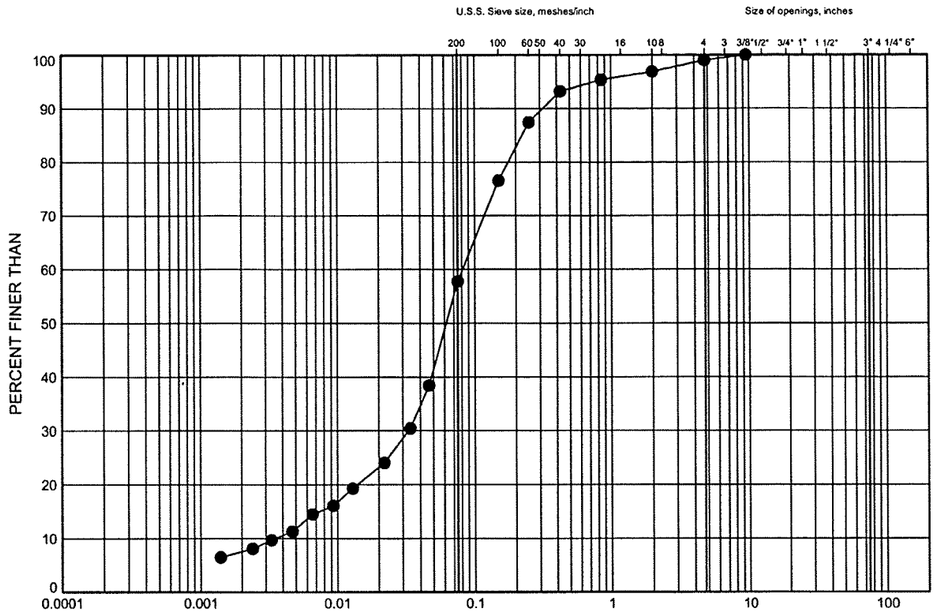
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 7/20/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM27-B4

SILT & SAND TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM27-2	22.90	186.02

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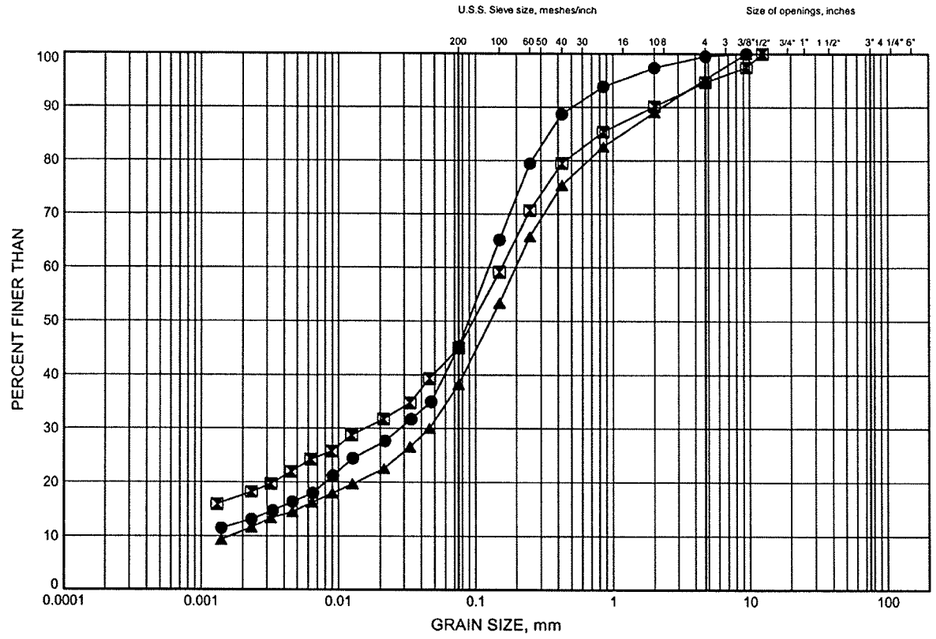
Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM28-B1

SILTY SAND TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM28-1	2.59	209.08
⊠	CM28-2	3.35	207.97
▲	CM28-2	7.80	203.52

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Prepared By AN
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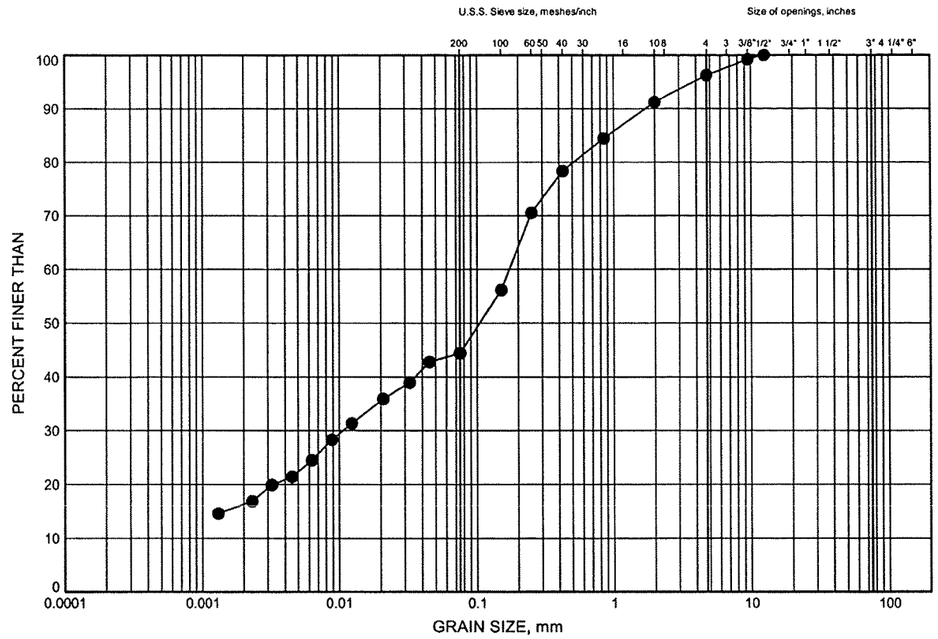
Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM28-B2

SILTY CLAY & SAND TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM28-1	6.28	205.39

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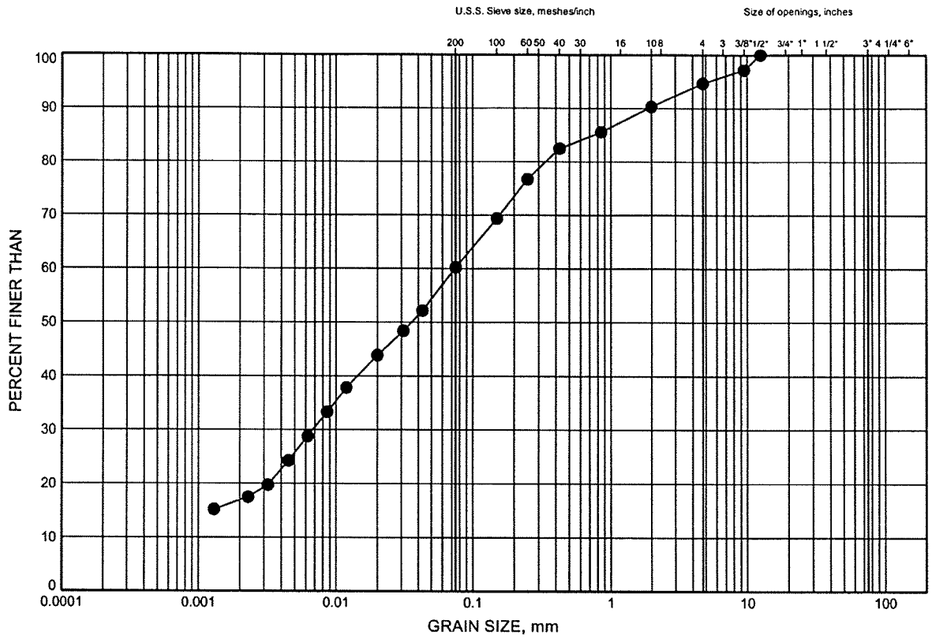
Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM28-B3

