PRELIMINARY FOUNDATION INVESTIGATION
AND DESIGN REPORT

HIGHWAY 427 EXPANSION PROJECT
EXTENSION FROM HIGHWAY 7 TO MAJOR MACKENZIE DRIVE
CITY OF VAUGHAN, ONTARIO
ASSIGNMENT NO.: 2014-E-0056
WORK ORDER NO. 18

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GEOCRES NO: 30M13-216

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March 2016

PML Ref.: 15TF013A
Index No.: 026FIDR

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PRELIMINARY FOUNDATION INVESTIGATION REPORT (GENERAL)

HIGHWAY 427 EXPANSION PROJECT
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1.0 INTRODUCTION

Peto MacCallum Limited (PML) has been retained by AECOM Canada (AECOM) under the Ministry of Transportation, Ontario (MTO) Work Order No.18 (WO No. 18), as specialist sub-consultant to provide preliminary Foundation Engineering services for the proposed expansion of Highway 427.

This preliminary Foundation Investigation and Design Report provides information for planning purposes at the locations of nine (9) structures and five (5) high fill areas within the extension section of the project as described in Section 2.0 of this report. A separate report will address the widening section of the project. The project limits and general location of each structure and high fill area are shown on the Site Location Plan on Drawing 1.

The Terms of Reference and Scope of Work for the Foundation Engineering services are outlined in the MTO WO No. 18 under Agreement No. 2014-E-0056, issued on June 22, 2015 and the PML revised proposal, dated August 21, 2015.

This report is based on a desktop study of available GEOCRES reports and supplemental boreholes advanced by PML. The Design-Builder shall satisfy himself as to the sufficiency of the subsurface information and supplement the information as needed to meet the detail design requirements. The existing subsurface investigations must be reviewed at the time of detail design to determine if they meet the then-current MTO requirements for the structure type and span configuration.

2.0 PROJECT DESCRIPTION

The Highway 427 expansion consists of widening a 4 km long section of the existing freeway from the Canadian National Railway (CNR) corridor south of Albion Road to Highway 7 and a 6.6 km northerly extension of the existing freeway from Highway 7 to Major Mackenzie Drive in the City of Toronto and the City of Vaughan. The freeway will be widened by 2 lanes in each direction from the CNR corridor south of Albion Road to Highway 7. The northerly extension of the freeway includes the construction of 8 lanes from Highway 7 to Rutherford Road and 6 lanes from Rutherford Road to Major Mackenzie Drive.

The extension section includes nine (9) structures and five (5) high fill areas. As part of Highway 427 northerly extension, the existing Langstaff Road and Major Mackenzie Drive grade will be modified and new bridge structures are proposed to carry the roadways over Rainbow Creek and West Robinson Creek, respectively.

The overall Highway 427 alignment is oriented in a south-north direction. In general, the surface topography along the Highway 427 alignment is relatively flat to gently sloping toward the south, with sparsely to densely treed areas in the vicinity of the Rainbow and West Robinson creeks. Commercial, residential, and industrial developments exist on both sides of the Highway 427 alignment from the southern limit of the project to north of Zenway Boulevard. Farm lands are present within the northern section of the Highway 427 alignment, from north of Zenway Boulevard to the northern limit of the project. A Canadian Pacific Railway (CPR) corridor traverses the northern section of the Highway 427 extension alignment.

3.0 INVESTIGATION PROCEDURES

3.1 Previous Foundation Investigations

Ten (10) GEOCRES reports were available for the structures and high fill areas within the Highway 427 extension section. As part of the previous investigations, sixty-four (64) boreholes were advanced for the proposed nine (9) structures and five (5) high fill areas between February and April, 2009. Eleven (11) piezometers were installed in selected boreholes for the structures and high fill areas. The details of these investigations are summarized in the existing GEOCRES reports.

3.2 Current Foundation Investigation

The existing GEOCRES reports were reviewed and new boreholes were advanced to supplement the existing subsurface information. The level of investigative effort for the current investigation was assigned by MTO in the WO No. 18. Three (3) contingency boreholes were added to the originally assigned investigative effort assigned in the WO No. 18.

The fieldwork was carried out between September 28 and December 8, 2015, during which time a total of twenty-one (21) boreholes were advanced for the structures to depths ranging from 9.6 m to 58.0 m. The Record of Borehole sheets are contained in site-specific appendices following the preliminary Foundation Investigation and Design Report (FIDR) sheets. The locations of these boreholes together with the boreholes from previous investigations are shown in plan on FIDR sheets for each structure.

The boreholes were laid out by J.D. Barnes Ltd., Ontario Land Surveyors contracted by PML or by PML and surveyed in MTM NAD 83 northing and easting coordinates. Where borehole locations had to be moved, the as-drilled locations were surveyed by PML in reference to the laid out locations.

The field investigation was carried out using truck-mounted and track-mounted drill rigs supplied and operated by Davis Drilling Ltd. of Milton, Ontario and Tri-Phase Group of Mississauga, Ontario. The boreholes were advanced using hollow stem augers or tri-cone using mud rotary drilling techniques. Generally, soil samples were obtained at ground surface and then at intervals of depth of 0.75 m to 3.0 m, using a nominal 50 mm outer diameter split-spoon sampler driven by an automatic hammer in accordance with Standard Penetration Test (SPT) procedures. All boreholes, except Boreholes MMD-2 and MMD-3, WRB-1 and WRB-2 were advanced at least 3 m into the “refusal” stratum, defined as a material for which SPT ‘N’-values exceed 100 blows per 0.3 m of penetration. Boreholes MMD-2 and MMD-3 were drilled to a depth of 30.0 m and Dynamic Cone Penetration Tests (DCPT) were advanced further from the bottom of boreholes to refusal at 37.2 m and 35.7 m depths, respectively. Although the refusal criteria had been reached at higher levels, Boreholes WRB-1 and WRB-2 were further advanced to depths of 23.3 m and 14.2 m and DCPTs were advanced from the bottom of boreholes to refusal at depths of 27.5 m and 15.7 m, respectively to verify the compactness conditions at the sites.

Where possible, the groundwater conditions in the open boreholes (or inside the augers) were observed during and upon completion of drilling. Piezometers were installed in Boreholes MMD-2 and MMRC-1 to permit monitoring of the groundwater level at these locations. The piezometers consist of nominal 50 mm diameter PVC pipes with slotted screens, surrounded with filter sand and seals placed at selected depths within the boreholes. The boreholes and annulus surrounding the riser pipes above the screen were backfilled to the ground surface with bentonite pellets. All other open boreholes were backfilled upon completion of drilling in accordance with Ontario Regulation 903, as amended by O.Reg 331/B.

Full-time supervision of the fieldwork was conducted by PML engineering staff members who monitored the sampling and in situ testing operations, tied in borehole locations to existing site features and logged the boreholes. PML engineering staff also arranged for the clearance of underground services and appropriate permit applications.

3.3 Laboratory Analysis

The soil samples were identified in the field in accordance with the MTO Soil Classification procedures and transported to the Toronto PML laboratory for further visual classification and testing. Classification testing (water content determination (320), grain size distributions (94) and Atterberg limits (76) was carried out on selected soil samples. Only index property testing of the soils was conducted and no complex testing (consolidation tests, triaxial tests) was carried out.

4.0 SITE GEOLOGY AND STRATIGRAPHY

4.1 Regional Geology

The Highway 427 alignment within the project limits lies within the physiographic region known as the Peel Plain, as delineated in *The Physiography of Southern Ontario* (Chapman and Putnam, 1984). A surficial till sheet, which generally follows the surface topography, is present throughout much of this area. The till is typically comprised of clayey silt to silty clay, with scatter silt to sand zones. Shallow, localized deposits of loose sand, silt and/or soft clay scatteredly overlie the till sheet, and represent relatively recent deposits, formed in small glacial meltwater ponds throughout the Peel Plain and often near river valleys. The glacial till sheet is underlain by discontinuous seams of gravel, sand and silt. The site is underlain by grey shale bedrock of the Georgian Bay Formation, which is generally highly weathered in its upper portion.

4.2 Site Specific Descriptions and Subsurface Conditions

Each structure category (underpass, overpass, bridge) and location, site complexity rating (level of investigative effort), and relevant GEOCRES Report with specific boreholes advanced as part of the previous and/or current investigations along with the information for high fill areas are summarized in Table A1 following the text of this report.

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 FIR sheets contained in Part C of this report. The detailed subsurface and groundwater conditions as encountered in the boreholes advanced during the current investigation and the results of geotechnical laboratory tests carried out on selected soil samples are given on the Record of Borehole sheets and laboratory test results figures included in the relevant appendices for each structure. A copy of the Record of Borehole sheets and laboratory test results figures from the previous investigations are also included in the relevant appendices.

Occurrence of sloughing of the borehole sidewalls upon completion of drilling was noted and recorded in the Record of Borehole sheets. Where cave-in was noted during drilling, the boreholes remained open by filling the borehole with water. At some locations, with deep boreholes where sloughing was encountered mud rotary drilling was implemented.

It should be noted that the stratigraphic boundaries shown on the Record of Borehole sheets and on the interpreted stratigraphic sections are inferred from non-continuous sampling and represent transitions between soil types rather than exact planes of geologic change. The subsoil conditions will vary between and beyond the borehole locations.

Till deposits in southern Ontario typically contain cobbles and/or boulders. Auger grinding, hard drilling and split-spoon sampler bouncing are noted on the Record of Borehole sheets and may suggest the presence of cobbles and/or boulders within the till deposit.

4.3 Groundwater Conditions

Where the drilling techniques allowed, the groundwater level was observed in open boreholes during and upon completion of drilling. The groundwater level measurements in boreholes and piezometers are contained in Table A2 of this report.

It should also be noted that the groundwater level is subjected to seasonal fluctuations in response to precipitation events and snow melt and is generally expected to be higher during the spring season and thereafter periods of heavy rainfall.

It should be noted that the sub-artesian conditions were encountered at specific sites and typically occurs where a cohesionless soil deposit at depth is overlaid by impervious cohesive clayey silt/silty clay till. The details of the artesian conditions are included in the individual FIR sheets contained in Part C of this report, where applicable.

5.0 CLOSURE

This preliminary Foundation Investigation Report was prepared by Mr. Al Varshoi, MESc, P.Eng, and Ms. Marzieh Kamranzadeh, MSc, EIT and reviewed by Mr. Brian R. Gray, MEng, P.Eng. Principal Consultant. The report was independently reviewed by Mr. Carlos M. P. Nascimento, P.Eng., MTO Designated Principal Contact.

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PART B
PRELIMINARY FOUNDATION DESIGN REPORT (GENERAL)

HIGHWAY 427 EXPANSION PROJECT
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6.0 ENGINEERING RECOMMENDATIONS FOR PRELIMINARY DESIGN

6.1 General

This part of the report provides preliminary project wide foundation recommendations to assist selection and preliminary design of foundation systems for the proposed nine (9) structures and five (5) high fill areas along the proposed Highway 427 extension section from Highway 7 to Major Mackenzie Drive.

The preliminary recommendations provided herein are based on the interpretation of the factual data obtained from the boreholes advanced during the previous and current investigations at each structure site. 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 and high fill areas. Further foundation investigation and design will be required during detail design.

Preliminary recommendations for structure foundation are provided in Section 6.2 of this report. For high fill areas identified along the Highway 427 extension section, no new boreholes have been advanced and recommendations are based on the boreholes advanced during the previous investigation and relevant structure boreholes. Preliminary recommendations for high fills are included in Section 6.8 of this report

Where comments are made on construction, they are intended to highlight those aspects that could affect the design of the project, and for which special provisions may be required during construction. Those requiring information on aspects of construction should make their own interpretation of the provided factual information.

For the integral abutment design, the H-piles should be driven to refusal in the very dense sand and silt till or bedrock anticipated at the depths/elevations and designed to reference axial resistances that were provided in the Preliminary Foundation Design Report (FDR) sheets.

Typically, to accommodate movement of the integral abutment system, two concentric CSPs that extend at least 3 m below the bottom of the abutment should be placed around the pile to create an annular space. The inner CSP should be filled with sand meeting the gradation requirements of Granular B Type I.

The sites are generally adequate for the use of integral abutments in the Highway 427 extension section.

6.2 Structure Foundation Recommendations

It is understood that nine (9) structures are currently proposed within the extension section of Highway 427 from Highway 7 northerly to Major Mackenzie Drive.

It is noted that the current investigation was generally limited to the number of boreholes identified in the MTO WO No. 18. Boreholes were strategically located at selected foundation elements to supplement previous investigations and obtain representative subsurface information. No boreholes were advanced at the approach embankment locations. Further investigations at the final locations of the structure abutments and piers will be required during detail design to obtain subsurface information specific to the foundation locations and to confirm that the subsurface conditions and the geotechnical parameters and resistance values provided in this preliminary design phase are valid for the detail design of the foundations and meet the then-current MTO requirements.

The foundation design for all highway structures must be carried out in accordance with the requirements in the Canadian Highway Bridge Design Code, 2014 (*CHBDC, 2014*). Design of railway grade separations must be carried out in accordance with the local railway authority requirements and American Railway Engineering and Maintenance-of-Way (AREMA) manual.

The following sub-sections provide general and project-wide recommendations applicable to all structure sites and high fill areas, including design assumptions and limitations associated with the recommendations provided in the preliminary Foundation Design Report (FDR) sheets.

Reference to Design-Build standard specifications such as DB 902, DB 903 and DB 539 were included for each site in Part C of this report. Selected Non Standard Special Provisions (NSSP) were provided in the preliminary Foundation Design Report (FDR) sheets, where applicable. Due to preliminary nature of the report and the Design-Build project delivery mode, the contractor was alerted in Part C of this report to potential problems related to cobbles and boulders and vibration monitoring.

6.2.1 Spread Footings

Preliminary foundation recommendations for spread footings on native undisturbed soil (free of topsoil, organics loosened/softened and deleterious materials) or on a granular pad are provided where subsoil conditions are suitable for shallow foundations, as indicated on the individual FDR sheets for each structure.

The granular pad for support of the abutments (and/or piers as designed by the Project Co.) should be designed for site-specific conditions and be at least 2.0 m thick and be comprised of Granular A in conformance with OPSS.PROV 1010 (Aggregates). The granular pad should extend at least 1.0 m beyond the outside edge of the footings in all directions, and then downward at a 1 Horizontal to 1 Vertical (1H:1V) gradient to native soils free of organics and deleterious materials in accordance with MTO guidelines (see Figure 1). The granular pad should be placed in maximum 150 mm loose lifts and uniformly compacted to 100% of ASTM D-689 (Standard Proctor) Maximum Dry Density (SPMDD) in accordance with OPSS.PROV 501 (Compacting).

The preliminary geotechnical resistance values at factored Ultimate Limit States (ULS) and Serviceability Limit States (SLS) for 25 mm of settlement provided in FDR sheets assume a 3.0 m wide footing. These preliminary design values are provided for loads that will be applied perpendicular to the surface of the footings. Where the load is not applied perpendicular to the footing, inclination of the load should be taken into account in accordance with Clauses 6.10.3 and 6.10.4 of the *CHBDC* and its *Commentary (2014)*.

The preliminary geotechnical resistance values will have to be re-evaluated and modified if necessary during detail design based on any additional subsurface investigation at the locations of the foundation elements and final arrangement of the footings.

The geotechnical horizontal resistance/sliding resistance between concrete footings and the subsoils (or the granular pad) should be calculated in accordance with Clause 6.10.5 of the *CHBDC (2014)*.

The footings should be provided with a minimum 1.4 m of soil cover for frost protection as per OPSD 3090.101 (Frost Penetration for Southern Ontario), as measured vertically and perpendicular from the face of the abutment slope to the edge of the underside of the footing.

If adequate soil cover cannot be provided for the footing, an equivalent thickness of extruded closed cell insulation (e.g. Styrofoam) should be used to compensate for the lack of soil cover. For preliminary design purposes, an equivalency of 25 mm of insulation for every 0.3 m reduction in soil cover may be used. The insulation sheets should extend laterally at least 1.4 m beyond the edge of the footings. The surface of the insulation sheets should be sloped such that groundwater contacting the impervious sheets is directed away into a ditch.

6.2.2 Driven Steel H-Piles / Steel Pipe Piles

Preliminary recommendations for driven steel H-piles (HP 310x110) are provided where considered practical for foundation design of abutments and piers. Alternatively, consideration was also given to driven steel pipe piles 324 mm (12 ¾ in) outer diameter and 6 mm (1/4 in) thickness. Pipe piles are not preferred at this project site due to presence of boulders.

Based on the subsurface conditions encountered at each foundation element of each structure, the factored geotechnical axial resistance at ULS and the geotechnical axial resistance at SLS for 25 mm of settlement for driven steel H-piles founded at the anticipated elevation are provided on the individual FDR sheets. The preliminary ULS and SLS resistance values should be re-evaluated and modified, if necessary, during detail design stage, in consideration of any additional subsurface information at each foundation element.

The ULS resistance values should be verified in the field by the use of the Hiley Formula (MTO Standard Drawing SS103-11, Pile Driving Control). Alternatively PDA testing should be included. For complex sites, if warranted during detail design stage, the ultimate load capacity and/or load-settlement behaviour (serviceability) should be verified by full-scale pile load tests.

Pile installation should be in accordance with OPSS 903 and DB 903 (Deep Foundations). The pile termination or set criteria will be dependent on the pile driving hammer type, helmet, selected pile size and length of pile and as such should be defined during detail design stage. In the extension section of this project, pile installation should be performed using fixed leads. The contractor should make an appropriate assessment of the effect for the potential for pile driving alignment and tolerance, pile damage and surface subsidence if submitting a proposal for the use of swinging leads.

The soils at some structure locations are typically very dense/hard glacial tills and to provide adequate length of pile at these locations, pre-augering (soil left in place) may be required to penetrate the very dense/hard glacial till soils to provide a minimum pile length of 5 m below the pile cap for integral abutments and 3 m for conventional abutments (refer to individual FDR sheets). These pre-auguring dimensions should be designed by the structural engineer to permit adequate distribution of loads over the pile group. For the installation of steel H-piles, consideration will have to be given to the possible presence of cobbles and/or boulders within the till deposits. Where applicable, the piles should be reinforced with driving shoes such as Titus Standard or flange plates as per OPSD 3000.100 (Steel H-Pile Driving Shoe) for protection during driving.

The resistance of piles against lateral loads should take into account the batter of the pile (if any), the relative rigidity of the pile to surrounding soil, the fixity condition at the head of the pile (pile cap level), the structural capacity of the pile to withstand bending moments, the soil resistance that can be mobilized, the tolerable lateral deflections at the head of the pile, and group effects. For a longer, more flexible pile, the maximum yield moment of the pile may be reached prior to mobilization of the lateral geotechnical resistance. In case of a vertical pile, the resistance to lateral loading will be derived solely from the soil in front of the pile, whereas a battered pile derive lateral resistance from the soil in front of the pile as well as the horizontal component of the axial load present in the inclined pile.

In the estimation of resistance to lateral loading, pile group action should be accounted for, if the pile spacing in the direction of loading is less than six to eight pile diameters.

For design purposes, both the structural and geotechnical resistances should be evaluated to establish the governing case. The coefficients of horizontal subgrade reaction should be generated for detail design purposes.

The structural design of the piles should be based on full downdrag load, where applicable and as indicated on the FDR sheets, unless measures to significantly reduce anticipated post-construction settlements are undertaken. In this case the downdrag loads can be eliminated. For preliminary design, downdrag should be designed in accordance with *CHBDC*.

All pile caps should be provided with a minimum of 1.4 m of soil cover or equivalent thickness of insulation for frost protection purposes as per OPSD 3090.101 (Foundation Frost Depths for Southern Ontario).

6.2.3 Caissons

Preliminary foundation recommendations for caissons founded within competent soils or shale bedrock were provided, where caissons considered to be practical for foundation design as indicated on the individual FDR sheets.

Based on the subsurface conditions encountered at each foundation element of each structure, the factored geotechnical axial resistance at ULS and the geotechnical axial resistance at SLS for 25 mm of displacement are provided for caisson diameters equal to 1.2 m and 1.5 m on the individual FDR sheets. The geotechnical resistance values are associated with a recommended caisson base elevation. The factored ULS and SLS resistance values provided will have to be re-evaluated and modified, if necessary, during detail design in consideration of the additional subsurface investigations at the locations of each bridge foundation element.

For complex sites, if warranted during detail design stage, the ultimate load capacity and/or load-settlement behaviour (serviceability) should be verified by full-scale caisson load tests.

Caisson installation should be in accordance with OPSS 903 and DB 903 (Deep Foundations).

It should be noted that “running” or “flowing” of water-bearing cohesionless strata, where encountered, could pose difficulties during drilling of caisson foundations. Therefore, where caisson foundations are considered, temporary or permanent caisson liners may be required to support these type of soils during construction and allow for cleaning and inspection of the caisson base. OHSA prohibits man entry into the caisson, the inspections shall be carried out with a downhole camera. At some locations (as indicated on the FDR sheets), it is recommended caissons be drilled while using slurry methods such as maintaining a constant head of an appropriated fluid, such as Bentonite slurry, inside the caisson liners to counterbalance high groundwater pressure followed by tremie concrete placement. Where 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” soils in which the caissons are installed. In such cases and to avoid “necking” of the caissons, 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 for the full length of the caissons. 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. Consideration will also have to be given to the possible presence of cobbles and/or boulders within the till deposits of these sites. Caisson drilling equipment must be capable of penetrating such obstacles, where applicable (see Section 6.7.4).

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 detail design. The coefficients of horizontal subgrade reaction should be generated for detail design purposes.

The structural design of the caissons should be based on full downdrag load where applicable and should be considered during detail design, unless measures to significantly reduce anticipated post-construction settlements are undertaken in which case the downdrag loads can be eliminated. For preliminary design, downdrag loads should be designed in accordance with *CHBDC*. Further analysis of downdrag loads is required during detail design.

Caisson caps, as applicable, should be provided with a minimum of 1.4 m of soil cover or equivalent thickness of insulation for frost protection.

6.3 Structure Retaining Walls/ Wing Walls

The proposed structures may require the construction of retaining walls and/or wing walls depending on the proposed crossing configuration, available space and surrounding ground elevations. Feasible retaining wall/wing wall options may include:

- Retained Soil System (RSS) walls: RSS walls are considered to be a feasible wall option for most of the structure abutment / approach locations provided differential settlements are within tolerable limits and an adequate Factor of Safety against global instability is achieved. The performance of an RSS wall during foundation settlement depends primarily on the characteristics of its front facing system. Construction of RSS walls should be in conformance with the MTO RSS Design Guidelines and Special Provision 599S22. Sub-excavation of surficial loosened/softened materials, where encountered, and replacing with compacted granular material, will be required to construct the reinforced soil mass. The front facing of RSS walls is typically supported on a granular pad. The granular pad must be founded on competent native soils or approved engineered fill, after sub-excavation and backfilling the areas where topsoil, fill, loosened/softened, organics and deleterious native soils exist. The factored

geotechnical axial resistance at ULS and the geotechnical axial resistance at SLS for the tolerable displacement should be provided for the front panel of the wall and reinforced earth mass during detail design. It should be noted that the limiting displacement value for SLS design that should be assessed and confirmed during detail design will be dependent on the actual facing type or possibly the serviceability limit of the supporting roadway or foundation (typically less than 25 mm). The internal stability of a reinforced earth wall should be assessed by the proprietary product supplier/designer. The global stability of the RSS wall should be confirmed by the foundation consultant at detail design stage taking into account the final geometry and configuration of the RSS walls.

- Conventional retaining walls: Retaining walls supported on spread footings or on deep foundations (often cantilevered beyond the abutment foundation) depending on the site-specific subsoil conditions are considered to be feasible. The preliminary foundation recommendations for this type of retaining wall can be considered to be similar to the recommendations provided for the preliminary design of the structure foundations elements.

For settlement sensitive sites, retaining walls will be affected by the post-construction settlement of the wall backfill materials, depending on the height/thickness of the backfill. The selection of the wall option for such sites will thus be dependent on the predicted settlement and should be assessed during detail design. Measures to reduce settlement could be achieved by incorporating site improvement techniques, such as using light weight fill materials (slag or expanded polystyrene (EPS)), preloading or surcharging, installing wick drains, and staged construction as discussed in the individual FDR sheets, where applicable. 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 the abutment stems and any associated retaining walls/wing walls will depend on the type and method of placement of the backfill materials, on the nature of the soils behind the backfill, on the magnitude of surcharge including construction loadings, on the freedom of lateral movement of the structure, as well as on the drainage conditions behind the walls. The following general recommendations are made concerning the design of the stems/wing walls.

These recommendations and parameters assume 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 Clause C6.12.2.2 of the *CHBDC Commentary (2014).*

- Backfill to the abutment and retaining walls should be in conformance with OPSS 902 and DB 902 (Excavating and Backfilling-Structures) and should consist of Granular A or Granular B Type II material. This material should be compacted in accordance with OPSS.PROV 501 (Compacting), OPSD 3101.150 (Walls Abutment, Backfill) and OPSD 3121.150 (Walls Retaining, Backfill).

- Where applicable, longitudinal drains and weep holes should be installed to provide positive drainage of the granular backfill. Other aspects of the granular backfill requirements with respect to sub-drains and frost taper should be in accordance with the standards noted above.

- The granular fill may be placed either in a zone with width equal to at least 1.4 m behind the back of the wall stem (Case I on Figure C6.20(a) of the *Commentary to the CHBDC* (2014)) or within the wedge-shaped zone defined by a line drawn at 1.5 horizontal to 1 vertical (1.5H:1V) extending up and back from the rear face of the footing (Case II on Figure C6.20(b) of the C*HBDC Commentary* (2014)).

- 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:	22.5 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

- If the wall support and superstructure allow lateral yielding of the abutment stem and retaining walls, active earth pressures (K_a) should be used in the geotechnical design of the structure. If the abutment support does not allow lateral yielding, at-rest earth pressures (K_o) 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 presented in Clause C6.12 and Table C6.6 of the *CHBDC Commentary* (2014). The earth pressure conditions for design of an integral abutment should be in accordance with MTO Report SO-96-01.

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.

- The design of lateral earth pressure should also include the effect of compaction pressure and local surcharge pressure in accordance with Clause 6.12.2.3 and Table 6.3 of the *CHBDC (2014).*

6.5 Approach Embankments

The configuration of the structure approaches varies from site to site and includes approach embankment construction with fills depending on the design grades and ground elevations for each crossing. Based on the available information provided at each structure site, recommendations associated with the approaches stability and settlement are provided on the individual FDR sheets. The following sub-sections provide project-wide recommendations associated with the preliminary design and construction of the approach embankments.

6.5.1 Subgrade Preparation and Embankment Construction

It is recommended that, where encountered, topsoil, organics and/or loosened/softened material, and deleterious soils 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 valley areas where thicker layers of organic/alluvial soils may be present. After stripping, the exposed subgrade should be proof-rolled to identify any loosened/softened areas requiring sub-excavation or additional compaction prior to fill placement.

Embankment fill should be excavated, placed and compacted in accordance with OPSS 206 (Grading) and OPSS.PROV 501 (Compacting).

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 in accordance with OPSS.PROV 804 (Seed and Cover) and OPSS 802 (Topsoil).

6.5.2 Approach Embankment Stability

The preliminary assessment for the stability of the approaches at each structure site was evaluated using the commercially available program Slide (Version 3.0) produced by Rocscience Inc. and is provided on the respective FDR sheets for each structure site. The assessments assume approach embankment side slopes at a gradient of 2 Horizontal to 1 Vertical (2H:1V) associated with a maximum approach height as indicated on the Preliminary General Arrangement drawings provided at the time of this report. Where designated as safe or adequate 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. The safety factor for seismic stability analyses should be in accordance with Clause C4.6.7 of the C*HBDC Commentary* (2014). Assessment of the overall stability of the embankment side slopes under seismic conditions is discussed in more details in Section 6.6.

Approaches equal to or greater than 8.0 m in height, where deemed feasible, should be constructed with a 2 m wide berm to control surficial erosion in accordance with general MTO guidelines so that no uninterrupted 2H:1V slope is greater than 8.0 m in height.

The preliminary assessment of stability of the approach slopes should be reviewed and confirmed based on the actual subsoil conditions encountered within the proposed approach/embankment footprint during detail design. Mitigation measures to improve slope stability for greater embankment heights may include slope flattening, utilizing light weight fill materials, use of geogrid reinforcement, ground improvement techniques, constructing stability berms, staged construction, or a combination of these options.

6.5.3 Approach Embankment Settlement

Settlement of the approach embankments will occur due to compression of the embankment fill itself, as well as compression and consolidation of the foundation soils. The total settlement within the founding soils has been estimated based on the existing site-specific subsoil conditions for preliminary design using hand/spreadsheet calculations and the results are reported on the individual FDR sheets for each site. These preliminary estimates do not include compression of the fill itself, which would typically occur during and shortly after the construction of embankment. The magnitude of fill compression is usually about 1% to 2% of the embankment height. Where granular fill is used for embankment construction, settlement of the fill itself is expected to occur during or immediately after completion of embankment construction, whereas non-granular earth fill or rock fill materials will exhibit additional consolidation settlement over time.

Embankment and platform width design should allow for the anticipated settlements and future padding of the pavement structure.

Where estimated post-construction consolidation settlement within the foundation soils exceeds acceptable limits (defined in the Embankment Settlement Criteria for Design specified in the MTO memorandum, July 2, 2010) measures to reduce such settlement to acceptable values have been proposed. For preliminary design, acceptable settlement values are assumed to be less than 25 mm at or near structure locations. Measures to mitigate embankment settlements may include utilizing light weight fill materials, ground improvement techniques, pre-loading and surcharging with staged construction, or a combination of these options. Comprehensive investigation, in situ and laboratory testing and analyses should be carried out during detail design to further estimate the anticipated amount and time rate of post-construction settlements and to develop the final design and construction requirements of the approach embankments in such site conditions, as well as develop mitigation measures to reduce anticipated settlements to acceptable levels.

6.6 Seismic Considerations

The Peak Ground Acceleration (PGA) for the project site is 0.081 for the City of the Vaughan, Ontario (National Building Code of Canada, 2015). The soil classification at each site for seismic design should be in accordance with Clause 4.4.3.2 of the CHBDC *(2014).*

Seismic loading must be taken into account in accordance with Clause 4.5.3 of the *CHBDC* (2014), as it can result in increased lateral earth pressures acting on the abutment stem and any associated wing walls/retaining walls.

Abutment stem and retaining/wing walls should be designed to withstand the combined loading for the appropriate static pressure conditions plus the earthquake-induced dynamic earth pressure in accordance with Clause 3.5 of the *CHBDC* (2014). The earthquake-induced pressure distribution is assumed to be linear with maximum pressure at the top of the wall and minimum pressure at its toe (an inverted triangular pressure distribution). The static and seismic active earth pressure coefficients can be determined in accordance with Clauses 6.12 and 4.6.5 of the *CHBDC* (2014) and its *Commentary.*

Approach Embankment design, liquefaction susceptibility 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 detail design stage in accordance with Clauses C4.6.6 and C4.6.7 of the *CHBDC Commentary* (2014), respectively.

6.7 Construction Considerations

6.7.1 Excavation and Backfill

Preliminary recommendations for open-cut excavations are provided on a site-specific basis on the FDR sheets for each site and include the type of soils anticipated to be within the foundation excavations according to the Occupational Health and Safety Act (OHSA), as well as the recommended maximum side slope inclination for temporary excavations. All backfill is to be placed and compacted in accordance with OPSS.PROV 501 (Compacting).

6.7.2 Temporary Protection Systems

Temporary protection systems will be required where excavation geometries are steeper than those recommended for safe excavation and adjacent to structures or roads carrying traffic. Where required, the temporary excavation support system should be designed and constructed in accordance with OPSS.PROV 539 and DB 539 (Temporary Protection Systems). In general, the lateral movement of the temporary shoring system should meet Performance Level 2 as specified in OPSS.PROV 539 (Temporary Protection Systems). Performance Level 1 may be required adjacent to railways.

6.7.3 Surface Water / Groundwater Control

Surface water run-off should be diverted away from the excavations at all times.

Anticipated groundwater levels within the foundation excavations at each structure site and anticipated groundwater and surface water control measures are included on the individual FIDR sheets.

At locations where near surface granular (non-cohesive) soils are present with a high water table, groundwater infiltration should be anticipated during excavation in such deposits, particularly during wet periods of the year. Dewatering at these sites will be required to allow for construction of foundation elements in a dry condition. Dewatering will be required before any excavation within floodplains with high groundwater table. Alternatively, the excavation should be carried out within a properly designed cofferdam.

6.7.4 Pile Installation / Caisson Construction

Till deposits have been encountered at the structure sites along the proposed Highway 427 extension section. The presence of cobbles and/or boulders was inferred during drilling within the till deposits, as noted on the Record of Borehole sheets, and may affect the driving of steel H-piles or construction of caissons.

It is noted that to ensure stability of caisson sidewall and base, provisions for liner installation, mud drilling techniques and depressurization methods should be made as appropriate for site specific groundwater/artesian conditions. Preliminary recommendations regarding potential obstructions during pile driving and caisson installation have been provided on the site-specific Preliminary FDR sheets.

6.7.5 Subgrade Preparation

The soils exposed at the footing subgrade will be susceptible to disturbance from construction traffic. Consideration should be given to pouring a concrete working slab (mud slab) on the subgrade within four hours after preparation, inspection and approval of the footing subgrade.

6.8 High Fills Recommendations

6.8.1 Slope Stability

Preliminary assessment of the stability of the fill embankment slopes was included in the previous report by others (Golder, 2009) for a typical high fill embankment and the results were summarized on FIDR Sheet J. A commercially available program such as Slide, produced by Rocscience Inc., should be used for slope stability analysis during detail design, when embankment cross-section geometry and provisions for stability and settlement mitigation measures are known. The safety factor for seismic stability analyses should be in accordance with Clause C4.6.7 of the C*HBDC Commentary* (2014). 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. Mitigation measures to improve slope stability, if required, may include slope flattening, utilizing light weight fill materials, constructing stability berms, staged construction, ground improvement techniques or a combination of these options.

6.8.2 Settlement Assessment

Preliminary assessment of the magnitude of settlement of the fill embankment is provided on the FIDR Sheet J. The preliminary assessment of settlement magnitude should be reviewed and confirmed based on the actual subsoil conditions encountered within the proposed embankment footprint during the detail design.

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 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 is usually about 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 immediately after completion of embankment construction. Non-granular earth fill or rock fill materials may exhibit additional consolidation settlement over time.

The settlement tolerance for embankments range from 25 mm to 100 mm depending on the distance from a structure in accordance to the Embankment Settlement Criteria for design in MTO memorandum dates July 2, 2010. The highway design criteria will be site-specific and based on maintenance considerations at the detail design stage.

Embankment and platform width design should allow for the anticipated settlements and future padding of the pavement structure.

Further investigation, in situ and laboratory testing and 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, utilizing ground improvement techniques, light weight fill, or combination of these options to reduce anticipated settlements to acceptable levels.

6.8.3 Embankment Construction Considerations

Topsoil, fill, loosened/softened, organics and deleterious soils should be stripped from the proposed embankment footprint. The depth and extent of stripped material shall be determined during detail design when additional subsurface information is available. Particular attention will be required in low valley areas where thicker layers of organic/alluvial soils may be present.

After stripping, the exposed subgrade should be proof-rolled to identify any loosened/softened areas requiring sub-excavation or additional compaction prior to fill placement.

Embankment fill should be placed and compacted in accordance with OPSS 206 (Grading) and OPSS.PROV 501 (Compacting). 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 (Benching).

In accordance with MTO standard practice, a minimum 2 m wide berm should be provided where the embankment side slopes are equal to or greater 8.0 m in height such that the uninterrupted slope height does not exceed 8.0 m. 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 in accordance with OPSS.PROV 804 (Seed and Cover) and OPSS 802 (Topsoil).

Trafficability of construction equipment may be problematic in low floodplain areas where loosened/softened and organic alluvial material may be encountered and where environmental constraints may be 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 geo-synthetics with granular/rock roadways in working area.

Potential environmental impacts will need to be minimized during construction access into sensitive floodplain or valley areas. Specific access preparation procedures such as the use of temporary work bridges, winter construction and/or gravel roadways underlain by geo-synthetics should be considered. Further, sediment control measures such as silt fences, straw bales and/or granular check-dams will need to be installed downgradient of the works to reduce sediments impacts to surface water bodies, in accordance with OPSS 805 (Temporary Erosion and Sediment Control Measures).

7.0 CLOSURE

This Preliminary Foundation Design Report was prepared by Mr. Al Varshoi, P.Eng. and Ms. Marzieh Kamranzadeh, MSc, EIT and reviewed by Mr. Brian R. Gray, MEng, P.Eng. Principal Consultant. Mr. Carlos M. P. Nascimento, P.Eng., MTO Designated Principal Contact conducted an independent review of the report.

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MK/BRG/CN:jk

REGION OF PEEL

REGIONAL MUNICIPALITY OF YORK

CITY OF VAUGHAN

HIGHWAY 427 AT
ZENWAY BOULEVARD UNDERPASS
HIGHFILL EMBANKMENT
STA. 9+700 TO 10+150

HIGHWAY 427 NBL AND SBL
BRIDGE OVER RAINBOW CREEK
HIGHFILL EMBANKMENT
STA. 10+350 TO 10+450

LANGSTAFF ROAD BRIDGE
OVER RAINBOW CREEK

HIGHWAY 427 AT
LANGSTAFF ROAD UNDERPASS
HIGHFILL EMBANKMENT
STA. 9+450 TO 10+350

HIGHWAY 427 NBL AND SBL AT
RUTHERFORD ROAD OVERPASS
HIGHFILL EMBANKMENT
STA. 13+500 TO 14+500

HIGHWAY 427 NBL AND SBL BRIDGES
OVER WEST ROBINSON CREEK

MAJOR MACKENZIE DRIVE BRIDGE
OVER WEST ROBINSON CREEK

HIGHWAY 427 NBL AND SBL AT
MAJOR MACKENZIE DRIVE OVERPASSES

HIGHWAY 427 NBL AND SBL AT
CPR/McGILLIVRAY ROAD OVERPASSES
HIGHFILL EMBANKMENT
STA. 15+800 TO 16+900

HIGHWAY 7

ZENWAY BOULEVARD

LANGSTAFF ROAD

RUTHERFORD ROAD

MAJOR MACKENZIE DRIVE

McGILLIVRAY ROAD

HIGHWAY 427 SBL

HIGHWAY 427 NBL

R=18000

A=350

R=1700

A=350

R=1700

A=375

SCALE

250 0 250 500m

Ontario

PML Peto MacCallum Ltd.
CONSULTING ENGINEERS

ASSIGNMENT No.: 2014-E-0056

WORK ORDER No.: 18

HIGHWAY 427 EXPANSION
EXTENSION FROM HIGHWAY 7 TO MAJOR MACKENZIE DRIVE
SITE LOCATION PLAN
STRUCTURES AND HIGHFILL EMBANKEMTS

DWG. 1

Table A1
Summary of Structures and High Fill Areas

Structure Number	Structure Category	Site Name (Location)	Complexity Rating	Existing GEOCRES Report	Boreholes		Preliminary FIDR Sheet
					Previous	Current	
Not Assigned	Underpass	Zenway Boulevard at Highway 427 NBL and SBL	Medium	30M13-167	S1 to S3	ZB-1, ZB-2	Sheet A
Not Assigned	Bridges	Highway 427 NBL and SBL Bridges over Rainbow Creek	Medium	30M13-168	S4 to S9	RC-1, RC-2	Sheet B
Not Assigned	Bridge	Langstaff Road Bridge over Rainbow Creek	Medium	30M13-170	S10 and S11	LRC-1 to LRC-3	Sheet C
Not Assigned	Underpass	Langstaff Road Underpass at Highway 427 NBL and SBL	Medium	30M13-169	S12 to S14, S14A	LR-1, LR-2	Sheet D
Not Assigned	Overpasses	Highway 427 NBL and SBL over Rutherford Road	Medium	30M13-171	S15 to S18	RR-1, RR-2	Sheet E
Not Assigned	Bridges	Highway 427 NBL and SBL over West Robinson Creek	Medium	30M13-172	S19 to S24, S19A	WRB-1, WRB-2	Sheet F
Not Assigned	Overpasses	Highway 427 NBL and SBL at CPR/ McGillivray Road	Medium	30M13-173	S25 to S30	MRG-1, MRG-2	Sheet G
Not Assigned	Overpasses	Highway 427 NBL and SBL at Major Mackenzie Drive	Medium	30M13-174	S34 and S36	MMD-1 to MMD-4	Sheet H
Not Assigned	Bridge	Major Mackenzie Drive EBL and WBL over West Robinson Creek	Medium	30M13-175	S31 and S32	MMRC-1, MMRC-2	Sheet I
Not Applicable	High Fill	Zenway Boulevard – STA. 9+700 to 10+150	Medium	30M13-177	E2 to E5, S1 to S3	ZB-1, ZB-2	Sheet J
Not Applicable	High Fill	South of Rainbow Creek – STA. 11+350 to 11+450	Medium		E6, E7, S4 and S5	-	
Not Applicable	High Fill	Langstaff Road – STA. 9+450 to 10+125	Medium		E8 to E13, S10 to S14, S14A	LR-1, LR-2, LRC-1 to LRC-3	
Not Applicable	High Fill	Rutherford Road – STA. 13+500 to 14+550	Medium		C9, C10, C13, C14, E14 to E16, E18, E19, S16, S18	RR-1, RR-2	
Not Applicable	High Fill	CPR/ McGillivray Road – STA. 15+800 to 16+900	Medium		E21 to E27, S26, S28 to S30, S36	MRG-1, MRG-2, MMD-1 to MMD-4	

Table A2
Summary of Groundwater Level Measurements

Site Name	Borehole No.	Ground Surface Elevation at Borehole Location (m)	Depth to Groundwater Level Below Ground Surface (m)	Groundwater Elevation (m)	Date of Measurement	Measurement Detail
Zenway Boulevard Underpass	S1	182.2	11.8	170.4	April 27, 2009	On Completion of Drilling
	S2	181.4	> 15.7	< 165.7	April 17, 2009	On Completion of Drilling
	S3	181.1	10.7	170.4	April 16, 2009	On Completion of Drilling
			1.3	179.8	May 13, 2009	In Piezometer
			0.9	180.2	June 15, 2009	In Piezometer
			0.9	180.2	July 09, 2009	In Piezometer
	ZB-1	183.0	9.7	173.3	September 30, 2015	On Completion of Drilling
	ZB-2	181.5	18.3	163.2	September 30, 2015	On Completion of Drilling
Rainbow Creek Bridges	S4	182.5	6.0	176.5	February 27, 2009	On Completion of Drilling
	S5	181.6	6.0	175.6	February 26, 2009	On Completion of Drilling
			4.4	177.2	April 24, 2009	In Piezometer
			4.4	177.2	May 13, 2009	In Piezometer
			4.6	177.0	May 21, 2009	In Piezometer
			4.7	176.9	June 15, 2009	In Piezometer
			4.9	176.7	July 9, 2009	In a Piezometer
	S6	177.6	3.0	174.7	March 13, 2009	On Completion of Drilling
	S7	175.8	0.9	174.9	March 13, 2009	On Completion of Drilling
	S8	175.8	0.9	176.7	March 12, 2009	On Completion of Drilling
	S9	176.0	1.2	174.8	March 16, 2009	On Completion of Drilling
			3.6	172.4	April 24, 2009	In Piezometer
			1.2	174.8	May 13, 2009	In Piezometer
			0.9	175.1	May 21, 2009	In Piezometer
			0.5	175.5	June 15, 2009	In Piezometer
			0.5	175.5	July 9, 2009	In Piezometer
	RC-1	175.7	4.6	171.1	November 6, 2015	During Drilling
	RC-2	177.3	3.4	173.9	October 15, 2015	On Completion of Drilling

Table A2
Summary of Groundwater Level Measurements

Site Name	Borehole No.	Ground Surface Elevation at Borehole Location (m)	Depth to Groundwater Level Below Ground Surface (m)	Groundwater Elevation (m)	Date of Measurement	Measurement Detail
Langstaff Road Bridge over Rainbow Creek	S10	183.4	> 8.1	< 175.3	March 20, 2009	On Completion of Drilling
	S11	180.9	7.8	173.1	March 20, 2009	On Completion of Drilling
			0.0	180.9	April 24, 2009	In Piezometer
			0.0	180.9	May 13, 2009	In Piezometer
			0.0	180.9	June 15, 2009	In Piezometer
			0.0	180.9	July 9, 2009	In Piezometer
	LRC-1	181.9	7.9	174.0	October 14, 2015	On Completion of Drilling
	LRC-2	180.6	10.5	170.1	October 15, 2015	On Completion of Drilling
	LRC-3	179.9	14.6	165.3	October 16, 2015	On Completion of Drilling
Langstaff Road Underpass	S12	187.5	5.2	182.3	March 26, 2009	On Completion of Drilling
			6.9	180.6	May 13, 2009	In Piezometer
			6.7	180.8	June 15, 2009	In Piezometer
			6.3	181.2	July 9, 2009	In Piezometer
	S13	187.7	7.8	179.9	March 31, 2009	On Completion of Drilling
	S14	187.7	17.7	170.0	April 2, 2009	On Completion of Drilling
	S14A	187.7	21.8	165.9	April 13, 2009	On Completion of Drilling
	LR-1	187.9	9.1	178.8	September 28, 2015	On Completion of Drilling
	LR-2	188.1	18.3	169.8	September 29, 2015	During Drilling
Rutherford Road Overpasses	S15	194.0	7.6	186.4	March 25, 2009	On Completion of Drilling
	S16	194.6	6.0	188.6	March 20, 2009	On Completion of Drilling
	S17	194.6	11.2	183.4	March 25, 2009	On Completion of Drilling
			4.0	190.6	April 24, 2009	In Piezometer
			4.1	190.5	May 25, 2009	In Piezometer
			4.0	190.6	June 15, 2009	In Piezometer
			3.8	190.8	July 9, 2009	In Piezometer
	S18	194.3	7.6	186.7	March 23, 2009	On Completion of Drilling
	RR-1	194.6	N/R	N/R	N/R	N/R – Not recorded due to use of mud rotary drilling
	RR-2	193.6	N/R	N/R	N/R	

Table A2
Summary of Groundwater Level Measurements

Site Name	Borehole No.	Ground Surface Elevation at Borehole Location (m)	Depth to Groundwater Level Below Ground Surface (m)	Groundwater Elevation (m)	Date of Measurement	Measurement Detail
West Robinson Creek Bridges	S19	193.8	6.1	187.7	March 2, 2009	On Completion of Drilling
	S19A	193.8	2.1	191.7	March 10, 2009	On Completion of Drilling
	S20	193.9	6.1	187.8	March 3, 2009	On Completion of Drilling
	S21	194.0	6.1	187.9	March 5, 2009	On Completion of Drilling
	S22	193.7	6.0	187.7	March 6, 2009	On Completion of Drilling
	S23	197.2	8.5	185.7	March 9, 2009	On Completion of Drilling
			3.8	193.4	April 24, 2009	In Piezometer
			3.8	193.4	May 21, 2009	In Piezometer
			4.0	193.2	June 15, 2009	In Piezometer
			4.1	193.1	July 9, 2009	In Piezometer
	S24	199.2	8.0	191.2	March 3, 2009	On Completion of Drilling
	WRB-1	200.0	10.2	189.8	December 7, 2015	During Drilling
	WRB-2	195.0	7.9	187.1	December 1, 2015	On Completion of Drilling
CPR / McGillivray Road Overpasses	S25	201.8	16.6	185.2	March 16, 2009	On Completion of Drilling
	S26	201.5	11.5	190.0	March 12, 2009	On Completion of Drilling
	S27	201.1	> 38.4	< 162.7	March 13, 2009	On Completion of Drilling
	S28	200.8	12.8	188.0	March 17, 2009	On Completion of Drilling
			8.5	192.3	April 27, 2009	In Piezometer
			8.5	192.3	May 13, 2009	In Piezometer
			8.6	192.2	May 25, 2009	In Piezometer
			9.1	191.7	June 15, 2009	In Piezometer
			9.1	191.7	July 9, 2009	In Piezometer
	S29	202.0	15.2	186.8	April 27, 2009	On Completion of Drilling
	S30	202.3	10.7	191.6	April 27, 2009	On Completion of Drilling
Major Mackenzie Drive Overpasses	S34	205.2	21.8	183.4	March 10, 2009	During Drilling
	S36	205.2	7.3	197.9	April 27, 2009	In Piezometer
			6.4	198.8	May 25, 2009	In Piezometer
			6.2	199.0	June 15, 2009	In Piezometer
			6.2	199.0	July 9, 2009	In Piezometer
	MMD-2	204.5	10.2	194.3	November 16, 2015	In Piezometer
			9.3	195.2	December 23, 2015	In Piezometer

Table A2
Summary of Groundwater Level Measurements

Site Name	Borehole No.	Ground Surface Elevation at Borehole Location (m)	Depth to Groundwater Level Below Ground Surface (m)	Groundwater Elevation (m)	Date of Measurement	Measurement Detail
Major Mackenzie Drive Bridge over West Robinson Creek	S31	201.3	3.4	197.9	March 19, 2009	On Completion of Drilling
	S32	201.8	4.9	196.9	March 18, 2009	On Completion of Drilling
			3.1	198.7	April 24, 2009	In Piezometer
			3.4	198.4	May 13, 2009	In Piezometer
			3.4	198.4	May 25, 2009	In Piezometer
	MMRC-1	200.7	3.7	197.0	October 13, 2015	On Completion of Drilling
			2.9	197.8	December 23, 2015	In Piezometer
	MMRC-2	202.1	3.7	198.4	October 9, 2015	On Completion of Drilling
High Fill at Zenway Boulevard Underpass	E2	188.3	> 9.6	< 178.7	April 17, 2009	On Completion of Drilling
	E3	181.6	> 8.2	< 173.4	April 14, 2009	On Completion of Drilling
	E4	183.0	> 6.7	< 176.3	April 7, 2009	On Completion of Drilling
	E5	183.2	> 6.7	< 176.5	April 7, 2009	On Completion of Drilling
	S1	182.2	11.8	170.4	April 27, 2009	On Completion of Drilling
	S2	181.4	> 15.7	<165.7	April 17, 2009	On Completion of Drilling
	S3	181.1	10.7	170.4	April 16, 2009	On Completion of Drilling
			1.3	179.8	May 13, 2009	In Piezometer
			0.9	180.2	June 15, 2009	In Piezometer
			0.9	180.2	July 09, 2009	In Piezometer
	ZB-1	183.0	9.7	173.3	September 30, 2015	On Completion of Drilling
	ZB-2	181.5	18.3	163.2	September 30, 2015	On Completion of Drilling
High Fill at South of Rainbow Creek	E6	179.1	> 5.2	< 173.9	February 27, 2009	On Completion of Drilling
	E7	178.3	> 5.2	< 173.2	March 2, 2009	On Completion of Drilling
	S4	182.5	6.0	176.5	February 27, 2009	On Completion of Drilling
	S5	181.6	6.0	175.6	February 26, 2009	On Completion of Drilling
			4.4	177.2	April 24, 2009	In Piezometer
			4.4	177.2	May 13, 2009	In Piezometer
			4.6	177.0	May 21, 2009	In Piezometer
			4.7	176.9	June 15, 2009	In Piezometer
			4.9	176.7	July 9, 2009	In Piezometer

Table A2
Summary of Groundwater Level Measurements

Site Name	Borehole No.	Ground Surface Elevation at Borehole Location (m)	Depth to Groundwater Level Below Ground Surface (m)	Groundwater Elevation (m)	Date of Measurement	Measurement Detail
High Fill at Langstaff Road Underpass	E8	186.7	> 6.7	< 180.0	April 1, 2009	On Completion of Drilling
	E9	181.4	3.0	178.4	April 14, 2009	On Completion of Drilling
	E10	185.6	> 8.2	< 177.4	April 14, 2009	On Completion of Drilling
	E11	186.9	> 8.2	< 178.7	April 14, 2009	On Completion of Drilling
	E12	187.4	> 8.2	< 179.2	April 14, 2009	On Completion of Drilling
	E13	187.3	> 8.2	< 179.1	April 13, 2009	On Completion of Drilling
	S10	183.4	> 8.1	< 175.3	March 20, 2009	On Completion of Drilling
	S11	180.9	7.8	173.1	March 20, 2009	On Completion of Drilling
			0.0	180.9	April 24, 2009	In Piezometer
			0.0	180.9	May 13, 2009	In Piezometer
			0.0	180.9	June 15, 2009	In Piezometer
			0.0	180.9	July 9, 2009	In Piezometer
	S12	187.5	5.2	182.3	March 26, 2009	On Completion of Drilling
			6.9	180.6	May 13, 2009	In Piezometer
			6.7	180.8	June 15, 2009	In Piezometer
			6.3	181.2	July 9, 2009	In Piezometer
	S13	187.7	7.8	179.9	March 31, 2009	On Completion of Drilling
	S14	187.7	17.7	170.0	April 2, 2009	On Completion of Drilling
	S14A	187.7	21.8	165.9	April 13, 2009	On Completion of Drilling
	LR-1	187.9	9.1	178.8	September 28, 2015	On Completion of Drilling
	LR-2	188.1	18.3	169.8	September 29, 2015	During Drilling
	LRC-1	181.9	7.9	174.0	October 14, 2015	On Completion of Drilling
	LRC-2	180.6	10.5	170.1	October 15, 2015	On Completion of Drilling
	LRC-3	179.9	14.6	165.3	October 16, 2015	On Completion of Drilling
High Fill at Rutherford Road Overpasses	C9	188.3	> 9.8	< 178.5	March 27, 2009	On Completion of Drilling
	C10	188.6	> 9.8	< 178.8	March 30, 2009	On Completion of Drilling
			7.6	181.0	April 24, 2009	In Piezometer
			8.0	180.6	May 21, 2009	In Piezometer
			7.9	180.7	May 21, 2009	In Piezometer
			7.9	180.7	June 15, 2009	In Piezometer
			7.6	181.0	July 9, 2009	In Piezometer
	C13	193.8	> 9.8	< 184.0	April 6, 2009	On Completion of Drilling

Table A2
Summary of Groundwater Level Measurements

Site Name	Borehole No.	Ground Surface Elevation at Borehole Location (m)	Depth to Groundwater Level Below Ground Surface (m)	Groundwater Elevation (m)	Date of Measurement	Measurement Detail
(Cont'd) High Fill at Rutherford Road Overpasses **(Note 1)**	C14	194.5	> 11.3	< 183.2	April 3, 2009	On Completion of Drilling
	E14	191.5	> 8.2	< 183.3	March 25, 2009	On Completion of Drilling
	E15	192.2	2.7	189.5	March 26, 2009	On Completion of Drilling
	E16	193.2	> 9.8	< 183.4	March 20, 2009	On Completion of Drilling
	E18	193.2	12.5	180.7	March 25, 2009	On Completion of Drilling
	E19	195.3	7.9	187.4	April 1, 2009	On Completion of Drilling
	S16	194.6	6.0	188.6	March 20, 2009	On Completion of Drilling
	S18	194.3	7.6	186.7	March 23, 2009	On Completion of Drilling
High Fill at CPR / McGillivray Road Overpasses	E21	202.2	> 5.2	< 197.0	March 11, 2009	On Completion of Drilling
	E22	202.4	> 11.3	< 191.1	April 29, 2009	On Completion of Drilling
	E23	203.0	> 11.3	< 191.7	April 29, 2009	On Completion of Drilling
	E24	203.8	11.9	191.9	March 17, 2009	On Completion of Drilling
	E25	203.8	12.5	191.3	March 17, 2009	On Completion of Drilling
	E26	204.3	> 12.8	< 191.5	March 18, 2009	On Completion of Drilling
	E27	203.8	9.8	194.0	March 18, 2009	On Completion of Drilling
	S26	201.5	11.5	190.0	March 12, 2009	On Completion of Drilling
	S28	200.8	12.8	188.0	March 17, 2009	On Completion of Drilling
			8.5	192.3	April 27, 2009	In Piezometer
			8.5	192.3	May 13, 2009	In Piezometer
			8.6	192.2	May 25, 2009	In Piezometer
			9.1	191.7	June 15, 2009	In Piezometer
			9.1	191.7	July 9, 2009	In Piezometer
	S29	202.0	15.2	186.8	April 27, 2009	On Completion of Drilling
	S30	202.3	10.7	191.6	April 27, 2009	On Completion of Drilling
	S36	205.2	7.3	197.9	April 27, 2009	In Piezometer
			6.4	198.8	May 25, 2009	In Piezometer
			6.2	199.0	June 15, 2009	In Piezometer
			6.2	199.0	July 9, 2009	In Piezometer
	MMD-2	204.5	10.3	194.3	November 16, 2015	In Piezometer
			9.3	195.2	December 23, 2015	In Piezometer

Note 1: Water levels were not obtained in Boreholes RR-1 and RR-2 because these boreholes were drilled by mud rotary methods.

Figure 1: Typical Granular A Pad

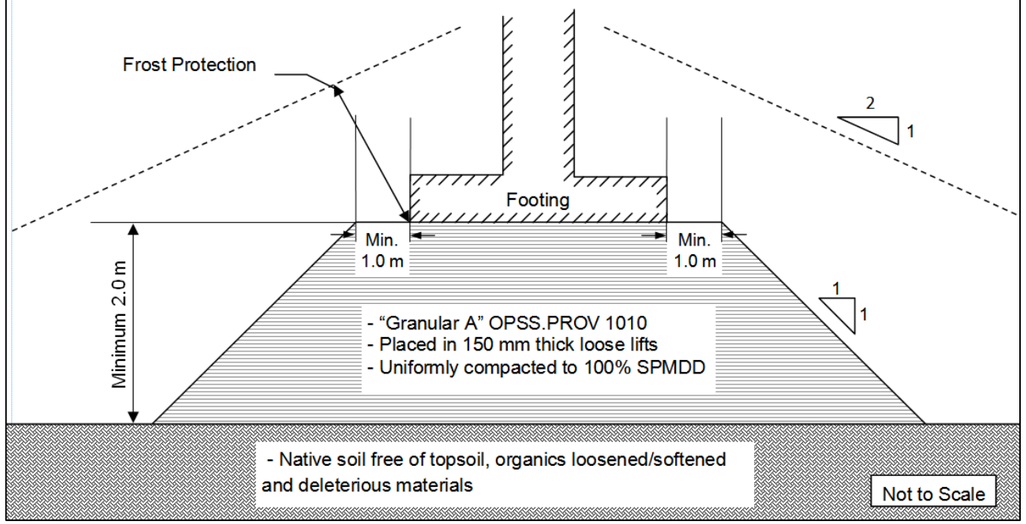
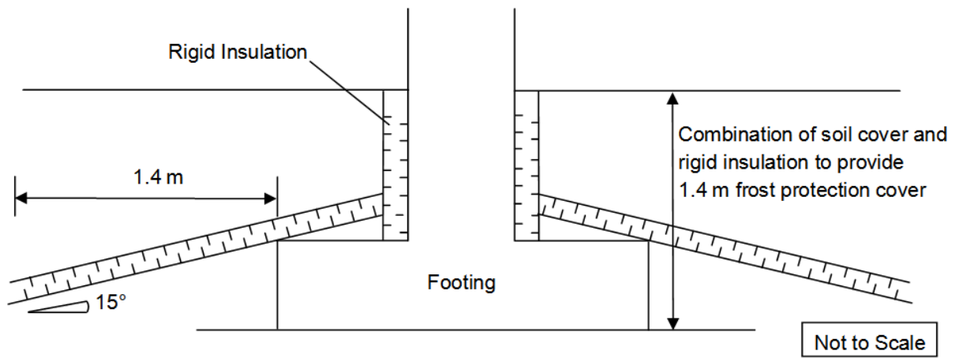


Figure 2: Typical Rigid Insulation

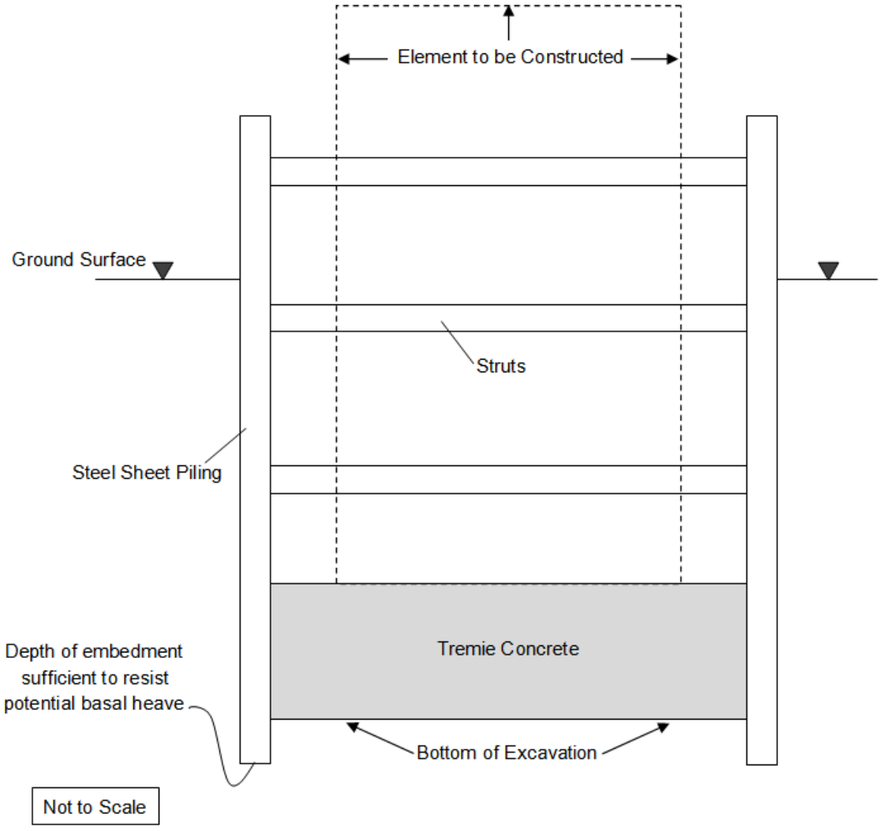


Note 1: Insulation to provide frost protection where sufficient soil cover can not be provided (25 mm extruded closed cell insulation thermally equivalent to 0.3 m soil cover)

Note 2: Refer to the following web sites for explicit information on rigid insulation application:

- http://msdssearch.dow.com/PublishedLiteratureDOWCOM/dh_0031/0901b803800311e8.pdf?filepath=styrofoam/pdfs/noreg/178-00542.pdf&fromPage=GetDoc
- http://insulation.owenscorning.ca/assets/0/188/1c2c8d2d-4fe5-4038-970c-9028b3af7414.pdf

Figure 3: Conceptual Cofferdam Construction



Note 1: Only a conceptual sketch is depicted. The contractor shall design a site specific cofferdam system.

LIST OF SYMBOLS

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

I. GENERAL

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

II. STRESS AND STRAIN

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

III. SOIL PROPERTIES

(a) Index Properties

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

(a) Index Properties (continued)

w	water content
w_1	liquid limit
w_p	plastic limit
I_p	plasticity index = $(w_1 - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_1 - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

(d) Shear Strength

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

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

Notes: 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

LIST OF ABBREVIATIONS

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

I. SAMPLE TYPE

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

II. PENETRATION RESISTANCE

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

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

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

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

III. SOIL DESCRIPTION

(a) Cohesionless Soils

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

(b) Cohesive Soils

Consistency

	c_u, s_u kPa	c_u, s_u psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	over 200	over 4,000

IV. SOIL TESTS

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

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

AUGUST 2009
Report No. 06-1111-012-6

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS $\bar{N}$.

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

COMPOSITION: SECONDARY SOIL COMPONENTS ARE DESCRIBED ON THE BASIS OF PERCENTAGE BY MASS OF THE WHOLE SAMPLE AS FOLLOWS:

PERCENT BY MASS	0 – 10	10 – 20	20 – 30	30 – 40	> 40
	TRACE	*SOME*	*WITH*	*ADJECTIVE (SILTY)*	*AND (AND SILT)*

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	>200
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	>50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	>3m
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE
F V	FIELD VANE		

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ε	%	LINEAR STRAIN
$\varepsilon_1, \varepsilon_2, \varepsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_{α}	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL
e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_l	%	LIQUID LIMIT
w_p	%	PLASTIC LIMIT
w_s	%	SHRINKAGE LIMIT
I_p	%	PLASTICITY INDEX = $w_l - w_p$
I_l	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	1	CONSISTENCY INDEX = $\frac{w_l - w}{I_p}$
DTPL		DRIER THAN PLASTIC LIMIT
APL		ABOUT PLASTIC LIMIT
WTPL		WETTER THAN PLASTIC LIMIT

e_{max}	1,%	VOID RATIO IN LOOSEST STATE
e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

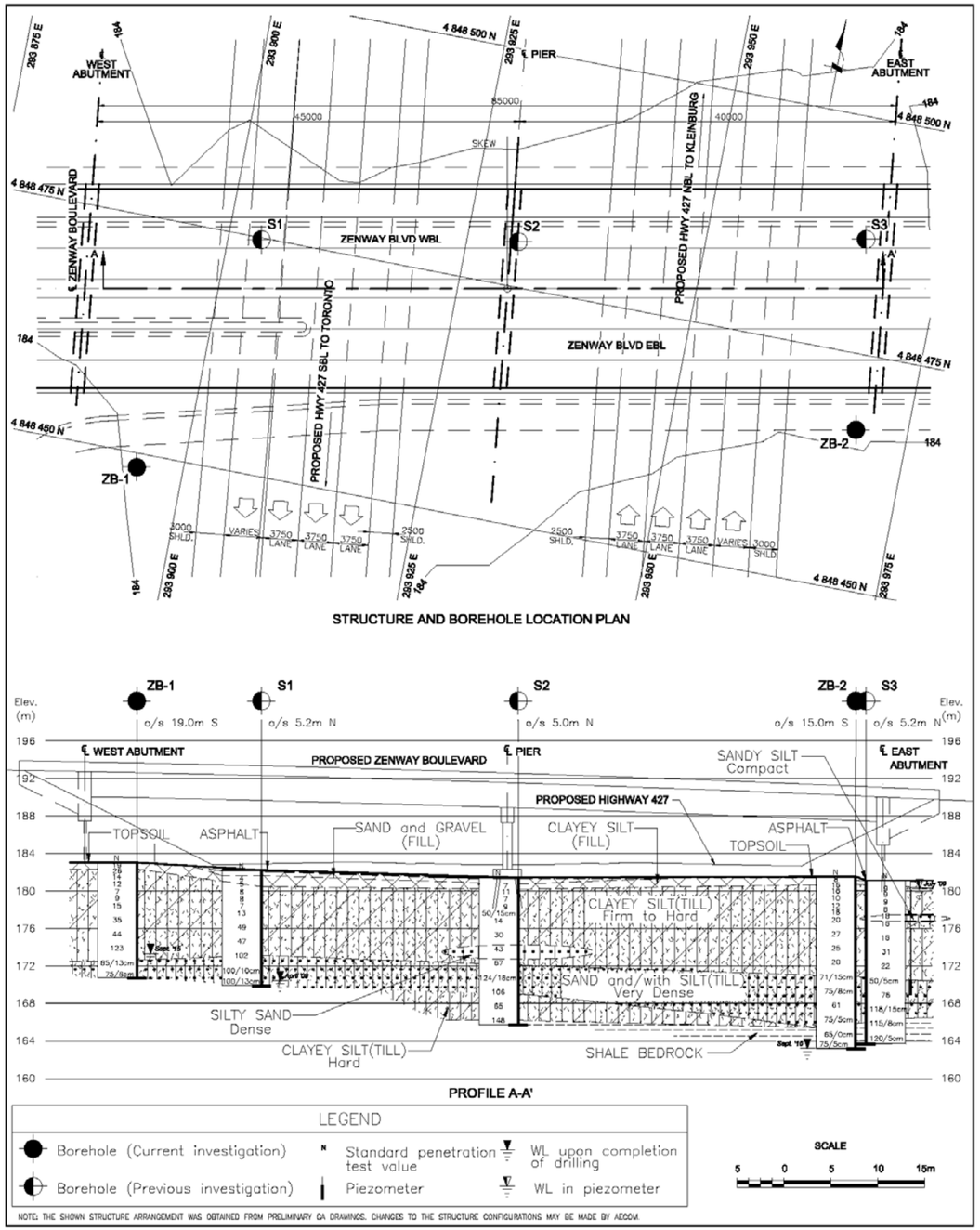
PART C
PRELIMINARY FOUNDATION INVESTIGATION AND DESIGN REPORT SHEETS

HIGHWAY 427 EXPANSION PROJECT
EXTENSION FROM HIGHWAY 7 TO MAJOR MACKENZIE DRIVE
CITY OF VAUGHAN, ONTARIO
ASSIGNMENT NO.: 2014-E-0056
WORK ORDER NO. 18

Structure Type: Underpass

Existing Ground Elevation across Boreholes: 183.0 m to 181.1 m

Complexity Rating: Medium



FOUNDATION INVESTIGATION

Site Description

The proposed structure is approximately 600 m north of Highway 7 and at the terminus of the interim arterial extension of Highway 427 at Zenway Boulevard, in the City of Vaughan, Ontario. The topography in the area of the proposed structure is nearly flat with scattered undulations on either side of the existing Zenway Boulevard.

Borehole Information

Borehole No.	Foundation Unit	MTM NAD 83 Coordinates		Ground Surface Elevation (m)	Borehole Depth (m)
		Northing (m)	Easting (m)		
Previous Investigation					
S1	West Abutment/ Centre Pier	4,848,474.8	293,903.5	182.2	12.3
S2	Centre Pier	4,848,479.8	293,930.4	181.4	15.7
S3	East Abutment	4,848,487.1	293,966.7	181.1	17.4
Current Investigation					
ZB-1	West Abutment	4,848,448.5	293,895.1	183.0	12.3
ZB-2	East Abutment	4,848,467.0	293,969.5	181.5	18.3

Subsurface Condition

***Pavement/Topsoil/Fill*:** Boreholes S1 to S3 were advanced from the road surface and encountered a 0.1 m thick layer of asphalt overlying a 0.7 m thick layer of non-cohesive fill extending to between Elevations 181.4 m and 180.3 m. Boreholes ZB-1 and ZB-2 were advanced from the shoulder of existing Zenway Boulevard and encountered an approximately 0.1 m thick layer of topsoil at Elevations 183.0 m and 181.5 m, respectively. All boreholes except Borehole S3, penetrated an approximately 0.5 m to 1.2 m thick layer of cohesive fill comprised of clayey silt, trace to some sand, trace to some gravel extending to Elevations 182.3 m and 180.1 m.

The SPT "N"-values ("N"-values) measured within the cohesive fill range from 4 to 19 blows, suggesting a firm to very stiff consistency.

***Clayey Silt Till (Upper)*:** A deposit of brown to grey cohesive till comprised of clayey silt, trace sand to sandy, trace gravel was encountered underlying the fill in all boreholes at 0.7 m to 1.3 m depths, Elevations 182.3 m to 180.1 m. Pockets of silty sand to sandy silt up to about 1.1 m thick was encountered within the till deposit in Boreholes S2 and S3 at 7.6 m and 3.7 m depths, Elevations 173.8 m and 177.4 m, respectively. The thickness of upper cohesive till deposit ranges from 7.3 m to 9.9 m, including the thickness of sandy silt and silty sand pockets. The deposit extends to depths from 9.1 m to 10.7 m, Elevations 173.1 m to 170.4 m.

The "N"-values measured within the upper cohesive till deposit range from 7 to 123 blows but generally greater than 8 blows, suggesting generally a stiff to hard consistency. The results of grain size distribution analyses and Atterberg limits tests of selected upper cohesive till samples obtained during the current investigation are shown on Figures A-1 and A-2, respectively.

***Sand and/with Silt Till*:** A non-cohesive till deposit comprised of sand and silt to silt with sand was encountered underlying the upper cohesive till deposit in all boreholes at depths from 9.1 m to 10.7 m, Elevations 173.1 m to 170.4 m. Boreholes ZB-1 and S1 were terminated within this deposit at practical refusal (3 m of "100 blow" soil) penetrating this deposit for 1.8 m and 3.2 m at 12.3 m depth, Elevations 170.7 m and 169.9 m, respectively. In other boreholes, the thickness of the deposit ranges from 2.9 m to 3.9 m, extending to depths from 12.2 m to 14.6 m, Elevations 169.2 m to 166.5 m.

The "N"-values measured within the non-cohesive till deposit range from 61 blows per 0.30 m of penetration to 124 blows per 0.18 m of penetration, indicating a very dense compactness. The results of grain size distribution analyses of selected non-cohesive till samples obtained during the current investigation are shown on Figure A-3.

***Clayey Silt Till (Lower)*:** Borehole S2 encountered a 3.0 m thick deposit of clayey silt till at 12.2 m depth, Elevation 169.2 m.

Within the lower cohesive till deposit, "N"-values of 65 and 106 blows were measured, suggesting a hard consistency. The result of an Atterberg limits test of selected lower cohesive till sample obtained during the current investigation is shown on Figure A-4.

***Shale Bedrock*:** Boreholes S2, S3 and ZB-2 penetrated highly weathered shale bedrock underlying the till deposit at 14.6 m to 16.1 m depths, Elevations 166.5 m and 165.4 m. All these boreholes terminated at practical refusal penetrating the shale bedrock for about 0.5 m to 2.8 m.

Groundwater Conditions

Sub-artesian condition was noted in Borehole S3 within the sand and silt till deposit with groundwater level measured at 0.9 m depth, Elevation 180.2 m. The water level in other boreholes during and upon completion of drilling was at 9.7 m to 18.3 m depths, Elevations 173.3 m to 163.2 m. For further details refer to Table A2 of this report.

FOUNDATION RECOMMENDATIONS

The following site-specific foundation recommendations are for preliminary design and planning purposes only and require refinement during detail design. Project-wide foundation recommendations, design assumptions and limitations are contained in Part B of this report. The proposed two-span underpass structure will carry Zenway Boulevard over Highway 427.

Foundation Option	Advantages	Disadvantages	Relative Costs	Risks/Consequences
Spread footings on firm to stiff clayey silt till or on "Granular A" pad.	• Conventional construction.	• Precludes use of integral abutments; • Provides low bearing capacity for support of abutments/ pier.	• Lower relative cost compared to deep foundation options.	• Disturbing of subgrade due to excavation; • Risk of improper compaction of "Granular A" pad.
Driven steel H-Piles to found within "100-blow" soils	• Allows for integral abutment design; • Negligible post-construction settlement.	• Piles may encounter obstructions during driving.	• More costly than spread footings.	• Minor potential for pile damage/ deflection if obstructions are encountered during pile driving.
Caissons founded within "100-blow" soils	• Provides higher capacity than driven piles.	• Precludes use of integral abutments; • Drilling mud and tremie techniques would be required for construction.	• More costly than driven steel H-piles.	• Risk of loosening or disturbing founding soils at base of caissons due to the presence of sub-artesian in the sand and silt till deposit.

Spread Footings

Spread footings founded on native soils were considered to support the abutments and pier. However, the bearing resistances at normal depths would be less than required for design as indicated by the preliminary geotechnical resistances at the ground interface presented in the following table.

Foundation Unit	Founding Stratum	Axial Geotechnical Resistance < 25mm settlement		Highest Founding Elevation within Native Soils (m)
		Factored ULS (kPa)	SLS (kPa)	
West Abutment	Firm to Stiff Clayey Silt Till	150	100	180.0 – 182.0
Centre Pier				180.0
East Abutment				180.0

Consequently, the alternative of spread footings on a Granular A pad of minimum 2 m thickness is recommended for preliminary design purposes assuming a factored geotechnical resistance at ULS of 750 kPa and geotechnical resistance at SLS of 300 kPa.

Driven Steel H-Pile/ Steel Pipe Piles

Steel H-piles 310x110 and Steel pipe piles, 324 mm (12 ¾ in) outer diameter and 6 mm (1/4 in) thickness, driven to refusal within the hard/very dense till soils may be used to support the abutments and pier. The preliminary geotechnical resistances and estimated tip elevations are as follows:

Foundation Unit	Axial Geotechnical Resistance		Approximate Pile Tip Elevation (m)
	Factored ULS (kN)	SLS (kN)	
West Abutment	1,600	1,200	172
Centre Pier	1,600	1,200	169
East Abutment	1,600	1,200	166

Driven piles should be controlled by Hiley Formula as per MTO Drawing SS-103-11 from 2 m above the approximate pile tip elevations, employing a maximum load of twice the factored geotechnical resistance at ULS per pile.

Caissons

Caissons founded within the hard/very dense till soils may be considered for support of the abutments and pier. The preliminary geotechnical resistances are as follows:

Foundation Unit	Caisson Diameter (m)	Axial Geotechnical Resistance		Caisson Base Elevation (m)
		Factored ULS (kN)	SLS (kN)	
West Abutment	1.2	5,000	4,000	172
	1.5	6,500	5,000	
Centre Pier	1.2	5,000	4,000	169
	1.5	6,500	5,000	
East Abutment	1.2	5,000	4,000	171
	1.5	6,500	5,000	

Recommended Foundation Alternative

The recommended foundation alternative at this site is driven steel H-piles into the hard/very dense till soils for the abutments and pier. Spread footings on engineered fill pads may be considered for the pier. Driven piles are preferred over caissons due to the presence of sub-artesian condition in the sand and silt till deposit.

Structure Abutments and Approaches

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

Construction of the underpass will require placement of up to about 9.0 m and 10.5 m of fill within the limits of the west and east approach embankments, respectively.

Structure Retaining Walls/Wing Walls

Earth retaining walls for this structure may include Cast-in-Place (CIP) or RSS Walls above the high water levels. For RSS walls the levelling pads of the facing may be founded on granular pad or CIP leveling pad. The retaining walls geometry should conform to High Appearance and High Performance in accordance with MTO.DSM 9.70 and current RSS Design Guidelines. The CIP retaining walls should be designed in conformance with the spread footing recommendation in this report.

Stability of Approach Embankments

Approach embankments constructed of suitable earth or granular fill and up to 10.5 m high are expected to be stable at side slopes of 2H:1V. For embankments equal to or greater than 8.0 m in height, a minimum of 2.0 m wide berm should be provided such that the uninterrupted slope height does not exceed 8.0 m.

Settlement of Approach Embankments

The settlement within founding soils is estimated to be in the order of 75 mm, most of which is expected to occur within three (3) months after the fill placement. Based on preliminary estimations, consideration should be given to preloading approach embankments for a period of three (3) months to mitigate the post-construction settlement.

Requirements for mitigation of downdrag loads by preloading should be considered during detail design for deep foundations.

Construction Considerations

Excavation

The construction of engineered fill pads for the piers will require excavations up to about 3 m below the existing Zenway Boulevard grade. These excavations will be made through existing fill and into firm to stiff clayey silt till which are classified as Type 3 soils in OHSA. Temporary unsupported excavations above the prevailing groundwater in these soils should be made with slopes no steeper than 1H:1V.

Surface Water / Groundwater Control

Surface water run-off should be diverted away from the excavations at all times.

The prevailing groundwater should be maintained a minimum of 0.5 m below the base of excavations. The groundwater level measured in the piezometer screened within the sand and silt till deposit at this site was at 0.9 m depth, Elevation 180.2 m. It is expected that shallow excavations for construction of spread footings/pile caps will be above the prevailing groundwater level. The minimal inflow of groundwater into excavations is expected to be handled by pumping from properly filtered sumps placed at the base of the excavations.

Pile Installation / Caisson Construction

It is anticipated that cobbles and/or boulders will be encountered within the till deposit, which may adversely impact the installation of steel H-piles or caissons. Piles should be equipped with flange plates or approved driving shoes.

For caisson foundations, sub-artesian pressure was noted within the sand and silt till deposit and consideration should be given to using drilling mud and tremie concrete placement technique to minimize the potential for basal heave. Water-bearing non-cohesive native soils (sandy silt to silty sand pockets and non-cohesive till) should be expected to run or flow into the caisson hole during and after the drilling for the caisson foundations and as such, appropriate equipment and procedures (including use of temporary or permanent caisson liners) will be required to minimize ground loss during drilling and concrete placement.

Recommendation for Additional Work

Further subsurface investigation should be carried out during the detail design to confirm the subsoil and groundwater conditions at the location of approach embankments and west abutment. It is also recommended to carry out additional in situ and laboratory testing (consolidation tests for the upper cohesive till) to confirm the estimated total settlements and to refine mitigation options.

Non Standard Special Provisions (NSSP)

NSSP – Surface Water Control and Dewatering (Addition to OPSS 902)

The Contractor shall take measures for necessary surface water diversions and drainage and to lower the prevailing groundwater level a minimum of 0.5 m below the base of excavations for work in-the-dry in overburden and to the bedrock surface for work in-the-dry in bedrock.

NSSP – Installation of Shoring (Addition to OPSS 539)

The Contractor shall be advised that cobbles, boulders and rockfill may be encountered during the excavation and that the Contractor shall use appropriate methods for shoring installation.

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No ZB-1 1 of 1 METRIC

G.W.P. _____ LOCATION Coords: 4 848 448.5 N; 293 895.1 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE September 30, 2015 CHECKED BY A.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
183.0	Ground Surface								
182.9 / 0.1	TOPSOIL								
	CLAYEY SILT, some sand, trace gravel		1	SS	19				
182.3 / 0.7	Very Stiff Brown Moist (FILL)		2	SS	26				
	CLAYEY SILT, trace to some sand, trace gravel Firm to Hard Brown, becoming grey below a depth of 3.0m Moist (TILL)		3	SS	14				
			4	SS	12				
			5A	SS	7				5 20 42 33
			5B	SS					
			6	SS	9				
			7A	SS	15				
			7B	SS					
			8	SS	35				
			9	SS	44				1 9 72 18
			10	SS	123				
172.5 / 10.5	SILT, with sand, trace clay, trace gravel Very dense (TILL)		11	SS	85/13cm				1 26 68 5 Sampler bouncing Auger grinding between 11.6m and 12.2m Sampler bouncing
170.7 / 12.3	End of borehole Split spoon sampler refusal		12	SS	75/8cm				

▽ Water level noted during drilling

▼ Water level measured upon completion

Note:

1. Groundwater level measured at a depth of 9.7m below groundwater surface (Elev.173.3m) upon completion of drilling.

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 (%) 10 20 30

ON MTO_NEW LOGO HWY 427 15TF013A-REV.GPJ ON_MOT.GDT 15/01/2016 9:35:42 AM

+7, ×5: Numbers refer to Sensitivity (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No ZB-2 1 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 848 467.0 N; 293 969.5 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE September 30, 2015 CHECKED BY A.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
181.5	Ground Surface								
181.4 / 0.1	TOPSOIL								
	CLAYEY SILT, some sand, some gravel		1	SS	8				
180.8 / 0.7	Firm Brown Moist (FILL)		2	SS	16				
	CLAYEY SILT, some sand to sandy, trace gravel, Stiff to very stiff Grey Moist (TILL)		3	SS	18				
			4	SS	10				3 20 48 29
			5	SS	12				
			6	SS	16				
			7	SS	20				5 24 46 25
			8	SS	27				
			9	SS	25				
			10	SS	20				
171.4 / 10.1	SILT and SAND, trace gravel, trace clay Very dense Grey Moist (TILL)		11	SS	71/15cm				8 46 42 4 Auger grinding at 11.7m Sampler bouncing
168.3 / 13.2	CLAYEY SILT, some sand, trace gravel Hard Grey Moist (TILL)		12	SS	75/8cm				
	Cont'd		13	SS	61				

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 (%) 10 20 30

ON MTO_NEW LOGO HWY 427 15TF013A-REV.GPJ ON_MOT.GDT 15/01/2016 9:35:43 AM

+7, ×5: Numbers refer to Sensitivity (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No ZB-2 2 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 848 467.0 N; 293 969.5 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE September 30, 2015 CHECKED BY A.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
166.5								
	shale fragments below a depth of 15.1m		14	SS	75/75cm		166	Sampler bouncing
165.4								
16.1	SHALE BEDROCK Highly weathered Grey		15	SS	65/0cm		165	Auger grinding at 16.5m Sampler bouncing
163.2						▼	164	
			16	SS	75/5cm			Sampler bouncing
18.3	End of borehole							

▼ Water level measured upon completion

Note:

1. Groundwater level measured at a depth 18.3m below ground surface (Elev. 163.2m) upon completion of drilling.

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 (%) — 10 20 30

UNIT WEIGHT γ kN/m³

+⁷, ×⁵: Numbers refer to Sensitivity

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

RECORD OF BOREHOLE No S1

1 OF 1 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4848474.8 ;E 293903.5 | ORIGINATED BY TB
W.O. 05-20012 | | COMPILED BY PKS/VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE April 27, 2009

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 (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
182.2	GROUND SURFACE						182				
0.0 / 0.1	ASPHALT										
	Sand and gravel (FILL) Brown Moist										
181.4							181				
0.8	Clayey silt, trace to some sand, trace gravel (FILL) Firm Brown grey Moist		1	SS	4						
180.4							180				
1.8	CLAYEY SILT, some sand, trace gravel (TILL) Firm to hard Grey Moist		2	SS	5						
			3	SS	8		179				5 23 45 27
			4	SS	8						
			5	SS	7		178				
			6	SS	13		177				
			7	SS	49		176				
			8	SS	47		175				
							174				
173.1											
9.1	SAND and SILT, trace gravel, trace clay (TILL) Very dense Grey Moist, becoming wet below a depth of 9.3 m		9	SS	102		173				4 45 49 2
			10	SS	00/0.10	▽	172				
							171				
169.9			11	SS	00/0.11		170				
12.3	END OF BOREHOLE										

NOTES:

1. Water level in open borehole at a depth of 11.8 m below ground surface (Elev. 170.4 m) upon completion of drilling.
2. Borehole backfilled with bentonite.

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

RECORD OF BOREHOLE No S2

1 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4848479.8 ;E 293930.4 | ORIGINATED BY JEB
W.O. 05-20012 | | COMPILED BY PKS/VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE April 17, 2009

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 (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
181.4	GROUND SURFACE						181				
0.0 / 0.1	ASPHALT										
	Sand and gravel (FILL) Brown Moist										
180.6							180				
0.8	Clayey Silt, trace sand, trace gravel (FILL) Firm Brown grey Moist		1	SS	7						
180.1 / 1.3	CLAYEY SILT, some sand, trace gravel, containg cobbles and boulders (TILL) Stiff to hard Brown Moist		2	SS	11		179				
			3	SS	7						
			4	SS	9		178				
	Becoming grey at 2.3 m depth		5	SS	50/0.15						
	Containing sandy silt layer at a depth of 3.8 m Containing cobble/boulder at a depth of 4.1 m		6	SS	14		177				
			7	SS	30		176				
173.8							175				
7.6	Silty SAND, trace gravel, trace clay Dense Grey Moist		8	SS	43		174				
172.7											
8.7	CLAYEY SILT, trace sand, trace gravel (TILL) Hard Grey Moist						173				
172.1 / 9.3	SAND and SILT, trace gravel, trace clay (TILL) Very dense Grey Wet		9	SS	67		172				
			10	SS	24/0.15		171				2 33 63 2
							170				
169.2											
12.2	CLAYEY SILT, trace to some sand and gravel, trace shale fragments (TILL) Hard Grey Moist		11	SS	106		169				
							168				
			12	SS	65		167				

Continued Next Page

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S2

2 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4848479.8 ;E 293930.4
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE April 17, 2009

ORIGINATED BY JEB
COMPILED BY PKS/VA
CHECKED BY SMM

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
166.2	— CONTINUED FROM PREVIOUS PAGE —										
15.2 / 165.7	SHALE (BEDROCK) Grey		13	SS	148		166				
15.7	END OF BOREHOLE NOTES: 1. Open borehole dry upon completion of drilling. 2. Borehole backfilled with bentonite. * Elevated SPT 'N' values indicate that the spoon was likely pentrating a cobble.										

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S3

1 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4848487.1 ;E 293966.7
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE April 16, 2009

ORIGINATED BY JEB
COMPILED BY PKS/VA
CHECKED BY SMM

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
181.1	GROUND SURFACE						181				
0.0	ASPHALT										
0.7 / 180.3	Sand and gravel (FILL) Brown Moist										
0.8	CLAYEY SILT, some sand, trace gravel (TILL) Stiff Grey Moist		1	SS	9		180				
			2	SS	9		179				
			3	SS	9						2 23 48 27
177.4			4	SS	8		178				
3.7	Sandy SILT, trace clay Compact Grey Moist		5	SS	18		177				
176.7											
4.4	CLAYEY SILT, some sand, trace gravel (TILL) Very stiff to hard Grey Moist		6	SS	18		176				
			7	SS	18		175				
							174				
			8	SS	31		173				
			9	SS	22		172				
							171				
170.4											
10.7	SAND and SILT, trace gravel, trace clay, containing cobbles (TILL) Very dense Grey Wet Containing cobbles between depths of 11.0 m and 11.6 m		10	SS	50/0.05		170				
			11	SS	76		169				3 38 57 2
							168				
			12	SS	18/0.1						
166.5							167				
14.6	SHALE (BEDROCK) Grey										

Continued Next Page

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S3

2 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4848487.1 ;E 293966.7
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE April 16, 2009

ORIGINATED BY JEB
COMPILED BY PKS/VA
CHECKED BY SMM

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, × REMOULDED; 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —										
	SHALE (BEDROCK) Grey		13	SS	15/0.0		166				
							165				
163.7			14	SS	20/0.0		164				
17.4	END OF BOREHOLE										

NOTES:

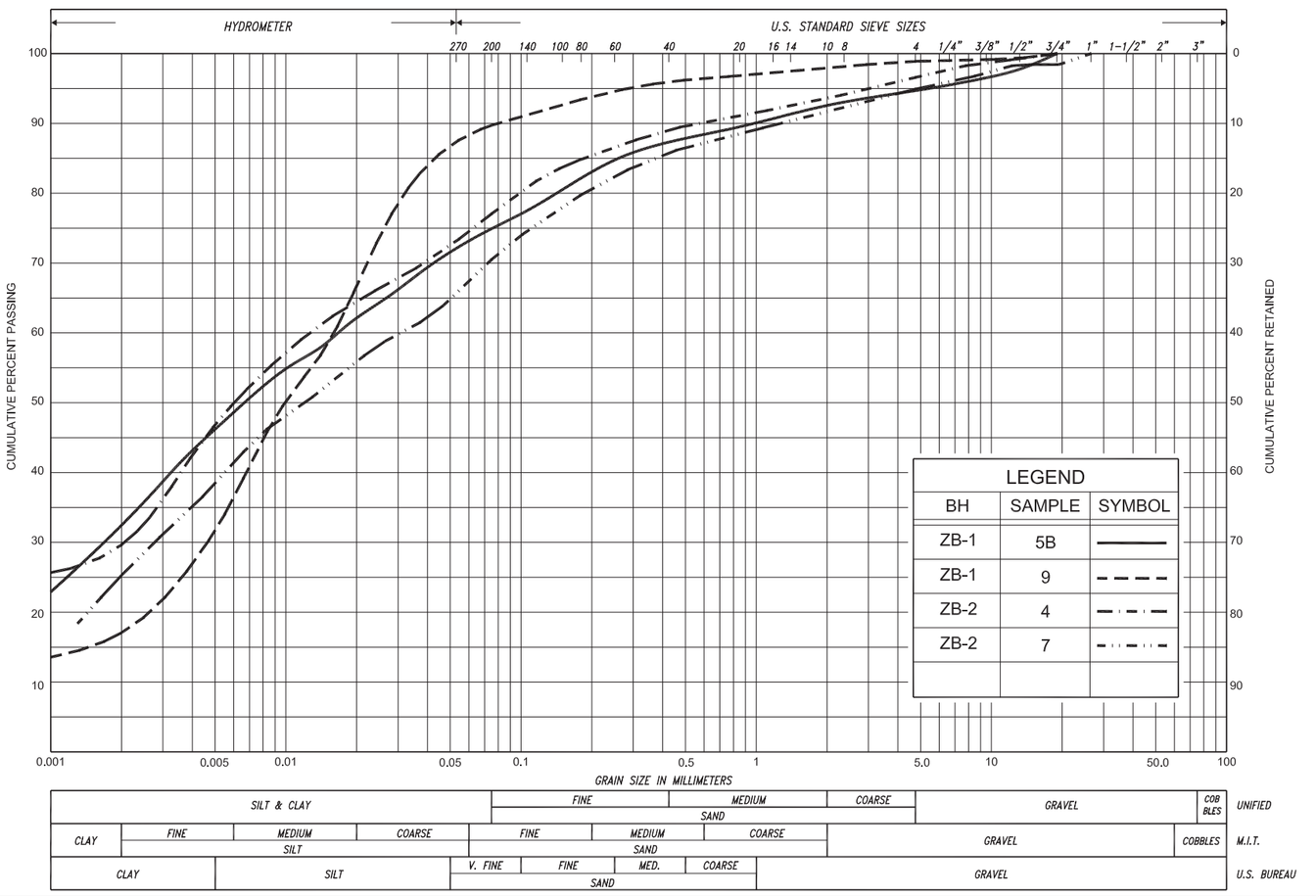
1. A 50 mm diameter monitoring well was installed at a depth of 16.8 m (Elev. 164.3 m).

Water level measurements

Date	Depth	Elev.
On Completion	10.7 m	170.4 m
May 13, 2009	1.3 m	179.8 m
June 15, 2009	0.9 m	180.2 m
July 09, 2009	0.9 m	180.3 m

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

$O^{3\%}$ STRAIN AT FAILURE

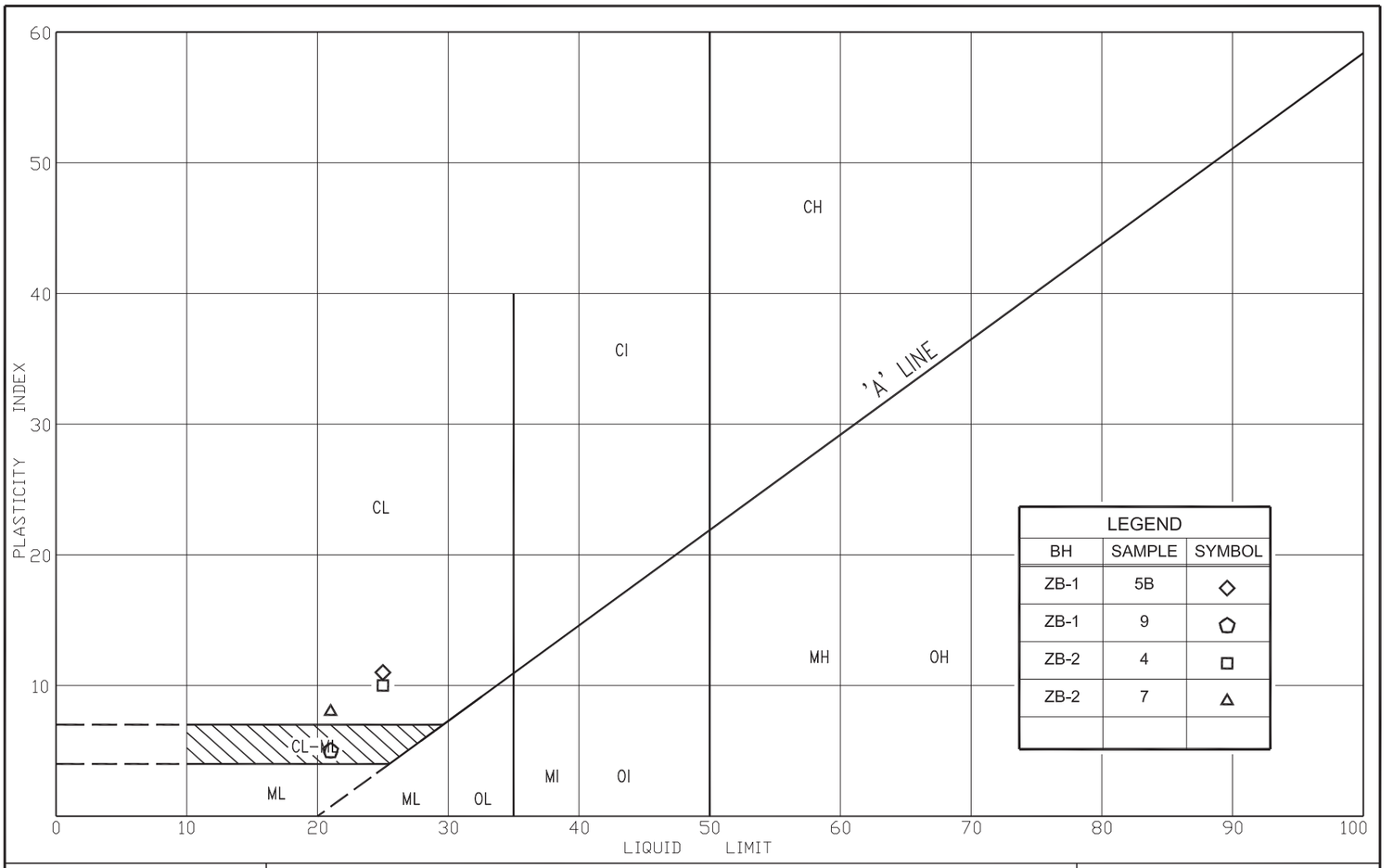


Ontario

GRAIN SIZE DISTRIBUTION

(SANDY) CLAYEY SILT (TILL) - Upper

FIG No.	A-1
HWY:	427
G.W.P. No.	