SANDY SILT TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM28-1	12.27	199.40

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Prepared By AN
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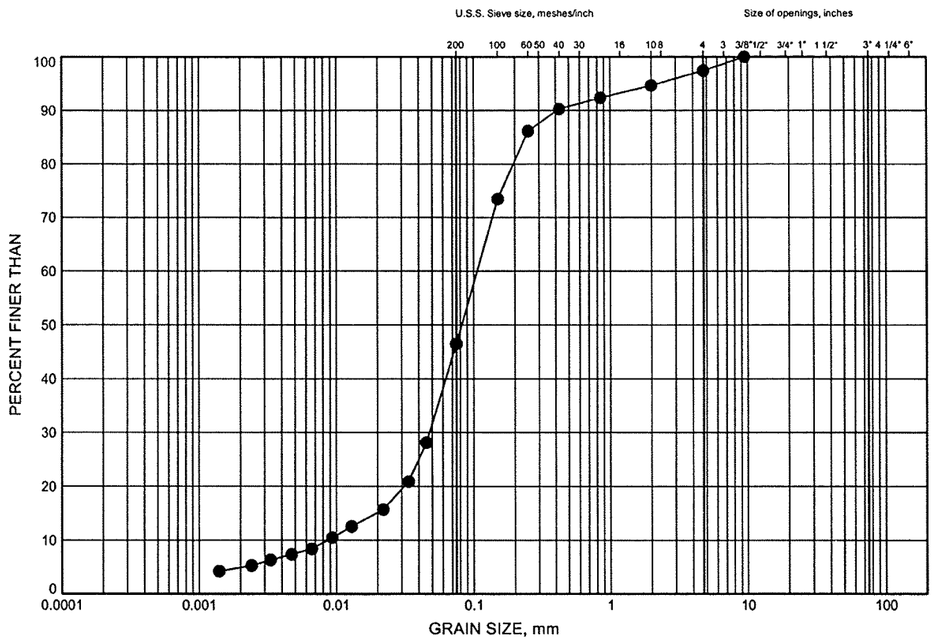
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 7/21/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM28-B4

SAND & SILT TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM28-2	10.74	200.58

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THURBER

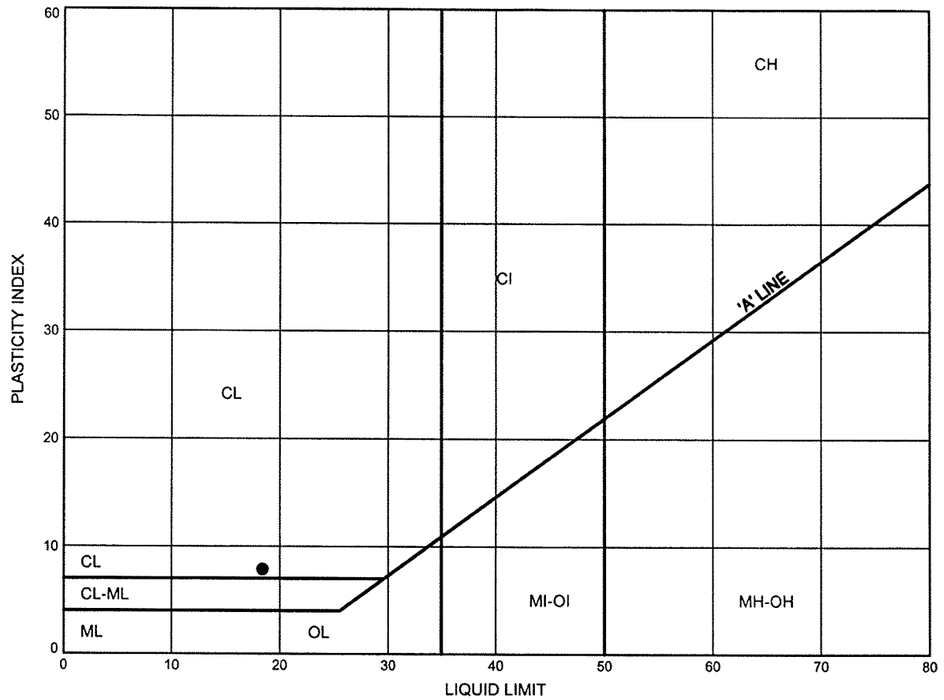
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 7/21/09

Hwy 407 East Extension - Central Section

ATTERBERG LIMITS TEST RESULTS

FIGURE CM28-B5

SILTY CLAY & SAND TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	CM28-1	6.28	205.39

Date July 2009

Project W.O. 07-20016

THURBER

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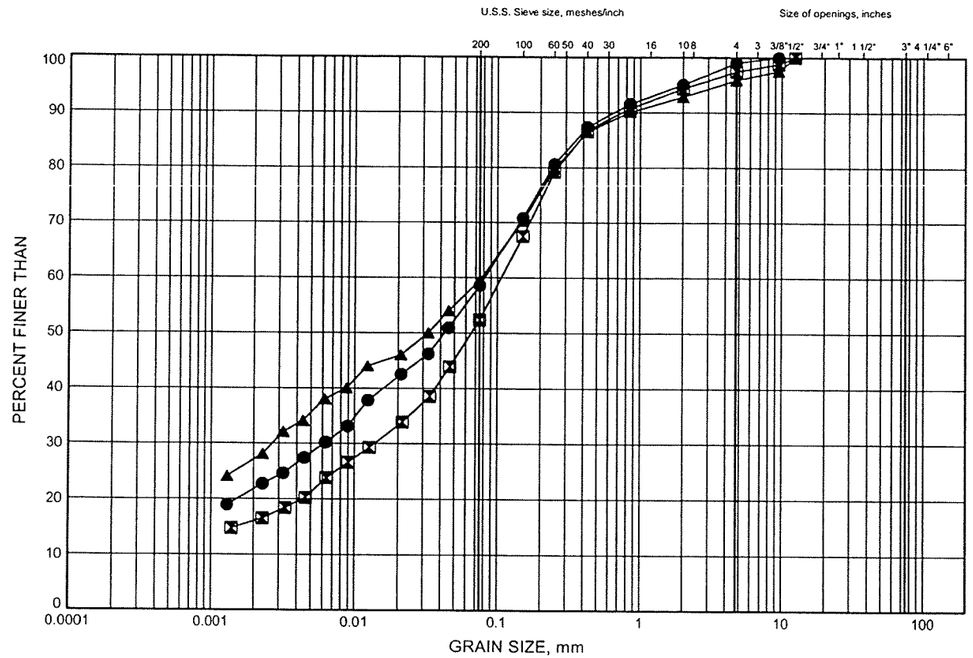
THURBALT 0510.GPJ 7/21/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM29-B1

SILTY CLAY



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM29b-1	3.35	201.37
⊠	CM29b-1	7.92	196.80
▲	CM29b-1	10.97	193.75

W.P.# W.O. 07-20016
Prepared By AN
Checked By MEF

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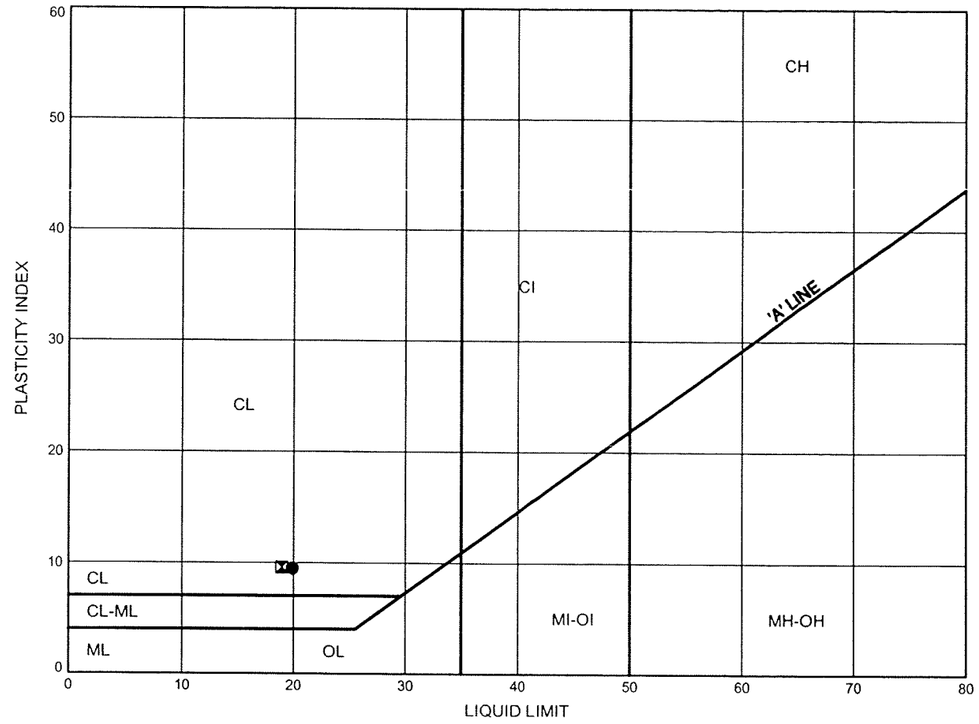
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 11/27/08

Hwy 407 East Extension - Central Section

ATTERBERG LIMITS TEST RESULTS

FIGURE CM29-B2

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	CM29b-1	3.35	201.37
⊠	CM29b-1	10.97	193.75

Date November 2008
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THURBER

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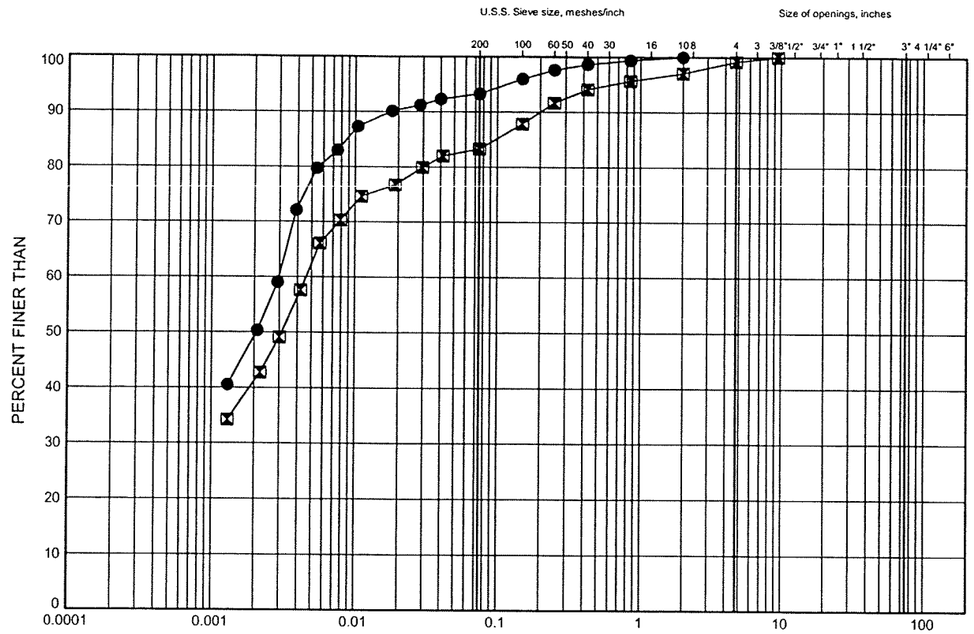
THURBALT 0510.GPJ 11/27/08

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM29-B3

SILTY CLAY TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM29-1	17.07	187.71
⊠	CM29b-1	18.59	186.13

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Prepared By AN
Checked By MEF

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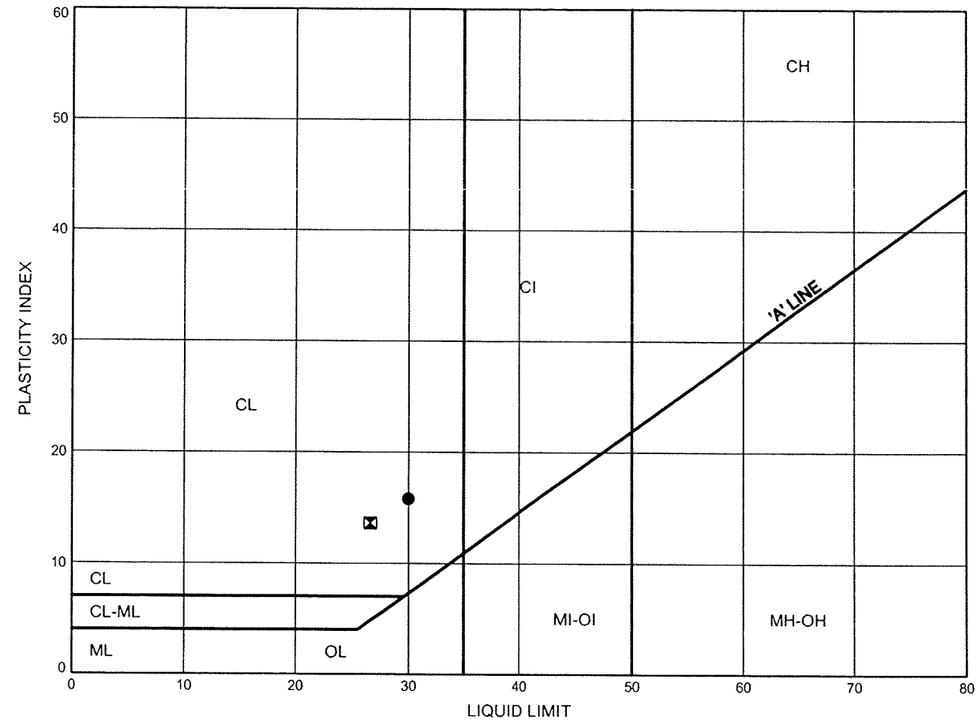
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 11/27/08

Hwy 407 East Extension - Central Section

ATTERBERG LIMITS TEST RESULTS

FIGURE CM29-B4

SILTY CLAY TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	CM29-1	17.07	187.71
⊠	CM29b-1	18.59	186.13