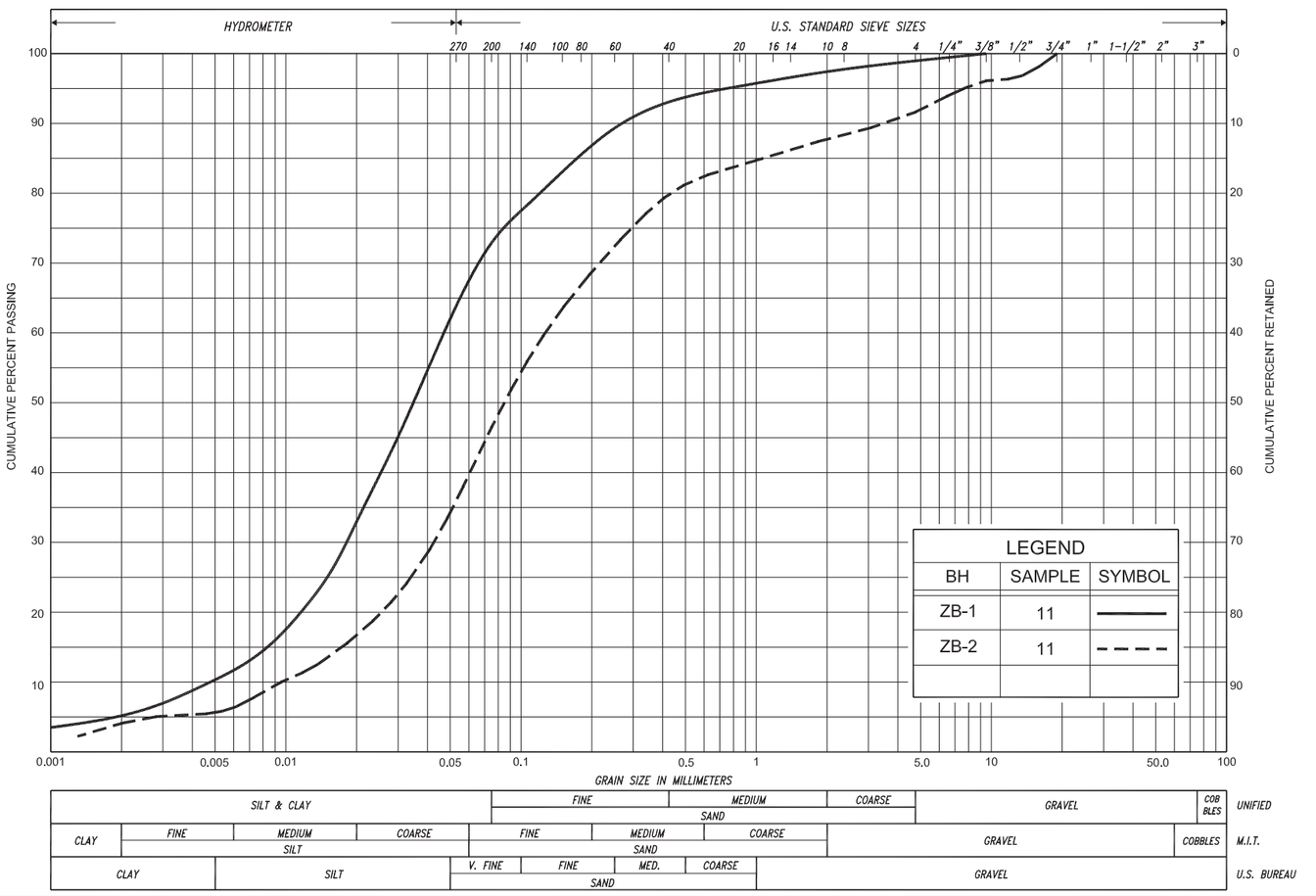


Ontario

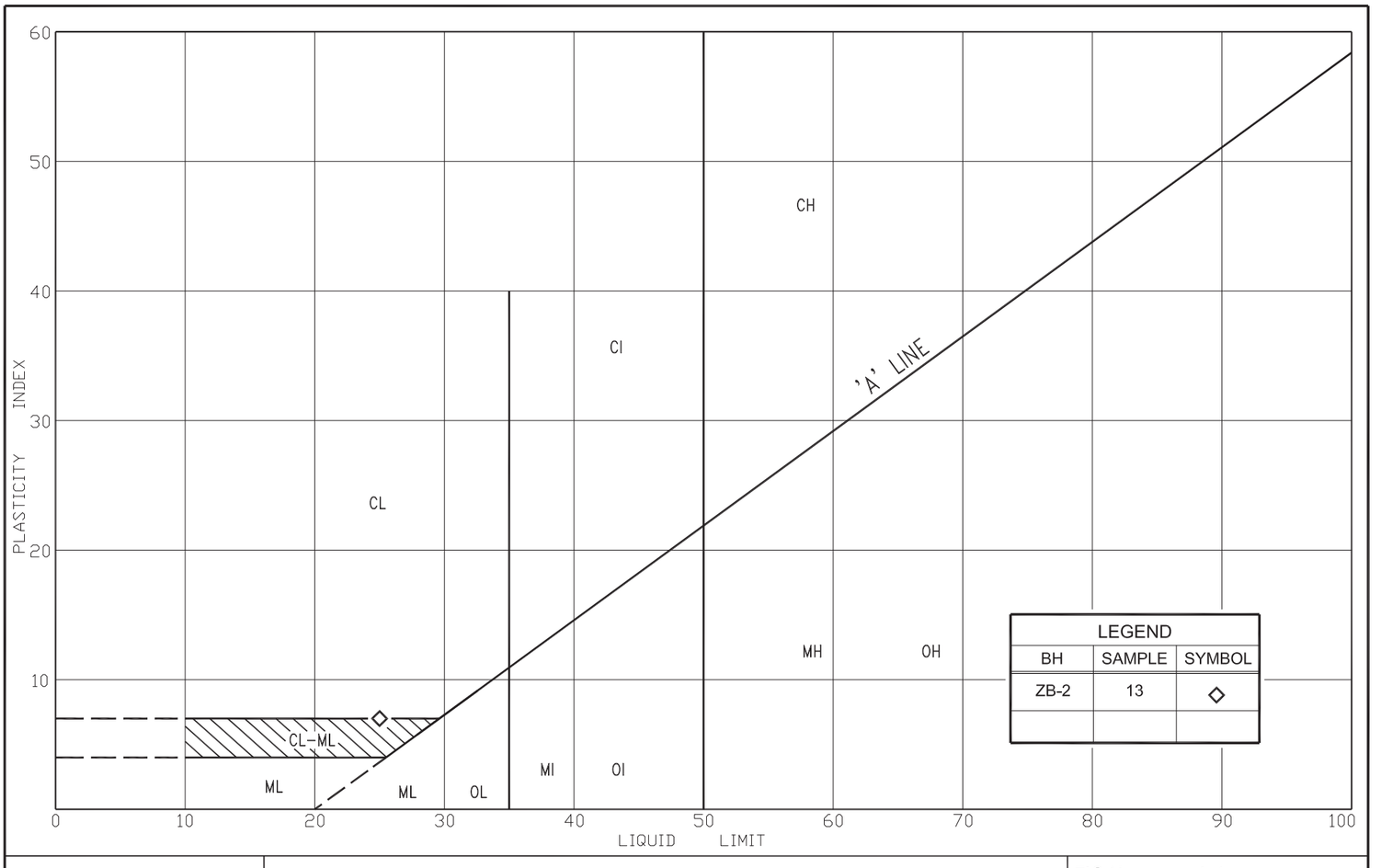
PLASTICITY CHART

CLAYEY SILT (TILL) - Upper

FIG No.	A-2
HWY:	427
G.W.P. No.	



Ontario	GRAIN SIZE DISTRIBUTION SILT, with sand to SAND and SILT (TILL)	FIG No. A-3 HWY: 427 G.W.P. No.

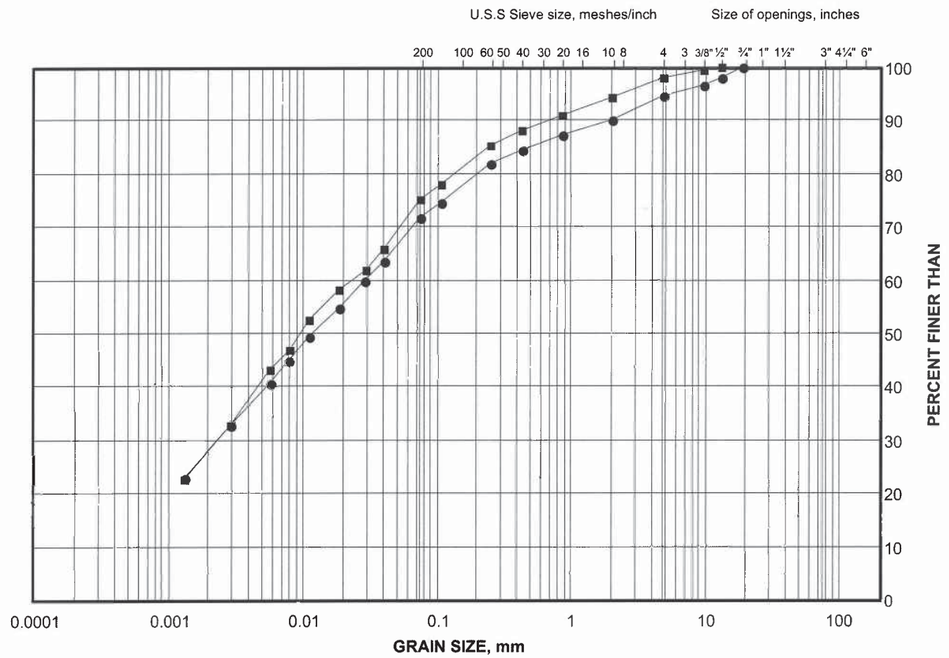


Ontario	PLASTICITY CHART CLAYEY SILT (TILL) - Lower	FIG No. A-4 HWY: 427 G.W.P. No.

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt Till (Upper Cohesive Till)

FIGURE B1



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

LEGEND

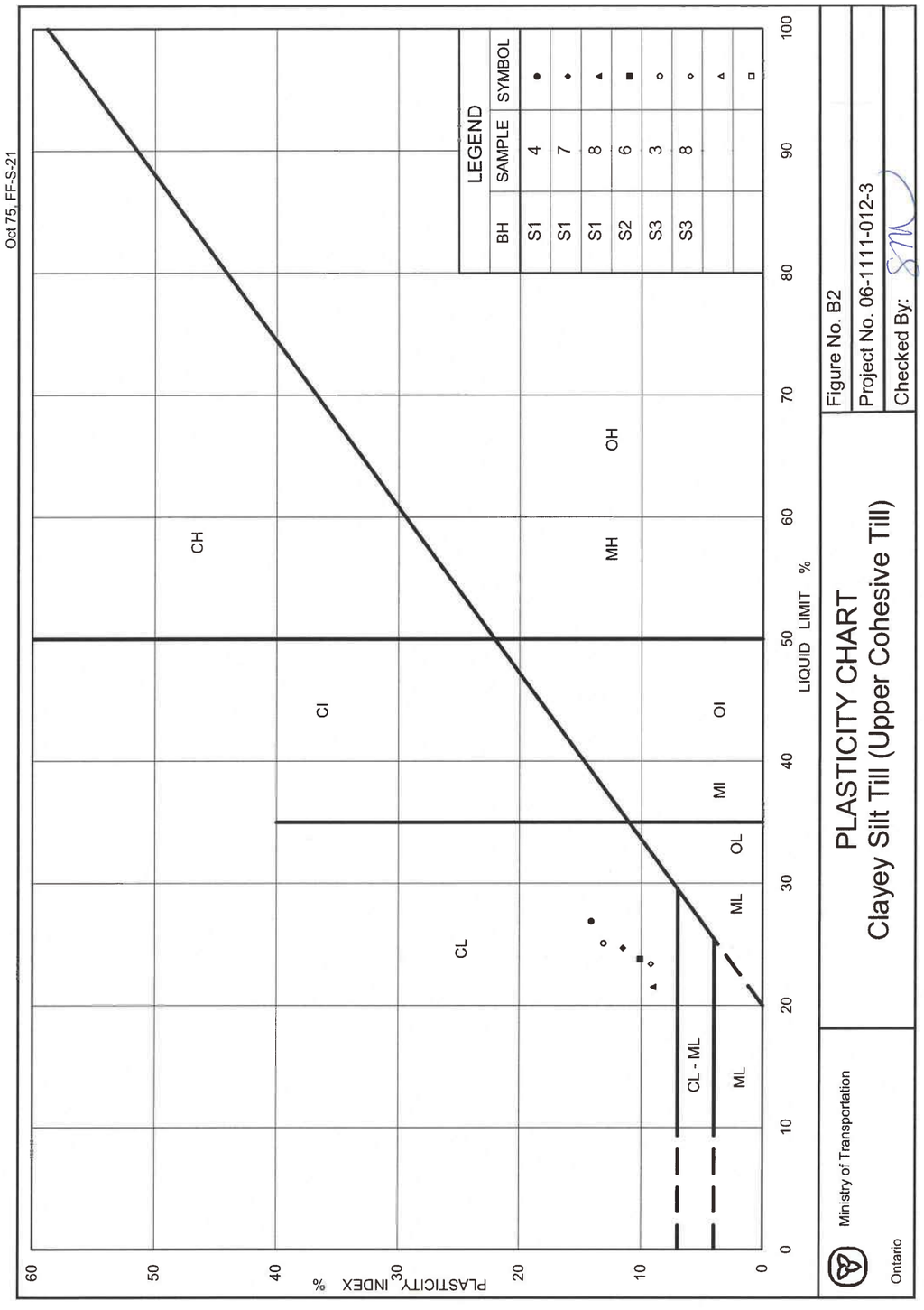
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S1	3	179.6
■	S3	3	179.5

Project Number: 06-1111-012-3

Checked By: SM

Golder Associates

Date: 04-Aug-09



PLASTICITY CHART

Clayey Silt Till (Upper Cohesive Till)

Figure No. B2

Project No. 06-1111-012-3

Checked By: SM

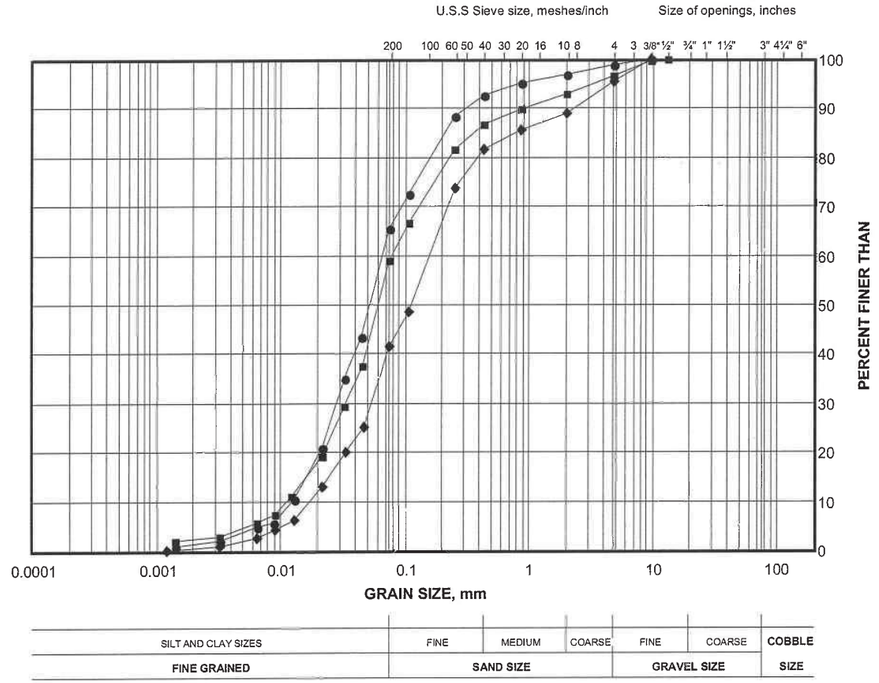
Ministry of Transportation

Ontario

GRAIN SIZE DISTRIBUTION TEST RESULTS

Sand and Silt Till

FIGURE B3



LEGEND

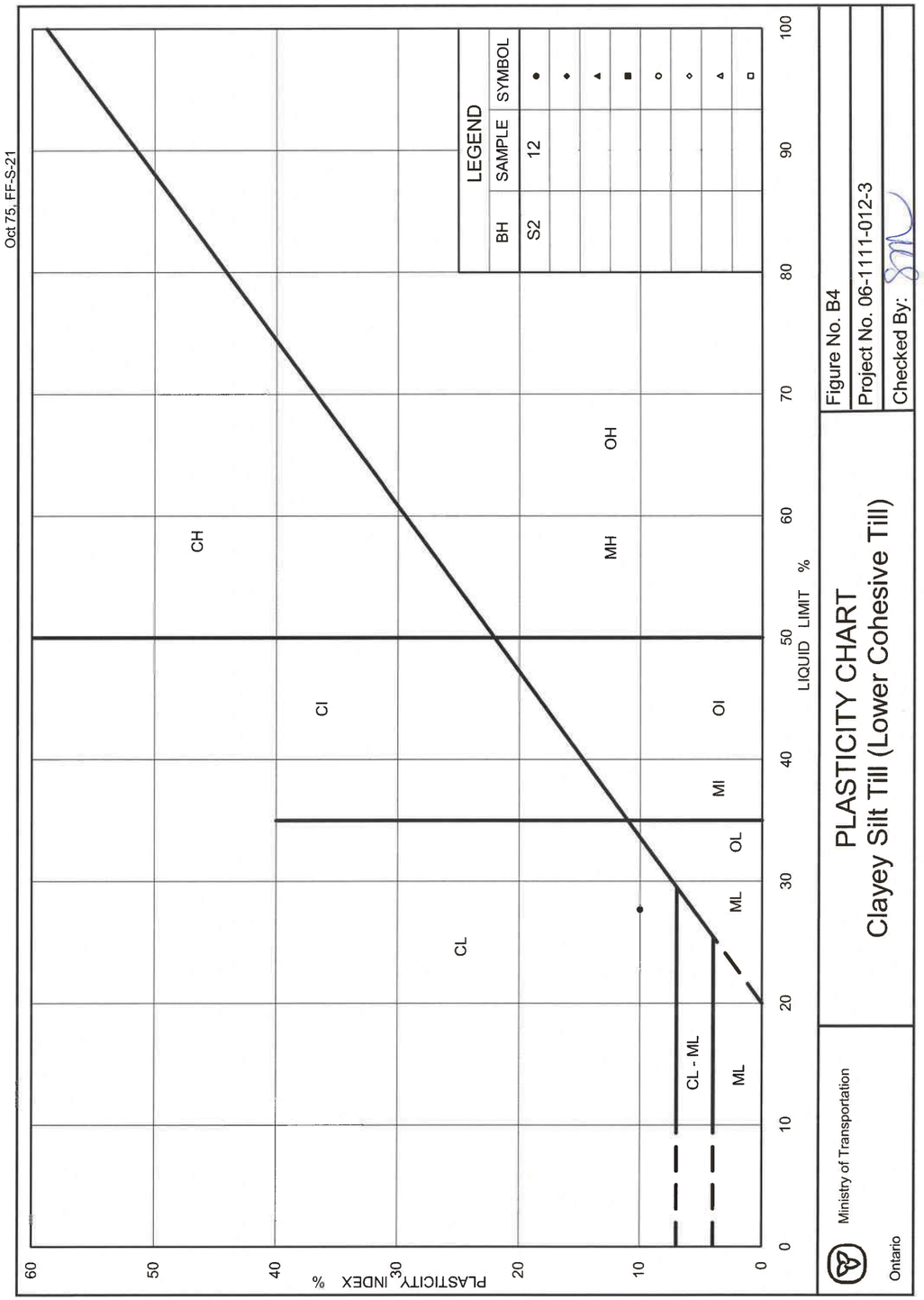
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S2	10	170.4
■	S3	11	168.6
◆	S1	9	172.7

Project Number: 06-1111-012-3

Checked By: SM

Golder Associates

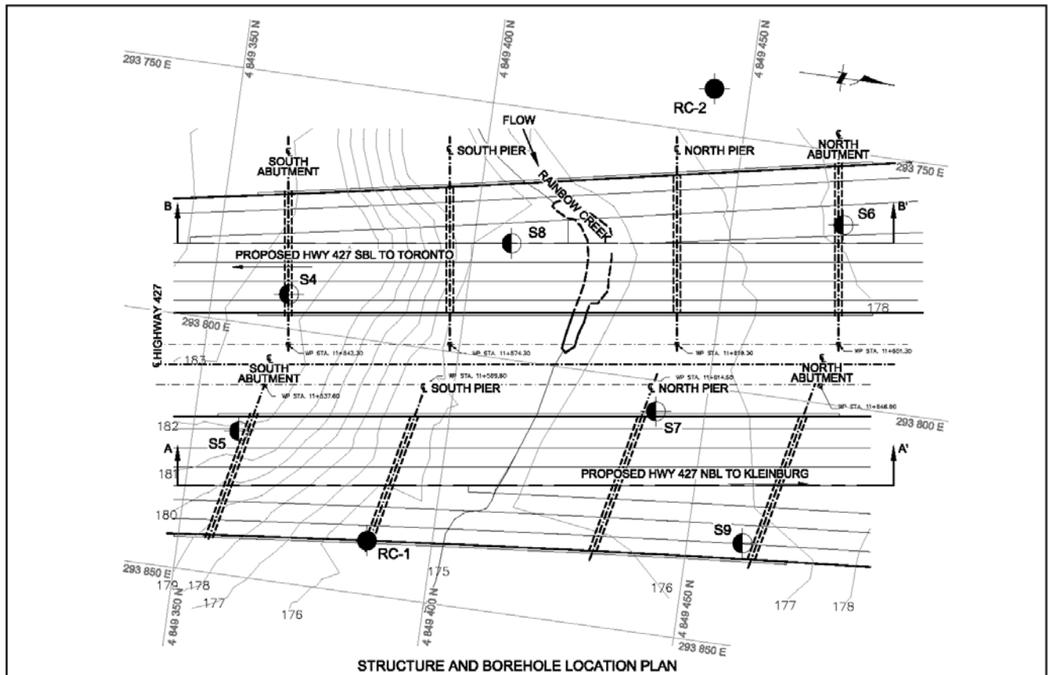
Date: 01-Jun-09

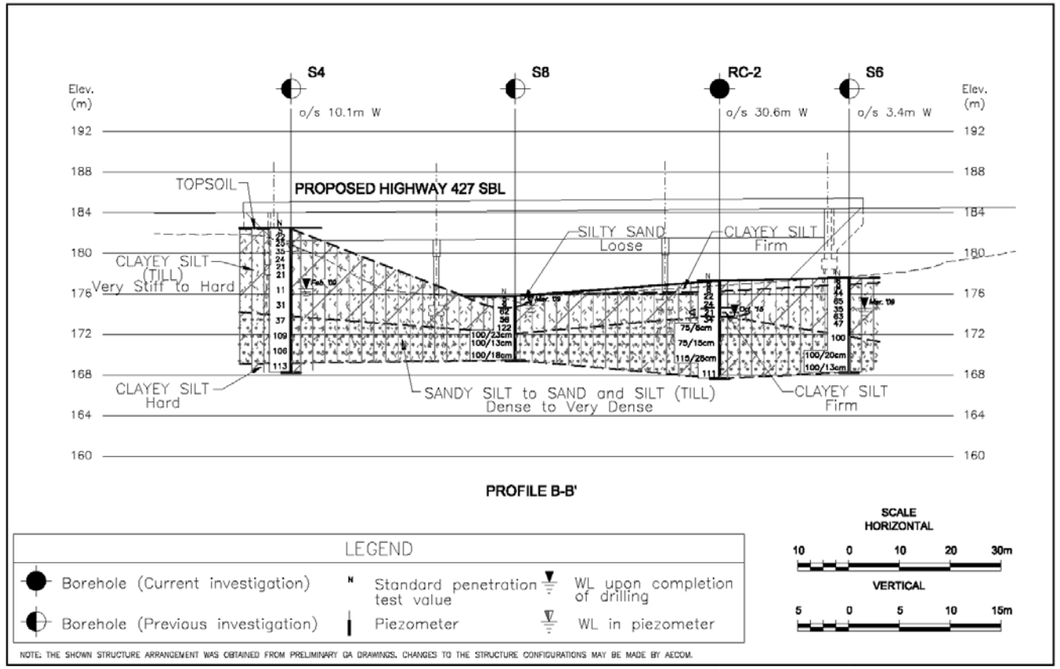


Structure Type: Bridges

Existing Ground Elevation across Boreholes: 182.5 m to 175.7 m

Complexity Rating: Medium





FOUNDATION INVESTIGATION

Site Description

The proposed structures are approximately 400 m north of the terminus of Rainbow Creek Drive and 550 m south of Langstaff Road, in the City of Vaughan, Ontario. The proposed bridge structures will be located within the valley of the Rainbow Creek. The up to about 8 m high valley slopes are moderately to densely treed, and slope downward to the approximately 80 m wide creek floodplain.

Borehole Information

Borehole No.	Foundation Unit	MTM NAD 83 Coordinates		Ground Surface Elevation (m)	Borehole Depth (m)
		Northing (m)	Easting (m)		
Previous Investigation					
S4	South Abutment of SBL Structure	4,849,365.1	293,793.2	182.5	14.2
S5	South Abutment of NBL Structure	4,849,359.7	293,821.4	181.6	14.0
S6	North Abutment of SBL Structure	4,849,472.0	293,764.4	177.6	9.3
S7	North Pier of NBL Structure	4,849,440.3	293,806.1	175.8	9.3
S8	South Pier of SBL Structure	4,849,407.4	293,777.1	175.8	6.3
S9	North Abutment of NBL Structure	4,849,460.9	293,829.6	176.0	7.9
Current Investigation					
RC-1	South Pier of SBL Structure	4,849,387.2	293,839.4	175.7	9.6
RC-2	North Pier of NBL Structure	4,849,442.0	293,736.3	177.3	9.6

Subsurface Condition

***Topsoil*:** Approximately 0.1 m to 0.2 m thick layer of topsoil was encountered at the ground surface in Boreholes S4, S5 and RC-2 at between Elevation 182.5 m and 177.3 m.

***Clayey Silt / Silty Sand (Surficial)*:** Boreholes S6, S7, S9, RC-1 and RC-2 penetrated an approximately 0.6 m to 1.3 m thick clayey silt deposit immediately below the ground surface or below the topsoil at between Elevations 177.6 m and 175.7 m. Borehole S8 penetrated a 1.5 m thick layer of silty sand immediately below ground surface at Elevation 175.8 m. These surficial layers generally contain trace organics and rootlets inclusions.

The SPT "N"-values ("N"-values) measured within the cohesive layer range from 4 to 8 blows, suggesting a firm consistency. "N"-values of 5 and 9 blows were measured within the silty sand layer, indicating a loose compactness.

***Clayey Silt to Silty Clay Till (Upper)*:** A 1.4 m to 8.6 m thick deposit of brown to grey clayey silt to silty clay till was contacted below the topsoil or surficial layers in all boreholes at 0.1 m to 1.5 m depth, Elevations 182.4 m to 174.3 m. Borehole RC-2 penetrated a 0.8 m thick pocket of sand underlying the cohesive till at Elevation 174.4 m.

The "N"-values measured within the cohesive till deposit range from 5 to 122 blows but generally greater than 11 blows, suggesting generally a stiff to hard consistency. The results of grain size distribution analyses and Atterberg limits tests of selected cohesive till samples obtained during the current investigation are shown on Figures B-1 and B-2. The result of a grain size distribution analysis on a sample of the sand pocket is shown on Figure B-3.

***Sandy Silt to Silty Sand Till*:** A deposit of non-cohesive till comprised of sandy silt, sand and silt to silty sand was encountered underlying the cohesive till or the sand pocket in all boreholes at 2.2 m to 8.7 m depths, Elevations 173.8 m to 170.0 m. All these boreholes, except Boreholes S4 and S7 were terminated within the non-cohesive till deposit at practical refusal at between Elevations 169.5 m and 166.1 m, penetrating it for 2.6 m to 7.4 m. The thickness of the deposit in Boreholes S4 and S7 was 4.6 m and 2.9 m, extending to Elevations 169.2 m and 167.1 m, respectively.

The "N"-values measured within the non-cohesive till deposit range from 34 to 139 blows, indicating a dense to very dense compactness. The results of grain size distribution analyses and Atterberg limits tests for selected samples from non-cohesive till deposit obtained during the current investigation are shown on Figures B-4 and B-5, respectively.

***Clayey Silt Till (Lower)*:** Boreholes S4 and S7 penetrated a clayey silt till deposit below the non-cohesive till at 13.3 m and 8.7 m depths, Elevations 169.2 m and 167.1 m. Both boreholes were terminated within this deposit at practical refusal at 14.2 m and 9.3 m depths, Elevations 168.3 m and 166.5 m, penetrating it for 0.9 m and 0.6 m.

The "N"-values measured within this deposit are greater than 100 blows, suggesting a hard consistency.

Groundwater Conditions

The groundwater level measured in piezometers installed in Boreholes S5 and S9 at this site was at 4.9 m and 0.5 m depths, Elevations 176.7 m and 175.5 m on July 9, 2009. Sub-artesian condition was noted in Boreholes S5 and S9 within the non-cohesive till. The water level in other boreholes during and upon completion of drilling was at 0.9 m to 6.0 m depths, Elevations 176.7 m to 171.1 m. For more details refer to Table A2 of this report.

FOUNDATION RECOMMENDATIONS

The following site-specific foundation recommendations are for preliminary design and planning purposes only. They require refinement during detail design.Project-wide foundation recommendations, design assumptions and limitations are contained in Part B of this report. The proposed twin three-span bridge structures will carry Highway 427 over the Rainbow Creek.

Foundation Option	Advantages	Disadvantages	Relative Costs	Risks/Consequences
Spread footings on very stiff to hard clayey silt till	• Conventional construction.	• Precludes use of integral abutments; • Provides relatively low bearing capacity; • Dewatering system and cofferdams required during construction.	• Lower relative cost compared to deep foundation options.	• Disturbing of subgrade due to excavation.
Driven steel H-Piles to found within "100-blow" soils	• Allows for integral abutment design; • Negligible post-construction settlement.	• Piles may encounter obstructions during driving; • Access, dewatering and environmental issues for pile cap construction in floodplain.	• More costly than spread footings.	• Minor potential for pile damage/ deflection if obstructions are encountered during pile driving.
Caissons founded within very dense non-cohesive till	• Provides higher capacity than driven piles.	• Precludes use of integral abutments; • Drilling mud and tremie techniques required for construction; • Access, dewatering and environmental issues for caisson cap construction in floodplain.	• More costly than driven steel H-piles.	• Risk of loosening or disturbing founding soils at the base of caissons.

Spread Footings

The following recommendations are for preliminary design and planning purposes only. They require refinement during detail design. Spread footings founded on native soils or on engineered Granular A pads may be used to support the abutments and piers if adequate scour protection is provided. However, the use of spread footings on native ground or on engineered Granular A pads is less preferable in floodplains than the deep foundation option. Also the bearing resistances at normal depths at the north abutment could be less than required for design as indicated by the preliminary geotechnical resistances at the ground interface presented in the following table.

Foundation Unit	Founding Stratum	Axial Geotechnical Resistance < 25mm settlement		Highest Founding Elevation within Native Soils (m)
		Factored ULS (kPa)	SLS (kPa)	
South Abutments	Very stiff to Hard Clayey Silt Till	600	400	181.0
South Piers		600	400	174.0
North Piers		600	400	175.0
North Abutments		450	300	175.0

Driven Steel H-Piles/Steel Pipe Piles

Steel H-piles 310x110 and Steel pipe piles, 324 mm (12 ¾ in) outer diameter and 6 mm (1/4 in) thickness, driven to refusal within the hard/very dense till layers may be used to support the abutments and piers. The preliminary geotechnical resistances and tip elevations are as follows:

Foundation Unit	Axial Geotechnical Resistance		Approximate Pile Tip Elevation (m)
	Factored ULS (kN)	SLS (kN)	
South Abutments	1,600	1,200	170 to 169
South Piers*	1,600	1,200	170 to 169
North Piers	1,600	1,200	170 to 168
North Abutments	1,600	1,200	170

Driven piles should be controlled by Hiley Formula as per MTO Drawing SS-103-11 from 2 m above the approximate pile tip elevations, employing a maximum load of twice the factored geotechnical resistance at ULS per pile.

Caissons

Caissons founded within the very dense non-cohesive till may be considered for support of the abutments and piers although installation techniques below the groundwater table will be required. The preliminary geotechnical resistances are as follows:

Foundation Unit	Caisson Diameter (m)	Axial Geotechnical Resistance		Caisson Base Elevation (m)
		Factored ULS (kN)	SLS (kN)	
South Abutments	1.2	5,000	4,000	170
	1.5	6,500	5,000	
South Piers	1.2	5,000	4,000	170
	1.5	6,500	5,000	
North Piers	1.2	5,000	4,000	168
	1.5	6,500	5,000	
North Abutments	1.2	5,000	4,000	170
	1.5	6,500	5,000	

Recommended Foundation Alternative

The recommended foundation alternative at this site is driven steel H-piles into the hard/very dense till soils for the abutments, and spread footings founded on native, very stiff to hard clayey silt till for the piers. Driven piles may also be used for the piers. The use of piles is preferred over caissons due to the presence of water bearing non-cohesive till at the base of caissons.

Structure Abutments and Approaches

The soil conditions at this site are suitable for conventional, semi-integral and integral abutment design. Construction of the bridges will require placement of up to about 3.0 m and 6.0 m of fill within the limits of the south and north approach embankments.

Structure Retaining Walls/Wing Walls

Earth retaining walls for this structure may include Cast-in-Place (CIP) or RSS Walls above the high water levels. For RSS walls the levelling pads of the facing may be founded on granular pad or CIP leveling pad. The retaining walls geometry should conform to High Appearance and High Performance in accordance with MTO.DSM 9.70 and current RSS Design Guidelines. The CIP retaining walls should be designed in conformance with the spread footing recommendation in this report.

Stability of Approach Embankments

Approach embankments constructed of suitable earth fill or granular fill and up to about 6.0 m high are expected to be stable at side slopes formed at 2H:1V slopes.

Settlement of Approach Embankments

The settlement within founding soils and of the fill to the abutments is estimated to be in the order of 50 mm, most of which will occur shortly following the fill placement. It is recommended that consideration be given to a preloading the approach embankments or to a waiting time before paving of two (2) months to mitigate post-construction differential settlements at the bridge.

Construction Considerations

Excavation

The construction of pier footings/pile caps will require excavations some 3.0 m deep that made through firm to stiff cohesive or loose non-cohesive soils which are classified as Type 3 soils. According to OHSA, temporary unsupported excavations above the prevailing groundwater in these soils should be made with side slopes no steeper than 1H:1V.

Surface Water / Groundwater Control

Surface water run-off and Rainbow Creek flow should be diverted away from the excavations at all times.

The groundwater should be maintained a minimum of 0.5 m below the base of excavations. The groundwater level measured in the piezometer installed in the floodplain was at 0.5 m depth, Elevation 175.5 m. It is expected that excavations for construction of foundation elements in the floodplain will extend below the prevailing groundwater level and creek water level, and a dewatering scheme including a cofferdam and stream diversion will be required during the construction.

The groundwater level in the piezometer installed in Borehole S5 was at 4.5 m depth, Elevation 176.7 m. It is expected that excavations for construction of the south abutment will be above the groundwater and the minimal inflow of groundwater is expected to be handled by pumping from properly filtered sumps placed at the base of the excavations.

Pile Installation / Caisson Construction

It is anticipated that cobbles and/or boulders will be encountered within the till deposits, which may adversely impact the installation of steel H-piles or caissons. Piles should be equipped with flange plates or approved driving shoes.

If consideration is being given to caisson foundations, water-bearing non-cohesive native soils (sand pockets, non-cohesive till) should be expected to run or flow into the caisson hole during and after the drilling for the caisson foundations and as such, appropriate equipment and procedures (including use of temporary or permanent caisson liners, drill mud and tremie concrete placement technique) will be required to minimize ground loss during drilling and concrete placement and to permit inspection and cleaning of the caisson base. Sub-artesian condition was noted within the non-cohesive till deposit and as such consideration should be given to using drilling mud and tremie concrete placement technique to minimize the potential for basal heave.

Recommendation for Additional Work

Further subsurface investigation should be carried out during the detail design to confirm the subsoil and groundwater conditions at the location of approach embankments and foundation elements in the floodplain.

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No RC-1 1 of 1 METRIC

G.W.P. _____ LOCATION Coords: 4 849 387.2 N; 293 839.4 E ORIGINATED BY F.P.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE November 06, 2015 CHECKED BY A.V.

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 (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (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
175.7	Ground Surface										
0.0	CLAYEY SILT, some sand, containing rootlets		1	SS	8						
175.1	Firm Brown and grey Moist						175				
0.6	SILTY CLAY, trace sand, trace gravel		2	SS	19						1 8 51 40
	Very stiff Brown Moist		3	SS	19		174				
173.5	(TILL)										
2.2	SANDY SILT to SILTY SAND, some clay, trace to some gravel, containing clayey silt seams		4	SS	34		173				
	Dense to very dense Grey Moist		5	SS	50/8cm						
	(TILL)		6	SS	54	▽	172				9 38 41 12
			7	SS	83		171				First groundwater strike at 4.6m
	containing cobbles and/or boulder below a depth of 5.3m		8	SS	50/15cm						
			9	SS	50/10cm		170				18 33 38 11
			10	SS	50/8cm		169				
							168				
							167				
166.1			11	SS	105						
9.6	End of borehole ▽ Water level noted during drilling Notes: 1. Groundwater was not encountered inside the borehole upon completion of drilling. 2. No cave-in was noted in the borehole upon extraction of hollow stem augers. 3. The borehole was backfilled with betonite grout.										

ON MTO_NEW LOGO HWY 427 15TF013A-REV.GPJ ON_MOT.GDT 14/01/2016 8:48:36 AM

+7, ×5: Numbers refer to Sensitivity (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No RC-2 1 of 1 METRIC

G.W.P. _____ LOCATION Coords: 4 849 442.0 N; 293 736.3 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE October 15, 2015 CHECKED BY A.V.

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 (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (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
177.3	Ground Surface										
177.1	TOPSOIL										
0.2	CLAYEY SILT, some sand, trace organics, containing rootlets		1	SS	6		177				
	Firm Brown Moist		2	SS	8						
175.8							176				
1.5	CLAYEY SILT, some sand, trace gravel, containing sand seams		3	SS	22						
	Very stiff Grey Wet		4	SS	24		175				2 21 51 26
174.4	(TILL)										
2.9	SAND, some silt, trace clay		5	SS	21	▽	174				0 81 13 6
	Compact Grey Moist										First groundwater strike at 3.2m
173.6											
3.7	SANDY SILT, some gravel, some clay containing clayey silt seams		6	SS	34		173				12 31 41 16
	Dense to very dense Grey Moist		7	SS	75/8cm						Auger grinding between depths of 4.4m and 6.1m
	(TILL)										
	containing cobbles and/or boulder between depths of 4.5m and 6.1m		8	SS	75/15cm		172				Sampler bouncing
							171				
			9	SS	115/28cm		170				18 31 38 13
							169				
167.7			10	SS	111		168				
9.6	End of borehole Notes: 1. Groundwater measured at a depth 3.4m below ground surface (Elev. 173.9m) upon completion of drilling. 2. The borehole caved in to a depth of 3.5m below ground surface (Elev. 173.8m) upon extraction of hollow stem augers.										

ON MTO_NEW LOGO HWY 427 15TF013A-REV.GPJ ON_MOT.GDT 14/01/2016 8:48:37 AM

+7, ×5: Numbers refer to Sensitivity (%) STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No S4

1 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4849365.1 ;E 293793.2 | ORIGINATED BY DD
W.O. 05-20012 | | COMPILED BY VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE February 27, 2009

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 × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L: WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
182.5	GROUND SURFACE						182				
0.0 / 0.1	TOPSOIL CLAYEY SILT, some sand, trace to some gravel (TILL), containing rootlets to a depth of 0.6 m and containing oxidation zones to a depth of 5.2 m Firm to hard Brown to grey Moist to wet		1	SS	5						
			2	SS	22		181				
			3	SS	25						
			4	SS	35		180				
			5	SS	24		179				6 12 62 20
			6	SS	21		178				
	Auger grinding at a depth of 5.2 m		7	SS	21		177				
			8	SS	11	▽	176				
			9	SS	31		175				
173.8							174				
8.7	SAND and SILT, some gravel, trace clay, containing cobbles below 11.4 m depth (TILL) Dense to very dense Grey Wet		10	SS	37		173				
			11	SS	109		172				
	Auger grinding at a depth of 11.4 m						171				
			12	SS	106		170				
169.2							169				
13.3	CLAYEY SILT with sand, some gravel (TILL) Hard Grey		13	SS	113						17 35 39 9
168.3	Wet										
14.2	END OF BOREHOLE										

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S4

2 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4849365.1 ;E 293793.2 | ORIGINATED BY DD
W.O. 05-20012 | | COMPILED BY VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE February 27, 2009

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 × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L: WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —										
	NOTES: 1. Water level in open borehole at a depth of 6.0 m below ground surface (Elev.176.5 m) upon completion of drilling. 2. Borehole backfilled with bentonite.										

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

Golder Associates

RECORD OF BOREHOLE No S5

1 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4849359.7 ;E 293821.4
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE February 26, 2009

ORIGINATED BY DD
COMPILED BY VA
CHECKED BY SMM SM

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	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
	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100													
181.6	GROUND SURFACE													
8.9	TOPSOIL													
8.1	CLAYEY SILT, some sand, trace gravel (TILL), containing rootlets and oxidation zones to a depth of 2.1 m Stiff to hard Brown to grey Moist		1	SS	8		181							
			2	SS	23									
			3	SS	33		180							
			4	SS	44		179							
			5	SS	63		178							
	Grey below a depth of 3.8 m		6	SS	31									
			7	SS	31	▽	177							
			8	SS	37		176							
			9	SS	48		175							
172.9	Auger grinding below a depth of 8.5m						174							
8.7	SAND and SILT, some gravel, trace clay, containing cobbles (TILL) Dense to very dense Grey Wet Auger grinding from depth of 9.7 m to 10.7 m		10	SS	39		173							
			11	SS	139		172							
	Auger grinding from depth of 11.9 m to 12.5 m		12	SS	100/0.0		171							14 39 41 6
							170							
	Auger grinding from depth of 13.4 m to 13.7 m		13	SS	102/0.1		169							
167.6							168							
14.0	END OF BOREHOLE													

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S5

2 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4849359.7 ;E 293821.4
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE February 26, 2009

ORIGINATED BY DD
COMPILED BY VA
CHECKED BY SMM SM

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	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
	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100													
	— CONTINUED FROM PREVIOUS PAGE —													
	NOTES: 1. A 50 mm diameter monitoring well was installed at a depth of 10.7 m (Elev.170.9 m) Water level measurements Date Depth Elev. On Completion 6.0 m 175.6 m April 24, 2009 4.4 m 177.2 m May 13, 2009 4.4 m 177.2 m May 21, 2009 4.6 m 177.0 m June 15, 2009 4.7 m 176.9 m July 09, 2009 4.9 m 176.7 m													

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

Golder Associates

RECORD OF BOREHOLE No S6

1 OF 1 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4849472.0 ;E 293764.4 | ORIGINATED BY PKS

W.O. 05-20012 | BOREHOLE TYPE 108 mm Diameter Solid Stem Augers | COMPILED BY VA

DIST Central HWY 427 | DATUM Geodetic | DATE March 13, 2009 | CHECKED BY SMM

ELEV / DEPTH	SOIL PROFILE: DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
177.6	GROUND SURFACE							SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)		WATER CONTENT (%) (10 20 30)			
0.0	CLAYEY SILT, some sand, trace gravel Firm Brown Moist		1	SS	6					○			
176.9							177						
0.7	CLAYEY SILT, some sand, trace gravel (TILL) Stiff to hard Brown to grey Moist becoming wet below a depth of 1.2 m		2	SS	9					○			
			3	SS	44		176			⊢○⊣			
			4	SS	65	▽	175			○			
	Grey below a depth of 3.0 m		5	SS	35					⊢○⊣			3 13 61 23
			6	SS	63		174			○			
			7	SS	47		173			○			
171.8	Augers grinding at a depth of 5.5 m						172						
5.8	SAND and SILT, some gravel, trace clay, containing cobbles (TILL) Very dense Grey Wet		8	SS	100		171			○			25 39 33 3
			9	SS	00/0.2		170			○			
							169						
168.3			10	SS	00/0.1					○			3 33 55 9
9.3	END OF BOREHOLE NOTES: 1. Water level in open borehole at a depth of 3.0 m below ground surface (Elev. 174.7 m) upon completion of drilling. 2. Borehole backfilled with bentonite.												

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Foundation Design

Golder Associates

RECORD OF BOREHOLE No S7

1 OF 1 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4849440.3 ;E 293806.1 | ORIGINATED BY PKS

W.O. 05-20012 | BOREHOLE TYPE 108 mm Diameter Solid Stem Augers | COMPILED BY VA

DIST Central HWY 427 | DATUM Geodetic | DATE March 13, 2009 | CHECKED BY SMM

ELEV / DEPTH	SOIL PROFILE: DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
175.8	GROUND SURFACE							SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)		WATER CONTENT (%) (10 20 30)			
0.0	CLAYEY SILT with sand, trace gravel Firm Brown Moist to wet		1	SS	4								
174.9						▽	175						
0.9	CLAYEY SILT, some sand, trace gravel (TILL) Very stiff to hard Brown to grey below a depth of 1.8 m Wet		2	SS	15								
			3	SS	48		174			○			
			4	SS	49								
			5	SS	42		173						
			6	SS	00/0.2								
			7	SS	84		172						
170.0							171						
5.8	SAND and SILT, trace to some gravel, trace clay (TILL) Very dense Grey Wet		8	SS	00/0.2		170			○			6 32 51 11
			9	SS	00/0.1		169						
167.1							168						
8.7	CLAYEY SILT, trace sand (TILL) Hard Grey Wet						167						
166.5			10	SS	00/0.1					○			0 2 83 15
9.3	END OF BOREHOLE NOTES: 1. Water level in open borehole at a depth of 0.9 m below ground surface (Elev.174.9 m) upon completion of drilling. 2. Borehole backfilled with bentonite.												

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S8

1 OF 1 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4849407.4 ;E 293777.1 | ORIGINATED BY PKS
W.O. 05-20012 | | COMPILED BY VA
DIST Central HWY 427 | BOREHOLE TYPE 108 mm Diameter Solid Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 12, 2009

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 (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
175.8	GROUND SURFACE										
0.0	Silty SAND, trace gravel, trace clay, containing rootlets Loose Brown Moist		1	SS	5	▽	175				
			2	SS	9						
174.3											
1.5	CLAYEY SILT with sand, trace gravel (TILL) Hard Grey Wet		3	SS	62		174				
			4	SS	58						
			5	SS	122		173				7 32 45 16
172.1											
3.7	SAND and SILT, some gravel, trace clay, containing cobbles (TILL) Very dense Grey Wet		6	SS	100/0.2		172				
			7	SS	100/0.1		171				16 36 40 8
	Augers grinding at depths of 3.7 m and 4.4 m										
169.5			8	SS	100/0.1		170				
6.3	END OF BOREHOLE										

NOTES:

1. Water level in open borehole at a depth of 0.9 m below ground surface (Elev.176.7m) upon completion of drilling.

2. Borehole backfilled with bentonite.

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S9

1 OF 1 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4849460.9 ;E 293829.6 | ORIGINATED BY PKS
W.O. 05-20012 | | COMPILED BY VA
DIST Central HWY 427 | BOREHOLE TYPE 108 mm Diameter Solid Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 16, 2009

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 (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
176.0	GROUND SURFACE										
0.0	CLAYEY SILT, some sand, trace gravel, containing rootlets Firm Brown Moist		1	SS	4						
175.3											
0.7	CLAYEY SILT, trace to some sand, trace gravel (TILL) Very stiff Brown to grey Moist to wet below a depth of 1.5 m		2	SS	22	▽	175				
			3	SS	27		174				
	Grey below a depth of 2.1 m		4	SS	22						2 7 56 35
			5	SS	23		173				
171.4			6	SS	22		172				
4.6	SAND and SILT, trace to some gravel, trace clay, containing cobbles (TILL) Very dense Grey Wet		7	SS	100/0.1		171				7 40 44 9
	Augers grinding at depths of 5.8 m and 8.8 m										
			8	SS	100/0.1		170				
							169				
168.2			9	SS	100/0.2						
7.9	END OF BOREHOLE										

NOTES:

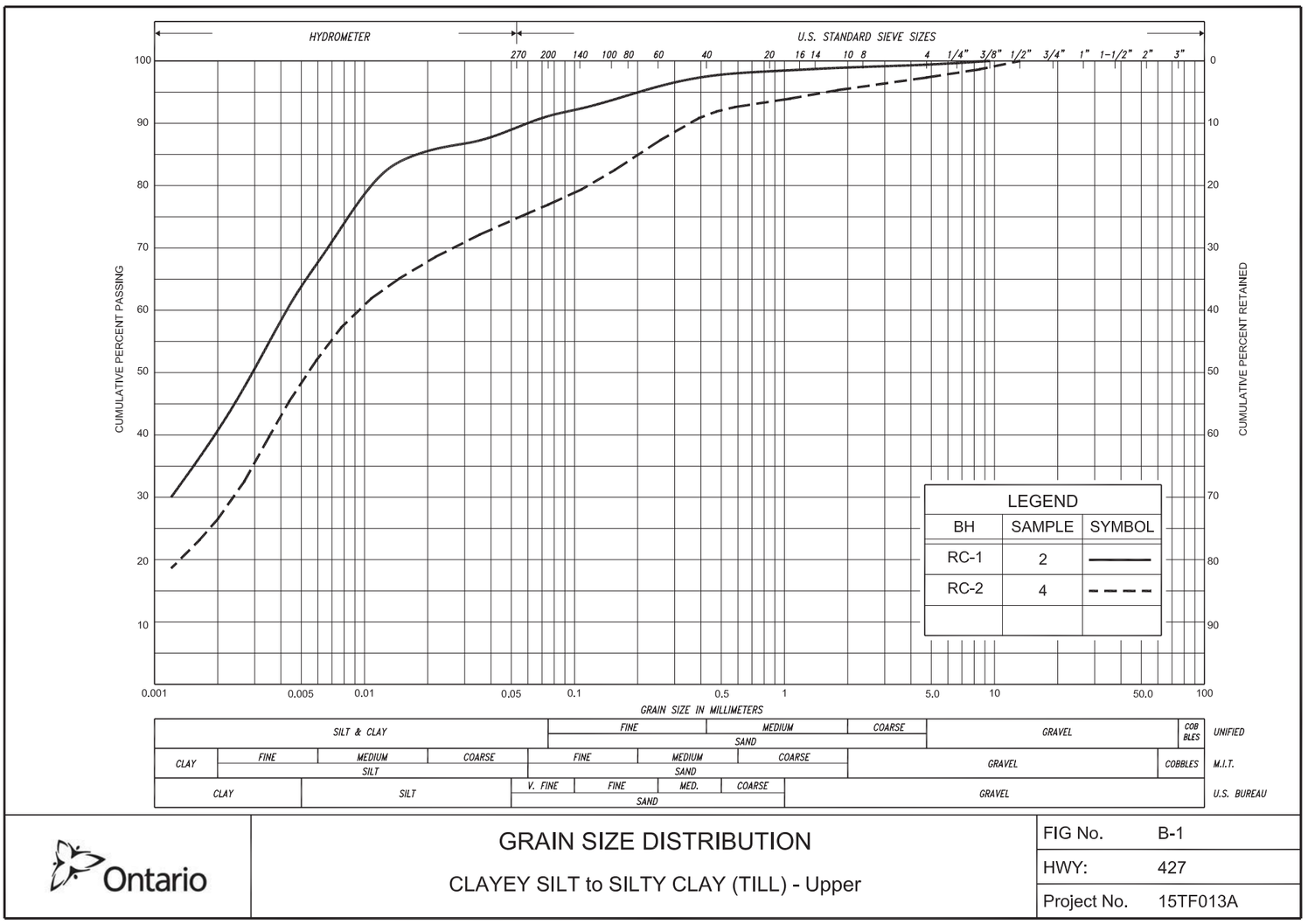
1. A 50 mm diameter monitoring well was installed at a depth of 7.6 m (Elev.168.4 m)

Water level measurements

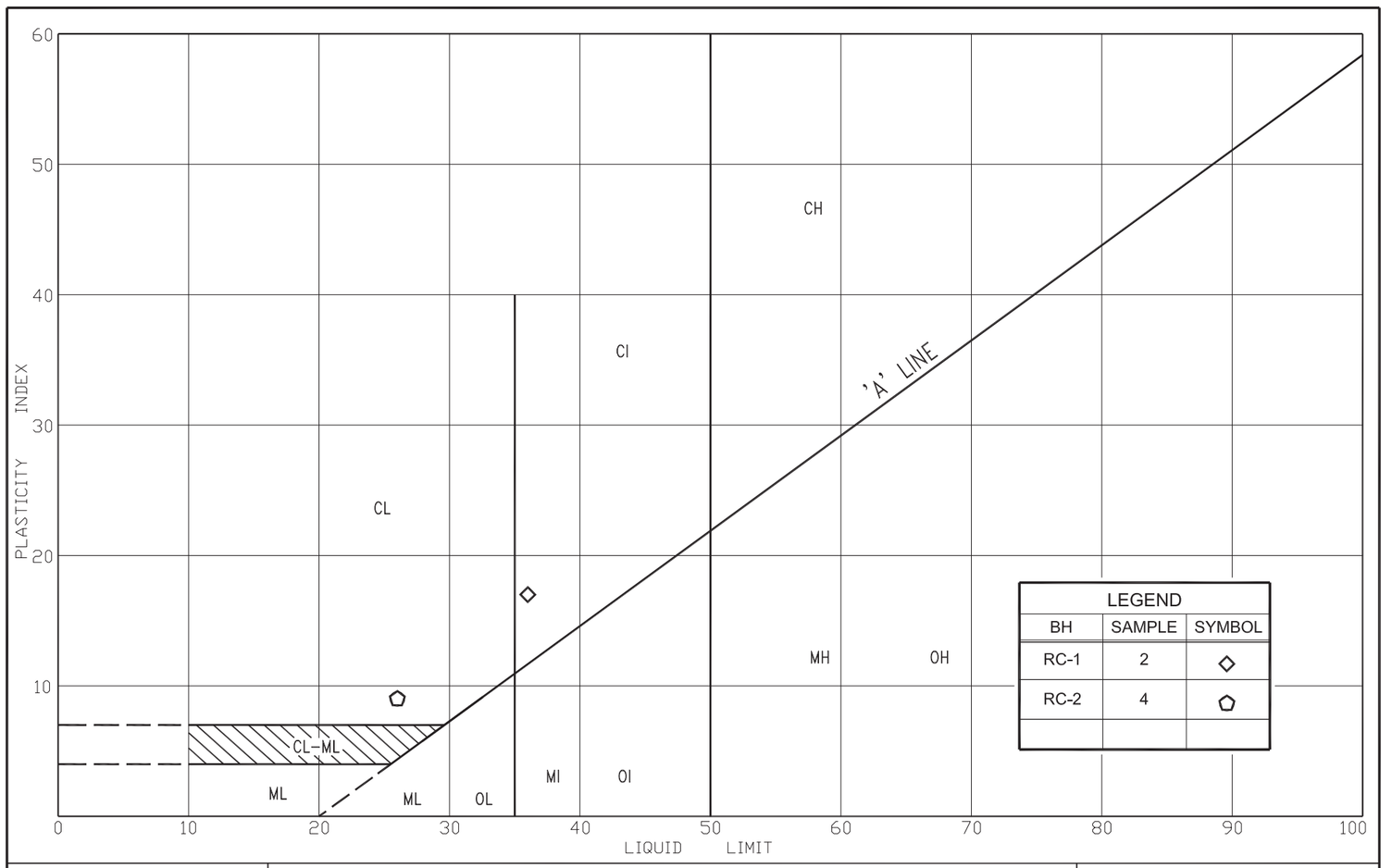
Date	Depth	Elev.
On Completion	1.2 m	174.8 m
April 24, 2009	3.6 m	172.4 m
May 13, 2009	1.2 m	174.8 m
May 21, 2009	0.9 m	175.1 m
June 15, 2009	0.5 m	175.4 m
July 09, 2009	0.5 m	175.5 m

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

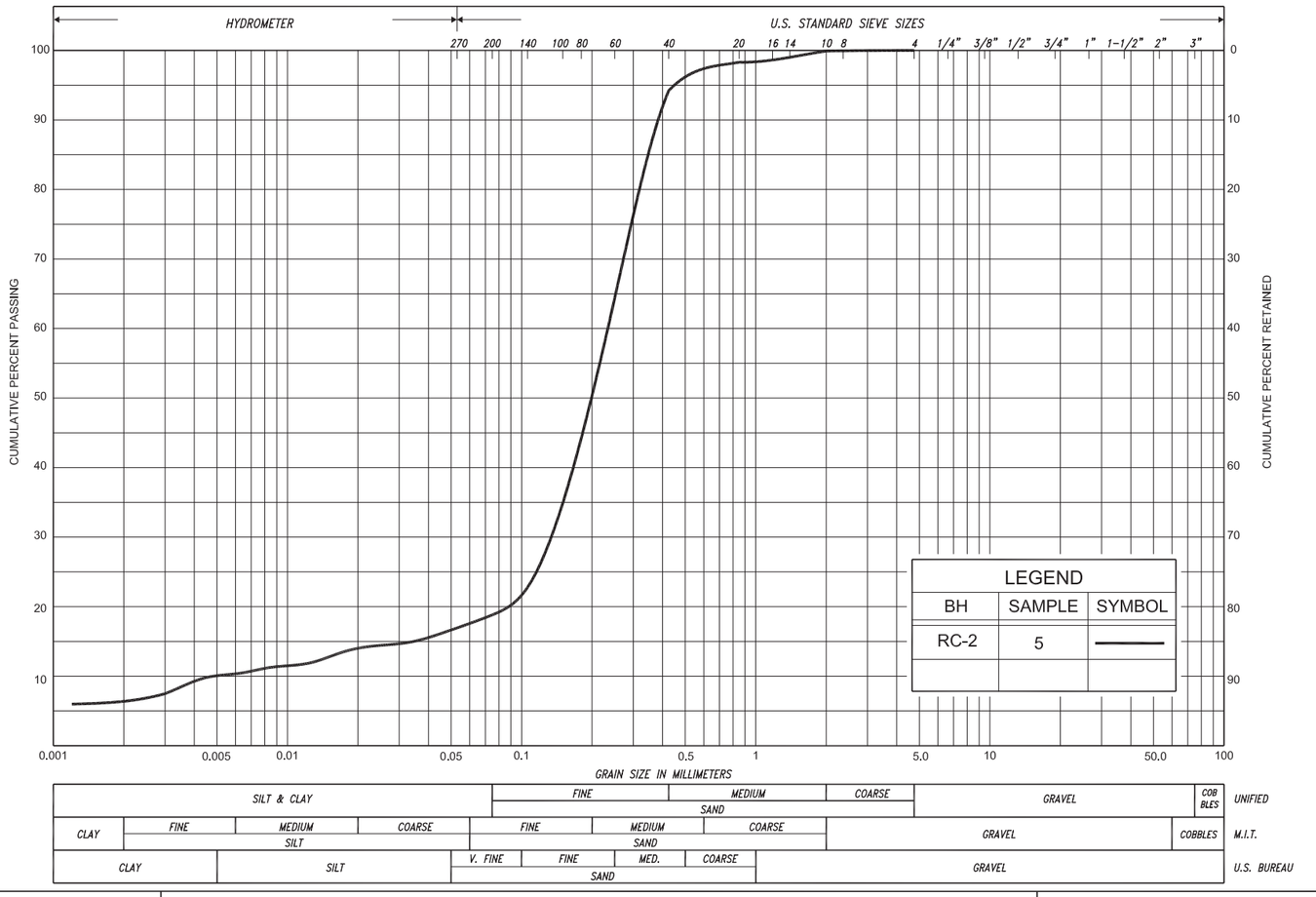
MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD



Ontario	GRAIN SIZE DISTRIBUTION CLAYEY SILT to SILTY CLAY (TILL) - Upper	FIG No. B-1 HWY: 427 Project No. 15TF013A



Ontario	PLASTICITY CHART CLAYEY SILT to SILTY CLAY (TILL) - Upper	FIG No. B-2 HWY: 427 Project No. 15TF013A

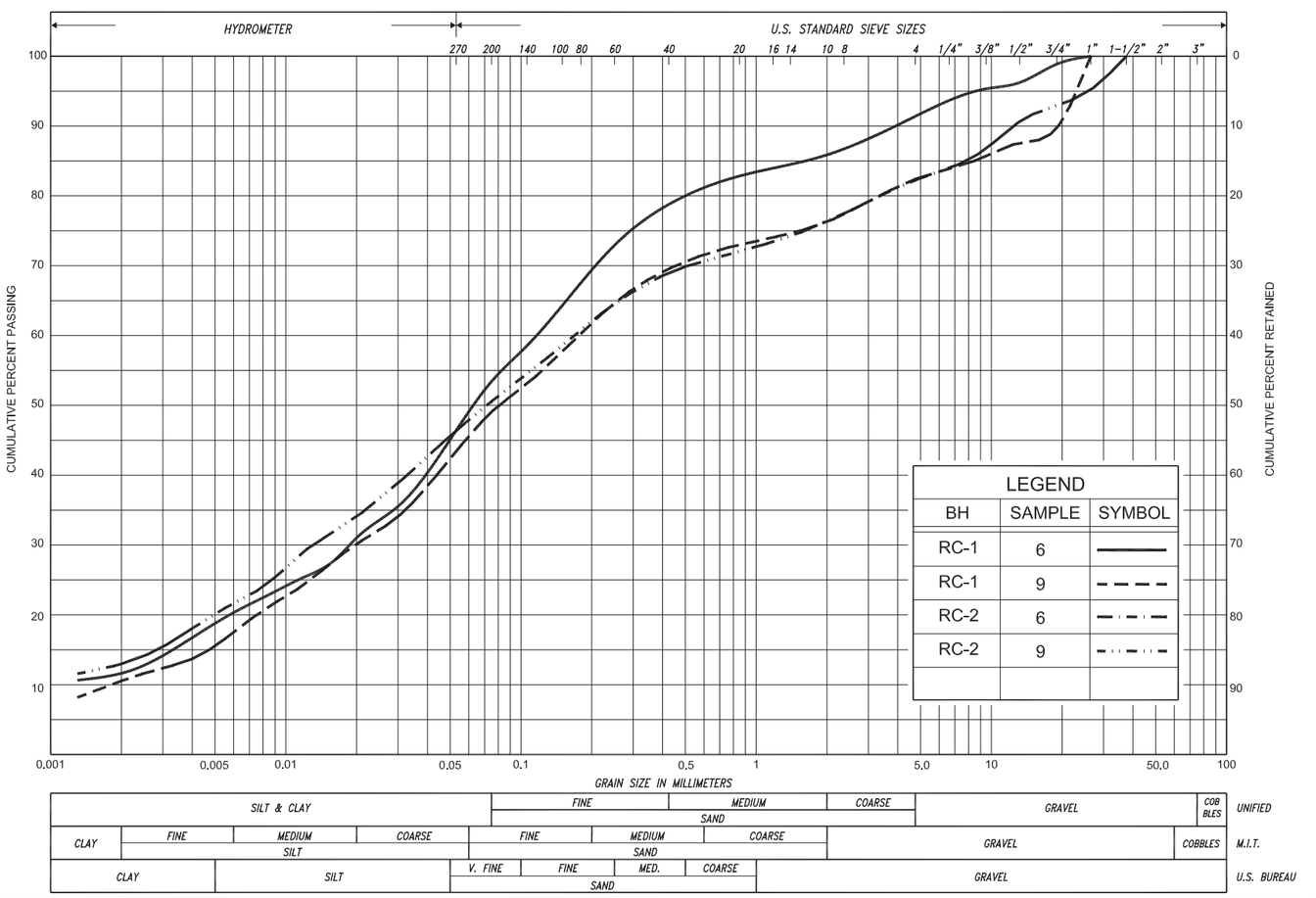


Ontario

GRAIN SIZE DISTRIBUTION

SAND

FIG No.	B-3
HWY:	427
Project No.	15TF013A

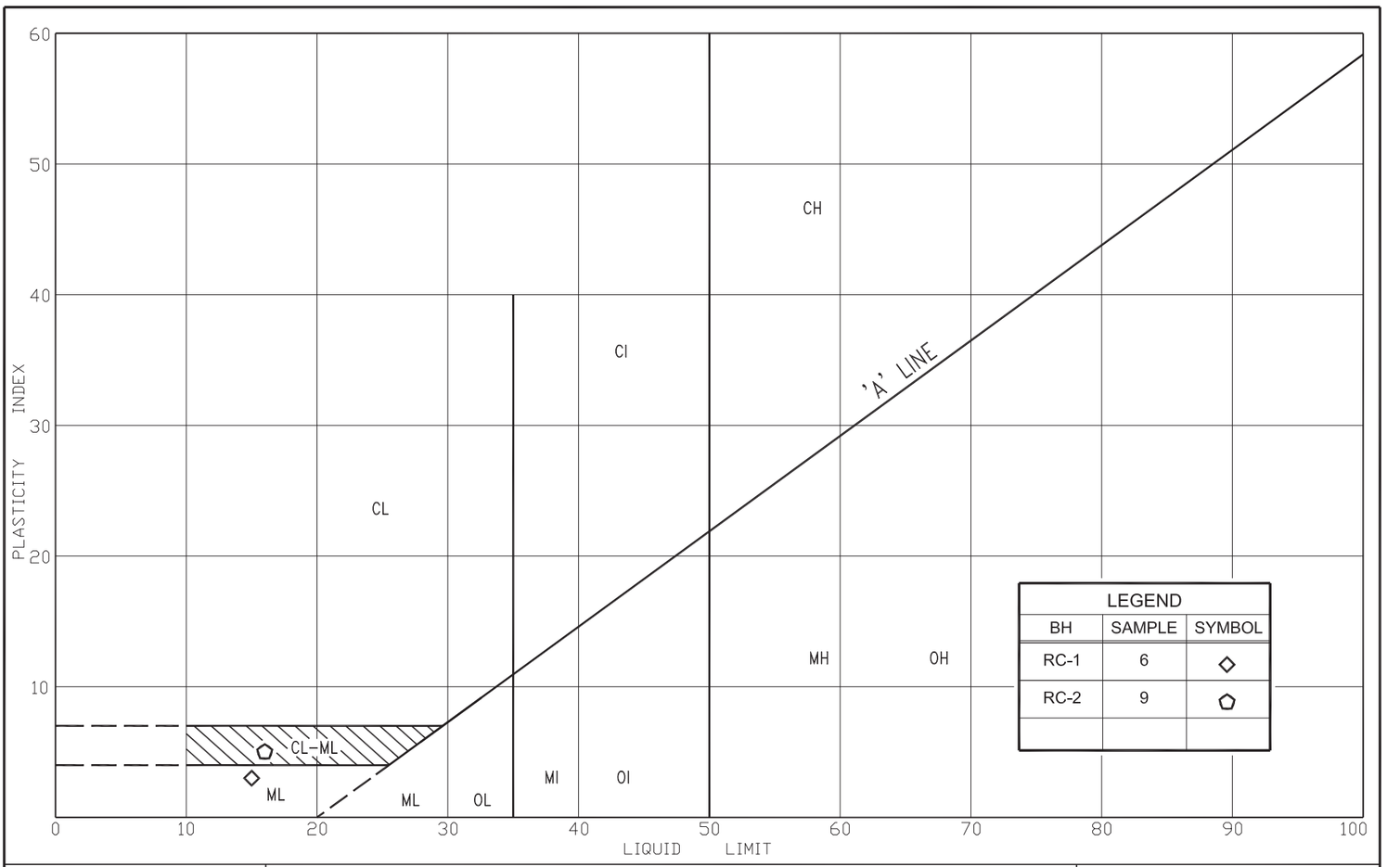


Ontario

GRAIN SIZE DISTRIBUTION

SANDY SILT to SILTY SAND (TILL)

FIG No.	B-4
HWY:	427
Project No.	15TF013A



Ontario

PLASTICITY CHART

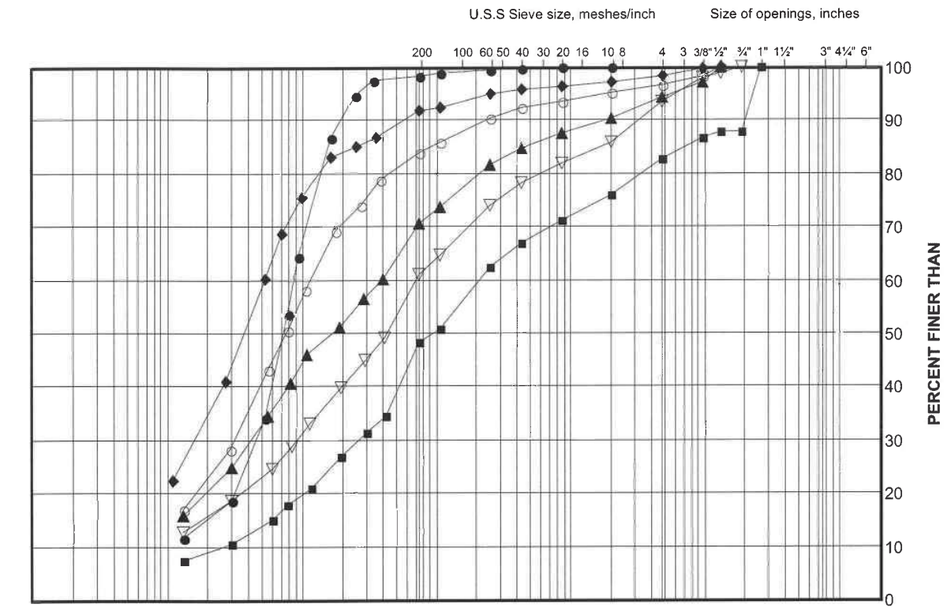
SANDY SILT to SILTY SAND (TILL) - Fine Contents

FIG No.	B-5
HWY:	427
Project No.	15TF013A

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt Till

FIGURE B1



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

LEGEND

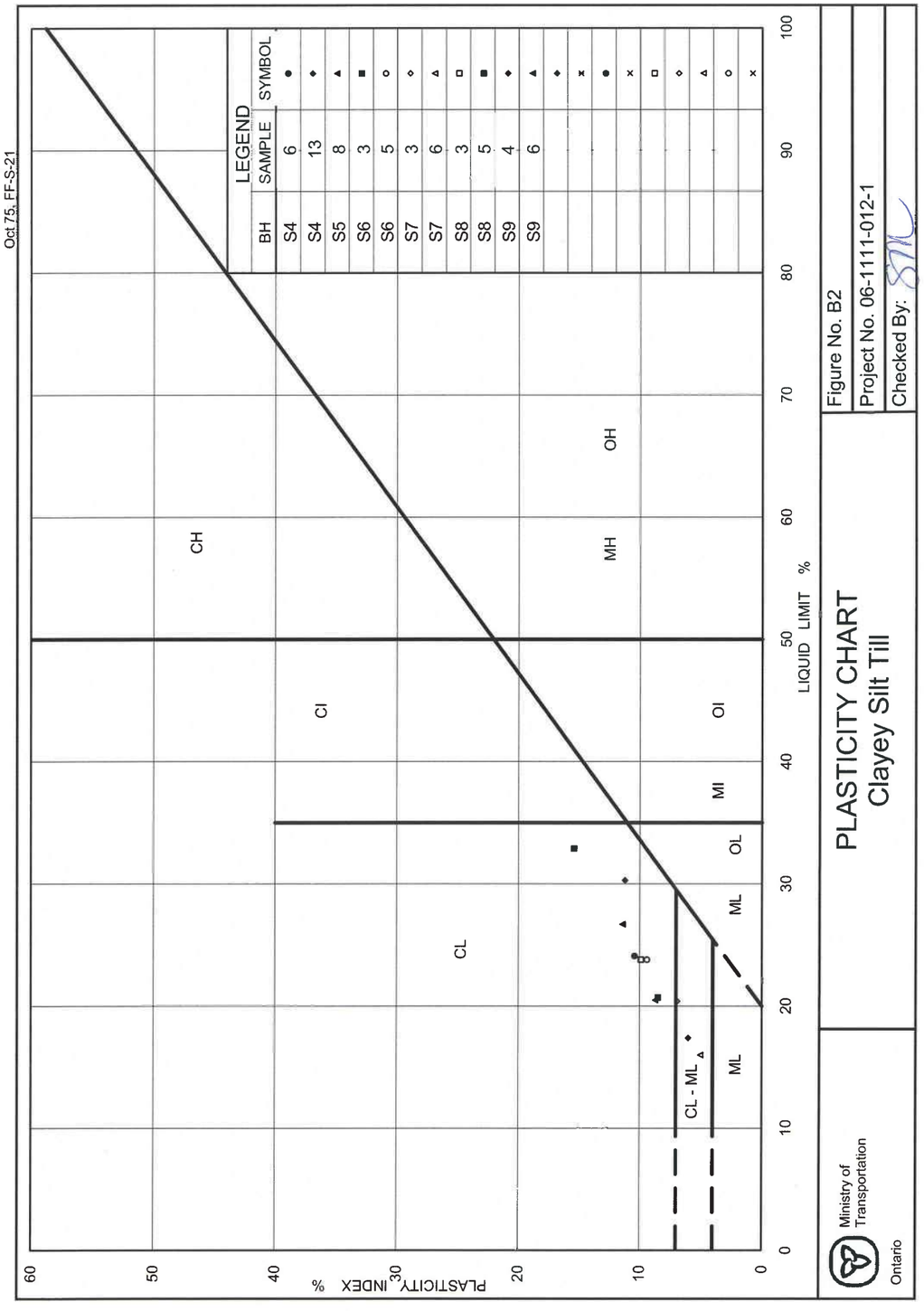
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S7	10	166.7
■	S4	13	168.5
◆	S9	4	173.4
▲	S4	5	179.2
▽	S8	5	172.5
○	S6	5	174.2

Project Number: 06-1111-012-1

Checked By:

Golder Associates

Date: 04-Aug-09



PLASTICITY CHART

Clayey Silt Till

Figure No. B2

Project No. 06-1111-012-1

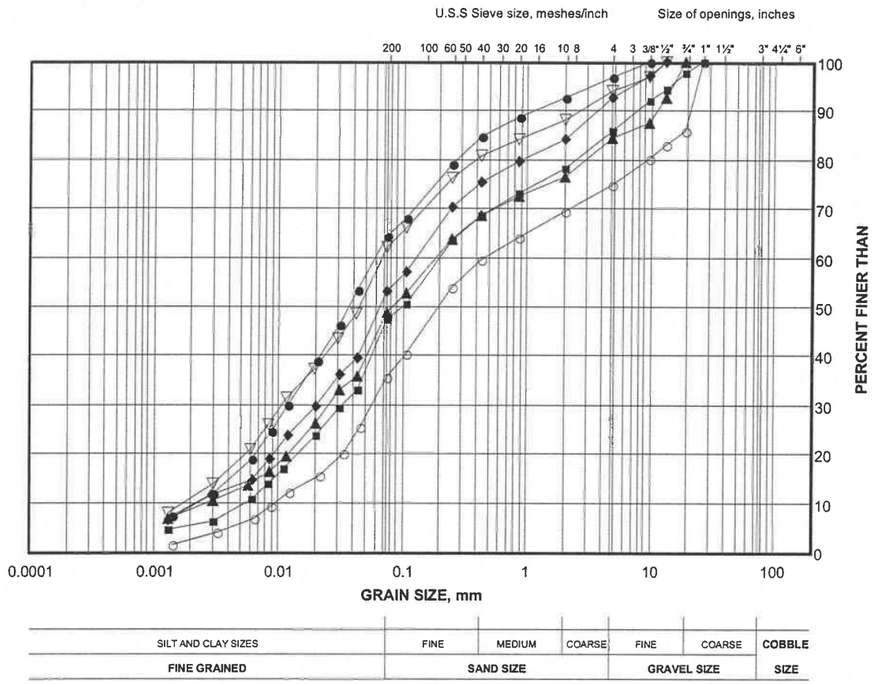
Checked By:

Ministry of Transportation

Ontario

GRAIN SIZE DISTRIBUTION TEST RESULTS
Sand and Silt Till

FIGURE B3



LEGEND

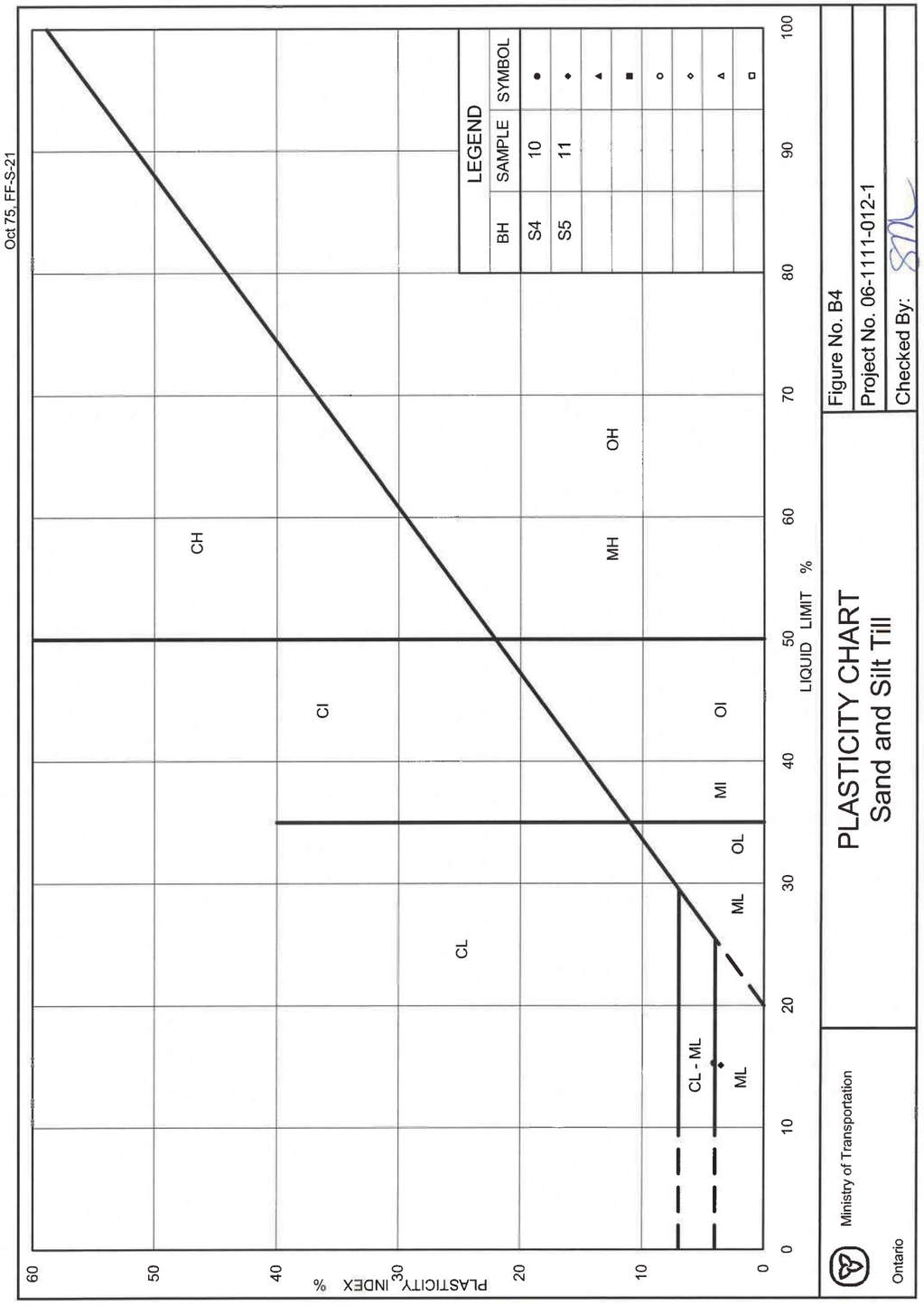
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S6	10	168.3
■	S5	11	170.7
◆	S9	7	171.2
▲	S8	7	171.2
▽	S7	8	169.6
○	S6	8	171.2

Project Number: 06-1111-012-1

Checked By: SM

Golder Associates

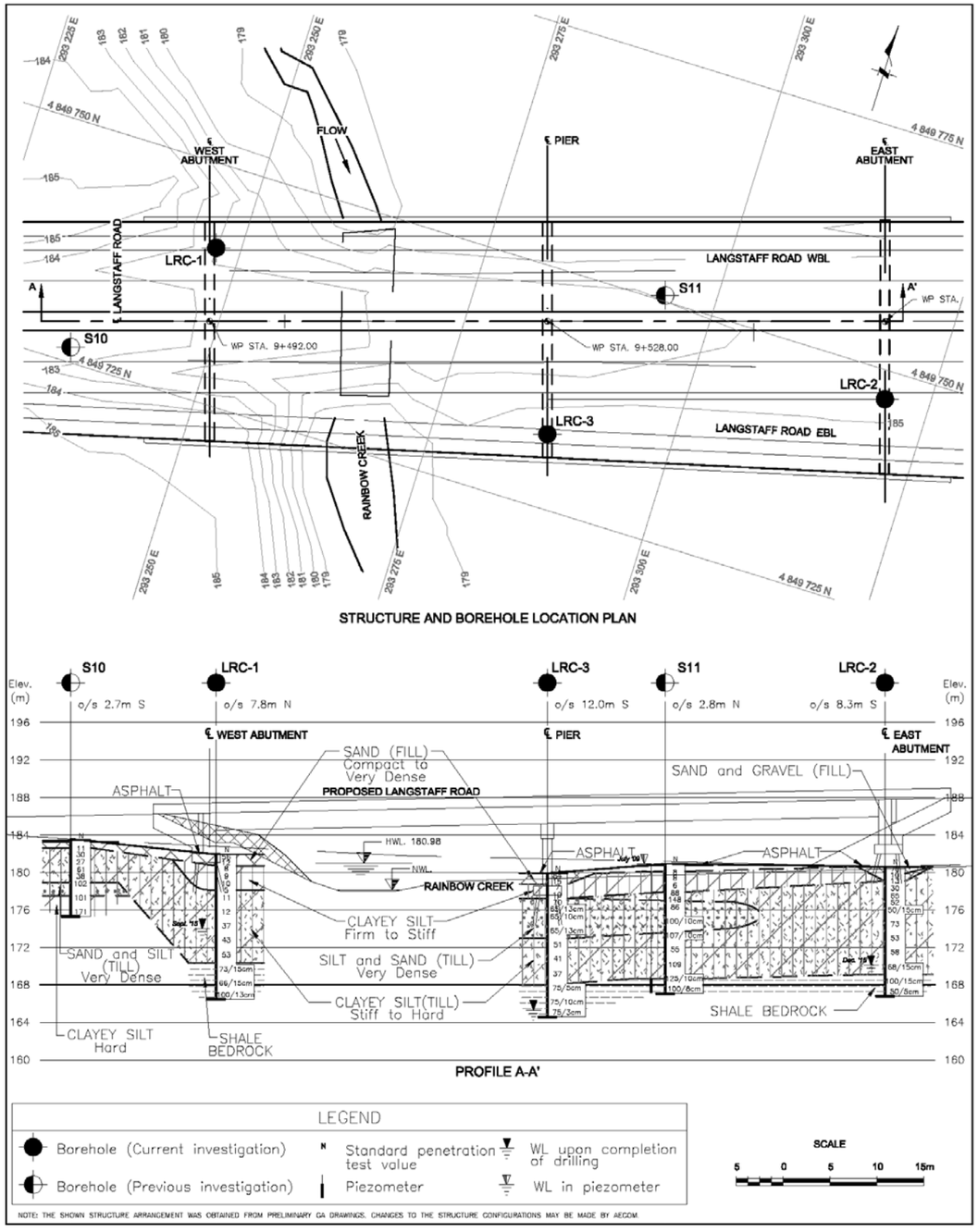
Date: 29-May-09



Structure Type: Bridge

Existing Ground Elevation across Borehole Locations: 183.4 m to 179.9 m

Complexity Rating: Medium



FOUNDATION INVESTIGATION

Site Description

The proposed structure is approximately 2 km south of Rutherford Road and 1.5 km west of Highway 27, in the City of Vaughan, Ontario. The proposed structure is located within the Creek valleys and floodplain. The creek valleys are moderately to densely treed and up to about 7.0 m high relative to the creek level. The creek currently flows through a corrugated steel pipe from north to south.

Borehole Information

Borehole No.	Foundation Unit	MTM NAD 83 Coordinates		Ground Surface Elevation (m)	Borehole Depth (m)
		Northing (m)	Easting (m)		
Previous Investigation					
S10	West Abutment	4,849,726.6	293,235.7	183.4	8.1
S11	Centre Pier/ East Abutment	4,849,750.6	293,294.6	180.9	13.8
Current Investigation					
LRC-1	West Abutment	4,849,741.3	293,247.4	181.9	15.4
LRC-2	East Abutment	4,849,747.0	293,320.3	180.6	13.8
LRC-3	Centre Pier	4,849,732.8	293,287.0	179.9	15.3

Subsurface Condition

***Pavement/ Non-cohesive Fill*:** Approximately 0.2 m thick layer of asphalt was encountered at the ground surface in all boreholes. Asphalt layer is underlain by a 0.6 m to 1.5 m thick layer of sand to sand with gravel fill at Elevations 183.2 m to 179.8 m.

The SPT "N"-values ("N"-values) measured within the fill range from 12 to 84 blows, indicating a compact to very dense compactness.

***Clayey Silt (Upper)*:** All boreholes except Borehole S10 penetrated an approximately 1.3 m to 3.4 m thick clayey silt deposit underlying the fill at depths from 0.8 m to 1.7 m, Elevations 180.7 m to 178.2 m. The deposit generally contains trace organics and rootlets and extends to 2.2 m to 4.6 m depths, Elevations 178.4 m to 176.7 m.

The "N"-values measured within the clayey silt deposit range from 5 to 13 blows, suggesting a firm to stiff consistency. The results of grain size distribution analysis and Atterberg limits tests completed on samples of the clayey silt deposit obtained during the current investigation are shown on Figures C-1 and C-2, respectively.

***Clayey Silt Till*:** A clayey silt till deposit was encountered underlying the fill and surficial clayey silt deposit in Boreholes S10, S11, LRC-1 and LRC-2 and below the non-cohesive till deposit in Borehole LRC-3 at 0.8 m to 7.0 m depths, Elevations 182.6 m to 172.9 m. The deposit extends to 4.5 m to 12.2 m depths, Elevations 178.9 m to 168.2 m. The deposit is separated into upper and lower portions in Borehole S11 by the non-cohesive till. The thickness of the deposit varies between 3.7 m and 9.4 m.

The "N"-values measured within the cohesive till deposit range from 11 blows per 0.30 m of penetration to 107 blows per 0.15 m of penetration, indicating a stiff to hard consistency. The results of grain size distribution analyses and Atterberg limits tests completed on samples of the clayey silt till deposit obtained during the current investigation are shown on Figures C-3 and C-4, respectively.

***Silt and Sand Till*:** An approximately 1.4 m to 3.8 m thick silt and sand till deposit was encountered underlying the surficial clayey silt deposit in Borehole LRC-3 and below the cohesive till in Boreholes S10 and S11 at depths from 3.2 m to 4.5 m, Elevations 178.9 m to 176.7 m. The deposit extends to 5.9 m to 7.0 m depths, Elevations 177.5 m to 172.9 m.

The "N"-values measured within the non-cohesive till deposit range from 65 blows per 0.13 m of penetration to 148 blows per 0.30 m of penetration, indicating a very dense compactness. The results of a grain size distribution analysis and an Atterberg limits test completed on a sample of the silt and sand till deposit are shown on Figures C-5 and C-6, respectively.

***Clayey Silt (Lower)*:** Borehole S10 contacted a deposit of grey clayey silt underlying the till deposit at 5.9 m depth, Elevation 177.5 m and terminated within this deposit at practical refusal at 8.1 m depth, Elevation 175.3 m, penetrating it for 2.2 m.

"N"-values of 101 and 171 blows were measured within this layer, suggesting a hard consistency.

Shale Bedrock: All boreholes except Borehole S10 penetrated highly weathered shale bedrock underlying the till deposits at 11.6 m to 12.2 m depths, Elevations 170.2 m to 168.2 m. These boreholes were terminated in the shale bedrock at 13.1 m to 15.4 m depths, Elevations 167.1 m to 164.6 m, penetrating it for about 1.6 m to 3.7 m.

Groundwater Conditions

Sub-artesian conditions were noted in the piezometer installed in Borehole S11 within the shale bedrock with the groundwater level at the ground surface (Elevation 180.9 m). Groundwater level measured in other boreholes upon completion of drilling was at depths from 7.9 m to 14.6 m, Elevations 174.0 m to 165.3 m. For more details refer to Table A2.

FOUNDATION RECOMMENDATIONS

The following site-specific foundation recommendations are for preliminary design and planning purposes only. They require refinement during detail design. Project-wide foundation recommendations, design assumptions and limitations are contained in Part B of this report. The proposed two-span bridge structure will carry proposed Langstaff Road over Rainbow Creek.

Foundation Option	Advantages	Disadvantages	Relative Costs	Risks/Consequences
Spread footings on stiff to hard clayey silt till	• Conventional construction.	• Precludes use of integral abutments; • Provides relatively low bearing capacity; • Cofferdam may be required.	• Lower relative cost compared to deep foundation options.	• Disturbing of subgrade due to excavation.
Driven Steel H-Piles to found within "100-blow" soils	• Allows for integral abutment design; • Negligible post-construction settlement.	• Piles may encounter obstructions during driving; • Specialized techniques may be required to control the upward water flow along the pile-soil interface; • Access, dewatering and environmental issues for pile cap construction in floodplain.	• More costly than spread footings.	• Minor potential for pile damage/ deflection if obstructions are encountered during pile driving.
Caissons founded within shale bedrock	• Provides higher capacity than driven piles.	• Precludes use of integral abutments; • Drilling mud and tremie techniques required for construction; • Access, dewatering and environmental issues for caisson cap construction in floodplain.	• More costly than driven steel H-piles.	• Presence of non-cohesive water bearing layers; • Risk of loosening or disturbing founding soils at base of caissons.

Spread Footings

Spread footings founded on native soils may be used to support the abutments and piers if adequate scour protection is provided. However, the use of spread footings on engineered Granular A pads in floodplains is not recommended. Also the bearing resistances at normal depths at the west abutment would be less than required for design as indicated by the preliminary geotechnical resistances at the ground interface presented in the following table.

Foundation Unit	Founding Stratum	Axial Geotechnical Resistance < 25mm settlement		Highest Founding Elevation within Native Soils (m)
		Factored ULS (kPa)	SLS (kPa)	
West Abutment	Stiff Clayey Silt Till	225	150	177.5
Centre Pier	Hard Clayey Silt Till	525	350	176.5
East Abutment				178.5

Driven Steel H-Pile/ Steel Pipe Piles

Steel H-piles 310x110 and Steel pipe piles, 324 mm (12 ¾ in) outer diameter and 6 mm (1/4 in) thickness, driven to refusal within the shale bedrock layer may be used to support the abutments and pier. The preliminary geotechnical resistances and tip elevations are as follows:

Foundation Unit	Axial Geotechnical Resistance		Approximate Pile Tip Elevation (m)
	Factored ULS (kN)	SLS (kN)	
West Abutment	1,800	1,400	169
Centre Pier	1,800	1,400	167
East Abutment	1,800	1,400	168

Driven piles should be controlled by Hiley Formula as per MTO Drawing SS-103-11 from 2 m above the approximate pile tip elevations, employing a maximum load of twice the factored geotechnical resistance at ULS per pile.

Caissons

Caissons founded within the shale bedrock may be considered for support of the abutments and pier. The preliminary geotechnical resistances are as follows:

Foundation Unit	Caisson Diameter (m)	Axial Geotechnical Resistance		Caisson Base Elevation (m)
		Factored ULS (kN)	SLS (kN)	
West Abutment	1.2	6,000	5,000	169
	1.5	7,800	6,500	
Centre Pier	1.2	6,000	5,000	167
	1.5	7,800	6,500	
East Abutment	1.2	6,000	5,000	168
	1.5	7,800	6,500	

Recommended Foundation Alternative

The recommended foundation alternative at this site is driven steel H-piles into the shale bedrock for the abutments, and spread footings founded on native, hard clayey silt till for the piers. Driven piles may also be used for the piers. Driven piles are preferred over caissons due to sub-artesian condition, which would necessitate special construction techniques.

Structure Abutments and Approaches

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

Construction of the underpass will require placement of up to about 3.0 m and 8.0 m of fill within the limits of the west and east approach embankments, respectively.

Structure Retaining Walls/Wing Walls

Earth retaining walls for this structure may include Cast-in-Place (CIP) or RSS Walls above the high water levels. For RSS walls the levelling pads of the facing may be founded on granular pad or CIP leveling pad. The retaining walls geometry should conform to High Appearance and High Performance in accordance with MTO.DSM 9.70 and current RSS Design Guidelines. The CIP retaining walls should be designed in conformance with the spread footing recommendation in this report.

Stability of Approach Embankments

Approach embankments constructed of suitable earth or granular fill and up to about 8.0 m high are expected to be stable at side slopes of 2H:1V. Where approach embankments are equal to or greater than 8.0 m in height, a minimum 2.0 m wide berm should be provided such that the uninterrupted slope height does not exceed 8.0 m.

Settlement of Approach Embankments

The settlements within founding soils and of the fill to the abutments under west and east approach embankments are estimated to be in the order of 25 mm and 50 mm, respectively. It is expected that most of these settlements occur shortly following the fill placement. It is recommended that consideration be given to preloading the east approach embankment for a period of two (2) months before paving to mitigate post-construction differential settlements at the bridge.

Construction Considerations

Excavation

The construction of piers and pile caps will require excavations up to about 4.0 m below the existing Langstaff Road grade. These excavations will be made through existing fill and into firm to stiff clayey silt which are classified as Type 3 soils in OHSA. Temporary unsupported excavations above the prevailing groundwater in these soils should be made with slopes no steeper than 1H:1V.

Surface Water / Groundwater Control

Surface water run-off and the Rainbow Creek flow should be diverted away from the excavations at all times.

The prevailing groundwater should be maintained a minimum of 0.5 m below the base of excavations for construction in-the-day. The groundwater level in the floodplain is anticipated to be at the ground surface, and as such excavations within the floodplain will require a dewatering scheme including a cofferdam and stream diversion system. The contractor shall provide the detail design of the dewatering system and cofferdam.

Pile Installation / Caisson Construction

It is anticipated that cobbles and/or boulders will be encountered within the till deposit, which may adversely impact the installation of steel H-piles or caissons. Piles should be equipped with flange plates or approved driving shoes. Sub-artesian groundwater condition was observed within the shale bedrock. Depending on the piezometric pressure relative to the pile cap level and the finished grade, specialized construction techniques (such as construction of a filter blanket with sub-drains) may be required to mitigate the potential upward water flow along the pile-soil interface.

For caisson foundations, water-bearing non-cohesive soils should be expected to run or flow into the caisson hole during and after the drilling and as such, appropriate procedures (use of temporary/permanent caisson liners) will be required to minimize ground loss during drilling and concrete placement. Sub-artesian condition was noted within the shale bedrock and as such consideration should be given to using drilling mud and tremie concrete placement techniques for caisson construction.

Recommendation for Additional Work

Further subsurface investigation should be carried out during the detail design to confirm the subsoil and groundwater conditions at the location of approach embankments and foundation elements. In particular, consideration should be given to coring the bedrock and confirming the groundwater level within the shale bedrock.

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No LRC-1 1 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 849 741.3 N; 293 247.4 E ORIGINATED BY F.P.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE October 14, 2015 CHECKED BY A.V.

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 (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
181.9	Ground Surface										
181.7	ASPHALT (200mm)										
0.2	SAND, with gravel Compact to very dense Brown and grey Moist		1	SS	56						
180.7	(FILL)		2	SS	12						
1.2	CLAYEY SILT, some sand, trace gravel, trace organics, containing silt seams Firm to stiff Mottled grey and brown Moist		3	SS	8						
			4	SS	9						6 16 51 27
			5	SS	10						
177.3			6	SS	5						
4.6	CLAYEY SILT, trace to some sand, trace gravel, conatining silt seams, and shale fragments Stiff to hard Grey Moist (TILL)		7	SS	11						
			8	SS	12						3 16 54 27
			9	SS	37	▽					
			10	SS	43						0 2 73 25
			11	SS	53						
170.2											
11.7	SHALE BEDROCK Highly weathered Grey		12	SS	73/15cm						First groundwater strike at 11.7m
			13	SS	66/15cm						
	Cont'd										

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

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No LRC-1 2 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 849 741.3 N; 293 247.4 E ORIGINATED BY F.P.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE October 14, 2015 CHECKED BY A.V.

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 (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
166.9											
166.5			14	SS	100/13cm						
15.4	End of borehole ▽ Water level noted during drilling ▼ Water level measured upon completion Notes: 1. Groundwater level measured at a depth of 7.9m below ground surface (Elev. 174.0m) upon completion of drilling. 2. No cave-in was noted upon extraction of hollow stem augers.										

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

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No LRC-2 1 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 849 747.0 N; 293 320.3 E ORIGINATED BY F.P.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE October 15, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	WATER CONTENT (%) (10 20 30)				GR SA SI CL
180.6	Ground Surface												
180.4 / 0.2	ASPHALT (180mm)												
	SAND, with gravel Very dense Brown Moist (FILL)		1	SS	70								
179.7 / 0.9	CLAYEY SILT, trace sand, trace gravel, trace organics Stiff Brown Moist		2	SS	10								
			3	SS	13								
178.4 / 2.2	CLAYEY SILT, trace sand, trace gravel Hard Brown becoming grey below a depth of 3.0m Moist to wet (TILL)		4	SS	30								2 8 68 22
			5	SS	65								
			6	SS	52								5 1 71 23
			7	SS	50/15cm								
			8	SS	73								
			9	SS	53								0 4 57 39
			10	SS	58								
			11	SS	68/15cm								First groundwater strike at 10.5m
169.0 / 11.6	SHALE BEDROCK Highly weathered Grey		12	SS	100/15cm								
166.8 / 13.8	End of borehole Water level measured upon completion Notes: 1. Groundwater level was measured at a depth of 10.5m below ground surface (Elev. 170.1m) upon completion of drilling. 2. No cave-in was noted in the borehole upon extraction of hollow stem augers.		13	SS	50/5cm								

Cont'd

+7, ×5: Numbers refer to Sensitivity (20, 15, 5, 10) (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No LRC-2 2 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 849 747.0 N; 293 320.3 E ORIGINATED BY F.P.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE October 15, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	WATER CONTENT (%) (10 20 30)				GR SA SI CL
165.6	measured at a depth of 10.5m below ground surface (Elev. 170.1m) upon completion of drilling. 2. No cave-in was noted in the borehole upon extraction of hollow stem augers.												

ON MTO_NEW LOGO HWY 427 15TF013A-REV.GPJ ON_MOT.GDT 15/01/2016 9:31:13 AM

+7, ×5: Numbers refer to Sensitivity (20, 15, 5, 10) (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No LRC-3 1 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 849 732.8 N; 293 287.0 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE October 16, 2015 CHECKED BY A.V.

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 (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
179.9	Ground Surface										
179.8	ASPHALT (150mm)										
0.2	SAND, with gravel Compact to very dense Brown Moist (FILL)		1	SS	84						
			2	SS	15						
178.2			3A	SS							
1.7	CLAYEY SILT, trace to some sand, containing topsoil Firm to Stiff Mottled brown and grey Moist		3B	SS	7						
			4	SS	10						
176.7			5A	SS							
3.2	SILT and SAND, trace to some gravel, trace clay Very dense Brown to grey Moist (TILL)		5B	SS	70						
			6	SS	65/13cm						10 40 41 9 Sampler bouncing
			7	SS	65/10cm						Sampler bouncing
			8	SS	65/13cm						Sampler bouncing
172.9											
7.0	CLAYEY SILT, trace sand Hard Grey Moist (TILL)		9	SS	51						0 0 58 42
			10	SS	41						
			11	SS	37						Auger grinding between depths of 11.3m and 12.2m
168.2											
11.7	SHALE BEDROCK Highly weathered Grey		12	SS	75/5cm						
			13	SS	75/10cm						Sampler bouncing
	Cont'd										

ON MTO_NEW LOGO HWY 427 15TF013A-REV.GPJ ON_MOT.GDT 15/01/2016 9:31:14 AM

+7, ×5: Numbers refer to Sensitivity (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No LRC-3 2 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 849 732.8 N; 293 287.0 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE October 16, 2015 CHECKED BY A.V.

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 (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
164.9											
164.6											Sampler bouncing
15.3	End of borehole ▼ Water level measured upon completion Notes: 1. Groundwater level measured at a depth of 14.6m below ground surface (Elev. 165.3m) upon completion of drilling. 2. No cave-in was noted in the borehole upon extraction of hollow stem augers.		14	SS	75/3cm						

ON MTO_NEW LOGO HWY 427 15TF013A-REV.GPJ ON_MOT.GDT 15/01/2016 9:31:14 AM

+7, ×5: Numbers refer to Sensitivity (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No S10

1 OF 1 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4849726.6 ;E 293235.7
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 20, 2009

ORIGINATED BY SB
COMPILED BY VA
CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS
183.4	GROUND SURFACE					
0.0	Asphalt					
0.2	Sand, trace gravel (FILL) Brown Moist					
182.6						
0.8	CLAYEY SILT, some sand, trace gravel, containing cobbles (TILL) Stiff to hard Brown Moist		1	SS	11	
			2	SS	30	
	Becoming grey at a depth of 2.3 m		3	SS	27	
			4	SS	61	
178.9			5	SS	38	
4.5	SAND and SILT, trace gravel, trace clay (TILL) Very dense Grey Moist		6	SS	102	
177.5						
5.9	CLAYEY SILT Hard Grey Moist		7	SS	101	
175.3			8	SS	171	
8.1	END OF BOREHOLE NOTES: 1. Open borehole dry upon completion of drilling. 2. Borehole backfilled with bentonite.					

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

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL
0	0	80	20

ELEVATION SCALE: 183, 182, 181, 180, 179, 178, 177, 176

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

RECORD OF BOREHOLE No S11

1 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4849750.6 ;E 293294.6
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 20, 2009

ORIGINATED BY SB
COMPILED BY VA
CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS
180.9	GROUND SURFACE					
0.0	Asphalt					
0.2	Sand, trace gravel (FILL) Brown Moist					
180.1						
0.8	CLAYEY SILT, some sand, trace gravel, slightly organic, containing rootlets Stiff Dark grey Moist		1	SS	8	
			2	SS	8	
178.7						
2.2	CLAYEY SILT with sand, trace gravel Firm Brown Moist		3	SS	6	
177.9						
3.0	CLAYEY SILT, some sand, trace gravel, containing cobbles (TILL) Hard Grey Moist		4	SS	88	
177.0						
3.9	SAND and SILT, trace gravel, trace clay (TILL) Very dense Grey Moist		5	SS	148	
			6	SS	86	
			7	SS	00/0.1	
173.9						
7.0	CLAYEY SILT, some sand, trace gravel (TILL) Hard Grey and brown Moist		8	SS	07/0.1	▽
			9	SS	55	
170.5						
10.4	CLAYEY SILT with sand, trace to some gravel, containing shale fragments (TILL) Hard Grey Moist		10	SS	109	
168.7						
12.2	SHALE (BEDROCK) Grey		11	SS	25/0.1	
167.1			12	SS	00/0.0	
13.8	END OF BOREHOLE					

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

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL
0	17	61	22
6	36	50	8
8	30	49	13

ELEVATION SCALE: 180, 179, 178, 177, 176, 175, 174, 173, 172, 171, 170, 169, 168

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S11

2 OF 2 **METRIC**

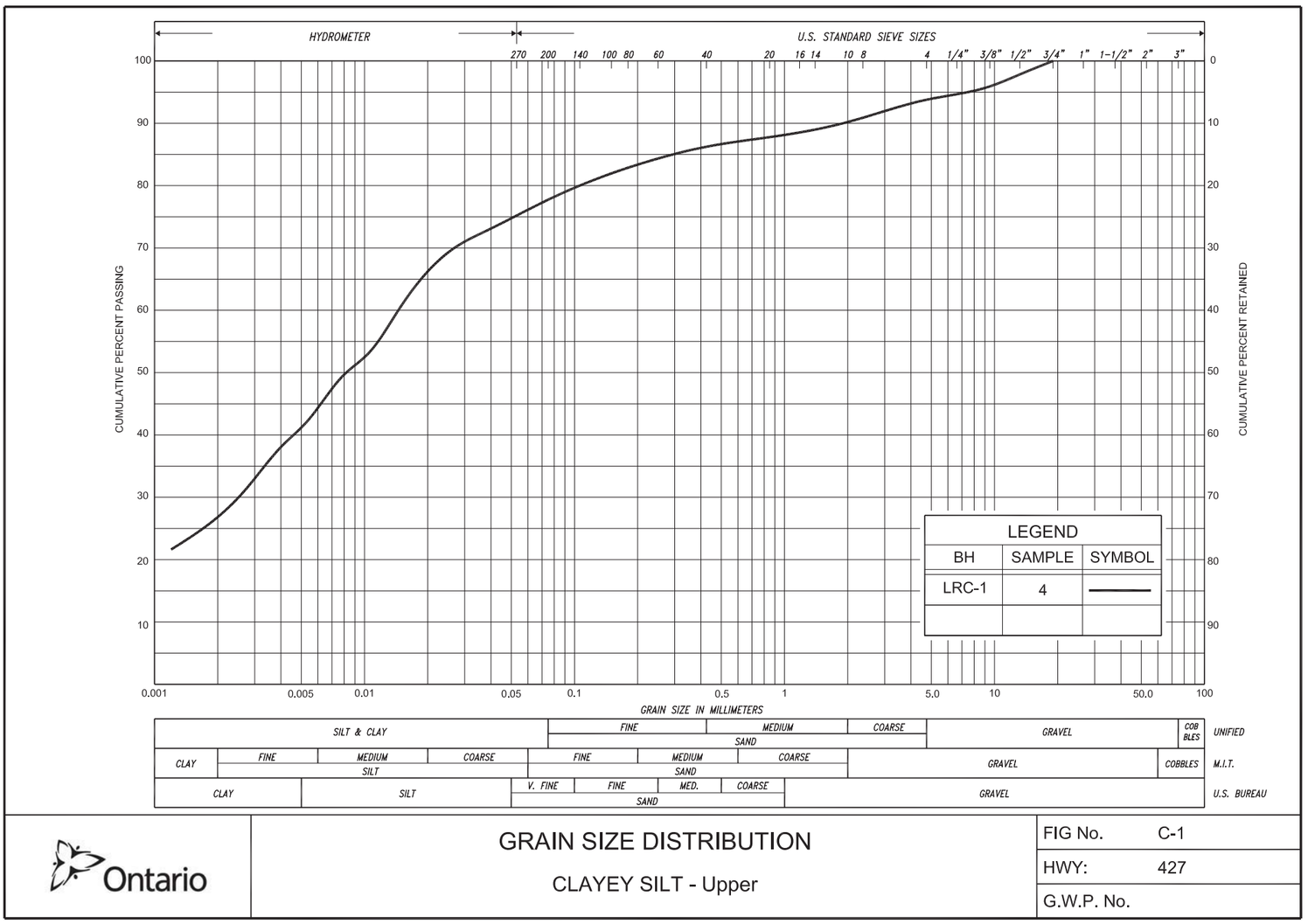
PROJECT 06-1111-012 | LOCATION N 4849750.6 ;E 293294.6 | ORIGINATED BY SB

W.O. 05-20012 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | COMPILED BY VA

DIST Central HWY 427 | DATE March 20, 2009 | CHECKED BY SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —										
	END OF BOREHOLE										
	NOTE:										
	1. A 50 mm diameter monitoring well was installed at a depth of 13.7 m (Elev. 167.2 m).										
	Water level measurements										
	Date Depth Elev.										
	On Completion 7.8 m 173.1 m April 24/09 0.0 m 180.9 m May 13/09 0.0 m 180.9 m June 15/09 0.0 m 180.9 m July 09/ 09 0.0 m 180.9 m										

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

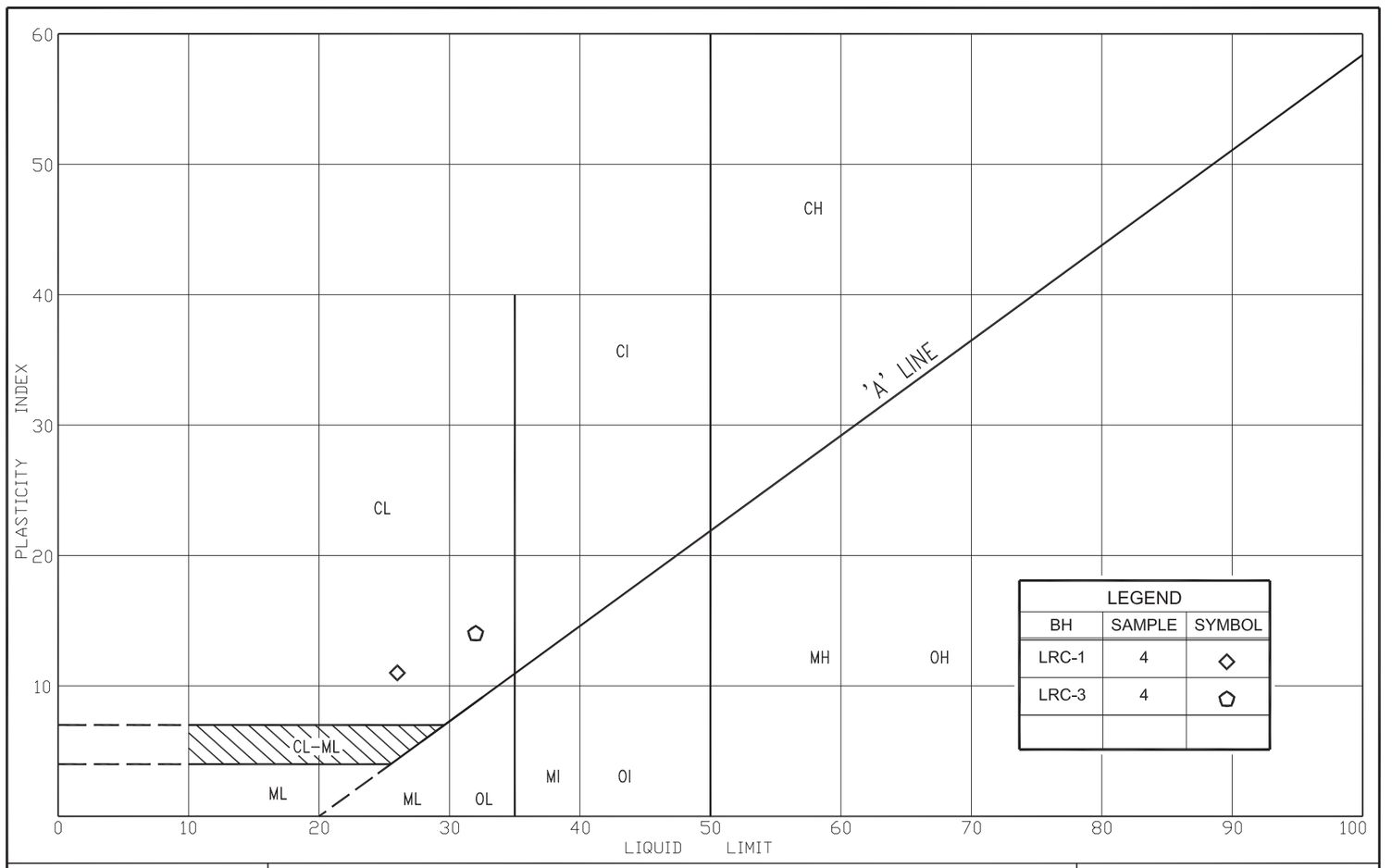


Ontario

GRAIN SIZE DISTRIBUTION

CLAYEY SILT - Upper

FIG No.	C-1
HWY:	427
G.W.P. No.	

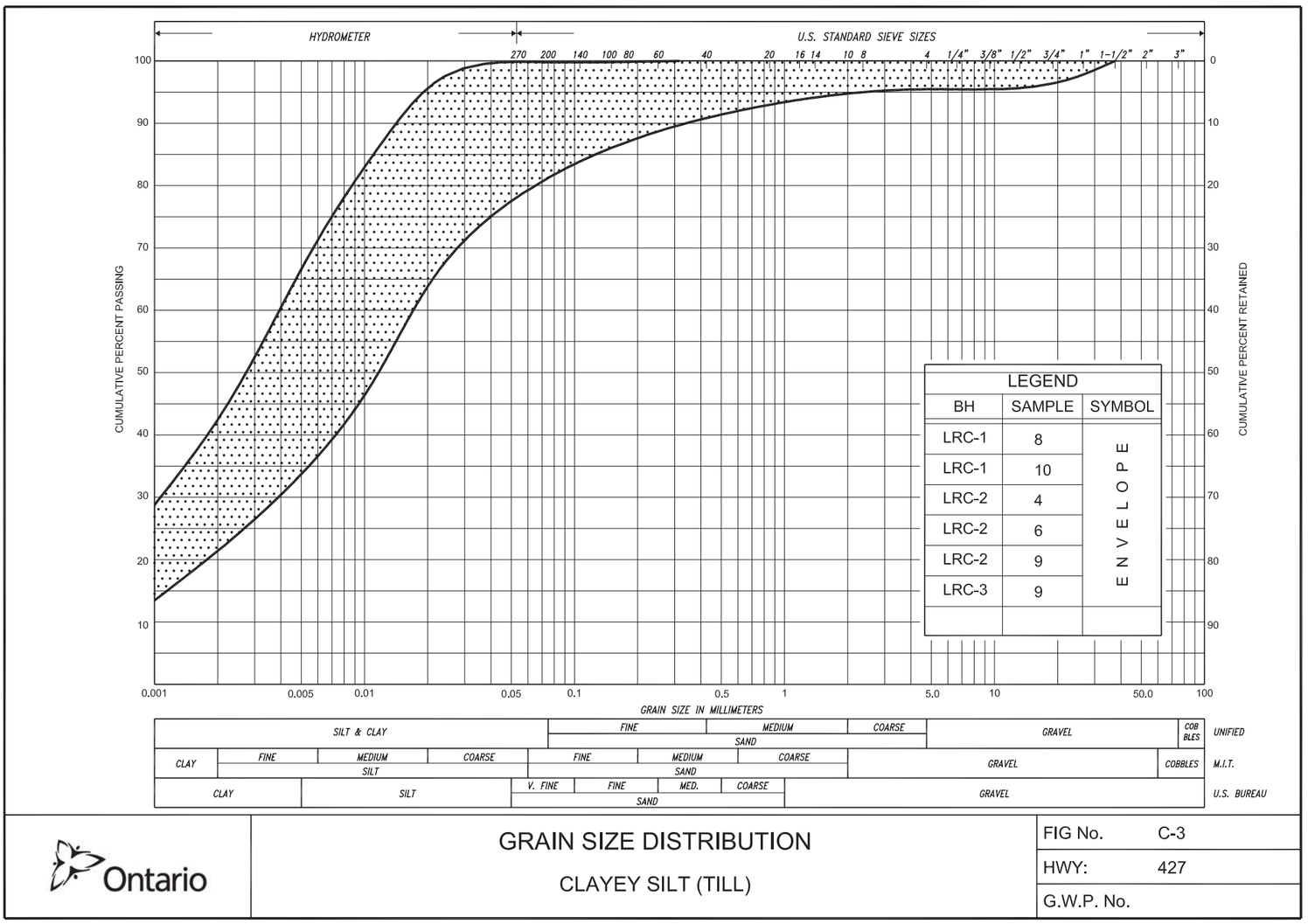


Ontario

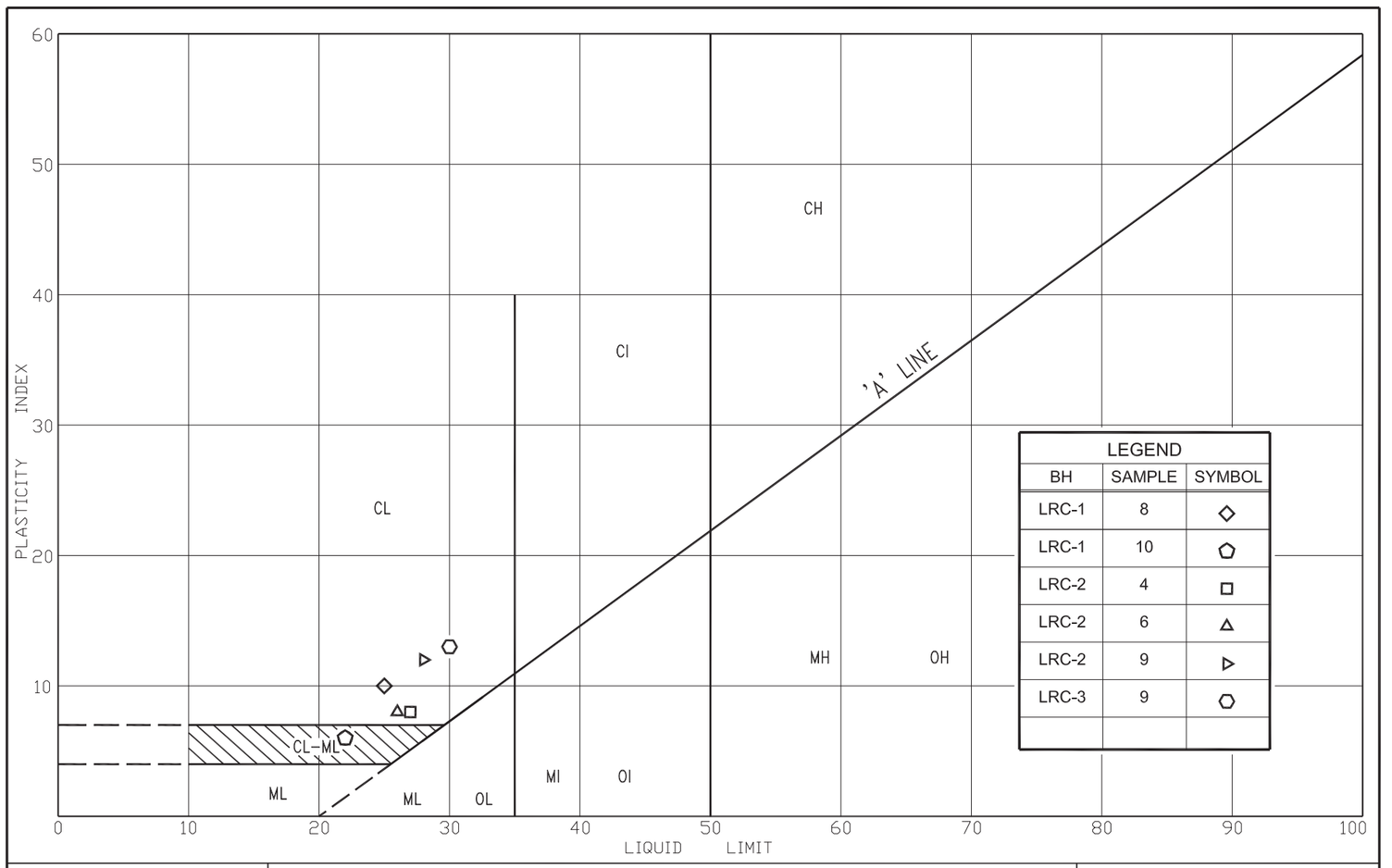
PLASTICITY CHART

CLAYEY SILT - Upper

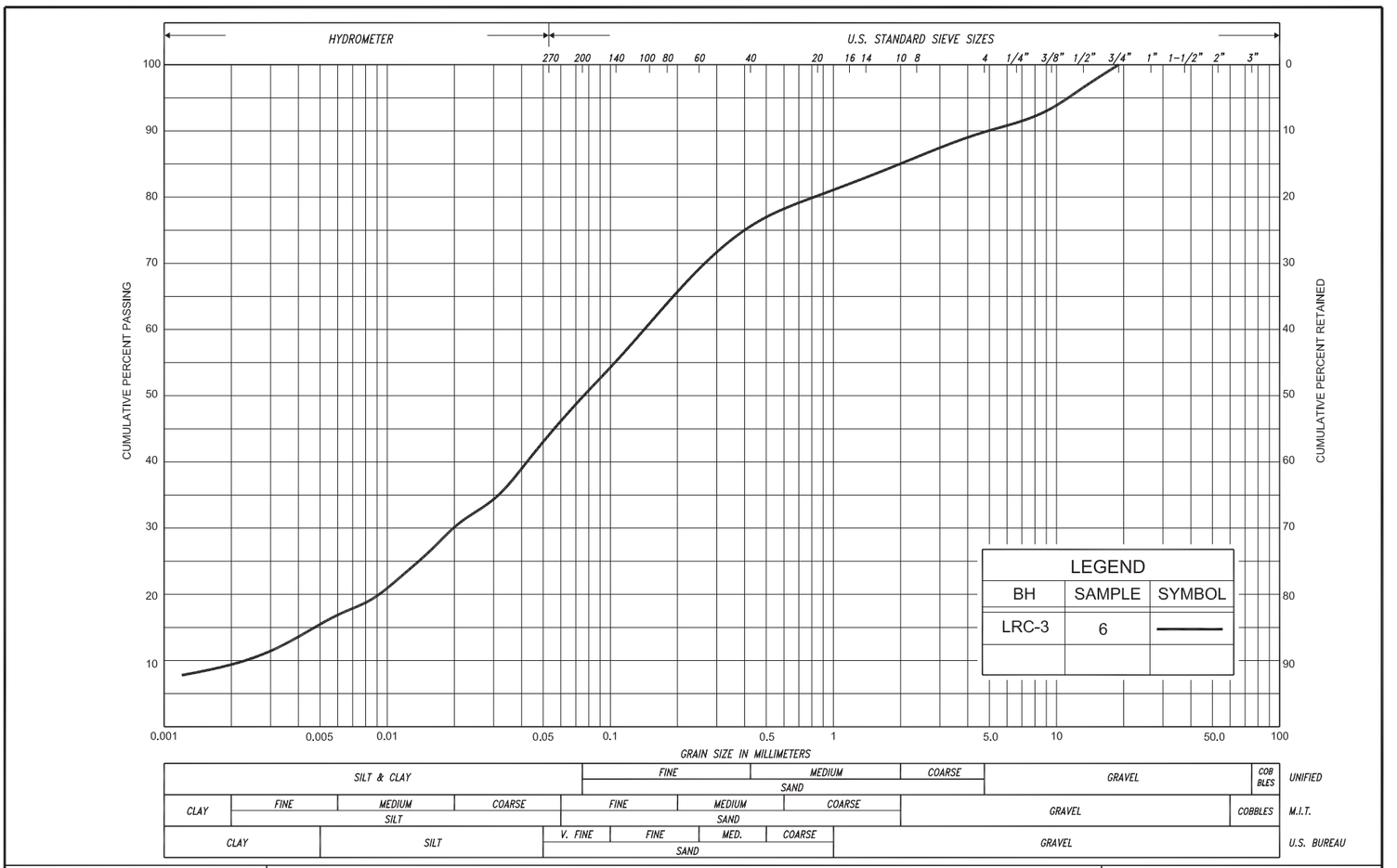
FIG No.	C-2
HWY:	427
G.W.P. No.	



Ontario	GRAIN SIZE DISTRIBUTION CLAYEY SILT (TILL)	FIG No. C-3 HWY: 427 G.W.P. No.



Ontario	PLASTICITY CHART CLAYEY SILT (TILL)	FIG No. C-4 HWY: 427 G.W.P. No.

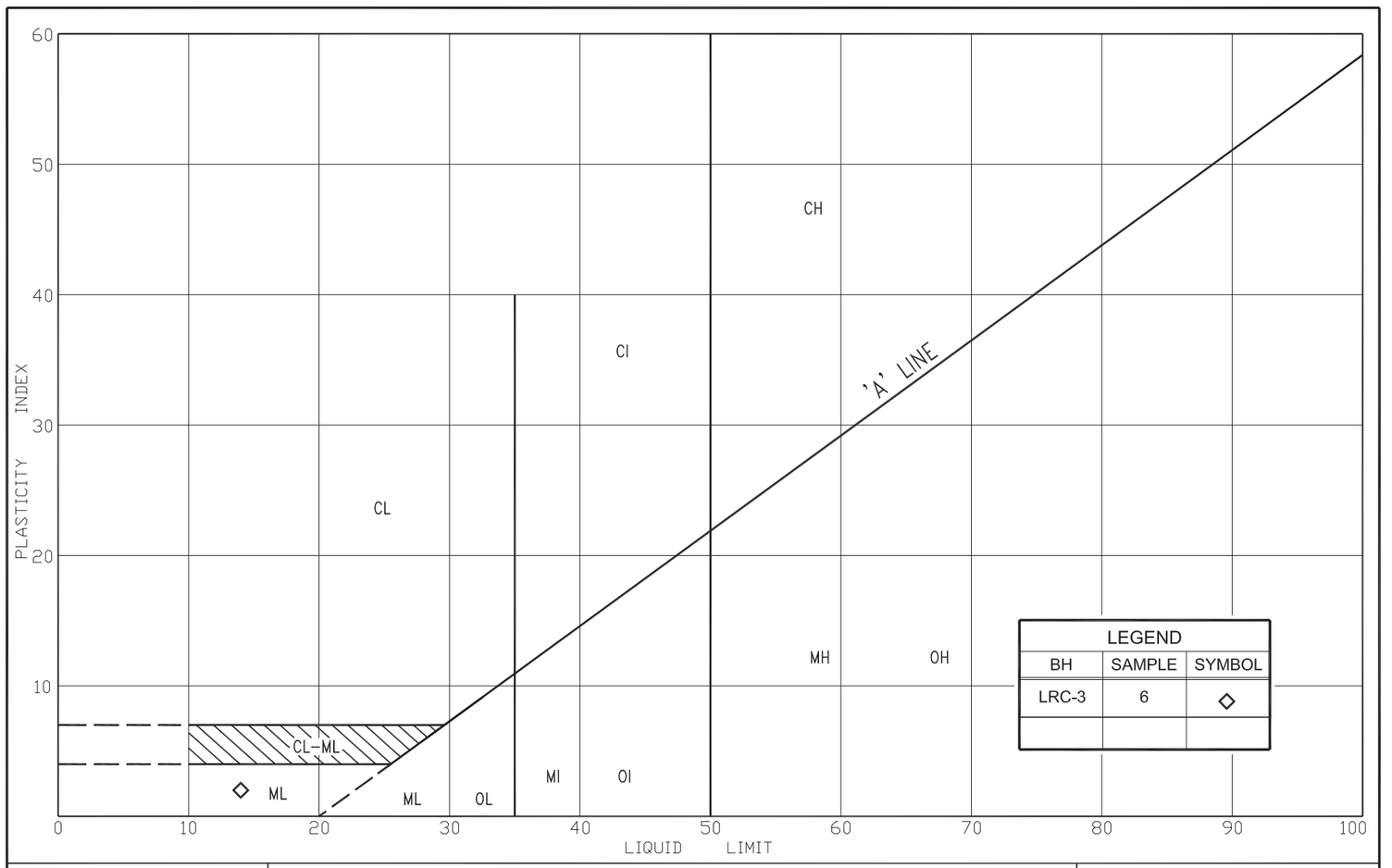


Ontario

GRAIN SIZE DISTRIBUTION

SILT and SAND (TILL)

FIG No.	C-5
HWY:	427
G.W.P. No.	



Ontario

PLASTICITY CHART

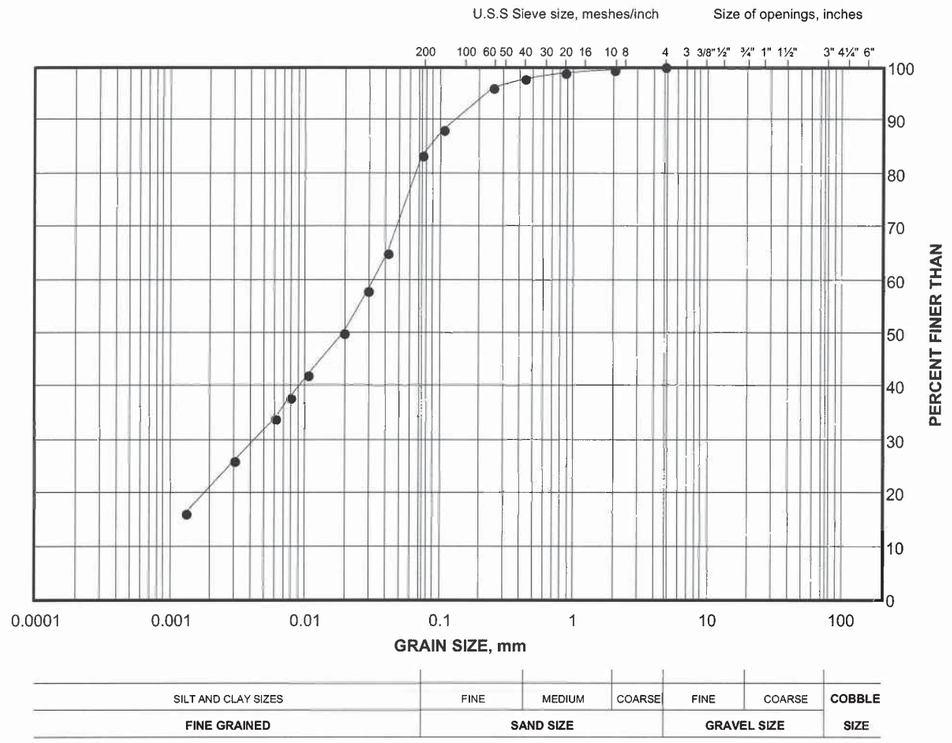
SAND and SILT (TILL) - Fine Contents

FIG No.	C-6
HWY:	427
G.W.P. No.	

GRAIN SIZE DISTRIBUTION TEST RESULT

Surficial Clayey Silt

FIGURE B1



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

LEGEND

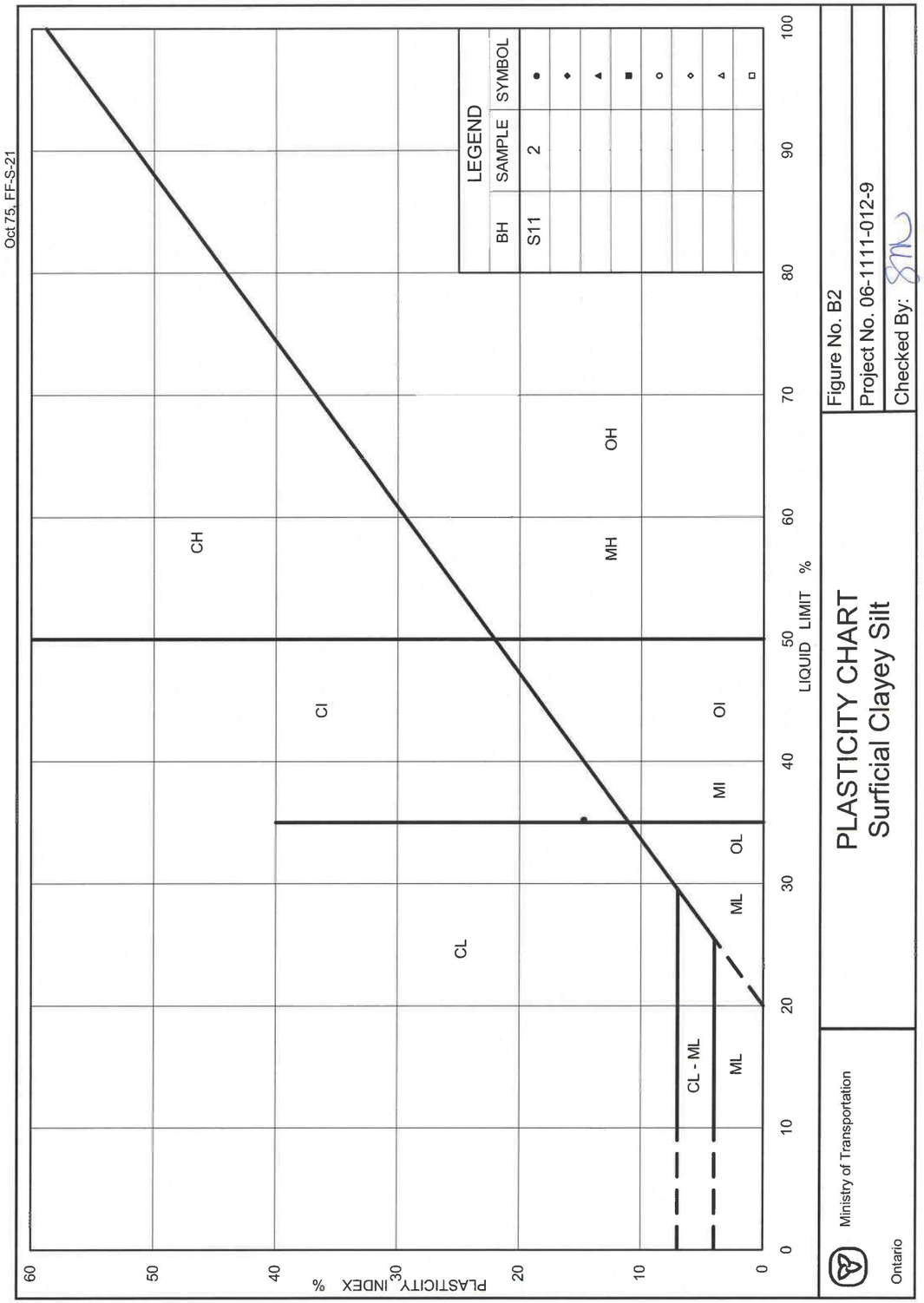
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S11	2	179.1

Project Number: 06-1111-012-9

Checked By: SM

Golder Associates

Date: 04-Aug-09



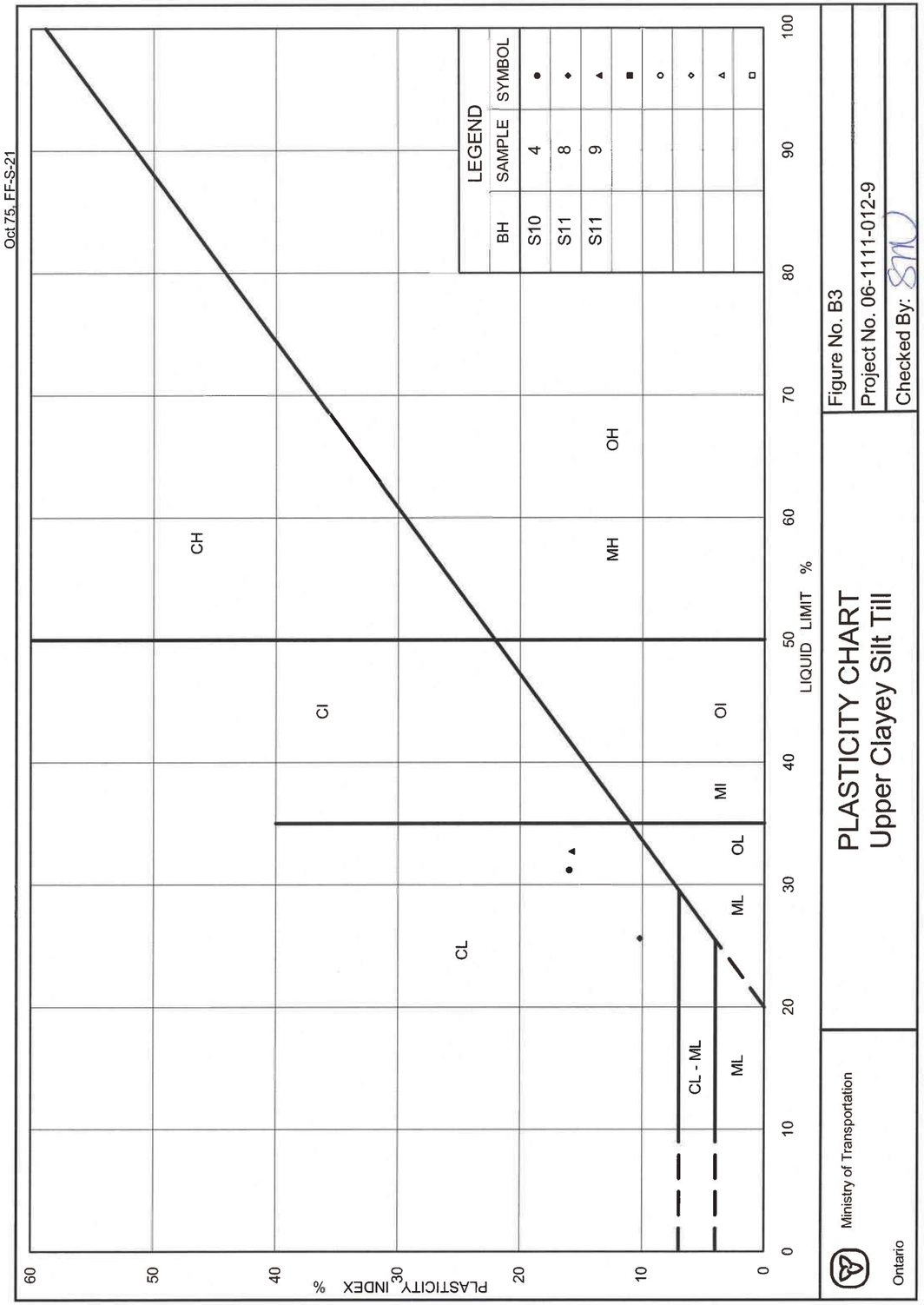
PLASTICITY CHART
Surficial Clayey Silt

Figure No. B2

Project No. 06-1111-012-9

Checked By: SM

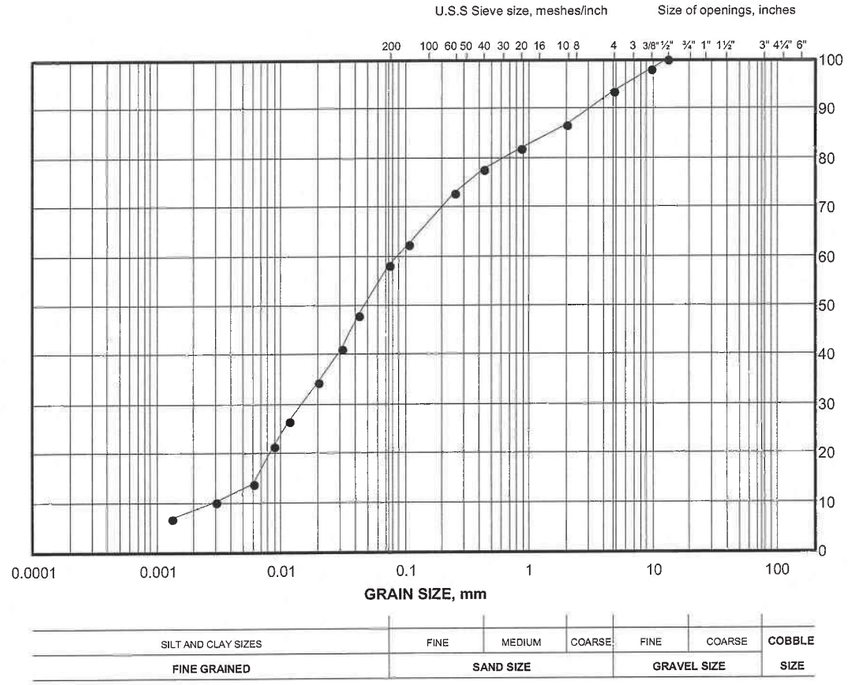
Ministry of Transportation
Ontario



GRAIN SIZE DISTRIBUTION TEST RESULT

Sand and Silt Till

FIGURE B4



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S11	5	176.9

Project Number: 06-1111-012-9

Checked By: SM

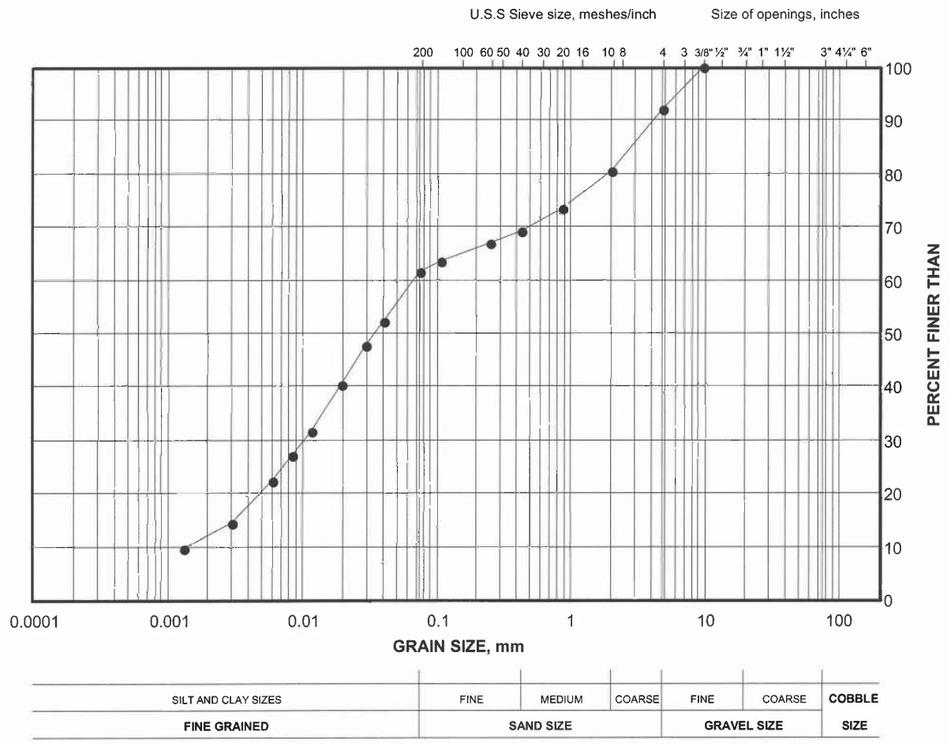
Golder Associates

Date: 04-Jul-09

GRAIN SIZE DISTRIBUTION TEST RESULT

Lower Clayey Silt Till

FIGURE B5



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S11	10	169.9

Project Number: 06-1111-012-9

Checked By: SM

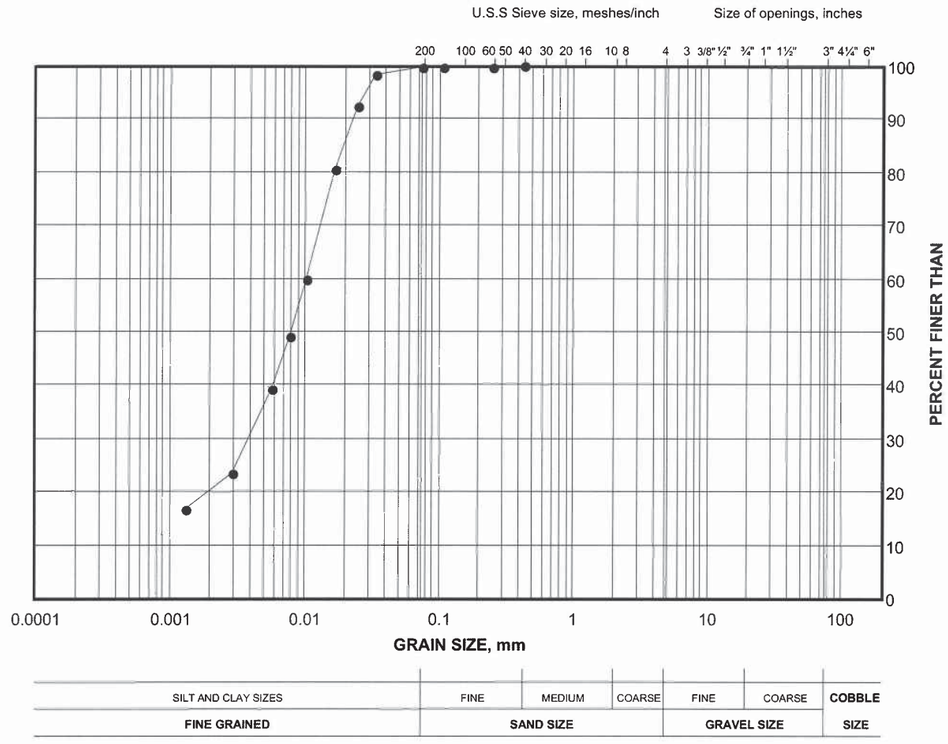
Golder Associates

Date: 04-Aug-09

GRAIN SIZE DISTRIBUTION TEST RESULT

Lower Clayey Silt

FIGURE B6



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S10	8	175.6

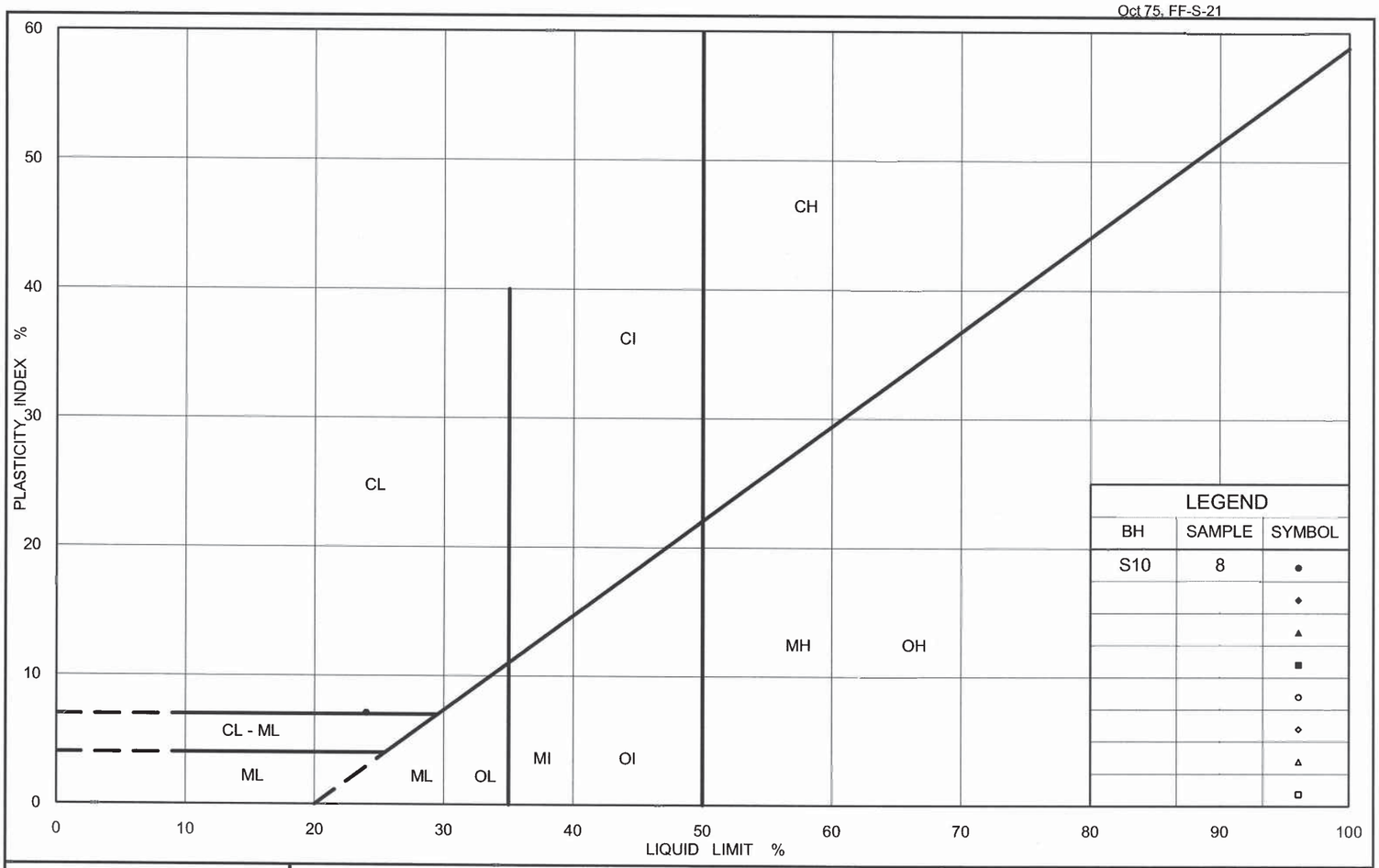
Project Number: 06-1111-012-9

Checked By: SM

Golder Associates

Date: 04-Aug-09

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
Lower Clayey Silt

Figure No. B7

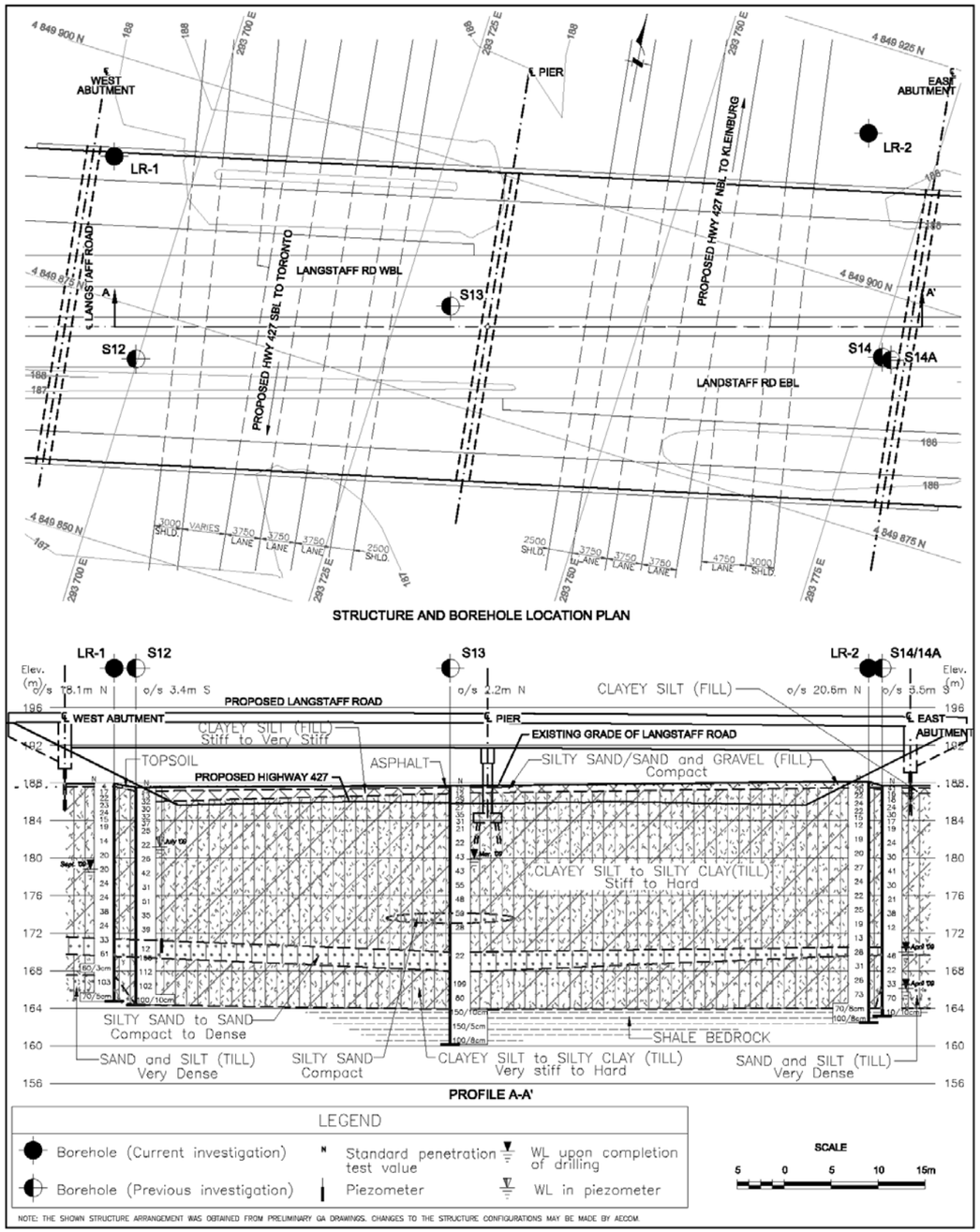
Project No. 06-1111-012-9

Checked By: SM

Structure Type: Underpasses

Existing Ground Elevation across Boreholes: 188.1 m to 187.9 m

Complexity Rating: Medium



FOUNDATION INVESTIGATIONS

Site Description

The proposed Langstaff Road underpass structure is located approximately 1.4 km north of Zenway Boulevard and 1 km west of Highway 27 in the City of Vaughan, Ontario. The topography in the area of the proposed structure is nearly flat. Land use at the north side of the existing Langstaff Road includes industrial developments. A moderately to densely treed area is present on the south side of the existing Langstaff Road.

Borehole Information

Borehole No.	Foundation Unit	MTM NAD 83 Coordinates		Ground Surface Elevation (m)	Borehole Depth (m)
		Northing (m)	Easting (m)		
Previous Investigation					
S12	West Abutment	4,849,869.7	293,699.8	187.5	23.1
S13	Centre Pier	4,849,885.0	293,730.1	187.7	27.5
S14	East Abutment	4,849,893.4	293,775.6	187.7	18.9
S14A	East Abutment	4,849,893.4	293,776.6	187.7	24.5
Current Investigation					
LR-1	West Abutment	4,849,889.6	293,691.2	187.9	23.1
LR-2	East Abutment	4,849,915.7	293,767.2	188.1	25.6

Subsurface Condition

Pavement/ Fill, Topsoil: Boreholes S12 to S14 were advanced from the road surface and encountered a 0.1 m thick layer of asphalt overlying a 0.1 m to 0.3 m thick layer of non-cohesive fill over a 0.5 m to 1.1 m thick cohesive fill. Borehole LR-2 encountered a 0.7 m thick layer of non-cohesive fill at the ground surface. The fill extends to Elevations 187.4 m to 186.1 m.

Borehole LR-1 encountered an approximately 0.1 m thick layer of topsoil at Elevations 187.9 m.

***Clayey Silt to Silty Clay Till*:** A 19.1 m to 21.8 m thick brown to grey cohesive till deposit comprised of clayey silt to silty clay, trace to with sand, trace gravel was encountered underlying the surficial layers of fill/topsoil in all boreholes at 0.1 m to 1.5 m depths, Elevations 187.8 m to 186.1 m. The deposit contains a 1.5 m thick silty sand pocket at 13.7 m depth, Elevation 174.0 m in Borehole S12. Borehole S12 was terminated within deposit at 23.1 m depth, Elevation 164.4 m.

The SPT "N"-values ("N"-values) measured within the till deposit range from 12 to 199 blows, suggesting a stiff to hard consistency. An "N"-value of 59 blows was measured within the silty sand pocket, indicating a very dense compactness. The results of grain size distribution analyses and Atterberg limits tests completed on samples of cohesive till obtained during the current investigation are shown on Figures D-1 and D-2, respectively.

Silty Sand to Sand: A 0.7 m to 2.1 m thick silty sand to sand layers were encountered within the till at 17.4 m to 17.7 m depths, Elevations 170.9 m to 170.0 m and were fully penetrated to 18.4 m to 19.8 m depths, Elevations 169.3 m to 167.9 m. "Blowing" sand was noted within this layer during the drilling operations.

The "N"-values measured within these layers range from 12 to 61 blows, indicating a compact to very dense compactness.

Sand and Silt Till: Boreholes S14A and LR-1 penetrated a non-cohesive till deposit comprised of sand and silt below the cohesive till deposit at 21.8 m and 20.7 m depths, Elevations 165.9 m and 167.2, respectively. Borehole LR-1 was terminated within this deposit at 23.1 m depth, Elevation 164.8 m penetrating it for 2.4 m. The thickness of the deposit was 1.9 m in Borehole S14A and the deposit extends to 23.7 m depth, Elevation 164.0 m.

"N"-values of 70 and 103 blows per 0.30 m of penetration and 70 blows per 0.05 m of penetration were measured within the sand and silt till deposit, indicating a very dense compactness. The results of grain size distribution analyses and Atterberg limits tests completed on samples of non-cohesive till obtained during the current investigation are shown on Figures D-3 and D-4, respectively.

Shale Bedrock: Boreholes S13, S14A, and LR-2 penetrated into the highly weathered shale bedrock underlying the till deposit at 23.7 m to 23.9 m depths, Elevations 164.2 m to 163.9 m. All boreholes terminated within this layer at 24.5 m to 27.5 m depths, Elevations 163.2 m to 160.2 m, at practical refusal penetrating it for 0.8 m to 3.7 m.

Groundwater Conditions

The groundwater level in the piezometer installed in Borehole S12 was at 6.3 m depth, Elevation 181.3 m. The water level in other boreholes during and upon completion of drilling was at 7.8 m to 21.8 m depths, Elevations 179.9 m to 165.9 m indicating sub-artesian conditions within the non-cohesive till below Elevation 172.0 m. For further details refer to Table A2 of this report.

FOUNDATION RECOMMENDATIONS:

The following site-specific foundation recommendations are for preliminary design and planning purposes only and they require refinement during detail design. Project-wide foundation recommendations, design assumptions and limitations are contained in Part B of this report. The proposed two-span underpass structure will carry Langstaff Road over Highway 427.

Foundation Option	Advantages	Disadvantages	Relative Costs	Risks/Consequences
Spread footings on very stiff to hard clayey silt till or "Granular A" pad	• Conventional construction.	• Precludes use of integral abutments; • Provides relatively low bearing capacity.	• Lower relative cost compared to deep foundation options.	• Disturbing of subgrade due to excavation; • Risk of improper compaction of "Granular A" pad.
Driven steel H-Piles to found within "100-blow" soils	• Allows for integral abutment design; • Negligible post-construction settlement.	• Piles may encounter obstructions during driving.	• More costly than spread footings.	• Minor potential for pile damage/ deflection if obstructions are encountered during pile driving.
Caissons founded within "100-blow" soils	• Provides higher capacity than driven piles.	• Precludes use of integral abutments; • Drilling mud and tremie technique is required for construction; • Uncertainties associated with cleaning and inspecting the base of caissons.	• More costly than driven steel H-piles.	• Risk of flowing water bearing soils into caisson holes; • Risk of loosening or disturbing founding soils at base of caissons.

Spread Footings

Spread footings founded on native soils may be used to support the foundation elements. The preliminary geotechnical resistances are presented in the following table.

Foundation Unit	Founding Stratum	Axial Geotechnical Resistance < 25mm settlement		Highest Founding Elevation within Native Soils (m)
		Factored ULS (kPa)	SLS (kPa)	
West Abutment	Very Stiff to Hard Clayey Silt Till	375	250	186.5
Centre Pier				186.5
East Abutment				186.0

Alternatively, spread footings can be placed on a Granular A pad with minimum 2 m thickness, assuming a factored geotechnical resistance at ULS of 900 kPa and geotechnical resistance at SLS of 350 kPa for preliminary design.

Driven Steel H-Pile/ Steel Pipe Piles

Steel H-piles 310x110 or Steel Pipe piles with 324 mm (12 ¾ in) outer diameter and 6 mm (1/4 in) thickness, driven to refusal within the hard clayey silt till deposit at the west abutment or shale bedrock at the other foundation elements may be used to support the foundation elements. The preliminary geotechnical resistances and tip elevations are as follows:

Foundation Unit	Axial Geotechnical Resistance		Approximate Pile Tip Elevation (m)
	Factored ULS (kN)	SLS (kN)	
West Abutment	1,600	1,200	167
Centre Pier	1,800	1,400	163
East Abutment	1,800	1,400	163

Driven piles should be controlled by Hiley Formula as per MTO Drawing SS-103-11 from 2 m above the approximate pile tip elevations, employing a maximum load of twice the factored geotechnical resistance at ULS per pile.

Refer to Part A, Section 6.2.2 of this report for comments on applicability of pipe piles.

Caissons

Caissons founded within the hard cohesive till or shale bedrock may be considered for support of the foundation elements. The preliminary geotechnical resistances are as follows:

Foundation Unit	Caisson Diameter (m)	Axial Geotechnical Resistance		Caisson Base Elevation (m)
		Factored ULS (kN)	SLS (kN)	
West Abutment	1.2	5,000	4,000	167
	1.5	6,500	5,000	
Centre Pier	1.2	6,000	5,000	163
	1.5	7,800	6,500	
East Abutment	1.2	6,000	5,000	163
	1.5	7,800	6,500	

Recommended Foundation Alternative

The recommended foundation alternative at this site is driven steel H-piles into the hard clayey silt till / shale bedrock for the abutments, and spread footings founded on native, very stiff to hard till for the piers. Driven piles may also be used for the piers. Driven piles are preferred over caissons as special construction techniques will be required for caisson construction through non-cohesive water bearing layers.

Structure Abutments and Approaches

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

Construction of the underpass will require placement of up to about 5.0 m to 6.0 m of fill within the limits of the west and east approach embankments, respectively.

Structure Retaining Walls/Wing Walls

Earth retaining walls for this structure may include Cast-in-Place (CIP) or RSS Walls above the high water levels. For RSS walls the levelling pads of the facing may be founded on granular pad or CIP leveling pad. The retaining walls geometry should conform to High Appearance and High Performance in accordance with MTO.DSM 9.70 and current RSS Design Guidelines. The CIP retaining walls should be designed in conformance with the spread footing recommendation in this report.

Stability of Approach Embankments

Approach embankments constructed of suitable earth fill or granular fill and up to about 6.0 m high are expected to be stable at side slope formed at a gradient of 2H:1V.

Settlement of Approach Embankments

The settlement within founding soils is estimated to be in the order of 50 mm, most of which will occur shortly after the fill placement. It is recommended that consideration be given to preloading the approach embankments for a period of two (2) months prior to paving to mitigate the post-construction differential settlements at the bridge abutments.

Construction Considerations

Excavation

The construction of foundation elements will require excavations up to about 2 m below the proposed Highway 427 cut grade, and will be made through existing fill and very stiff to hard clayey silt till soils, which are classified as Type 3 soils in OHSA. Temporary unsupported excavations above the prevailing groundwater in these soils should be made with side slopes no steeper than 1H:1V.

Surface Water /Groundwater Control

Surface water run-off should be diverted away from the excavations at all times.

The prevailing groundwater should be maintained a minimum of 0.5 m below the base of excavations. The groundwater level measured in the piezometer screened within the sand layer at this site was at 6.3 m depth below the existing Langstaff Road, Elevation 181.3 m. It is expected that excavations for construction of foundation elements will be above the prevailing groundwater level at this site. The inflow of surface water or perched groundwater into excavations is expected to be handled by pumping from properly filtered sumps placed at the base of excavations.

Pile Installation / Caisson Construction

It is anticipated that cobbles and/or boulders will be encountered within the till deposits, which may adversely impact the installation of steel H-piles and caissons. Piles should be equipped with flange plates or approved driving shoes.

If consideration is being given to caisson foundations, water-bearing non-cohesive native soils (silty sand to sand layers) should be expected to run or flow into the caisson hole during and after drilling for the caisson foundation. As such, appropriate equipment and procedures (including use of temporary or permanent caisson liners) would be required to minimize ground loss during drilling and concrete placement and to permit inspection (using downhole cameras) and cleaning of the caisson bases.

Recommendations for Additional Work

Further subsurface investigation should be carried out during the detail design to confirm the subsoil and groundwater conditions at the location of approach embankments and centre pier. Further subsurface investigation, in situ and laboratory testing and analysis will be required to estimate total and differential settlements and to refine mitigation options.

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No LR-1 1 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 849 889.6 N; 293 691.2 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE September 28, 2015 CHECKED BY A.V.

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 (○ 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 (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
187.9	Ground Surface										
187.8 / 0.1	TOPSOIL										
	CLAYEY SILT, trace to some sand, trace gravel Stiff to hard Brown becoming grey below 3.8m Moist (TILL)		1	SS	4		187				
			2	SS	17		186				
			3	SS	22						
			4	SS	23		185				
			5	SS	24						5 16 49 30
			6	SS	15		184				
			7	SS	19		183				Auger grinding at a depth 5.2m
			8	SS	14		182				8 16 39 37
	rock fragments at a depth 7.8m		9	SS	20		181				
			10	SS	20		180				
			11	SS	24		179				0 15 59 26
			12	SS	24		178				
			13	SS	38		177				1 7 66 26
172.9	Cont'd						176				
							175				
							174				
							173				

+7 ,×5 : Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No LR-1 2 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 849 889.6 N; 293 691.2 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE September 28, 2015 CHECKED BY A.V.

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 (○ 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 (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
172.9											
15.0	(Cont'd) CLAYEY SILT, trace to some sand, trace gravel Stiff to hard Brown becoming grey below 3.8m Moist (TILL)		14	SS	24		172				
170.3			15	SS	33	▽	171				
17.6	SAND, trace silt Very dense Grey Wet		16	SS	61		170				First groundwater strike at 17.7m
168.8							169				
19.1	CLAYEY SILT, some sand, trace gravel Hard Grey Moist (TILL)		17	SS	60/3cm		168				6 20 49 25 Sampler bouncing
167.2							167				
20.7	SAND and SILT, some clay, trace gravel Very dense Grey Moist (TILL)		18	SS	103		166				9 41 39 11
164.8			19	SS	70/5cm		165				
23.1	End of borehole Split spoon sampler refusal ▽ Water level noted during drilling ▼ Water level measured upon completion Note: 1. Groundwater level measured at a depth of 9.1m below ground surface (Elev. 178.8) upon completion of drilling.										

+7 ,×5 : Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No LR-2 1 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 849 915.7 N; 293 767.2 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE September 29, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
188.1	Ground Surface						188				
0.0	SAND and GRAVEL Compact Brown Moist (FILL)		1	SS	22						
187.4	CLAYEY SILT, some to with sand, trace gravel Stiff to very stiff Brown becoming grey below 3.1m Moist (TILL)		2	SS	20		187				
0.7			3	SS	22						
			4	SS	24		186				
			5	SS	22		185				
			6	SS	15		184				5 22 35 38
			7	SS	12		183				
			8	SS	19		182				
			9	SS	20		181				
			10	SS	27		180				
			11	SS	24		179				1 13 61 25
			12	SS	22		178				
			13	SS	25		177				
							176				
							175				
173.1	Cont'd						174				

+7, ×5: Numbers refer to Sensitivity (20 / 15 / 10 / 5) (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No LR-2 2 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 849 915.7 N; 293 767.2 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE September 29, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
173.1											
15.0	(Cont'd) CLAYEY SILT, trace sand, trace gravel Stiff to very stiff Grey Moist (TILL)		14	SS	19		173				1 12 54 33
170.4			15	SS	13		172				
17.7	SILTY SAND, trace clay Compact Grey Moist		16	SS	28	▽	171				
169.0							170				First groundwater strike at 18.3m
19.1	CLAYEY SILT, some sand, some gravel Very stiff to hard Grey Moist (TILL)		17	SS	31		169				
			18	SS	26		168				
			19	SS	73		167				
164.2							166				
23.9	SHALE BEDROCK Highly weathered Grey		20	SS	~~70/8cm~~		165				20 20 46 14
162.5							164				
25.6	End of borehole due to auger refusal ▽ Water level noted during drilling		21	SS	~~100/8cm~~		163				

+7, ×5: Numbers refer to Sensitivity (20 / 15 / 10 / 5) (%) STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No S12

1 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4849869.7 ;E 293699.8 | ORIGINATED BY CR
W.O. 05-20012 | | COMPILED BY PKS/VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 26, 2009

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 (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
187.5	GROUND SURFACE										
0.0	ASPHALT										
	Silty sand, some gravel (FILL) Compact Brown to grey Moist		1	SS	29		187		○		
0.4	Clayey silt, trace gravel, trace sand, containing rootlets (FILL) Stiff to very stiff Brown Moist		2	SS	13				○		
186.1	SILTY CLAY, trace gravel, trace sand (TILL) Hard Brown Moist		3	SS	32		186		○—⊢		
1.5			4	SS	30		185		○		
			5	SS	32		184		○		
182.9			6	SS	37		183		○		
4.6	CLAYEY SILT, some sand, trace gravel, containing cobbles (TILL) Very stiff to hard Grey Moist		7	SS	25	▽	182		○		
			8	SS	22		181		○		1 18 58 23
			9	SS	26		180		○—⊢		
			10	SS	42		179		○		
			11	SS	31		178		○		
	Augers grinding at 11.4 m depth						177				
			12	SS	51		176		○		
			13	SS	35		175		○		
							174		⊢○⊣		
							173				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S12

2 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4849869.7 ;E 293699.8 | ORIGINATED BY CR
W.O. 05-20012 | | COMPILED BY PKS/VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 26, 2009

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 (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —										
170.1	CLAYEY SILT, some sand, trace gravel, containing cobbles (TILL) Very stiff to hard Grey Moist		14	SS	39		172		○		
17.4	SAND, trace gravel, trace silt, trace clay Compact Grey Wet Augers grinding between 17.6 m and 18.0 m depth		15	SS	12		171				
168.6							170				
18.9	SILTY CLAY, some sand, trace gravel (TILL) Hard Grey Wet		16	SS	155		169		○		2 91 4 3
166.6			17	SS	112		168		○		
20.9	CLAYEY SILT, trace gravel, trace sand, containing cobbles (TILL) Hard Grey Wet		18	SS	102		167				
	Augers grinding between 22.1 m and 22.5 m depth						166		○		
164.4			19	SS	00/0.1		165		○		
23.1	END OF BOREHOLE										

NOTES:

1. A 50 mm diameter monitoring well was installed at a depth of 18.9 m (Elev. 168.6 m).

Water level measurements

Date	Depth	Elev.
On Completion	5.2 m	182.3 m
May 13, 2009	6.9 m	180.6 m
June 15, 2009	6.7 m	180.8 m
July 09, 2009	6.3 m	181.3 m

2. At 18.3 m depth (Elev. 169.2 m) 1.2 m of sand was up inside the augers during drilling due to "blowing" sands.

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

Golder Associates

RECORD OF BOREHOLE No S13

1 OF 3 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4849885.0 ;E 293730.1 | ORIGINATED BY CR
W.O. 05-20012 | | COMPILED BY PKS/VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 30 & 31, 2009

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 × REMOULDED, 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
187.7	GROUND SURFACE						187				
0.0	ASPHALT										
0.2	Silty sand, some gravel (FILL) Compact Brown Moist		1	SS	15						
186.9							186				
0.8	Clayey silt, some sand, trace gravel (FILL) Very stiff Brown Moist		2	SS	12						
			3	SS	29						
	SILTY CLAY, trace sand, trace gravel (TILL) Stiff to hard Brown Moist		4	SS	27		185				
			5	SS	35						
			6	SS	31		184				
183.1											
4.6	CLAYEY SILT, some sand, trace gravel, containing cobbles (TILL) Very stiff to hard Grey Moist Augers grinding at 5.2 m depth		7	SS	21		183				
							182				
			8	SS	22		181				
	Augers grinding at 8.4 m depth		9	SS	43	▽	180				
							179				
			10	SS	43		178				
			11	SS	55		177				
							176				
			12	SS	48		175				
174.0							174				
13.7	Silty SAND, trace gravel Very dense Grey Wet		13	SS	59						
							173				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S13

2 OF 3 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4849885.0 ;E 293730.1 | ORIGINATED BY CR
W.O. 05-20012 | | COMPILED BY PKS/VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 30 & 31, 2009

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 × REMOULDED, 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —										
172.5											
15.2	CLAYEY SILT, some sand, trace gravel (TILL) Very stiff Grey Wet		14	SS	28		172				
170.0											
17.7	SAND, trace to some silt, trace gravel Compact Grey Wet		15	SS	22		171				1 87 9 3
							170				
167.9											
19.8	CLAYEY SILT, some sand, trace gravel (TILL) Hard Grey Wet						169				
	Augers grinding at 21.0 m depth		16	SS	199		168				
							167				
	Augers grinding at 22.0 m depth		17	SS	80		166				
163.9							165				
23.8	SHALE (BEDROCK) Grey		18	SS	50/0.10		164				
							163				
			19	SS	50/0.05		162				
160.2											
27.5	END OF BOREHOLE		20	SS	00/0.01		161				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S13

3 OF 3 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4849885.0 ;E 293730.1
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 30 & 31, 2009

ORIGINATED BY CR
COMPILED BY PKS/VA
CHECKED BY SMM

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)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L (WATER CONTENT (%) 10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —							SHEAR STRENGTH kPa (20 40 60 80 100) o UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED			
	NOTES: 1. A hydrostatic head of water was required inside the augers at 18.3 m depth (Elev. 169.4 m) in order to advance the borehole due to "blowing" sands. 2. Water level in open borehole at a depth of 7.8 m below ground surface (Elev. 179.9 m) upon completion of drilling. 3. Borehole backfilled with bentonite.										

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

Golder Associates

RECORD OF BOREHOLE No S14

1 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4849893.4 ;E 293775.6
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE April 2, 2009

ORIGINATED BY CR
COMPILED BY PKS/VA
CHECKED BY SMM

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)	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
								SHEAR STRENGTH kPa (20 40 60 80 100) o UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED			
187.7	GROUND SURFACE						187				
0.0	ASPHALT										
0.3	Silty sand, some gravel (FILL) Dense Brown Moist		1	SS	41						
186.9							186				
0.8	Clayey silt, some sand, trace gravel (FILL) Hard Brown Moist		2	SS	16						
	CLAYEY SILT, some sand, trace gravel (TILL) Stiff to hard Brown Moist		3	SS	18						
			4	SS	24		185				
			5	SS	30						
	Becoming grey below a depth of 3.8 m		6	SS	17		184				
			7	SS	19						
							183				
			8	SS	24						
							182				
			9	SS	30						
							181				
			10	SS	41		180				
			11	SS	30		179				
			12	SS	21		178				
			13	SS	38		177				
							176				
							175				
							174				
							173				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S14 2 OF 2 METRIC

PROJECT 06-1111-012 | LOCATION N 4849893.4 ;E 293775.6 | ORIGINATED BY CR
W.O. 05-20012 | | COMPILED BY PKS/VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE April 2, 2009

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 / WATER CONTENT (%)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —												
	CLAYEY SILT, some sand, trace gravel (TILL) Stiff to hard Brown Moist		14	SS	12		172						
170.0						▽	171						
17.7	Silty SAND, trace to some silt, trace gravel, trace clay Dense Grey Wet						170						
169.3 18.4	SILTY CLAY, some sand, trace gravel (TILL) Hard Grey Wet		15	SS	46		169						
168.8 18.9	END OF BOREHOLE												

NOTES:

1. Water level in open borehole at a depth of 17.7 m below ground surface (Elev. 170.0 m) upon completion of drilling.
2. An additional borehole was drilled adjacent to Borehole S14; See Record of Borehole S14A for details.
3. Borehole backfilled with bentonite.

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED: 20 40 60 80 100
WATER CONTENT (%): 10 20 30

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

Golder Associates

RECORD OF BOREHOLE No S14A 1 OF 2 METRIC

PROJECT 06-1111-012 | LOCATION N 4849893.4 ;E 293776.6 | ORIGINATED BY JEB
W.O. 05-20012 | | COMPILED BY PKS/VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE April 13, 2009

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 / WATER CONTENT (%)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
187.7 0.0	GROUND SURFACE						187						
	Unsampled, see Record of Borehole S14 for stratigraphy above a depth of 19.8 m.						186						
							185						
							184						
							183						
							182						
							181						
							180						
							179						
							178						
							177						
							176						
							175						
							174						
							173						

Continued Next Page

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED: 20 40 60 80 100
WATER CONTENT (%): 10 20 30

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

Golder Associates

RECORD OF BOREHOLE No S14A

2 OF 2 **METRIC**

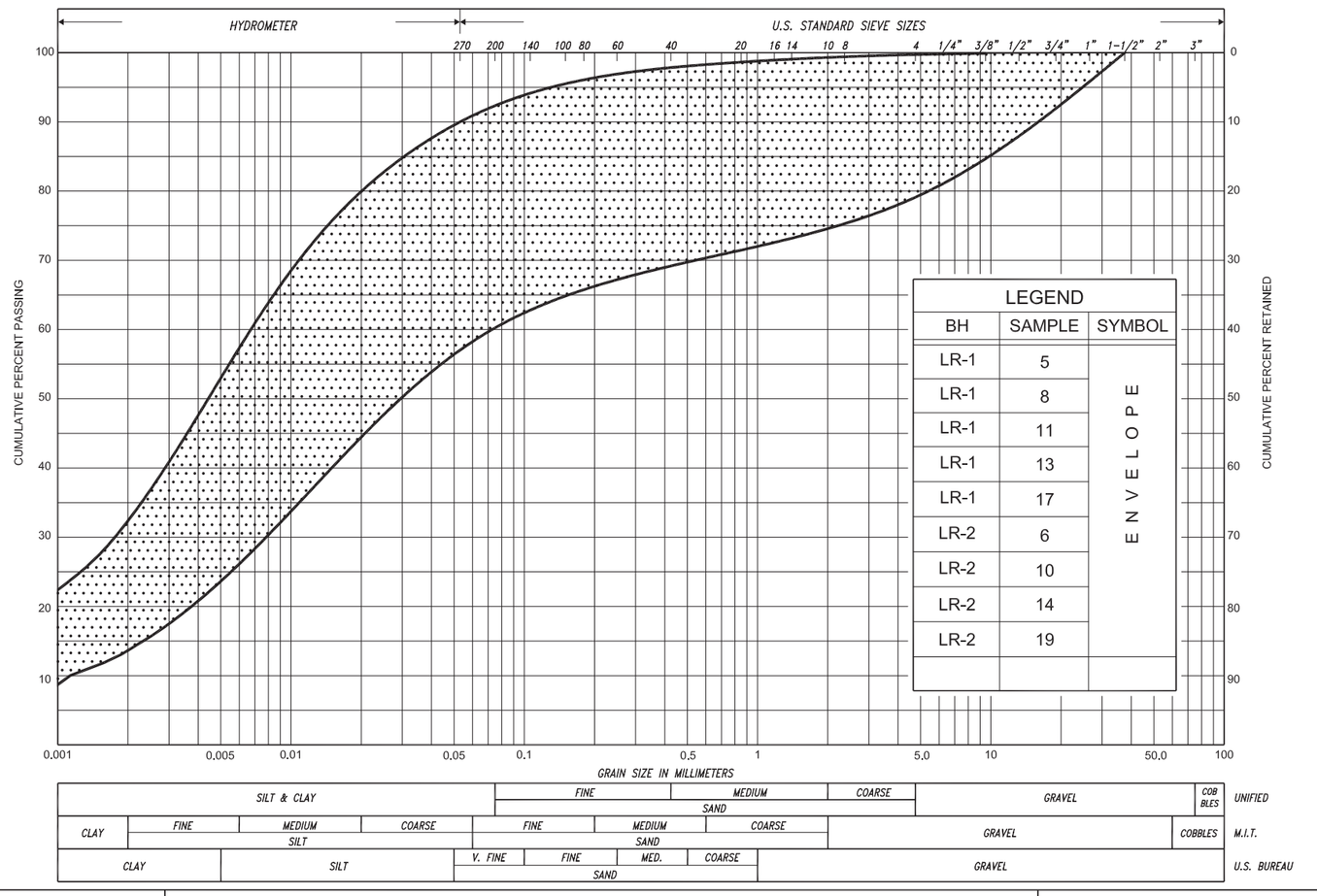
PROJECT 06-1111-012 | LOCATION N 4849893.4 ;E 293776.6 | ORIGINATED BY JEB

W.O. 05-20012 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | COMPILED BY PKS/VA

DIST Central HWY 427 | DATE April 13, 2009 | CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION — CONTINUED FROM PREVIOUS PAGE —	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, × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
167.9	Unsampled, see Record of Borehole S14 for stratigraphy above a depth of 19.8 m.						172				
19.8	SILTY CLAY, trace gravel, trace sand (TILL) Very stiff to hard Grey Moist		1	SS	22		171		42		
165.9			2	SS	33	▽	170				
21.8	SAND and SILT, some gravel, trace clay (TILL) Dense to very dense Grey Wet						169				
164.0			3	SS	70		168		o		12 40 39 9
23.7	SHALE (BEDROCK) Grey						167				
163.2			4	SS	110/0.10		166				
24.5	END OF BOREHOLE NOTES: 1. Water level in open borehole at a depth of 21.8 m below ground surface (Elev. 165.9 m) upon completion of drilling. 2. Borehole backfilled with bentonite.						165				
							164				

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

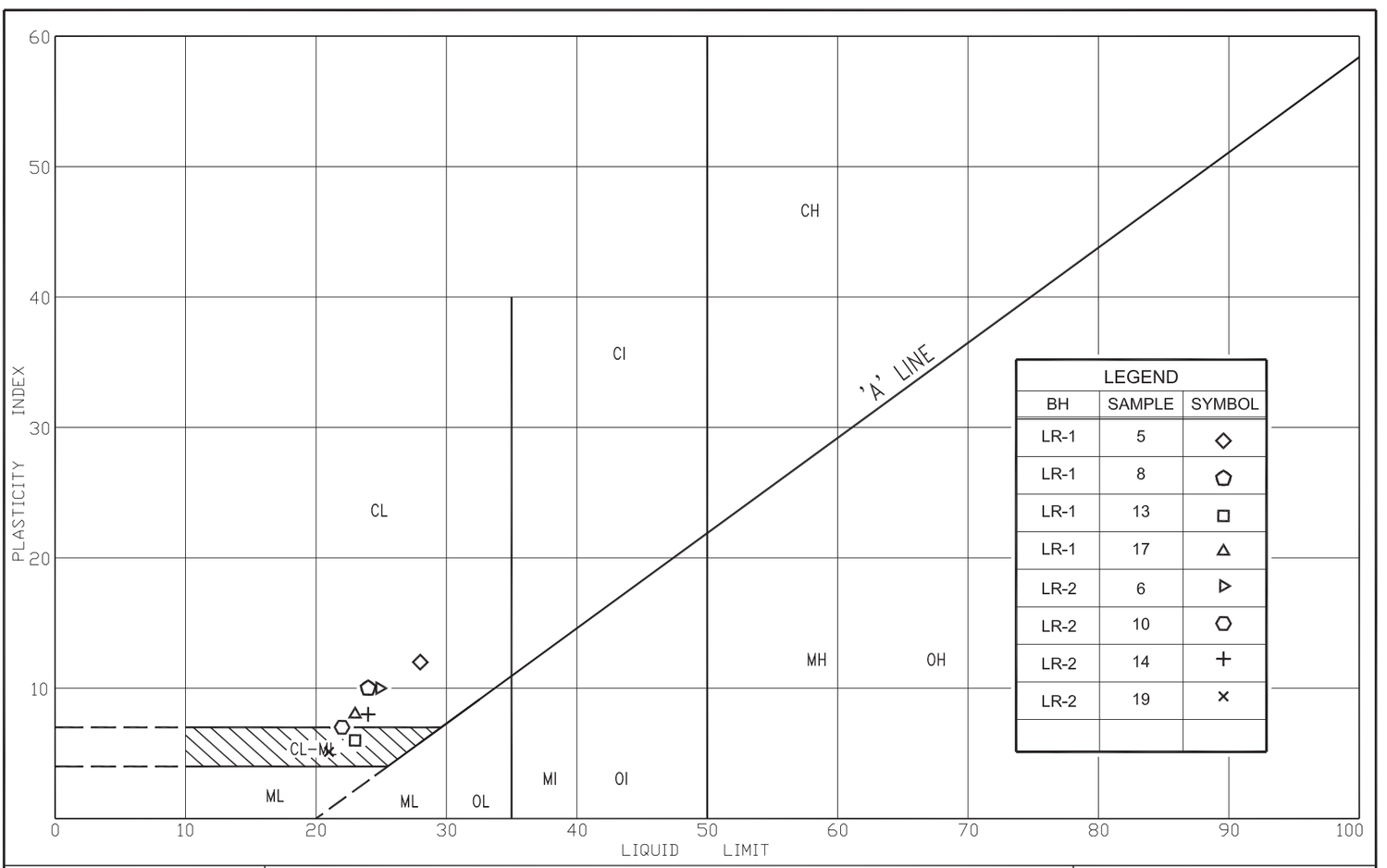


Ontario

GRAIN SIZE DISTRIBUTION

CLAYEY SILT (with sand) (TILL)

FIG No.	D-1
HWY:	427
G.W.P. No.	

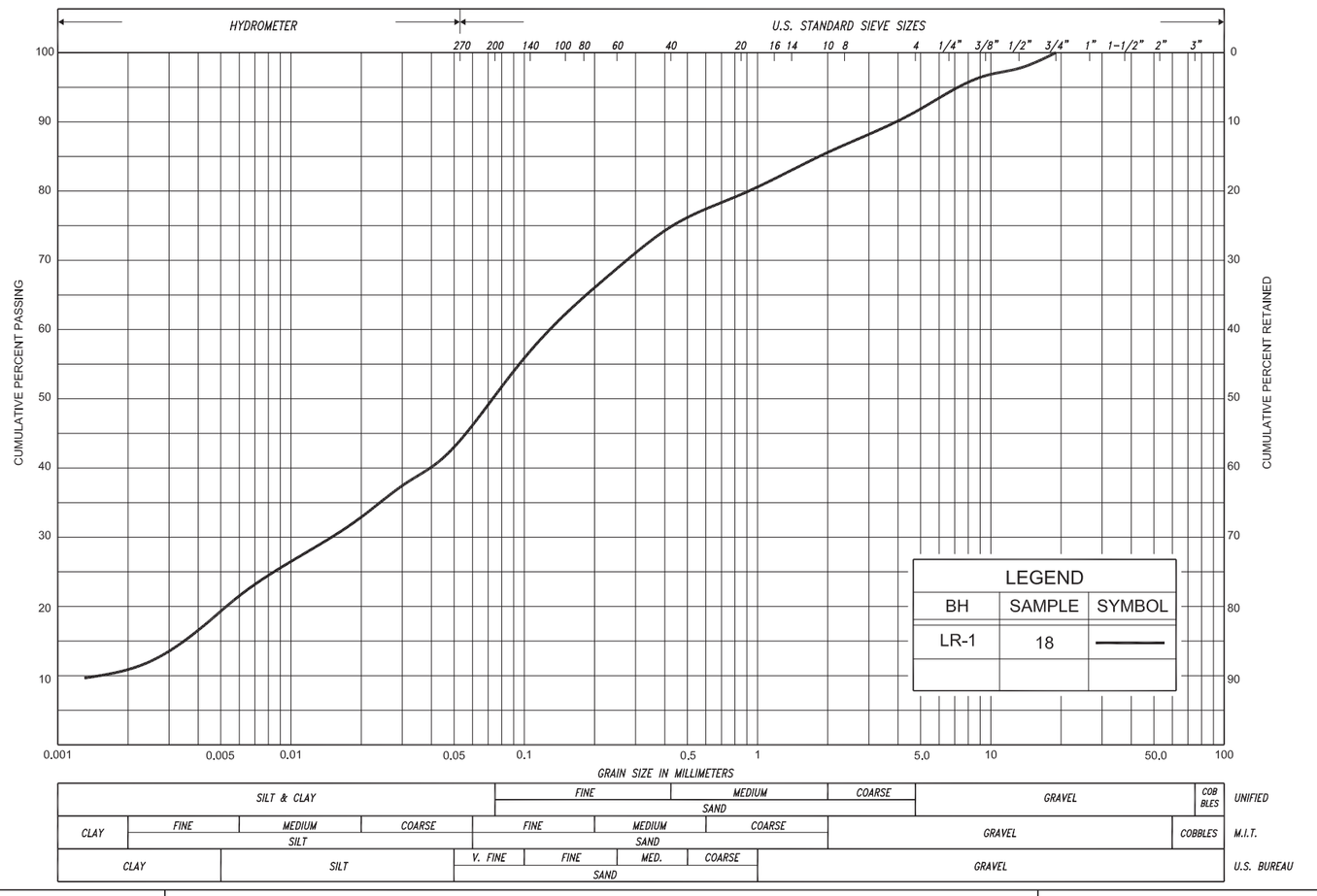


Ontario

PLASTICITY CHART

CLAYEY SILT (TILL)

FIG No.	D-2
HWY:	427
G.W.P. No.	

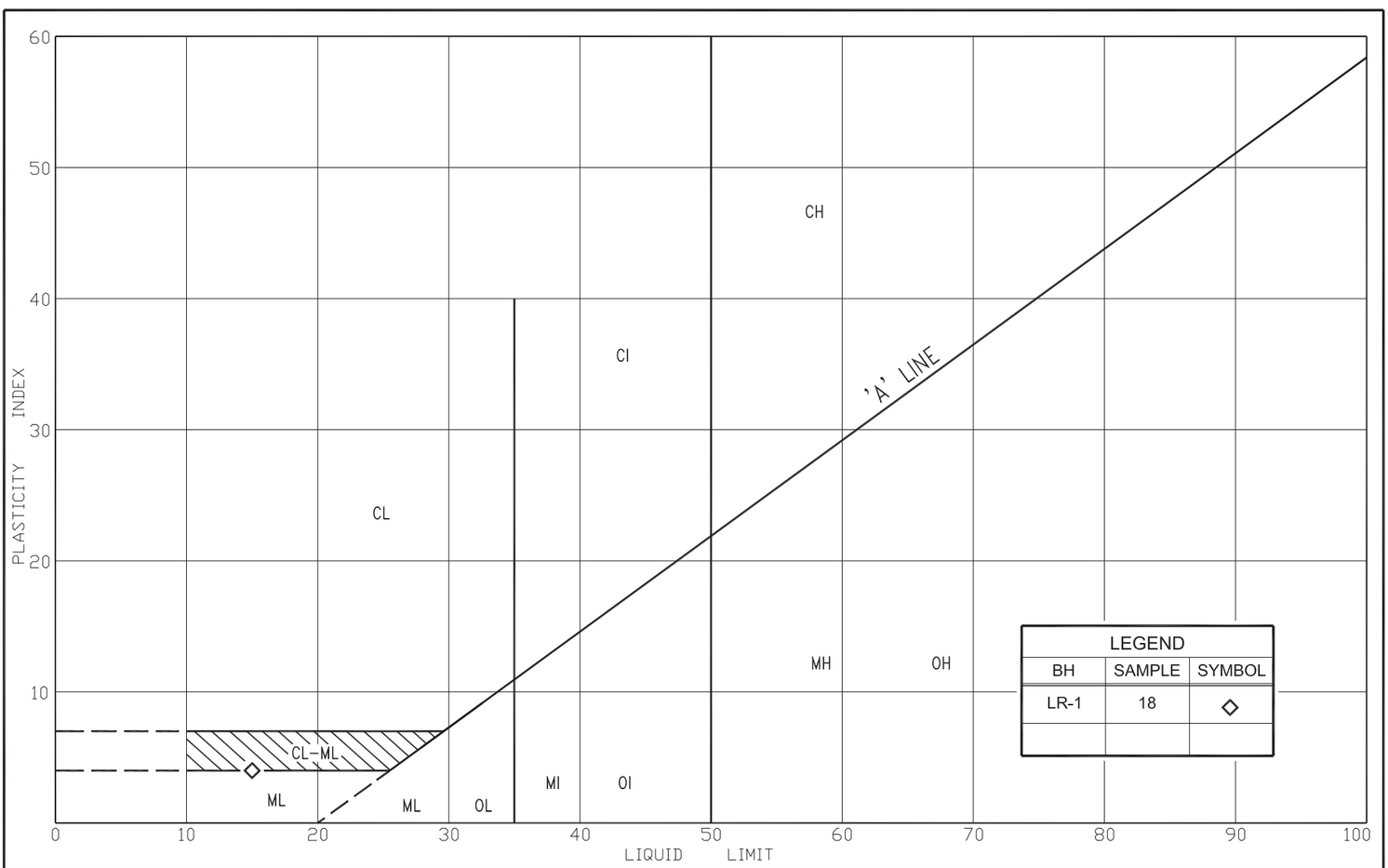


Ontario

GRAIN SIZE DISTRIBUTION

SAND and SILT (TILL)

FIG No.	D-3
HWY:	427
G.W.P. No.	