Date November 2008
Project W.O. 07-20016

THURBER

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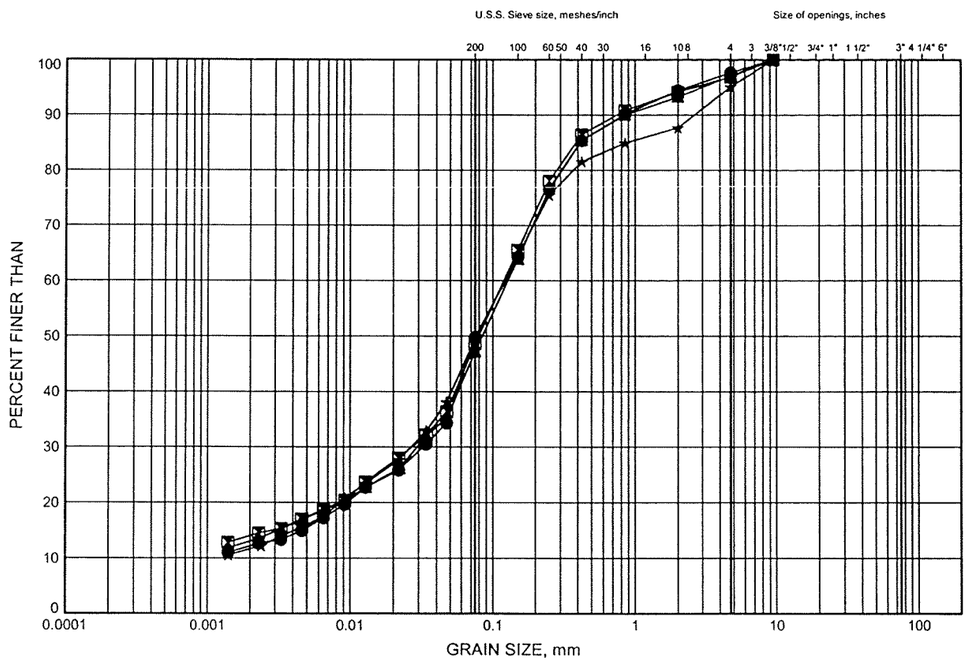
THURBALT 0510.GPJ 11/27/08

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM29-B5

SAND AND SILT TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM29-1	2.59	202.19
⊠	CM29-1	6.40	198.38
▲	CM29-1	9.45	195.33
★	CM29b-1	22.92	181.80

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Prepared By AN
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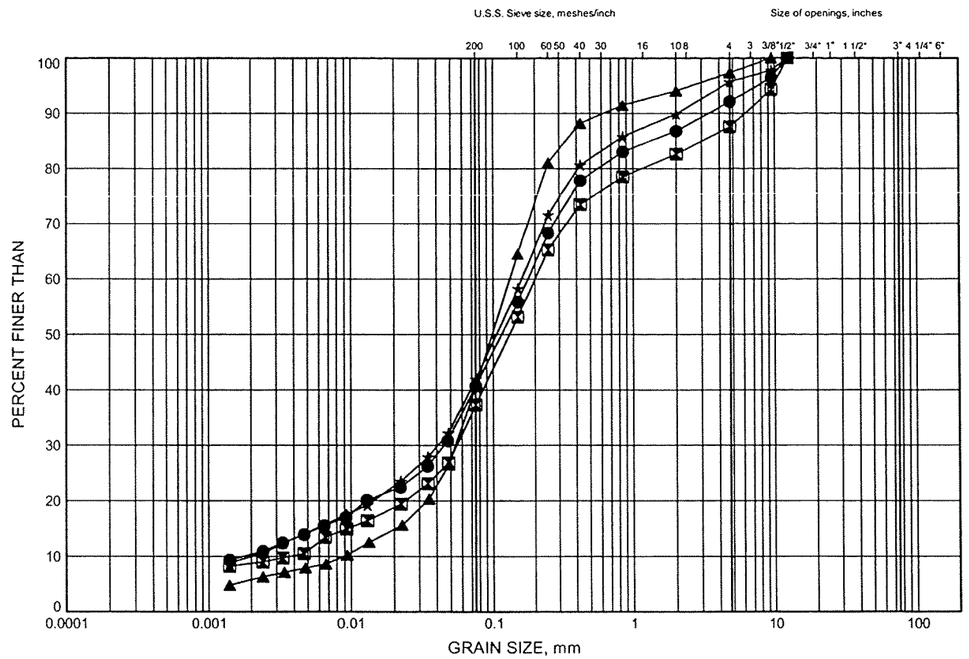
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 11/27/08

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM29-B6

SILTY SAND TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM29-1	13.91	190.87
⊠	CM29-1	19.95	184.83
▲	CM29-1	23.16	181.62
★	CM29b-1	14.02	190.70

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Prepared By AN
Checked By SKP

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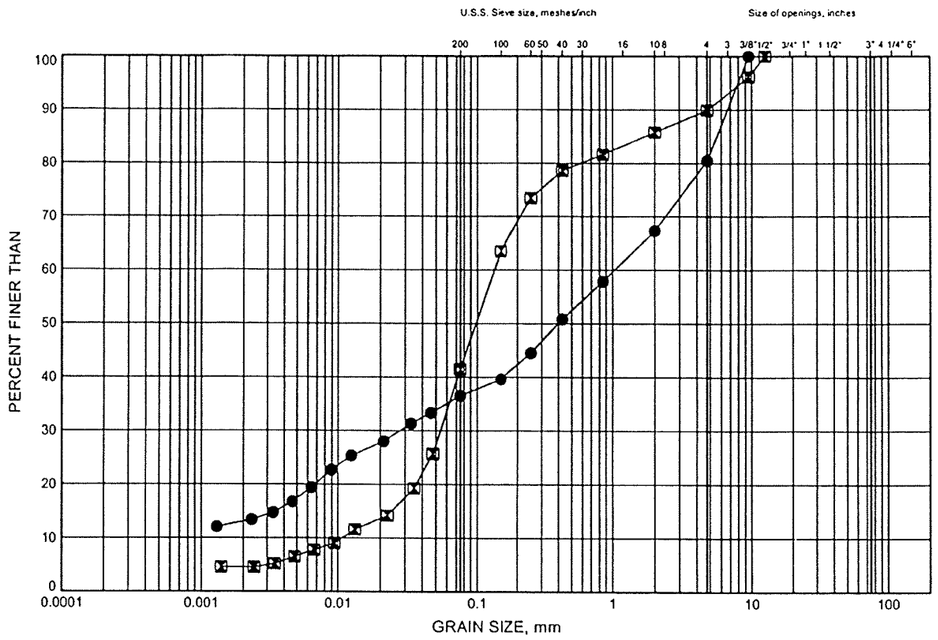
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 12/5/08

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM29d-B1

SILTY SAND



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM29d-1	3.35	195.25
⊠	CM29d-2	3.35	194.95

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Prepared By AN
Checked By LT