Ontario

PLASTICITY CHART

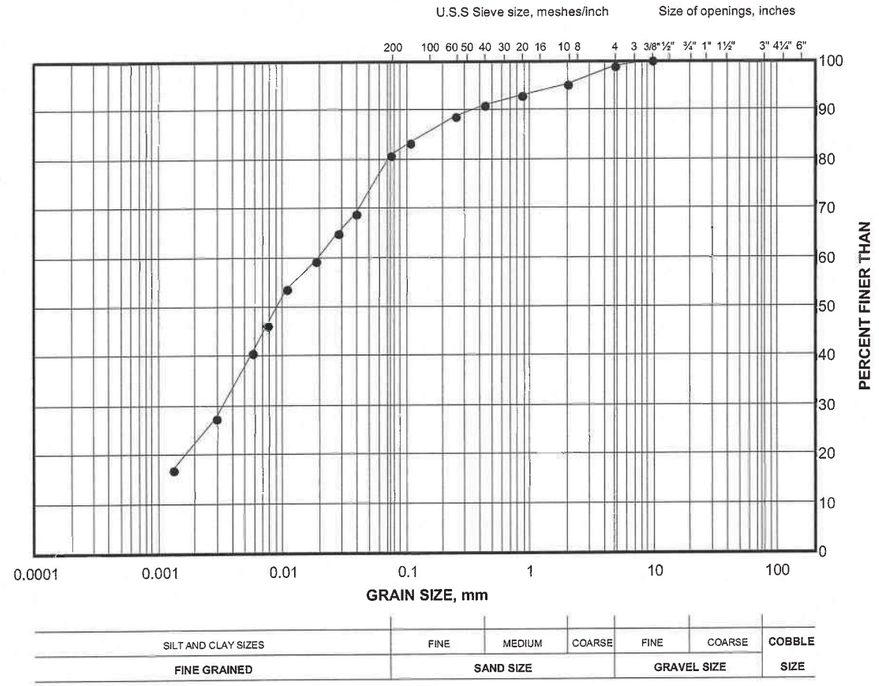
SAND and SILT (TILL)

FIG No.	D-4
HWY:	427
G.W.P. No.	

GRAIN SIZE DISTRIBUTION TEST RESULT

Clayey Silt Till

FIGURE B1



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

LEGEND

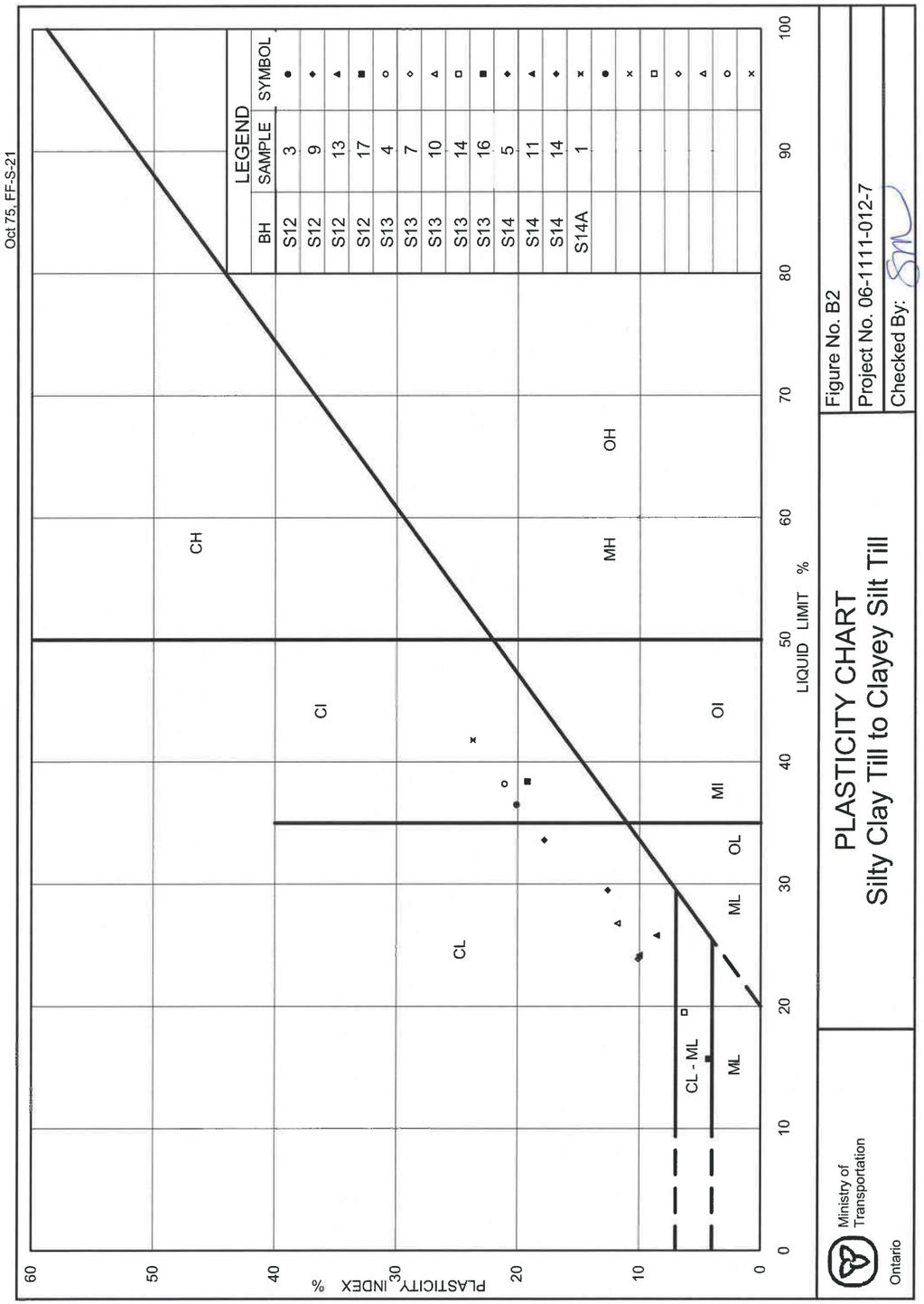
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S12	8	181.1

Project Number: 06-1111-012-7

Checked By: SM

Golder Associates

Date: 08-Jun-09



PLASTICITY CHART

Silty Clay Till to Clayey Silt Till

Figure No. B2

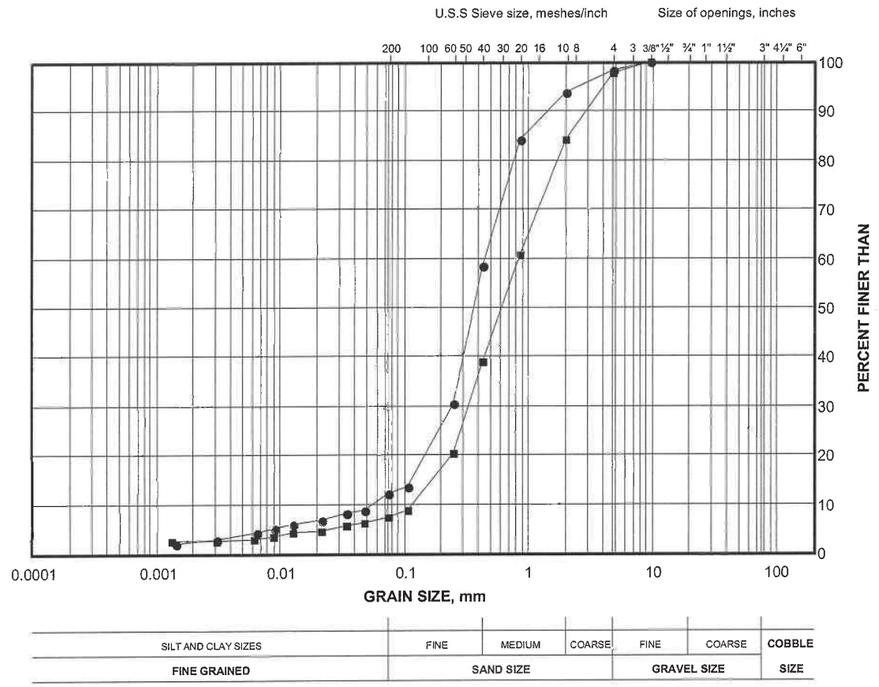
Project No. 06-1111-012-7

Checked By: SM

Ministry of Transportation Ontario

GRAIN SIZE DISTRIBUTION TEST RESULTS
Sand

FIGURE B3



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S13	15	153.9
■	S12	15	168.9

Project Number: 06-1111-012-7

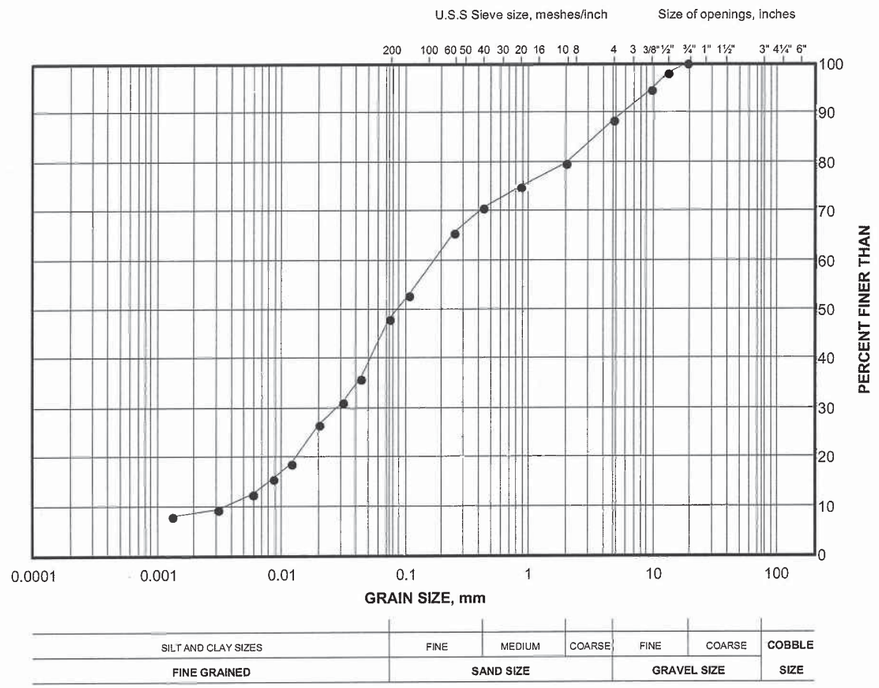
Checked By: SM

Golder Associates

Date: 08-Jun-09

GRAIN SIZE DISTRIBUTION TEST RESULT
Sand and Silt Till

FIGURE B4



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S14A	3	164.5

Project Number: 06-1111-012-7

Checked By: SM

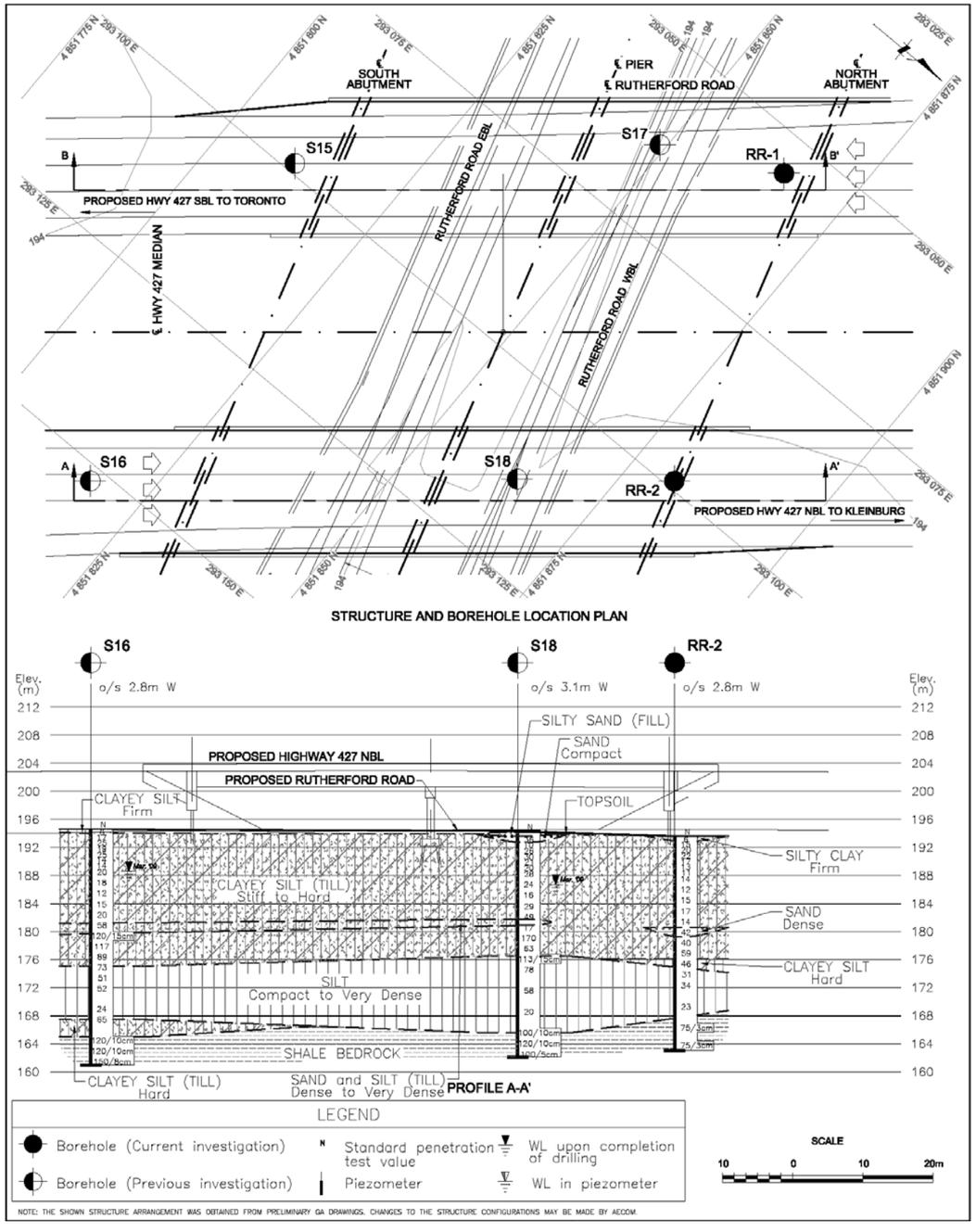
Golder Associates

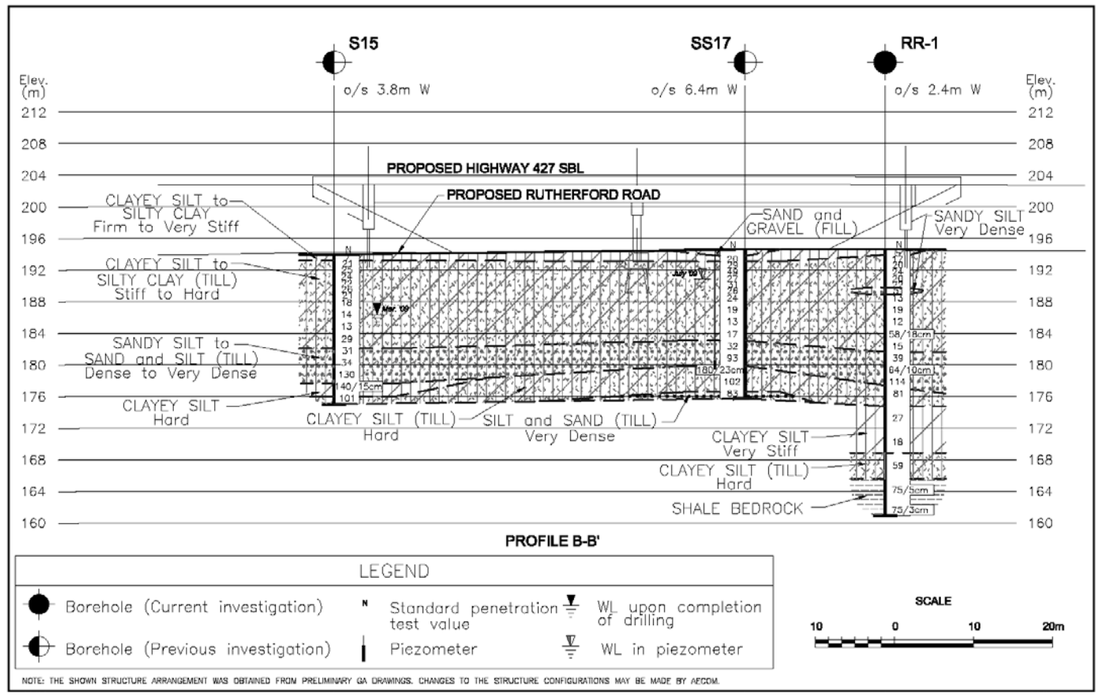
Date: 08-Jun-09

Structure Type: Overpasses

Existing Ground Elevation across Boreholes: 194.6 m to 193.6 m

Complexity Rating: Medium





FOUNDATION INVESTIGATION

Site Description

The proposed overpass structures are approximately 800 m east of Huntington Road and 200 m west of McGillivray Road, in the City of Vaughan, Ontario. The topography in the area of proposed overpass structures is nearly flat and the structures will be located within farm lands on either side of the existing Rutherford Road.

Borehole Information

Borehole No.	Foundation Unit	MTM NAD 83 Coordinates		Ground Surface Elevation (m)	Borehole Depth (m)
		Northing (m)	Easting (m)		
Previous Investigation					
S15	South Abutment of SBL Structure	4,851,810.8	293,098.7	194.0	18.9
S16	South Abutment of NBL Structure	4,851,817.3	293,152.1	194.6	33.6
S17	Centre Pier of SBL Structure	4,851,849.1	293,063.4	194.6	18.8
S18	Centre Pier of NBL Structure	4,851,883.9	293,113.0	194.3	32.1
Current Investigation					
RR-1	North Abutment of SBL Structure	4,851,865.3	293,055.2	194.6	33.6
RR-2	North Abutment of NBL Structure	4,851,881.3	293,098.9	193.6	30.5

Subsurface Condition

***Topsoil/ Fill*:** Approximately 0.1 m to 0.3 m of topsoil was encountered at the ground surface in Boreholes S18 and RR-2.

Approximately 0.8 m and 0.7 m of fill comprised of silty sand or sand and gravel was encountered at the ground surface in Borehole S17 and below the topsoil in Borehole S18.

Clayey Silt to Silty Clay/ Sand: A 0.3 m to 0.8 m thick deposit of cohesive soils comprised of clayey silt to silty clay was encountered immediately below the ground surface or underlying the fill or topsoil layers in all boreholes except Borehole S18 at Elevations 194.6 m to 193.3 m.

Borehole S18 encountered an approximately 1.0 m thick layer of sand below the topsoil at Elevation 193.5 m.

The SPT "N"-values ("N"-values) measured within the clayey silt to silty clay layers range from 5 blows to 20 blows per 0.30 m of penetration, suggesting a firm to very stiff consistency. "N"-values of 10 and 36 blows were measured at the interface of sand layer with the underlying deposit or within the sand layer, indicating a compact to dense compactness.

***Clayey Silt to Silty Clay Till (Upper)*:** A deposit of brown to grey clayey silt to silty clay till was encountered underlying the surficial layers in all boreholes at depths from 0.6 m to 1.8 m, Elevations 194.0 m and 192.5 m. Boreholes RR-1 and RR-2 penetrated 1.2 m and 2.5 m thick pockets of sand, with gravel or sandy silt within the upper cohesive till at Elevations 190.2 m and 180.4 m and Borehole S15 penetrated a 1.7 m thick layer of clayey silt at Elevation 177.7 m. The deposit is interlayered by the sand and silt till deposit in Boreholes S15 to S18. The overall thickness of the deposit, including the thickness of pockets and interlayers varies between 11.1 m and 18.9 m. The deposit extends to depths from 13.2 m to 19.1 m, Elevations 181.4 m to 175.1 m.

The "N"-values measured within the cohesive till deposit range from 11 blows per 0.30 m of penetration to 180 blows per 0.23 m of penetration, suggesting a stiff to hard consistency. The results of grain size distribution analyses and Atterberg limits tests of selected samples of the upper cohesive till obtained during the current investigation are shown on Figures E-1 and E-2, respectively. The result of a grain size distribution analysis completed on a sample of sand, with gravel from the current investigation is shown on Figure E-3.

Sandy Silt to Sand and Silt Till: All boreholes except Borehole RR-2 penetrated layers of sandy silt to sand and silt till within or below the upper cohesive till at depths from 11.6 m to 13.4 m, Elevations 183.0 to 181.2 m. Borehole S17 was terminated within this deposit at 18.8 m depth, Elevation 175.9 penetrating it for 0.8 m. Where fully penetrated, the thickness of this deposit varies between 0.9 m and 4.6 m. The deposit extends to depths from 13.2 m to 20.1 m, Elevations 184.5 m to 180.9 m.

The "N"-values measured within the non-cohesive till range from 31 to 130 blows, indicating a dense to very dense compactness. The result of a grain size distribution analysis completed on a sample of sandy silt till obtained during the current investigation is shown on Figure E-4.

***Silt*:** An approximately 6.8 m to 10.9 m thick deposit of grey silt, trace to some sand, trace to some clay was encountered underlying the till deposit in Boreholes S16, S18 and RR-2 at depths from 17.8 m to 19.5 m, Elevations 176.5 m to 174.3 m. The deposit extends to 26.1 m to 28.7 m depths, Elevations 167.5 m to 165.7 m.

The "N"-values measured within the silt deposit range from 20 blows per 0.30 m of penetration to 130 blows per 0.15 m of penetration, indicating a compact to very dense compactness. The result of a grain size distribution analysis on a selected sample of silt obtained during the current investigation is shown on Figure E-5.

***Clayey Silt*:** A 1.5 m to 8.3 m thick deposit of grey clayey silt was encountered underlying the till deposits in Boreholes S15, RR-1 and RR-2 at depths from 16.3 m to 17.8 m, Elevations 177.7 m to 175.5 m. The deposit extends to depths from 18.0 m to 26.1 m, Elevations 176.0 m to 168.5 m.

The "N"-values measured within the silt deposit range from 18 blows per 0.30 m of penetration to 140 blows per 0.15 m of penetration, suggesting a very stiff to hard consistency. The results of grain size distribution analyses and an Atterberg limits test of selected samples of this deposit obtained during the current investigation are shown on Figures E-6 and E-7, respectively.

***Clayey Silt Till (Lower)*:** An approximately 3.1 m and 2.5 m thick deposit of clayey silt till was encountered underlying the clayey silt deposit in Borehole RR-1 at 26.1 m depth, Elevation 168.5 m and below the silt deposit in Borehole S16 at 27.1 m depth, Elevation 167.5 m. The deposit extends to shale bedrock in Boreholes S16 and RR-1 at 29.6 m and 29.2 m depths, Elevations 165.0 m and 165.4 m.

"N"-values of 59 and 65 blows were measured within the lower cohesive till deposit, suggesting a hard consistency. The result of a grain size distribution analysis on a selected sample of the lower cohesive till obtained during the current investigation is shown on Figure E-8.

***Shale Bedrock*:** Boreholes S16, S18, RR-1 and RR-2 penetrated highly weathered shale bedrock underlying the lower cohesive till or silt deposit at 26.1 m to 29.6 m depths, Elevations 167.5 m to 165.0 m. All these boreholes were terminated within the shale bedrock layer at 30.5 m to 33.6 m depths, Elevations 163.1 m to 161.0 m, penetrating it for 3.4 m to 4.4 m.

Groundwater Conditions

The groundwater level noted in the piezometer installed in Borehole S17 at this site was at 3.8 m depth, Elevation 190.7 m on July 9, 2009. The water level in open boreholes upon completion of drilling was at 6.0 m to 7.6 m depths, Elevations 188.6 m to 186.4 m. Based on measurements in other open boreholes the groundwater elevation is at approximately 187.0 m in Boreholes RR-1 and RR-2 and based on piezometer in other boreholes the sub-artesian is at approximate Elevation 190.5 m. For further details refer to Table A2 of this report.

FOUNDATION RECOMMENDATIONS

The following site-specific foundation recommendations are for preliminary design and planning purposes only .They require refinement during detail design. Project-wide foundation recommendations, design assumptions and limitations are contained in Part B of this report. The proposed twin two-span overpass structures will carry Highway 427 over Rutherford Road.

Foundation Option	Advantages	Disadvantages	Relative Costs	Risks/Consequences
Spread footings on stiff to hard clayey silt till or "Granular A" pad	• Conventional Construction.	• Precludes use of integral abutments; • Provides relatively low bearing capacity.	• Lower relative cost compared to deep foundation options.	• Disturbing of subgrade due to excavation; • Risk of improper compaction of "Granular A" pad.
Driven steel H-Piles	• Allows for integral abutment design.	• Piles may encounter obstructions during driving.	• More costly than spread footings.	• Risk of not achieving capacities due to the variable thickness of the "100-blow" soil layer; • Minor potential for pile damage/ deflection if obstructions are encountered during pile driving.
Caissons	• Provides higher capacity than driven piles.	• Precludes use of integral abutments.	• More costly than driven steel H-piles.	• Risk of loosening or disturbing founding soils at base of caissons.

Spread Footings

Spread footings founded on native soils were considered to support the abutments and pier. However, the bearing resistances at normal depths would be less than required for design as indicated by the preliminary geotechnical resistances at the ground interface presented in the following table.

Foundation Unit	Founding Stratum	Axial Geotechnical Resistance < 25mm settlement		Highest Founding Elevation within Native Soils (m)
		Factored ULS (kPa)	SLS (kPa)	
South Abutments	Stiff to Hard Clayey Silt Till	225	150	193.0
Centre Piers				192.0
North Abutments				193.0

Consequently, the alternative of spread footings on a "Granular A" pad of minimum 2 m thickness is recommended for preliminary design purposes assuming a factored geotechnical resistance at ULS of 900 kPa and geotechnical resistance at SLS of 350 kPa.

Driven Steel H-Pile/ Steel Pipe Piles

Steel H-piles 310x110 and Steel pipe piles, 324 mm (12 ¾ in) outer diameter and 6 mm (1/4 in) thickness, driven to the levels indicated in the following table may be used to support the abutments and piers. The preliminary geotechnical resistances and tip elevations are as follows:

Foundation Unit	Axial Geotechnical Resistance		Approximate Pile Tip Elevation (m)
	Factored ULS (kN)	SLS (kN)	
South Abutments	1,800	1,400	165
Centre Piers	1,800	1,400	165
North Abutment of SBL	1,800	1,400	166
North Abutment of NBL	1,800	1400	167

Driven piles should be controlled by Hiley Formula as per MTO Drawing SS-103-11 from 2 m above the approximate pile tip elevations, employing a maximum load of twice the factored geotechnical resistance at ULS per pile.

Caissons

Caissons founded within the hard cohesive till may be considered for support of the abutments and piers. The preliminary geotechnical resistances are as follows:

Foundation Unit	Caisson Diameter (m)	Axial Geotechnical Resistance		Caisson Base Elevation (m)
		Factored ULS (kN)	SLS (kN)	
South Abutments	1.2	6,000	5,000	165
	1.5	7,800	6,500	
Centre Piers	1.2	6,000	5,000	165
	1.5	7,800	6,500	
North Abutments	1.2	6,000	5,000	165
	1.5	7,800	6,500	

Recommended Foundation Alternative

The recommended foundation alternative at this site is driven steel H-piles into the hard/very dense till deposit or shale bedrock for the abutments, and spread footings founded on native, stiff to hard clayey silt till for the piers. Driven piles may also be used for the piers. Driven piles are preferred over caissons due to the presence of non-cohesive water bearing layers.

Structure Abutments and Approaches

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

Construction of the overpass structures will require placement of up to about 8.5 m of fill within the limits of the south and north approach embankments.

Structure Retaining Walls/Wing Walls

The earth retaining walls for this structure may include Cast-in-Place (CIP) or RSS Walls. For RSS walls the facing should be founded on granular pad or CIP leveling pad. The retaining walls geometry should conform to High Appearance and High Performance in accordance with MTO.DSM 9.70 and current RSS Design Guidelines. The CIP retaining walls should be designed in conformance with spread footing.

Stability of Approach Embankments

Approach embankments constructed of suitable earth fill or granular fill and up to about 8.5 m high are expected to be stable at side slopes formed at a maximum gradient of 2H:1V. Where approach embankments are equal to or greater than 8.0 m in height, a minimum 2.0 m wide berm should be provided such that the uninterrupted slope height does not exceed 8.0 m.

Settlement of Approach Embankments

The settlement within founding soils is estimated to be in the order of 75 mm, most of which is expected to occur within three (3) months after the fill placement. Based on preliminary estimations, consideration should be given to preloading the approach embankments for three (3) months to mitigate the post-construction settlements. Downdrag loads should be considered during the detail design for deep foundations.

Construction Considerations

Excavation

The construction of piers will require excavations up to about 3 m below the existing Rutherford Road grade. These excavations will be made through existing fill and into firm to stiff clayey silt layers which are classified as Type 3 soils in OHSA. Temporary unsupported excavations above the prevailing groundwater in these soils should be made with side slopes no steeper than 1H:1V.

Surface Water / Groundwater Control

Surface water run-off should be diverted away from the excavations at all times.

The prevailing groundwater should be maintained a minimum of 0.5 m below the base of excavations. The groundwater level measured in the piezometer installed at this site was at 3.8 m depth, Elevation 190.7 m. It is expected that excavations for construction of piers/pile caps will be above the prevailing groundwater level at this site. The minimal inflow of groundwater into excavations is expected to be handled by pumping from properly filtered sumps placed at the base of the excavations.

Pile Installation / Caisson Construction

It is anticipated that cobbles and/or boulders will be encountered within the till deposits, which may adversely impact the installation of steel H-piles and caissons. Piles should be equipped with flange plates or approved driving shoes.

If consideration is being given to caisson foundations, water-bearing non-cohesive native soils should be expected to run or flow into the caisson hole during and after the drilling for the caisson foundations and as such, appropriate equipment and procedures (including use of temporary or permanent caisson liners) will be required to minimize ground loss during drilling and concrete placement and to permit inspection and cleaning of the caisson base.

Recommendations for Additional Work

Further subsurface investigation, in situ and laboratory testing and analysis will be required to confirm the estimated total settlement and to refine mitigation options.

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No RR-1 1 of 3 METRIC

G.W.P. _____ LOCATION Coords: 4 851 865.3 N; 293 055.2 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 02, 2015 CHECKED BY A.V.

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 (○ 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 (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.6	Ground Surface										
0.0	SILTY CLAY trace organics		1	SS	5		194				
194.0	Firm Brown Moist										
0.6	SILTY CLAY, some sand, trace gravel containing sand seams		2	SS	17						
	Very stiff Brown Moist (TILL)		3	SS	20		193				2 12 36 50
			4	SS	24						
			5	SS	20		192				
			6	SS	22						
190.2							191				
4.4	SANDY SILT, trace gravel		7	SS	51						
	Very dense Brown Moist						190				
189.0											
5.6	CLAYEY SILT, some sand, trace gravel		8	SS	13		189				5 21 50 24
	Stiff to very stiff Grey Moist to wet (TILL)										
							188				
	sand and gravel seams		9	SS	19		187				
							186				
			10	SS	12						4 14 55 27
							185				
	rock fragments		11	SS	58/18cm		184				Sampler bouncing
							183				
			12	SS	15		182				
181.4											
13.2	SANDY SILT, trace clay containing sand and gravel seams		13A	SS	39		181				
	Dense to very dense Grey Moist to wet (TILL)		13B	SS							
179.6	Cont'd						180				

+7, ×5: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No RR-1 2 of 3 METRIC

G.W.P. _____ LOCATION Coords: 4 851 865.3 N; 293 055.2 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 02, 2015 CHECKED BY A.V.

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 (○ 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 (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
179.6											
15.0	(Cont'd) Sandy SILT, trace clay		14	SS	64/10cm		179				0 31 66 3
	Dense to very dense Grey Moist to wet (TILL)										
			15	SS	114		178				
176.8											
17.8	CLAYEY SILT, trace sand						177				
	Very stiff Grey Wet		16	SS	81		176				
							175				
							174				
			17	SS	27		173				0 3 70 27
							172				
							171				
			18	SS	18		170				
							169				
168.5											
26.1	CLAYEY SILT, with sand, trace gravel						168				
	Hard Grey Moist (TILL)		19	SS	59		167				8 23 46 23
							166				
165.4											
29.2	SHALE BEDROCK						165				
	Highly weathered Grey										
164.6	Cont'd										

+7, ×5: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No RR-1 3 of 3 METRIC

G.W.P. _____ LOCATION Coords: 4 851 865.3 N; 293 055.2 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 02, 2015 CHECKED BY A.V.

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 (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
164.6											
30.0	(Cont'd)										
	SHALE BEDROCK										
	Highly weathered Grey		20	SS	7575cm		164				
							163				
							162				
161.0											
33.6	End of borehole		21	SS	7573cm		161				
	Note: 1. Groundwater level cannot be measured upon completion of drilling due to utilization of mud rotary drilling technique.										

+7, ×5: Numbers refer to Sensitivity 20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No RR-2 1 of 3 METRIC

G.W.P. _____ LOCATION Coords: 4 851 881.3 N; 293 098.9 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 01, 2015 CHECKED BY A.V.

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 (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.6	Ground Surface										
0.0 193.3	TOPSOIL		1	SS	6		193				
0.3 193.0	SILTY CLAY, trace sand										
0.6	Firm Brown Moist		2	SS	15						
	CLAYEY SILT, trace to some sand, trace gravel						192				
	Stiff to very stiff Brown becoming grey below 2.2m Moist		3	SS	20						
	(TILL)		4A	SS			191				1 12 54 33
			4B	SS	22						
			5	SS	17		190				
			6	SS	13						1 9 45 45
			7	SS	11		189				
			8	SS	14		188				
			9	SS	12		187				
			10	SS	15		186				
			11	SS	17		185				
181.9 11.7	SANDY CLAYEY SILT, trace gravel						184				
	Stiff to hard Grey Moist						183				
	(TILL)		12	SS	14		182				5 33 36 26
180.4 13.2	SAND, with gravel						181				
	Dense Grey Moist		13	SS	42		180				28 61 (11)
	Cont'd						179				

+7, ×5: Numbers refer to Sensitivity 20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No RR-2 2 of 3 METRIC

G.W.P. _____ LOCATION Coords: 4 851 881.3 N; 293 098.9 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 01, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
178.6						*					
177.9			14	SS	40		178				
15.7	CLAYEY SILT, trace sand, trace gravel Hard Grey Moist (TILL)		15	SS	59		177				
175.8							176				
17.8	CLAYEY SILT, trace sand, trace gravel Hard Grey Moist		16	SS	46		175				1 2 68 29
174.3							174				
19.3	SILT, trace sand, trace gravel, containing clayey silt seams Compact to dense Grey Moist to wet		17	SS	31		173				
			18	SS	34		172				
							171				
							170				
			19	SS	23		169				2 2 81 15
167.5							168				
26.1	SHALE BEDROCK Highly weathered Grey						167				
			20	SS	75/3cm		166				Sampler bouncing
	Cont'd.						165				
							164				

+⁷ ,×⁵ : Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No RR-2 3 of 3 METRIC

G.W.P. _____ LOCATION Coords: 4 851 881.3 N; 293 098.9 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 01, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
163.6						*					
163.1			21	SS	75/3cm						
30.5	End of borehole Note: 1. Groundwater level cannot be measured upon completion of drilling due to utilization of mud rotary drilling technique.										

+⁷ ,×⁵ : Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No S15

1 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4851810.8 ;E 293098.7 | ORIGINATED BY JEB
W.O. 05-20012 | | COMPILED BY TB/VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 25, 2009

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 (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.0	GROUND SURFACE										
0.0	CLAYEY SILT, trace gravel, trace sand, containing organics (REWORKED) Firm Brown Moist		1	SS	7						
193.2							193				
0.8	CLAYEY SILT, some sand, trace gravel (TILL) Stiff to very stiff Brown Moist Containing sand seam at depths of 1.2 m and 1.8 m		2	SS	21						
			3	SS	25		192				
			4	SS	24						
			5	SS	22		191				1 17 49 33
			6	SS	26		190				
			7	SS	21		189				
			8	SS	18		188				
			9	SS	14	▽	187				
			10	SS	13		186				
			11	SS	29		185				
182.1	Containing about 50 mm thick sandy silt layer at a depth of 11.4 m						184				
11.9	SAND and SILT, trace to some gravel, some clay (TILL) Dense to very dense Grey Wet		12	SS	31		183				5 32 49 14
							182				
			13	SS	34		181				
							180				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S15

2 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4851810.8 ;E 293098.7 | ORIGINATED BY JEB
W.O. 05-20012 | | COMPILED BY TB/VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 25, 2009

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 (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —										
177.7	SAND and SILT, trace to some gravel, some clay (TILL) Dense to very dense Grey Wet		14	SS	130		178				
16.3	CLAYEY SILT, trace sand Hard Grey Moist		15	SS	40/0.15		177				0 2 80 18
176.0							176				
18.0	CLAYEY SILT, some sand, trace gravel (TILL) Hard Grey Moist		16	SS	101						
175.1											
18.9	END OF BOREHOLE NOTES: 1. Water level in open borehole at a depth of 7.6 m below ground surface (Elev. 186.4 m) upon completion of drilling. 2. Borehole backfilled with bentonite.										

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

Golder Associates

RECORD OF BOREHOLE No S16

1 OF 3 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4851817.3 ;E 293152.1
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 20. 2009

ORIGINATED BY JEB
COMPILED BY TB/VA
CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.6	GROUND SURFACE										
0.0	CLAYEY SILT, some sand, containing rootlets (REWORKED) Firm Brown Moist		1	SS	6		194				
194.0											
0.6	CLAYEY SILT, some sand, trace gravel (TILL) Stiff to very stiff Brown Moist		2	SS	17		193				
			3	SS	25		192				
			4	SS	19						
			5	SS	25		191				
			6	SS	14						
			7	SS	14		190				
			8	SS	20	▽	189				2 18 56 24
			9	SS	18		188				
			10	SS	12		187				
			11	SS	15		186				
			12	SS	20		185				
181.2							184				
13.4	SAND and SILT, some gravel, trace clay (TILL) Very dense Grey Wet		13	SS	58		183				19 30 46 5
179.7							182				
							181				
							180				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S16

2 OF 3 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4851817.3 ;E 293152.1
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 20. 2009

ORIGINATED BY JEB
COMPILED BY TB/VA
CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —										
14.9	CLAYEY SILT, trace to some sand, trace gravel, containing cobbles (TILL) Hard Grey Wet to moist		14	SS	20/0.15		179				
175.1											
19.5	SILT, trace to some sand, trace clay Compact to very dense Grey Moist		15	SS	117		178				
			16	SS	89		177				
			17	SS	73		176				
			18	SS	51		175				0 0 90 10
			19	SS	52		174				
			20	SS	24		173				
167.5							172				
27.1	CLAYEY SILT, some sand, some gravel (TILL) Hard Grey Moist		21	SS	65		171				
165.0							170				
29.6	SHALE (BEDROCK) Grey						169				
							168				
							167				
							166				
							165				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S16

3 OF 3 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4851817.3 ;E 293152.1
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 20, 2009

ORIGINATED BY JEB
COMPILED BY TB/VA
CHECKED BY SMM

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 × REMOULDED)	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	10 20 30		
	SHALE (BEDROCK) Grey		22	SS	20/0.10		164				
			23	SS	20/0.10		163				
161.0			24	SS	50/0.05		162				
33.6	END OF BOREHOLE NOTES: 1. Water level in open borehole at a depth of 6.0 m below ground surface (Elev. 188.6 m) upon completion of drilling. 2. Borehole backfilled with bentonite.										

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S17

1 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4851849.1 ;E 293063.4
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 25, 2009

ORIGINATED BY SB
COMPILED BY VA
CHECKED BY SMM

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 × REMOULDED)	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
								20 40 60 80 100	10 20 30		
194.6	GROUND SURFACE						194				
0.0	Sand and gravel (FILL) Brown Moist										
193.8							193				
0.8	CLAYEY SILT, trace gravel, trace sand (Reworked) Very stiff Brown and grey to brown Moist		1	SS	20						
193.2							192				
1.5	SILTY CLAY, some sand, trace gravel (TILL) Very stiff to hard Grey Moist		2	SS	29						
			3	SS	49		191				
			4	SS	27						5 13 44 38
			5	SS	31		190				
			6	SS	26						
			7	SS	24		189				
187.3							188				
7.3	CLAYEY SILT, some sand, trace gravel (TILL) Stiff to very stiff Grey Moist		8	SS	19		187				
			9	SS	13		186				
							185				1 16 58 25
			10	SS	17		184				
183.0							183				
11.6	SAND and SILT, trace to some gravel, trace clay (TILL) Dense to very dense Grey Moist to wet		11	SS	32		182				
			12	SS	93		181				7 35 49 9
179.9							180				
14.7											

Continued Next Page

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

RECORD OF BOREHOLE No S17

2 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4851849.1 ;E 293063.4 | ORIGINATED BY SB
W.O. 05-20012 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | COMPILED BY VA
DIST Central HWY 427 | DATE March 25, 2009 | CHECKED BY SMM
DATUM Geodetic

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 × REMOULDED 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L (WATER CONTENT (%) 10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —										
	CLAYEY SILT, trace gravel, trace sand (TILL) Hard Grey Moist		13	SS	80/0.2		179				
							178				
			14	SS	102		177				
176.6											
18.0	SAND and SILT, trace gravel, trace clay (TILL) Very dense Moist Grey		15	SS	83		176				
175.9											
18.8	END OF BOREHOLE										
	NOTES: 1. A 50 mm diameter monitoring well was installed at a depth of 15.2 m (Elev. 179.4 m).										
	Water level measurements Date Depth Elev. On Completion 11.2 m 183.4 m April 24, 2009 4.0 m 190.6 m May 25, 2009 4.1 m 190.4 m June 15, 2009 4.0 m 190.5 m July 09, 2009 3.8 m 190.7 m										

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

RECORD OF BOREHOLE No S18

1 OF 3 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4851863.9 ;E 293113.0 | ORIGINATED BY SB
W.O. 05-20012 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | COMPILED BY VA
DIST Central HWY 427 | DATE March 23, 2009 | CHECKED BY SMM
DATUM Geodetic

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 × REMOULDED 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L (WATER CONTENT (%) 10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.3	GROUND SURFACE						194				
0.0 0.1	TOPSOIL Silty sand, some gravel (FILL) Brown Moist										
193.5											
0.8	SAND, some gravel, trace silt Compact to dense Brown Moist		1	SS	36		193				
192.5											
1.8	CLAYEY SILT, some sand, trace gravel (TILL) Stiff to hard Brown to grey Moist		2	SS	10		192				
			3	SS	26						
			4	SS	30		191				
	Becoming grey below a depth of 3.8 m		5	SS	21		190				1 23 48 28
			6	SS	20						
							189				
			7	SS	28		188				
			8	SS	24		187				
			9	SS	16		186				
							185				
			10	SS	29		184				2 11 55 31
181.8			11	SS	49		183				
12.5	SAND and SILT, some gravel, trace clay (TILL) Dense Grey Wet						182				
180.9											
13.4	CLAYEY SILT, some sand, trace gravel (TILL) Very stiff to hard Grey Moist		12	SS	17		181				
							180				

Continued Next Page

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S18

2 OF 3 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4851863.9 ;E 293113.0 | ORIGINATED BY SB
W.O. 05-20012 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | COMPILED BY VA
DIST Central HWY 427 | DATE March 23, 2009 | CHECKED BY SMM
DATUM Geodetic

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)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —							SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)						
	CLAYEY SILT, some sand, trace gravel (TILL) Very stiff to hard Grey Moist		13	SS	170		179			○				
			14	SS	63		178							
176.5							177							
17.8	SILT, trace to some clay Compact to very dense Grey Moist		15	SS	13/0.15		176			○				
			16	SS	78		175							0 0 84 16
							174							
			17	SS	58		173							
							172							
							171			○				
							170							
			18	SS	20		169							
							168							0 6 89 5
							167							
							166							
165.7							165			○				
28.7	SHALE (BEDROCK) Grey		19	SS	100/0.10									

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S18

3 OF 3 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4851863.9 ;E 293113.0 | ORIGINATED BY SB
W.O. 05-20012 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | COMPILED BY VA
DIST Central HWY 427 | DATE March 23, 2009 | CHECKED BY SMM
DATUM Geodetic

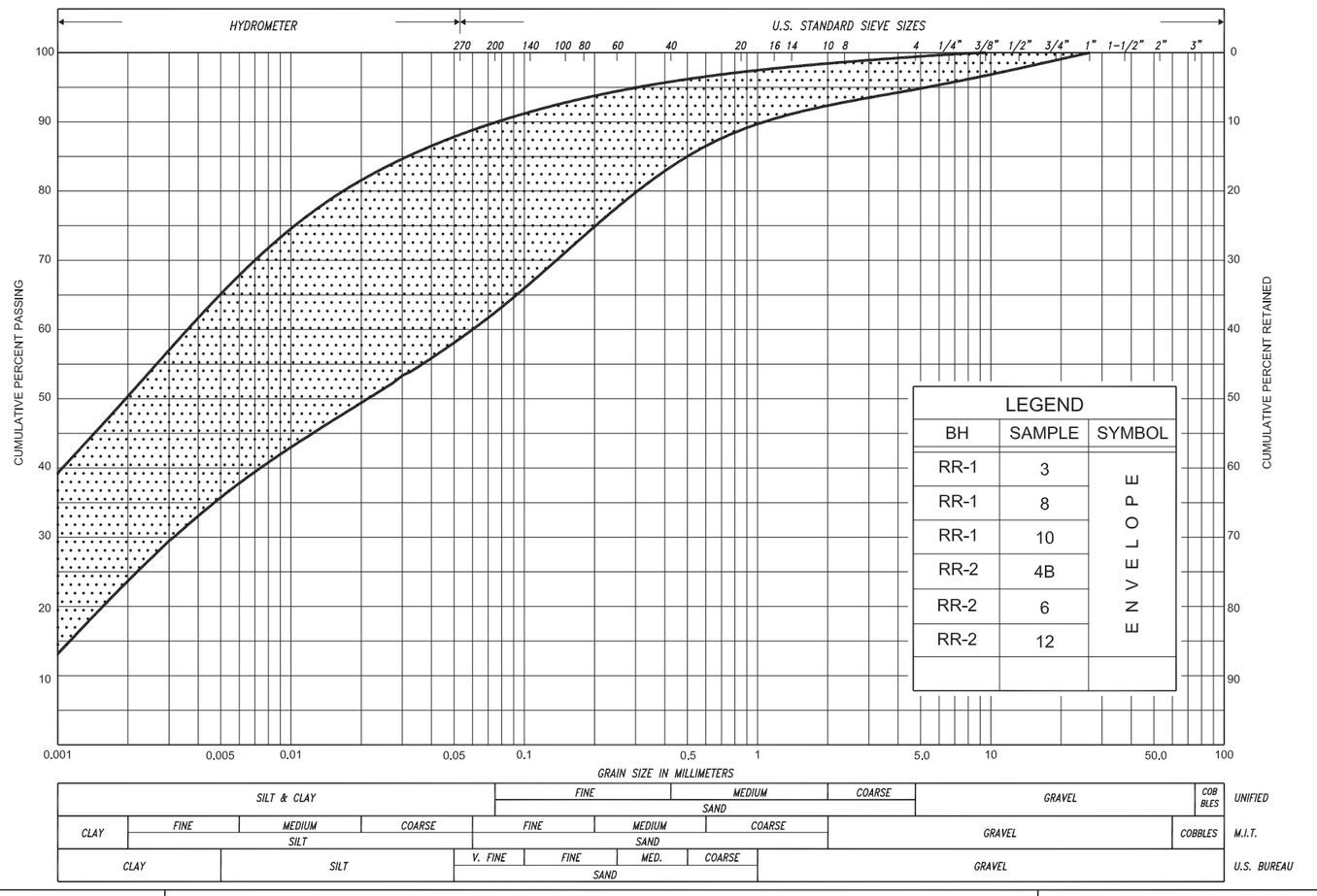
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —							SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)						
	SHALE (BEDROCK) Grey		20	SS	20/0.10		164							
162.2							163							
32.1	END OF BOREHOLE		21	SS	00/0.05									

NOTES:

1. Water level in open borehole at a depth of 7.6 m below ground surface (Elev. 186.7 m) upon completion of drilling.

2. Borehole backfilled with bentonite.

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

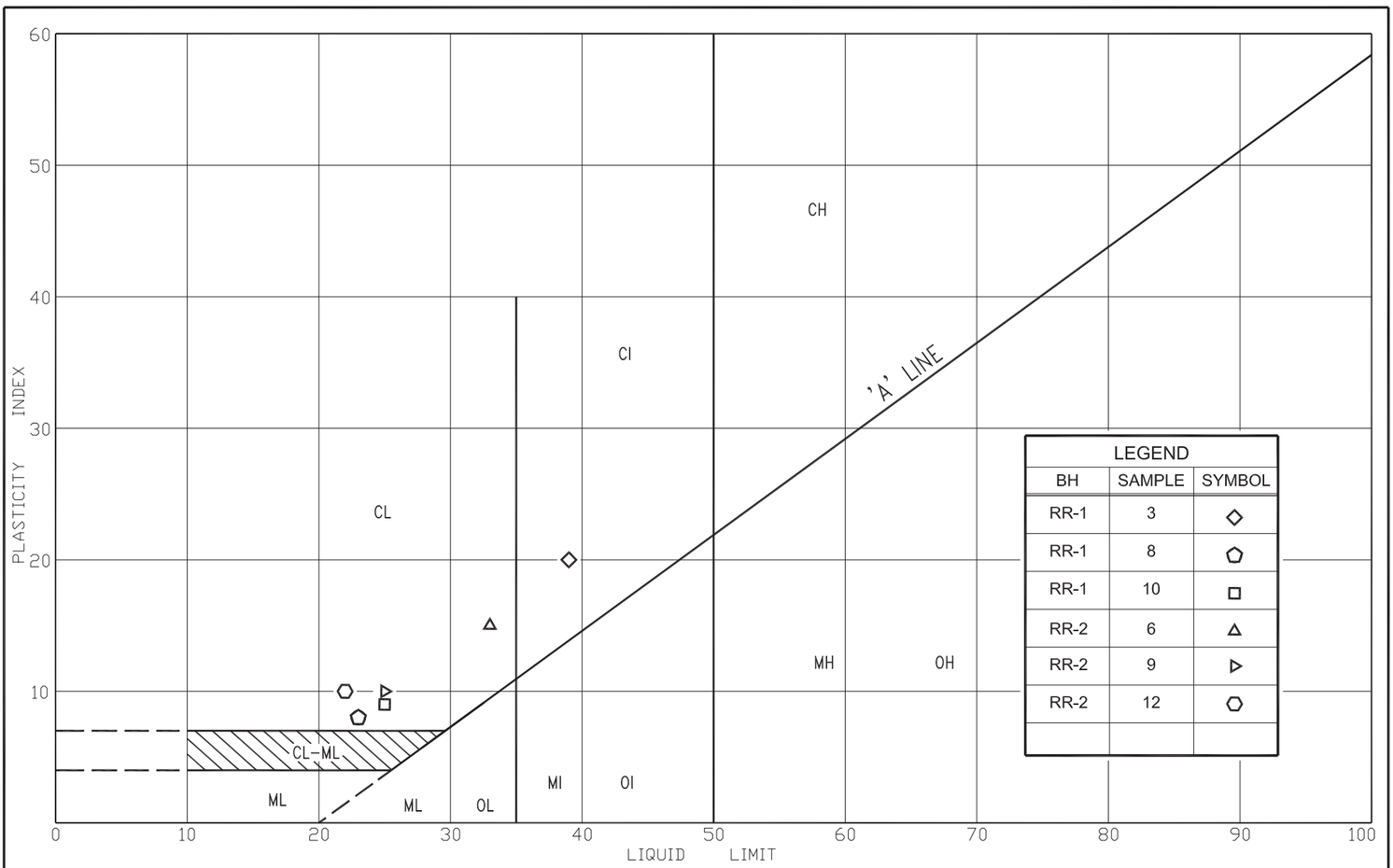


Ontario

GRAIN SIZE DISTRIBUTION

(SANDY) CLAYEY SILT to SILTY CLAY (TILL) - Upper

FIG No.	E-1
HWY:	427
G.W.P. No.	

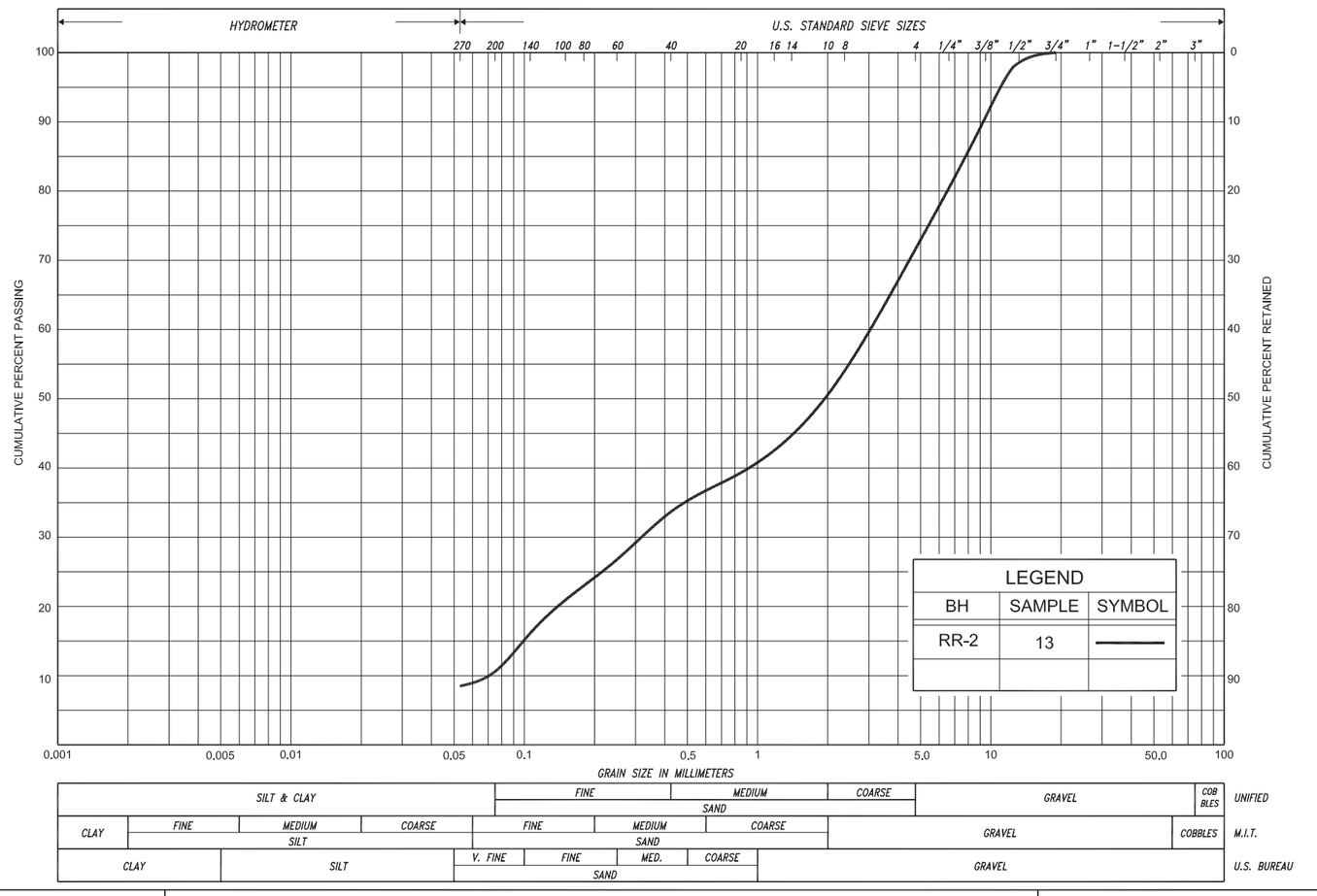


Ontario

PLASTICITY CHART

CLAYEY SILT to SILTY CLAY (TILL) - Upper

FIG No.	E-2
HWY:	427
G.W.P. No.	

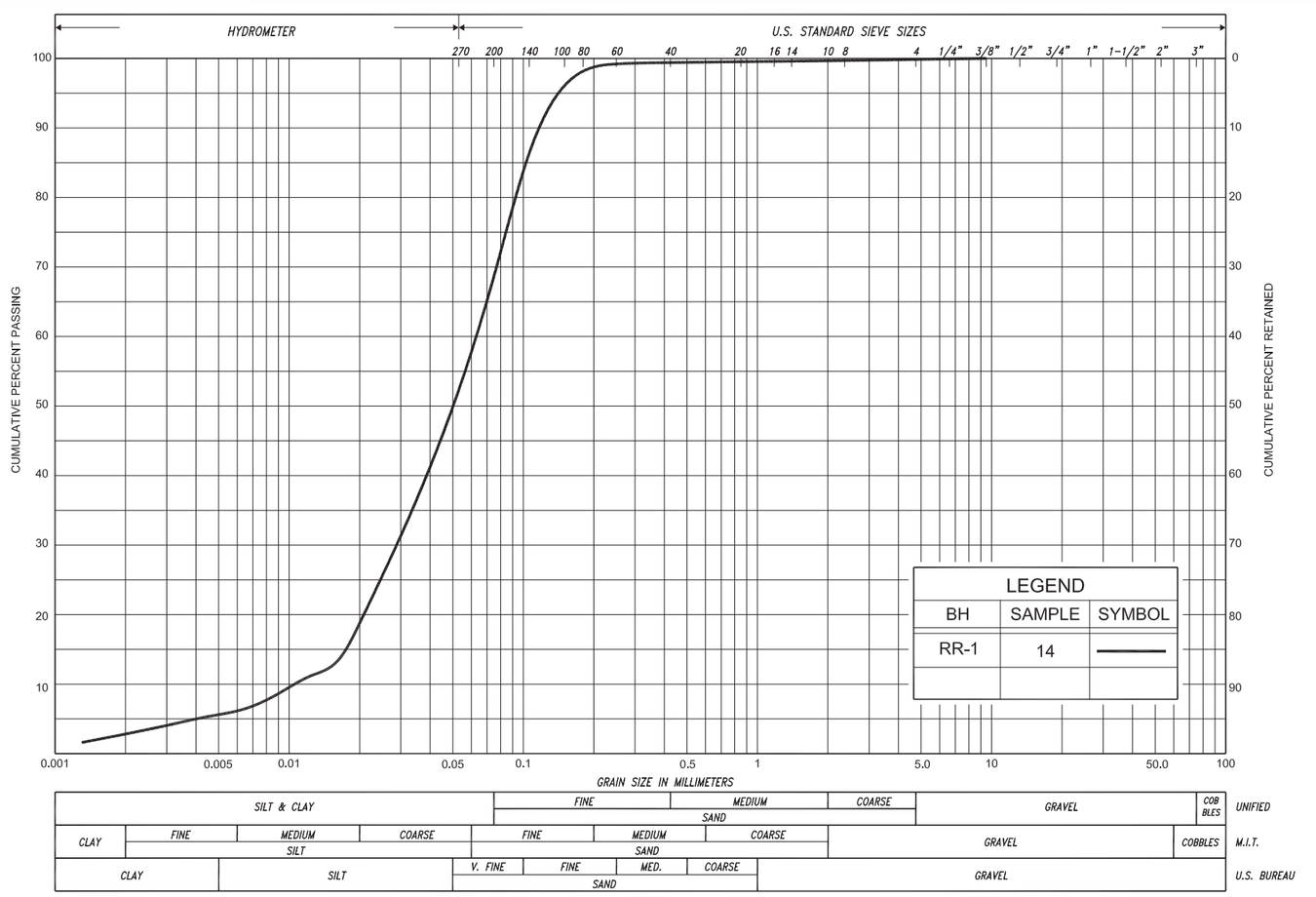


Ontario

GRAIN SIZE DISTRIBUTION

SAND, with gravel

FIG No.	E-3
HWY:	427
G.W.P. No.	

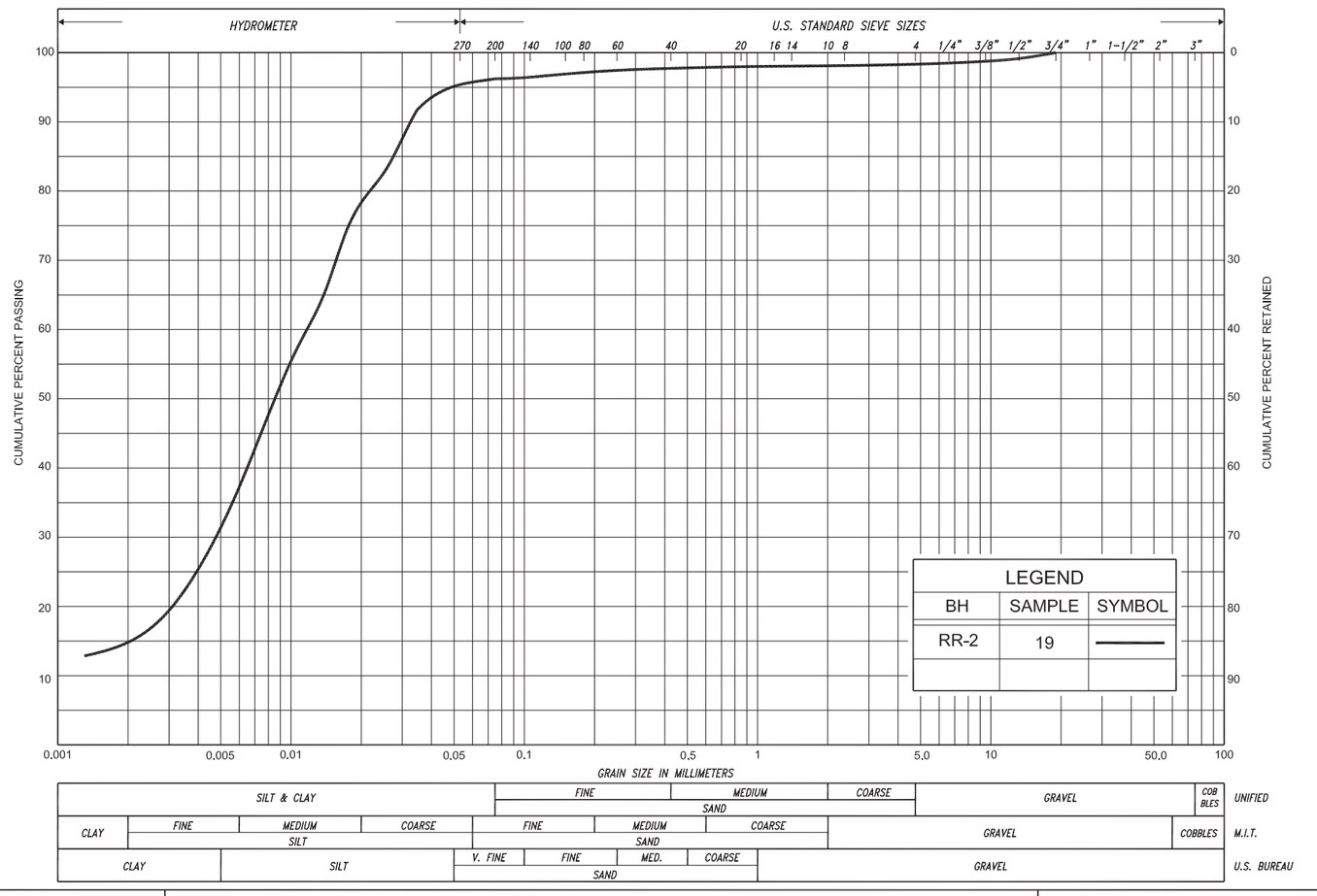


Ontario

GRAIN SIZE DISTRIBUTION

SANDY SILT (TILL)

FIG No.	E-4
HWY:	427
G.W.P. No.	



Ontario

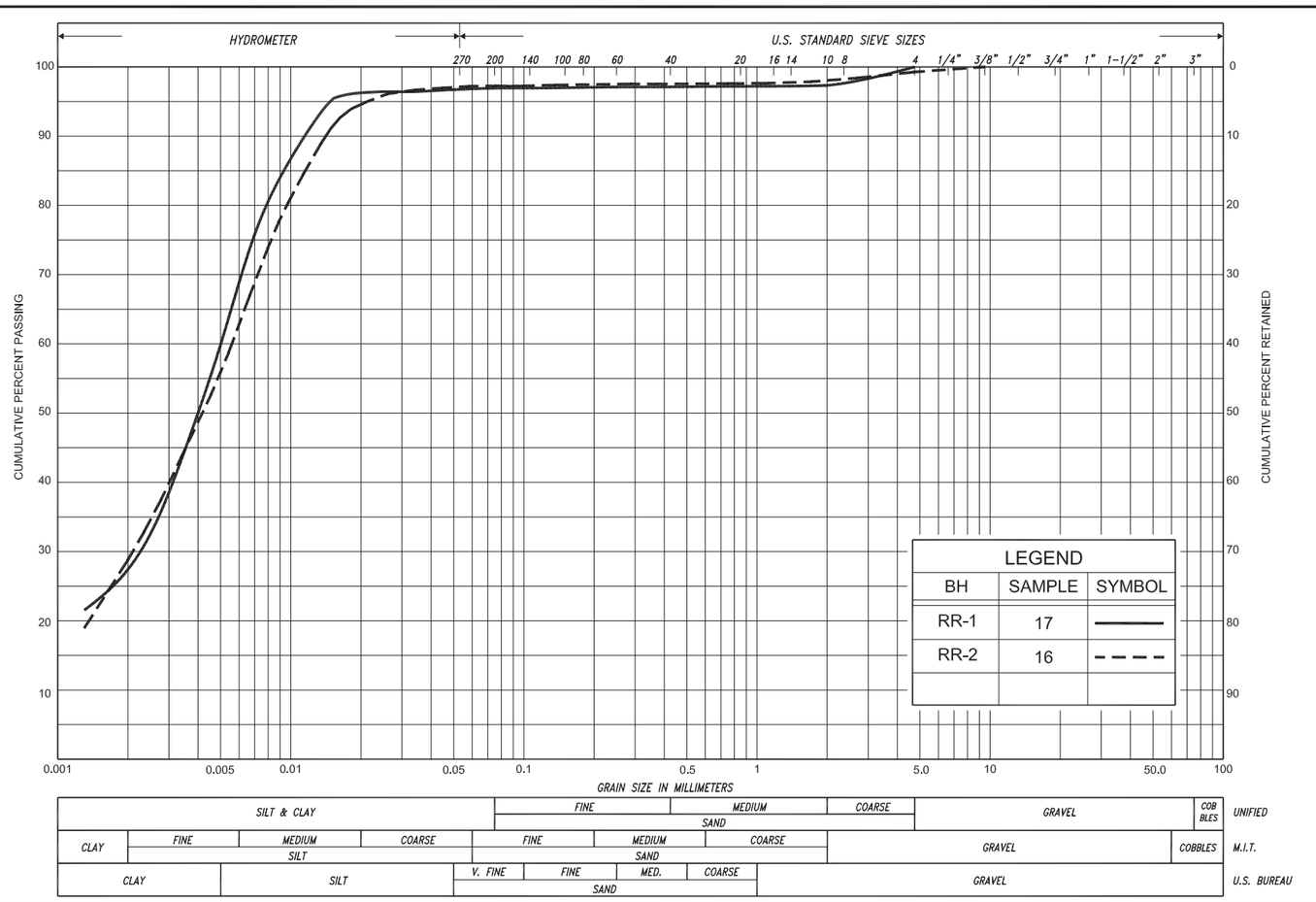
GRAIN SIZE DISTRIBUTION

SILT

FIG No. E-5

HWY: 427

G.W.P. No.



Ontario

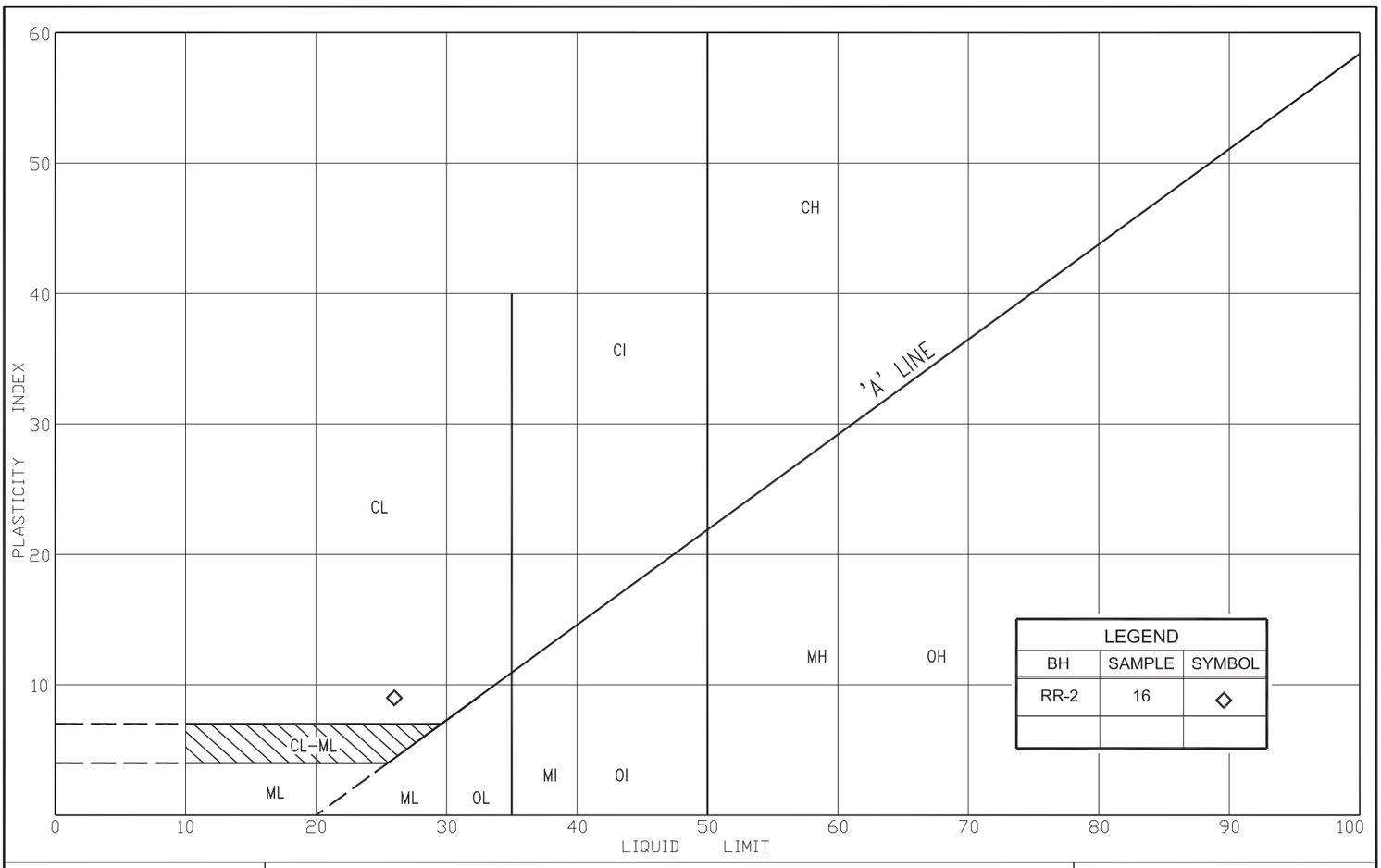
GRAIN SIZE DISTRIBUTION

CLAYEY SILT

FIG No. E-6

HWY: 427

G.W.P. No.

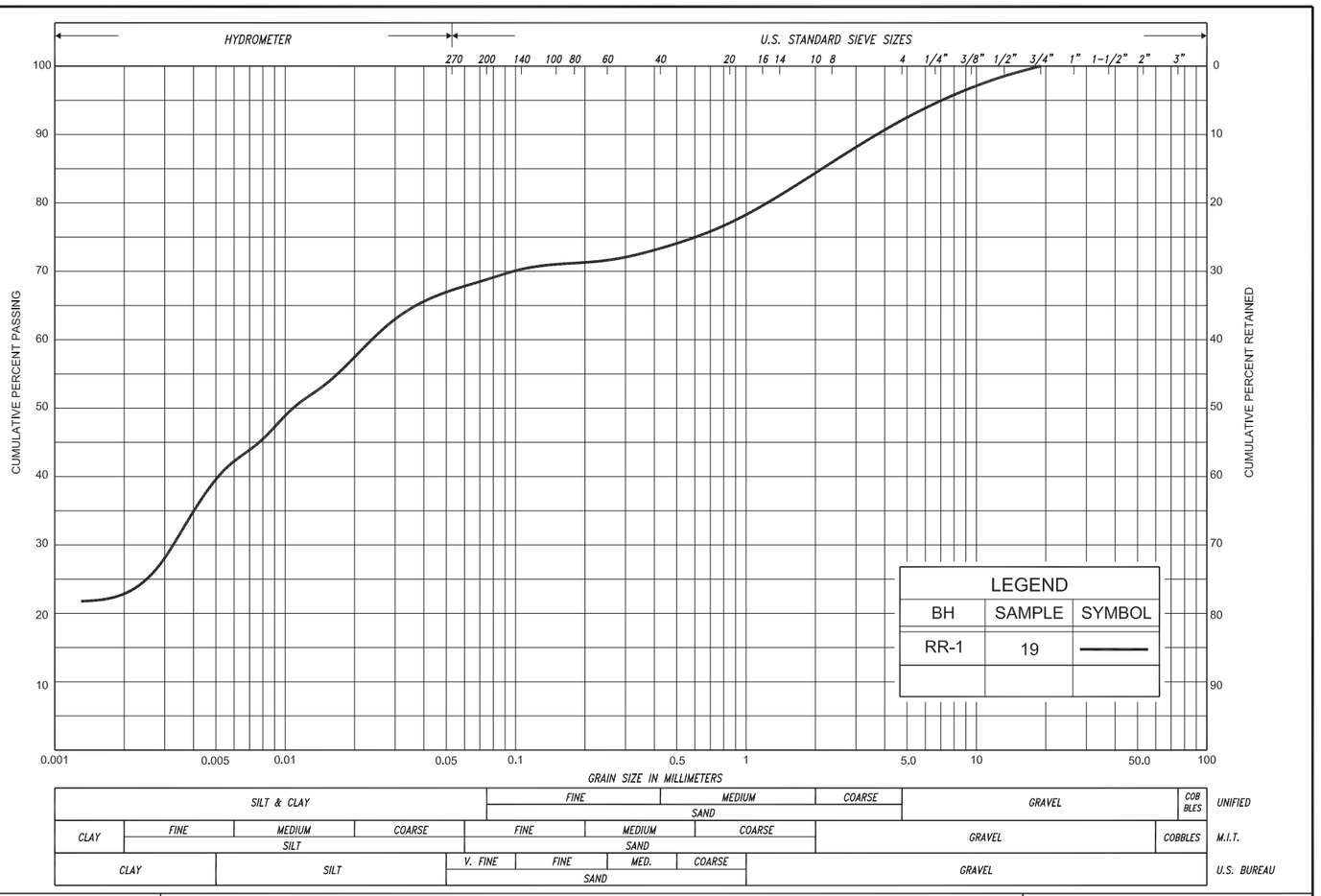


Ontario

PLASTICITY CHART

CLAYEY SILT (TILL)

FIG No. E-7
HWY: 427
G.W.P. No.



Ontario

GRAIN SIZE DISTRIBUTION

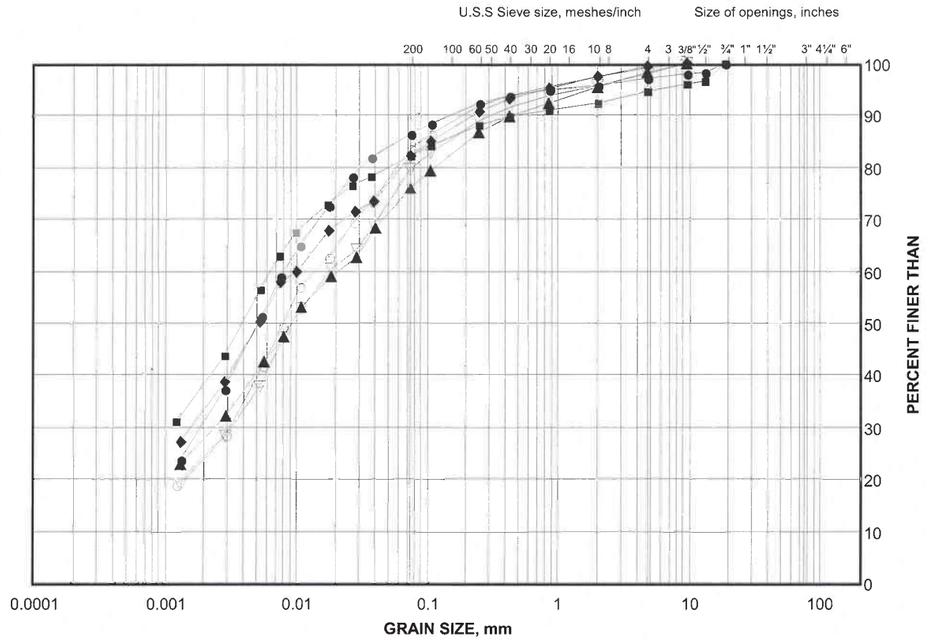
CLAYEY SILT, with sand (TILL) - Lower

FIG No. E-8
HWY: 427
G.W.P. No.

GRAIN SIZE DISTRIBUTION TEST RESULTS

Silty Clay to Clayey Silt Till

FIGURE B1



LEGEND

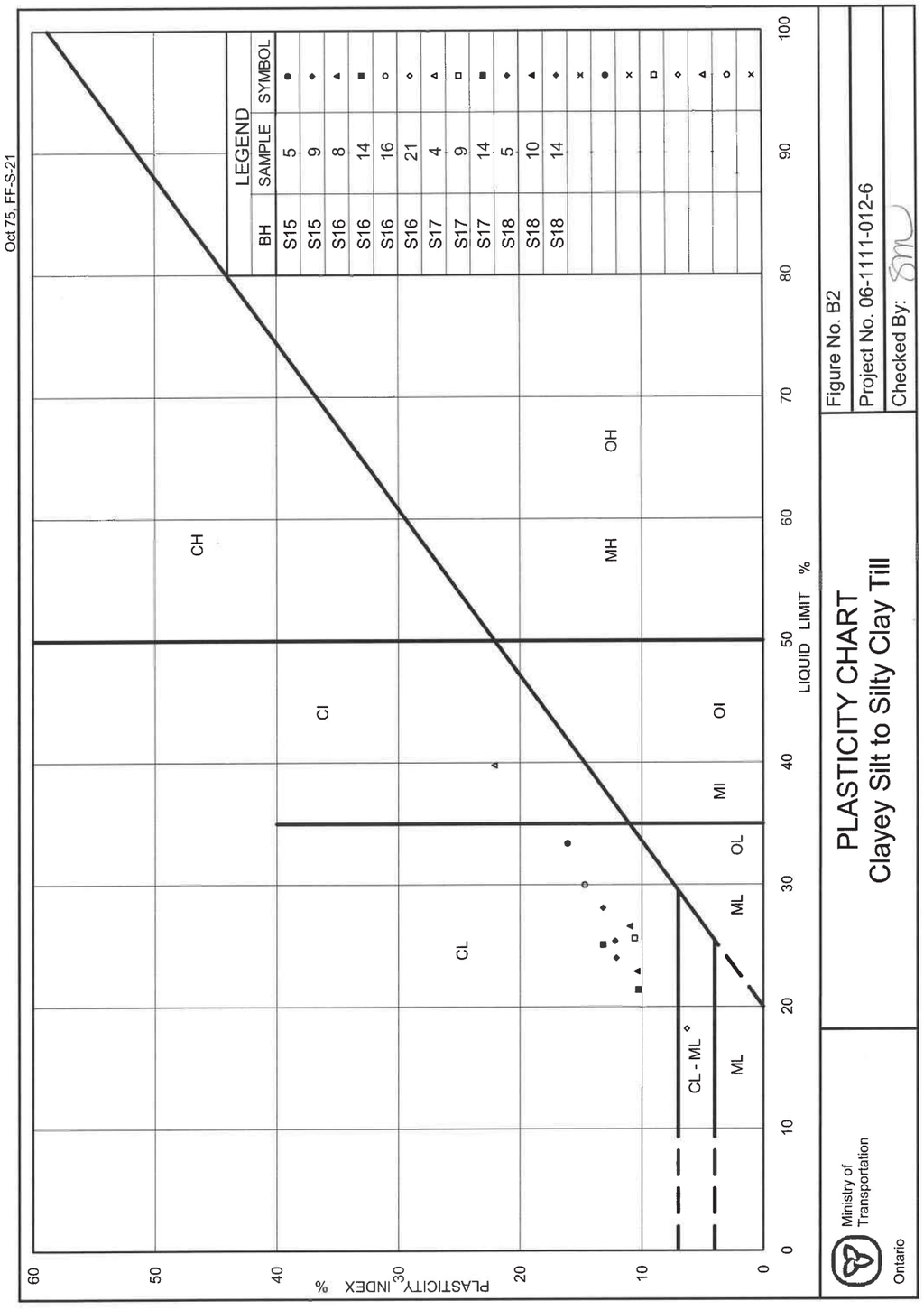
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S18	10	183.3
■	S17	4	191.2
◆	S15	5	190.6
▲	S18	5	188.3
▽	S16	8	188.2
○	S17	9	185.2

Project Number: 06-1111-012-6

Checked By: SM

Golder Associates

Date: 08-Jun-09



PLASTICITY CHART

Clayey Silt to Silty Clay Till

Figure No. B2

Project No. 06-1111-012-6

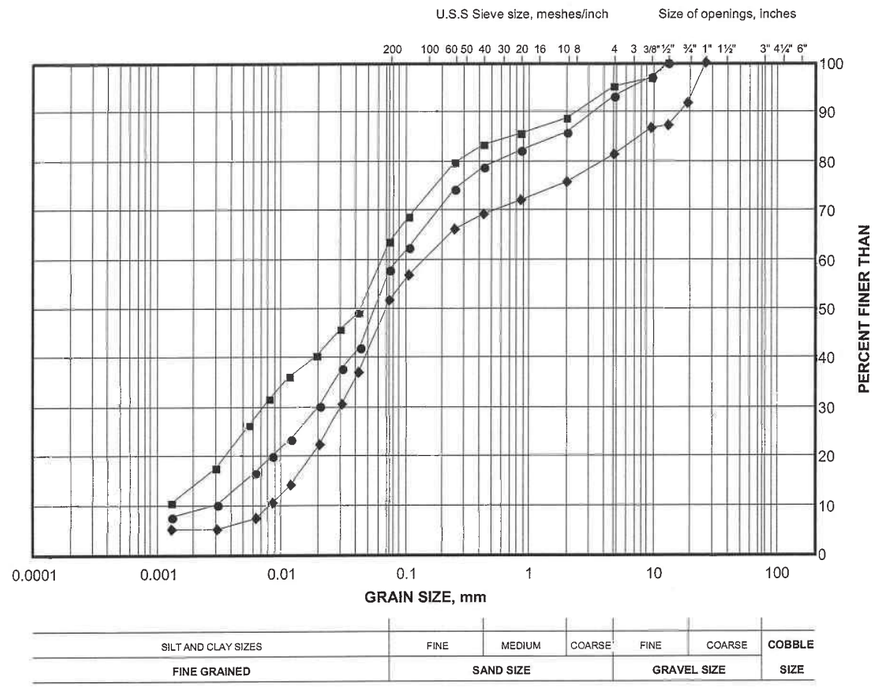
Checked By: SM

Ministry of Transportation Ontario

GRAIN SIZE DISTRIBUTION TEST RESULTS

Sand and Silt Till

FIGURE B3



LEGEND

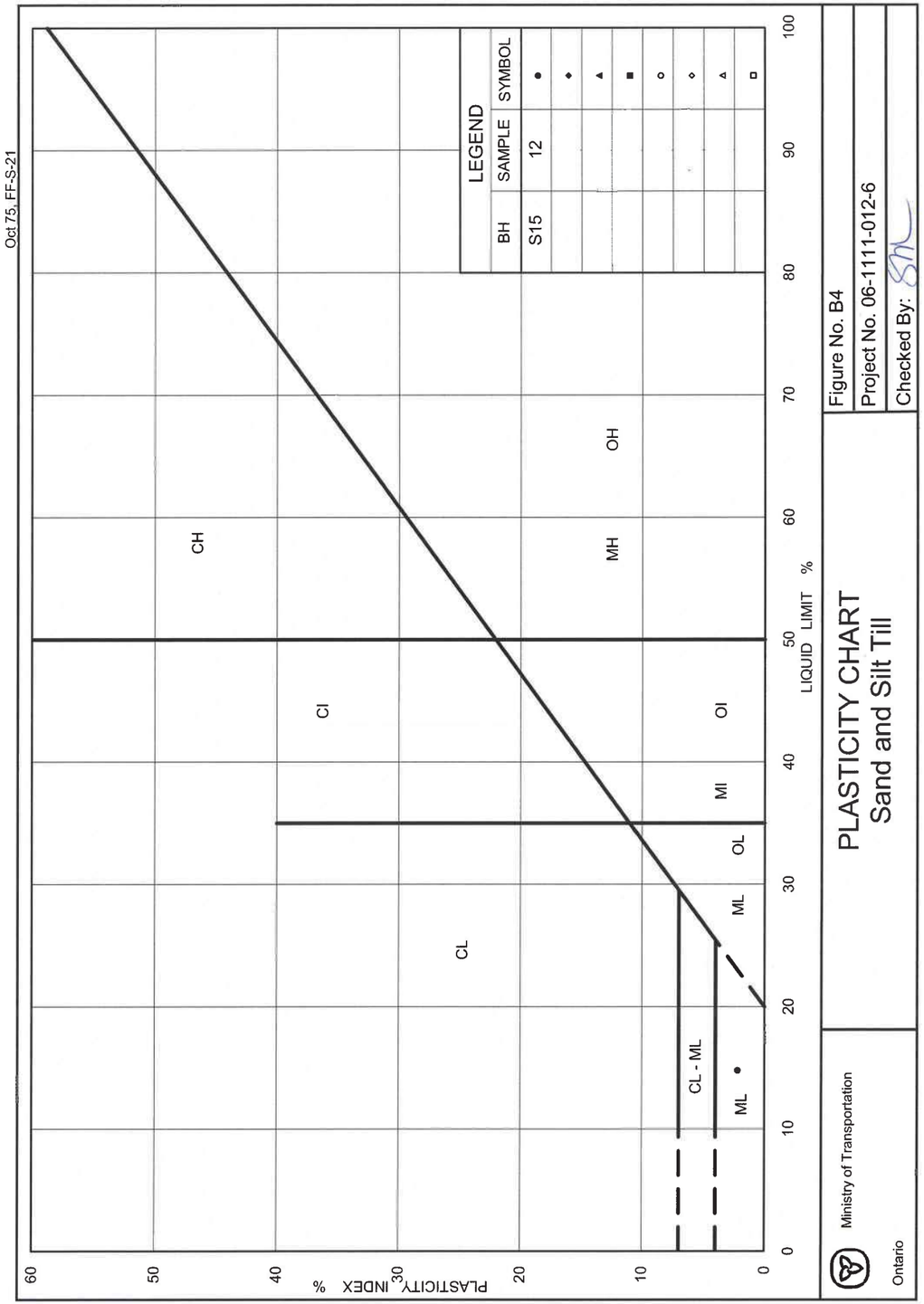
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S17	12	180.7
■	S15	12	181.5
◆	S16	13	180.6

Project Number: 06-1111-012-6

Checked By: SM

Golder Associates

Date: 08-Jun-09



PLASTICITY CHART
Sand and Silt Till

Figure No. B4

Project No. 06-1111-012-6

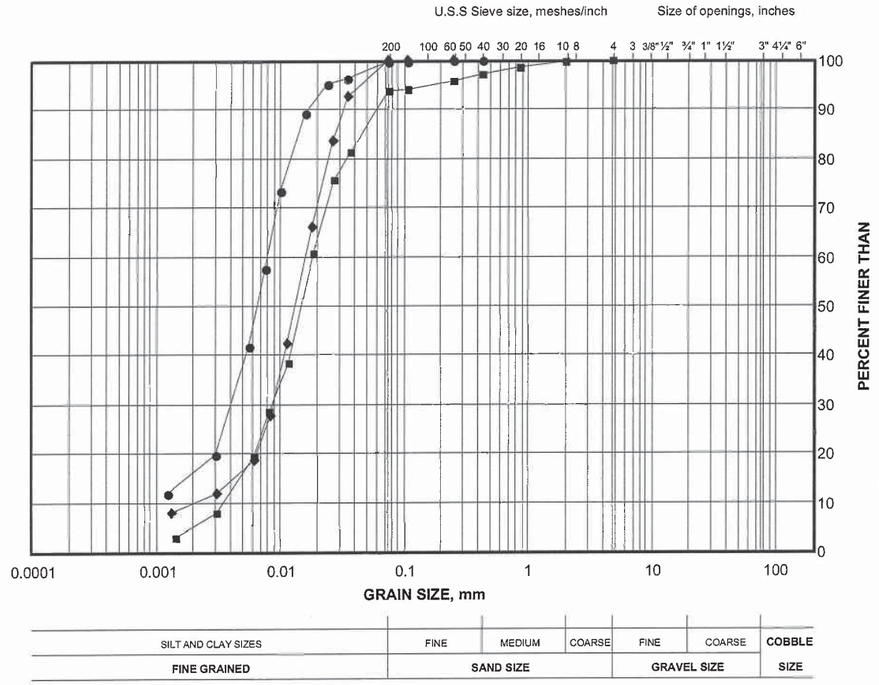
Checked By: SM

Ministry of Transportation

Ontario

GRAIN SIZE DISTRIBUTION TEST RESULTS
Silt

FIGURE B5



LEGEND

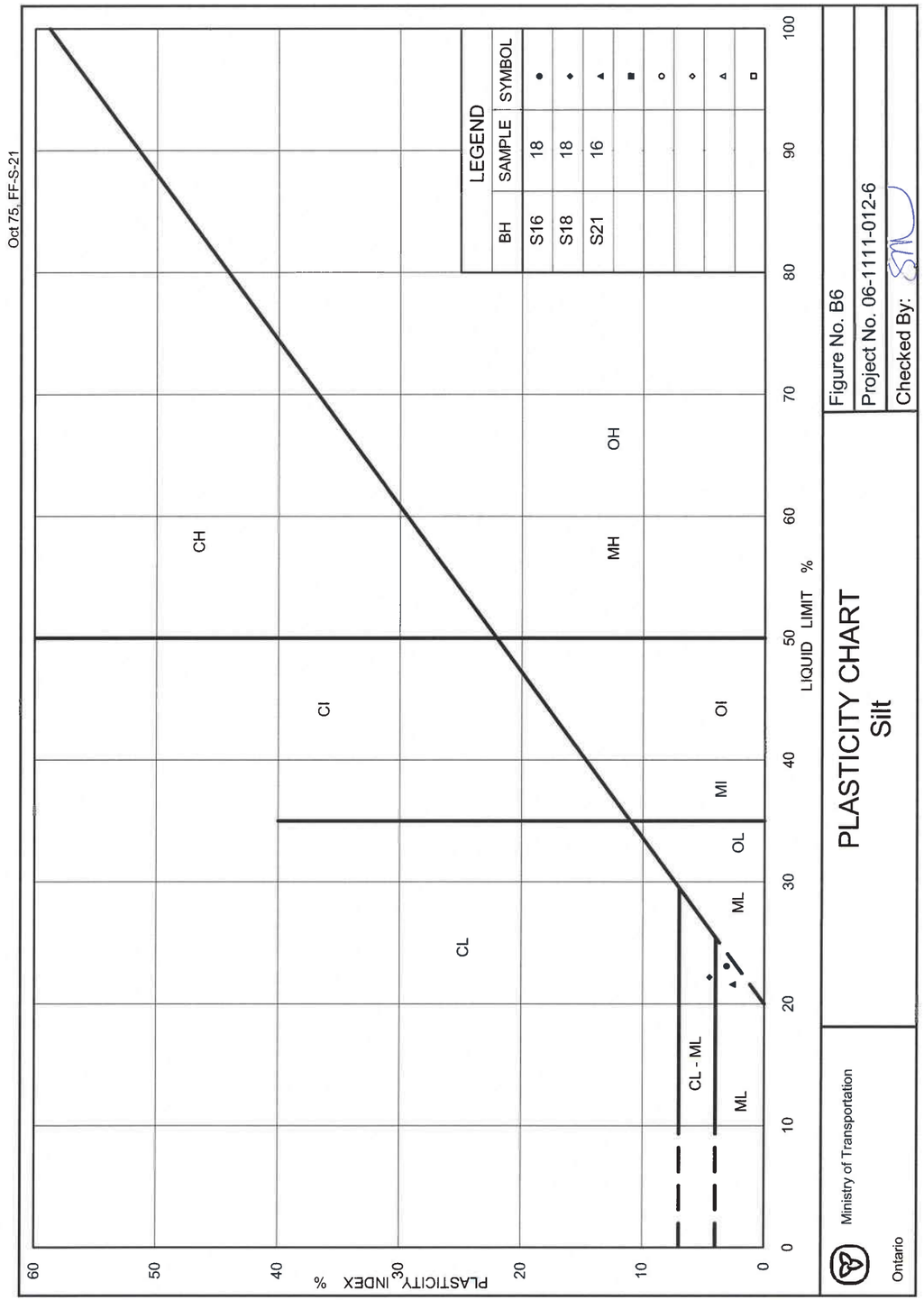
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S18	16	174.6
■	S18	18	168.1
◆	S16	18	173.0

Project Number: 06-1111-012-6

Checked By: SM

Golder Associates

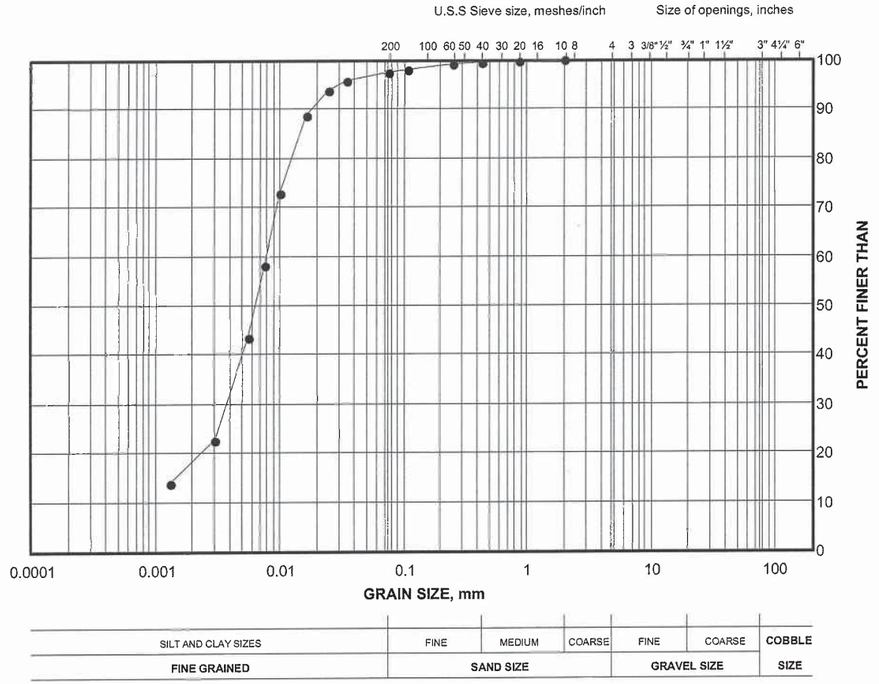
Date: 03-Jun-09



GRAIN SIZE DISTRIBUTION TEST RESULT

Clayey Silt

FIGURE B7



LEGEND

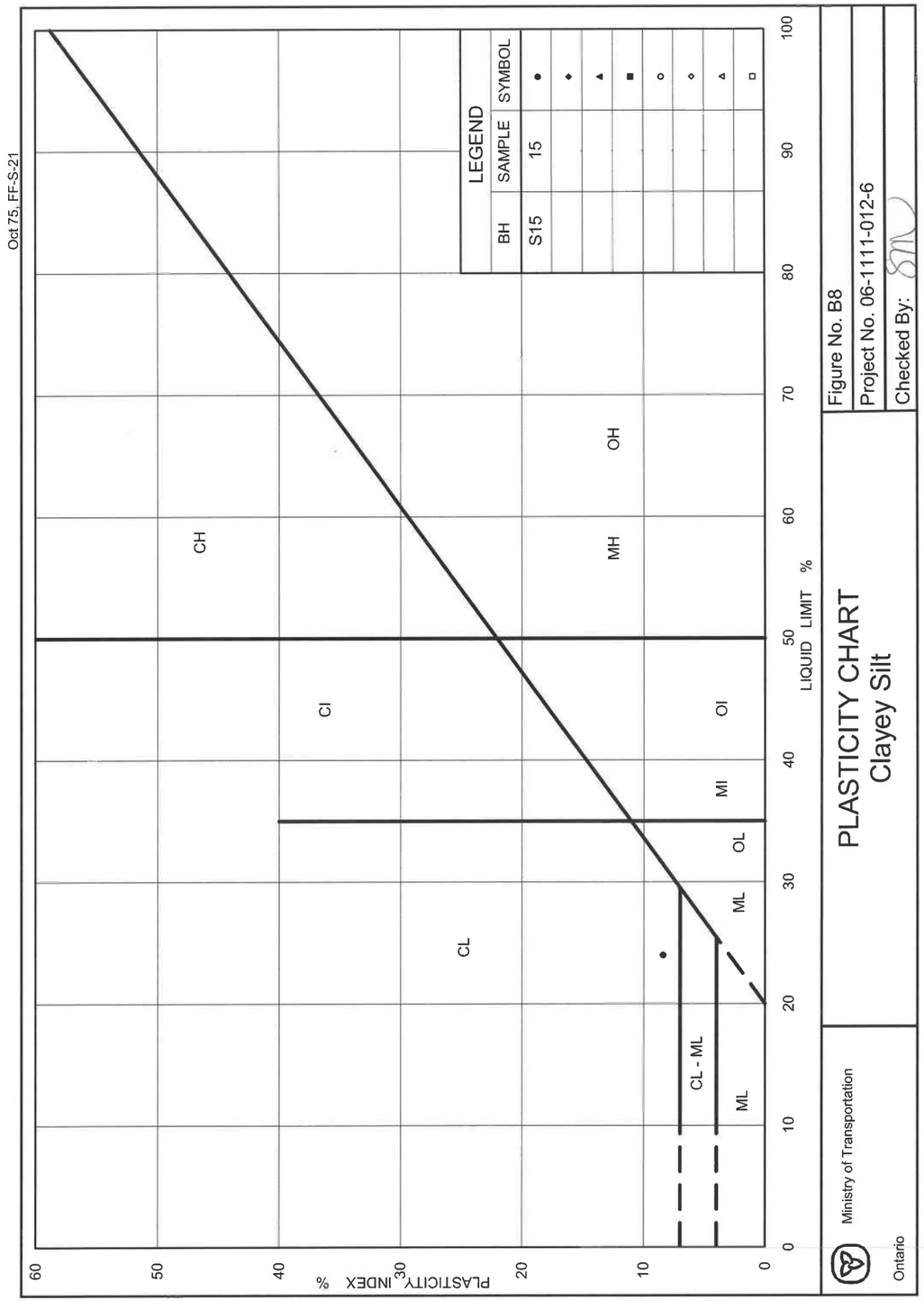
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	S15	15	176.9

Project Number: 06-1111-012-6

Checked By: SM

Golder Associates

Date: 03-Jun-09



PLASTICITY CHART

Clayey Silt

Figure No. B8

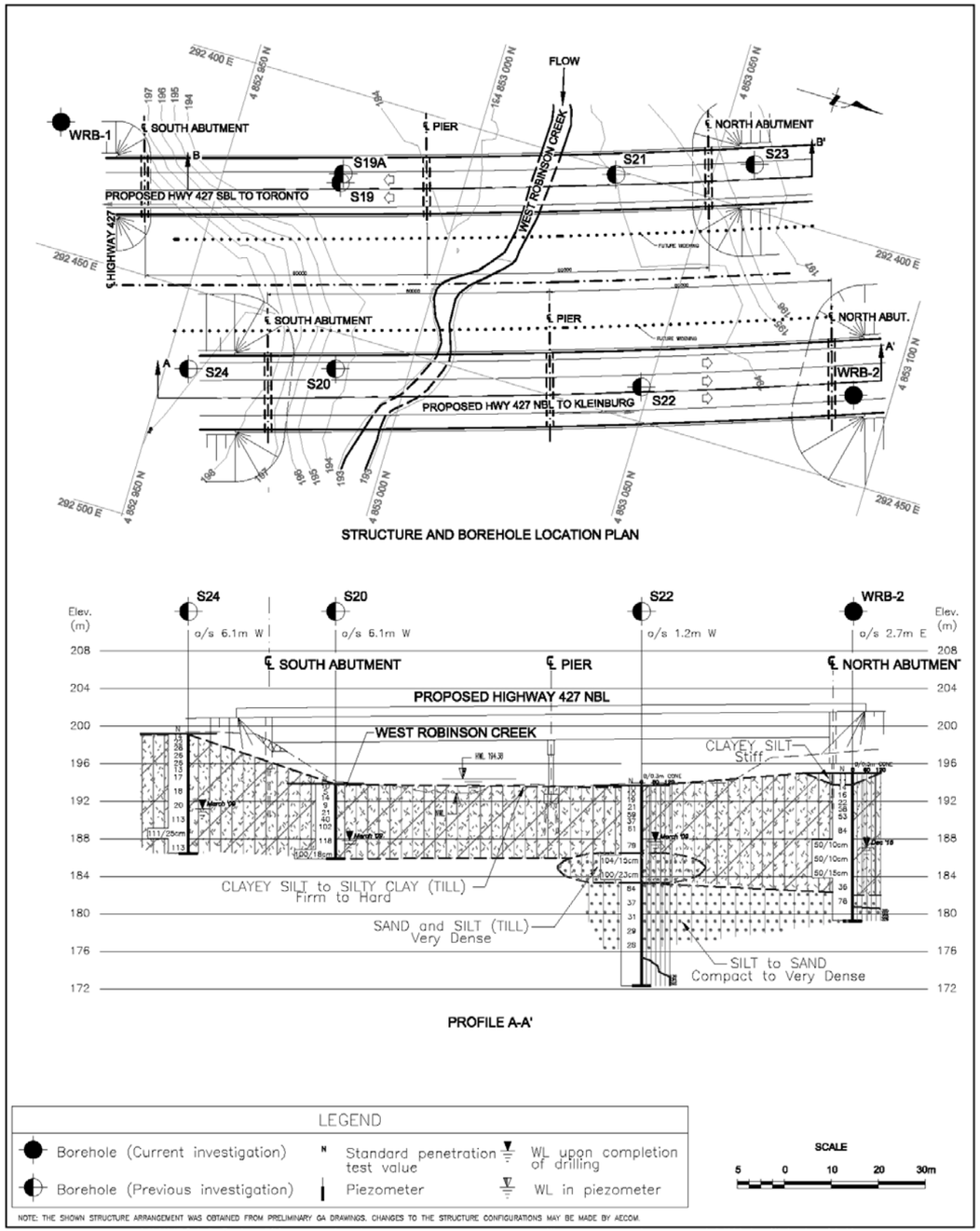
Project No. 06-1111-012-6

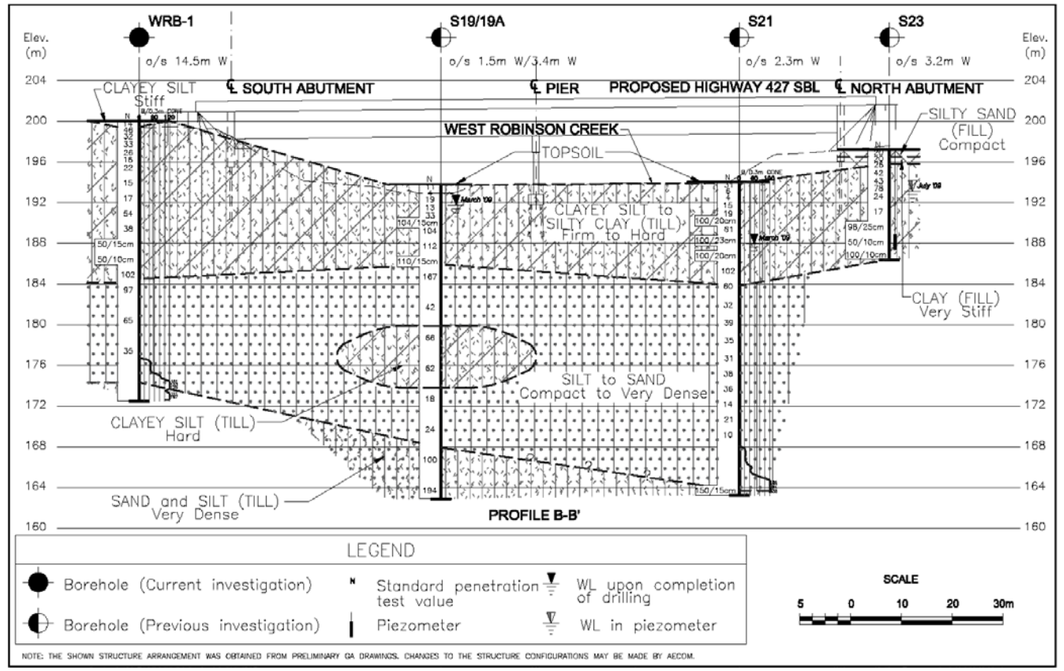
Checked By: SM

Ministry of Transportation

Ontario

Structure Type: Bridges **Existing Ground Elevation across Boreholes:** 200.0 m to 193.7 **Complexity Rating:** Medium





FOUNDATION INVESTIGATION

Site Description

The proposed structures are approximately 350 m east of Huntington Road and 450 m south of McGillivray Road, in the City of Vaughan, Ontario. The proposed structures will be located within the West Robinson Creek valley and floodplain. The crest of the valley is about 6 m higher than the creek level and the valley is covered by brush and trees.

Borehole Information

Borehole No.	Foundation Unit	MTM NAD 83 Coordinates		Ground Surface Elevation (m)	Borehole/DCPT Depth (m)
		Northing (m)	Easting (m)		
Previous Investigation					
S19	Centre Pier of SBL Structure	4,852,973.6	292,419.3	193.8	7.9
S19A	Centre Pier of SBL Structure	4,852,973.6	292,417.3	193.8	30.9
S20	South Abutment of NBL Structure	4,852,984.8	292,457.6	193.9	8.0
S21	North Abutment of SBL Structure	4,853,030.3	292,401.0	194.0	25.0/30.8
S22	Centre Pier of NBL Structure	4,853,048.3	292,442.8	193.7	17.4/21.3
S23	North Abutment of SBL Structure	4,853,058.0	292,390.6	197.2	10.8
S24	South Abutment of SBL Structure	4,852,954.8	292,466.5	199.2	12.7
Current Investigation					
WRB-1	South Abutment of SBL Structure	4,852,913.9	292,423.8	200.0	23.3/27.5
WRB-2	North Abutment of NBL Structure	4,853,092.1	292,431.7	195.0	14.2/15.7

Subsurface Condition

***Topsoil/ Fill/ Surficial Clayey Silt*:** Approximately 0.1 m thick layer of topsoil was encountered immediately below ground surface in Boreholes S19, S20, S21, S22 and S24. Borehole S23 encountered a 1.4 m thick layer of fill comprised of silty sand over clay, some sand extending to 1.4 m depth, Elevation 195.8 m. Boreholes WRB-1 and WRB-2 encountered 0.6 m and 1.4 m thick layers of clayey silt, containing rootlets, topsoil and wood fragments immediately below the ground surface and extending to 0.6 m and 1.4 m depths, Elevations 199.4 m and 193.6 m, respectively.

***Clayey Silt to Silty Clay Till*:** A brown to grey clayey silt to silty clay till deposit was encountered underlying the surficial layers in all boreholes at 0.1 m to 1.4 m depths, Elevations 199.4 m to 193.6 m. Boreholes S19, S20, S23 and S24 were terminated within this layer penetrating it for 7.8 m to 12.6 m. In all other boreholes and where the deposit was fully penetrated, its thickness varies between 7.1 m and 15.6 m. The deposit extends to 7.2 m to 13.2 m depths, Elevations 186.5 m to 181.8 m.

Borehole S19A penetrated a 6.0 m thick pocket of clayey silt till at 14.0 m depth, Elevation 179.8 m within the silt to sand deposit.

The SPT "N"-values ("N"-values) measured within the cohesive till deposit range from 13 to greater than 100 blows, suggesting a stiff to hard consistency. The results of grain size distribution analyses and Atterberg limits tests of selected cohesive till samples obtained during the current investigation are shown on Figures F-1 and F-2, respectively.

Silt to Sand: A non-cohesive soil deposit comprised of silt to silt and sand to silty sand to sand, with silt was encountered underlying the cohesive till deposit in Boreholes WRB-1, WRB-2, S19A, S21 and S22 at depths from 9.1 m to 16.2 m, Elevations 184.7 m to 181.8 m. Boreholes WRB-1, WRB-2 and S22 were terminated within this deposit and DCPTs were advanced from the bottom of boreholes to practical refusal at depths ranging from 15.7 m to 27.5 m, Elevations 179.3 m to 172.4 m. Borehole 21 was terminated within this deposit at 25.0 m depth, Elevation 169.0 m. A DCPT was advanced further to 30.5 m depth, Elevation 163.5 m.

The "N"-values measured within the non-cohesive deposit range from 14 to greater than 100 blows, indicating a compact to very dense compactness. The grain size distributions of two samples from the deposit obtained during the current investigation are shown on Figure F-3.

***Sand and Silt Till*:** Borehole S22 penetrated a 3.2 m thick deposit of sand and silt till below the cohesive till at 7.2 m depth, Elevation 186.5 extending to 10.4 m depth, Elevation 183.3 m. Boreholes S19A and 21 penetrated a sand and silt till deposit below the non-cohesive silt to sand deposit at 25.9 m and 30.5 m depths, Elevations 167.5 m and 163.5 m and terminated within this layer at 30.9 m and 30.8 m depths, Elevations 162.9 m and 163.2 m.

The "N"-values measured within this layer are greater than 100 blows, indicating a very dense compactness.

Groundwater Conditions

The groundwater level in the piezometer installed in Borehole S23 was measured at 4.1 m depth, Elevation 193.1 m on July 9, 2009. The water level in other boreholes during and upon completion of drilling was at 2.1 m to 10.2 m depths, Elevations 191.7 m to 187.1 m. For more details, refer to Table A2 of this report.

FOUNDATION RECOMMENDATIONS

The following site-specific foundation recommendations are for preliminary design and planning purposes only .They require refinement during detail design. Project-wide foundation recommendations, design assumptions and limitations are contained in Part B of this report. It is understood that the proposed twin two-span bridge structures will carry Highway 427 Northbound and Southbound Lanes over the West Robinson Creek.

Foundation Option	Advantages	Disadvantages	Relative Costs	Risks/Consequences
Spread footings on very stiff to hard clayey silt till	• Conventional construction.	• Precludes use of integral abutments; • Provides relatively low bearing capacity; • Dewatering may be required.	• Lower relative cost compared to deep foundation options.	• Disturbing of subgrade due to excavation.
Driven steel H-Piles to found within "100-blow" soils	• Allows for integral abutment design.	• Piles may encounter obstructions during driving; • Access, dewatering and environmental issues for pile cap construction within floodplain.	• More costly than spread footings.	• Risk of not achieving capacities due to the variable thickness of the "100-blow" soils; • Minor potential for pile damage/ deflection if obstructions are encountered.
Caissons founded within very dense sand and silt till	• Provides higher capacity than driven piles.	• Precludes use of integral abutments; • Drilling mud and tremie techniques required for construction; • Access, dewatering and environmental issues for caisson cap construction within floodplain.	• More costly than driven steel H-piles.	• Presence of non-cohesive water bearing layers; • Risk of loosening or disturbing founding soils at base of caissons.

Spread Footings

Spread footings founded on native soils may be used to support the abutments and piers if adequate scour protection is provided. However, the use of spread footings ~~or~~ on engineered Granular A pads in floodplains is not recommended.Also the bearing resistances at normal depths at the abutments could be less than required for design as indicated by the preliminary geotechnical resistances at the ground interface presented in the following table.

Foundation Unit	Founding Stratum	Axial Geotechnical Resistance < 25mm settlement		Highest Founding Elevation within Native Soils (m)
		Factored ULS (kPa)	SLS (kPa)	
South Abutments	Stiff to Hard Clayey Silt Till	375	250	196.0
Centre Piers	Very Stiff to Hard Clayey Silt Till	525	350	191.0
North Abutment of SBL Structure	Stiff to Hard Clayey Silt Till	375	250	195.0
North Abutment of NBL Structure				193.0

Driven Steel H-Pile/ Steel Pipe Piles

Steel H-piles 310x110 and Steel pipe piles, 324 mm (12 ¾ in) outer diameter and 6 mm (1/4 in) thickness, driven to levels provided below may be used to support the abutments and piers. The preliminary geotechnical resistances and approximate tip elevations are presented in the following table.

Foundation Unit	Axial Geotechnical Resistance		Approximate Pile Tip Elevation (m)
	Factored ULS (kN)	SLS (kN)	
South Abutment of SBL Structure	1,000	750	186
South Abutment of NBL Structure	1,000	750	188
Centre Pier of SBL Structure	900	675	186
Centre Pier of NBL Structure	900	675	185
North Abutment of SBL Structure	1,000	750	188
North Abutment of NBL Structure	1,000	750	186

Driven piles should be controlled by Hiley Formula as per MTO Drawing SS-103-11 from 2 m above the approximate pile tip elevations, employing a maximum load of twice the factored geotechnical resistance at ULS per pile. Piles should not be driven more than 1 m deeper than the approximate pile tip elevation due to the limited thickness of the bearing layer.

Caissons

Caissons are not recommended due to the variable thickness of "100 blow" soils and presence of underlying compact to very dense silt to sand underlying a thin bearing layer.

Recommended Foundation Alternative

The recommended foundation alternative at this site is driven steel H-piles into the hard/very dense till deposits for the abutments, and spread footings founded on native, very stiff to hard clayey silt till for the piers. Driven piles may also be used for the piers. Driven piles are preferred over caissons due to the presence of non-cohesive water bearing soils.

Structure Abutments and Approaches

The soil conditions at this site are suitable for conventional, semi-integral and integral abutment design. Construction of the bridge structures will require placement of up to about 1.0 m and 6.5 m of fill within the limits of the south and north approach embankments.

Structure Retaining Walls/Wing Walls

The earth retaining walls for this structure may include Cast-in-Place (CIP) or RSS Walls. For RSS walls the facing should be founded on granular pad or CIP leveling pad. The retaining walls geometry should conform to High Appearance and High Performance in accordance with MTO.DSM 9.70 and current RSS Design Guidelines. The CIP retaining walls should be designed in conformance with spread footing recommendations in this report.

Stability of Approach Embankments

Approach embankments constructed of suitable earth fill or granular fill and up to about 6.5 m high are expected to be stable at side slopes formed at a maximum gradient of 2H:1V.

Settlement of Approach Embankments

The settlement within founding soils of south approach embankments is estimated to be less than 25 mm.

The settlement within founding soils of north approach embankments is estimated to be in the order of 50 mm, most of which will occur shortly following the fill placement. It is recommended that consideration be given to preloading the north approach embankments for two (2) months to mitigate the post-construction settlements.

Construction Considerations

Excavation

The construction of footings and pile/caisson caps will require excavations up to about 4.0 m below the ground surface. These excavations will be made through firm to hard cohesive soils or fill which are classified as Type 3 soils in OHSA. Temporary unsupported excavations above the prevailing groundwater in these soils should be made with side slopes no steeper than 1H:1V.

Surface Water / Groundwater Control

Surface water run-off and the West Robinson Creek flow should be diverted away from the excavations at all times.

The prevailing groundwater should be maintained a minimum of 0.5 m below the base of excavations. The groundwater level measured in the piezometer installed at this site was at 4.1 m depth below the existing ground surface, Elevation 193.1 m. It is expected that excavations at the floodplain will extend below the prevailing groundwater level and creek water level at this site, and a cofferdam system is required. The excavations for the south abutments will be at the groundwater level at this site and the water inflow can be handled by pumping from properly filtered sumps placed at the base of excavations.

Pile Installation / Caisson Construction

It is anticipated that cobbles and/or boulders will be encountered within the till deposit, which may adversely impact the installation of steel H-piles or caissons. Piles should be equipped with flange plates or approved driving shoes.

If consideration is being given to caisson foundations, water-bearing non-cohesive native soils should be expected to run or flow into the caisson hole during and after the drilling for the caisson foundations and as such, appropriate equipment and procedures (including use of temporary or permanent caisson liners) will be required to minimize ground loss during drilling and concrete placement and to permit inspection and cleaning of the caisson bases.

Recommendation for Additional Work

Further subsurface investigation should be carried out during the detail design to confirm the subsoil and groundwater conditions. Since the founding stratum thickness is variable across the site, it is recommended that for the additional subsurface investigation during the detail design consideration be given to sampling intervals of 0.75 m close to the approximate tip elevations (approximately between Elevations 186 m and 180 m) to more accurately define the thickness and extent of the "100 blow" soil layer. Caution should be exercised to avoid groundwater issues during borehole drilling due to the presence of noncohesive soil at depth.

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No WRB-1 1 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 852 913.9 N; 292 423.8 E ORIGINATED BY F.P.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY M.K

DATUM Geodetic DATE December 7 and 8, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE, 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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
200.0	Ground Surface										
0.0	CLAYEY SILT containing wood fragments		1	SS	14		199				
199.4	Stiff Dark brown Moist										
0.6	CLAYEY SILT to SILTY CLAY, trace to some sand, trace gravel		2	SS	46		198				
	Very stiff to hard Brown becoming grey below a depth of 3.8m Moist to wet		3	SS	32		197				1 7 47 45
	(TILL)		4	SS	33		196				
			5	SS	26		195				
			6	SS	16		194				
			7	SS	22		193				
			8	SS	15		192				3 11 51 35
			9	SS	17		191				
			10	SS	54		190				First groundwater strike at 10.2m
			11	SS	38		189				
	with sand between depths of 12.1m and 14.1m		12	SS	50/15cm		188				2 25 55 18
			13	SS	50/10cm		187				
	Cont'd						186				

+⁷ ,×⁵ : Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No WRB-1 2 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 852 913.9 N; 292 423.8 E ORIGINATED BY F.P.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY M.K

DATUM Geodetic DATE December 7 and 8, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE, 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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
185.0											
			14	SS	102		184				0 4 72 24
183.8											
16.2	SILTY SAND, trace clay Dense to very dense Grey Wet		15	SS	97		183				0 57 37 6
							182				
			16	SS	65		181				
							180				
							179				
							178				
			17	SS	35		177				
176.7											
23.3	Switched to Dynamic Cone Penetration Test						176				
							175				
							174	121 123 125 121			
							173	197			
172.5											
27.5	End of Dynamic Cone Penetration Test ▽ Water level noted during drilling Note: 1. Groundwater was not encountered inside the borehole upon completion of drilling.										

+⁷ ,×⁵ : Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No WRB-2 1 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 853 092.1 N; 292 431.7 E ORIGINATED BY F.P.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY M.K

DATUM Geodetic DATE December 01, 2015 CHECKED BY A.V.

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 (○ 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 (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
195.0	Ground Surface										
0.0	CLAYEY SILT contaiing rootlets and topsoil Stiff Dark brown Moist		1	SS	11						
193.6			2	SS	11		194				
1.4	CLAYEY SILT, with sand, trace gravel Stiff to hard Brown becoming grey below a depth of 3.8m Moist to wet (TILL)		3	SS	14		193				
			4	SS	16		192				1 10 45 44
			5	SS	22						
			6	SS	58		191				
			7	SS	53		190				
			8	SS	84		189				1 14 72 13
			9	SS	50/10cm		188				
			10	SS	50/10cm		187				5 25 47 23
			11	SS	50/15cm		186				
			12	SS	36		185				
181.8							184				
13.2	SAND, with silt Very dense Grey Wet		13	SS	78		183				
180.8							182				
14.2	Switched to Dynamic Cone Penetration Test Cont'd						181	285 190			0 71 24 5

ON MTO_NEW LOGO HWY 427 15TF013A-REV.GPJ ON_MOT.GDT 14/01/2016 4:21:15 PM

+⁷ ,×⁵ : Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No WRB-2 2 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 853 092.1 N; 292 431.7 E ORIGINATED BY F.P.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY M.K

DATUM Geodetic DATE December 01, 2015 CHECKED BY A.V.

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 (○ 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 (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
180.0								223			
179.3								326			
15.7	End of Dynamic Cone Penetration Test ▽ Water level noted during drilling ▼ Water level measured upon completion Notes: 1. Groundwater level measured at a depth 7.9m below ground surface (Elev. 187.1m) upon completion of drilling. 2. The borehole caved in at a depth 12.5m below ground surface (Elev. 182.5m).										

ON MTO_NEW LOGO HWY 427 15TF013A-REV.GPJ ON_MOT.GDT 14/01/2016 4:21:15 PM

+⁷ ,×⁵ : Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No S19

1 OF 1 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4852973.6 ;E 292419.3 | ORIGINATED BY DD
W.O. 05-20012 | | COMPILED BY VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 2, 2009

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 + FIELD VANE ● QUICK TRIAXIAL × REMOULDED)	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
193.8	GROUND SURFACE										
0.0 / 0.1	TOPSOIL										
	CLAYEY SILT with sand, trace gravel (TILL) containing rootlets and topsoil to a depth of 0.6 m Firm to hard Dark brown to grey Moist		1	SS	11		193				
			2	SS	4						
	Containing oxidation zones between depths of 1.5 m and 2.1 m		3	SS	19		192				
			4	SS	13		191				
			5	SS	33						
			6	SS	104/0.15		190				
	Augers grinding at a depth of 4.9 m		7	SS	104		189				
			8	SS	112	▽	188				1 24 60 15
	Augers grinding at a depth of 7.0 m						187				
185.9			9	SS	10/0.15		186				
7.9	END OF BOREHOLE										

NOTES:

1. Water level in open borehole at a depth of 6.1 m below ground surface (Elev. 187.7 m) upon completion of drilling.
2. An additional borehole was drilled adjacent to Borehole S19; See Record of Borehole S19A for details.
3. Borehole backfilled with bentonite.

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

Golder Associates

RECORD OF BOREHOLE No S19A

1 OF 3 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4852973.6 ;E 292417.3 | ORIGINATED BY CR
W.O. 05-20012 | | COMPILED BY VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 10, 2009

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 + FIELD VANE ● QUICK TRIAXIAL × REMOULDED)	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
193.8	GROUND SURFACE										
0.0	Unsampled, see Record of Borehole S19 for stratigraphy above a depth of 7.9 m .					▽	193				
							192				
							191				
							190				
							189				
							188				
							187				
							186				
							185				
							184				
184.7											
9.1	SAND, trace silt Very dense Brown Moist		1	SS	167		183				
183.4											
10.4	SAND and SILT, trace clay, containing clayey silt and sand seams Dense Grey Wet		2	SS	42		182				
							181				
179.8							180				
14.0	CLAYEY SILT, some sand, trace gravel (TILL) Very dense Grey Moist to wet						179				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S19A

2 OF 3 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4852973.6 ;E 292417.3
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 10, 2009

ORIGINATED BY CR
COMPILED BY VA
CHECKED BY SMM

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 × REMOULDED, 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —										
	CLAYEY SILT, some sand, trace gravel (TILL) Very dense Grey Moist to wet		3	SS	66		178				5 10 68 17
	Wet below a depth of 17.1 m		4	SS	62		177 176 175				
173.8							174				
20.0	SILT, trace clay, containing sand seams Compact Grey Wet		5	SS	18		173 172		H ○		0 0 92 8
170.6							171				
23.2	Sandy SILT, trace clay Compact Grey Wet		6	SS	24		170 169		○		
167.9							168 167				
25.9	SAND and SILT, trace to some gravel, trace clay, containing cobbles and boulders (TILL) Very dense Grey Wet		7	SS	100		166		○H		10 37 48 5
							165 164				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S19A

3 OF 3 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4852973.6 ;E 292417.3
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 10, 2009

ORIGINATED BY CR
COMPILED BY VA
CHECKED BY SMM

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 × REMOULDED, 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —										
162.9	SAND and SILT, trace to some gravel, trace clay, containing cobbles and boulders (TILL) Very dense Grey Wet		8	SS	194		163		○		
30.9	END OF BOREHOLE										
	NOTES: 1. Water level in open borehole at a depth of 2.1 m below ground surface (Elev. 191.7 m) upon completion of drilling. 2. Borehole backfilled with bentonite.										

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

Golder Associates

RECORD OF BOREHOLE No S20

1 OF 1 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4852984.8 ;E 292457.6
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 3, 2009

ORIGINATED BY DD
COMPILED BY VA
CHECKED BY SMM

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	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.9	GROUND SURFACE							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	WATER CONTENT (%) 10 20 30		
0.0	TOPSOIL										
0.1	CLAYEY SILT with sand, trace gravel (TILL) containing rootlets and oxidation zones to a depth of 1.4 m Firm to hard Dark brown to grey Moist to wet		1	SS	10		193				
			2	SS	5						
			3	SS	14		192				
	Becoming grey below a depth of 2.3 m		4	SS	9						
			5	SS	21		191				
			6	SS	40		190				
			7	SS	102		189				3 27 59 11
			8	SS	118	▽	188				
							187				
			9	SS	100/0.1						
186.0							186				
8.0	END OF BOREHOLE										
	NOTES: 1. Water level in open borehole at a depth of 6.1 m below ground surface (Elev. 187.8 m) upon completion of drilling. 2. Borehole backfilled with bentonite.										

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S21

1 OF 3 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4853030.3 ;E 292401.0
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 4 & 5, 2009

ORIGINATED BY DD
COMPILED BY VA
CHECKED BY SMM

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	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.0	GROUND SURFACE							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	WATER CONTENT (%) 10 20 30		
0.0	TOPSOIL										
0.1	CLAYEY SILT, some sand, trace gravel (TILL) containing rootlets, topsoil and oxidation zones to a depth of 2.1 m Firm to hard Dark brown to grey Moist		1	SS	31						
			2	SS	6		193				
			3	SS	4						
			4	SS	15		192				
			5	SS	19		191				
			6	SS	100/0.2		190				
			7	SS	81		189				
	Containing cobbles between depths of 6.1 m and 6.5 m		8	SS	100/0.2	▽	188				5 23 58 14
			9	SS	100/0.2		187				
			10	SS	102		186				
183.8							185				
10.2	Silty SAND, trace clay Very dense Grey Wet		11	SS	60		184				
182.3							183				0 70 26 4
11.7	SAND and SILT, trace clay Dense Grey Moist to wet below a depth of 12.5 m		12	SS	32		182				
			13	SS	39		181				
							180				

Continued Next Page

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S21

2 OF 3 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4853030.3 ; E 292401.0
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 4 & 5, 2009

ORIGINATED BY DD
COMPILED BY VA
CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —										
	SAND and SILT, trace clay Dense Grey Moist to wet below a depth of 12.5 m		14	SS	35		178				
177.7											
16.3	SILT, trace sand, trace to some clay Stiff to hard Grey Wet		15	SS	31		177				
			16	SS	38		176		H		
			17	SS	36		175				0 0 88 12
			18	SS	14		174		○		
			19	SS	21		173				
			20	SS	10*		172				
169.0	Augers sinking below a depth of 24.4 m						171				
25.0	Dynamic Cone Penetration Test (DCPT) below a depth of 25.9 m						170		○		0 4 93 3
							169				
							168				
							167				
							166				
							165	184 407			

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S21

3 OF 3 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4853030.3 ; E 292401.0
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 4 & 5, 2009

ORIGINATED BY DD
COMPILED BY VA
CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —										
	Dynamic Cone Penetration Test (DCPT) below a depth of 25.9 m							621 835			
163.5											
163.2	SAND and SILT, some gravel, trace clay, containing cobbles (TILL) Very dense Grey Wet		21	SS	50/0.15						
30.8	END OF BOREHOLE										

NOTES:

1. Water level in open borehole at a depth of 6.1 m below ground surface (Elev. 187.9 m) upon completion of drilling.
2. A Dynamic Cone Penetration Test was carried out between depths of 25.9 m and 30.5 m .
3. Borehole backfilled with bentonite.

* SPT "N" value affected by sample disturbance due to groundwater inflow to the borehole.

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

Golder Associates

RECORD OF BOREHOLE No S22

1 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4853048.3 ;E 292442.8 | ORIGINATED BY DD
W.O. 05-20012 | | COMPILED BY VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 6, 2009

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 × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.7	GROUND SURFACE										
0.0 / 0.1	TOPSOIL										
	CLAYEY SILT, some to with sand, trace gravel (TILL) containing rootlets and topsoil to a depth of 0.6 m Stiff to hard Brown to grey Moist		1	SS	10		193				
			2	SS	10		192				
			3	SS	19						
			4	SS	21		191				0 15 53 32
			5	SS	59						
			6	SS	37		190				
			7	SS	61		189				
			8	SS	79	▽	188				
186.5							187				
7.2	SAND and SILT, trace gravel, trace clay (TILL) Very dense Grey Moist to wet below a depth of 7.6 m		9	SS	04/0.1[illegible]		186				9 43 41 7
			10	SS	00/0.2[illegible]		185				
183.3							184				
10.4	Silty SAND, trace clay Very dense Grey Wet		11	SS	84		183				
182.0							182				
11.7	SAND and SILT, trace clay Dense Grey Wet		12	SS	37		181				0 43 53 4
			13	SS	31		180				
178.9							179				
14.8											

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S22

2 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4853048.3 ;E 292442.8 | ORIGINATED BY DD
W.O. 05-20012 | | COMPILED BY VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 6, 2009

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 × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —										
	SILT, trace sand, trace to some clay Very stiff Grey Wet		14	SS	29		178				
176.3			15	SS	28		177				0 1 88 11
17.4	END OF BOREHOLE Dynamic Cone Penetration Test (DCPT) below a depth of 18.3 m						176				
							175				
							174				
							173				
172.4											
21.3	END OF DCPT Refusal to Further DCPT Penetration NOTES: 1. Water level in open borehole at a depth of 6.0 m below ground surface (Elev. 187.7 m) upon completion of drilling. 2. A Dynamic Cone Penetration Test was carried out between depths of 18.3 m and 21.3 m . 3. Borehole backfilled with bentonite.										

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

Golder Associates

RECORD OF BOREHOLE No S23

1 OF 1 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4853058.0 ;E 292390.6 | ORIGINATED BY CR
W.O. 05-20012 | | COMPILED BY VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 9, 2009

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)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
197.2	GROUND SURFACE							SHEAR STRENGTH kPa: O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)	WATER CONTENT (%) (10 20 30)		
0.0	Silty sand, some gravel, trace clay, containing debris, wood, brick and concrete fragments and rootlets (FILL)		1	SS	20		197				
196.5											
0.7	Compact Brown Moist to wet		2	SS	20		196		51		
195.8											
1.4	Clay, some sand, some gravel, containing debris, brick and concrete fragments (FILL) Very stiff Mottled brown and grey Moist		3	SS	26		195				
	CLAYEY SILT, trace to some sand, trace gravel (TILL), containing cobbles containing oxidation zones to a depth of 3.7 m Very stiff to hard Brown becoming grey below a depth of 3.7 m Moist		4	SS	42		194				
			5	SS	43						
			6	SS	78		193				0 12 55 33
			7	SS	24		192				
			8	SS	17		191				
			9	SS	98/0.25		190				
	Wet below a depth of 9.1 m		10	SS	50/0.10		189				
							188				
186.4			11	SS	100/0.1		187				
10.8	END OF BOREHOLE										

NOTES:

1. A 50 mm diameter monitoring well was installed at a depth of 10.7 m (Elev. 186.5 m).

Water level measurements:

Date	Depth	Elev.
On Completion	8.5 m	185.7 m
April 24, 2009	3.8 m	193.4 m
May 21, 2009	3.8 m	193.4 m
June 15, 2009	4.0 m	193.2 m
July 09, 2009	4.1 m	193.1 m

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Foundation Design

Golder Associates

RECORD OF BOREHOLE No S24

1 OF 1 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4852954.8 ;E 292466.5 | ORIGINATED BY DD
W.O. 05-20012 | | COMPILED BY VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 3, 2009

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)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
199.2	GROUND SURFACE							SHEAR STRENGTH kPa: O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)	WATER CONTENT (%) (10 20 30)		
0.0	TOPSOIL										
0.1	SILTY CLAY, some sand, trace gravel, (TILL) containing rootlets to a depth of 0.6 m Stiff to very stiff Brown to grey Moist		1	SS	14		199				
			2	SS	22		198				2 13 49 36
			3	SS	28				44		
			4	SS	26		197				
195.5			5	SS	26		196				
3.7	CLAYEY SILT some to with sand, trace gravel, containing cobbles below a depth of 9.8 m (TILL) Stiff to hard Grey Moist to wet		6	SS	13		195				
			7	SS	17		194				
			8	SS	18		193				
							192				
			9	SS	20	▽	191				
	Auger grinding at a depth of 9.8 m		10	SS	113		190				
	Wet below a depth of 10.7 m						189				
			11	SS	111/0.25		188				5 32 50 13
186.6							187				
12.7	END OF BOREHOLE										

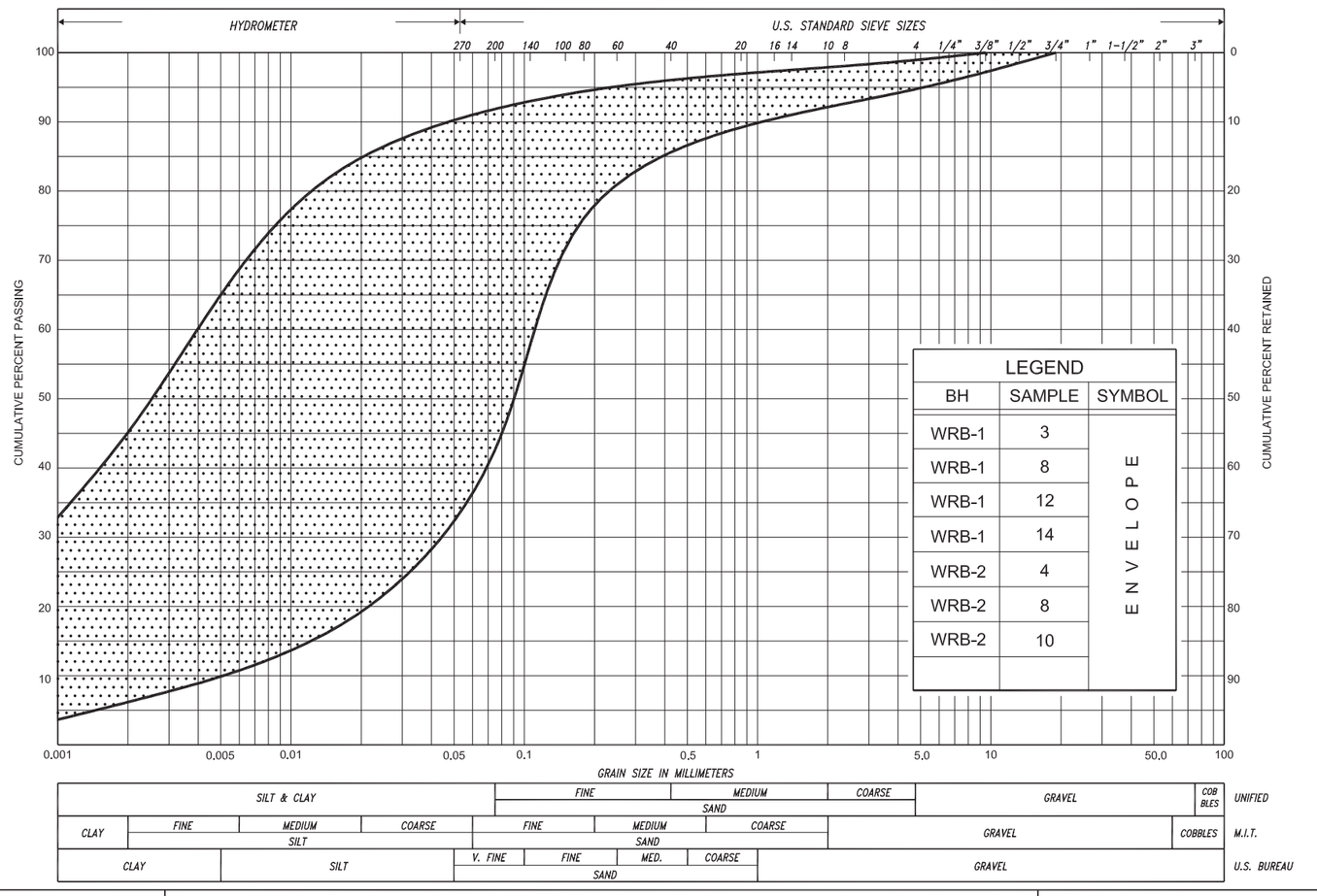
NOTES:

1. Water level in open borehole at a depth of 8.0 m below ground surface (Elev. 191.2 m) upon completion of drilling.

2. Borehole backfilled with bentonite.

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

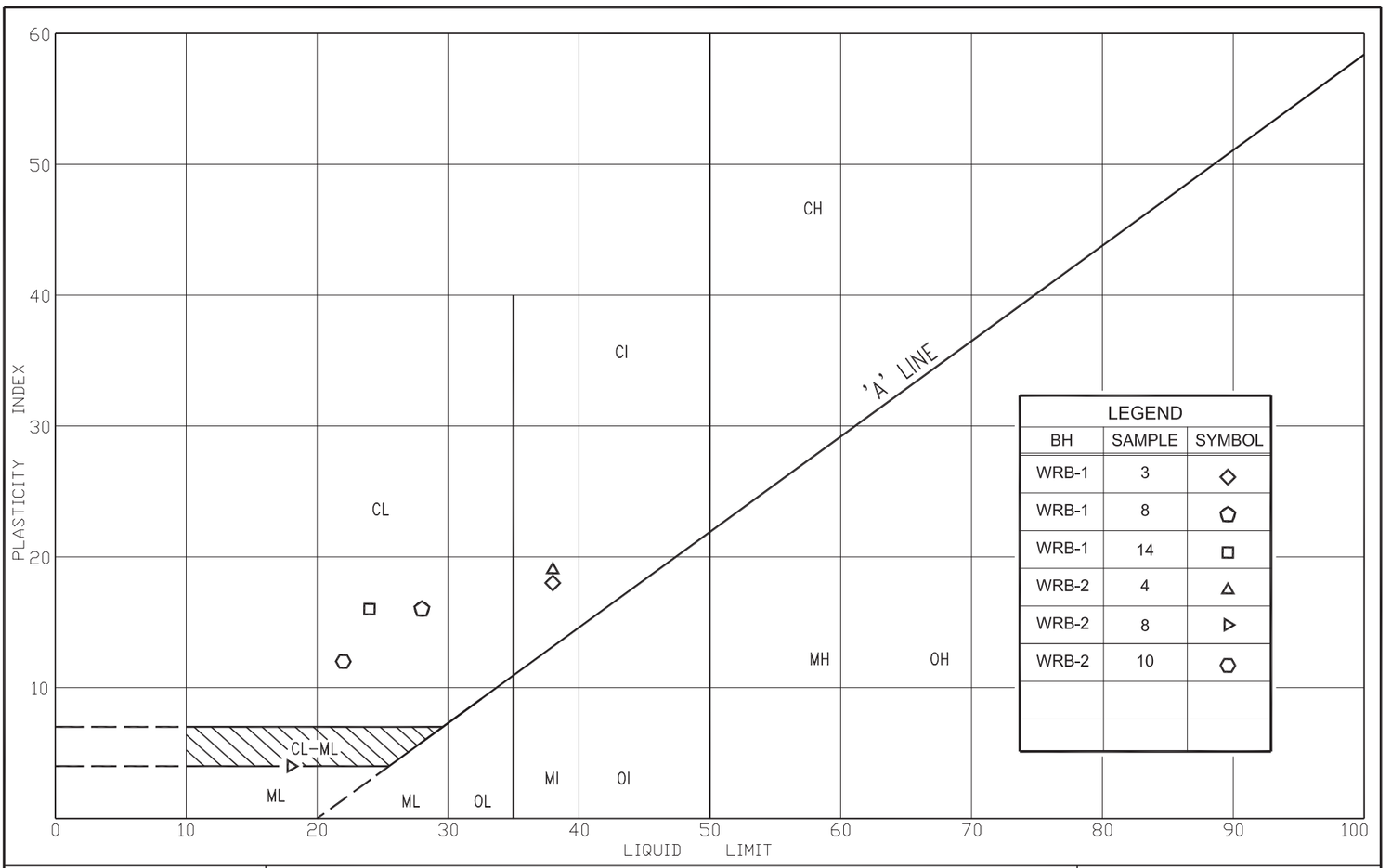


Ontario

GRAIN SIZE DISTRIBUTION

CLAYEY SILT to SILTY CLAY (TILL)

FIG No.	F-1
HWY:	427
G.W.P. No.	

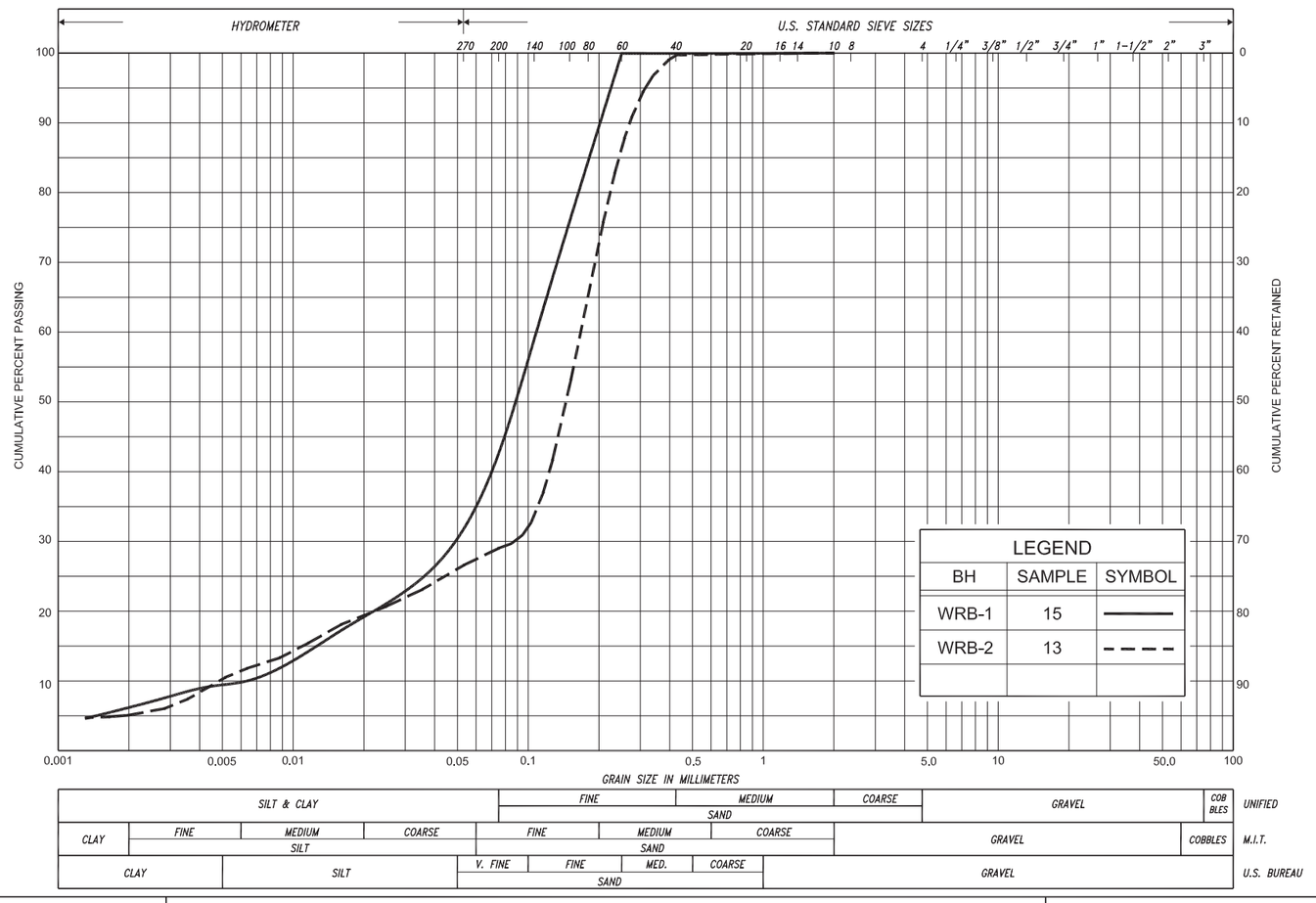


Ontario

PLASTICITY CHART

CLAYEY SILT to SILTY CLAY (TILL)

FIG No.	F-2
HWY:	427
G.W.P. No.	

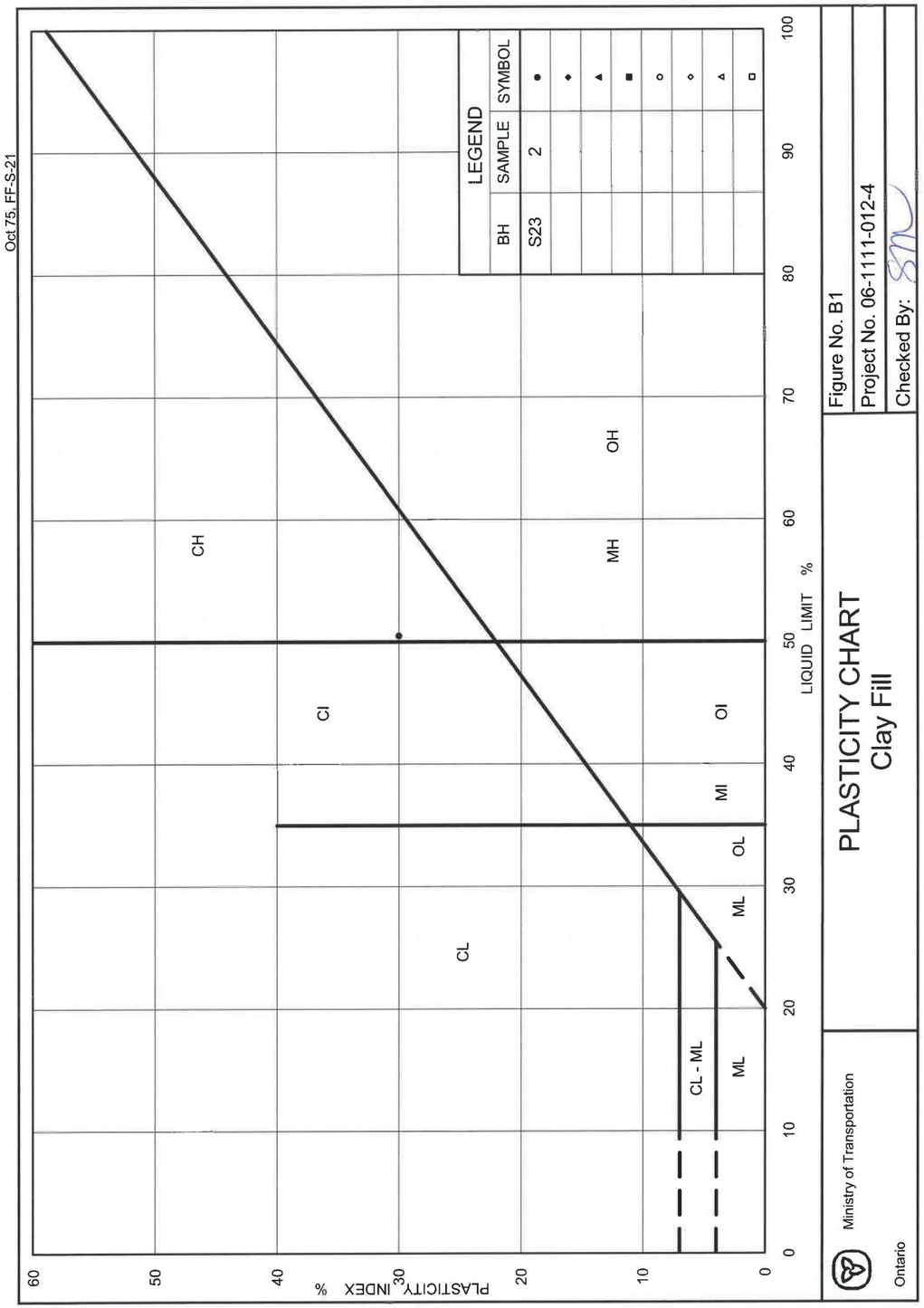


Ontario

GRAIN SIZE DISTRIBUTION

SILT, with sand to SILTY SAND

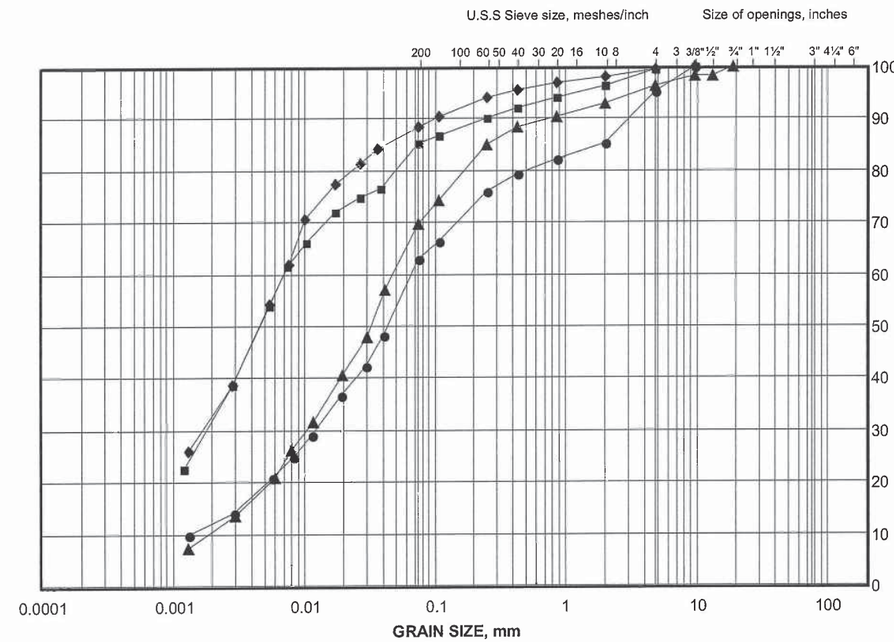
FIG No.	F-3
HWY:	427
G.W.P. No.	



GRAIN SIZE DISTRIBUTION TEST RESULTS

Upper Clayey Silt to Silty Clay Till

FIGURE B2-A



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S24	11	188.3
■	S22	4	191.1
◆	S23	6	188.2
▲	S20	7	189.1

Project Number: 06-1111-012-4

Checked By: SM

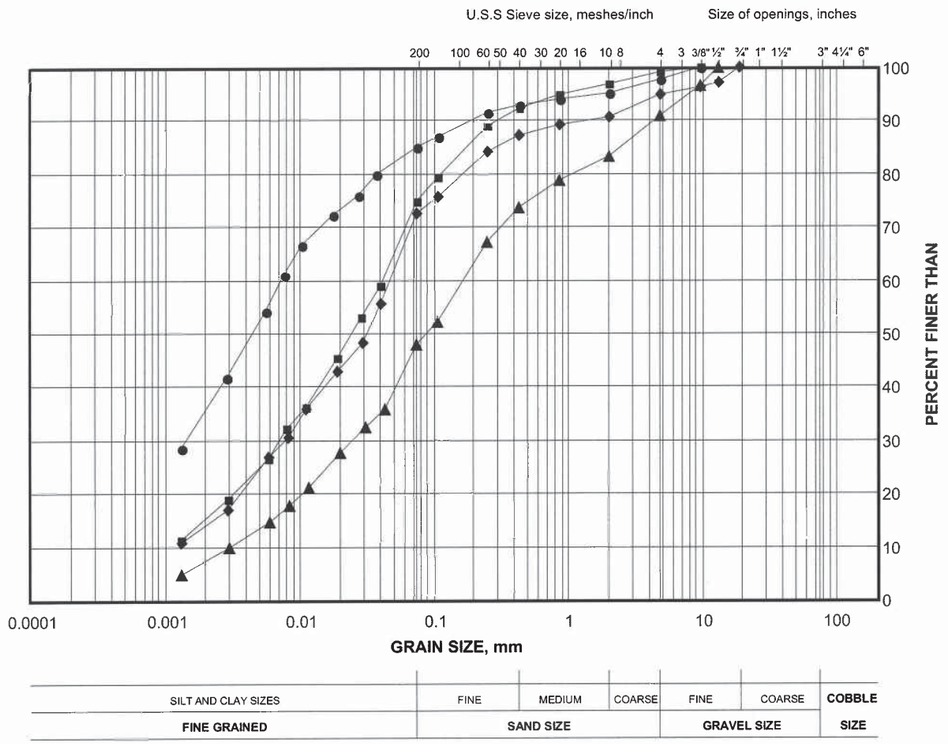
Golder Associates

Date: 04-Aug-09

GRAIN SIZE DISTRIBUTION TEST RESULTS

Upper Clayey Silt to Silty Clay Till

FIGURE B2-B



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

LEGEND

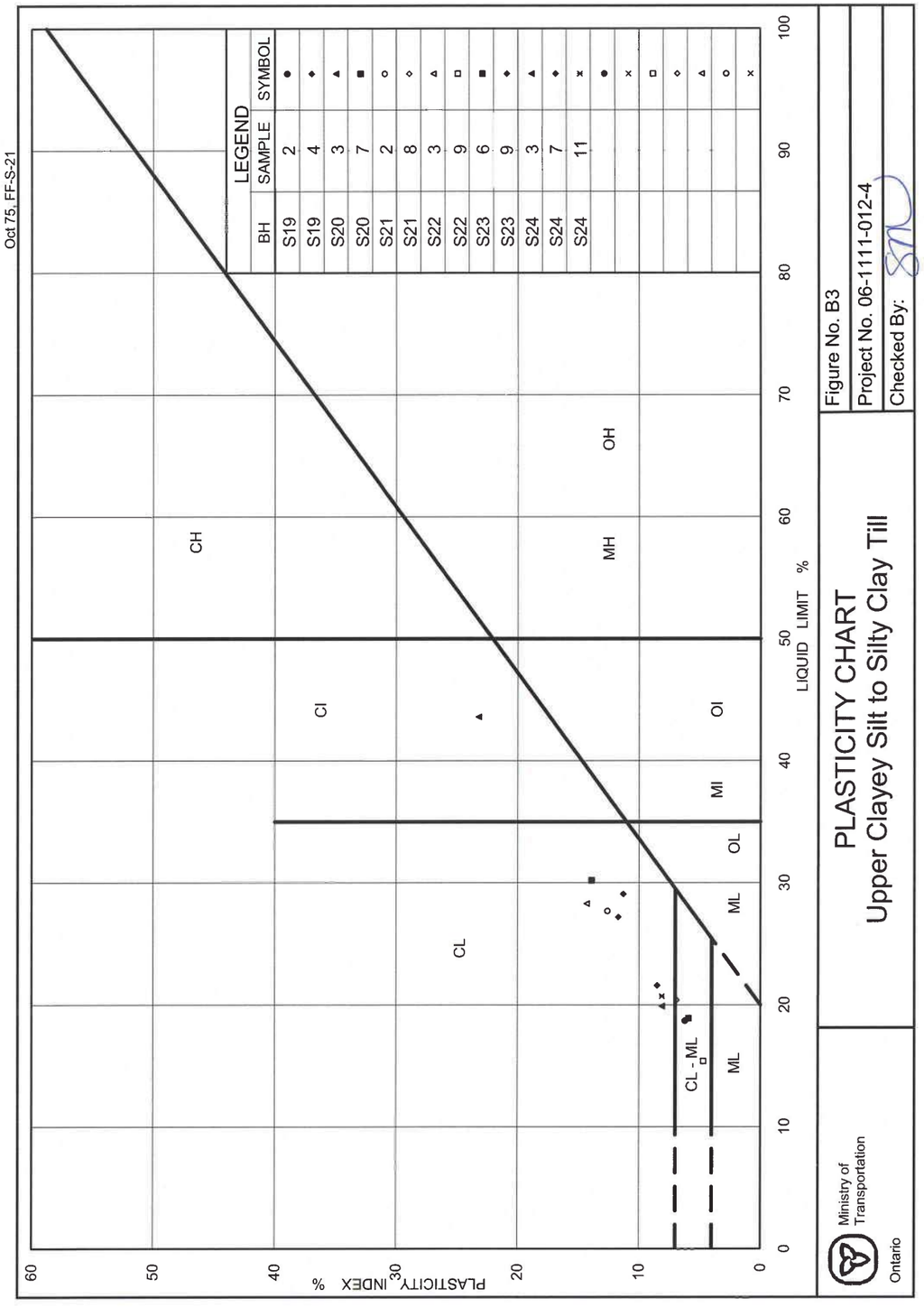
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S24	2	198.1
■	S19	8	187.5
◆	S21	8	187.9
▲	S22	9	186.0

Project Number: 06-1111-012-4

Checked By: SM

Golder Associates

Date: 04-Aug-09



PLASTICITY CHART

Upper Clayey Silt to Silty Clay Till

Figure No. B3

Project No. 06-1111-012-4

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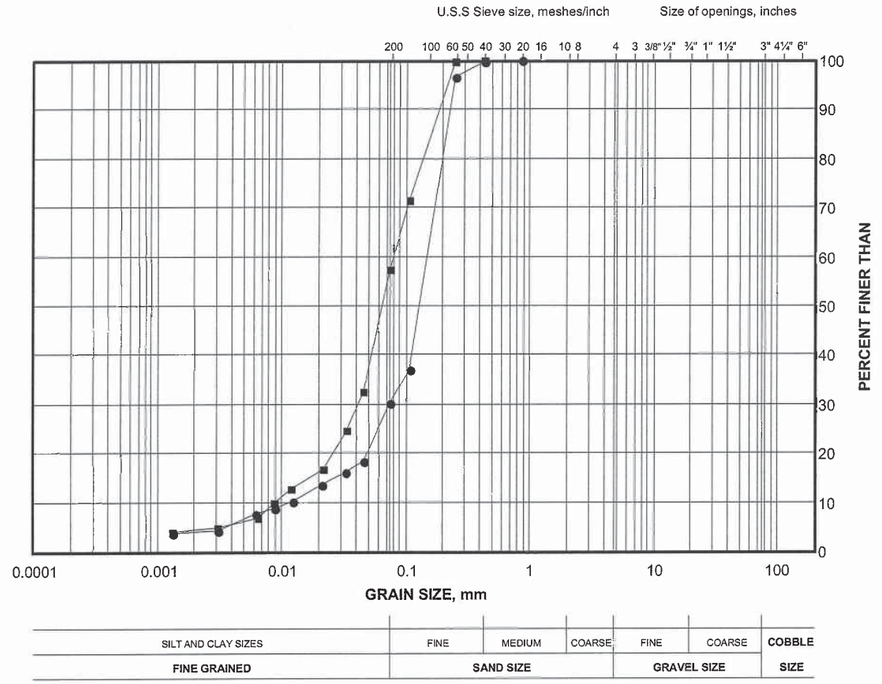
Ministry of Transportation Ontario

GRAIN SIZE DISTRIBUTION TEST RESULTS

Silty Sand to Sand and Silt

FIGURE B4



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S21	11	183.0
■	S22	12	181.2

Project Number: 06-1111-012-4

Checked By: SM

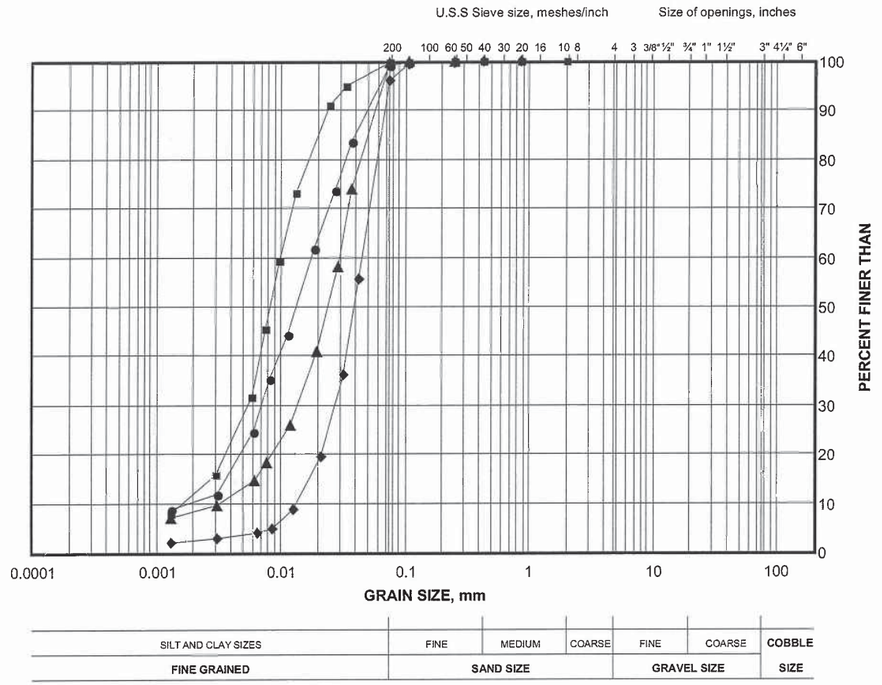
Golder Associates

Date: 29-May-09

GRAIN SIZE DISTRIBUTION TEST RESULTS

Silt

FIGURE B5



LEGEND

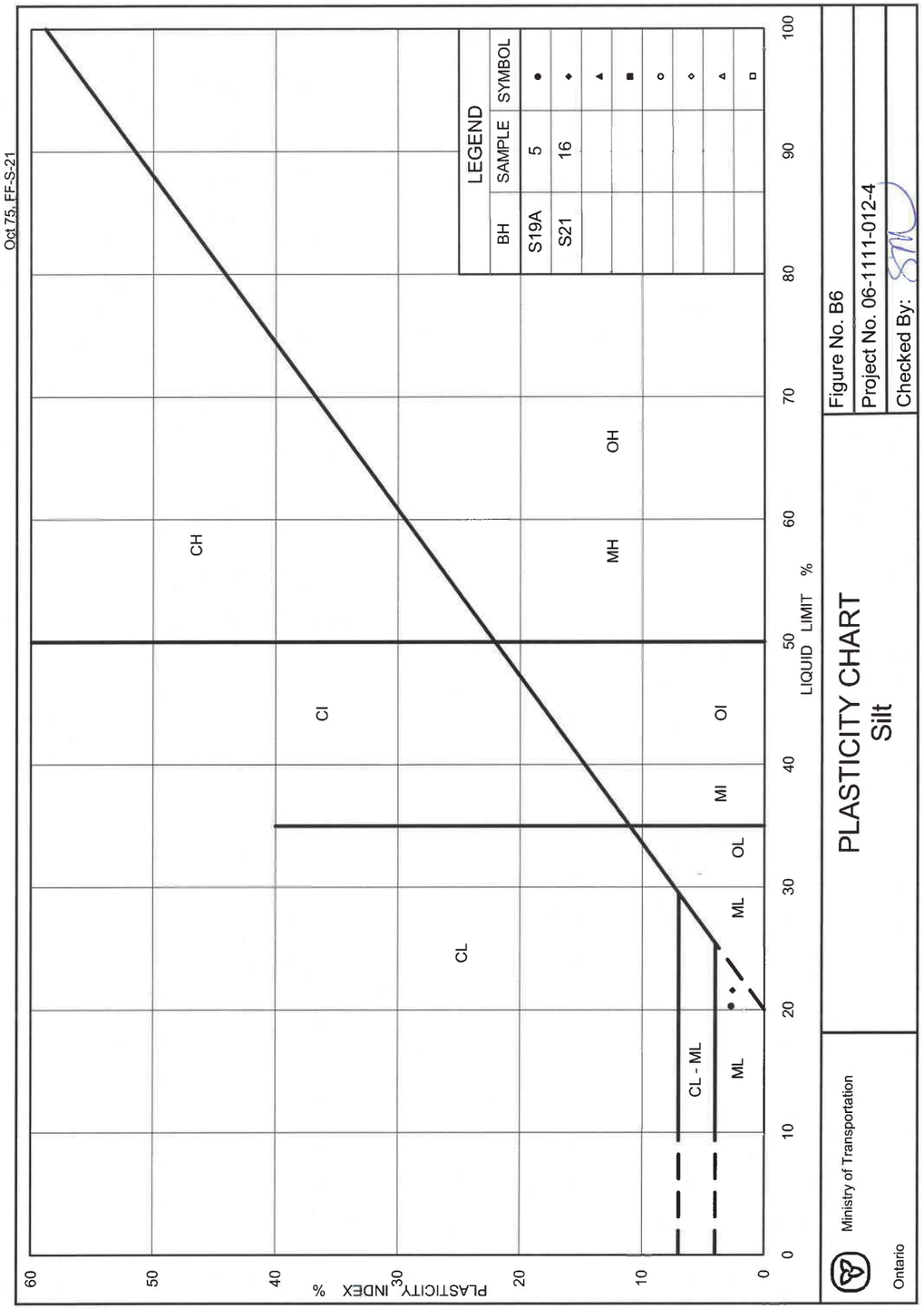
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S22	15	176.6
■	S21	17	174.0
◆	S21	20	169.3
▲	S19A	5	172.2

Project Number: 06-1111-012-4

Checked By: SM

Golder Associates

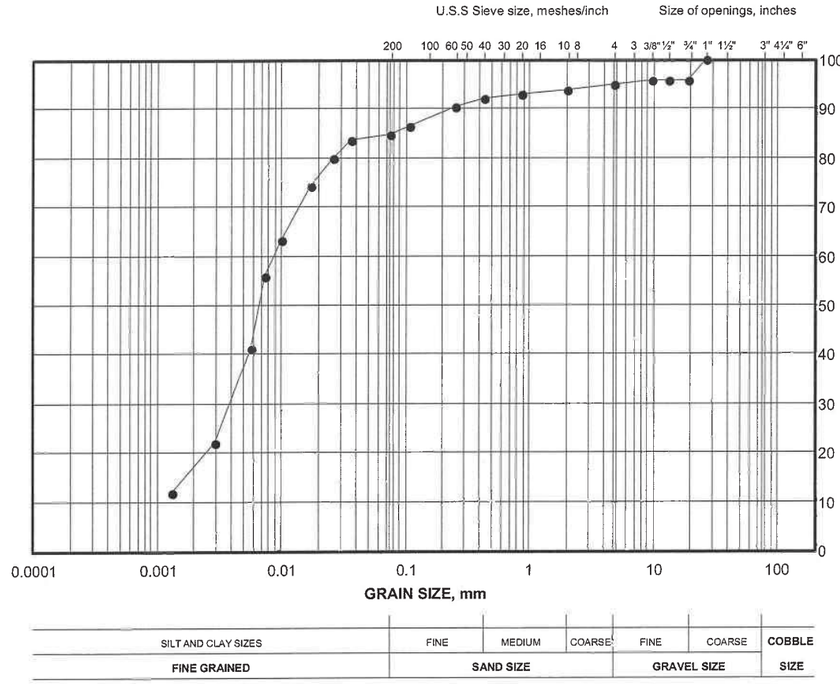
Date: 29-May-09



GRAIN SIZE DISTRIBUTION TEST RESULT

Clayey Silt Till (Lower Cohesive Till)

FIGURE B7



LEGEND

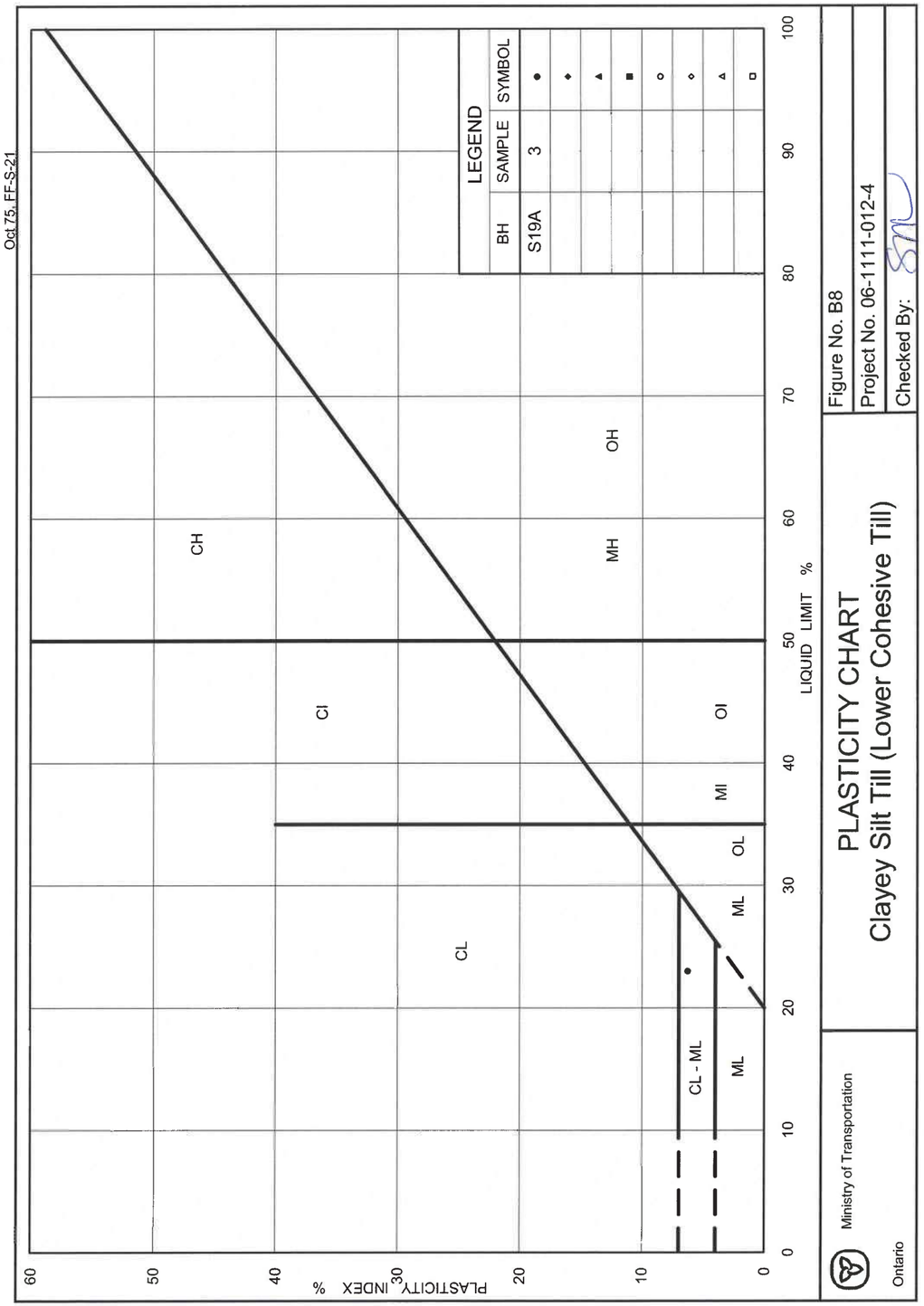
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S19A	3	178.3

Project Number: 06-1111-012-4

Checked By: SM

Golder Associates

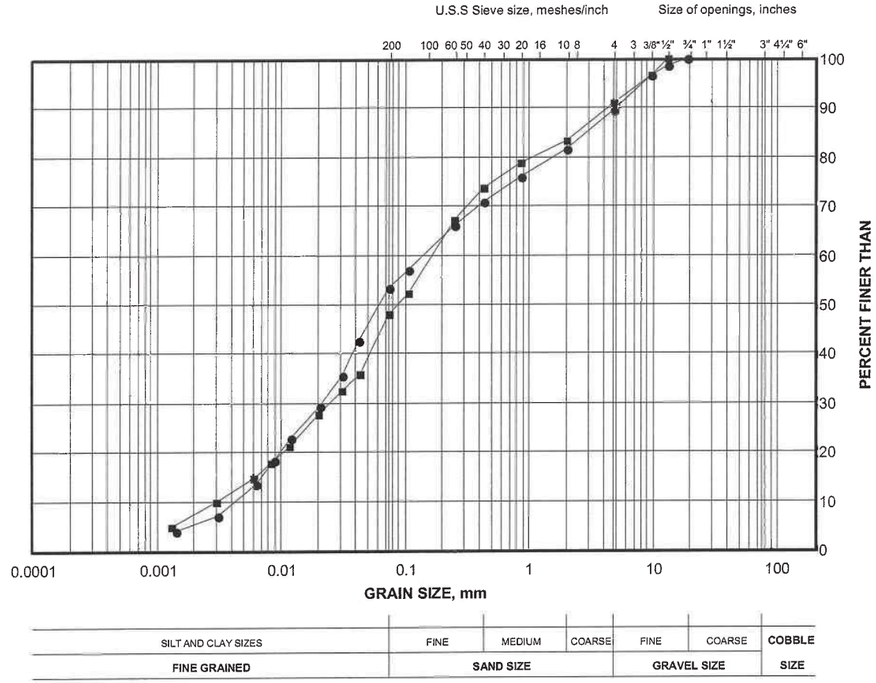
Date: 29-May-09



GRAIN SIZE DISTRIBUTION TEST RESULTS

Sand and Silt Till

FIGURE B9



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S19A	7	166.1
■	S22	9	186.0

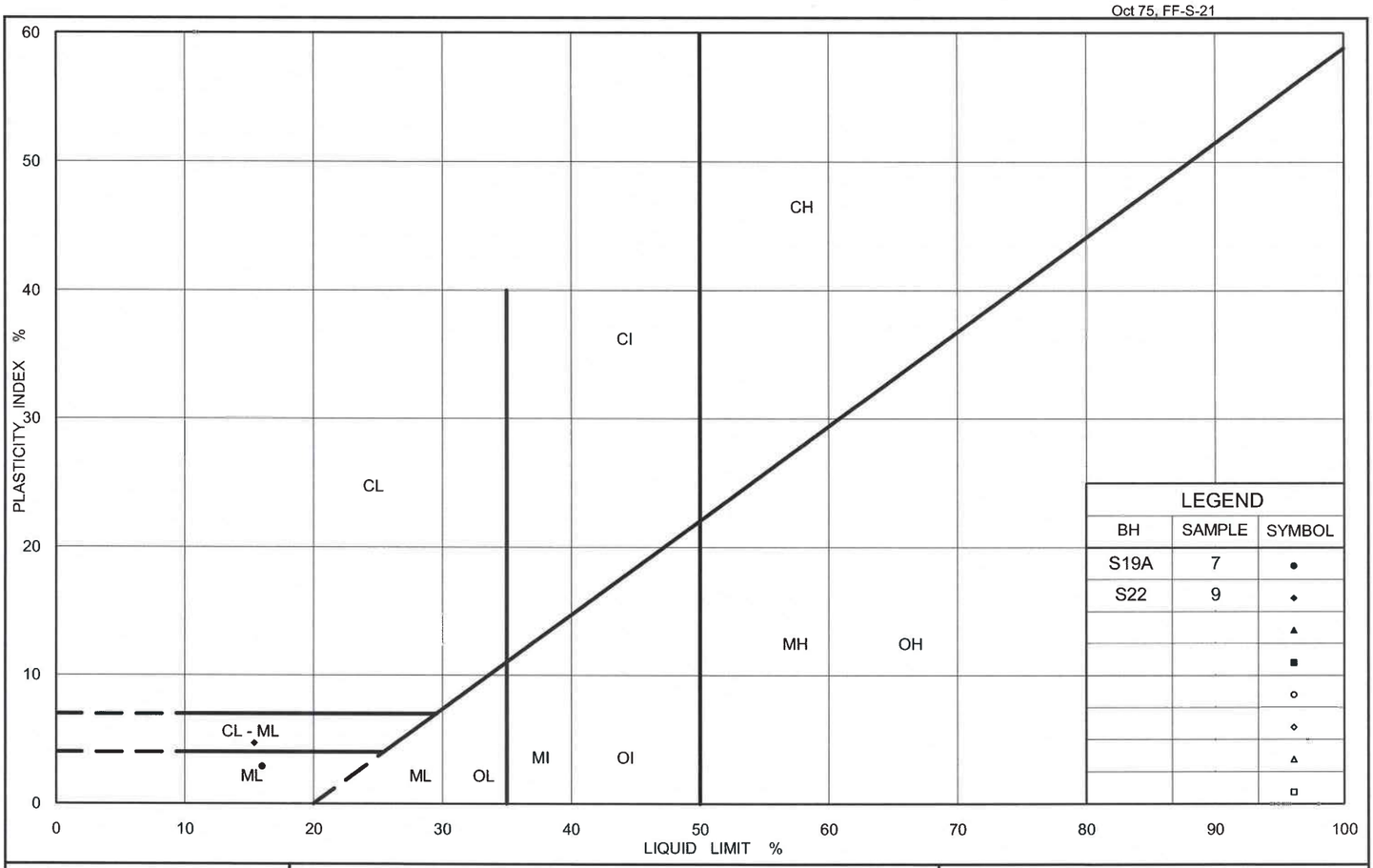
Project Number: 06-1111-012-4

Checked By:

Golder Associates

Date: 29-May-09

Oct 75, FF-S-21



Ministry of Transportation
Ontario

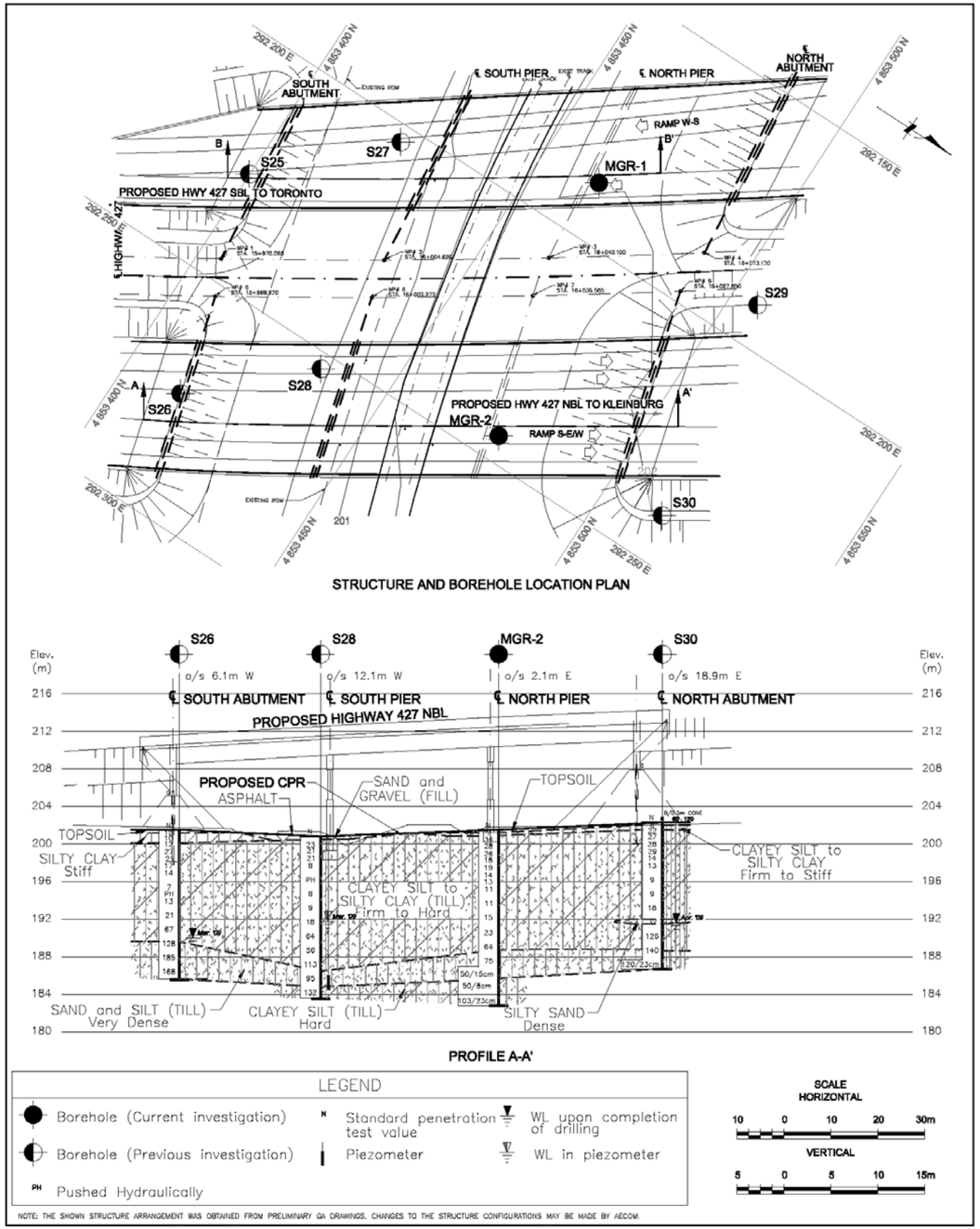
PLASTICITY CHART
Sand and Silt Till

Figure No. B10
Project No. 06-1111-012-4
Checked By: SM

Structure Type: Overpasses

Existing Ground Elevation across Boreholes: 202.3 m to 201.1 m

Complexity Rating: Medium



FOUNDATION INVESTIGATION

Site Description

The proposed structures are approximately 300 m south of the existing Major Mackenzie Dive and 250 m east of Huntington Road, in the City of Vaughan, Ontario. The twin CPR tracks are about 10 m north of the existing McGillivray Road and the land is generally in agricultural use north of the CPR tracks.

Borehole Information

Borehole No.	Foundation Unit	MTM NAD 83 Coordinates		Ground Surface Elevation (m)	Borehole/DCPT Depth (m)
		Northing (m)	Easting (m)		
Previous Investigation					
S25	South Abutment of SBL Structure	4,853,399.9	292,226.9	201.8	22.0
S26	South Abutment of NBL Structure	4,853,413.1	292,274.0	201.5	15.9
S27	South Pier of SBL Structure	4,853,423.2	292,203.6	201.1	34.1/38.4
S28	South Pier of NBL Structure	4,853,435.3	292,253.3	200.8	17.2
S29	North Abutments	4,853,505.8	292,191.2	202.0	18.7/19.7
S30	North Abutment of NBL Structure	4,853,513.2	292,239.8	202.3	15.6
Current Investigation					
MGR-1	North Pier of SBL Structure	4,853,463.3	292,187.8	202.1	17.1
MGR-2	North Pier of NBL Structure	4,853,474.8	292,244.6	201.5	18.7

Subsurface Condition

***Pavement Structure/ Fill, Topsoil*:** Boreholes S27 and S28 were advanced from the road surface and encountered a 0.1 m thick layer of asphalt overlying a 0.3 m to 0.4 thick layer of sand and gravel fill. All other boreholes encountered a 0.3 m thick layer of topsoil immediately below the ground surface.

***Clayey Silt to Silty Clay*:** A 0.5 m to 1.2 m thick deposit of clayey silt to silty clay was encountered below the topsoil in all boreholes, except Boreholes S27 and S28 at 0.3 m depth, Elevations 202.0 m and 201.2 m.

The SPT "N"-values ("N"-values) measured within the cohesive deposit range from 6 to 15 blows, suggesting a firm to stiff consistency.

***Clayey Silt to Silty Clay Till (Upper)*:** A 10.5 m to 18.5 m thick deposit of brown to grey clayey silt to silty clay till was encountered underlying the surficial layers of fill/clayey silt in all boreholes at 0.3 m to 1.5 m depths, Elevations 201.5 m and 200.1 m. Borehole S30 penetrated a 0.8 m thick pocket of silty sand within the cohesive till deposit at 10.4 m depth, Elevation 191.9 m.

The "N"-values measured within the till deposit range from 7 to 213 blows, suggesting a firm to hard consistency. An "N"-value of 32 blows was measured within the silty sand pocket, indicating a dense compactness. The results of grain size distribution analyses and Atterberg limits tests of selected cohesive till samples obtained during the current investigation are shown on Figures G-1 and G-2, respectively.

***Sand and Silt Till*:** A non-cohesive till deposit comprised of sand and silt was encountered underlying the cohesive till in all boreholes except Boreholes S25 and S27 at 11.9 m to 14.5 m depths, Elevations 189.6 m to 186.3 m. The deposit extends to 15.6 m to 18.4 m depths, Elevations 186.7 m to 183.7 m. Boreholes S26, S30 and MGR-1 were terminated within this deposit at practical refusal at 15.6 m to 17.1 m depths, Elevations 186.7 m to 185.0 m, penetrating it for about 1.9 m to 3.9 m. In other boreholes, the thickness of deposit varies between 1.5 m and 4.6 m.

The "N"-values measured within the non-cohesive till deposit range from 75 to 185 blows, indicating a very dense compactness. The result of a grain size distribution analysis and an Atterberg limits test of a selected sample of the non-cohesive till obtained during the current investigation are shown on Figures G-3 and G-4, respectively.

***Clayey Silt Till (Lower)*:** Boreholes S28, S29 and MGR-2 contacted a clayey silt till deposit below the non-cohesive till at 16.0 m to 18.4 m depths, Elevations 184.8 m to 183.7 m. All the boreholes were terminated within this deposit at 17.2 m to 18.7 m depths, Elevations 183.6 m to 182.8 m, penetrating it for about 0.3 m to 1.2 m. A DCPT was advanced from the bottom of Borehole S29 to practical refusal at 19.7 m depth, Elevation 182.4 m.

The "N"-values measured within this layer are greater than 100 blows, suggesting a hard consistency. The results of a grain size distribution analysis and an Atterberg limits test of selected sample of the lower cohesive till obtained during the current investigation are shown on Figures G-5 and G-6, respectively.

***Sand and Silt*:** Boreholes S25 and S27 penetrated a deposit of sand and silt below the upper cohesive till at 20.0 m and 18.0 m depths, Elevations 181.8 m and 183.1 m, respectively. Borehole S25 was terminated within this deposit penetrating it for about 2.0 m at 22.0 m depth, Elevation 177.9 m. In Borehole S27, the 5.7 m thick deposit extends to 23.7 m depth, Elevation 177.4 m.

"N"-values of 48 and 55 were measured within the sand and silt deposit, indicating a very dense compactness.

***Silt to Sandy Silt*:** Borehole S27 contacted a 10.7 m thick deposit of silt to sandy silt layer below the sand and silt deposit at 23.7 m depth, Elevation 177.4 m. A DCPT was advanced from the bottom of Borehole S27 to practical refusal at 38.4 m depth, Elevation 162.7 m.

The "N"-values measured within this deposit range from 13 to 37 blows, indicating a compact to dense compactness.

Groundwater Conditions

Sub-artesian condition was noted in Borehole S28 within the sand and silt till deposit with groundwater level measured at 8.5 m depth, Elevation 192.3 m on May 13, 2009. The water level in other open boreholes upon completion of drilling was at 10.7 m to 16.6 m depths, Elevations 191.6 m to 185.2 m. For further details refer to Table A2 of this report.

FOUNDATION RECOMMENDATIONS

The following site-specific foundation recommendations are for preliminary design and planning purposes only .They require refinement during detail design. Project-wide foundation recommendations, design assumptions and limitations are contained in Part B of this report. The proposed twin three-span overpass structures will carry Highway 427 Northbound and Southbound Lanes over re-aligned CPR tracks and McGillivray Road.

Foundation Option	Advantages	Disadvantages	Relative Costs	Risks/Consequences
Spread footings on stiff to very stiff clayey silt till or "Granular A" pad	• Conventional construction.	• Precludes use of integral abutments; • Provides relatively low bearing capacity.	• Lower relative cost compared to deep foundation options.	• Disturbing of subgrade due to excavation; • Risk of improper compaction of "Granular A" pad
Driven steel H-Piles to found within "100-blow" soils	• Allows for integral abutment design.	• Piles may encounter obstructions during driving.	• More costly than spread footings.	• Risk of not achieving capacities due to the variable thickness of the "100-blow" soil layer; • Minor potential for pile damage/ deflection if obstructions are encountered during pile driving.
Caissons founded within "100-blow" soils	• Provides higher capacity than driven piles.	• Precludes use of integral abutments; • Drilling mud and tremie techniques may be required for construction.	• More costly than driven steel H-piles.	• Risk of presence of non-cohesive water bearing layers within the cohesive till; • Risk of loosening or disturbing founding soils at base of caissons.

Spread Footings

Spread footings founded on native soils were considered to support the abutments and pier. However, the bearing resistances at normal depths could be less than required for design as indicated by the preliminary geotechnical resistances at the ground interface presented in the following table.

Foundation Unit	Founding Stratum	Axial Geotechnical Resistance < 25mm settlement		Highest Founding Elevation within Native Soils (m)
		Factored ULS (kPa)	SLS (kPa)	
South Abutments	Stiff to Very Stiff Clayey Silt Till	300	200	200.0
South Piers				200.0
North Piers				200.0
North Abutments				200.0

Consequently, the alternative of spread footings on a Granular A pad of minimum 2 m thickness is recommended for preliminary design purposes assuming a factored geotechnical resistance at ULS of 900 kPa and geotechnical resistance at SLS of 350 kPa.

Driven Steel H-Pile/ Steel Pipe Piles

Steel H-piles 310x110 and Steel pipe piles, 324 mm (12 ¾ in) outer diameter and 6 mm (1/4 in) thickness, driven to levels provided below within the hard/very dense till soils may be used to support the foundation elements. The preliminary geotechnical resistances and tip elevations are as follows:

Foundation Unit	Axial Geotechnical Resistance		Approximate Pile Tip Elevation (m)
	Factored ULS (kN)	SLS (kN)	
South Abutments	1,600	1,200	188
South Piers	1,200	1,000	188
North Piers	1,600	1,200	186
North Abutments	1,600	1,200	188

Driven piles should be controlled by Hiley Formula as per MTO Drawing SS-103-11 from 2 m above the approximate pile tip elevations, employing a maximum load of twice the factored geotechnical resistance at ULS per pile. Piles should not be driven more than 1 m deeper than the approximate pile tip elevation due to the limited thickness of the bearing layer.

Caissons

Caissons founded within the hard/very dense till deposits may be considered for support of the abutments and piers. The preliminary geotechnical resistances are as follows:

Foundation Unit	Caisson Diameter (m)	Axial Geotechnical Resistance		Caisson Base Elevation (m)
		Factored ULS (kN)	SLS (kN)	
South Abutments	1.2	5,000	4,000	188
	1.5	6,500	5,000	
South Piers	1.2	4,000	3,000	188
	1.5	5,200	4,200	
North Piers	1.2	5,000	4,000	186
	1.5	6,500	5,000	
North Abutments	1.2	5,000	4,000	188
	1.5	6,500	5,000	

Caissons should not extend more than 2 m below the caisson tip elevation due to the presence of a noncohesive layer below the bearing layer. For the same reason, the risks of installation problems due to dewatering issues related to the underlying noncohesive layer should be considered for caisson selection and design.

Recommended Foundation Alternative

The recommended foundation alternative at this site is driven steel H-piles into the hard/very dense till soils for the abutments and for the piers. Driven piles are preferred over caissons.

Structure Abutments and Approaches

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

Construction of the underpass will require placement of up to about 9.0 m and 11.5 m of fill within the limits of the south and north approach embankments.

Structure Retaining Walls/Wing Walls

The earth retaining walls for this structure may include Cast-in-Place (CIP) or RSS Walls. For RSS walls the facing should be founded on granular pad or CIP leveling pad. The retaining walls geometry should conform to High Appearance and High Performance in accordance with MTO.DSM 9.70 and current RSS Design Guidelines. The CIP retaining walls should be designed in conformance with spread footing recommendations in this report.

Stability of Approach Embankments

Approach embankments constructed of suitable earth fill or granular fill and up to about 11.5 m high are expected to be stable at side slopes formed at a maximum gradient of 2H:1V. Where approach embankments are equal to or greater than 8.0 m in height, a minimum 2.0 m wide berm should be provided such that the uninterrupted slope height does not exceed 8.0 m.

Settlement of Approach Embankments

The magnitude settlement within founding soils is estimated to be in the order of 75 mm to 100 mm. Based on preliminary estimations, consideration can be given to preloading the approach embankments for a period of six (6)) months to mitigate post-construction settlements. Alternatively and to accelerate the settlement process, consideration may be given to employing a 2.0 m high surcharge, subject to further assessment during detail design to ensure that adequate Factor of Safety against slope instability is maintained. Downdrag loads should be considered during the detail design for deep foundations.

Construction Considerations

Excavation

The construction of pier footings/ pile caps will require excavations up to about 2 m below the existing ground surface. These excavations will be made generally through surficial firm clayey silt and into very stiff to hard clayey silt till which are classified as Type 3 soils in accordance with OHSA. Temporary unsupported excavations above the prevailing groundwater in these soils should be made with side slopes no steeper than 1H:1V.

Surface Water / Groundwater Control

Surface water run-off should be diverted away from the excavations at all times.

The prevailing groundwater should be maintained a minimum of 0.5 m below the base of excavations. It is expected that excavations for construction of piers/pile caps will be above the prevailing groundwater level. The minimal inflow of groundwater into excavations is expected to be handled by pumping from properly filtered sumps placed at the base of the excavations.

Pile Installation / Caisson Construction

It is anticipated that cobbles and/or boulders will be encountered within the till deposit, which may adversely impact the installation of steel H-piles or caissons. Piles should be equipped with flange plates or approved driving shoes.

If consideration is being given to caisson foundations for support of the abutments and north piers, where encountered, water-bearing non-cohesive native soils should be expected to run or flow into the caisson hole during and after the drilling for the caisson foundations. As such, appropriate equipment and procedures (including use of temporary or permanent caisson liners) would be required to minimize ground loss during drilling and concrete placement and to permit inspection and cleaning of the caisson bases. Sub-artesian condition was noted within the non-cohesive till deposit and as such consideration should be given to using drilling mud and tremie concrete placement technique to minimize the potential for basal heave.

Railway Proximity Considerations

It should be anticipated that works near the railway will require monitoring of vibrations and settlements.

Recommendation for Additional Work

Since the founding stratum thickness is variable across the site, it is recommended that for the additional subsurface investigation during the detail design consideration be given to sampling intervals of 0.75 m close and below to the approximate tip elevations (approximately between Elevations 186 m and 180 m) to more accurately define the thickness of competent (“100 blow”) layer. It is also recommended to carry out additional in situ and laboratory testing to determine the compressibility parameters of the upper cohesive till deposit and settlement mitigation options.