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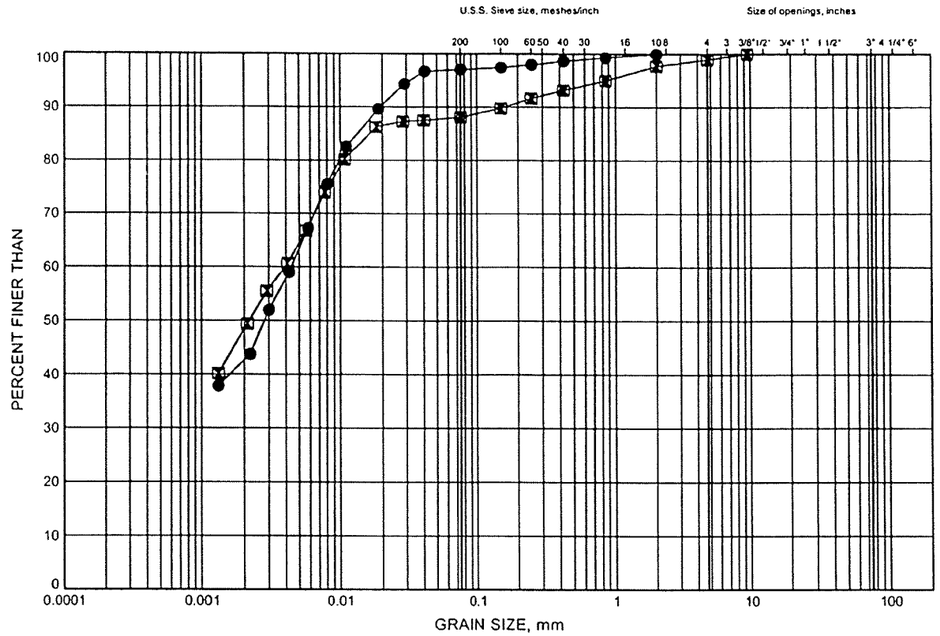
Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM29d-B2

SILTY CLAY



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM29d-1	6.40	192.20
⊠	CM29d-2	7.92	190.38

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Prepared By AN
Checked By LT

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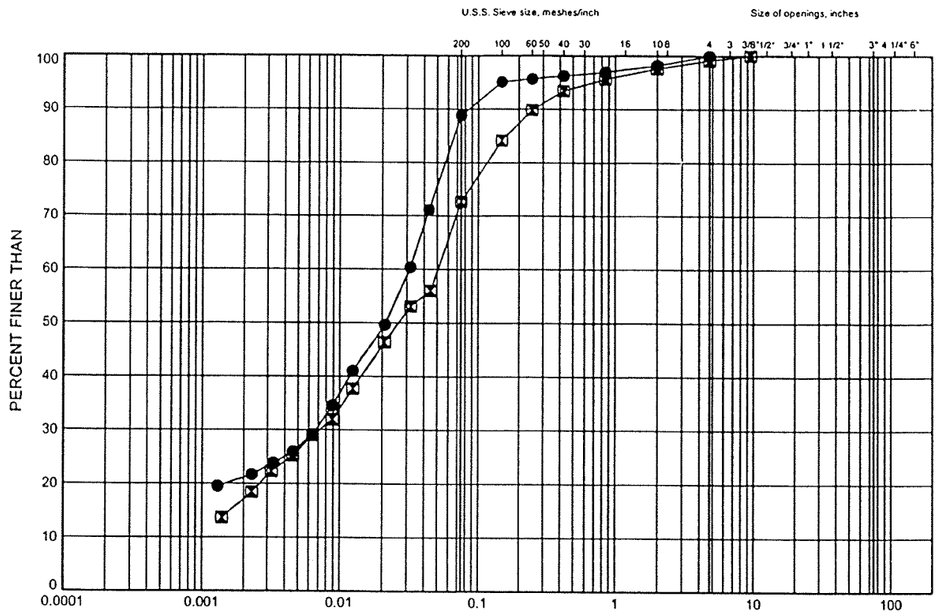
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 8/13/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM29d-B3

SILT
some sand to sandy



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM29d-1	12.50	186.11
⊠	CM29d-2	12.50	185.80

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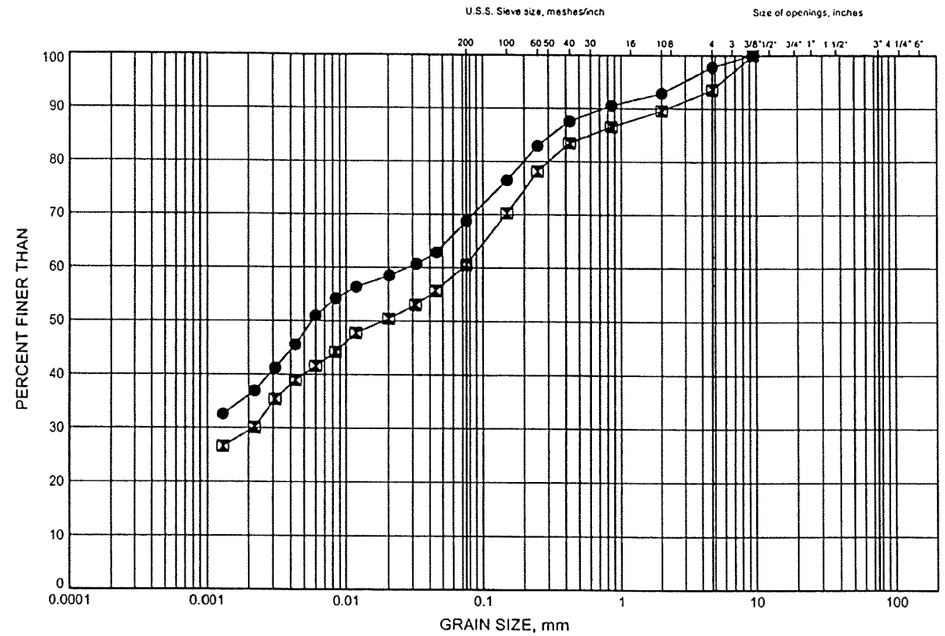
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 8/13/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CM29d-B4

SANDY, SILTY CLAY TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CM29d-1	15.54	183.06
⊠	CM29d-2	17.07	181.23

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Prepared By AN
Checked By LT

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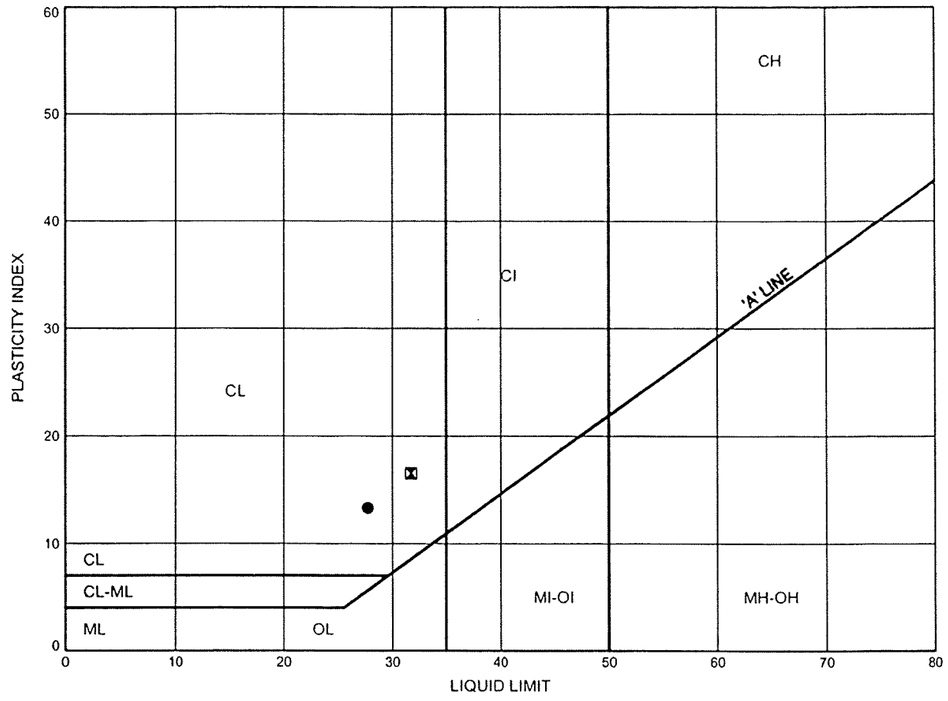
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 8/13/09