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No MGR-1 1 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 853 463.3 N; 292 187.8 E ORIGINATED BY F.P.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 3.5m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE November 11, 2015 CHECKED BY A.V.

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 ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (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
202.1	Ground Surface										
0.0 / 201.8	TOPSOIL		1	SS	6		202				
0.3	SILTY CLAY Firm to stiff Brown and grey Moist to wet		2	SS	10		201				
200.7											
1.4	CLAYEY SILT to SILTY CLAY, trace to with sand, trace gravel Stiff to hard Brown becoming grey below a depth of 3.8m Moist (TILL)		3	SS	30						7 9 43 41
			4	SS	29		200				
			5	SS	20		199				
			6	SS	18		198				
			7	SS	15		197				5 10 41 44
			8	SS	26						
			9	SS	19		196				
			10	SS	9		195				
				FV			194	+			
			11	SS	15		193				
							192				
			12	SS	29		191			46	5 24 48 23
			13	SS	41		190				
188.9							189				
13.2	SILT and SAND, trace clay, trace gravel Very dense Grey Moist (TILL)		14	SS	101/25cm		188				5 38 49 8
187.1	Cont'd										

ON MTO_NEW LOGO HWY 427 15TF013A-REV.GPJ ON_MOT.GDT 14/01/2016 10:29:16 AM

+7, ×5: Numbers refer to Sensitivity (20, 15, 10, 5) (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No MGR-1 2 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 853 463.3 N; 292 187.8 E ORIGINATED BY F.P.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 3.5m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE November 11, 2015 CHECKED BY A.V.

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 ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (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
187.1											
15.0	(Cont'd) SAND and SILT, trace clay, trace gravel Very dense Grey Moist (TILL)		15	SS	103/15cm		187				
185.0			16	SS	100/23cm		186				
17.1	End of borehole Note: 1. Groundwater level cannot be measured upon completion of drilling due to utilization of mud rotary drilling technique.						185				

ON MTO_NEW LOGO HWY 427 15TF013A-REV.GPJ ON_MOT.GDT 14/01/2016 10:29:16 AM

+7, ×5: Numbers refer to Sensitivity (20, 15, 10, 5) (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No MGR-2 1 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 853 474.8 N; 292 244.6 E ORIGINATED BY F.P.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 3.8m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE November 10, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
201.5	Ground Surface										
0.0 / 201.2	TOPSOIL		1	SS	7		201				
0.3 / 200.7	SILTY CLAY, trace sand Firm Brown and grey Moist		2	SS	34						
0.8	CLAYEY SILT to SILTY CLAY, trace to with sand, trace gravel Stiff to hard Brown becoming grey below a depth of 3.0m Moist to wet (TILL)		3	SS	28		200				
			4	SS	26		199				2 3 32 63
			5	SS	18						
			6	SS	19		198				
			7	SS	14		197				1 6 43 50
			8	SS	13		196				
			9	SS	11		195				4 21 48 27
				FV				+			
			10	SS	11		194				
			11	SS	15		193				
			12	SS	23		192				
			13	SS	64		191				
188.3							190				
13.2	SILT and SAND, trace clay, trace gravel Very dense Grey Wet (TILL)		14	SS	75		189				
186.5	Cont'd						188				
							187				

+7, ×5: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No MGR-2 2 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 853 474.8 N; 292 244.6 E ORIGINATED BY F.P.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 3.8m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE November 10, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
186.5											
15.0	(Cont'd) SILT and SAND, trace clay, trace gravel Very dense Grey Wet (TILL)		15	SS	50/15cm		186				
183.8			16	SS	50/8cm		185				
17.7	CLAYEY SILT, some sand, trace gravel Hard Grey Moist (TILL)		17	SS	103/23cm		184				
182.8							183				3 11 67 19
18.7	End of borehole Note: 1. Groundwater level cannot be measured upon completion of drilling due to utilization of mud rotary drilling technique.										

ON MTO_NEW LOGO HWY 427 15TF013A-REV.GPJ ON_MOT.GDT 14/01/2016 10:29:17 AM

+7, ×5: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No S25

1 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4853399.9 ;E 292226.9
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 12, 13 & 16, 2009

ORIGINATED BY CR
COMPILED BY PKS/VA
CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
201.8	GROUND SURFACE										
0.0 / 201.5	TOPSOIL										
0.3 / 200.3	SILTY CLAY, some sand, trace gravel (Reworked to a depth of 0.8 m) Stiff Brown to grey Moist		1	SS	13		201				
			2	SS	10						
1.5 / 198.1	SILTY CLAY, trace sand, trace gravel (TILL) Very stiff Brown to grey Moist		3	SS	23		200		44		
			4	SS	23		199				
			5	SS	25						
3.7	CLAYEY SILT, trace to some sand, trace to some gravel (TILL) Stiff to hard Grey Moist to wet		6	SS	17		198				
			7	TO	PH		197		+ >100		
			8	SS	14		196				4 12 56 28
			9	SS	15		195				
			10	TO	PH		194				
	Auger grinding between a depth of 10.7 m to 11.3 m		11	SS	49		193				
	Auger grinding between a depth of 12.2 m to 12.8 m		12	SS	135		192				
	Auger grinding between a depth of 13.1 m to 14.3 m		13	SS	213		191				
							190				
							189				
							188				
							187				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S25

2 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4853399.9 ;E 292226.9
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 12, 13 & 16, 2009

ORIGINATED BY CR
COMPILED BY PKS/VA
CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —										
	CLAYEY SILT, trace to some sand, trace to some gravel (TILL) Stiff to hard Grey Moist to wet		14	SS	140/0.15		186				
	Auger grinding between a depth of 16.5 m to 16.8 m					▽	185				
	Auger grinding between a depth of 17.4 m to 17.8 m						184				
181.8			15	SS	102		183		○		23 16 44 17
20.0	SAND and SILT, trace gravel Very dense Grey Wet						182				
179.9			16	SS	55		181				
22.0	END OF BOREHOLE						180				

NOTES:

1. Water level in open borehole at a depth of 16.6 m below ground surface (Elev. 185.2 m) upon completion of drilling.
2. Borehole backfilled with bentonite.

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

Golder Associates

RECORD OF BOREHOLE No S26

1 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4853413.1 ;E 292274.0 | ORIGINATED BY CR
W.O. 05-20012 | | COMPILED BY VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 11 & 12, 2009

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 (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED, 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L (WATER CONTENT (%) 10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
201.5	GROUND SURFACE										
0.0 / 201.2	TOPSOIL										
0.3	SILTY CLAY, some gravel, some sand, containing organics and rootlets (Reworked to a depth of 0.8 m) Stiff Brown Moist		1	SS	15		201				
			2	SS	10						
200.1							200				
1.4	CLAYEY SILT, some sand, trace to some gravel (TILL), containing oxidation zones Stiff to very stiff Brown Moist		3	SS	12						
			4	SS	27		199				
			5	SS	21						
197.8							198				
3.7	SILTY CLAY, trace to some sand, trace gravel (TILL) Stiff to very stiff Grey Moist to wet		6	SS	17						
			7	SS	14		197			43	
	Wet below a depth of 6.1 m										
			8	SS	7		196				
			9	TO	PH			>100			
			10	SS	13		195				
192.8							194				
8.7	CLAYEY SILT, some sand, trace gravel, containing cobbles and boulders (TILL) Very stiff to hard Grey Moist		11	SS	21		193				
							192				0 17 57 26
			12	SS	67	▽	191				
189.6							190				
11.9	SAND and SILT, trace clay, trace gravel (TILL) Very dense Grey Moist		13	SS	128		189				
							188				
			14	SS	185		187				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S26

2 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4853413.1 ;E 292274.0 | ORIGINATED BY CR
W.O. 05-20012 | | COMPILED BY VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 11 & 12, 2009

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 (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED, 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L (WATER CONTENT (%) 10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —										
185.7	SAND and SILT, trace clay, trace gravel (TILL) Very dense Grey Moist		15	SS	168		186				
15.9	END OF BOREHOLE										

NOTES:

1. Water level in open borehole at a depth of 11.5 m below ground surface (Elev. 190.0 m) upon completion of drilling.

2. Borehole caved to a depth of 13.0 m below ground surface (Elev. 188.5 m) upon removal of augers and backfilled with bentonite.

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

Golder Associates

RECORD OF BOREHOLE No S27

1 OF 3 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4853423.2 ;E 292203.6
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 13, 2009

ORIGINATED BY SB
COMPILED BY JB/VA
CHECKED BY SMM

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	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
201.1	GROUND SURFACE						201	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100						
0.0	Asphalt													
200.6	Sand and gravel (FILL) Compact Brown Moist													
0.5	SILTY CLAY, trace gravel, trace sand (TILL) Stiff to very stiff Brown Moist		1	SS	15		200							
			2	SS	29									
	Becoming grey at a depth of 2.2 m		3	SS	17		199					44		
			4	SS	13		198							
196.5			5	SS	13		197							
4.6	CLAYEY SILT, with sand, trace to some gravel (TILL) Stiff to hard Grey Moist		6	SS	9		196							
			7	SS	10		195	>145						
			8	SS	14		194	>145						
			9	SS	21		193							
			10	SS	74		192							
			11	SS	168		191							
			12	SS	128		190							
							189							24 24 44 8
							188							
							187							

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S27

2 OF 3 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4853423.2 ;E 292203.6
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 13, 2009

ORIGINATED BY SB
COMPILED BY JB/VA
CHECKED BY SMM

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	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100						
	CLAYEY SILT, with sand, trace to some gravel (TILL) Stiff to hard Grey Moist		13	SS	77		186							4 29 47 20
183.1			14	SS	61		185							
18.0	SAND and SILT, trace clay Dense to very dense Grey Moist to wet		15	SS	55		184							
			16	SS	48		183							
177.4							182							
23.7	Sandy SILT, trace clay Compact to dense Grey Moist to wet		17	SS	37		181							
			18	SS	27		180							
172.1							179							
29.0	SILT, trace clay Compact Grey Moist to wet						178							
							177							
							176							
							175							
							174							
							173							
							172							

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S27

3 OF 3 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4853423.2 ;E 292203.6
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 13, 2009

ORIGINATED BY SB
COMPILED BY JB/VA
CHECKED BY SMM

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)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —							SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)					
	SILT, trace clay Compact Grey Moist to wet						171				WATER CONTENT (%) (10 20 30)		
			19	SS	28		170			○			0 1 90 9
							169						
							168						
167.0			20	SS	13		167						
34.1	END OF BOREHOLE Dynamic Cone Penetration Test (DCPT) was performed between depths of 33.8 m and 38.4 m						166						
							165						
							164	165					
							163	195 230 258					
162.7													
38.4	END OF DCPT NOTES: 1. Borehole open to 25 m and dry upon completion of drilling. 2. A Dynamic Cone Penetration Test was carried out between depths of 33.8 m and 38.4 m . 3. Borehole backfilled with bentonite.												

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S28

1 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4853435.3 ;E 292253.3
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 17, 2009

ORIGINATED BY SB
COMPILED BY JB/VA
CHECKED BY SMM

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)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
200.8	GROUND SURFACE							SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)					
0.0	Asphalt						200				WATER CONTENT (%) (10 20 30)		
0.3	Sand and gravel, trace silt (FILL) Brown Moist						199						
	CLAYEY SILT, trace gravel, trace sand (TILL) Very stiff Brown and grey Moist		1	SS	23		198						
			2	SS	21								
			3	SS	21		197	>145					
197.8													
3.1	SILTY CLAY, trace sand, trace gravel (TILL) Stiff Grey Moist		4	SS	8		196						
			5	TO	PH		195	>145					
			6	SS	8		194	+ × >145					
			7	SS	9		193						
192.0							192	>145 >145					
8.8	CLAYEY SILT, with sand, trace gravel (TILL) Very stiff to hard Grey Moist		8	SS	18		191						
			9	SS	64		190	○					3 30 55 12
			10	SS	56		189						
			11	SS	113		188						
186.3							187						
14.5							186						

Continued Next Page

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

RECORD OF BOREHOLE No S28

2 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4853435.3 ;E 292253.3 | ORIGINATED BY SB
W.O. 05-20012 | | COMPILED BY JB/VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 17, 2009

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 + FIELD VANE ● QUICK TRIAXIAL × REMOULDED)	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	10 20 30		
	SAND and SILT, trace gravel, trace clay (TILL) Very dense Grey Moist		12	SS	95		185		H		
184.8											
16.0	CLAYEY SILT, some sand, trace gravel (TILL) Hard Grey Moist		13	SS	132		184		○		2 12 59 27
183.6											
17.2	END OF BOREHOLE										

NOTES:

1. A 50 mm diameter monitoring well was installed at a depth of 16.8 m (Elev. 184.0 m).

Water level measurements

Date	Depth	Elev.
On Completion	12.8 m	188.0 m
April 27, 2009	8.5 m	192.3 m
May 13, 2009	8.5 m	192.3 m
May 25, 2009	8.6 m	192.2 m
June 15, 2009	9.1 m	191.7 m
July 09, 2009	9.1 m	191.7 m

2. Borehole backfilled with bentonite.

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

RECORD OF BOREHOLE No S29

1 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4853505.8 ;E 292191.2 | ORIGINATED BY JEB
W.O. 05-20012 | | COMPILED BY PKS/VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE April 27, 2009

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 + FIELD VANE ● QUICK TRIAXIAL × REMOULDED)	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
202.0	GROUND SURFACE							20 40 60 80 100	10 20 30		
0.0	TOPSOIL										
201.7			1	SS	9		201		○		
0.3	SILTY CLAY, trace sand, trace gravel (Reworked to a depth of 0.8 m) Stiff Brown Moist		2	SS	10				○		
200.6							200				
1.4	CLAYEY SILT, trace to some sand, trace gravel (TILL) Stiff to hard Brown becoming grey below a depth of 2.3 m Moist		3	SS	11				○		
			4	SS	23		199		○		
			5	SS	18				⊢○⊣		
	Auger grinding between a depth of 3.8 m to 4.4 m		6	SS	18		198		○		
			7	SS	12		197				0 5 41 54
			8	SS	10		196				
							195				
			9	SS	8		194		⊢○⊣		
								× + ×			
			10	SS	14		193		○		
							192				
			11	SS	32		191		○		
							190				
			12	SS	79		189				
188.3											
13.7	SAND and SILT, trace gravel, trace clay (TILL) Very dense Grey Moist		13	SS	20/0.25		188		○		1 29 62 8

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S29

2 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4853505.8 ;E 292191.2 | ORIGINATED BY JEB
W.O. 05-20012 | | COMPILED BY PKS/VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE April 27, 2009

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 × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —												
	SAND and SILT, trace gravel, trace clay (TILL) Very dense Grey Moist Becoming wet below a depth of 15.2 m		14	SS	80	▽	186 185 184						
183.7 183.4 18.7	CLAYEY SILT, trace sand, trace gravel (TILL) Hard Grey Wet		15	SS	100/0.1		183	140/240					
182.4 19.7	END OF BOREHOLE End of DCPT Dynamic Cone Penetration Test (DCPT) below a depth of 18.7 m												

NOTES:

1. At 15.2 m depth (Elev. 186.8 m) 1.0 m of sand was up inside the augers during drilling due to "blowing" sands.
2. Water level in open borehole at a depth of 15.2 m below ground surface (Elev. 186.8 m) upon completion of drilling.
3. Borehole backfilled with bentonite.

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S30

1 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4853513.2 ;E 292239.8 | ORIGINATED BY JEB
W.O. 05-20012 | | COMPILED BY PKS/VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE April 27, 2009

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 × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
202.3	GROUND SURFACE												
0.0 202.0	TOPSOIL		1	SS	8		202						
0.3 201.5	CLAYEY SILT, some sand, trace gravel, containing organics (Reworked) Stiff Brown Moist		2	SS	22		201						
0.8	SILTY CLAY, trace sand, trace gravel (TILL) Stiff to very stiff Brown grey Moist		3	SS	27		200						
			4	SS	28								
			5	SS	29		199						
			6	SS	14		198						
	Becoming grey below a depth of 4.6 m		7	SS	13		197						
196.7 5.6	CLAYEY SILT, some sand, trace gravel (TILL) Stiff to very stiff Grey Moist		8	SS	9		196						
			9	SS	9		195						
			10	SS	18		194						
191.9 10.4	Silty SAND, trace gravel, trace clay Dense Grey Wet		11	SS	32	▽	193 192						
191.1 11.2	CLAYEY SILT, with sand, trace gravel (TILL) Hard Grey Moist		12	SS	126		191 190						3 26 59 12
188.6 13.7	Auger grinding at a depth of 13.4 m SAND and SILT, some gravel, trace clay (TILL) Very dense Grey Wet		13	SS	140		189 188						13 31 52 4

Continued Next Page

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S30

2 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012 LOCATION N 4853513.2 ;E 292239.8 ORIGINATED BY JEB
DIST Central HWY 427 BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers COMPILED BY PKS/VA
DATUM Geodetic DATE April 27, 2009 CHECKED BY SMM

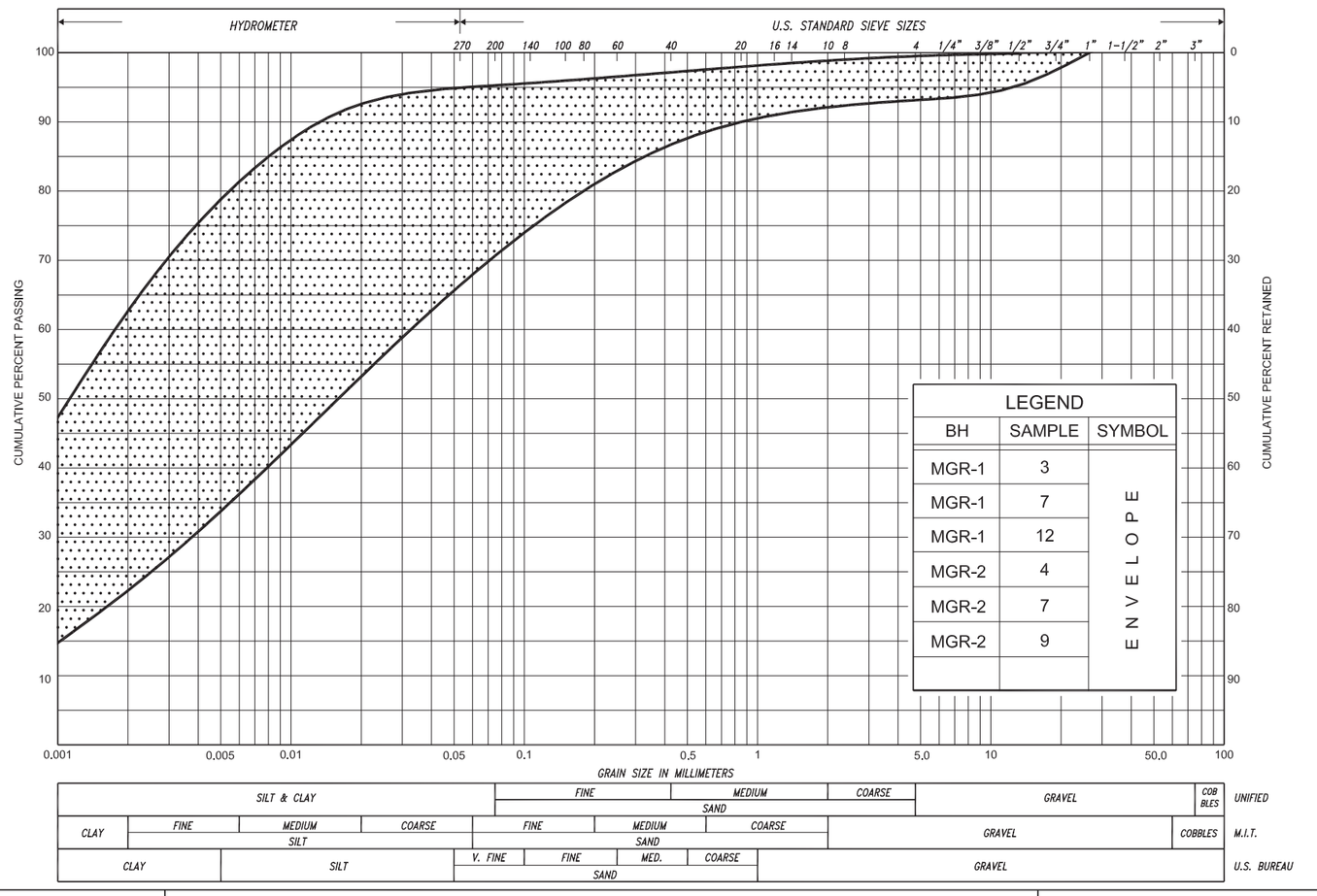
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —										
	SAND and SILT, some gravel, trace clay (TILL) Very dense Grey Wet						187				
186.7 15.6	Auger grinding at a depth of 14.6 m END OF BOREHOLE		14	SS	20/0.2						

NOTES:

1. Water level in open borehole at a depth of 10.7 m below ground surface (Elev. 191.6 m) upon completion of drilling.

2. Borehole backfilled with bentonite.

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

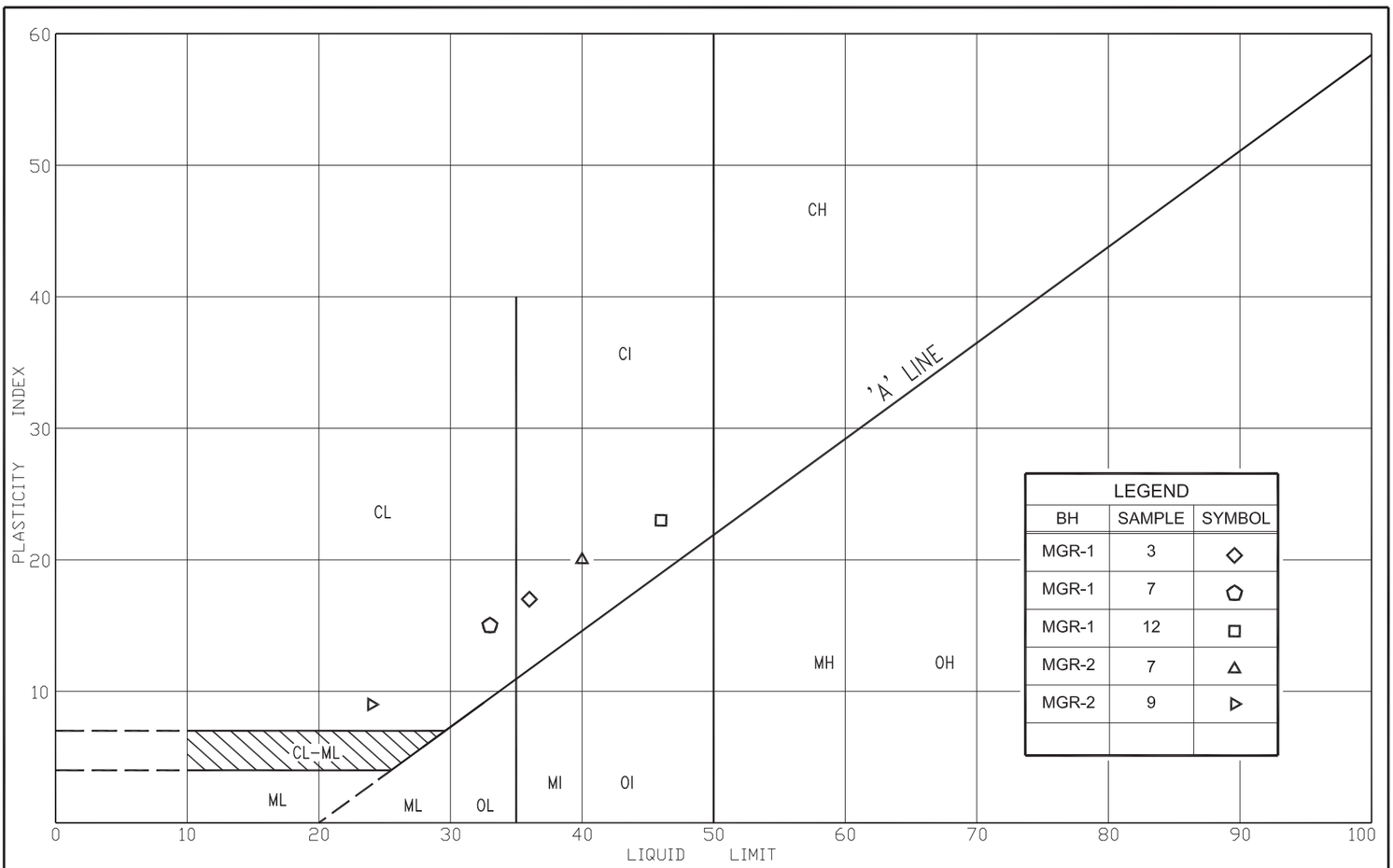


Ontario

GRAIN SIZE DISTRIBUTION

CLAYEY SILT to SILTY CLAY (TILL) - Upper

FIG No.	G-1
HWY:	427
G.W.P. No.	

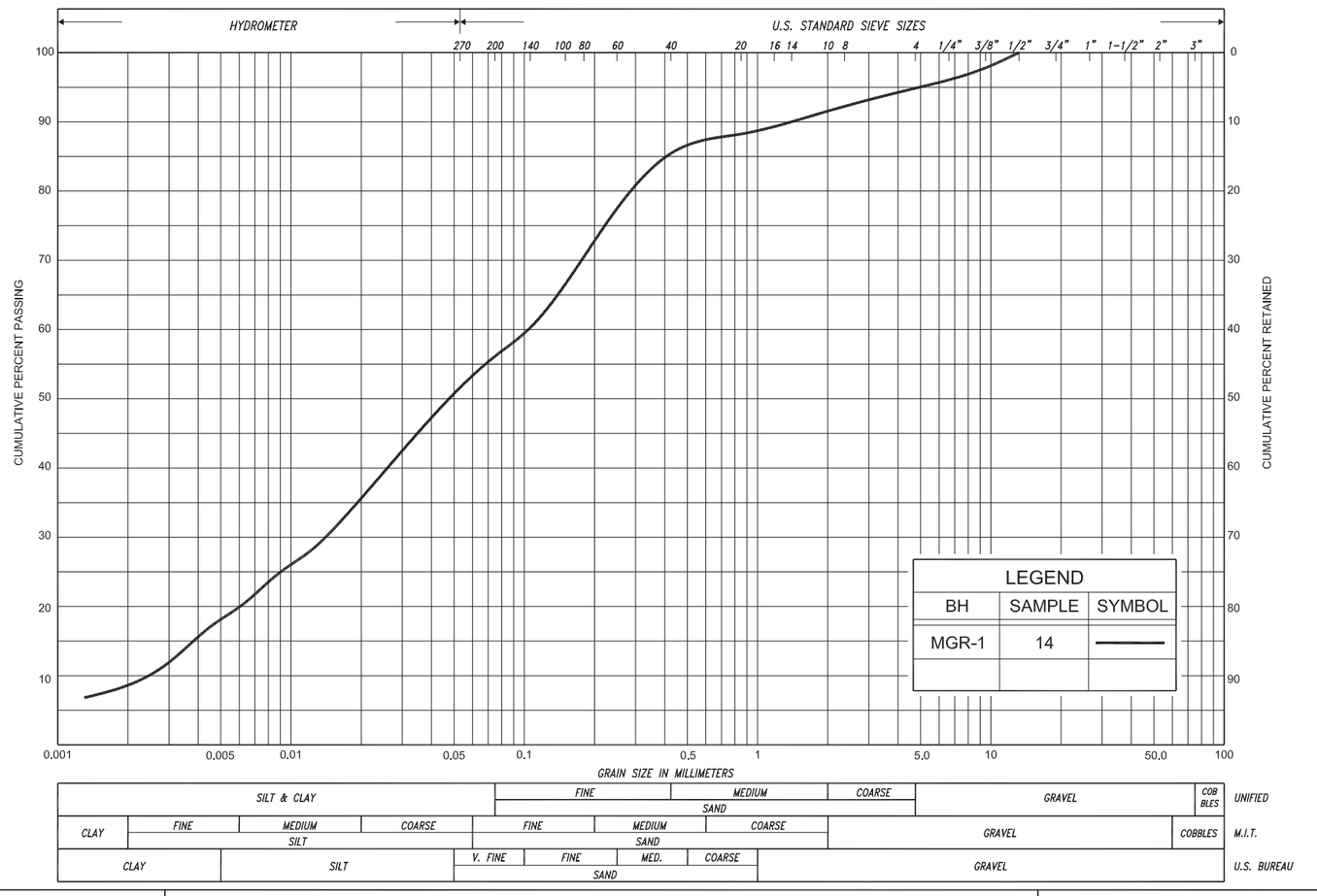


Ontario

PLASTICITY CHART

CLAYEY SILT to SILTY CLAY (TILL) - Upper

FIG No.	G-2
HWY:	427
G.W.P. No.	

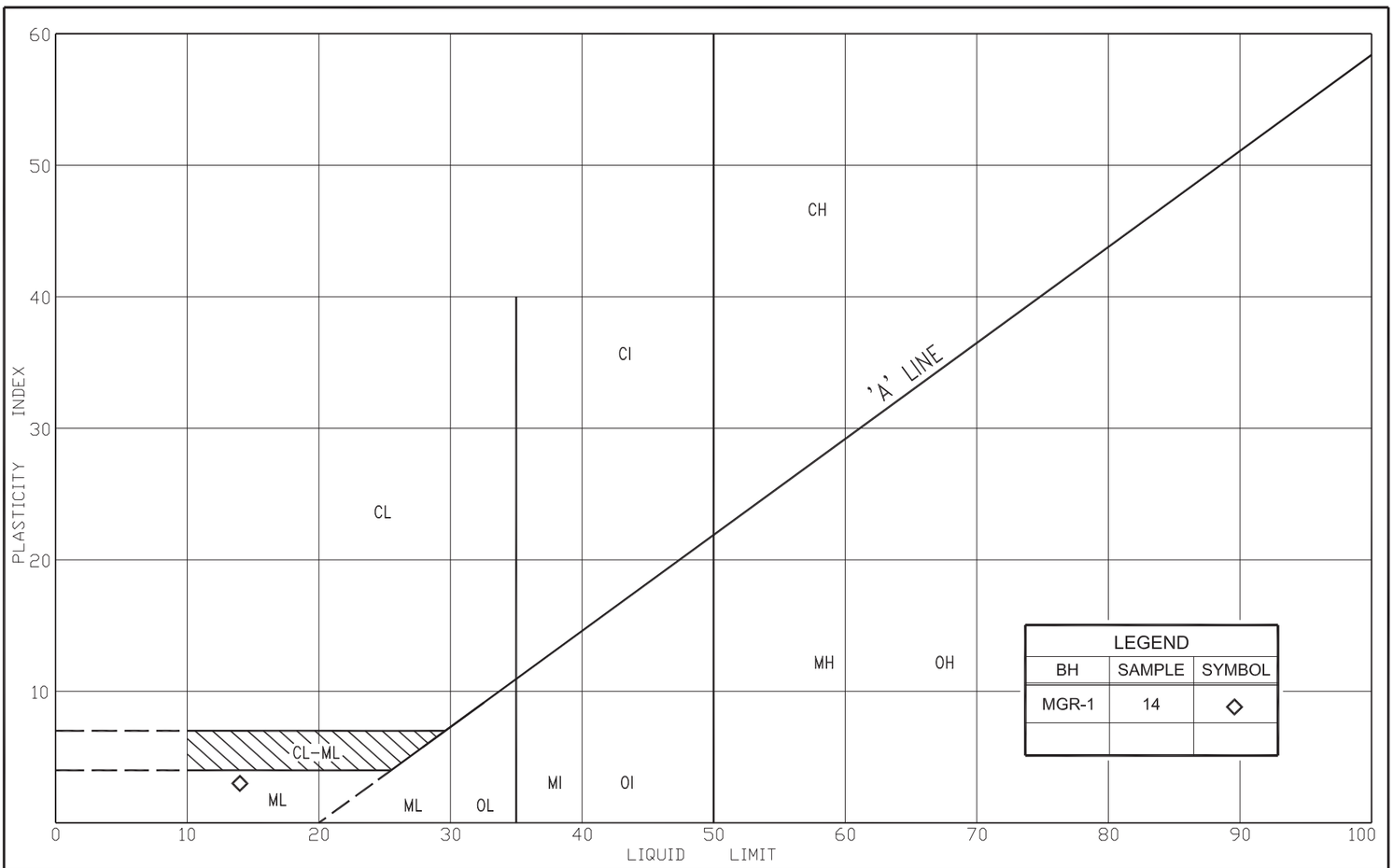


Ontario

GRAIN SIZE DISTRIBUTION

SILT and SAND (TILL)

FIG No.	G-3
HWY:	427
G.W.P. No.	

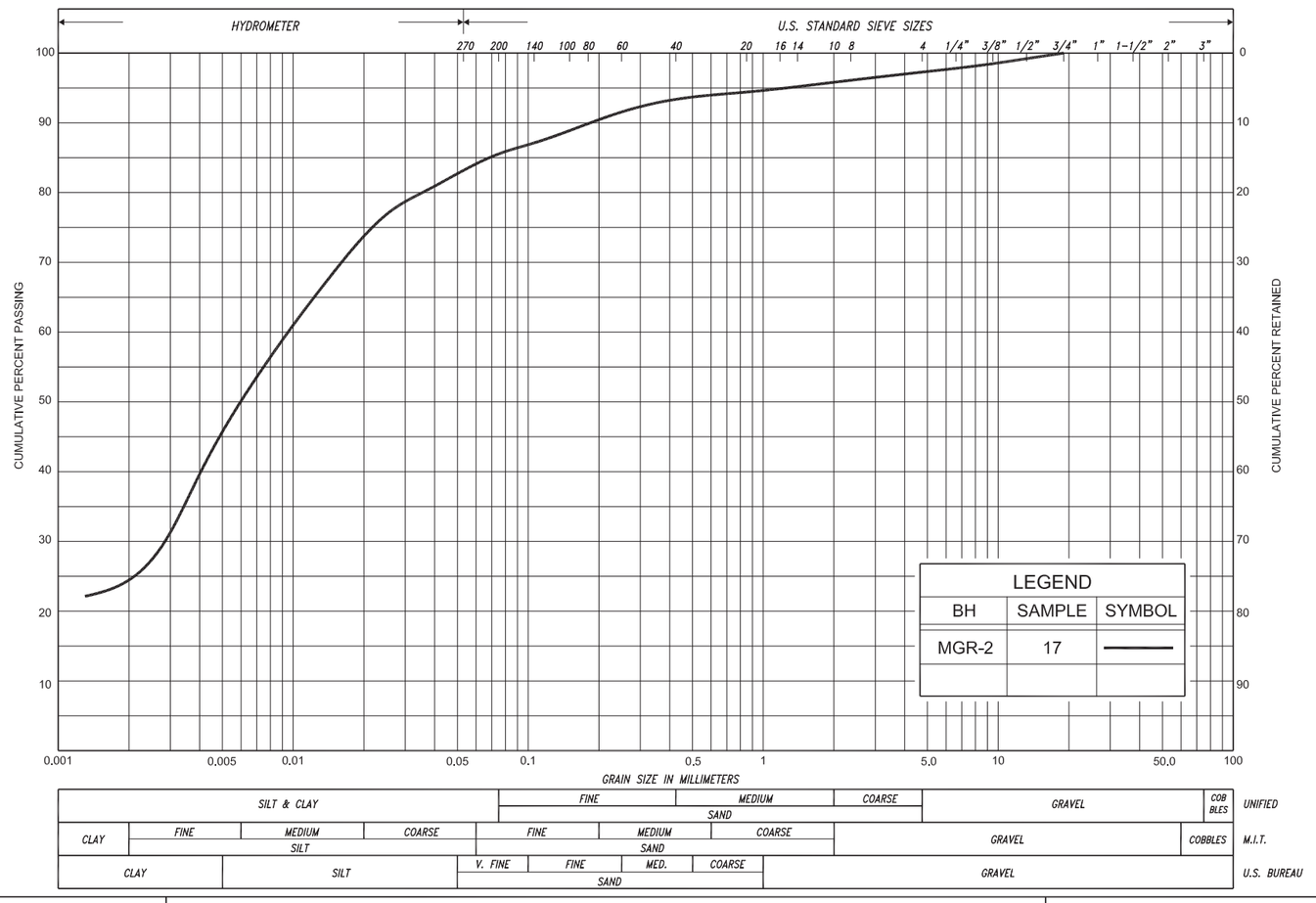


Ontario

PLASTICITY CHART

SILT and SAND (TILL) - Fine Contents

FIG No.	G-4
HWY:	427
G.W.P. No.	

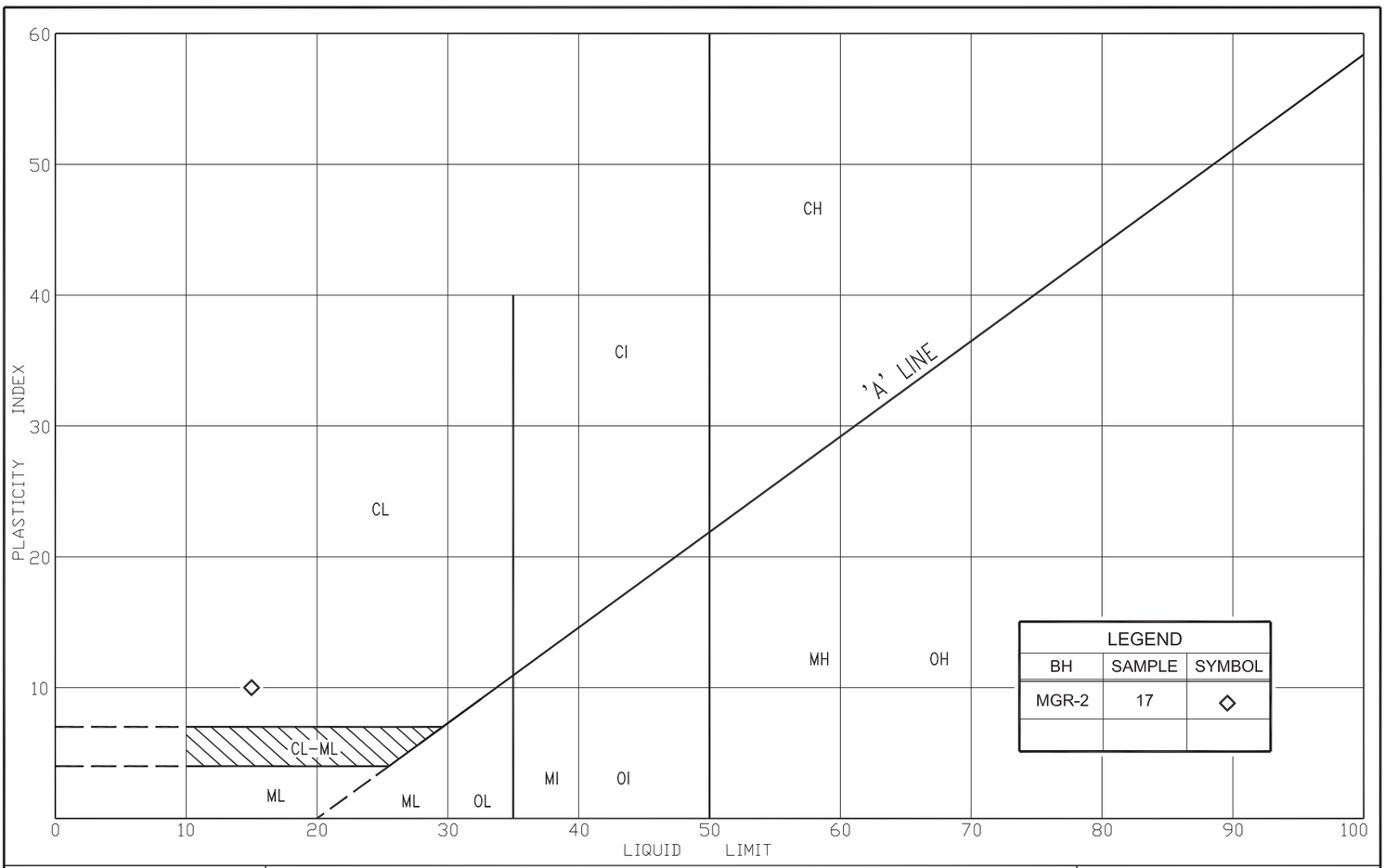


Ontario

GRAIN SIZE DISTRIBUTION

CLAYEY SILT (TILL) - Lower

FIG No.	G-5
HWY:	427
G.W.P. No.	



Ontario

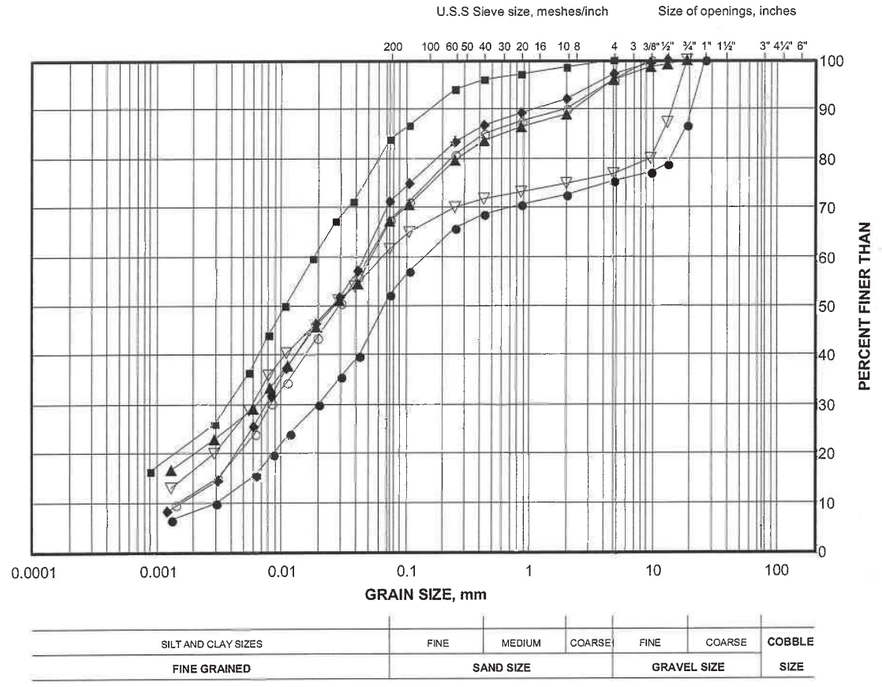
PLASTICITY CHART

CLAYEY SILT (TILL) - Lower

FIG No.	G-6
HWY:	427
G.W.P. No.	

GRAIN SIZE DISTRIBUTION TEST RESULTS
Clayey Silt Till

FIGURE B1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S27	11	188.7
■	S26	12	190.5
◆	S30	12	190.0
▲	S27	13	185.6
▽	S25	15	183.2
❍	S28	9	189.8

Project Number: 06-1111-012-8

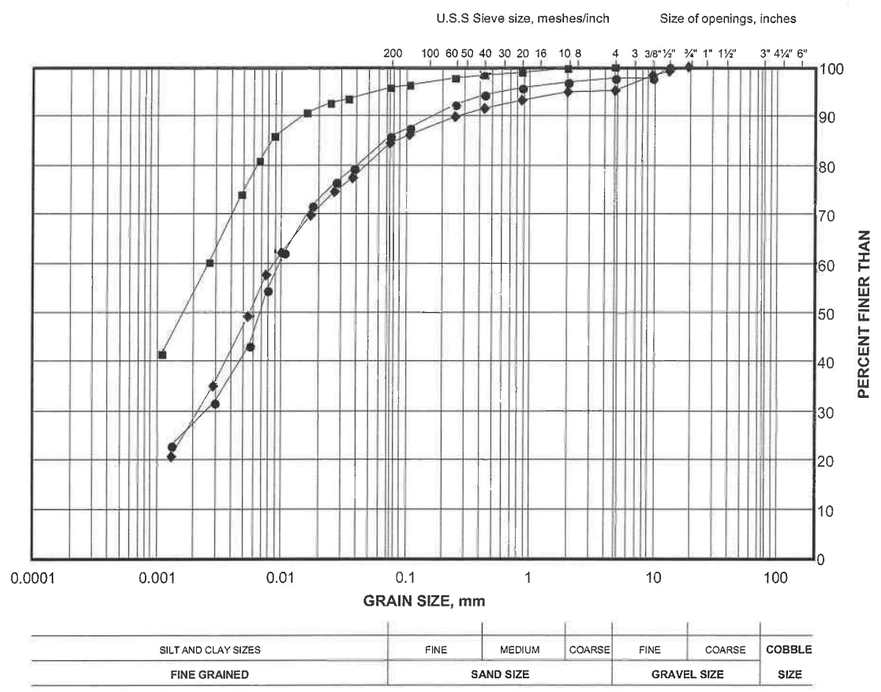
Checked By: SM

Golder Associates

Date: 16-Jun-09

GRAIN SIZE DISTRIBUTION TEST RESULTS
Clayey Silt Till

FIGURE B2



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S28	13	183.8
■	S29	7	197.1
◆	S25	8	195.4

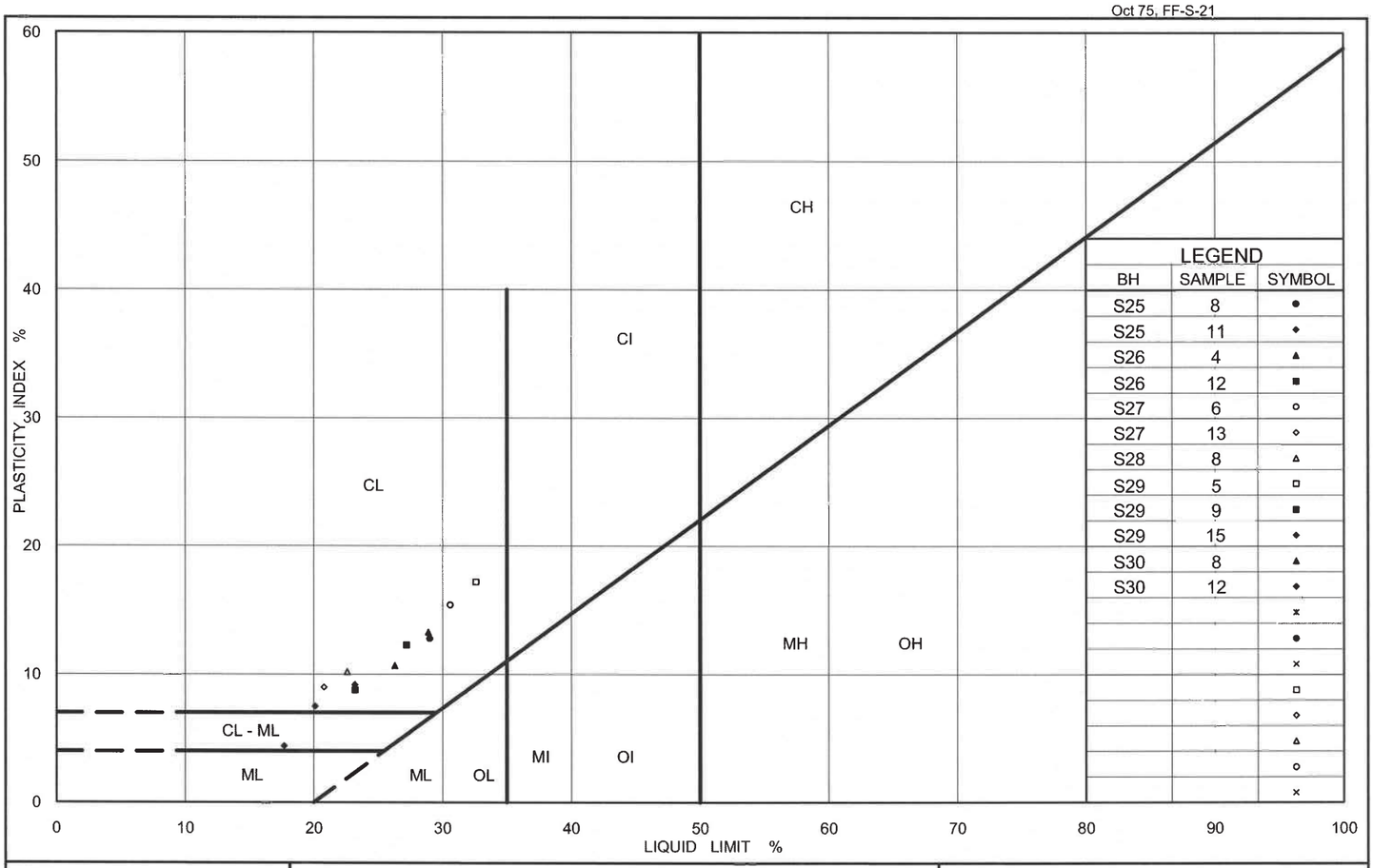
Project Number: 06-1111-012-8

Checked By: SM

Golder Associates

Date: 16-Jun-09

Oct 75, FF-S-21



Ministry of Transportation
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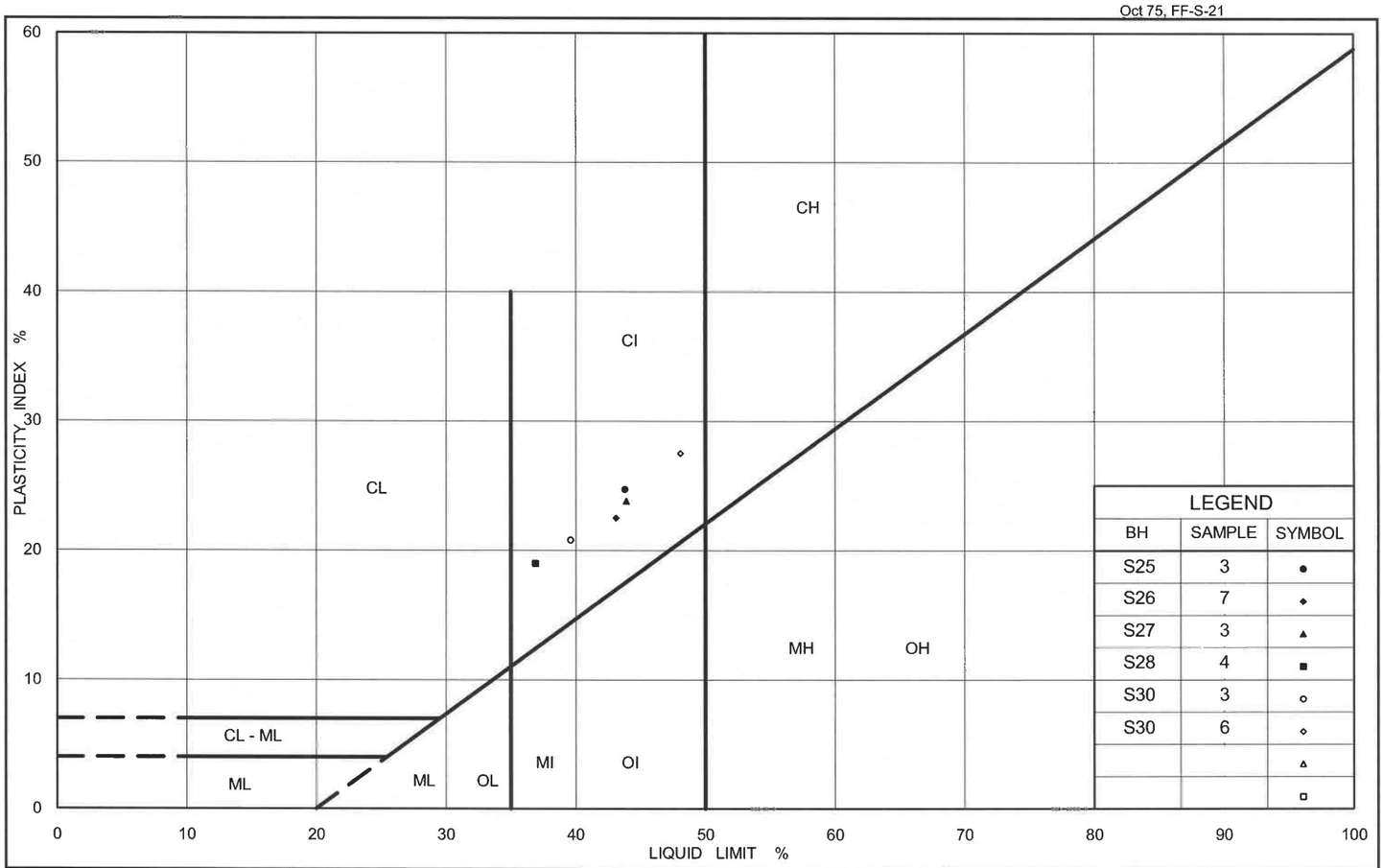
PLASTICITY CHART
Clayey Silt Till

Figure No. B3
Project No. 06-1111-012-8
Checked By: SM

Oct 75, FF-S-21



Ministry of Transportation
Ontario

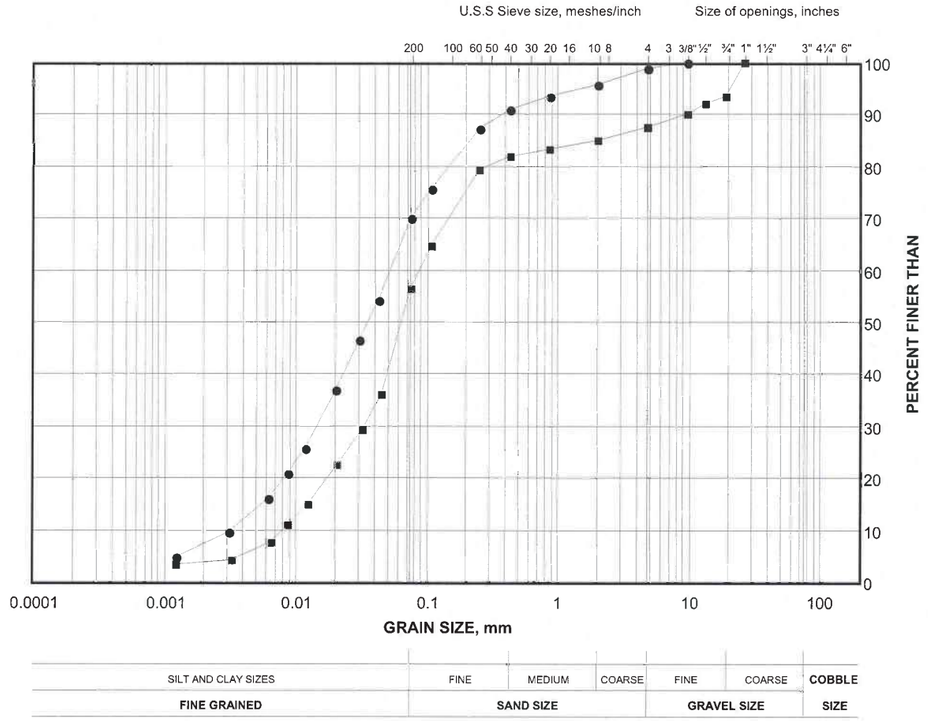
PLASTICITY CHART
Silty Clay Till

Figure No. B4
Project No. 06-1111-012-8
Checked By: SM

GRAIN SIZE DISTRIBUTION TEST RESULTS

Sand and Silt Till

FIGURE B5



LEGEND

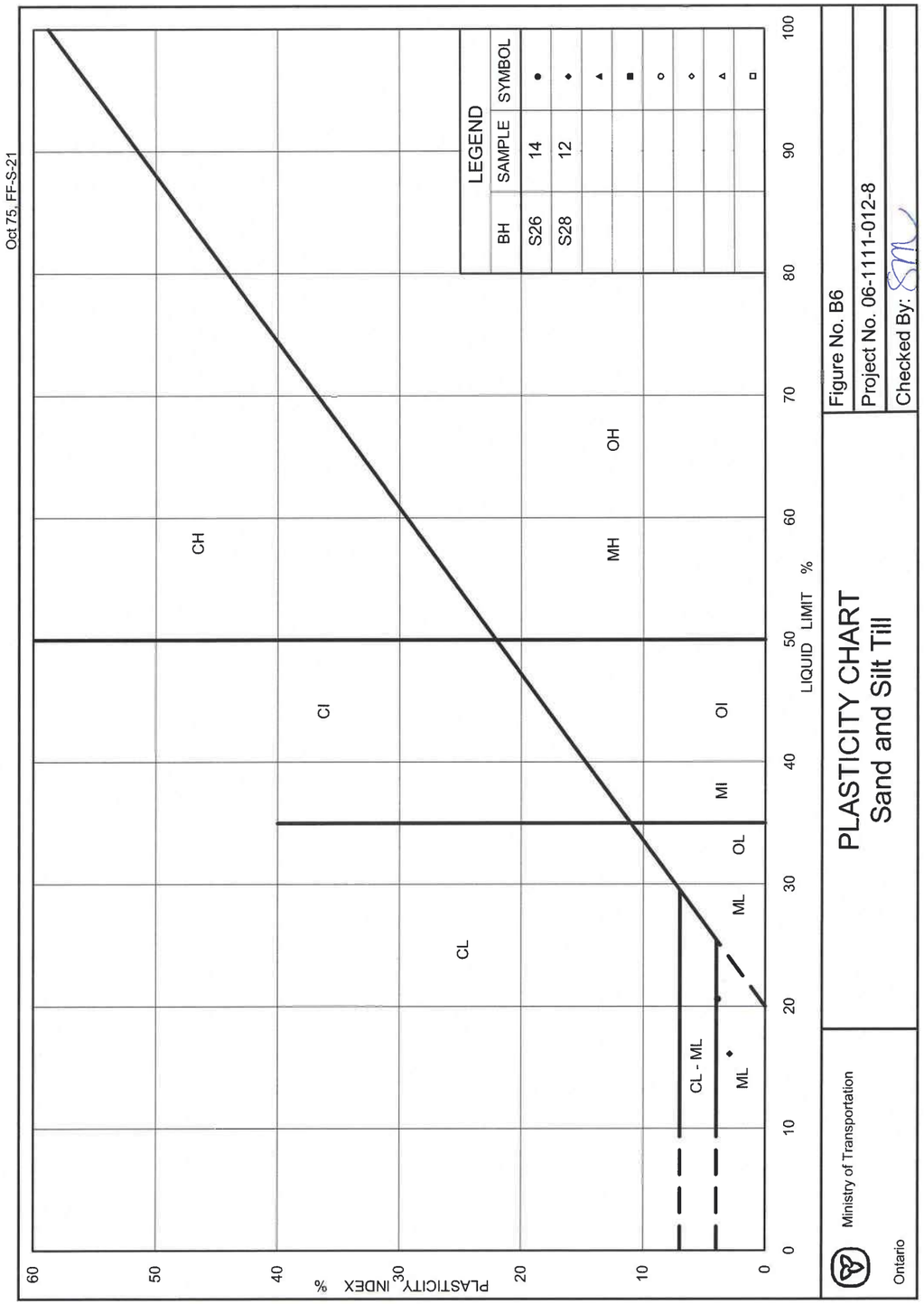
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S29	13	188.0
■	S30	13	188.3

Project Number: 06-1111-012-8

Checked By:

Golder Associates

Date: 16-Jun-09



PLASTICITY CHART
Sand and Silt Till

Figure No. B6

Project No. 06-1111-012-8

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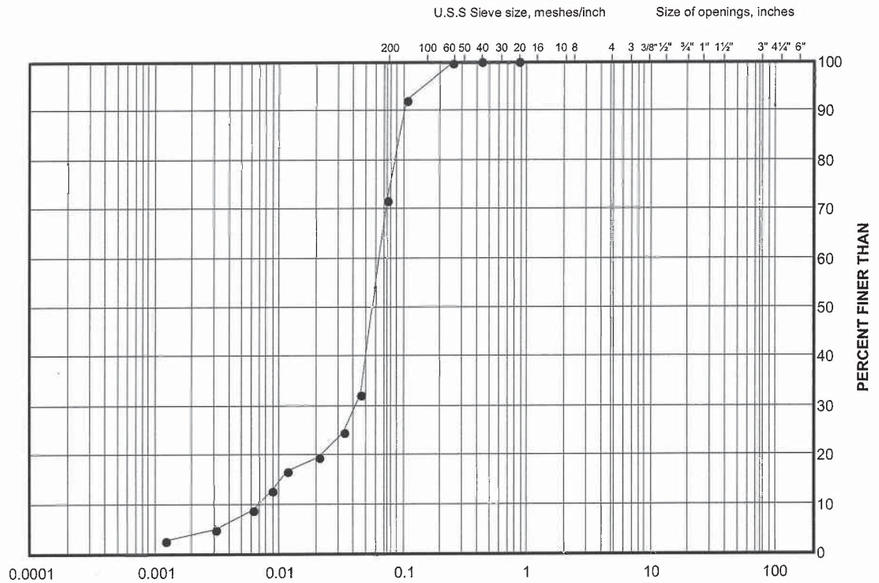
GRAIN SIZE DISTRIBUTION TEST RESULT
Sandy Silt

FIGURE B7



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S27	17	176.4

Project Number: 06-1111-012-8

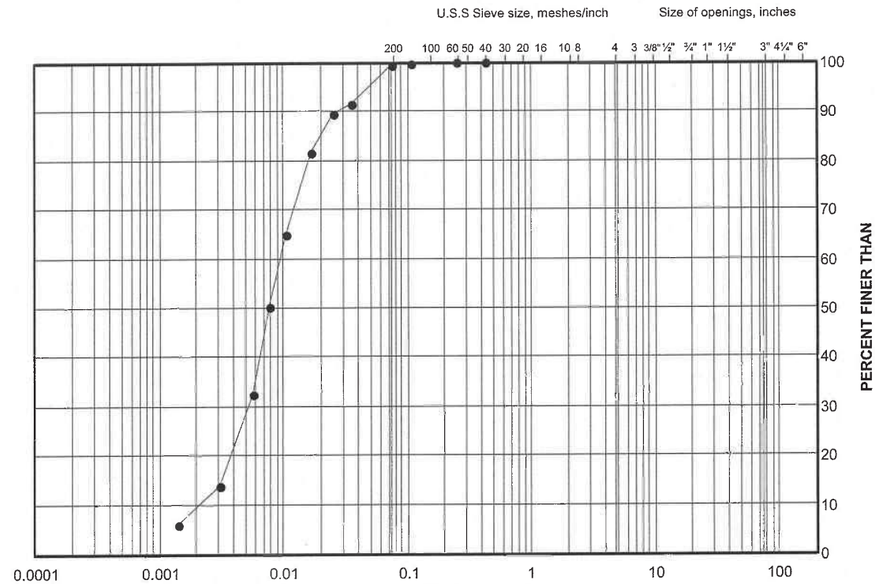
Checked By: SM

Golder Associates

Date: 16-Jun-09

GRAIN SIZE DISTRIBUTION TEST RESULT
Silt

FIGURE B8



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S27	19	170.3

Project Number: 06-1111-012-8

Checked By: SM

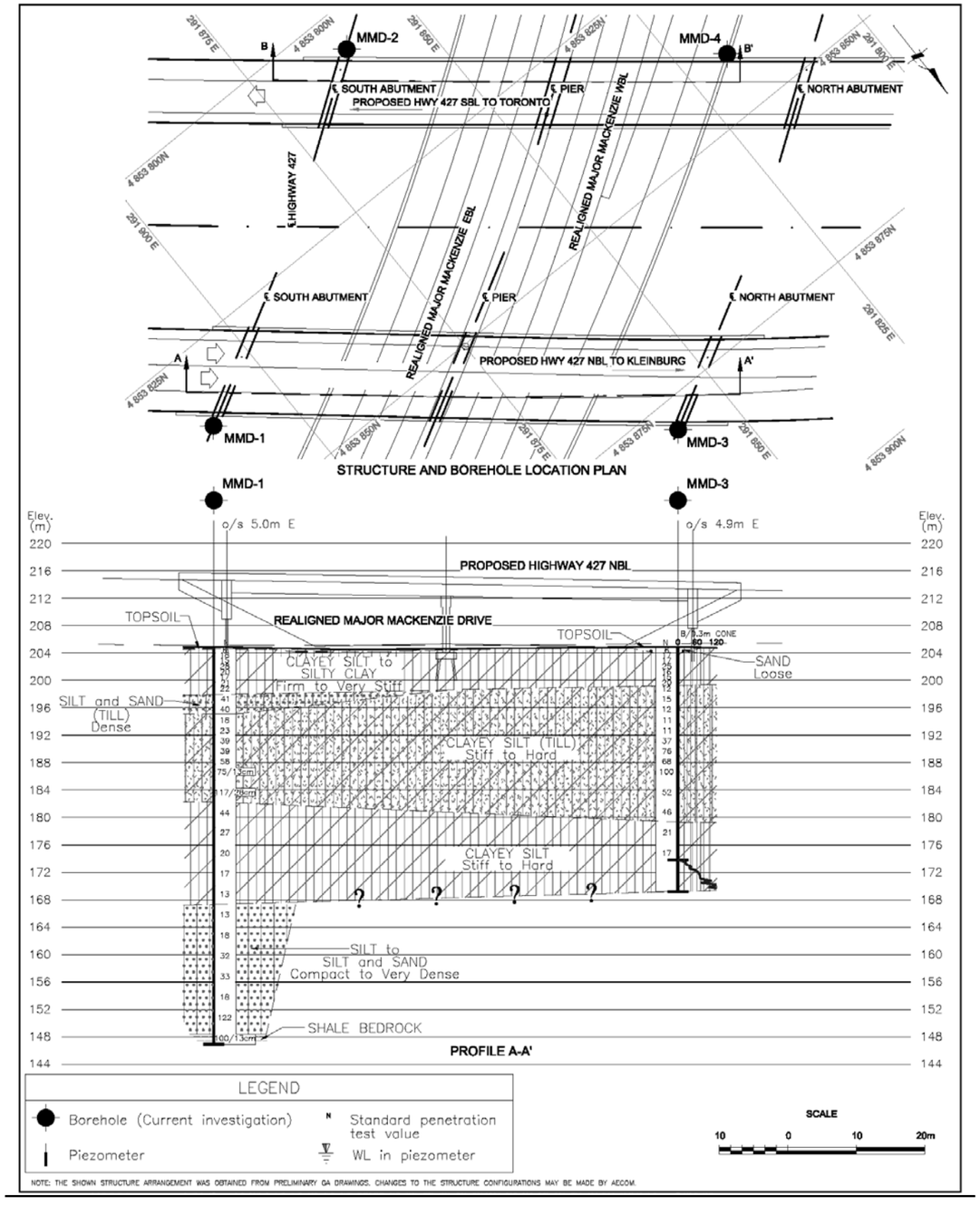
Golder Associates

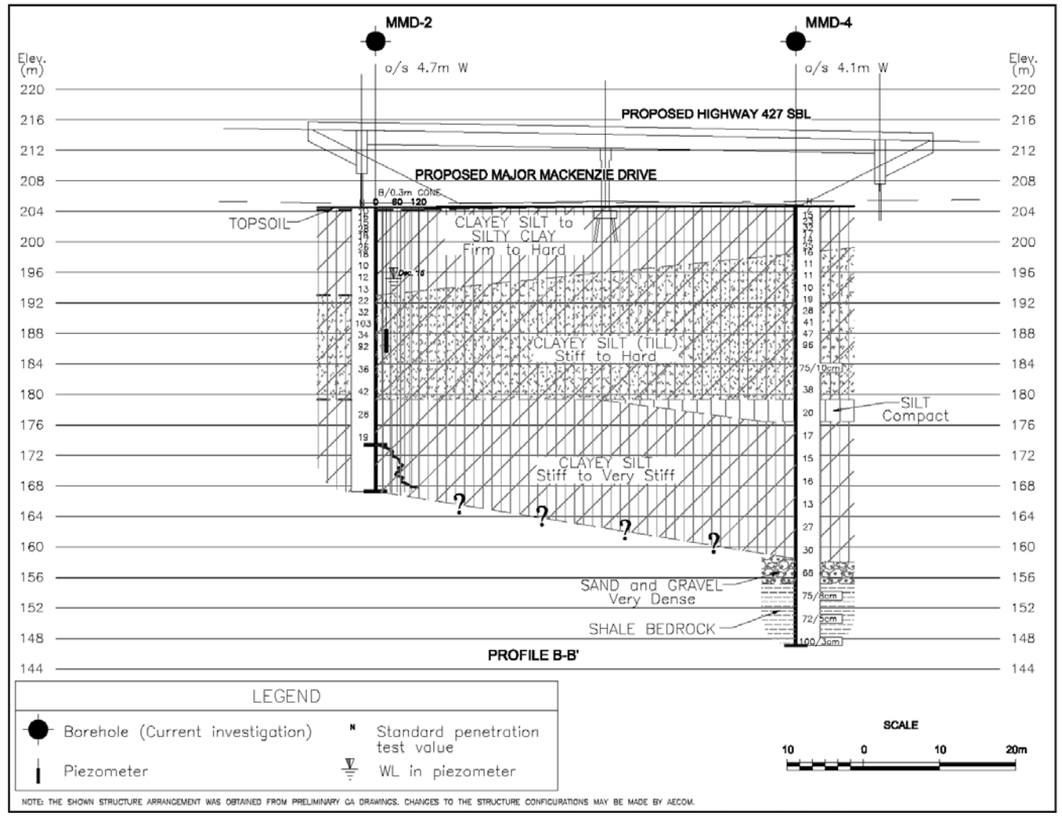
Date: 16-Jun-09

Structure Type: Overpasses

Existing Ground Elevation across Boreholes: 205.2 m to 204.5

Complexity Rating: Medium





FOUNDATION INVESTIGATION

Site Description

The proposed structures are approximately 150 m north of the existing Major Mackenzie Drive and approximately 50 m west of Huntington Road, in the City of Vaughan, Ontario. Major Mackenzie Drive will be realigned approximately 250 m north of its current location in vicinity of the proposed Highway 427 Extension. The terrain in the area of proposed overpass structures is relatively flat.

Borehole Information

Borehole No.	Foundation Unit	MTM NAD 83 Coordinates		Ground Surface Elevation (m)	Borehole/DCPT Depth (m)
		Northing (m)	Easting (m)		
Previous Investigation					
S34(*)	Not at Foundation Element	4,853,856.8	291,927.3	205.2	43.3/47.6
S36(*)	Not at Foundation Element	4,853,883.4	291,922.9	205.2	15.9
Current Investigation					
MMD-1	South Abutment of Hwy 427 NBL	4,853,836.0	291,910.8	204.9	58.0
MMD-2	South Abutment of Hwy 427 SBL	4,853,805.7	291,861.1	204.5	30.9/37.2
MMD-3	North Abutment of Hwy 427 NBL	4,853,879.3	291,858.6	204.9	30.9/35.7
MMD-4	North Abutment of Hwy 427 SBL	4,853,841.2	291,818.4	204.7	57.6

(*) Boreholes are away from the proposed structures and as such are not included in the Subsurface Condition summary presented herein.

Subsurface Condition

The subsurface condition summarized below is based on Boreholes MMD-1 to MMD-4 that were advanced at the proposed structure foundation elements.

Topsoil: All boreholes encountered a 0.2 m to 0.3 m thick layer of topsoil immediately below the ground surface, extending to Elevations 204.6 m to 204.2 m. Borehole MMD-3 penetrated a 0.5 m thick layer of sand below the topsoil at Elevation 204.6 m.

***Clayey Silt to Silty Clay (Upper)*:** A 4.8 m to 11.4 m thick brown to grey clayey silt to silty clay deposit was encountered below the topsoil/sand layer in all boreholes at 0.2 m to 0.8 m depths, Elevations 204.6 m and 204.1 m. The deposit extends to 5.6 m to 11.7 m depths, Elevations 199.3 m to 192.8 m.

The SPT "N"-values ("N"-values) measured within the upper cohesive deposit range from 6 to 32 blows, suggesting a firm to hard consistency. The results of grain size distribution analyses and Atterberg limits tests of selected samples of upper cohesive deposit are shown on Figures H-1 and H-2, respectively.

Silt and Sand Till: Borehole MMD-1 penetrated a 3.0 m thick silt and sand till deposit below the upper cohesive till at 7.1 m depth, Elevation 197.8 m.

"N"-values of 40 and 41 blows were measured within the non-cohesive till deposit, indicating a dense compactness. The result of a grain size distribution analysis of a sample of silt and sand till is shown on Figure H-3.

***Clayey Silt Till*:** A 13.0 m to 20.5 m thick cohesive till deposit comprised of clayey silt to sandy clayey silt was encountered underlying the upper cohesive deposit in all boreholes at 5.6 m to 11.7 m depths, Elevations 199.3 m to 192.8 m. The deposit extends to 23.1 m to 26.1 m depths, Elevations 181.8 m to 178.4 m.

The "N"-values measured in the cohesive till deposit range from 10 blows per 0.30 m of penetration to 117 blows per 0.28 m of penetration, suggesting a stiff to hard consistency. The results of grain size distribution analyses and Atterberg limits tests of selected cohesive till samples are shown on Figures H-4 and H-5.

***Clayey Silt (Lower)*:** A lower deposit of cohesive soils comprised of clayey silt was encountered underlying the cohesive till in Boreholes MMD-1 to MMD-3 and below a pocket of silt in Borehole MMD-4 at 23.1 m to 30.0 m depths, Elevations 181.8 m to 174.7 m. The thickness of the lower cohesive deposit is 15.2 m and 16.8 m in Boreholes MMD-1 and MMD-4, respectively where the deposit is fully penetrated to 38.3 m and 46.8 m depths, Elevations 166.6 m and 157.9 m. Boreholes MMD-2 and MMD-3 were terminated within the lower cohesive deposit penetrating it for about 4.8 m, and further DCPTs were advanced from the bottom of these boreholes to refusal at 37.2 m and 35.7 m depths, Elevations 167.3 m and 169.2 m.

The "N"-values measured within the lower cohesive deposit range from 13 to 44 blows, suggesting a stiff to hard consistency. The results of grain size distribution analyses and Atterberg limits tests for selected samples from lower cohesive deposit are shown on Figures H-6 and H-7, respectively.

***Silt to Silt and Sand*:** Borehole MMD-4 penetrated a 3.9 m thick pocket of silt below the till deposit at 26.1 m depth, Elevation 178.6 m. Borehole MMD-1 penetrated a 18.3 m thick deposit of silt to silt and sand underlying the lower cohesive deposit at 38.3 m depth, Elevation 166.6 m. The deposit extends to 56.6 m depth, Elevation 148.3 m.

The "N"-values measured within these layers range from 13 to 122 blows, indicating a compact to very dense compactness. The results of grain size distribution analyses for selected samples of this deposit are shown on Figure H-8.

***Sand and Gravel*:** Borehole MMD-4 penetrated a 3.7 m thick layer of sand and gravel underlying the lower cohesive deposit at 46.8 m depth, Elevation 157.9 m.

An "N"-value of 68 blows was measured within this layer, indicating a very dense compactness. The result of a grain size distribution analysis on a sample of this layer is shown on Figure H-9.

***Shale Bedrock*:** Boreholes MMD-1 and MMD-4 penetrated 1.4 m to 7.1 m highly weathered shale bedrock at 56.6 m and 50.5 m depths, Elevations 148.2 m and 147.0 m and met practical refusal at 57.6 m and 58.0 m, Elevations 146.9 m and 147.1 m.

The "N"-values measured within this layer range from 75 blows per 0.08 m of penetration to 100 per 0.13 m of penetration.

Groundwater Conditions

The groundwater level in the piezometer installed in Borehole MMD-2 was at 9.3 m depth, Elevation 195.2 m on December 23, 2015. For further details refer to Table A2 of this report.

FOUNDATION RECOMMENDATIONS

The following site-specific foundation recommendations are for preliminary design and planning purposes only .They require refinement during detail design. Project-wide foundation recommendations, design assumptions and limitations are contained in Part B of this report. The proposed twin two-span overpass structures will carry Highway 427 Northbound and Southbound Lanes over Major Mackenzie Drive.

Foundation Option	Advantages	Disadvantages	Relative Costs	Risks/Consequences
Spread footings on very stiff clayey silt or "Granular A" pad	• Conventional construction.	• Precludes use of integral abutments; • Provides relatively low bearing capacity.	• Lower relative cost compared to deep foundation options.	• Disturbing of subgrade due to excavation; • Risk of improper compaction of "Granular A" pad.
Driven steel H-Piles to found by friction within the hard clayey silt till	• Allows for integral abutment design.	• Piles may encounter obstructions during driving.	• More costly than spread footings.	• Risk of not achieving capacities due the variable thickness of the "100-blow" soil layer; • Minor potential for pile damage/ deflection if obstructions are encountered during pile driving.
Caissons founded within the hard clayey silt till	• Provides higher capacity than driven piles.	• Precludes use of integral abutments.	• More costly than driven steel H-piles.	• Risk of not achieving capacities due the variable thickness of the "100-blow" soil layer; • Risk of loosening or disturbing founding soils at base of caissons.

Spread Footings

Spread footings founded on native soils were considered to support the abutments and pier. However, the bearing resistances at normal depths would be less than required for design as indicated by the preliminary geotechnical resistances at the ground interface presented in the following table.

Foundation Unit	Founding Stratum	Axial Geotechnical Resistance < 25 mm settlement		Highest Founding Elevation within Native Soils (m)
		Factored ULS (kPa)	SLS (kPa)	
South Abutments	Stiff to Very Stiff Clayey Silt	225	150	204.0
Centre Piers				204.0
North Abutments				204.0

Consequently, the alternative of spread footings on a Granular A pad of minimum 2 m thickness is recommended for preliminary design purposes assuming a factored geotechnical resistance at ULS of 900 kPa and geotechnical resistance at SLS of 350 kPa.

Driven Steel H-Pile/ Steel Pipe Piles

Steel H-piles 310x110 and Steel pipe piles, 324 mm (12 ¾ in) outer diameter and 6 mm (1/4 in) thickness, driven to the levels indicated in the following table may be used to support the abutments and pier. The preliminary geotechnical resistances and tip elevations are as follows:

Foundation Unit	Axial Geotechnical Resistance		Approximate Pile Tip Elevation (m)
	Factored ULS (kN)	SLS (kN)	
South Abutments	1,100	850	186
Centre Piers	900	700	186
North Abutments	1,100	850	186

Driven piles should be controlled by Hiley Formula as per MTO Drawing SS-103-11 from 2 m higher than the approximate pile tip elevations, employing a maximum load of twice the factored geotechnical resistance at ULS per pile.

Alternatively, piles may be driven to about Elevations 148 m and 154 m (onto the shale bedrock) to achieve higher resistances of 1,600 kN at Factored ULS and 1,200 at SLS. Further subsurface investigation would be required during the detail design to for the driven piles to shale bedrock option.

Caissons

Caissons founded within the hard cohesive till may be considered for support of the abutments and pier. The preliminary geotechnical resistances are as follows:

Foundation Unit	Caisson Diameter (m)	Axial Geotechnical Resistance		Caisson Base Elevation (m)
		Factored ULS (kN)	SLS (kN)	
South Abutments	1.2	3,500	2,800	186
	1.5	4,500	3,600	
Centre Piers	1.2	2,800	2,300	186
	1.5	3,650	3,000	
North Abutments	1.2	3,500	2,800	186
	1.5	4,500	3,600	

Recommended Foundation Alternative

The recommended foundation alternative at this site is driven steel H-piles into the hard cohesive till for the abutments, and spread footings founded on native, very stiff clayey silt for the piers. Driven piles may also be used for the piers. Driven piles are preferred over caissons.

Structure Abutments and Approaches

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

Construction of the overpass structures will require placement of up to about 11.5 m and 9.0 m of fill within the limits of the south and north approach embankments, respectively.

Structure Retaining Walls/Wing Walls

The earth retaining walls for this structure may include Cast-in-Place (CIP) or RSS Walls. For RSS walls the facing should be founded on granular pad or CIP leveling pad. The retaining walls geometry should conform to High Appearance and High Performance in accordance with MTO.DSM 9.70 and current RSS Design Guidelines. The CIP retaining walls should be designed in conformance with spread footing recommendations in this report.

Stability of Approach Embankments

Approach embankments up to about 11.5 m high are expected to be stable at side slope gradient of 2H:1V provided that suitable earth fill or granular fill will be used. Where approach embankments are equal to or greater than 8.0 m in height, a minimum 2.0 m wide mid-height bench should be provided.

Settlement of Approach Embankments

The settlement within founding soils is estimated to be in the order of 100 mm to 150 mm, most of which is expected to occur within six (6) months after the fill placement. Based on preliminary estimations, consideration can be given to preloading the approach embankments for a period of six (6) months to mitigate the post-construction settlements. Alternatively and to expedite the construction, consideration may be given to employing a 2.0 m high surcharge, subject to further assessment during detail design to ensure that adequate Factor of Safety against slope instability is maintained. Downdrag loads should be considered during detail design for deep foundations.

Construction Considerations

Excavation

The construction of piers/pile caps will require excavations up to about 3.0 m deep. These excavations will be made generally through firm to very stiff clayey silt deposit which is classified as Type 3 soils in OHSA. Temporary unsupported excavations above the prevailing groundwater in these soils should be made with side slopes no steeper than 1H:1V.

Surface Water / Groundwater Control

Surface water run-off should be diverted away from the excavations at all times.

The prevailing groundwater should be maintained a minimum of 0.5 m below the base of excavations. The groundwater level measured in the piezometer installed at this site was at 9.3 m depth, Elevation 195.2 m. It is expected that excavations for construction of piers/pile caps will be above the prevailing groundwater level at this site. The minimal groundwater inflow into excavations is expected to be handled by pumping from properly filtered sumps placed at the base of the excavations.

Pile Installation / Caisson Construction

It is anticipated that cobbles and/or boulders will be encountered within the till deposit, which may adversely impact the installation of steel H-piles or caissons. Piles should be equipped with flange plates or approved driving shoes.

If consideration is being given to caisson foundations, water-bearing non-cohesive native soils (silt and sand till) should be expected to run or flow into the caisson hole during and after the drilling for the caisson foundations and as such, appropriate equipment and procedures (including use of temporary or permanent caisson liners) will be required to minimize ground loss during drilling and concrete placement and to permit inspection and cleaning of the caisson bases.

Recommendation for Additional Work

Further subsurface investigation should be carried out during the detail design to confirm the subsoil and groundwater conditions at the location of approach embankments foundation elements and at the piers. Since the founding stratum thickness is variable across the site, it is recommended that for the additional subsurface investigation during the detail design consideration be given to sampling intervals of 0.75 m within the approximate pile tip elevations (approximately between Elevations 188 m and 180 m) to more accurately define the thickness of competent (100 blow) layer. It is also recommended to carry out consolidation tests to determine the compressibility parameters of the upper cohesive soil deposit.

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No MMD-1 1 of 4 METRIC

G.W.P. _____ LOCATION Coords: 4 853 836.0 N; 291 910.8 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 5 to 7, 2015 CHECKED BY A.V.

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 (○ 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 (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
204.9	Ground Surface										
0.0 / 204.6	TOPSOIL										
0.3	CLAYEY SILT to SILTY CLAY, trace to some sand, trace gravel Firm to very stiff Brown becoming grey below a depth of 2.3m Moist		1	SS	6		204				
			2	SS	18						
			3	SS	15		203				
			4	SS	28						
			5	SS	20		202				
			6	SS	17		201				0 3 44 53
			7	SS	21		200				
197.8			8	SS	22		199				1 10 48 41
7.1	SILT and SAND, trace clay, trace gravel Dense Grey Moist (TILL)		9	SS	41		198				Auger grinding at a depth of 7.3m
			10	SS	40		197				9 40 43 8
194.8							196				
10.1	CLAYEY SILT, trace sand, trace gravel Very stiff to hard Grey Moist (TILL)		11	SS	18		195				
							194				
			12	SS	23		193				
							192				
			13	SS	39		191				1 9 67 23
189.9	Cont'd						190				

+7, ×5: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Ontario

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Foundation Design

RECORD OF BOREHOLE No MMD-1 2 of 4 METRIC

G.W.P. _____ LOCATION Coords: 4 853 836.0 N; 291 910.8 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 5 to 7, 2015 CHECKED BY A.V.

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 (○ 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 (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
189.9											
15.0	(Cont'd) CLAYEY SILT, trace sand, trace gravel Very stiff to hard Grey Moist (TILL)		14	SS	39		189				
			15	SS	58		188				
187.1											
17.8	SANDY CLAYEY SILT, trace gravel Hard Grey Moist (TILL)		16	SS	75/13cm		187				Auger grinding at a depth of 18.7m
							186				
							185				
							184				
			17	SS	117/28cm		183				2 32 46 20
181.8											
23.1	CLAYEY SILT, trace sand to sandy Stiff to hard Grey Moist to wet		18	SS	44		182				
							181				
							180				
							179				
							178				
			19	SS	27		177				
							176				
174.9	Cont'd						175				

+7, ×5: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

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Foundation Design

RECORD OF BOREHOLE No MMD-1 3 of 4 METRIC

G.W.P. _____ LOCATION Coords: 4 853 836.0 N; 291 910.8 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 5 to 7, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
174.9											
30.0	(Cont'd) CLAYEY SILT, trace sand to sandy Stiff to hard Grey Moist to wet		20	SS	20		174				0 0 83 17
			21	SS	17		171				
			22	SS	13		168				
166.6											
38.3	SILT, trace clay Compact Grey Moist to wet		23*	SS	13		165				
			24	SS	18		162		non-plastic		1 10 82 7
159.9	Cont'd						160				Hard drilling below a depth of 38.4m

+⁷ ,×⁵ : Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

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Foundation Design

RECORD OF BOREHOLE No MMD-1 4 of 4 METRIC

G.W.P. _____ LOCATION Coords: 4 853 836.0 N; 291 910.8 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 5 to 7, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
45.0	(Cont'd) SILT, trace clay Compact Grey Moist to wet		25*	SS	32		159				
157.6											
47.3	SILT and SAND, trace clay, trace to some gravel Compact to very dense Grey Moist to wet		26	SS	33		156				0 51 42 7
	containing shale fragments below a depth of 54.9m		27	SS	18		153				
			28	SS	122		150				
148.3											
56.6	SHALE BEDROCK Highly weathered Grey		29	SS	100/13cm		147				Hard drilling below a depth of 55.3m
146.9											
58.0	End of borehole *no recovery in split-spoon sampler Notes: 1. Groundwater level cannot be measured upon completion of drilling due to utilization of mud rotary drilling technique.										

+⁷ ,×⁵ : Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

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Foundation Design

RECORD OF BOREHOLE No MMD-2 1 of 3 METRIC

G.W.P. _____ LOCATION Coords: 4 853 805.7 N; 291 861.1 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 7 and 8, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	WATER CONTENT (%) (10 20 30)				GR SA SI CL
204.5	Ground Surface												
0.0 / 204.2	TOPSOIL		1	SS	10		204						
0.3	SILTY CLAY, trace to some sand, trace gravel Stiff to very stiff Brown becoming grey below a depth of 3.1m Moist		2	SS	16								3 17 35 45
			3	SS	15		203						
			4	SS	28		202						
			5	SS	18		201						
			6	SS	17								
			7	SS	26		200						1 7 39 53
			8	SS	18		199						Hard drilling at a depth of 5.5m
			9	SS	10		198						
			10	SS	12		197						
			11	SS	13		196						
192.8 / 11.7	CLAYEY SILT, trace to with sand, trace gravel Very stiff to hard Grey Moist (TILL)		12	SS	22		195						4 26 52 18
			13	SS	32		194						
189.5	Cont'd						193						
							192						
							191						
							190						

+7, ×5: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

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Foundation Design

RECORD OF BOREHOLE No MMD-2 2 of 3 METRIC

G.W.P. _____ LOCATION Coords: 4 853 805.7 N; 291 861.1 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 7 and 8, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	WATER CONTENT (%) (10 20 30)				GR SA SI CL
189.5													
15.0	(Cont'd) CLAYEY SILT, trace to with sand, trace gravel Very stiff to hard Grey Moist (TILL)		14	SS	103		189						
			15	SS	34		188						0 2 73 25
			16	SS	92		187						
			17	SS	36		186						
			18	SS	42		185						
178.4							184						
26.1	CLAYEY SILT Very stiff Grey Moist		19	SS	26		183						Hard drilling at a depth of 21.8m
							182						
							181						
							180						0 3 73 24
							179						
							178						
							177						
							176						
174.5	Cont'd						175						

+7, ×5: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

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Foundation Design

RECORD OF BOREHOLE No MMD-2 3 of 3 METRIC

G.W.P. _____ LOCATION Coords: 4 853 805.7 N; 291 861.1 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 7 and 8, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE; ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	WATER CONTENT (%) (10 20 30)				GR SA SI CL
174.5						*							
30.0	(Cont'd) CLAYEY SILT Very stiff Grey Moist		20	SS	19		174			○			
173.6							173						
30.9	Switched to Dynamic Cone Penetration Test						172						
							171						
							170						
							169						
							168	144 320					
167.3													
37.2	End of Dynamic Cone Penetration Test												

Monitoring Well Legend:

- Bentonite seal
- Native
- Filter sand
- 50mm dia. screen
- Bentonite
- Water level measured in piezometer

Notes:

1. Groundwater level cannot be measured upon completion of drilling due to utilization of mud rotary drilling technique.

Monitoring Well Readings:

Date	Depth (m)	Elev. (m)
16/11/15	10.2	194.3
23/12/15	9.3	195.2

+7, ×5: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No MMD-3 1 of 3 METRIC

G.W.P. _____ LOCATION Coords: 4 853 879.3 N; 291 858.6 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 8 and 9, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE; ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	WATER CONTENT (%) (10 20 30)				GR SA SI CL
204.9	Ground Surface					*							
0.0	TOPSOIL		1	SS	6		204						
204.6													
0.3	SAND, trace silt Loose Brown Moist		2	SS	17		203						
204.1													
0.8	SILTY CLAY, trace sand Very stiff Brown becoming grey below 2.3m Moist		3	SS	17		202						
			4	SS	25		201		41				0 5 42 53
			5	SS	16		200						
			6	SS	15		199						
			7	SS	20		198						
199.3							197						
5.6	CLAYEY SILT, some sand, trace gravel Stiff to hard Grey Moist to wet (TILL)		8	SS	12		196						
			9	SS	15		195						2 11 50 37
			10	SS	12		194						
			11	SS	11		193						
			12	SS	11		192						
			13	SS	37		191						Hard drilling at a depth of 13.1m
189.9	Cont'd						190						

+7, ×5: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No MMD-3 2 of 3 METRIC

G.W.P. _____ LOCATION Coords: 4 853 879.3 N; 291 858.6 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 8 and 9, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
189.9											
15.0	(Cont'd) CLAYEY SILT, some sand, trace gravel Stiff to hard Grey Moist to wet (TILL)		14	SS	76		189				9 18 54 19
			15	SS	68		188				
	sand and gravel seams		16	SS	100		187				4 15 53 28
			17	SS	52		184				
			18	SS	46		183				2 5 69 24
							182				
							181				
							180				
178.8							179				
26.1	CLAYEY SILT Very stiff Grey Wet		19	SS	21		178				
	Cont'd						177				
							176				
							175				

+7, ×5: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No MMD-3 3 of 3 METRIC

G.W.P. _____ LOCATION Coords: 4 853 879.3 N; 291 858.6 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 8 and 9, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
174.9											
174.0			20	SS	17		174				
30.9	Switched to Dynamic Cone Penetration Test						173				
							172				
							171				
							170	128 130 235			
169.2											
35.7	End of Dynamic Cone Penetration Test Notes: 1. Groundwater level cannot be measured upon completion of drilling due to utilization of mud rotary drilling technique.										

ON MTO_NEW LOGO HWY 427 15TF013A-REV.GPJ ON_MOT.GDT 14/01/2016 12:29:46 PM

+7, ×5: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No MMD-4 1 of 4 METRIC

G.W.P. _____ LOCATION Coords: 4 853 841.2 N; 291 818.4 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 13 and 14, 2015 CHECKED BY A.V.

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 (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
204.7	Ground Surface														
204.5	TOPSOIL														
0.2	CLAYEY SILT to SILTY CLAY, trace to some sand, trace gravel Firm to hard Brown Moist		1	SS	7		204								
			2	SS	15										
			3	SS	23		203								2 19 55 24
			4	SS	32										
			5	SS	17		202								
			6	SS	14		201								1 7 43 49
			7	SS	25		200								
199.1															
5.6	CLAYEY SILT, some sand, trace gravel Stiff to hard Grey Moist (TILL)		8	SS	16		199								
			9	SS	11		198								
							197								
			10	SS	11		196								2 11 49 38
			11	SS	10		195								
							194								
			12	SS	19		193								
							192								
			13	SS	28		191								1 11 58 30
189.7	Cont'd						190								

ON MTO_NEW LOGO HWY 427 15TF013A-REV.GPJ ON_MOT.GDT 14/01/2016 12:29:47 PM

+7, ×5: Numbers refer to Sensitivity (%) STRAIN AT FAILURE

Ontario

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Foundation Design

RECORD OF BOREHOLE No MMD-4 2 of 4 METRIC

G.W.P. _____ LOCATION Coords: 4 853 841.2 N; 291 818.4 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 13 and 14, 2015 CHECKED BY A.V.

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 (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
189.7															
15.0	(Cont'd) CLAYEY SILT, some sand, trace gravel Stiff to hard Grey Moist (TILL)		14	SS	41		189								
							188								
			15	SS	47										
							187								Hard drilling at a depth of 17.7m
			16	SS	96		186								7 14 58 21
							185								Hard drilling at a depth of 19.8m
			17	SS	75/10cm		184								
							183								Sampler bouncing
							182								
			18	SS	38		181								
							180								
178.6							179								
26.1	SILT, trace sand, trace clay Compact Grey Moist to wet						178								
			19	SS	20		177								non-plastic 0 7 85 8
							176								
							175								
174.7	Cont'd														

ON MTO_NEW LOGO HWY 427 15TF013A-REV.GPJ ON_MOT.GDT 14/01/2016 12:29:47 PM

+7, ×5: Numbers refer to Sensitivity (%) STRAIN AT FAILURE

Ontario

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Foundation Design

RECORD OF BOREHOLE No MMD-4 3 of 4 METRIC

G.W.P. _____ LOCATION Coords: 4 853 841.2 N; 291 818.4 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 13 and 14, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	*					GR SA SI CL
174.7 30.0	CLAYEY SILT, trace sand Stiff to very stiff Grey Moist to wet		20	SS	17		174				
			21	SS	15		171				
			22	SS	16		168				0 1 82 17
			23	SS	13		165				
			24	SS	27		162				
159.7	Cont'd						160				

+7, ×5: Numbers refer to Sensitivity (%) STRAIN AT FAILURE

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Foundation Design

RECORD OF BOREHOLE No MMD-4 4 of 4 METRIC

G.W.P. _____ LOCATION Coords: 4 853 841.2 N; 291 818.4 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 13 and 14, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	*					GR SA SI CL
45.0	(Cont'd) CLAYEY SILT, trace sand Stiff to very stiff Grey Moist		25	SS	30		159				
157.9 46.8	SAND and Gravel, trace silt Very dense Grey Moist		26	SS	68		157				13 54 29 4
154.2 50.5	SHALE BEDROCK Highly weathered Grey		27	SS	75/8cm		154				Hard drilling at a depth of 51.2m Sampler bouncing
			28	SS	92/5cm		150				Sampler bouncing
147.1 57.6	End of borehole * no recovery in split-spoon sampler Notes: 1. Groundwater level cannot be measured upon completion of drilling due to the utilization of mud rotary drilling technique		29	SS	100/3cm		148				

+7, ×5: Numbers refer to Sensitivity (%) STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No S34

1 OF 4 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4853856.8 ;E 291927.3
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 10 & 11, 2009

ORIGINATED BY SB
COMPILED BY VA
CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%): GR SA SI CL
205.2	GROUND SURFACE						
0.0	Asphalt						
0.1	Sand and gravel (FILL) Brown Moist						
204.4	Silty sand, trace clay (FILL) Loose Brown Moist		1A 1B	SS	9		
204.1	SILTY CLAY, trace to some sand, trace gravel (TILL) Stiff to very stiff Brown Moist		2	SS	14		
1.1			3	SS	16		0 13 54 33
	Becoming grey at a depth of 3.0 m		4	SS	19		
			5	SS	10		
			6	SS	7		
			7	SS	9		
198.1							
7.1	CLAYEY SILT, some to with sand, trace gravel (TILL) Stiff to hard Grey Moist		8	SS	8		
			9	SS	10		
			10	SS	12		
			11	SS	9		
			12	SS	36		1 10 64 25
190.2							

Continued Next Page

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

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)

ELEVATION SCALE: 205, 204, 203, 202, 201, 200, 199, 198, 197, 196, 195, 194, 193, 192, 191

UNIT WEIGHT γ kN/m³

>120

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S34

2 OF 4 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4853856.8 ;E 291927.3
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 10 & 11, 2009

ORIGINATED BY SB
COMPILED BY VA
CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%): GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —						
15.0	CLAYEY SILT, some to with sand, trace gravel (TILL) Hard Grey Moist		13	SS	30		
			14	SS	46		
			15	SS	71		
			16	SS	103		7 28 42 23
			17	SS	62	▽	
			18	SS	47		
			19	SS	36		
			20	SS	32		0 3 72 25
178.4							
26.8	CLAYEY SILT, trace sand Stiff to hard Grey Moist to wet		21	SS	13		0 3 83 17

Continued Next Page

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

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)

ELEVATION SCALE: 190, 189, 188, 187, 186, 185, 184, 183, 182, 181, 180, 179, 178, 177, 176

UNIT WEIGHT γ kN/m³

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S34

3 OF 4 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4853856.8 ;E 291927.3
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 10 & 11, 2009

ORIGINATED BY SB
COMPILED BY VA
CHECKED BY SMM

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 × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —										
	CLAYEY SILT, trace sand Stiff to hard Grey Moist to wet		22	SS	35		175				0 0 81 19
172.2			23	SS	26		174				
33.0	SILT, trace clay Compact Grey Wet		24	SS	21		173				
			25	SS	16		172				
			26	SS	19		171				0 0 89 11
			27	SS	WR		170				
161.9							169				
43.3	END OF BOREHOLE Dynamic Cone Penetration Test (DCPT) below a depth of 43.3 m						168				
160.2							167				
							166				
							165				
							164				
							163				
							162				
							161				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S34

4 OF 4 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4853856.8 ;E 291927.3
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 10 & 11, 2009

ORIGINATED BY SB
COMPILED BY VA
CHECKED BY SMM

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 × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —										
45.0	Dynamic Cone Penetration Test (DCPT) below a depth of 43.3 m						160				
157.7							159	126 145 198			
47.6	END OF DCPT Refusal to Further Penetration						158	165 160			
	NOTES: 1. Water level noted inside augers at a depth of 21.8 m below ground surface (Elev. 183.4 m) on March 10, 2009. 2. A Dynamic Cone Penetration Test was carried out below a depth of 43.3 m . 3. Open borehole dry upon completion of drilling on March 11, 2009. 4. Borehole backfilled with bentonite.										

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

Golder Associates

RECORD OF BOREHOLE No S36

1 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4853883.4 ;E 291922.9 | ORIGINATED BY SB
W.O. 05-20012 | | COMPILED BY VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 12, 2009

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
205.2	GROUND SURFACE						205				
0.0	Asphalt										
0.2	Sand with gravel (FILL) Silty sand, trace gravel, trace clay (FILL) Compact Brown Moist		1	SS	10						
203.7							204				
1.5	SILTY CLAY, trace sand, trace gravel (TILL) Stiff to very stiff Brown becoming grey below a depth of 2.3 m Wet		2	SS	15						
			3	SS	16		203				
			4	SS	13		202				
			5	SS	17		201				
			6	SS	13		200				
			7	TO	PH	▽	199		41	c	1 4 43 52
198.1							198	>120			
7.1	CLAYEY SILT, some sand, trace gravel (TILL) Stiff to hard Grey Wet		8	SS	11						1 14 52 33
			9	TO	PH		197	+ >120			
							196				
			10	SS	10		195				
							194	>120			
			11	SS	6		193				
							192	>120			
			12	SS	64		191				1 17 59 23

Continued Next Page

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S36

2 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4853883.4 ;E 291922.9 | ORIGINATED BY SB
W.O. 05-20012 | | COMPILED BY VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 12, 2009

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
	— CONTINUED FROM PREVIOUS PAGE —										
	CLAYEY SILT, some sand, trace gravel (TILL) Stiff to hard Grey Wet		13	SS	34		190		o		0 8 68 24
189.4											
15.9	END OF BOREHOLE										

NOTES:

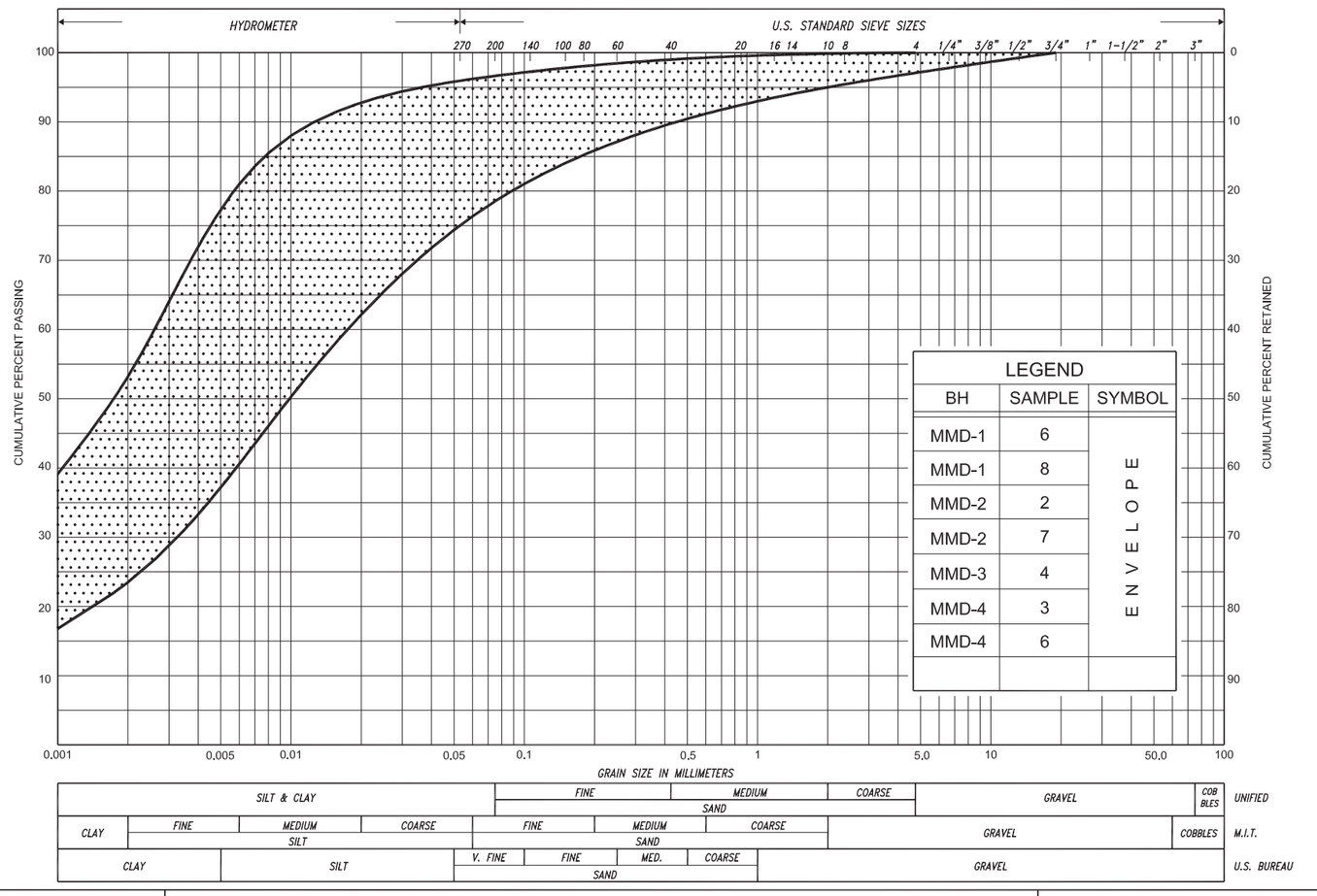
1. A 50 mm diameter monitoring well was installed at a depth of 13.9 m (Elev. 191.3 m).

Water level measurements:

Date	Depth	Elev.
On Completion	Dry	
April 27, 2009	7.3 m	197.9 m
May 25, 2009	6.4 m	198.8 m
June 15, 2009	6.2 m	199.0 m
July 09, 2009	6.2 m	199.0 m

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

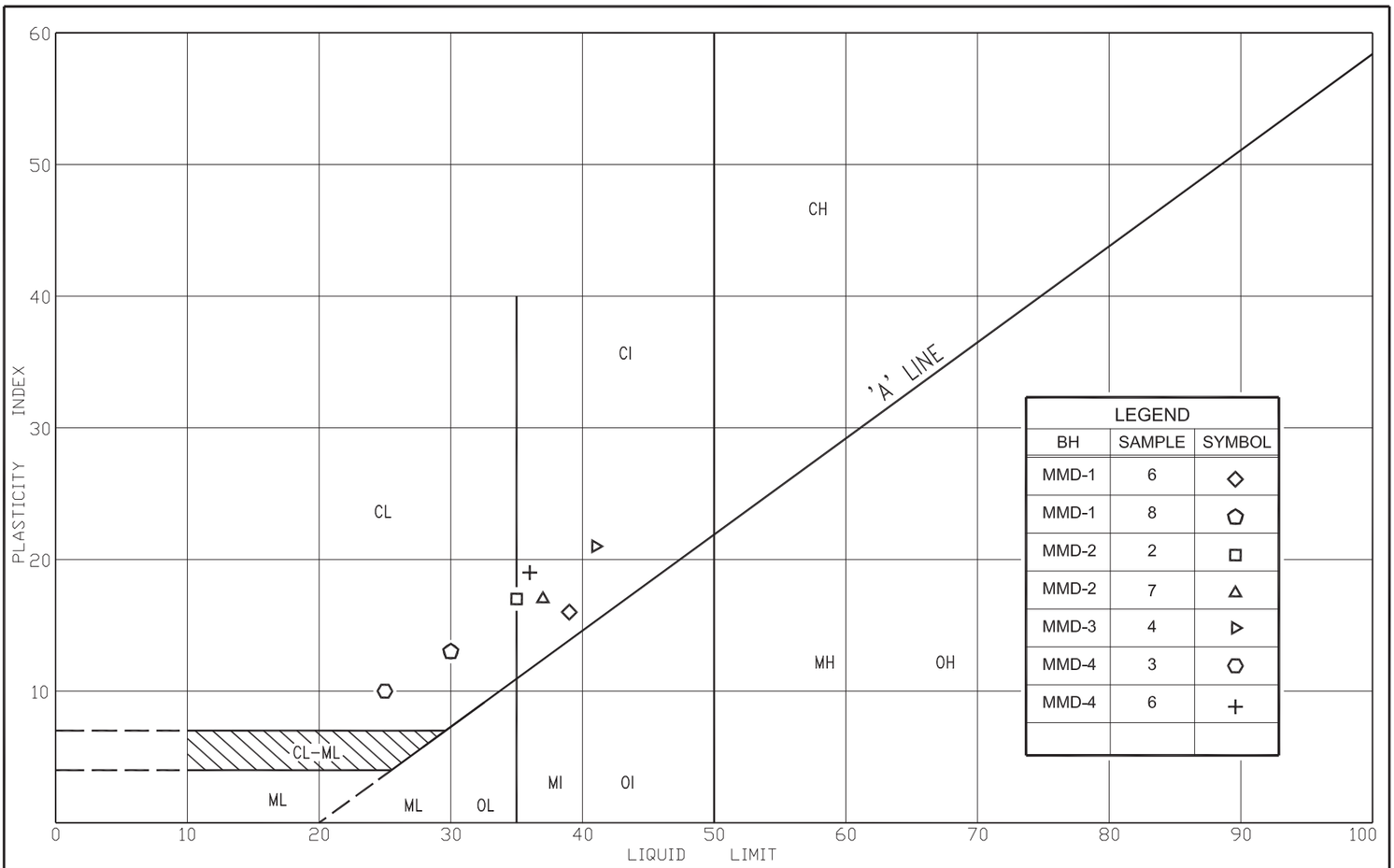


Ontario

GRAIN SIZE DISTRIBUTION

CLAYEY SILT to SILTY CLAY - Upper

FIG No.	H-1
HWY:	427
G.W.P. No.	

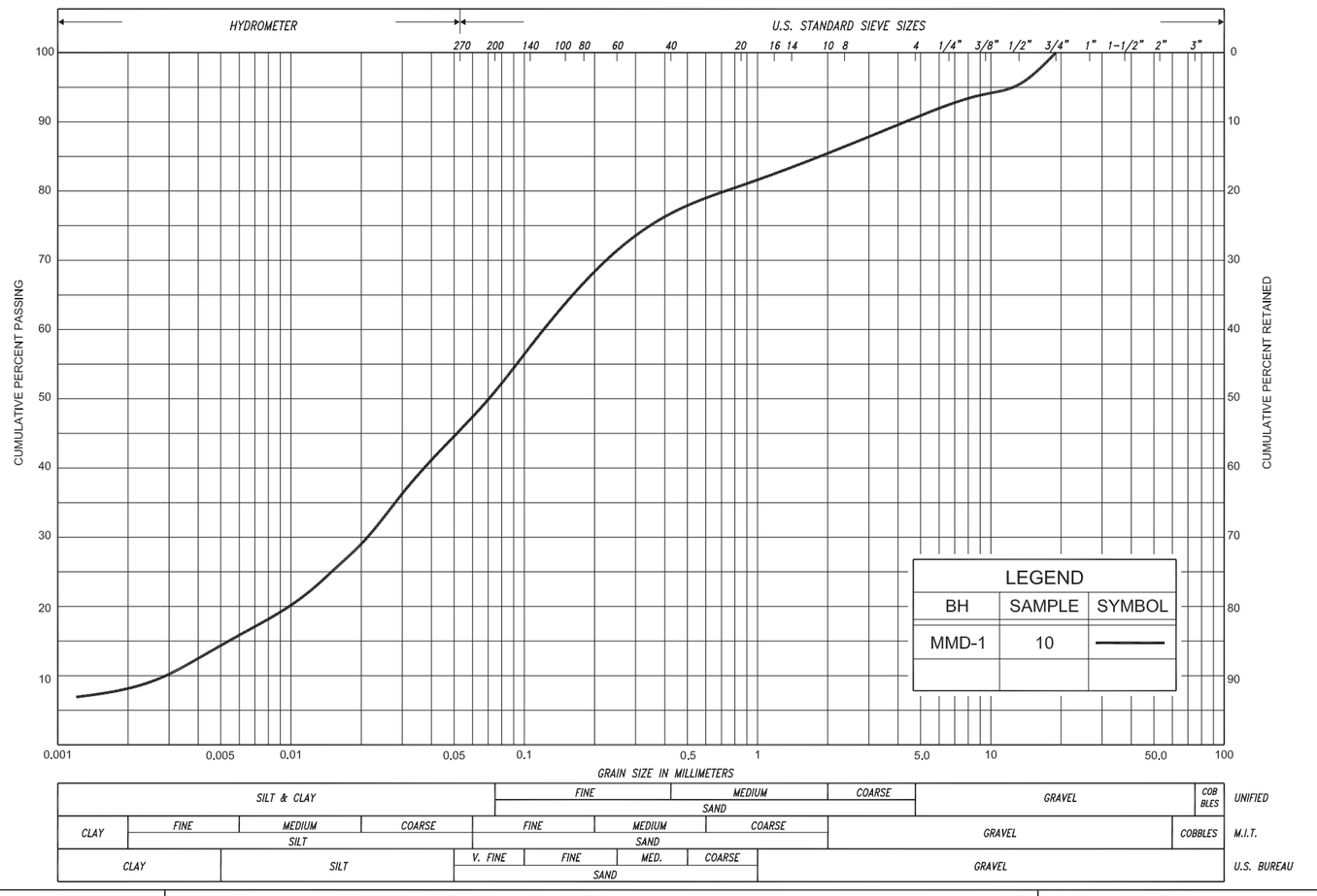


Ontario

PLASTICITY CHART

CLAYEY SILT to SILTY CLAY - Upper

FIG No.	H-2
HWY:	427
G.W.P. No.	

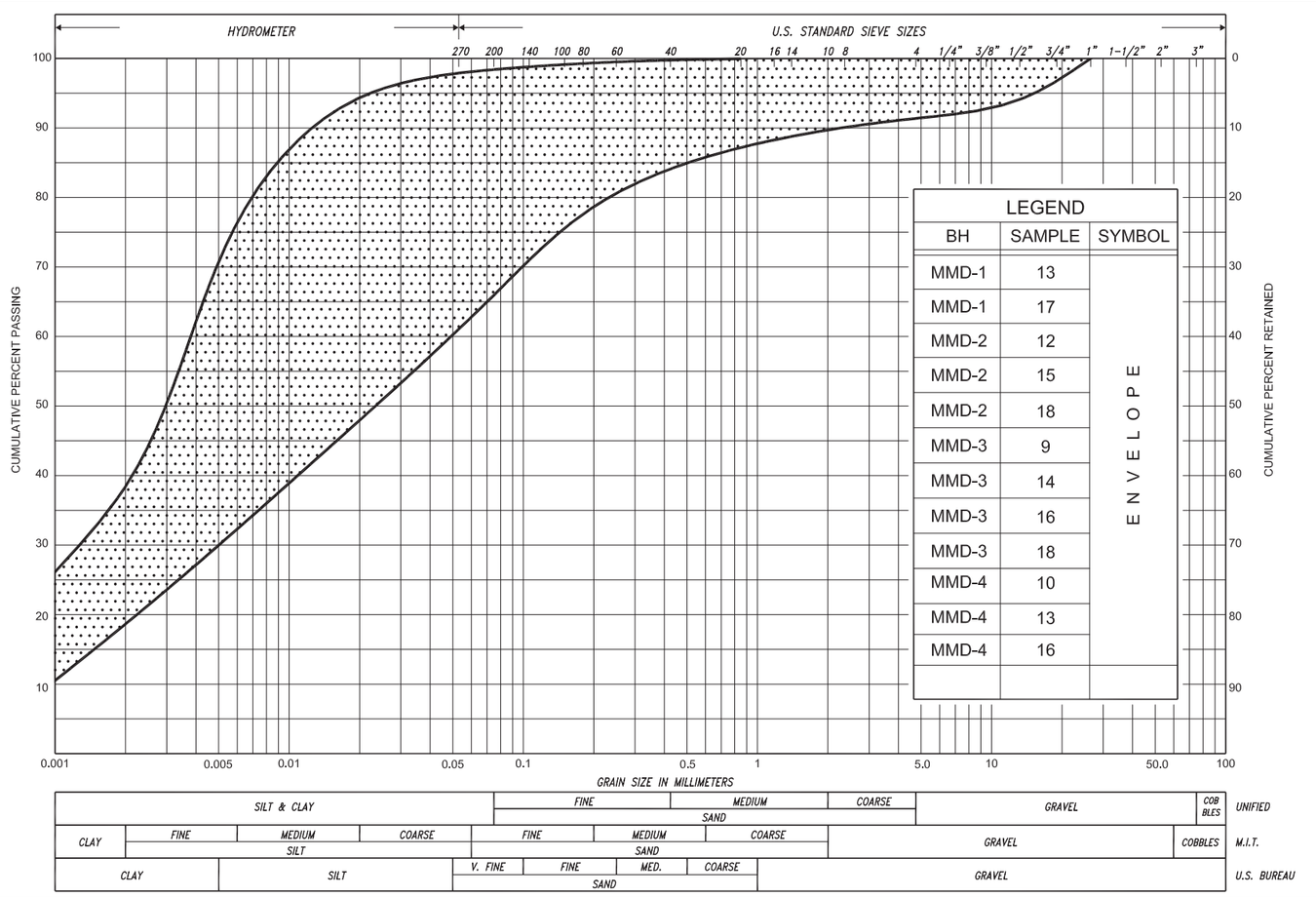


Ontario

GRAIN SIZE DISTRIBUTION

SILT and SAND (TILL)

FIG No.	H-3
HWY:	427
G.W.P. No.	

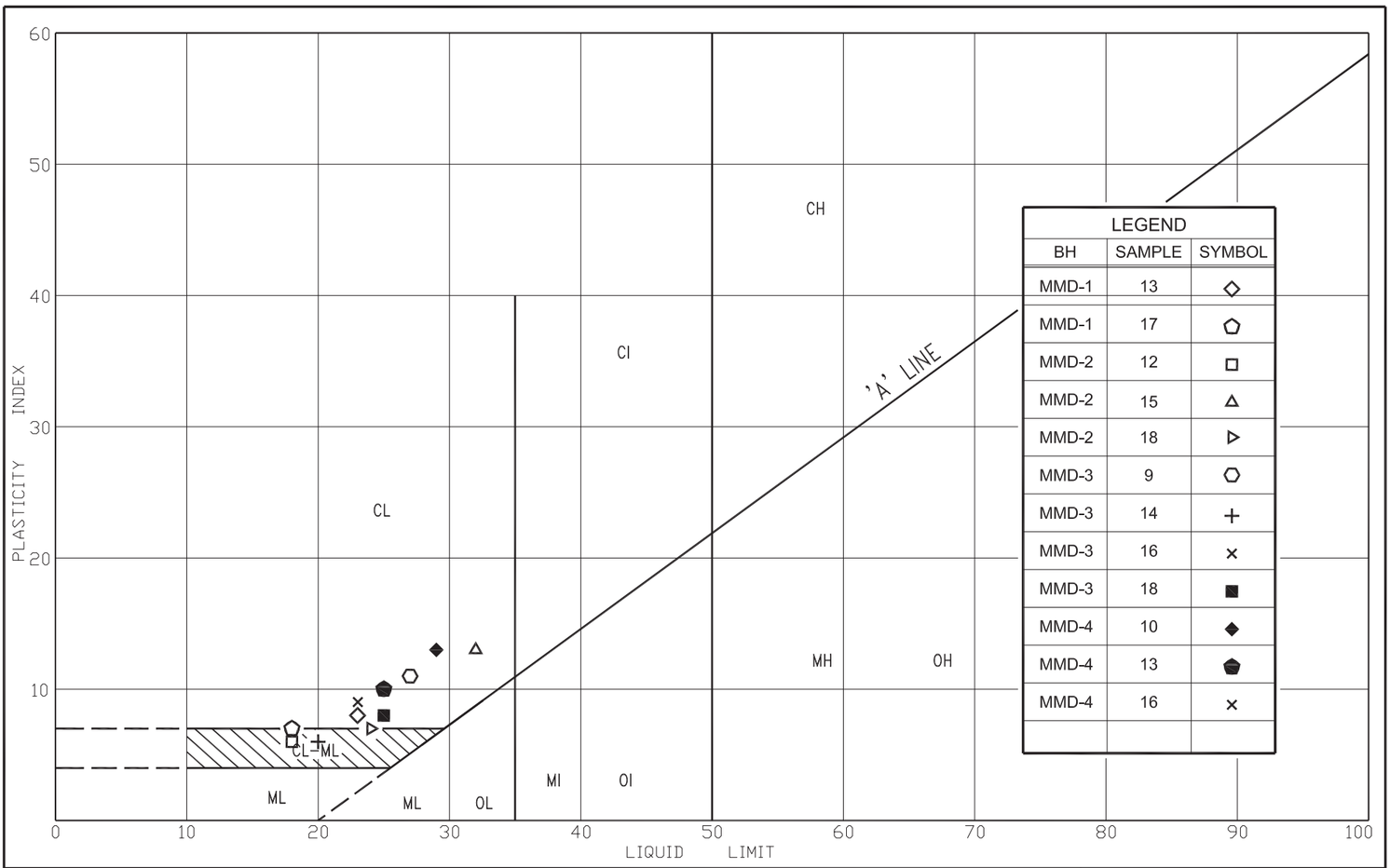


Ontario

GRAIN SIZE DISTRIBUTION

(SANDY) CLAYEY SILT (TILL)

FIG No.	H-4
HWY:	427
G.W.P. No.	

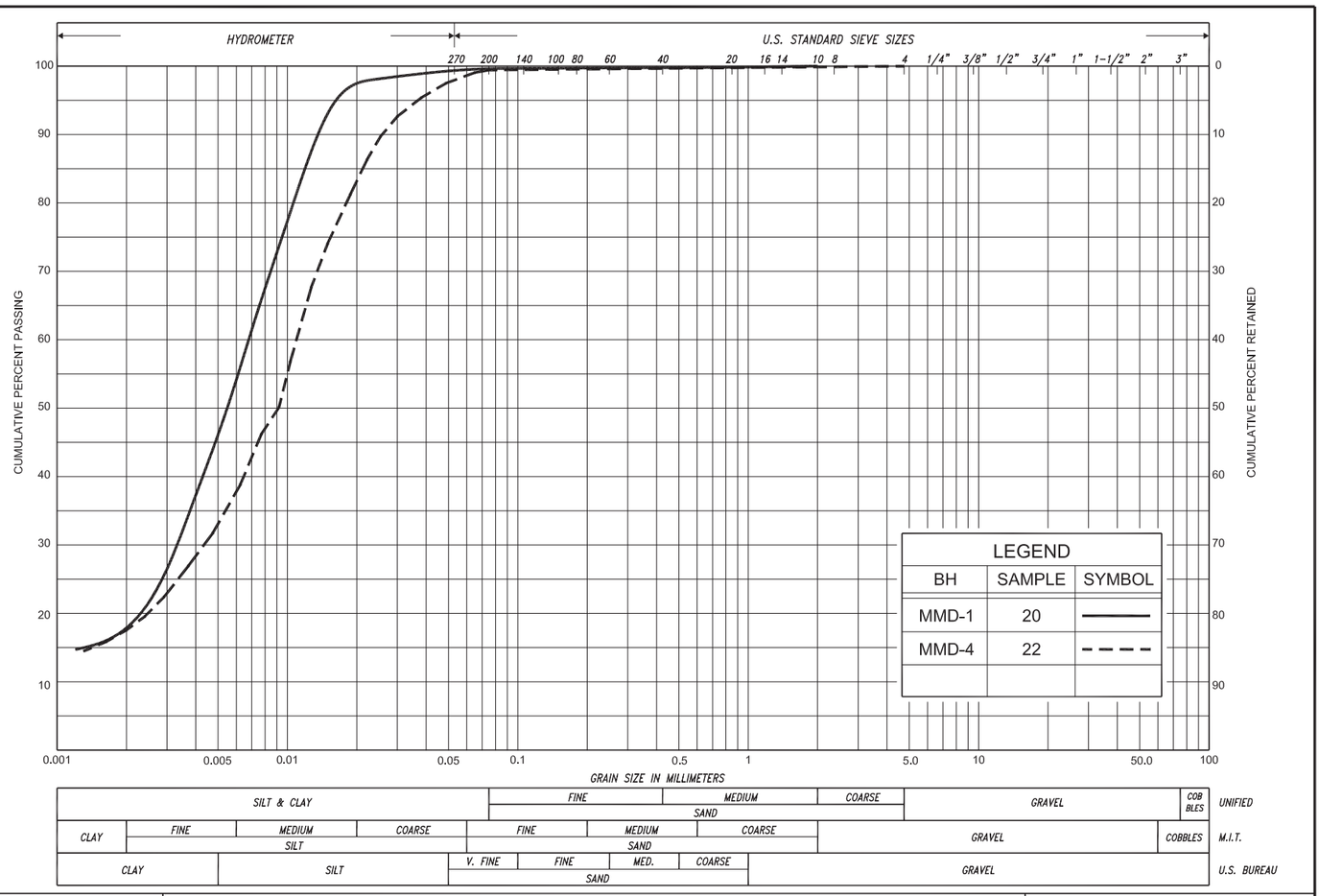


Ontario

PLASTICITY CHART

CLAYEY SILT (TILL)

FIG No.	H-5
HWY:	427
G.W.P. No.	

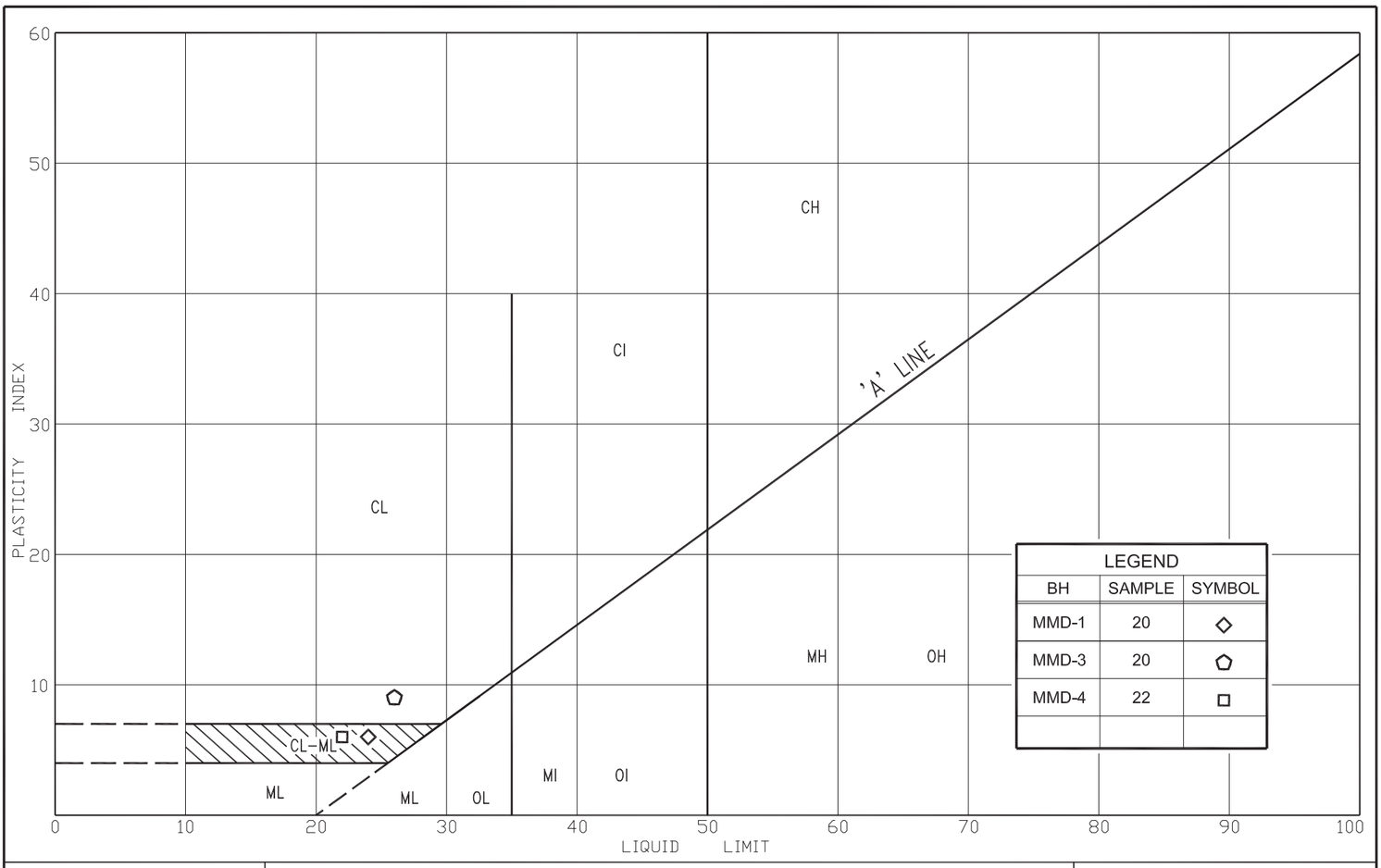


Ontario

GRAIN SIZE DISTRIBUTION

CLAYEY SILT - Lower

FIG No.	H-6
HWY:	427
G.W.P. No.	



Ontario

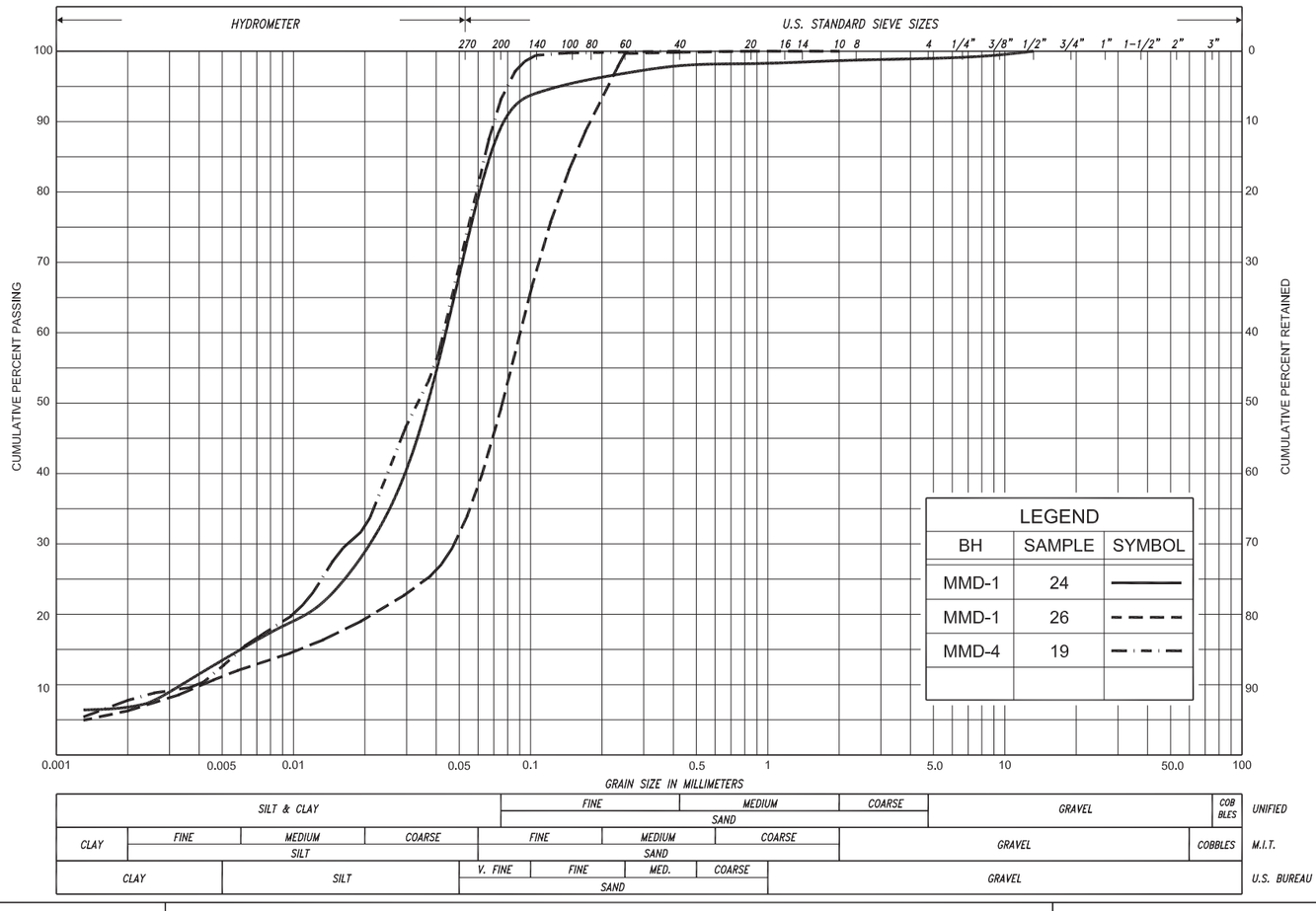
PLASTICITY CHART

CLAYEY SILT - Lower

FIG No. H-7

HWY: 427

G.W.P. No.



Ontario

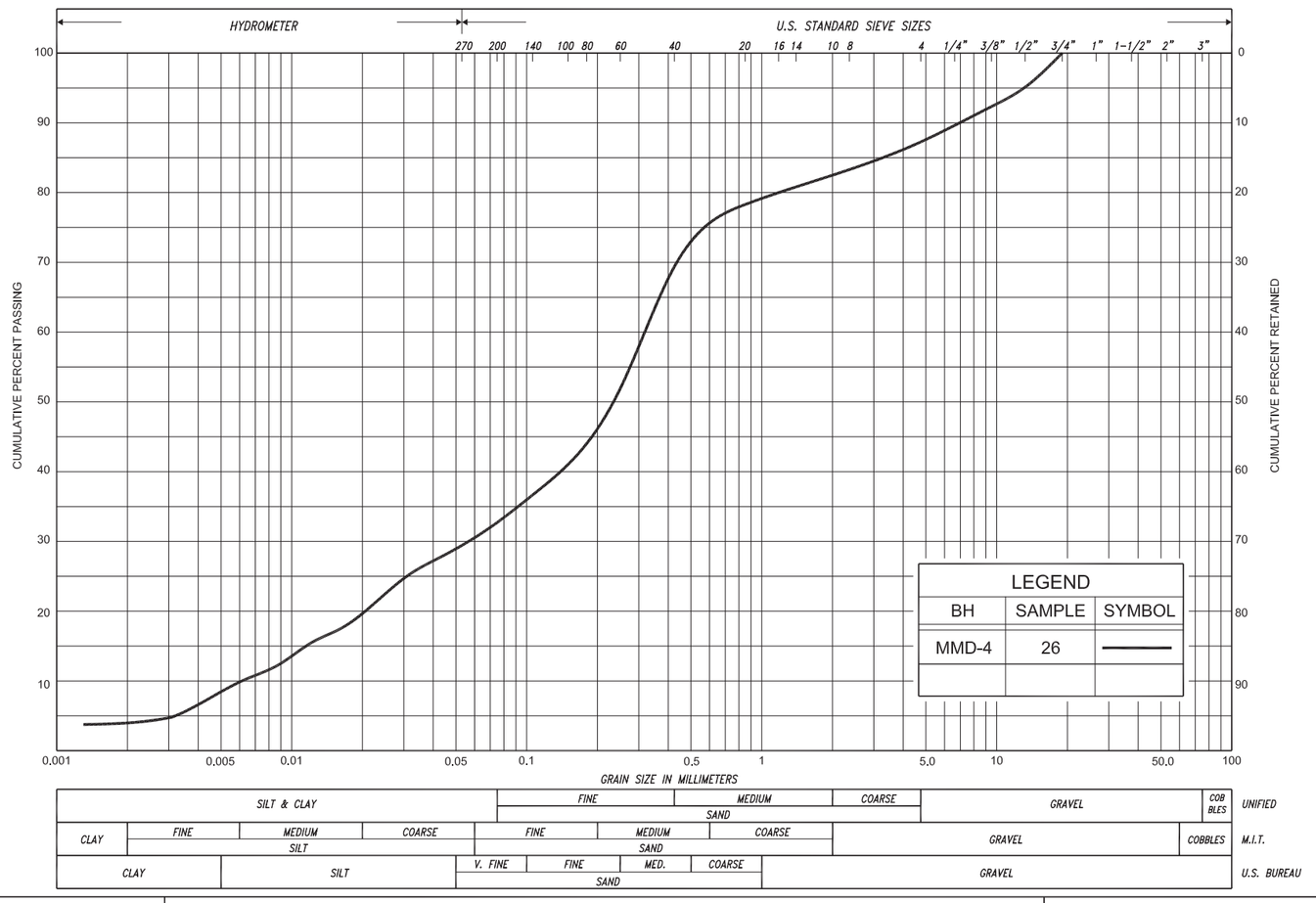
GRAIN SIZE DISTRIBUTION

SILT to SILT and SAND

FIG No. H-8

HWY: 427

G.W.P. No.



Ontario

GRAIN SIZE DISTRIBUTION

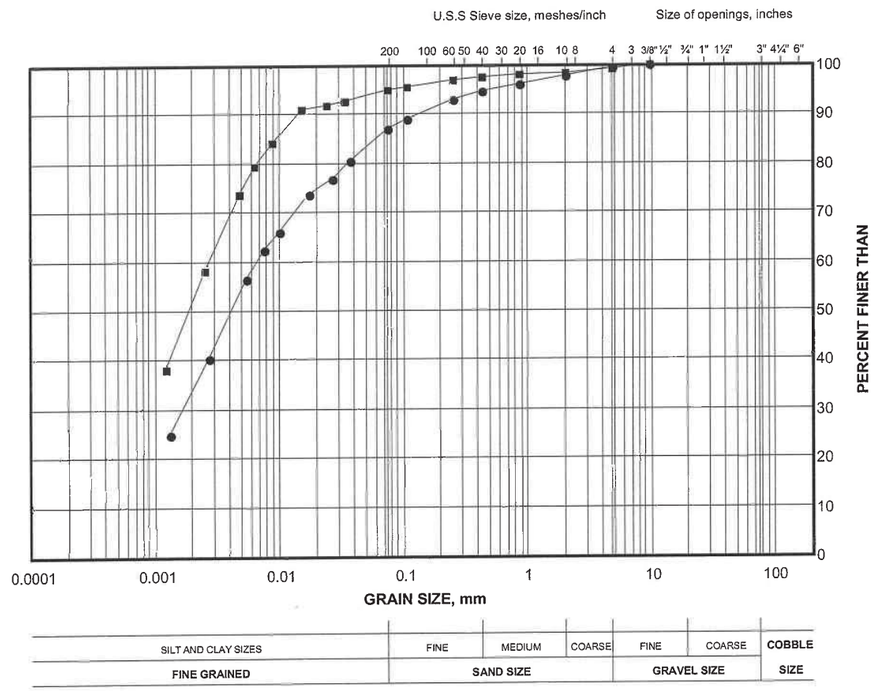
SAND and GRAVEL

FIG No.	H-9
HWY:	427
G.W.P. No.	

GRAIN SIZE DISTRIBUTION TEST RESULTS

Silty Clay Till

FIGURE B1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S34	3	202.6
■	S36	7	198.8

Project Number: 06-1111-012-2

Checked By: SM

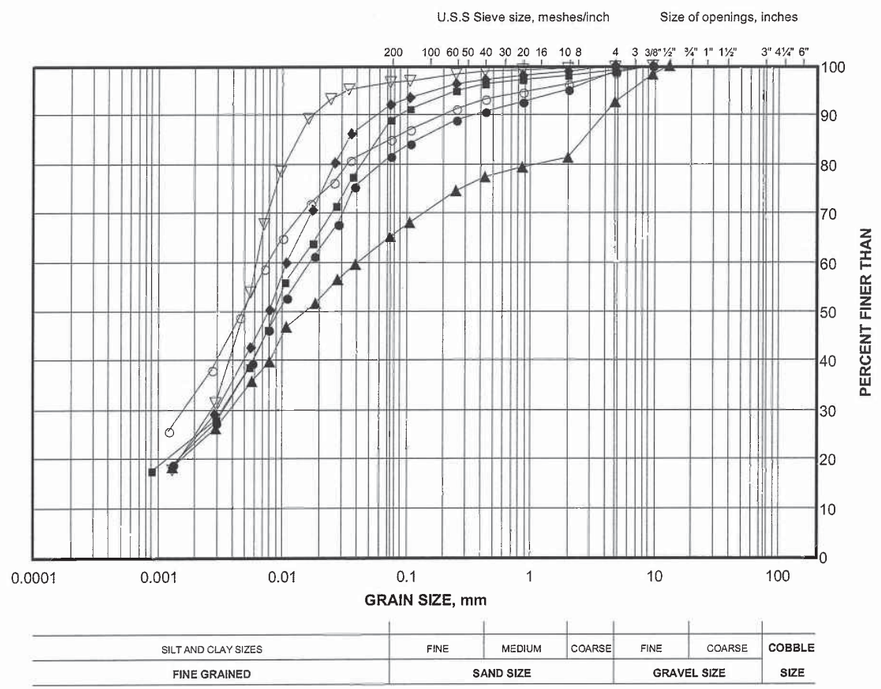
Golder Associates

Date: 29-May-09

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt Till

FIGURE B2



LEGEND

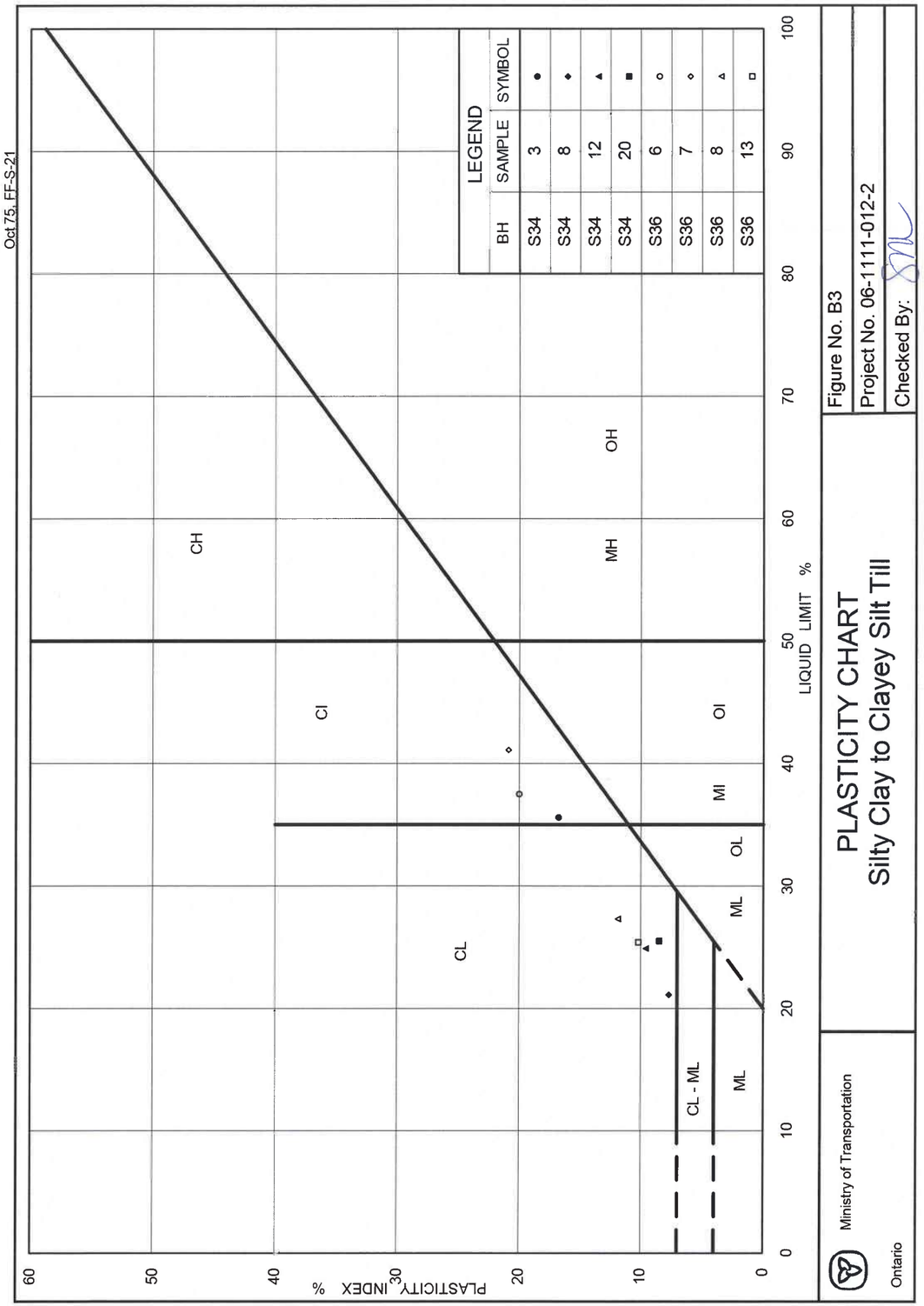
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S36	12	191.2
■	S34	12	191.2
◆	S36	13	189.7
▲	S34	16	185.1
▽	S34	20	179.0
○	S36	8	197.3

Project Number: 06-1111-012-2

Checked By: SM

Golder Associates

Date: 29-May-09



OEDOMETER CONSOLIDATION SUMMARY

Silty Clay Till

FIGURE B4
(Sheet 1 of 4)

SAMPLE IDENTIFICATION

Project Number	06-1111-012-2	Sample Number	7
Borehole Number	S36	Sample Depth, m	6.1-6.7

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	3		
Date Started	03/27/2009		
Date Completed	04/10/2009		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.54	Unit Weight, kN/m^3	20.23
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m^3	16.33
Area, cm^2	31.62	Specific Gravity, measured	2.77
Volume, cm^3	80.28	Solids Height, cm	1.526
Water Content, %	23.94	Volume of Solids, cm^3	48.25
Wet Mass, g	165.65	Volume of Voids, cm^3	32.03
Dry Mass, g	133.65	Degree of Saturation, %	99.9

TEST COMPUTATIONS

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t_{90} sec	cv. cm^2/s	mv m^2/kN	k cm/s
0.00	2.539	0.664	2.539				
4.70	2.529	0.657	2.534	1	1.36E+00	8.38E-04	1.12E-04
9.55	2.515	0.648	2.522	2	6.74E-01	1.18E-03	7.78E-05
19.44	2.514	0.647	2.514	12	1.12E-01	3.98E-05	4.36E-07
38.70	2.508	0.644	2.511	9	1.48E-01	1.15E-04	1.67E-06
77.55	2.495	0.635	2.501	9	1.47E-01	1.31E-04	1.89E-06
154.93	2.476	0.623	2.485	8	1.64E-01	9.72E-05	1.56E-06
309.49	2.448	0.604	2.462	8	1.61E-01	7.21E-05	1.13E-06
619.14	2.403	0.575	2.425	23	5.42E-02	5.70E-05	3.03E-07
1239.29	2.323	0.522	2.363	60	1.97E-02	5.09E-05	9.85E-08
2500.36	2.229	0.460	2.276	29	3.79E-02	2.94E-05	1.09E-07
1239.29	2.237	0.466	2.233				
309.49	2.294	0.503	2.265				
77.50	2.352	0.541	2.323				
19.44	2.403	0.575	2.378				
4.76	2.436	0.597	2.420				

Note:
k calculated using cv based on t_{90} values.

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

Sample Height, cm	2.44	Unit Weight, kN/m^3	21.02
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m^3	17.01
Area, cm^2	31.62	Specific Gravity, measured	2.77
Volume, cm^3	77.04	Solids Height, cm	1.526
Water Content, %	23.55	Volume of Solids, cm^3	48.25
Wet Mass, g	165.13	Volume of Voids, cm^3	28.79
Dry Mass, g	133.65		

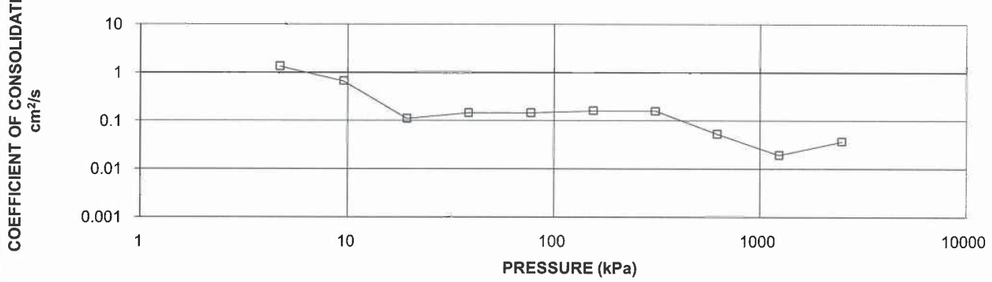
Prepared By: LH — **Golder Associates** — Checked By: MM

OEDOMETER CONSOLIDATION SUMMARY

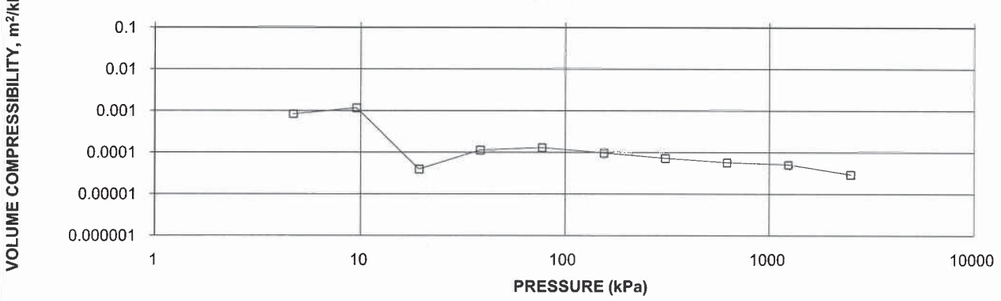
Silty Clay Till

FIGURE B4
(Sheet 2 of 4)

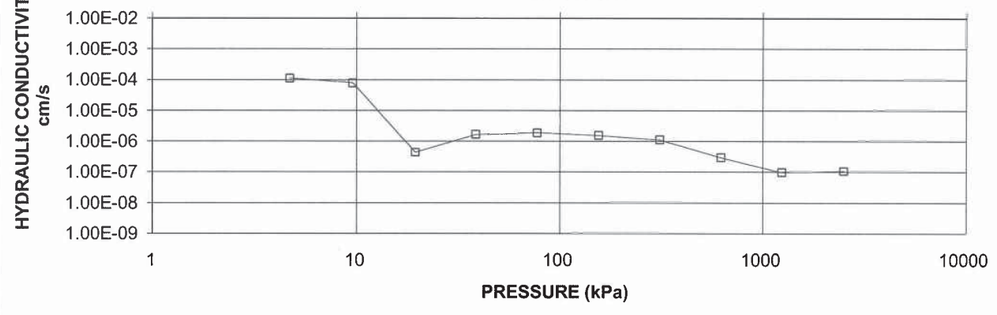
CONSOLIDATION TEST
CV cm^2/s VS PRESSURE (kPa)
BH S36 SA 7



CONSOLIDATION TEST
MV m^2/kN vs PRESSURE (kPa)
BH S36 SA 7



CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs PRESSURE
BH S36 SA 7

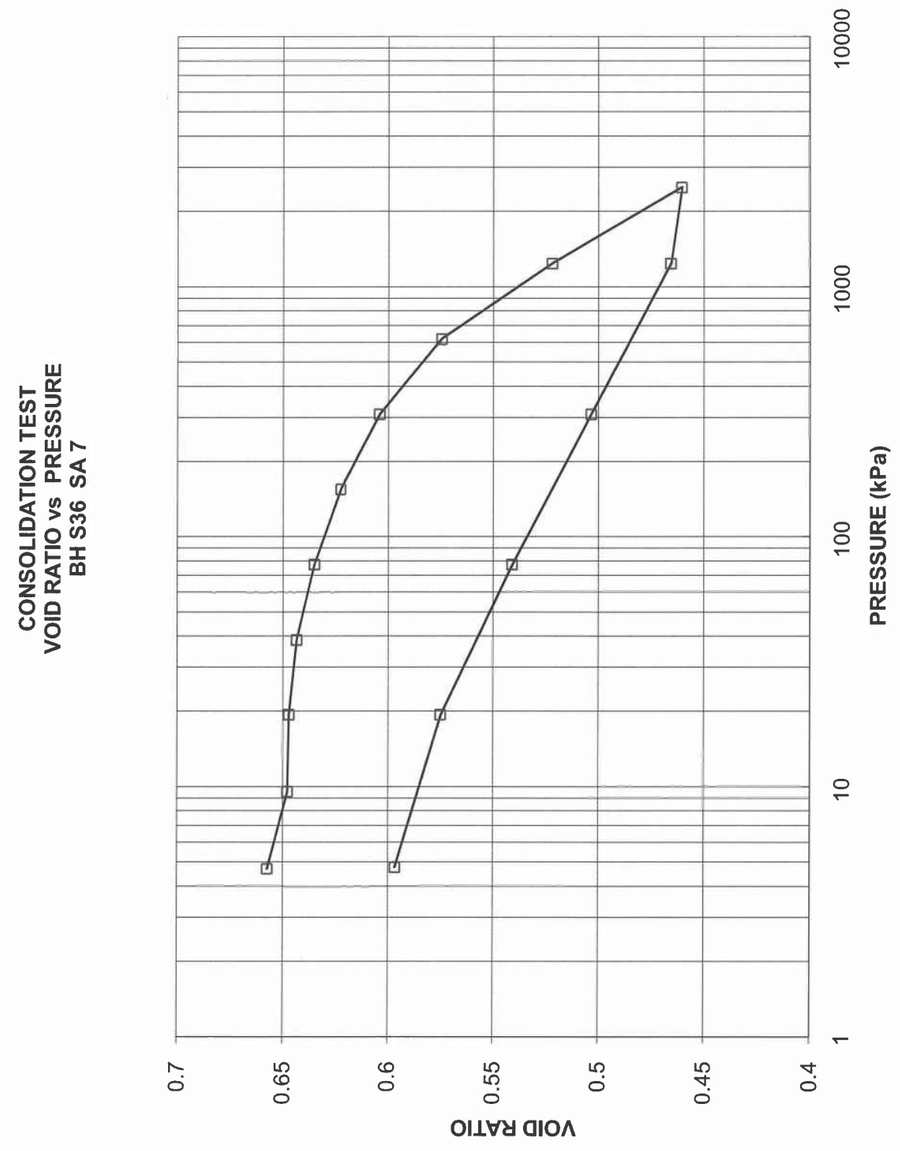


Project No. 06-1111-012-2
Prepared By: LH
Golder Associates
Checked By: MM

CONSOLIDATION TEST
VOID RATIO VS. LOG PRESSURE
Silty Clay Till

FIGURE B4
(Sheet 3 of 4)

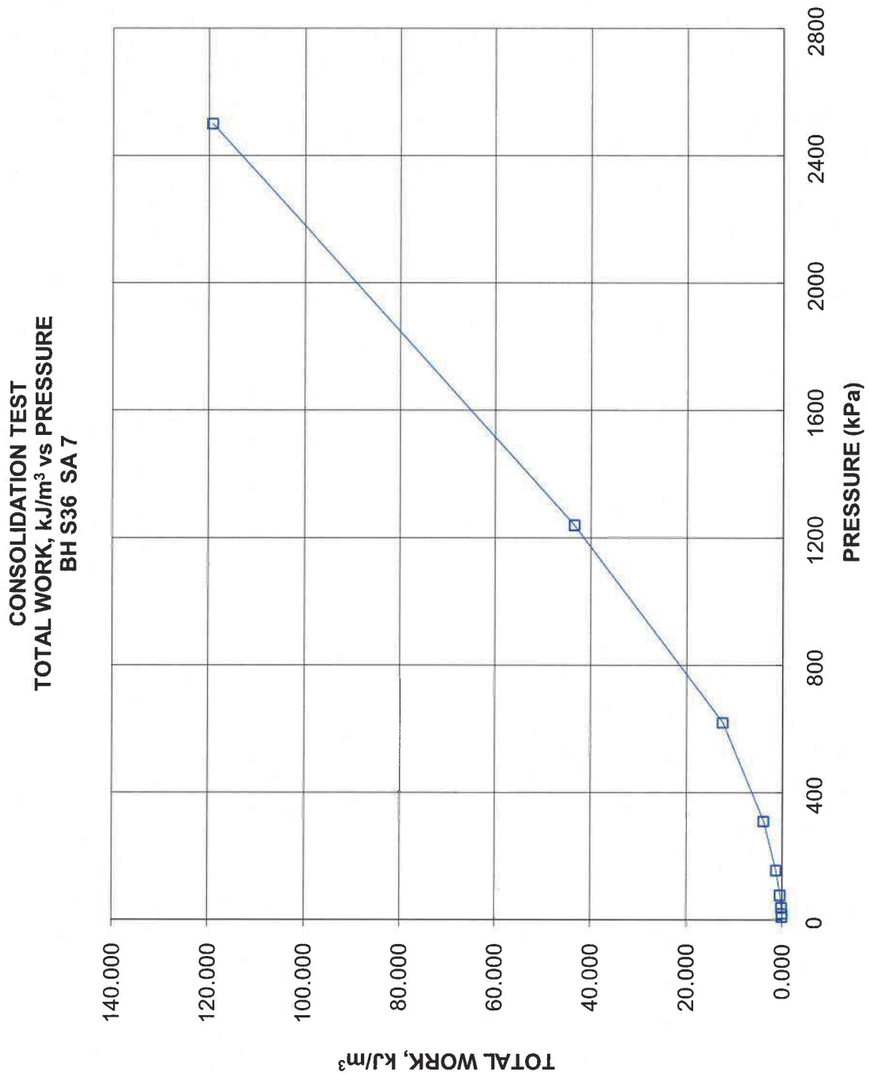
CONSOLIDATION TEST
VOID RATIO vs PRESSURE
BH S36 SA 7



Project No. 06-1111-012 -2
Prepared By: LH
Golder Associates
Checked By: MM

CONSOLIDATION TEST
TOTAL WORK VS. PRESSURE
Silty Clay Till

FIGURE B4
(Sheet 4 of 4)



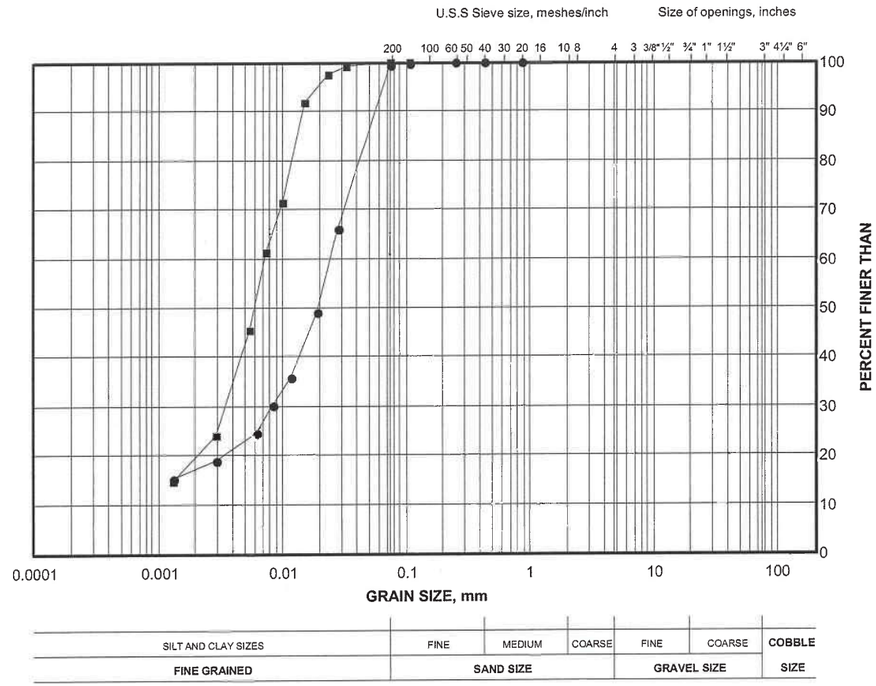
Project No. 06-1111-012-2
Prepared By: LH

Golder Associates

Checked By: MM

GRAIN SIZE DISTRIBUTION TEST RESULTS
Clayey Silt

FIGURE B5



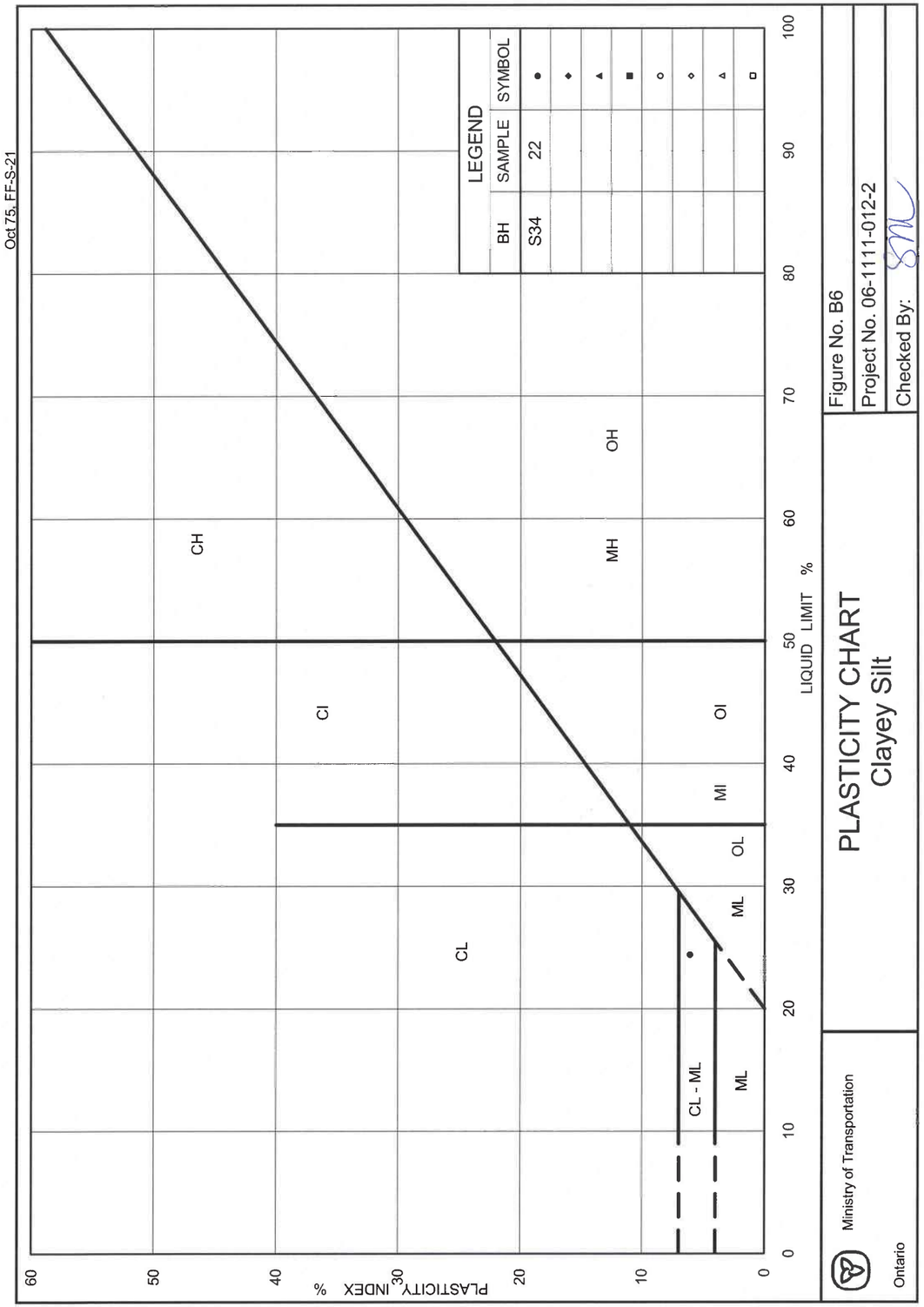
LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S34	21	177.5
■	S34	22	174.4

Project Number: 06-1111-012-2
Checked By: SM

Golder Associates

Date: 29-May-09



PLASTICITY CHART
Clayey Silt

Figure No. B6

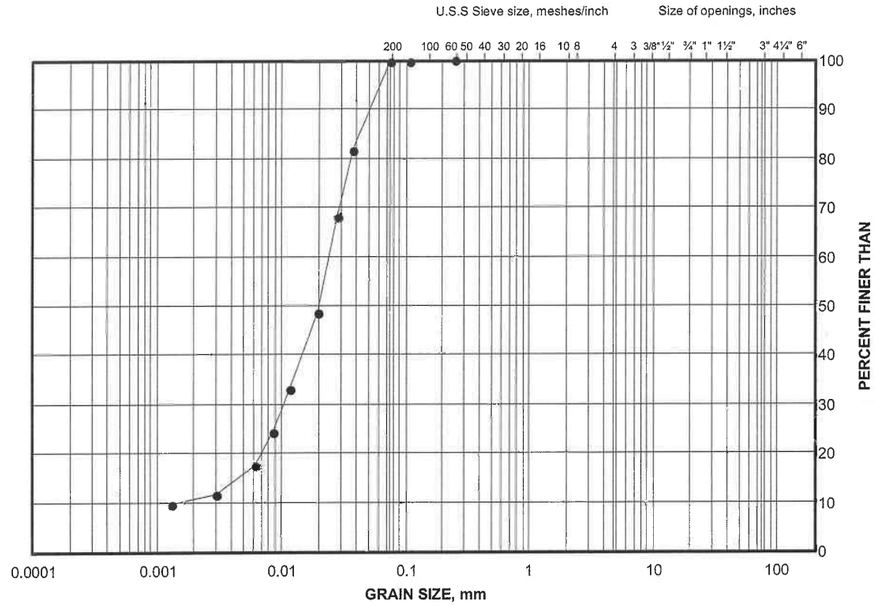
Project No. 06-1111-012-2

Checked By: SM

Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION TEST RESULT
Silt

FIGURE B7



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S34	26	165.3

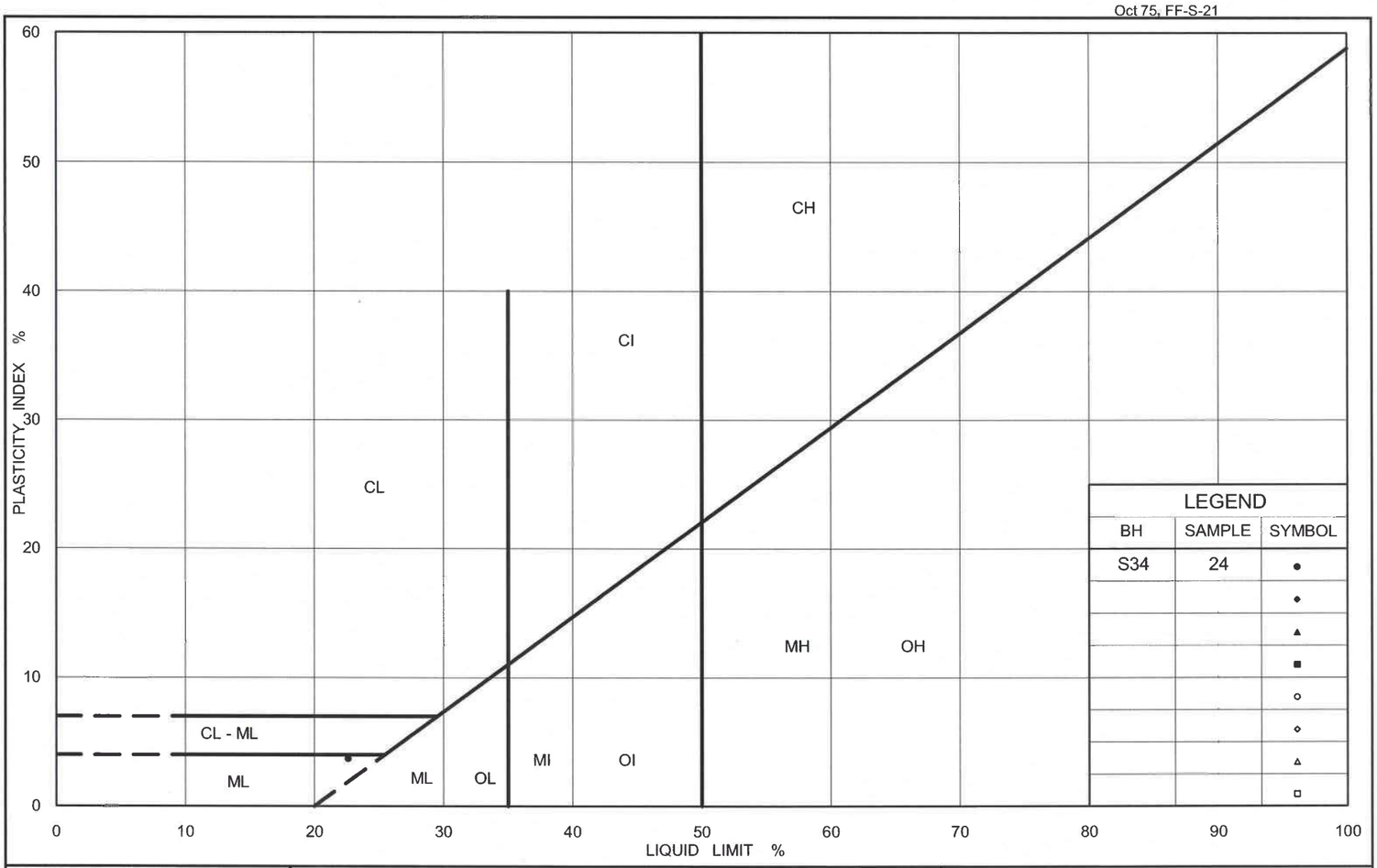
Project Number: 06-1111-012-2

Checked By: SM

Golder Associates

Date: 29-May-09

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
Silt

Figure No. B8

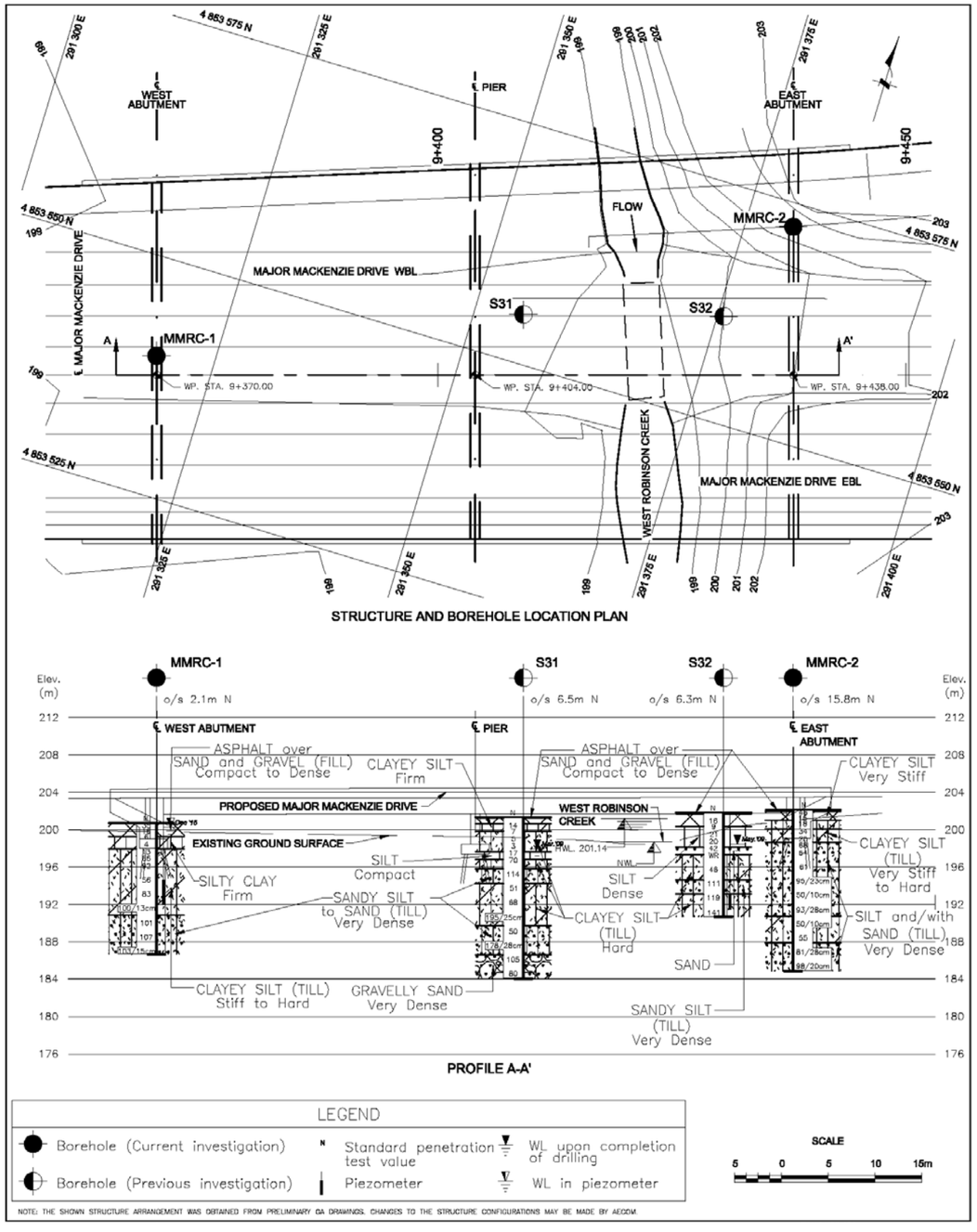
Project No. 06-1111-012-2

Checked By:

Structure Type: Bridge

Existing Ground Elevation across Boreholes: 202.1 m to 201.3 m

Complexity Rating: Medium



FOUNDATION INVESTIGATION

Site Description

The proposed structure is approximately 600 m west of Huntington Road and about 100 m north of Canadian Pacific Railway (CPR) in the City of Vaughan, Ontario. The proposed bridge will be located within the West Robinson Creek valley and floodplain area west of the creek. At this site creek is about 6 m wide and currently flows from north to south through a corrugated steel pipe culvert. It is noted that the eastbound lanes are located within CPR property and permission to enter was not provided for the field investigation.

Borehole Information

Borehole No.	Foundation Unit	MTM NAD 83 Coordinates		Ground Surface Elevation (m)	Borehole Depth (m)
		Northing (m)	Easting (m)		
Previous Investigation					
S31	Centre Pier	4,853,555.2	291,355.1	201.3	17.2
S32	Between Centre Pier and East Abutment	4,853,561.2	291,375.7	201.8	11.1
Current Investigation					
MMRC-1	West Abutment	4,853,539.6	291,318.9	200.7	14.0
MMRC-2	East Abutment	4,849,744.6	293,321.0	202.1	17.1

Subsurface Condition

***Pavement/ Non-cohesive Fill*:** Approximately 0.1 m to 0.2 m of asphalt was encountered immediately below ground surface in all boreholes at between Elevations 202.1 and 200.7 m. Below the asphalt, all boreholes penetrated a 1.2 m to 1.4 m thick layer of non-cohesive fill comprised of sand to sand and gravel at between Elevations 201.9 m and 200.5 m. The non-cohesive fill extends to 1.4 to 1.5 depths, Elevations 200.7 m to 199.2 m.

The SPT "N"-values ("N"-values) measured within the non-cohesive fill range from 14 to 46 blows, indicating a compact to dense compactness.

***Clayey Silt to Silty Clay*:** A 0.8 m to 2.2 m thick deposit of clayey silt to silty clay, trace to some sand, trace gravel was encountered below the fill in all boreholes at 1.4 m to 1.5 m depths, Elevations 200.7 m to 199.2 m. The deposit extends to 2.2 m to 3.7 m depths, Elevations 199.9 m to197.6 m.

The "N"-values measured within the cohesive deposit range from 3 to 21 blows, suggesting a soft to very stiff consistency.

Silt to Sand: Boreholes S31 and S32 penetrated 0.8 m and 2.1 m thick pockets of silt to sand underlying the clayey silt to silty clay deposit at 3.7 m depth, Elevations 197.6 m and 198.1 m. The deposit extends to 4.5 m to 5.8 m depths, Elevations 197.3 m to 196.0 m.

An "N"-value of 0 blows (weight of rod) was measured within the sand layer in Borehole S31, probably suggesting hydraulic disturbance during sampling. "N"-values of 17 and 42 blows were measured within the silt layer, indicating a compact to dense compactness.

***Clayey Silt Till*:** A 3.8 m to 7.0 m thick clayey silt till deposit was encountered at 2.2 m to 5.8 m depths, Elevations 199.9 m to 196.0 m in all boreholes and extends to 9.9 m to 15.1 m depths, Elevations 190.8 m to 187.0 m. The deposit contains interlayers and pockets of non-cohesive till in Boreholes S31, S32 and MMRC-2 at 3.7 m to 7.2 m depths, Elevations 198.4 m to 194.6 m. Borehole S32 was terminated within the cohesive till deposit at 11.1 m depth, Elevation 190.7 m.

The "N"-values measured within the cohesive till deposit range from 13 blows per 0.30 m of penetration to 195 blows per 0.23 m of penetration, suggesting a stiff to hard consistency. The results of grain size distribution analyses and Atterberg limits tests of selected cohesive till samples obtained during the current investigation are shown on Figures I-1 and I-2, respectively.

Sandy Silt to Sand Till: A 1.5 m to 9.8 m thick non-cohesive till deposit comprised of sandy silt to silt and sand to sand was encountered within and underlying the cohesive till deposit at depths ranging from 3.7 m to 9.9 m, between Elevations 198.4 m and 190.8 m. Boreholes MMRC-1 and MMRC-2 were terminated within this deposit at 14.0 m and 17.1 m depths, Elevations 186.7 m and 185.0 m.

The "N"-values measured within the non-cohesive till deposit range from 61 blows per 0.30 m of penetration to 178 blows per 0.23 m of penetration, indicating a very dense compactness. The results of grain size distribution analyses of selected non-cohesive till samples obtained during the current investigation is shown on Figure I-3.

***Gravelly Sand*:** Borehole S31 penetrated a 2.5 m thick gravelly sand deposit underlying the till deposit at 14.7 m depth, Elevation 186.6 m and terminated within this deposit at practical refusal at 17.2 m depth, Elevation 184.1 m.

"N"-values of 80 and 105 blows were measured within the gravelly sand deposit, indicating a very dense compactness.

Groundwater Conditions

The groundwater level in the piezometers installed in Boreholes S32 and MMRC-1 was measured at 3.4 m depth (Elevation 198.4 m) on May 5, 2009 and 2.9 m (Elevation 197.8 m) on December 23, 2015. The water level measured at 3.7 m and 3.4 m depths, Elevations 198.4 m and 197.9 m upon completion of drilling in Boreholes MMRC-2 and S31. For further details refer to Table A2.

FOUNDATION RECOMMENDATIONS

The following site-specific foundation recommendations are for preliminary design and planning purposes only .They require refinement during detail design. Project-wide foundation recommendations, design assumptions and limitations are contained in Part B of this report. The proposed two-span bridge structures will carry Major Mackenzie Drive over the West Robinson Creek.

Foundation Option	Advantages	Disadvantages	Relative Costs	Risks/Consequences
Spread footings on stiff to hard clayey silt till	• Conventional construction.	• Precludes use of integral abutments; • Provides relatively low bearing capacity; • Dewatering system and a cofferdam will be required during the construction.	• Lower relative cost compared to deep foundation options.	• Disturbing of subgrade due to excavation; • Environmental and constructability concerns associated with excavations in the floodplain.
Driven steel H-Piles to found within "100-blow" soils	• Allows for integral abutment design; • Negligible post-construction settlement.	• Piles may encounter obstructions during driving; • Access, dewatering and environmental issues for pile cap construction in the floodplain.	• More costly than spread footings.	• Minor potential for pile damage/ deflection if obstructions are encountered during pile driving.
Caissons founded within very dense sand and silt till	• Provides higher capacity than driven piles.	• Precludes use of integral abutments; • Drilling mud and tremie techniques required for installation; • Access, dewatering and environmental issues for caisson cap construction in the floodplain.	• More costly than driven steel H-piles.	• Risk of loosening or disturbing founding soils at base of caissons.

Spread Footings

Spread footings founded on native soils may be used to support abutments and pier. The preliminary geotechnical resistances are presented in the following table.

Foundation Unit	Founding Stratum	Axial Geotechnical Resistance		Highest Founding Elevation within Native Soils (m)
		Factored ULS (kPa)	SLS (kPa)	
West Abutment	Stiff to Hard Clay Silt Till	750	500	197.5
Centre Pier				196.5
East Abutment				197.0

Driven Steel H-Pile/ Steel Pipe Piles

Steel H-piles 310x110 and Steel pipe piles, 324 mm (12 ¾ in) outer diameter and 6 mm (1/4 in) thickness may be used to support the foundation elements. The preliminary geotechnical resistances and tip elevations are as follows:

Foundation Unit	Axial Geotechnical Resistance		Approximate Pile Tip Elevation (m)
	Factored ULS (kN)	SLS (kN)	
West Abutment	1,600	1,200	190
Centre Pier	1,600	1,200	187
East Abutment	1,600	1,200	192

Driven piles should be controlled by Hiley Formula as per MTO Drawing SS-103-11 from 2 m above the approximate pile tip elevations, employing a maximum load of twice the factored geotechnical resistance at ULS per pile. Piles should not be driven below Elevation 184 m without further investigation to prove the ground conditions below this elevation.

Caissons

Caissons founded within the very dense non-cohesive till may be considered for support of the abutments and pier although installation techniques below the groundwater table would be required. The preliminary geotechnical resistances are as follows:

Foundation Unit	Caisson Diameter (m)	Axial Geotechnical Resistance		Caisson Base Elevation (m)
		Factored ULS (kN)	SLS (kN)	
West Abutment	1.2	5,000	4,000	190
	1.5	6,500	5,000	
Centre Pier	1.2	5,000	4,000	187
	1.5	6,500	5,000	
East Abutment	1.2	5,000	4,000	192
	1.5	6,500	5,000	

Recommended Foundation Alternative

The recommended foundation alternative at this site is driven steel H-piles into the very dense non-cohesive till for the abutments and piers. Spread footings may also be used for abutments and piers, however a dewatering scheme will be required. Driven piles are preferred over caissons due to the presence of non-cohesive water bearing soils.

Structure Abutments and Approaches

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

Construction of the bridge will require placement of up to about 4.5 m and 2.5 m of fill within the limits of the west and east approach embankments, respectively.

Structure Retaining Walls/Wing Walls

The earth retaining walls for this structure may include Cast-in-Place (CIP) or RSS Walls. For RSS walls the facing should be founded on granular pad or CIP leveling pad. The retaining walls geometry should conform to High Appearance and High Performance in accordance with MTO.DSM 9.70 and current RSS Design Guidelines. The CIP retaining walls should be designed in conformance with spread footing recommendations in this report.

Stability of Approach Embankments

Approach embankments constructed of suitable earth fill or granular fill and up to about 4.5 m high are expected to be stable at side slopes formed at a maximum gradient of 2H:1V.

Settlement of Approach Embankments

The settlement within founding soils is estimated to be in the order of 50 mm, most of which will occur shortly following the fill placement. Based on preliminary estimations, consideration should be given to preloading the approach embankments for a period of two (2) months to mitigate the post-construction settlements.

Construction Considerations

Excavation

The construction of pile caps will require excavations up to about 2.0 m below the existing grade. These excavations will be made through firm to stiff cohesive or compact non-cohesive soils which are classified as Type 3 soils in OHSA. Temporary unsupported excavations above the prevailing groundwater in these soils should be made with side slopes no steeper than 1H:1V. Consideration should be given to utilizing a cofferdam for excavations within the creek floodplain.

Surface Water / Groundwater Control

Surface water run-off and the West Robinson Creek flow should be diverted away from the excavations at all times. The prevailing groundwater should be maintained a minimum of 0.5 m below the base of excavations. The groundwater level was at 2.9 m depth below the existing Major Mackenzie Drive, Elevation 197.8 m. The excavation for the construction of west abutment is expected to be at the groundwater level and the groundwater inflow is expected to be handled by pumping from properly filtered sumps placed at the base of excavation.

It is expected that excavations for construction of foundation elements in the floodplain will extend below the prevailing groundwater and creek water level, and a dewatering scheme (e.g. use of a stream diversion around excavations and installation of a cofferdam) will be required during the excavations.

Pile Installation / Caisson Construction

It is anticipated that cobbles and/or boulders will be encountered within the till deposits, which may adversely impact the installation of steel H-piles or caissons. Piles should be equipped with flange plates or approved driving shoes.

Water-bearing non-cohesive native soils should be expected to run or flow into the caisson hole during and after the drilling for caisson foundations and as such, appropriate equipment and procedures (including use of temporary or permanent caisson liners, and/or use of drilling mud) will be required to minimize ground loss during drilling and concrete placement.

Recommendation for Additional Work

Further subsurface investigation should be carried out during the detail design to confirm the subsoil and groundwater conditions at the location of approach embankments. In particular, subsurface investigation should be carried out at the south side of the foundation elements located in the CPR property.

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No MMRC-1 1 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 853 539.6 N; 291 318.9 E ORIGINATED BY F.P.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE October 13, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
200.7	Ground Surface										
200.5	ASPHALT (150mm)										
0.2	SAND and GRAVEL Compact to dense Brown and grey Moist (FILL)		1	SS	35				○		
			2	SS	16				○		
199.2											
1.5	SILTY CLAY, trace sand, trace gravel Firm Dark brown to brown Moist to wet		3	SS	6				○		
			4	SS	4				○		
197.8											
2.9	CLAYEY SILT, with sand to sandy, trace to some gravel Stiff to hard Grey Moist (TILL)		5	SS	13	▽			○		First groundwater strike at 2.9m 13 35 40 12
			6	SS	66				○		
			7	SS	92				○		
			8	SS	56				○		7 25 54 14
			9	SS	83				○		
			10	SS	100/13cm				○		
190.8											
9.9	SANDY SILT, trace to some gravel, trace clay Very dense Grey Moist to wet (TILL)		11	SS	101				○		5 31 61 3
			12	SS	107				○		
			13	SS	103/15cm	▼			○		
186.7											
14.0	End of borehole										

Cont'd

+⁷, ×⁵: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No MMRC-1 2 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 853 539.6 N; 291 318.9 E ORIGINATED BY F.P.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE October 13, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
185.7											

Monitoring Well Legend:

- Flush mount + Concrete
- Bentonite seal
- Filter sand
- 50mm dia. screen
- Filter bed
- Bentonite
- Water level noted during drilling
- Water level measured in piezometer

Note:

1. Groundwater level measurments in piezometer measured at a depth of 3.7m and 29m below groundwater surface (Elev. 197.0m and 197.8m, respectively).

Monitoring Well Readings:

Date	Depth (m)	Elev. (m)
13/10/15	3.7	197.0
23/12/15	2.9	197.8

+⁷, ×⁵: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No MMRC-2 1 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 849 744.6 N; 293 321.0 E ORIGINATED BY M.Kh

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 09, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)		WATER CONTENT (%) (10 20 30)			GR SA SI CL
202.1	Ground Surface						202						
201.9	ASPHALT (150mm)												
0.2	SAND and GRAVEL Compact to dense Brown and grey Moist		1	SS	46								
			2	SS	15		201						
200.7	(FILL)												
1.4	CLAYEY SILT, trace to some sand, trace gravel Very stiff Brown Moist		3	SS	18								
199.9							200						
2.2	CLAYEY SILT, with sand, trace gravel Very stiff to hard Brown to grey Moist to wet		4	SS	34								
	(TILL)		5	SS	25	▼	199						4 14 51 31
198.4													
3.7	SILT and SAND to SILT, with sand, trace clay, trace gravel Very dense Grey Wet		6	SS	68		198						
	(TILL)		7	SS	64		197						0 49 48 3
	containing sand and gravel		8	SS	61		196						
			9	SS	95/23cm		195						3 63 28 6
			10	SS	50/10cm		194						
			11	SS	93/28cm		193						
							192						
							191						
190.6													
11.5	CLAYEY SILT, some sand, trace gravel Hard Grey Moist		12	SS	50/10cm		190						2 19 57 22
	(TILL)						189						
			13	SS	55		188						
	Cont'd												

+⁷, ×⁵: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No MMRC-2 2 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 849 744.6 N; 293 321.0 E ORIGINATED BY M.Kh

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 09, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)		WATER CONTENT (%) (10 20 30)			GR SA SI CL
187.1													
187.0	SAND, with silt, some gravel, trace clay Very dense Grey Moist		14	SS	81/28cm		187						16 55 25 4
15.1	(TILL)												
185.0			15	SS	98/20cm		186						
17.1	End of borehole ▼ Water level measured upon completion						185						

Notes:

1. Groundwater level measured at a depth of 3.7m below groundwater surface (Elev. 198.4) upon completion of drilling.

2. Upon completion of drilling, the borehole did not cave-in

+⁷, ×⁵: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No S31

1 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4853555.2 ;E 291355.1
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 19, 2009

ORIGINATED BY SB
COMPILED BY VA
CHECKED BY SMM

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
201.3	GROUND SURFACE						201				
0.9	Asphalt										
0.4	Sand, trace to some gravel, trace clay (FILL) Compact Brown Moist		1	SS	14						
199.9							200				
1.5	CLAYEY SILT with sand, trace gravel, containing oxidation zones to a depth of 3.0 m Firm Brown Moist		2	SS	7						
			3	SS	5		199				
197.6			4	SS	3	▽	198				
3.7	SILT, some sand, trace gravel, containing clay seams Compact Brown to grey Moist to wet		5	SS	17						1 16 81 2
196.8							197				
4.5	CLAYEY SILT with sand, trace gravel (TILL) Hard Grey Moist		6	SS	70						
195.8							196				
5.5	SAND and SILT, trace to some gravel, trace clay (TILL) Very dense Grey Moist		7	SS	114						8 41 42 9
194.2							195				
7.1	CLAYEY SILT, some sand, trace gravel, containing cobbles and boulders (TILL) Hard Grey Moist		8	SS	51						
							194				
			9	SS	68						
							193				
			10	SS	95/0.2						1 15 68 16
	Containing cobbles and boulders between depths of 11.0 m and 11.4 m						192				
189.7											
11.6	SAND, some gravel, trace to some silt, trace clay (TILL) Very dense Grey Moist becoming wet below a depth of 12.2 m		11	SS	50		191				
							190				
			12	SS	78/0.2						20 72 7 1
							189				
							188				
186.6							187				
14.7											

Continued Next Page

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

Foundation Design

Golder Associates

RECORD OF BOREHOLE No S31

2 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4853555.2 ;E 291355.1
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 19, 2009

ORIGINATED BY SB
COMPILED BY VA
CHECKED BY SMM

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
	— CONTINUED FROM PREVIOUS PAGE —										
	GRAVELLY SAND, trace to some silt, trace clay Very dense Grey and black Wet		13	SS	105		186				28 64 7 1
							185				
184.1			14	SS	80						
17.2	END OF BOREHOLE NOTES: 1. Water level in open borehole at a depth of 3.4 m below ground surface (Elev. 197.9m) upon completion of drilling. 2. Borehole backfilled with bentonite.										