Hwy 407 East Extension - Central Section

ATTERBERG LIMITS TEST RESULTS

FIGURE CM29d-B5

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	CM29d-1	6.40	192.20
⊠	CM29d-2	7.92	190.38

THURBALT 0510.GPJ 8/13/09

Date August 2009

Project W.O. 07-20016

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Prep'd AN

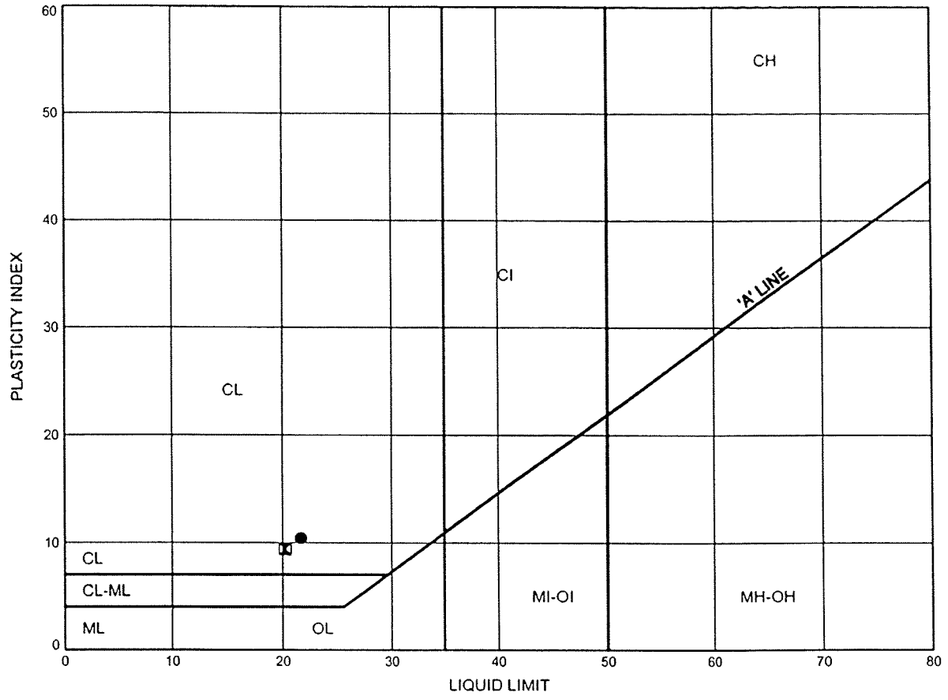
Chkd. LT

Hwy 407 East Extension - Central Section

ATTERBERG LIMITS TEST RESULTS

FIGURE CM29d-B6

SILTY CLAY TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	CM29d-1	15.54	183.06
⊠	CM29d-2	17.07	181.23

THURBALT 0510.GPJ 8/13/09

Date August 2009

Project W.O. 07-20016

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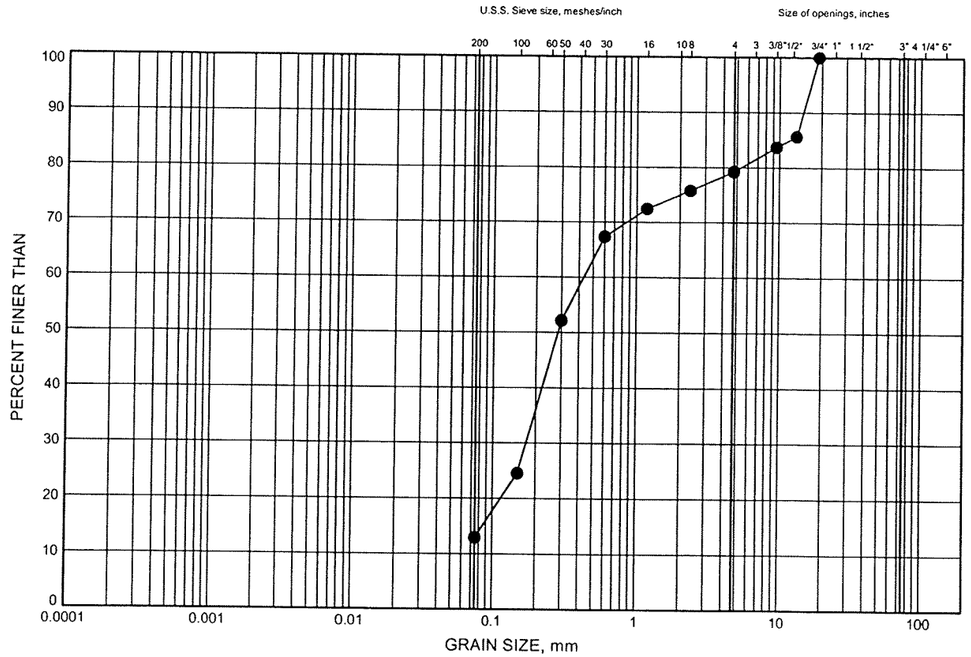
Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CF-B1

GRAVELLY SAND



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CCM-05	4.88	215.42

W.P.# W.O. 07-20016
Prepared By MFA
Checked By MRA

THURBER

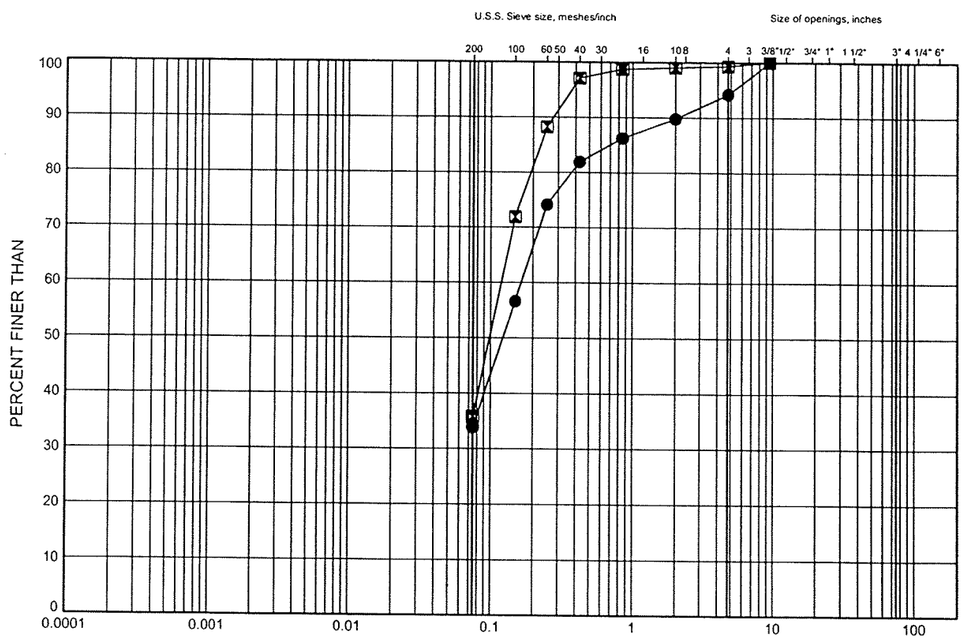
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 3/6/09

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CF-B2

SILTY SAND



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CCM-04	1.75	236.70
⊠	CCM-04	4.79	233.66

W.P.# W.O. 07-20016
Prepared By MFA
Checked By MRA

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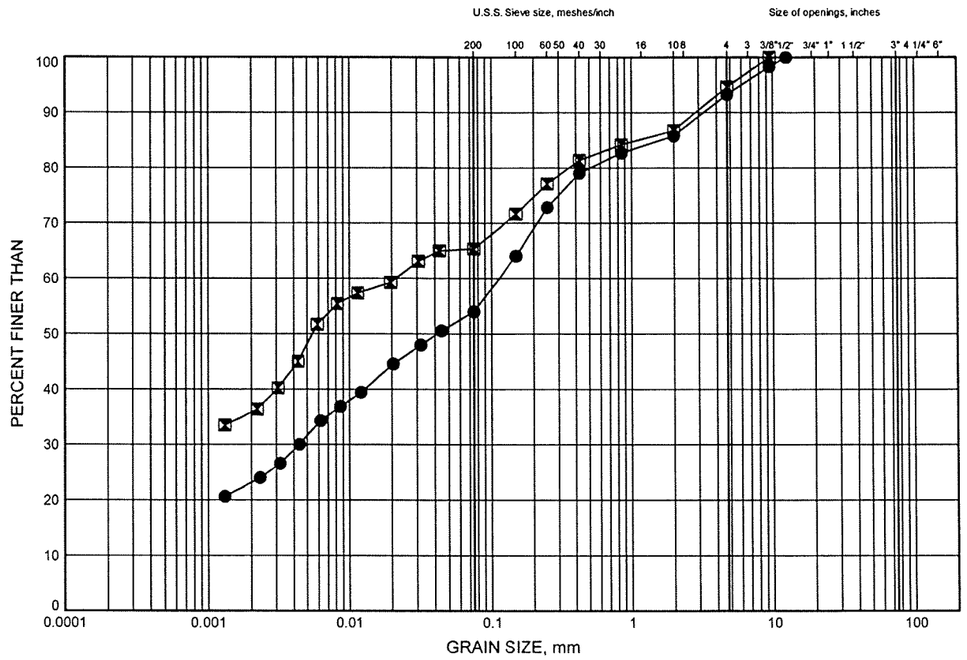
Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CF-B3

SILTY CLAY TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CCM-03	1.83	235.27
⊠	CCM-03	3.35	233.75

W.P.# W.O. 07-20016
Prepared By MFA
Checked By MEF

THURBER

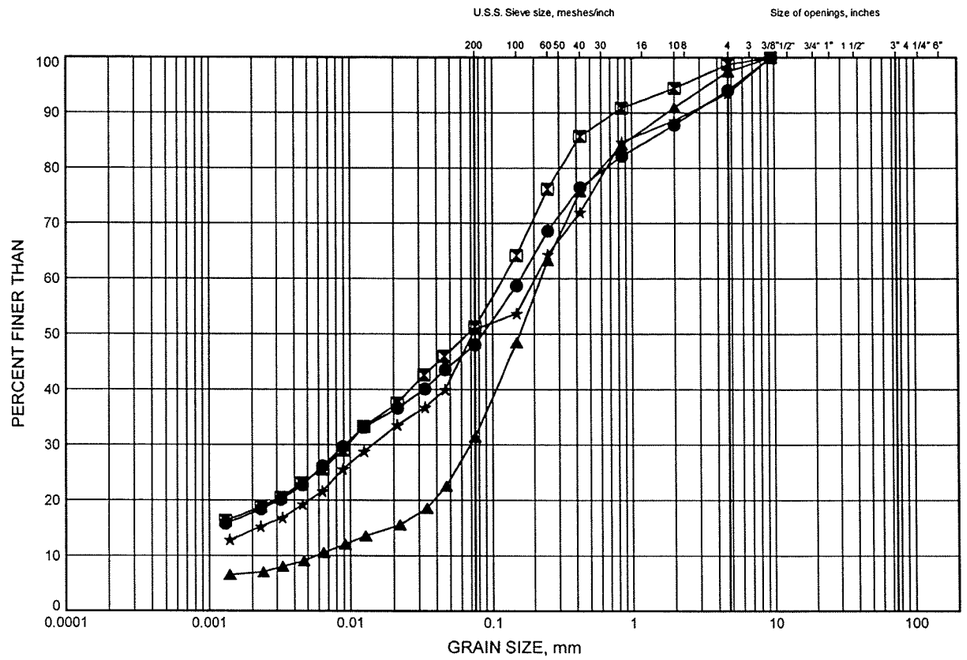
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 4/22/10

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CF-B4

SILTY SAND TO SANDY SILT TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CCM-03	7.70	229.40
⊠	CCM-04	7.67	230.78
▲	CCM-05	1.83	218.47
★	CCM-05	9.35	210.95

W.P.# W.O. 07-20016
Prepared By MFA
Checked By MEF

THURBER

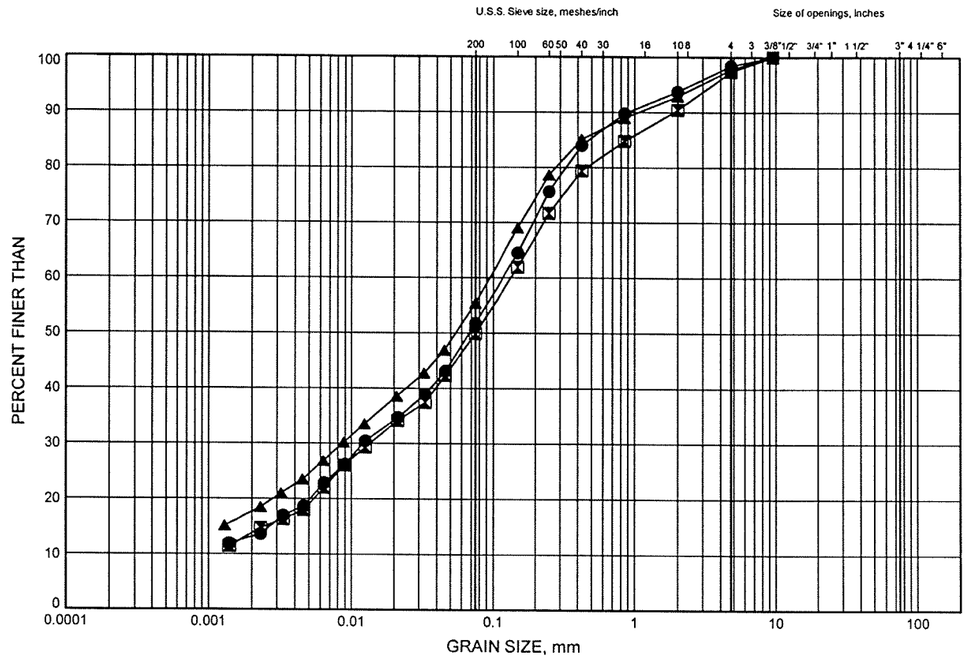
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 4/22/10

Hwy 407 East Extension - Central Section

GRAIN SIZE DISTRIBUTION

FIGURE CF-B5

SILTY SAND TO SANDY SILT TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CCM-06	1.73	215.87
⊠	CCM-06	4.88	212.72
▲	CCM-06	7.92	209.68

W.P.# W.O. 07-20016
Prepared By MFA
Checked By MEF

THURBER

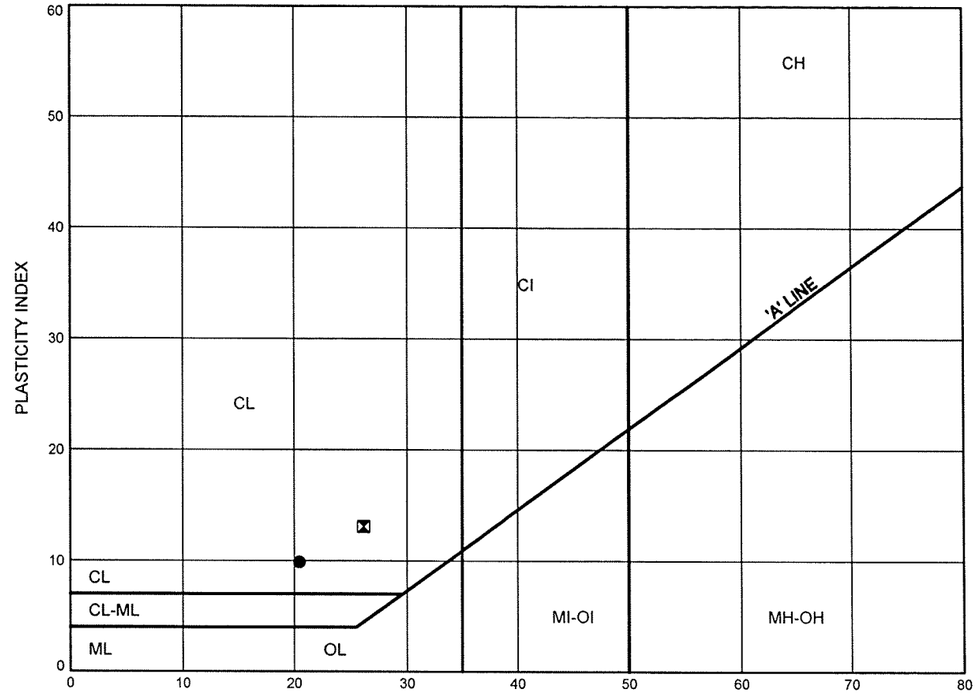
GRAIN SIZE DISTRIBUTION - THURBER 0510.GPJ 4/22/10

Hwy 407 East Extension - Central Section

ATTERBERG LIMITS TEST RESULTS

FIGURE CF-B6

SILTY CLAY TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	CCM-03	1.83	235.27
⊠	CCM-03	3.35	233.75

Date April 2010
Project W.O. 07-20016

THURBER

Prep'd MFA
Chkd. MEF

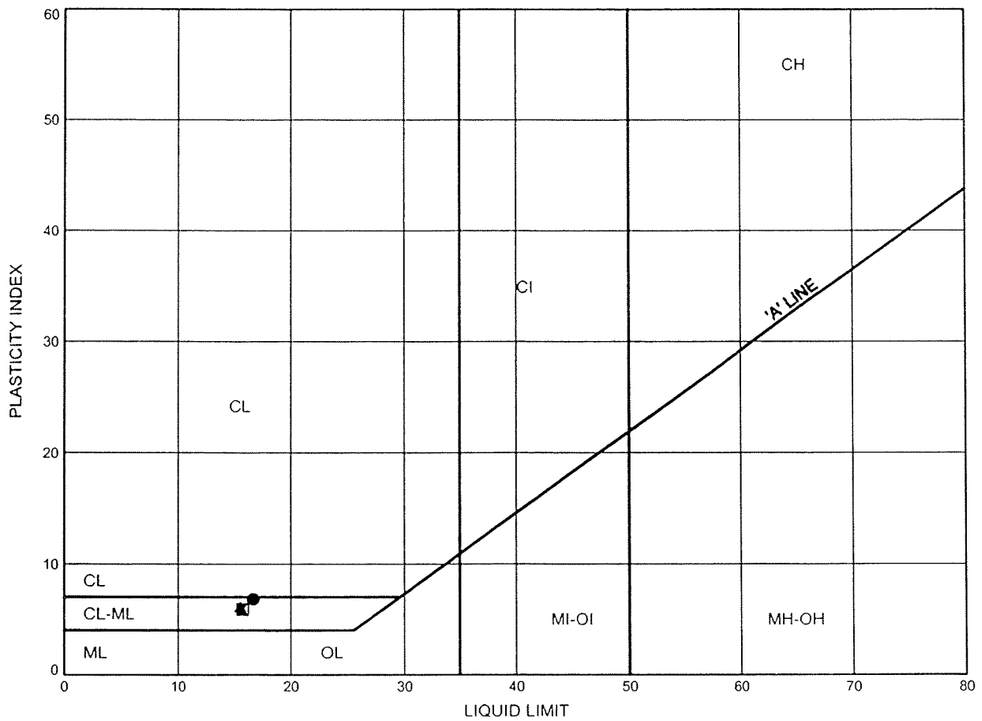
THURBALT 0510.GPJ 4/22/10

Hwy 407 East Extension - Central Section

ATTERBERG LIMITS TEST RESULTS

FIGURE CF-B7

SAND AND SILT TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	CCM-05	9.35	210.95
⊠	CCM-06	4.88	212.72
▲	CCM-06	7.92	209.68

Date March 2009

Project W.O. 07-20016

THURBER

Prep'd MFA

Chkd. MRA

THURBALT 0510.GPJ 3/6/09

APPENDIX C

RECORD OF BOREHOLE SHEETS FROM GEOCRES REPORTS

Ministry of Transportation
Ontario

Foundation Design

RECORD OF BOREHOLE No P26 1 OF 1 METRIC

W.P. 326-88-01 LOCATION Coords.: N 4 869 399.7, E 359 124.9 ORIGINATED BY LO
DIST 6 HWY 407 BOREHOLE TYPE Solid Stem COMPILED BY LO
DATUM Geodetic DATE 1994 05 25 CHECKED BY KA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
210.8	Ground Surface							o UNCONFINED + FIELD VANE • QUICK TRIAXIAL × LAB VANE			
0.0	Silty Sand to Sandy Silt Trace of Clay, Trace of Gravel V. Dense (Glacial Till)		1	SS	135	▼	210				
			2	SS	150		208				
			3	SS	138		206				
200.8			4	SS	150 /15cm		204				
9.8	Clayey Silt Some Sand, Some Gravel Hard (Glacial Till)		5	SS	150 /18cm		202				
			6	SS	150 /18cm		200				
			7	SS	138		198				
			8	SS	150 /15cm		196				
193.6			9	SS	150 /15cm		194				
16.9	End of Borehole										

+³, ×⁵ : Numbers refer to Sensitivity 20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

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RECORD OF BOREHOLE No P27 1 OF 1 METRIC

W.P. 326-88-01 LOCATION Coords.: N 4 869 259.2, E 360 032.5 ORIGINATED BY LO
DIST 6 HWY 407 BOREHOLE TYPE Solid Stem / Hollow Stem COMPILED BY LO
DATUM Geodetic DATE 1994 05 30 CHECKED BY KA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
205.4	Ground Surface							o UNCONFINED + FIELD VANE • QUICK TRIAXIAL × LAB VANE			
0.0	Silty Sand to Sandy Silt Trace of Clay, Trace of Gravel Dense to V. Dense (Glacial Till)					DRY •					
			1	SS	33		204				
			2	SS	105		202				
			3	SS	150 /27cm		200				
			4	SS	89		198				
			5	SS	70						
195.8			6	SS	116		196				
9.6	End of Borehole										

+³, ×⁵ : Numbers refer to Sensitivity 20 / 15 ◇ 5 (%) STRAIN AT FAILURE