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

Golder Associates

RECORD OF BOREHOLE No S32

1 OF 1 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4853561.2 ;E 291375.7
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 18, 2009

ORIGINATED BY SB
COMPILED BY VA
CHECKED BY SMM

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 ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
201.8	GROUND SURFACE						201				
0.9	Asphalt										
	Sand, trace to some gravel, trace clay (FILL) Compact Brown Moist		1	SS	16						
200.4							200				
1.5	SILTY CLAY, trace to some sand Stiff to very stiff Brown to grey Moist		2	SS	9						
			3	SS	21		199		46		
			4	SS	20	▽					
198.1							198				
3.7	SILT, trace sand, containing clay seams Dense Grey Moist		5	SS	42						0 2 91 7
197.3							197				
4.5	Containing oxidation zones to a depth of 3.8 m SAND, trace to some silt Loose Grey Wet		6	SS	WR	▽					
196.0							196				
5.8	CLAYEY SILT, some sand, trace gravel (TILL) Hard Grey Moist		7	SS	46						
194.6							195				
7.2	Sandy SILT, trace gravel, trace clay (TILL) Very dense Grey Moist		8	SS	111		194				2 19 75 4
193.1							193				
8.7	CLAYEY SILT, some sand, trace gravel (TILL) Hard Grey Moist		9	SS	119						
			10	SS	141		192				
190.7							191				
11.1	END OF BOREHOLE										

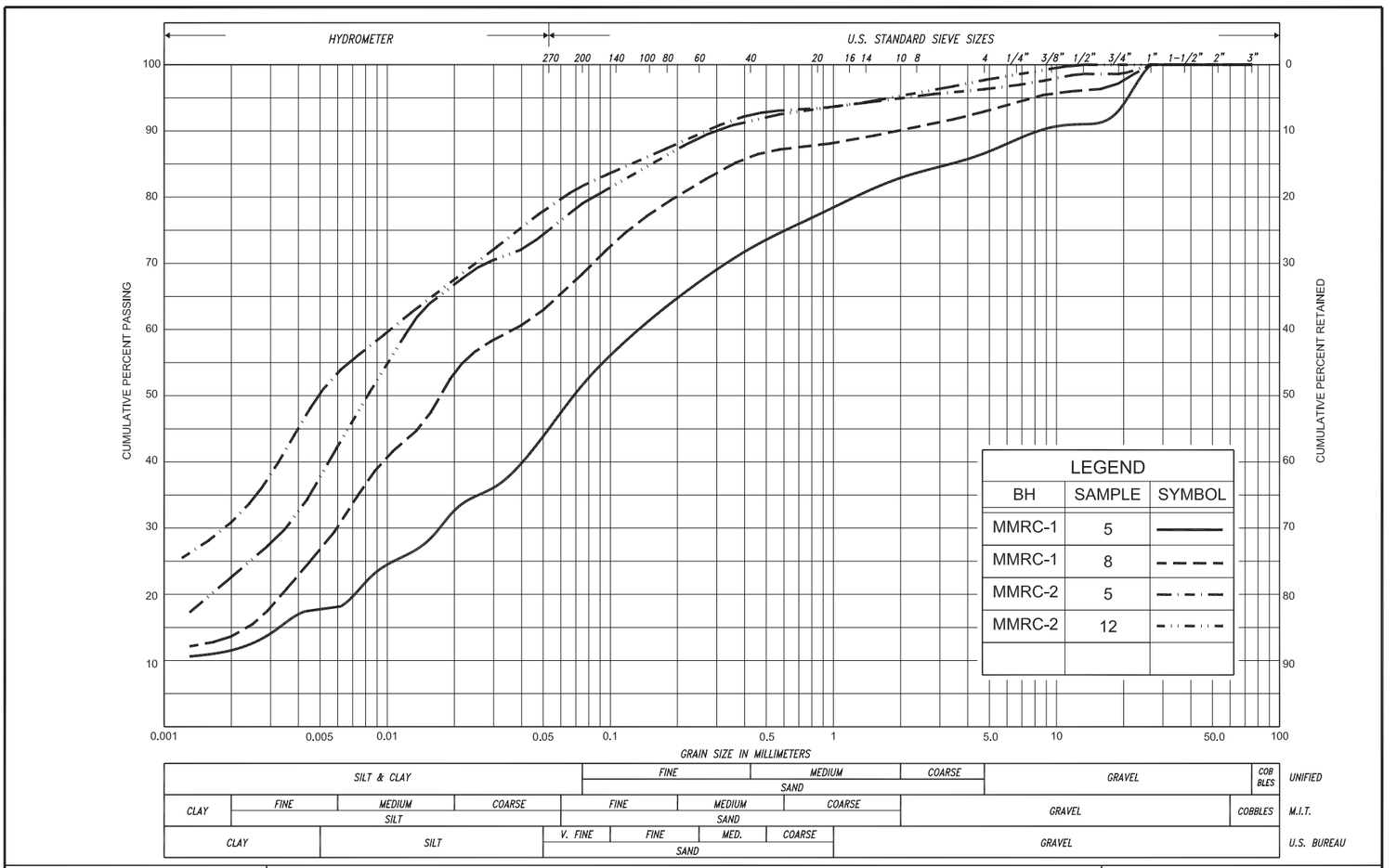
NOTES:

1. A 50 mm diameter monitoring well was installed at a depth of 10.4 m (Elev. 191.4 m).

Water level measurements

Date	Depth	Elev.
On Completion	4.9 m	196.9 m
April 24, 2009	3.1 m	198.7 m
May 13, 2009	3.4 m	198.4 m
May 25, 2009	3.4 m	198.4 m

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

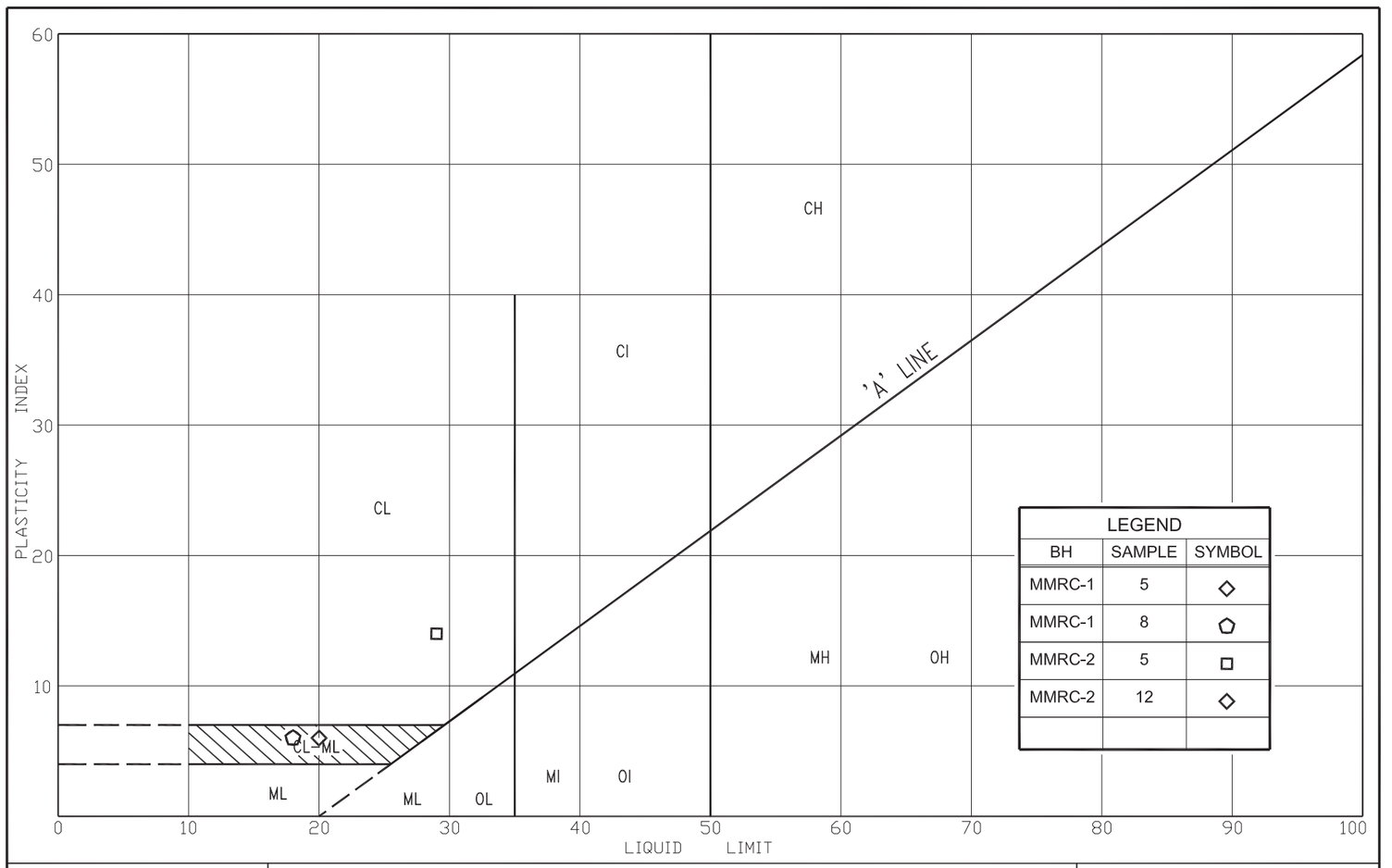


Ontario

GRAIN SIZE DISTRIBUTION

CLAYEY SILT (TILL)

FIG No.	I-1
HWY:	427
G.W.P. No.	

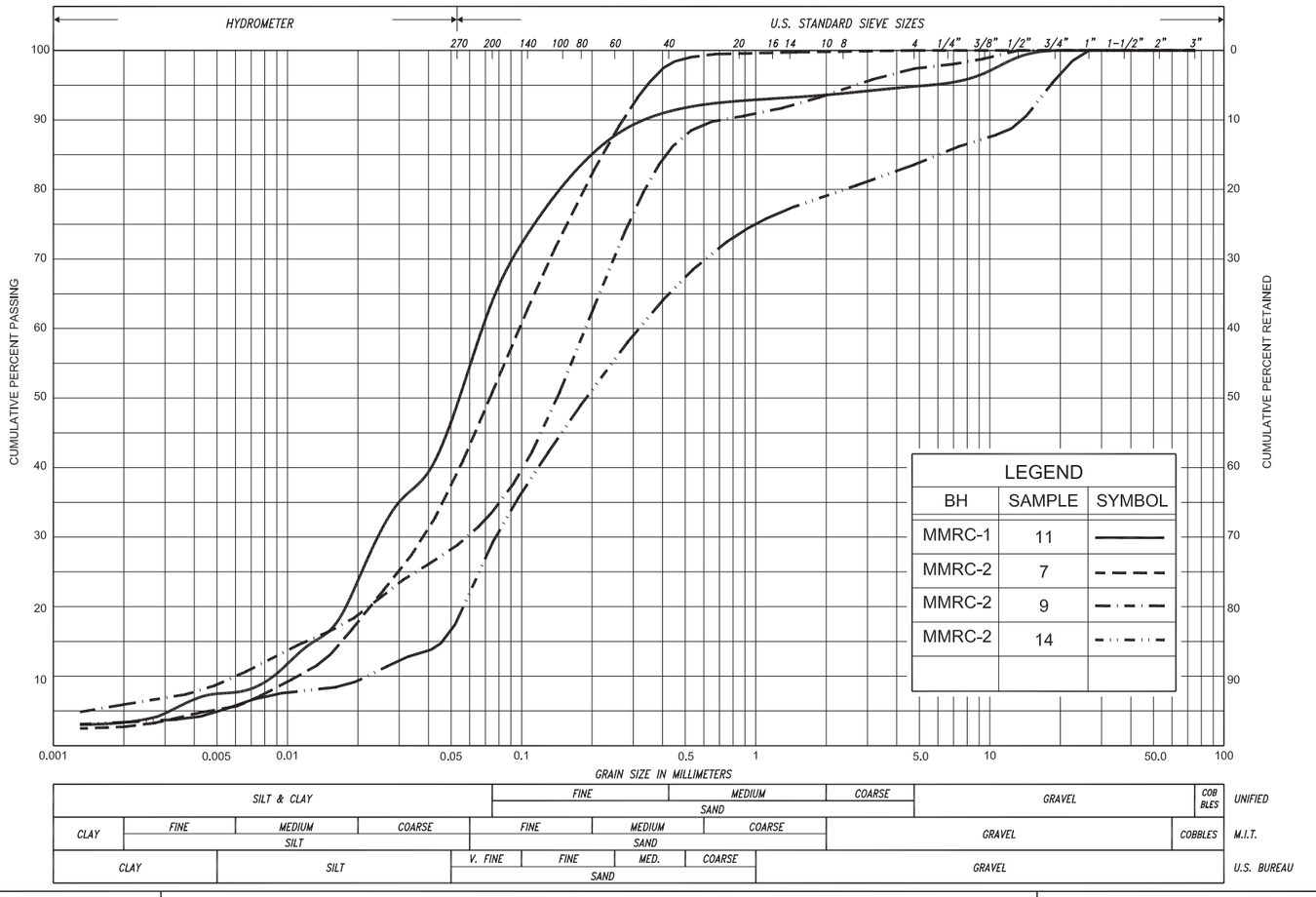


Ontario

PLASTICITY CHART

CLAYEY SILT (TILL)

FIG No.	I-2
HWY:	427
G.W.P. No.	

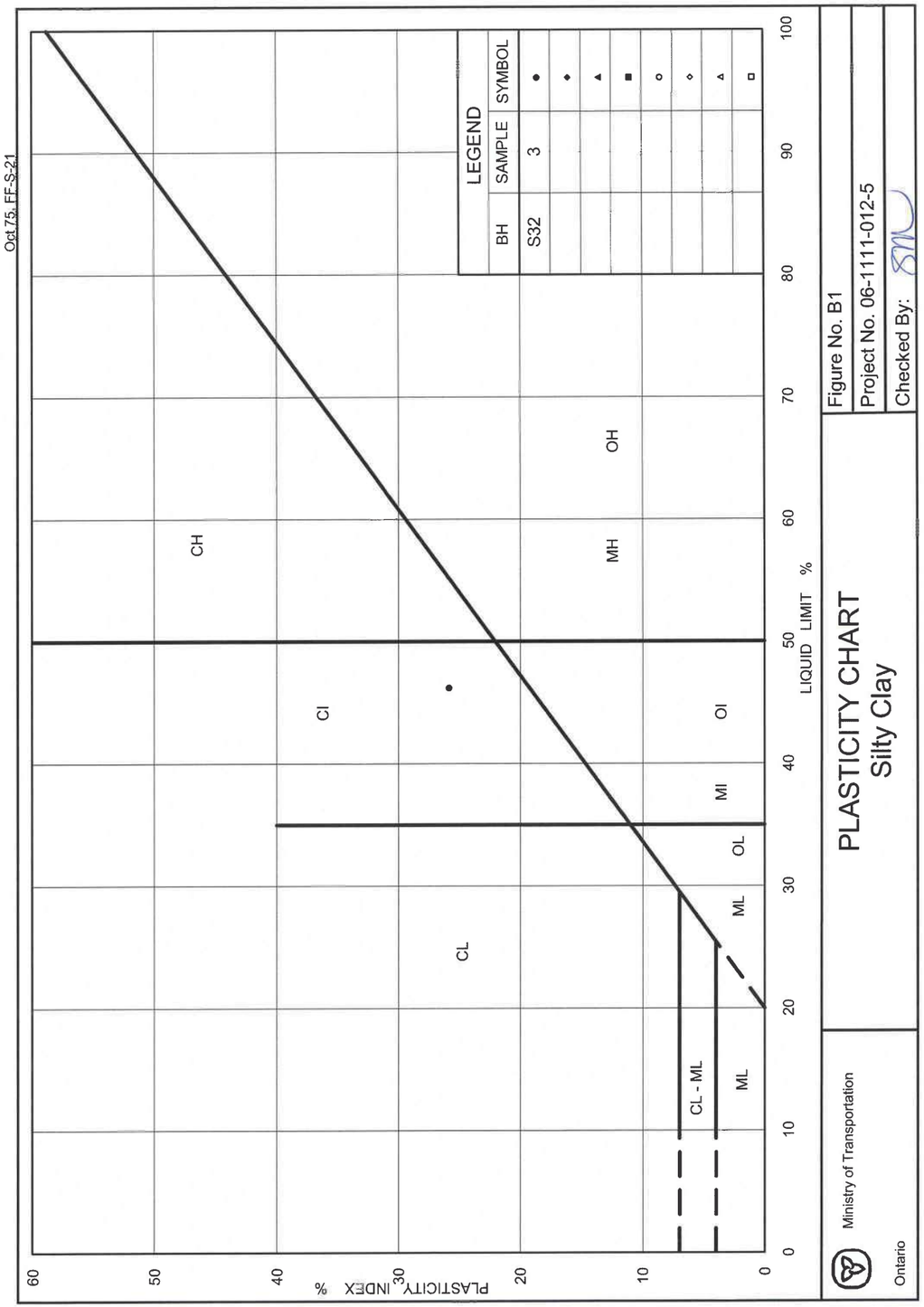


Ontario

GRAIN SIZE DISTRIBUTION

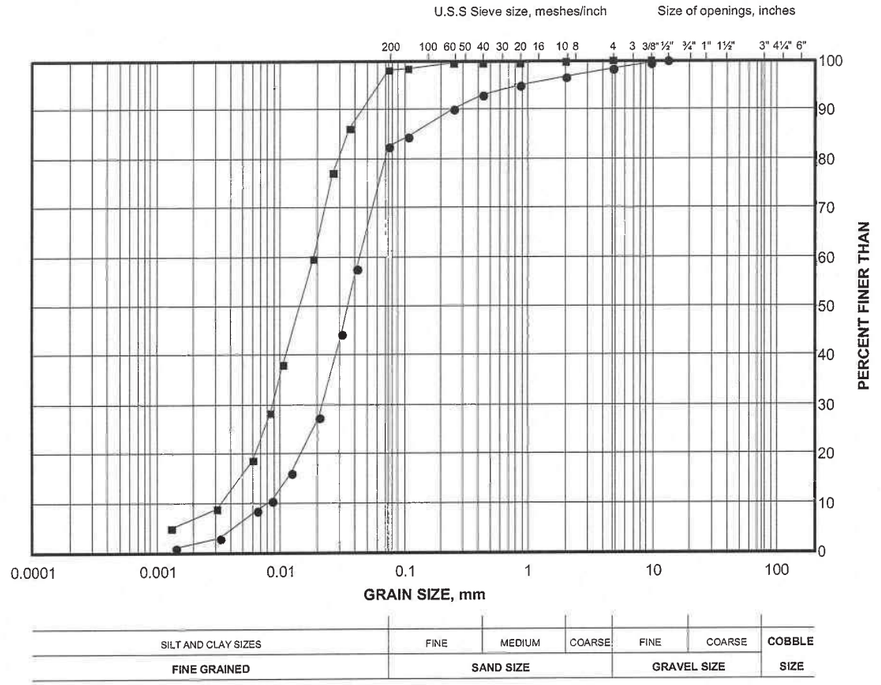
SILT, with sand to SAND, with silt (TILL)

FIG No.	I-3
HWY:	427
G.W.P. No.	



GRAIN SIZE DISTRIBUTION TEST RESULTS
Silt

FIGURE B2



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S31	5	197.2
■	S32	5	197.7

Project Number: 06-1111-012-5

Checked By: SM

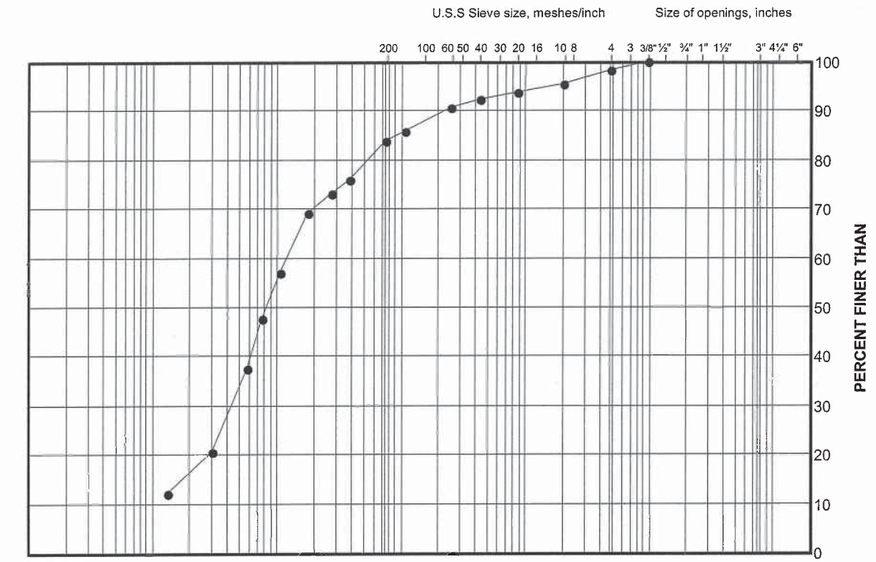
Golder Associates

Date: 29-May-09

GRAIN SIZE DISTRIBUTION TEST RESULT

Clayey Silt Till

FIGURE B3



LEGEND

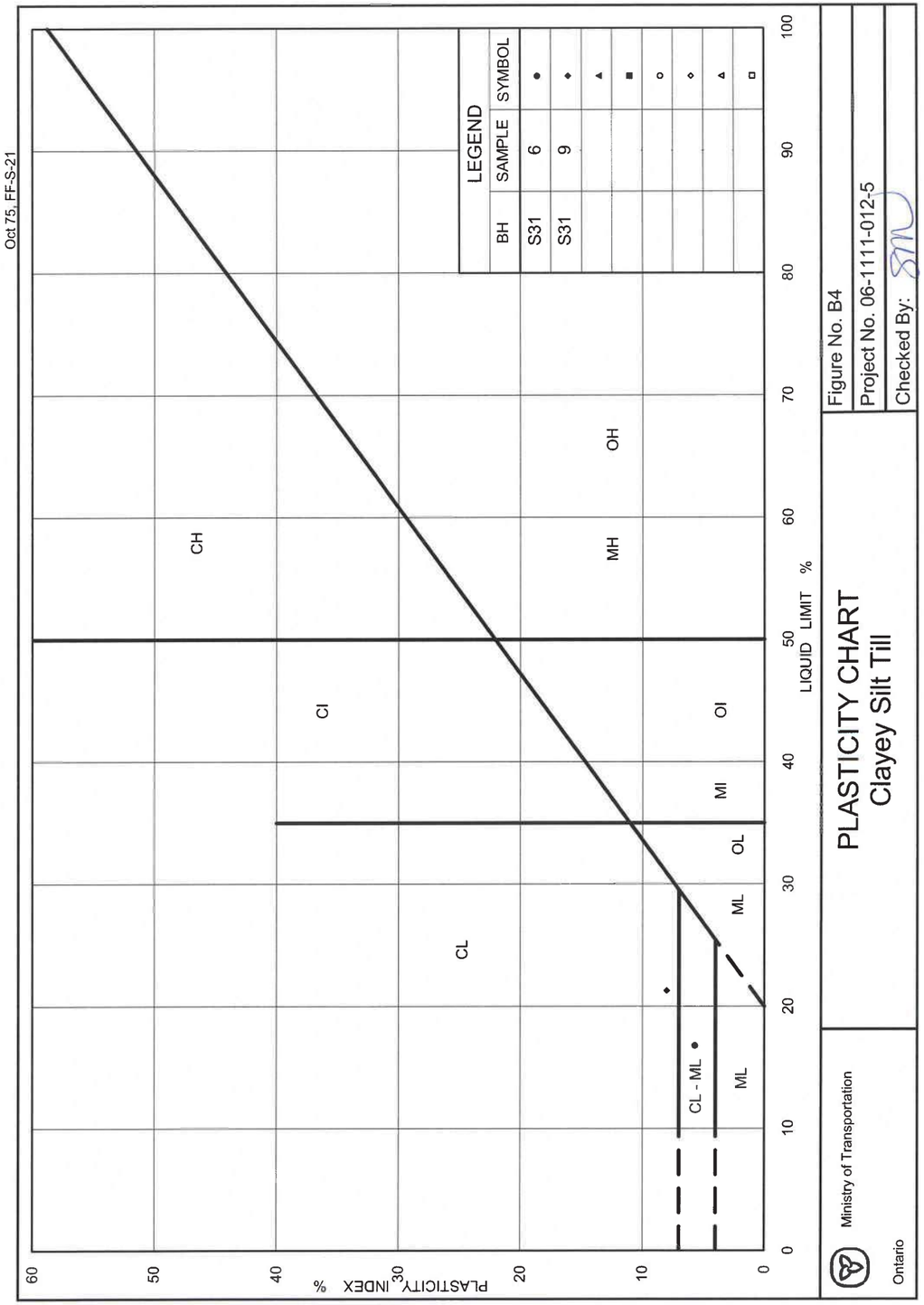
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S31	10	190.5

Project Number: 06-1111-012-5

Checked By: SM

Golder Associates

Date: 29-May-09



PLASTICITY CHART

Clayey Silt Till

Figure No. B4

Project No. 06-1111-012-5

Checked By: SM

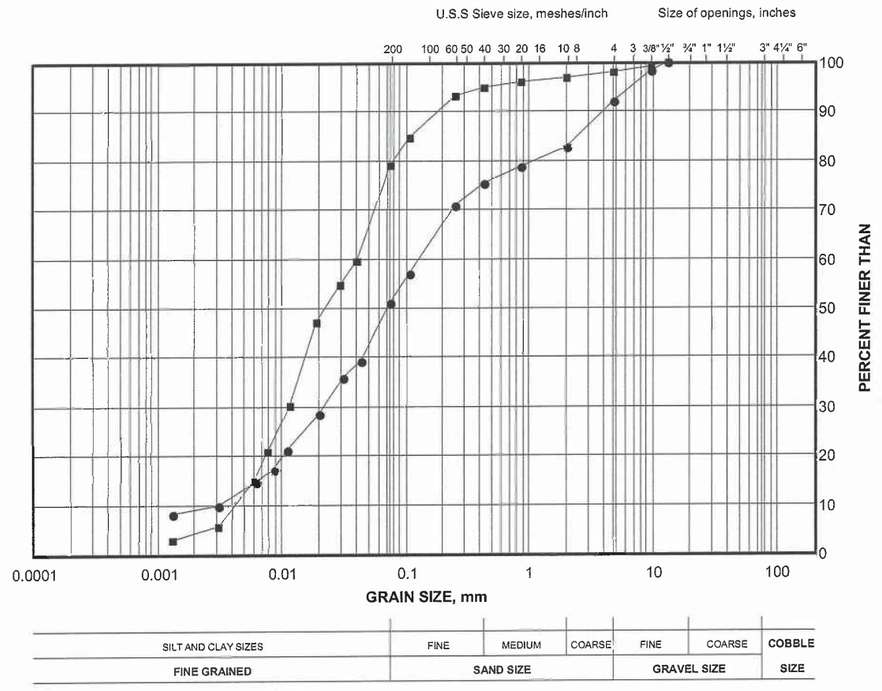
Ministry of Transportation

Ontario

GRAIN SIZE DISTRIBUTION TEST RESULTS

Sand and Silt to Sandy Silt Till

FIGURE B5



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S31	7	195.0
■	S32	8	194.0

Project Number: 06-1111-012-5

Checked By: SM

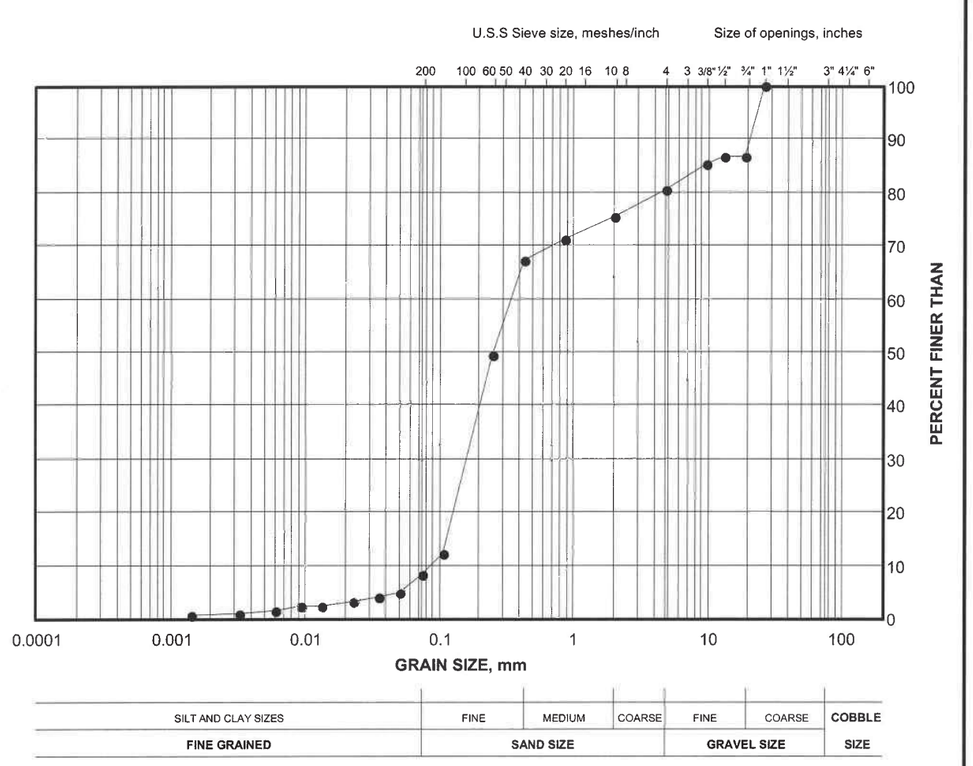
Golder Associates

Date: 29-May-09

GRAIN SIZE DISTRIBUTION TEST RESULT

Sand Till

FIGURE B6



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S31	12	187.4

Project Number: 06-1111-012-5

Checked By: SM

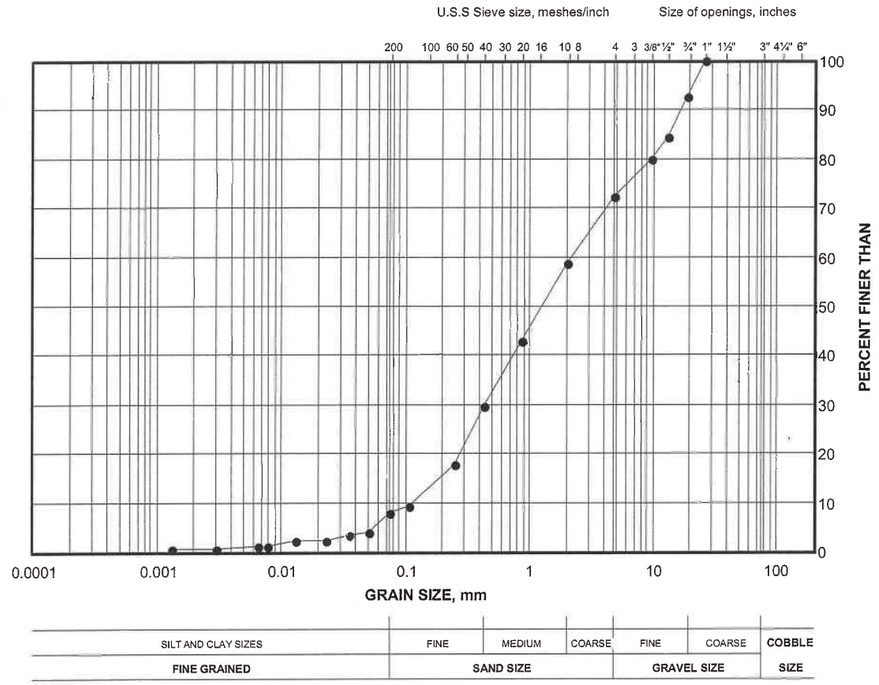
Golder Associates

Date: 25-Jun-09

GRAIN SIZE DISTRIBUTION TEST RESULT

Gravelly Sand

FIGURE B7



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S31	13	185.9

Project Number: 06-1111-012-5

Checked By: SM

Golder Associates

Date: 25-Jun-09

No.	High Fill Designation	Station (From – To)	Maximum Fill Height (m)	References / Boreholes	Subsurface Conditions	Preliminary Recommendations
J1	Zenway Boulevard Underpass	9+700 to 10+150	Up to 10.0 m	GEOCRES Report 30M13-177 and Sheet A of this report. Boreholes: E2 to E5, S1 to S3, ZB-1 and ZB-2	**Stratigraphy:** In general, the subsoils consist of surficial layers of topsoil or pavement structure and fill underlain by till deposits extending to the shale bedrock. The till is comprised of an upper and a lower clayey silt deposits interlayered by a sand and/with silt layers. For further details refer to Sheet A and GEOCRES Report 30M13-177. **Groundwater:** Refer to Table A2.	**Subgrade Preparation:** All softened/loosened material, deleterious material and compressible topsoil should be removed from the high fill areas prior to filling to ensure adequate stability. Refer to OPSS 206 for requirements. **Maximum Slope Gradient:** Fill slopes constructed of suitable earth fill or granular fill according to OPSS 206 may be constructed with side slopes not steeper than 2H:1V, with a 2.0 m wide berm where slope height is equal to or greater than 8.0 m. **Stability:** No slope stability issues are anticipated subject to additional data from detailed investigations. **Settlement:** Settlements in the order of 75 mm are anticipated within the founding soils. For preliminary design purposes, consideration should be given to a three (3) month preload period following the construction of the embankment. **Recommendations for further Investigation:** Boreholes should be advanced to confirm the stratigraphy in the high fill section. In situ and laboratory testing and analysis will be required to estimate total settlement and mitigation options.
J2	South of Rainbow Creek	11+350 to 11+450	Up to 4.5 m	GEOCRES Report 30M13-177 and Sheet B of this report. Boreholes: E6, E7, S4 and S5	**Stratigraphy:** In general, the subsoils consist of a surficial layer of topsoil underlain by a clayey silt to silty clay till deposit, which in turn is underlain by a sand and silt till deposit. Borehole S4 contacted a clayey silt till deposit below the sand and silt till. For further details refer to Sheet B and GEOCRES Report 30M13-177. **Groundwater:** Refer to Table A2.	**Subgrade Preparation:** All softened/loosened material, deleterious material and compressible topsoil should be removed from the high fill areas prior to filling to ensure adequate stability. Refer to OPSS 206 for requirements. **Maximum Slope Gradient:** Fill slopes constructed of suitable earth fill or granular fill according to OPSS 206 may be constructed with side slopes not steeper than 2H:1V. **Stability:** No stability issues are anticipated subject to additional data from detailed investigations. **Settlement:** Settlements in the order of 25 mm are anticipated within the founding soils. **Recommendations for further Investigation:** Boreholes should be advanced to confirm the stratigraphy in the high fill section.
J3	Langstaff Road Underpass	9+450 to 10+125	Up to 6.5 m	GEOCRES Report 30M13-177 and Sheets C and D of this report. Boreholes: E8 to E13, S10 to S14, S14A, LRC-1 to LRC-3, LR-1 and LR-2	**Stratigraphy:** In general, the subsoils consist of surficial layers of topsoil or pavement structure and fill. These surficial layers are underlain by deposits of clayey silt or organic clayey silt in the vicinity of the Rainbow Creek, and are underlain by a till deposit elsewhere. The till is comprised of cohesive clayey silt to silty clay deposit with non-cohesive portions and layers. The till deposit is underlain by the shale bedrock. For further details refer to Sheets C and D and GEOCRES Report 30M13-177. **Groundwater:** Refer to Table A2.	**Subgrade Preparation:** All softened/loosened material, deleterious material and compressible topsoil should be removed from the high fill areas prior to filling to ensure adequate stability. Refer to OPSS 206 for requirements. **Maximum Slope Gradient:** Fill slopes constructed of suitable earth fill or granular fill according to OPSS 206 may be constructed with side slopes not steeper than 2H:1V. **Stability:** No stability issues are anticipated subject to additional data from detailed investigations. **Settlement:** Settlements in the order of 50 mm are anticipated within the founding soils. For preliminary design purposes, consideration should be given to a two (2) month preload period following the construction of the embankment. **Recommendations for further Investigation:** Boreholes should be advanced to confirm the stratigraphy in the high fill section. In situ and laboratory testing and analysis will be required to estimate total settlement and mitigation options. In particular, boreholes should be advanced to delineate the extent of the organic clayey silt layer in the vicinity of the creek.
J4	Rutherford Road Overpasses	13+500 to 14+550	Up to 8.5 m	GEOCRES Report 30M13-177 and Sheet E of this report. Boreholes: C9, C10, C13, C14, E14 to E16, E18, E19, S16, S18, RR-1 and RR-2	**Stratigraphy:** In general, the subsoils consist of surficial layers of topsoil or pavement structure and fill and/or clayey silt to silty clay underlain by a till deposit. The till deposit is generally comprised of clayey silt to silty clay with interlayers of non-cohesive soils and is underlain by a silt deposit, which in turn extends to the shale bedrock. For further details refer to Sheet E and GEOCRES Report 30M13-177. **Groundwater:** Refer to Table A2.	**Subgrade Preparation:** All softened/loosened material, deleterious material and compressible topsoil should be removed from the high fill areas prior to filling to ensure adequate stability. Refer to OPSS 206 for requirements. **Maximum Slope Gradient:** Fill slopes constructed of suitable earth fill or granular fill according to OPSS 206 may be constructed with side slopes not steeper than 2H:1V, with a 2 m wide berm where slope height is equal to or greater than 8.0 m. **Stability:** No stability issues are anticipated subject to additional data from detailed investigations. **Settlement:** Settlements in the order of 75 mm are anticipated within the founding soils. For preliminary design purposes, consideration should be given to a three (3) month preload period following the construction of the embankment. **Recommendations for further Investigation:** Boreholes should be advanced to confirm the stratigraphy in the high fill section. In situ and laboratory testing and analysis will be required to estimate total settlement and mitigation options.
J5	CPR / McGillivray Road Overheads	15+800 to 16+900	Up to 11.5 m	GEOCRES Report 30M13-177 and Sheets G and H of this report. Boreholes: E21 to E27, S26, S28 to S30, S34, S36, MGR-1, MGR-2 and MMD-1 to MMD-4	**Stratigraphy:** In general, the subsoils consist of surficial layers of topsoil or pavement structure over fill. The surficial layers are underlain by clayey silt to silty clay deposit, which in turn is underlain by a till stratum. The till deposit is generally comprised of an upper and a lower clayey silt to silty clay layers interlayered by a sand and silt till. The till is underlain by deposits of sand and silt to silt to sandy silt or clayey silt over the shale bedrock. For further details refer to Sheet G and GEOCRES Report 30M13-177. **Groundwater:** Refer to Table A2.	**Subgrade Preparation:** All softened/loosened material, deleterious material and compressible topsoil should be removed from the high fill areas prior to filling to ensure adequate stability. Refer to OPSS 206 for requirements. **Maximum Slope Gradient:** Fill slopes constructed of suitable earth fill or granular fill according to OPSS 206 may be constructed with side slopes not steeper than 2H:1V, with a 2 m wide berm where slope height is equal to or greater than 8.0 m. **Stability:** No stability issues are anticipated subject to additional data from detailed investigations. **Settlement:** Settlements in the order of 100 mm to 150 mm are anticipated within the founding soils. For preliminary design purposes, consideration should be given to a six (6) month preload period following the construction of the embankment. Alternatively, consideration can be given to employing a 2 m high surcharge to accelerate the settlement process. **Recommendations for further Investigation:** Boreholes should be advanced to confirm the stratigraphy in the high fill section. In situ and laboratory testing and analysis will be required to estimate total settlement and mitigation options.

J1 – ZENWAY BOULEVARD UNDERPASS

Record of Current and Previous Borehole Sheets
Laboratory Test Results – Current and Previous Investigations

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No ZB-1 1 of 1 METRIC

G.W.P. _____ LOCATION Coords: 4 848 448.5 N; 293 895.1 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE September 30, 2015 CHECKED BY A.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
183.0	Ground Surface								
182.9 / 0.1	TOPSOIL								
	CLAYEY SILT, some sand, trace gravel		1	SS	19				
182.3 / 0.7	Very Stiff Brown Moist (FILL)		2	SS	26				
	CLAYEY SILT, trace to some sand, trace gravel Firm to Hard Brown, becoming grey below a depth of 3.0m Moist (TILL)		3	SS	14				
			4	SS	12				
			5A	SS	7				5 20 42 33
			5B	SS					
			6	SS	9				
			7A	SS	15				
			7B	SS					
			8	SS	35				
			9	SS	44				1 9 72 18
			10	SS	123				
172.5 / 10.5	SILT, with sand, trace clay, trace gravel Very dense (TILL)		11	SS	85/13cm				1 26 68 5 Sampler bouncing Auger grinding between 11.6m and 12.2m Sampler bouncing
170.7 / 12.3	End of borehole Split spoon sampler refusal		12	SS	75/8cm				

▽ Water level noted during drilling

▼ Water level measured upon completion

Note:

1. Groundwater level measured at a depth of 9.7m below groundwater surface (Elev.173.3m) upon completion of drilling.

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 (%) 10 20 30

ON MTO_NEW LOGO HWY 427 15TF013A-REV.GPJ ON_MOT.GDT 15/01/2016 9:35:42 AM

+7, ×5: Numbers refer to Sensitivity (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No ZB-2 1 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 848 467.0 N; 293 969.5 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE September 30, 2015 CHECKED BY A.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
181.5	Ground Surface								
181.4 / 0.1	TOPSOIL								
	CLAYEY SILT, some sand, some gravel		1	SS	8				
180.8 / 0.7	Firm Brown Moist (FILL)		2	SS	16				
	CLAYEY SILT, some sand to sandy, trace gravel, Stiff to very stiff Grey Moist (TILL)		3	SS	18				
			4	SS	10				3 20 48 29
			5	SS	12				
			6	SS	16				
			7	SS	20				5 24 46 25
			8	SS	27				
			9	SS	25				
			10	SS	20				
171.4 / 10.1	SILT and SAND, trace gravel, trace clay Very dense Grey Moist (TILL)		11	SS	71/15cm				8 46 42 4 Auger grinding at 11.7m Sampler bouncing
168.3 / 13.2	CLAYEY SILT, some sand, trace gravel Hard Grey Moist (TILL)		12	SS	75/8cm				
	Cont'd		13	SS	61				

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 (%) 10 20 30

ON MTO_NEW LOGO HWY 427 15TF013A-REV.GPJ ON_MOT.GDT 15/01/2016 9:35:43 AM

+7, ×5: Numbers refer to Sensitivity (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No ZB-2 2 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 848 467.0 N; 293 969.5 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE September 30, 2015 CHECKED BY A.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
166.5								
	shale fragments below a depth of 15.1m		14	SS	75/75cm		166	Sampler bouncing
165.4								
16.1	SHALE BEDROCK Highly weathered Grey		15	SS	65/0cm		165	Auger grinding at 16.5m Sampler bouncing
163.2						▼	164	
			16	SS	75/5cm			Sampler bouncing
18.3	End of borehole							

▼ Water level measured upon completion

Note:

1. Groundwater level measured at a depth 18.3m below ground surface (Elev. 163.2m) upon completion of drilling.

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 (%) — 10 20 30

UNIT WEIGHT γ kN/m³

+⁷, ×⁵: Numbers refer to Sensitivity

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

Golder Associates

RECORD OF BOREHOLE No E2

1 OF 1 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4848442.5 ;E 293736.6 | ORIGINATED BY JEB
W.O. 05-20012 | | COMPILED BY PKS/VA
DIST Central HWY 427 | BOREHOLE TYPE 108 mm Diameter Solid Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE April 17, 2009

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS
188.3	GROUND SURFACE					
0.0 / 0.1	ASPHALT					
	Sand and gravel (FILL) Brown Moist					
187.5						
0.8	Clayey silt, trace sand, trace gravel (FILL) Firm to stiff Brown Moist		1	SS	8	
			2	SS	4	
186.2						
2.1	CLAYEY SILT, some sand, trace gravel (TILL) Very stiff Brown moist		3	SS	16	
			4	SS	23	
			5	SS	10	
			6	SS	8	
			7	SS	11	
			8	SS	19	
178.7			9	SS	23/0.2	
9.6	END OF BOREHOLE NOTES: 1. Open borehole dry upon completion of drilling. 2. Borehole backfilled with bentonite.					

ELEVATION SCALE: 188, 187, 186, 185, 184, 183, 182, 181, 180, 179

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED; 20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No E3

1 OF 1 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4848492.8 ;E 293996.0 | ORIGINATED BY JEB
W.O. 05-20012 | | COMPILED BY PKS/VA
DIST Central HWY 427 | BOREHOLE TYPE 108 mm Diameter Solid Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE April 14, 2009

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS
181.6	GROUND SURFACE					
0.0 / 0.1	ASPHALT					
	Sand and gravel (FILL) Brown Moist					
180.8						
0.8	Clayey silt, trace sand, trace gravel (FILL) Stiff Brown Moist		1	SS	9	
			2	SS	9	
179.5						
2.1	CLAYEY SILT, trace sand, trace gravel (TILL) Stiff Grey Moist		3	SS	9	
			4	SS	11	
177.9						
3.7	Silty SAND, containing clayey silt seams Compact Grey Moist		5	SS	16	
177.0						
4.6	CLAYEY SILT, some sand, trace gravel (TILL) Very stiff to hard Grey Moist		6	SS	16	
			7	SS	21	
			8	SS	34	
173.4						
8.2	END OF BOREHOLE NOTES: 1. Open borehole dry upon completion of drilling. 2. Borehole backfilled with bentonite.					

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

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED; 20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No E4 1 OF 1 METRIC

PROJECT 06-1111-012 | LOCATION N 4848534.0 ;E 293931.7 | ORIGINATED BY JEB
W.O. 05-20012 | BOREHOLE TYPE 108 mm Diameter Solid Stem Augers | COMPILED BY PKS/VA
DIST Central HWY 427 | DATUM Geodetic | DATE April 7, 2009 | CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
183.0	GROUND SURFACE						
0.0	TOPSOIL						
0.2	CLAYEY SILT, trace sand, trace gravel, containing rootlets (Reworked)		1	SS	9		
182.2	Stiff						
0.8	Brown Moist		2	SS	23		
	SILTY CLAY, some sand, trace gravel (TILL) Very stiff to hard Brown to grey Moist		3	SS	30		
			4	SS	35		
			5	SS	33		
	Becoming grey at a depth of 3.8 m		6	SS	18		
178.5							
4.5	CLAYEY SILT, trace sand, trace gravel (TILL) Very stiff Grey Moist		7	SS	16		
			8	SS	24		
176.3							
6.7	END OF BOREHOLE						

NOTES:

1. Open borehole dry upon completion of drilling.
2. Borehole backfilled with bentonite

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

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL
4	20	46	30

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

+3, ×3: Numbers refer to Sensitivity O3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No E5 1 OF 1 METRIC

PROJECT 06-1111-012 | LOCATION N 4848694.6 ;E 293894.9 | ORIGINATED BY JEB
W.O. 05-20012 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | COMPILED BY PKS/VA
DIST Central HWY 427 | DATUM Geodetic | DATE April 7, 2009 | CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
183.2	GROUND SURFACE						
0.0	TOPSOIL						
0.2	CLAYEY SILT, trace sand, trace gravel, containing rootlets (Reworked)		1	SS	11		
182.4	Stiff						
0.8	Brown Moist		2	SS	14		
	CLAYEY SILT, some sand, trace gravel (TILL) Very stiff Brown to grey Moist		3	SS	20		
			4	SS	27		
			5	SS	21		
	Becoming grey at a depth of 3.8 m		6	SS	23		
	Containing sand layer between depths of 4.9 m and 5.0 m		7	SS	22		
176.5			8	SS	20		
6.7	END OF BOREHOLE						

NOTES:

1. Open borehole dry upon completion of drilling.
2. Borehole backfilled with bentonite

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

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL
4	25	50	21

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

+3, ×3: Numbers refer to Sensitivity O3% STRAIN AT FAILURE

RECORD OF BOREHOLE No S1 1 OF 1 METRIC

PROJECT 06-1111-012 | LOCATION N 4848474.8 ;E 293903.5 | ORIGINATED BY TB
W.O. 05-20012 | | COMPILED BY PKS/VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE April 27, 2009

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 (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L (WATER CONTENT (%) 10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
182.2	GROUND SURFACE						182				
0.0 / 0.1	ASPHALT										
	Sand and gravel (FILL) Brown Moist										
181.4 / 0.8	Clayey silt, trace to some sand, trace gravel (FILL) Firm Brown grey Moist		1	SS	4		181				
180.4			2	SS	5		180				
1.8	CLAYEY SILT, some sand, trace gravel (TILL) Firm to hard Grey Moist		3	SS	8						5 23 45 27
			4	SS	8		179				
			5	SS	7		178				
			6	SS	13		177				
			7	SS	49		176				
			8	SS	47		175				
173.1							174				
9.1	SAND and SILT, trace gravel, trace clay (TILL) Very dense Grey Moist, becoming wet below a depth of 9.3 m		9	SS	102		173				4 45 49 2
			10	SS	100/0.10	▽	172				
169.9							171				
12.3	END OF BOREHOLE		11	SS	100/0.12		170				

NOTES:

1. Water level in open borehole at a depth of 11.8 m below ground surface (Elev. 170.4 m) upon completion of drilling.
2. Borehole backfilled with bentonite.

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

RECORD OF BOREHOLE No S2 1 OF 2 METRIC

PROJECT 06-1111-012 | LOCATION N 4848479.8 ;E 293930.4 | ORIGINATED BY JEB
W.O. 05-20012 | | COMPILED BY PKS/VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE April 17, 2009

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 (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L (WATER CONTENT (%) 10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
181.4	GROUND SURFACE						181				
0.0 / 0.1	ASPHALT										
	Sand and gravel (FILL) Brown Moist										
180.6 / 0.8	Clayey Silt, trace sand, trace gravel (FILL) Firm Brown grey Moist		1	SS	7		180				
180.1 / 1.3	CLAYEY SILT, some sand, trace gravel, containg cobbles and boulders (TILL) Stiff to hard Brown Moist		2	SS	11		179				
			3	SS	7						
			4	SS	9		178				
	Becoming grey at 2.3 m depth		5	SS	50/0.15						
	Containing sandy silt layer at a depth of 3.8 m Containing cobble/boulder at a depth of 4.1 m		6	SS	14		177				
			7	SS	30		176				
173.8							175				
7.6	Silty SAND, trace gravel, trace clay Dense Grey Moist		8	SS	43		174				
172.7							173				
8.7	CLAYEY SILT, trace sand, trace gravel (TILL) Hard Grey Moist		9	SS	67		172				
172.1 / 9.3	SAND and SILT, trace gravel, trace clay (TILL) Very dense Grey Wet		10	SS	24/0.18		171				2 33 63 2
169.2							170				
12.2	CLAYEY SILT, trace to some sand and gravel, trace shale fragments (TILL) Hard Grey Moist		11	SS	106		169				
			12	SS	65		168				
							167				

Continued Next Page

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

RECORD OF BOREHOLE No S2

2 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4848479.8 ;E 293930.4 | ORIGINATED BY JEB
W.O. 05-20012 | | COMPILED BY PKS/VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE April 17, 2009

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —							SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)		WATER CONTENT (%) (10 20 30)			
166.2													
15.2	SHALE (BEDROCK) Grey		13	SS	148		166						
165.7													
15.7	END OF BOREHOLE												

NOTES:

1. Open borehole dry upon completion of drilling.
2. Borehole backfilled with bentonite.

* Elevated SPT 'N' values indicate that the spoon was likely pentrating a cobble.

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

RECORD OF BOREHOLE No S3

1 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4848487.1 ;E 293966.7 | ORIGINATED BY JEB
W.O. 05-20012 | | COMPILED BY PKS/VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE April 16, 2009

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
181.1	GROUND SURFACE						181	SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)		WATER CONTENT (%) (10 20 30)			
0.0	ASPHALT												
0.1	Sand and gravel (FILL) Brown Moist												
180.3													
0.8	CLAYEY SILT, some sand, trace gravel (TILL) Stiff Grey Moist		1	SS	9		180						
			2	SS	9		179						
			3	SS	9								2 23 48 27
177.4			4	SS	8		178						
3.7	Sandy SILT, trace clay Compact Grey Moist		5	SS	18		177						
176.7													
4.4	CLAYEY SILT, some sand, trace gravel (TILL) Very stiff to hard Grey Moist		6	SS	18		176						
			7	SS	18		175						
							174						
			8	SS	31		173						
			9	SS	22		172						
							171						
170.4													
10.7	SAND and SILT, trace gravel, trace clay, containing cobbles (TILL) Very dense Grey Wet Containing cobbles between depths of 11.0 m and 11.6 m		10	SS	50/0.05		170						
			11	SS	76		169						3 38 57 2
							168						
			12	SS	18/0.1								
166.5							167						
14.6	SHALE (BEDROCK) Grey												

Continued Next Page

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S3

2 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4848487.1 ;E 293966.7 | ORIGINATED BY JEB

W.O. 05-20012 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | COMPILED BY PKS/VA

DIST Central HWY 427 | DATE April 16, 2009 | CHECKED BY SMM

DATUM Geodetic

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 × REMOULDED 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —										
	SHALE (BEDROCK) Grey		13	SS	15/0.0		166				
							165				
163.7			14	SS	20/0.0		164				
17.4	END OF BOREHOLE										

NOTES:

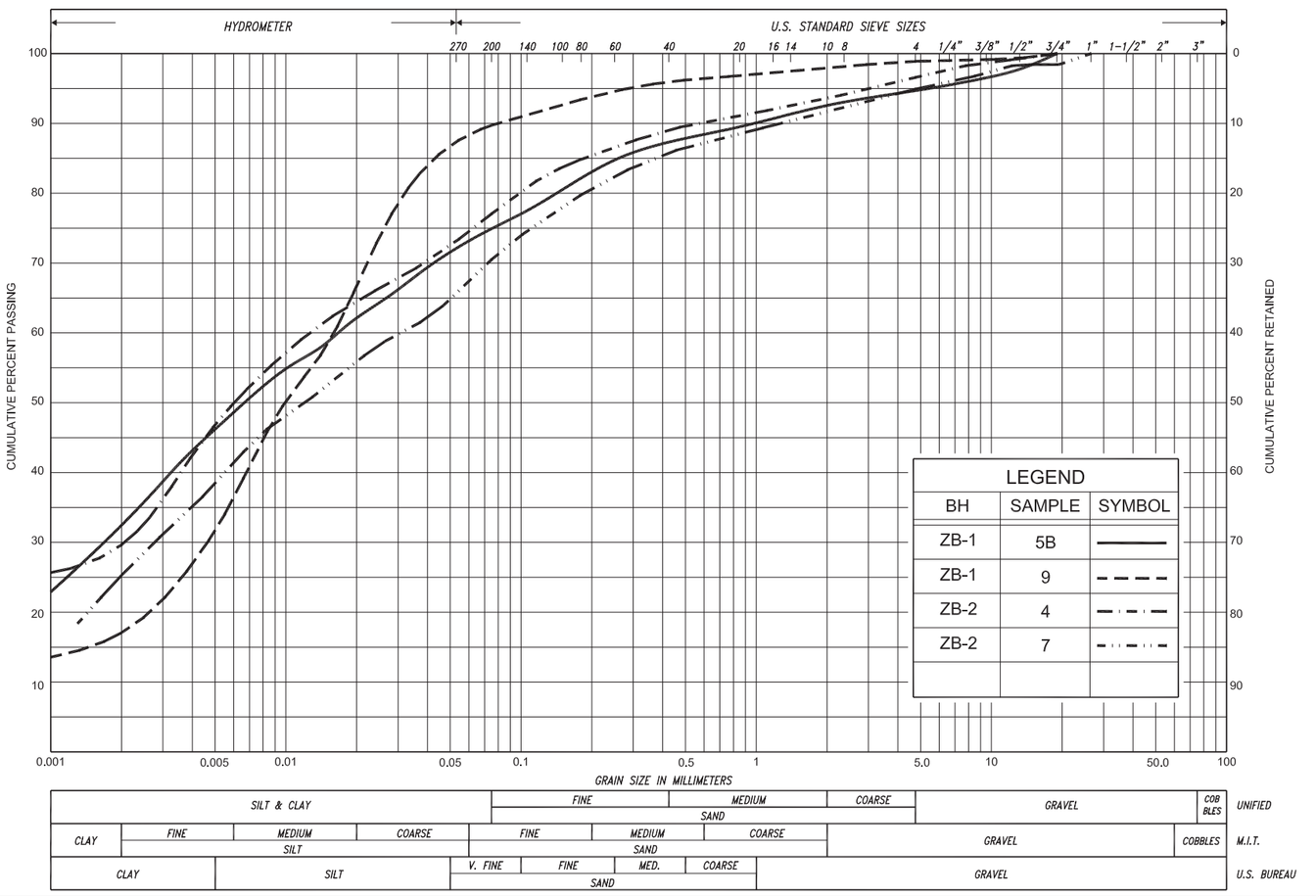
1. A 50 mm diameter monitoring well was installed at a depth of 16.8 m (Elev. 164.3 m).

Water level measurements

Date	Depth	Elev.
On Completion	10.7 m	170.4 m
May 13, 2009	1.3 m	179.8 m
June 15, 2009	0.9 m	180.2 m
July 09, 2009	0.9 m	180.3 m

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

$\circ^{3\%}$ STRAIN AT FAILURE

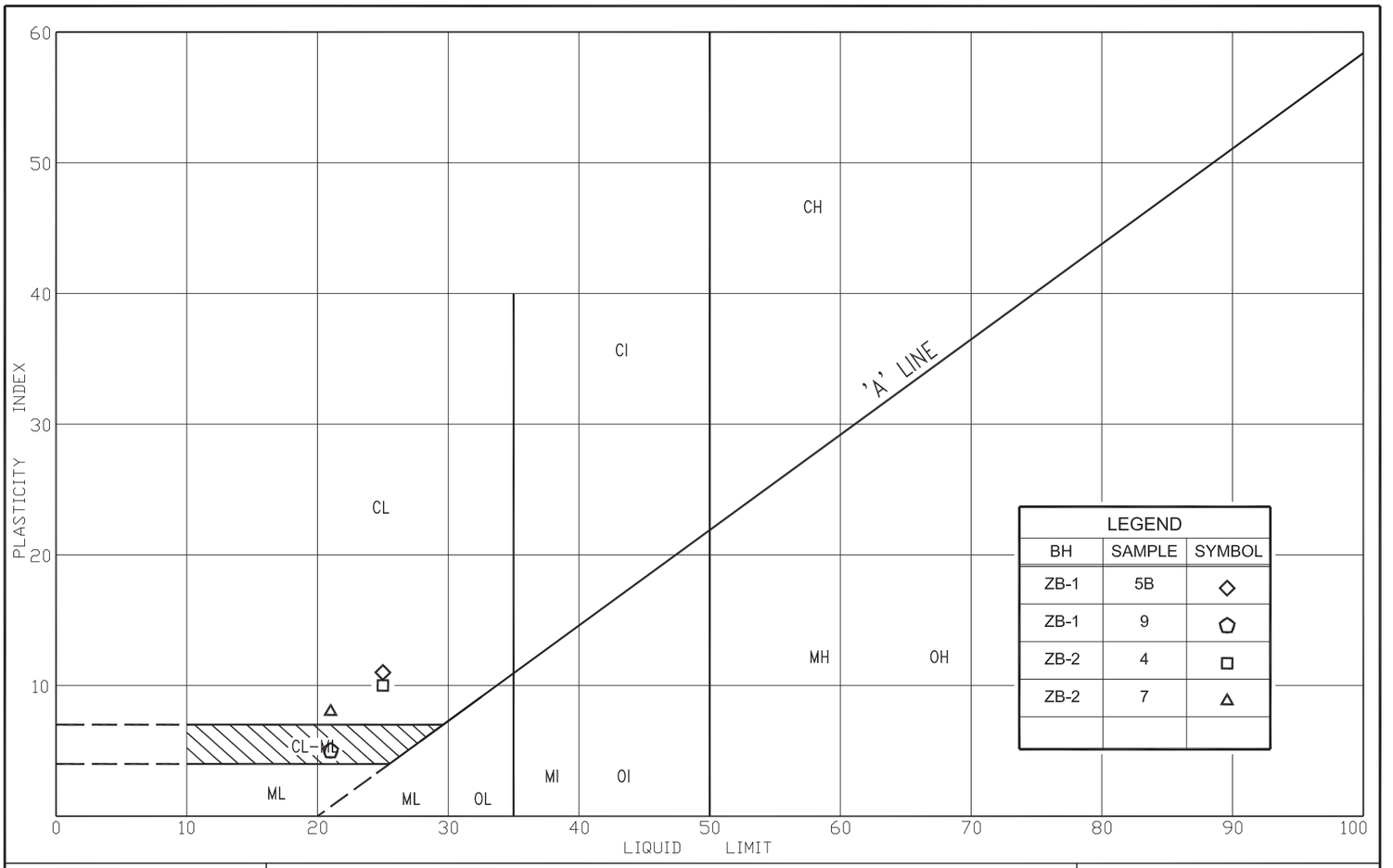


Ontario

GRAIN SIZE DISTRIBUTION

(SANDY) CLAYEY SILT (TILL) - Upper

FIG No.	A-1
HWY:	427
G.W.P. No.	

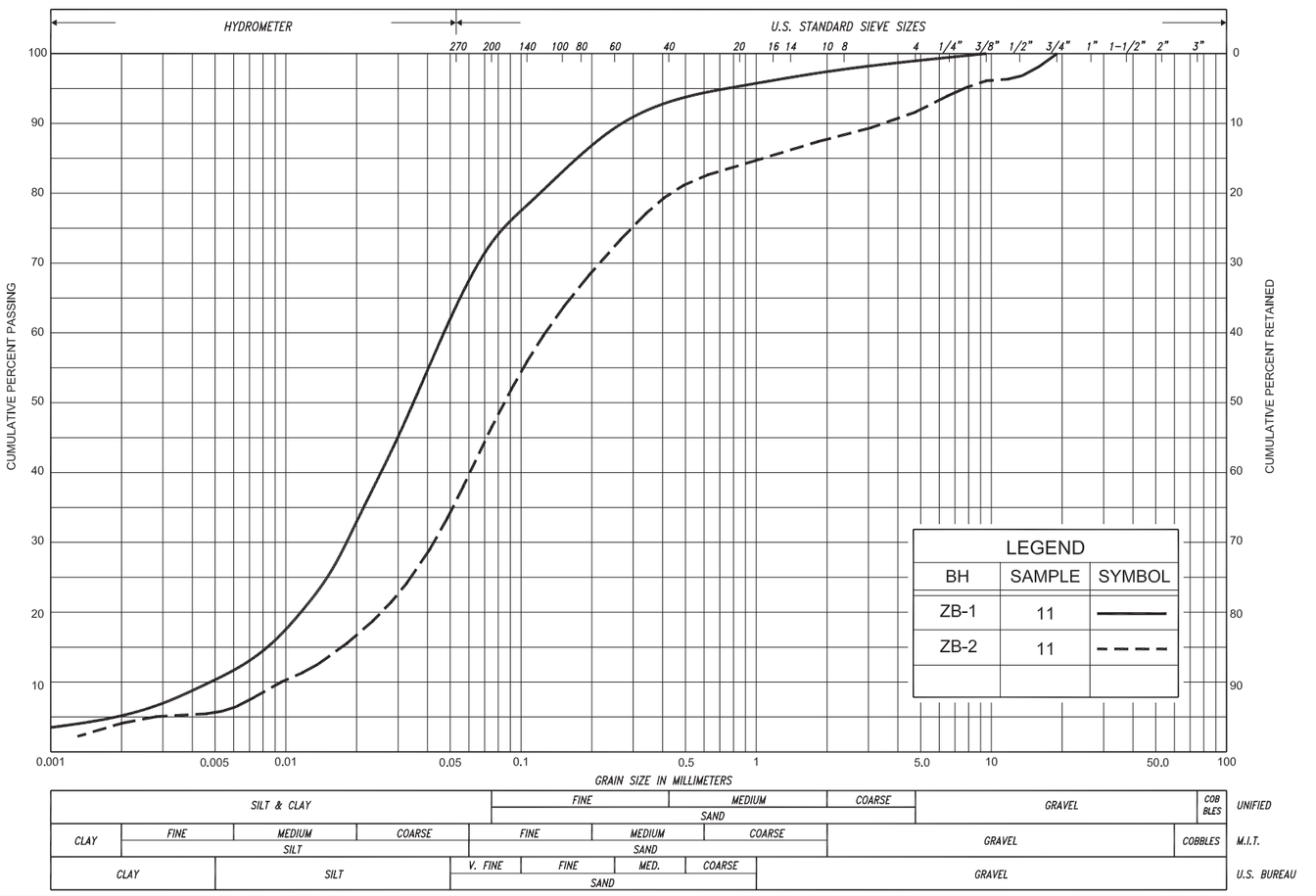


Ontario

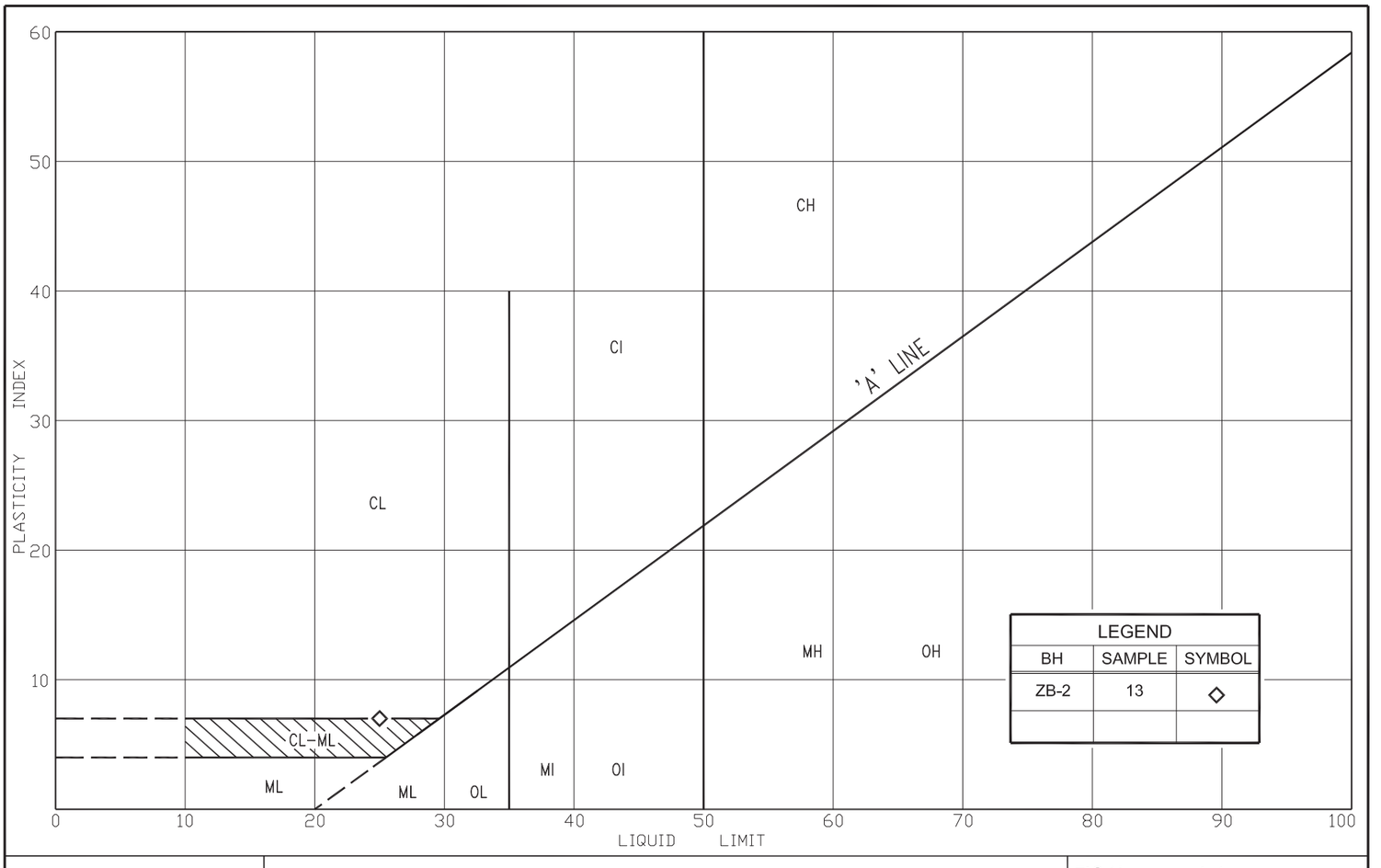
PLASTICITY CHART

CLAYEY SILT (TILL) - Upper

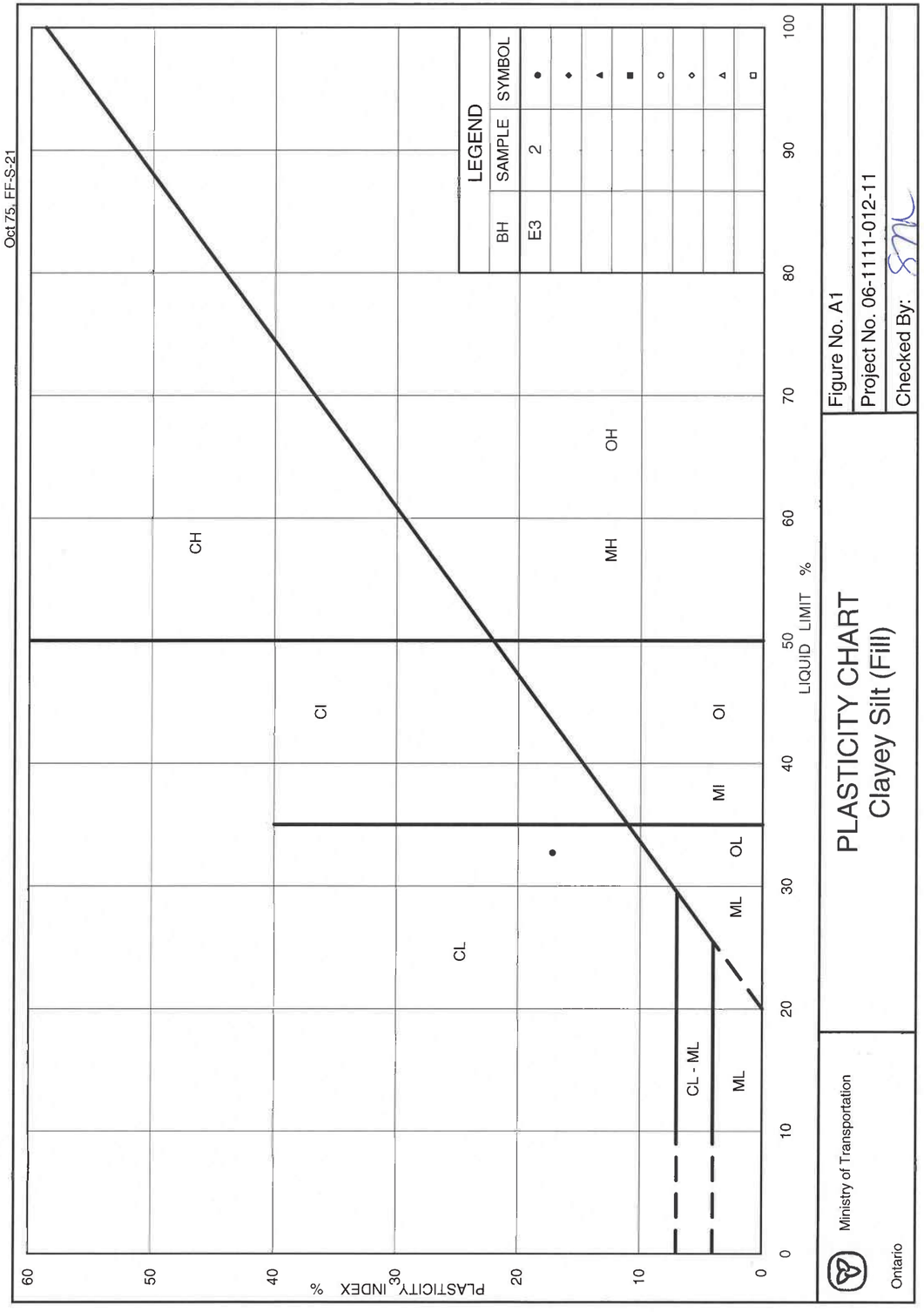
FIG No.	A-2
HWY:	427
G.W.P. No.	



Ontario	GRAIN SIZE DISTRIBUTION SILT, with sand to SAND and SILT (TILL)	FIG No. A-3 HWY: 427 G.W.P. No.



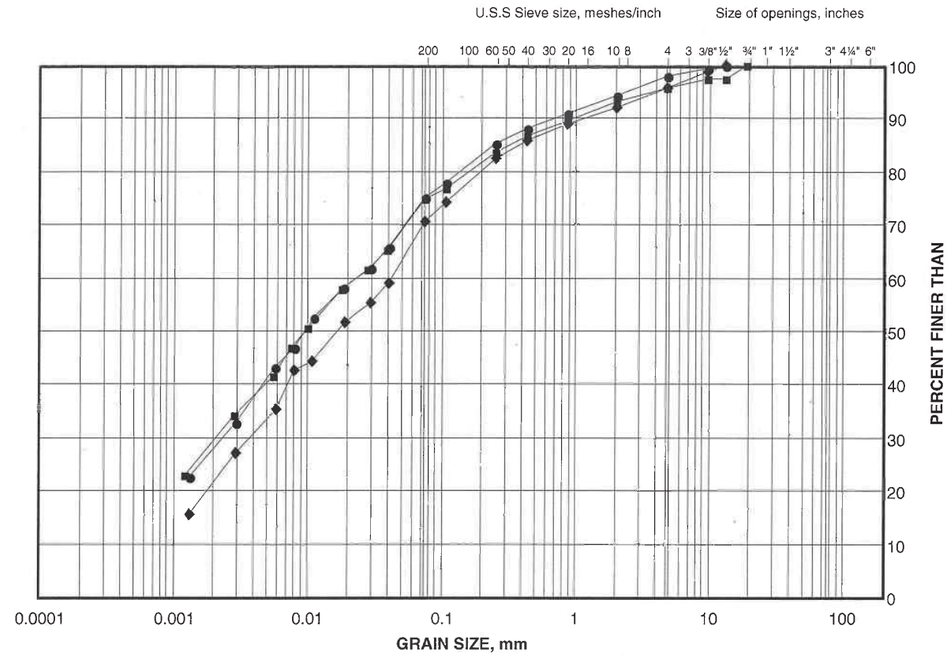
Ontario	PLASTICITY CHART CLAYEY SILT (TILL) - Lower	FIG No. A-4 HWY: 427 G.W.P. No.



GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt to Silty Clay Till

FIGURE A2



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

LEGEND

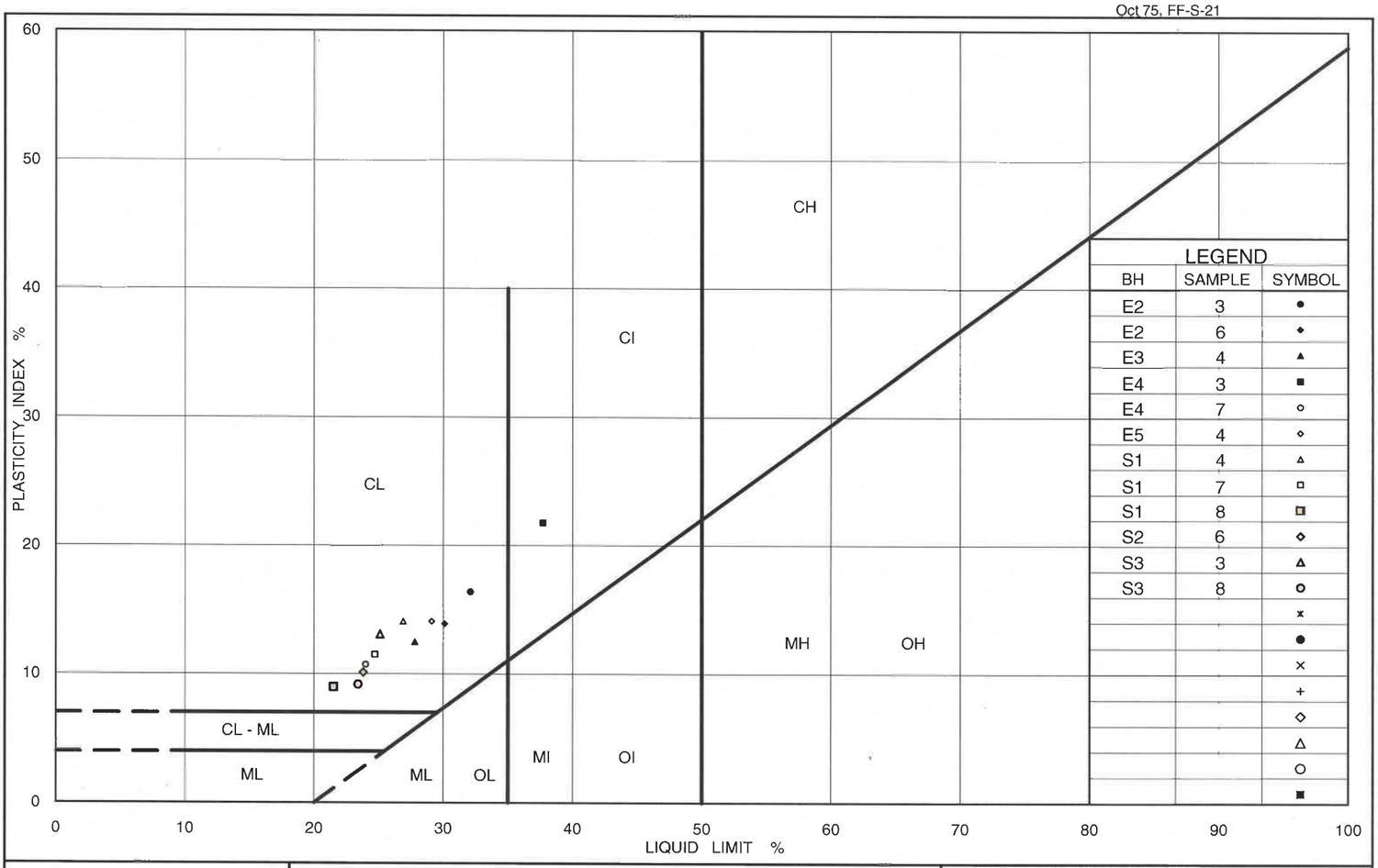
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S3	3	179.5
■	E4	5	179.6
◆	E5	6	179.2

Project Number: 06-1111-012-11

Checked By:

Golder Associates

Date: 16-Jul-09



Ministry of Transportation
Ontario

PLASTICITY CHART
Clayey Silt to Silty Clay Till

Figure No. A3

Project No. 06-1111-012-11

Checked By: SM

J2 – SOUTH OF RAINBOW CREEK

Record of Current and Previous Borehole Sheets
Laboratory Test Results – Current and Previous Investigations

RECORD OF BOREHOLE No E6

1 OF 1 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4849219.0 ;E 293803.8 | ORIGINATED BY DD
W.O. 05-20012 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | COMPILED BY VA
DIST Central HWY 427 | DATE February 27, 2009 | CHECKED BY SMM
DATUM Geodetic

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
179.1	GROUND SURFACE							
0.0 / 0.1	TOPSOIL							
	CLAYEY SILT, some sand, trace gravel (TILL), containing oxidation zones Stiff to hard Brown to grey Moist		1	SS	8			
			2	SS	27			
176.9			3	SS	31			1 19 56 24
2.2	SILTY CLAY, trace gravel, trace sand (TILL) Hard Brown to grey Moist		4	SS	53			
175.3			5	SS	49			
3.8	CLAYEY SILT, trace to some sand, trace gravel (TILL) Very stiff to hard Grey Moist		6	SS	25			
173.9			7	SS	46			
5.2	END OF BOREHOLE							

NOTES:

1. Open borehole dry upon completion of drilling.
2. Borehole backfilled with bentonite.

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)
SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED
PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)
ELEVATION SCALE: 179, 178, 177, 176, 175, 174

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

RECORD OF BOREHOLE No E7

1 OF 1 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4849217.1 ;E 293850.2 | ORIGINATED BY DD
W.O. 05-20012 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | COMPILED BY VA
DIST Central HWY 427 | DATE March 2, 2009 | CHECKED BY SMM
DATUM Geodetic

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
178.3	GROUND SURFACE							
0.0 / 0.1	TOPSOIL							
	CLAYEY SILT, trace sand, trace gravel (TILL), containing rootlets to a depth of 0.6 m Firm to hard Brown to grey Moist		1	SS	4			
			2	SS	19			
			3	SS	43			
			4	SS	40			
	Becoming grey below a depth of 3.0 m		5	SS	14			
			6	SS	11			0 3 56 41
173.2	Containing thin sand layer at a depth of 5.1 m		7	SS	16			
5.2	END OF BOREHOLE							

NOTES:

1. Open borehole dry upon completion of drilling.
2. Borehole backfilled with bentonite hole plug.

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)
SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED
PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)
ELEVATION SCALE: 178, 177, 176, 175, 174

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S4

1 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4849365.1 ;E 293793.2
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE February 27, 2009

ORIGINATED BY DD
COMPILED BY VA
CHECKED BY SMM

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)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
182.5	GROUND SURFACE							SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE; ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)		WATER CONTENT (%) (10 20 30)			
0.0	TOPSOIL												
0.1	CLAYEY SILT, some sand, trace to some gravel (TILL), containing rootlets to a depth of 0.6 m and containing oxidation zones to a depth of 5.2 m Firm to hard Brown to grey Moist to wet		1	SS	5		182						
			2	SS	22		181						
			3	SS	25		180						
			4	SS	35		179						
			5	SS	24								6 12 62 20
			6	SS	21		178						
	Auger grinding at a depth of 5.2 m		7	SS	21		177						
						▽							
			8	SS	11		176						
							175						
			9	SS	31								
173.8							174						
8.7	SAND and SILT, some gravel, trace clay, containing cobbles below 11.4 m depth (TILL) Dense to very dense Grey Wet		10	SS	37		173						
							172						
			11	SS	109								
	Auger grinding at a depth of 11.4 m						171						
			12	SS	106		170						
169.2													
13.3	CLAYEY SILT with sand, some gravel (TILL) Hard Grey Wet						169						
			13	SS	113								17 35 39 9
168.3													
14.2	END OF BOREHOLE												

Continued Next Page

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

Foundation Design

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RECORD OF BOREHOLE No S4

2 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4849365.1 ;E 293793.2
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE February 27, 2009

ORIGINATED BY DD
COMPILED BY VA
CHECKED BY SMM

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)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —							SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE; ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)		WATER CONTENT (%) (10 20 30)			
	NOTES: 1. Water level in open borehole at a depth of 6.0 m below ground surface (Elev.176.5 m) upon completion of drilling. 2. Borehole backfilled with bentonite.												

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S5

1 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4849359.7 ;E 293821.4
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE February 26, 2009

ORIGINATED BY DD
COMPILED BY VA
CHECKED BY SMM

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	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
181.6	GROUND SURFACE							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100		WATER CONTENT (%) 10 20 30			
8.6	TOPSOIL												
0.1	CLAYEY SILT, some sand, trace gravel (TILL), containing rootlets and oxidation zones to a depth of 2.1 m Stiff to hard Brown to grey Moist		1	SS	8		181						
			2	SS	23								
			3	SS	33		180						
			4	SS	44		179						
			5	SS	63		178						
	Grey below a depth of 3.8 m		6	SS	31								
			7	SS	31	▽	177						
			8	SS	37		176						
			9	SS	48		175						
172.9	Auger grinding below a depth of 8.5m						174						
8.7	SAND and SILT, some gravel, trace clay, containing cobbles (TILL) Dense to very dense Grey Wet Auger grinding from depth of 9.7 m to 10.7 m		10	SS	39		173						
			11	SS	139		172						14 39 41 6
	Auger grinding from depth of 11.9 m to 12.5 m		12	SS	100/0.0		171						
	Auger grinding from depth of 13.4 m to 13.7 m		13	SS	102/0.1		170						
167.6							169						
14.0	END OF BOREHOLE						168						

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S5

2 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4849359.7 ;E 293821.4
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE February 26, 2009

ORIGINATED BY DD
COMPILED BY VA
CHECKED BY SMM

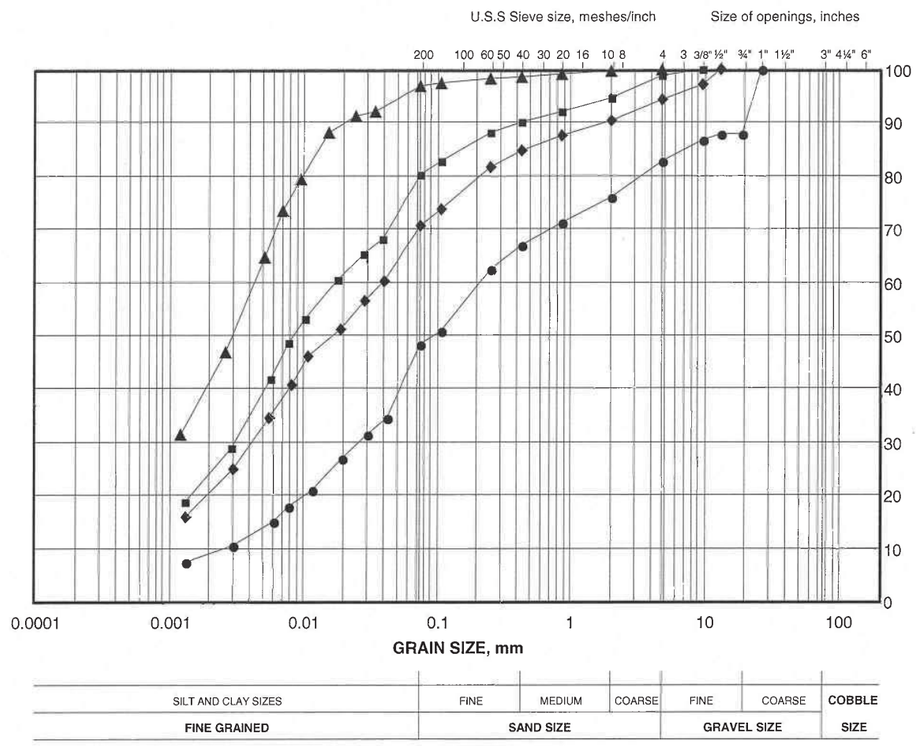
ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100		WATER CONTENT (%) 10 20 30			
	NOTES: 1. A 50 mm diameter monitoring well was installed at a depth of 10.7 m (Elev.170.9 m) Water level measurements Date Depth Elev. On Completion 6.0 m 175.6 m April 24, 2009 4.4 m 177.2 m May 13, 2009 4.4 m 177.2 m May 21, 2009 4.6 m 177.0 m June 15, 2009 4.7 m 176.9 m July 09, 2009 4.9 m 176.7 m												

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

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt Till

FIGURE B1



LEGEND

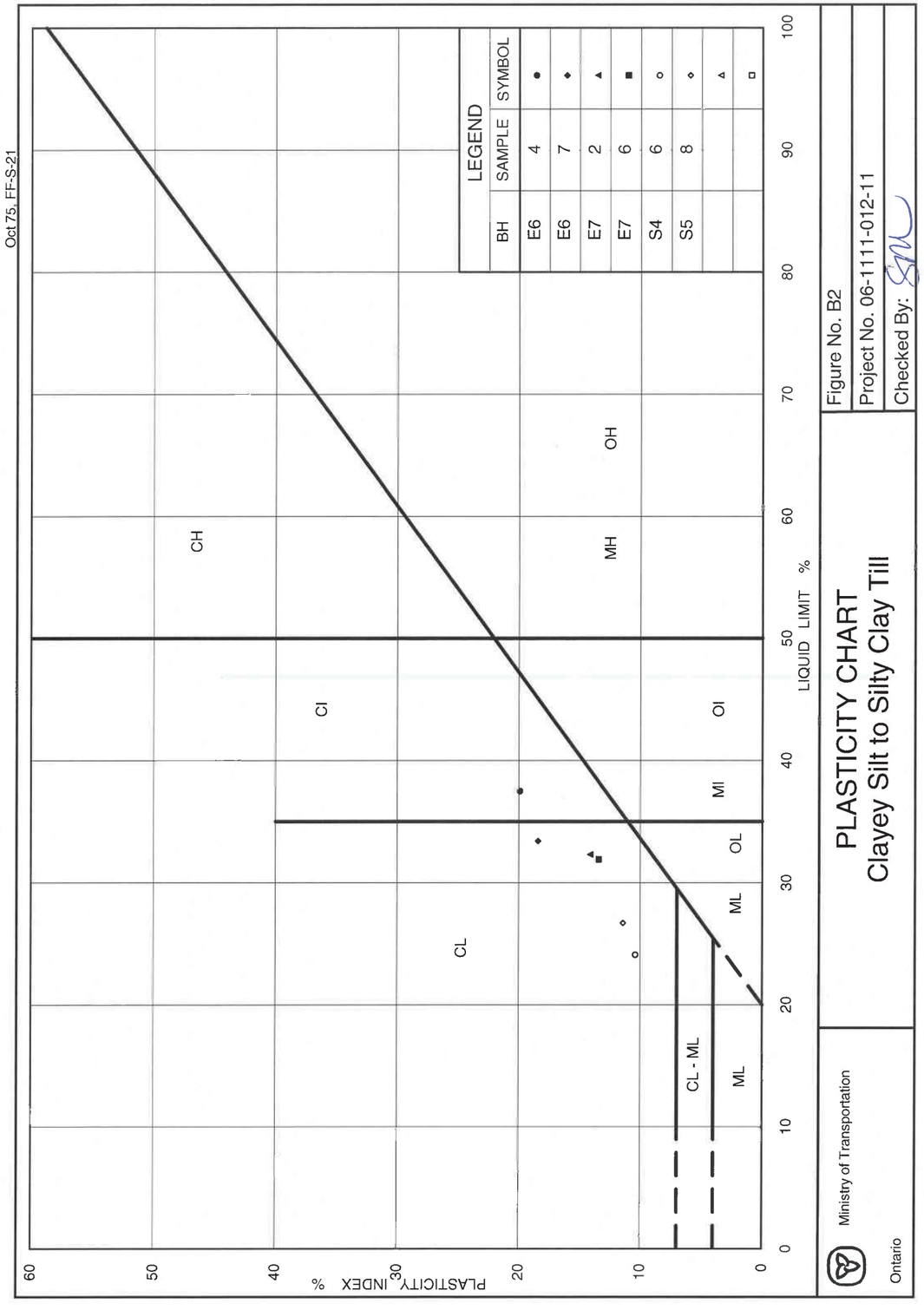
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S4	13	168.5
■	E6	2	178.0
◆	S4	5	179.2
▲	E7	6	174.2

Project Number: 06-1111-012-11

Checked By: SM

Golder Associates

Date: 04-Aug-09



PLASTICITY CHART

Clayey Silt to Silty Clay Till

Figure No. B2

Project No. 06-1111-012-11

Checked By: SM

Ministry of Transportation

Ontario

J3 – LANGSTAFF ROAD UNDERPASS

Record of Current and Previous Borehole Sheets
Laboratory Test Results – Current and Previous Investigations

Ontario

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RECORD OF BOREHOLE No LR-1 1 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 849 889.6 N; 293 691.2 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE September 28, 2015 CHECKED BY A.V.

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 (○ 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 (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
187.9	Ground Surface										
187.8 / 0.1	TOPSOIL										
	CLAYEY SILT, trace to some sand, trace gravel Stiff to hard Brown becoming grey below 3.8m Moist (TILL)		1	SS	4		187				
			2	SS	17		186				
			3	SS	22						
			4	SS	23		185				
			5	SS	24						5 16 49 30
			6	SS	15		184				
			7	SS	19		183				Auger grinding at a depth 5.2m
			8	SS	14		182				8 16 39 37
	rock fragments at a depth 7.8m		9	SS	20		181				
			10	SS	20		180				
			11	SS	24		179				0 15 59 26
			12	SS	24		178				
			13	SS	38		177				1 7 66 26
172.9	Cont'd						176				
							175				
							174				
							173				

+7 ,×5 : Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Ontario

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RECORD OF BOREHOLE No LR-1 2 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 849 889.6 N; 293 691.2 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE September 28, 2015 CHECKED BY A.V.

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 (○ 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 (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
172.9											
15.0	(Cont'd) CLAYEY SILT, trace to some sand, trace gravel Stiff to hard Brown becoming grey below 3.8m Moist (TILL)		14	SS	24		172				
170.3			15	SS	33	▽	171				
17.6	SAND, trace silt Very dense Grey Wet		16	SS	61		170				First groundwater strike at 17.7m
168.8							169				
19.1	CLAYEY SILT, some sand, trace gravel Hard Grey Moist (TILL)		17	SS	60/3cm		168				6 20 49 25 Sampler bouncing
167.2							167				
20.7	SAND and SILT, some clay, trace gravel Very dense Grey Moist (TILL)		18	SS	103		166				9 41 39 11
164.8			19	SS	70/5cm		165				
23.1	End of borehole Split spoon sampler refusal ▽ Water level noted during drilling ▼ Water level measured upon completion Note: 1. Groundwater level measured at a depth of 9.1m below ground surface (Elev. 178.8) upon completion of drilling.										

+7 ,×5 : Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No LR-2 1 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 849 915.7 N; 293 767.2 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE September 29, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
188.1	Ground Surface						188				
0.0	SAND and GRAVEL Compact Brown Moist (FILL)		1	SS	22						
187.4	CLAYEY SILT, some to with sand, trace gravel Stiff to very stiff Brown becoming grey below 3.1m Moist (TILL)		2	SS	20		187				
0.7			3	SS	22						
			4	SS	24		186				
			5	SS	22		185				
			6	SS	15		184				5 22 35 38
			7	SS	12		183				
			8	SS	19		182				
			9	SS	20		181				
			10	SS	27		180				
			11	SS	24		179				1 13 61 25
			12	SS	22		178				
			13	SS	25		177				
							176				
							175				
173.1	Cont'd						174				

+7, ×5: Numbers refer to Sensitivity (20 / 15 / 10 / 5) (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No LR-2 2 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 849 915.7 N; 293 767.2 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE September 29, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
173.1											
15.0	(Cont'd) CLAYEY SILT, trace sand, trace gravel Stiff to very stiff Grey Moist (TILL)		14	SS	19		173				1 12 54 33
170.4			15	SS	13		172				
17.7	SILTY SAND, trace clay Compact Grey Moist		16	SS	28	▽	171				
169.0							170				First groundwater strike at 18.3m
19.1	CLAYEY SILT, some sand, some gravel Very stiff to hard Grey Moist (TILL)		17	SS	31		169				
			18	SS	26		168				
			19	SS	73		167				
164.2							166				
23.9	SHALE BEDROCK Highly weathered Grey		20	SS	~~70/8cm~~		165				20 20 46 14
162.5							164				
25.6	End of borehole due to auger refusal ▽ Water level noted during drilling		21	SS	~~100/8cm~~		163				

+7, ×5: Numbers refer to Sensitivity (20 / 15 / 10 / 5) (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No LRC-1 1 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 849 741.3 N; 293 247.4 E ORIGINATED BY F.P.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE October 14, 2015 CHECKED BY A.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES 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
181.9	Ground Surface										
181.7 / 0.2	ASPHALT (200mm)										
	SAND, with gravel Compact to very dense Brown and grey Moist		1	SS	56						
180.7	(FILL)		2	SS	12						
1.2	CLAYEY SILT, some sand, trace gravel, trace organics, containing silt seams Firm to stiff Mottled grey and brown Moist		3	SS	8						
			4	SS	9						6 16 51 27
			5	SS	10						
177.3			6	SS	5						
4.6	CLAYEY SILT, trace to some sand, trace gravel, conatining silt seams, and shale fragments Stiff to hard Grey Moist (TILL)		7	SS	11						
			8	SS	12						3 16 54 27
			9	SS	37						
			10	SS	43						0 2 73 25
			11	SS	53						
170.2 / 11.7	SHALE BEDROCK Highly weathered Grey		12	SS	73/15cm						First groundwater strike at 11.7m
	Cont'd		13	SS	66/15cm						

ELEVATION SCALE: 181, 180, 179, 178, 177, 176, 175, 174, 173, 172, 171, 170, 169, 168, 167

+ⁿ, ×ˢ: Numbers refer to Sensitivity (20 / 15 5 / 10)

(%) STRAIN AT FAILURE

Ontario

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RECORD OF BOREHOLE No LRC-1 2 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 849 741.3 N; 293 247.4 E ORIGINATED BY F.P.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE October 14, 2015 CHECKED BY A.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES 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
166.9											
166.5			14	SS	100/13cm						
15.4	End of borehole ▽ Water level noted during drilling ▼ Water level measured upon completion Notes: 1. Groundwater level measured at a depth of 7.9m below ground surface (Elev. 174.0m) upon completion of drilling. 2. No cave-in was noted upon extraction of hollow stem augers.										

+ⁿ, ×ˢ: Numbers refer to Sensitivity (20 / 15 5 / 10)

(%) STRAIN AT FAILURE

Ontario

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RECORD OF BOREHOLE No LRC-2 1 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 849 747.0 N; 293 320.3 E ORIGINATED BY F.P.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE October 15, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (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
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES								
180.6	Ground Surface												
180.4 / 0.2	ASPHALT (180mm)												
	SAND, with gravel Very dense Brown Moist (FILL)		1	SS	70								
179.7 / 0.9	CLAYEY SILT, trace sand, trace gravel, trace organics Stiff Brown Moist		2	SS	10								
			3	SS	13								
178.4 / 2.2	CLAYEY SILT, trace sand, trace gravel Hard Brown becoming grey below a depth of 3.0m Moist to wet (TILL)		4	SS	30								2 8 68 22
			5	SS	65								
			6	SS	52								5 1 71 23
			7	SS	50/15cm								
			8	SS	73								
			9	SS	53								0 4 57 39
			10	SS	58								
			11	SS	68/15cm								First groundwater strike at 10.5m
169.0 / 11.6	SHALE BEDROCK Highly weathered Grey		12	SS	100/15cm								
166.8 / 13.8	End of borehole Water level measured upon completion		13	SS	50/5cm								

Notes:

1. Groundwater level was Cont'd

+7, ×5: Numbers refer to Sensitivity (20, 15, 5, 10) (%) STRAIN AT FAILURE

Ontario

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RECORD OF BOREHOLE No LRC-2 2 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 849 747.0 N; 293 320.3 E ORIGINATED BY F.P.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE October 15, 2015 CHECKED BY A.V.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (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
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES							
165.6	measured at a depth of 10.5m below ground surface (Elev. 170.1m) upon completion of drilling. 2. No cave-in was noted in the borehole upon extraction of hollow stem augers.											

ON MTO_NEW LOGO HWY 427 15TF013A-REV.GPJ ON_MOT.GDT 15/01/2016 9:31:13 AM

+7, ×5: Numbers refer to Sensitivity (20, 15, 5, 10) (%) STRAIN AT FAILURE

Ontario

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RECORD OF BOREHOLE No LRC-3 1 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 849 732.8 N; 293 287.0 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE October 16, 2015 CHECKED BY A.V.

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 (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
179.9	Ground Surface										
179.8	ASPHALT (150mm)										
0.2	SAND, with gravel Compact to very dense Brown Moist (FILL)		1	SS	84						
			2	SS	15						
178.2			3A	SS							
1.7	CLAYEY SILT, trace to some sand, containing topsoil Firm to Stiff Mottled brown and grey Moist		3B	SS	7						
			4	SS	10						
176.7			5A	SS							
3.2	SILT and SAND, trace to some gravel, trace clay Very dense Brown to grey Moist (TILL)		5B	SS	70						
			6	SS	65/13cm						10 40 41 9 Sampler bouncing
			7	SS	65/10cm						Sampler bouncing
			8	SS	65/13cm						Sampler bouncing
172.9											
7.0	CLAYEY SILT, trace sand Hard Grey Moist (TILL)		9	SS	51						0 0 58 42
			10	SS	41						
			11	SS	37						Auger grinding between depths of 11.3m and 12.2m
168.2											
11.7	SHALE BEDROCK Highly weathered Grey		12	SS	75/5cm						
			13	SS	75/10cm						Sampler bouncing
	Cont'd										

ON MTO_NEW LOGO HWY 427 15TF013A-REV.GPJ ON_MOT.GDT 15/01/2016 9:31:14 AM

+7, ×5: Numbers refer to Sensitivity (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No LRC-3 2 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 849 732.8 N; 293 287.0 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE October 16, 2015 CHECKED BY A.V.

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 (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
164.9											
164.6											Sampler bouncing
15.3	End of borehole ▼ Water level measured upon completion Notes: 1. Groundwater level measured at a depth of 14.6m below ground surface (Elev. 165.3m) upon completion of drilling. 2. No cave-in was noted in the borehole upon extraction of hollow stem augers.		14	SS	75/3cm						

ON MTO_NEW LOGO HWY 427 15TF013A-REV.GPJ ON_MOT.GDT 15/01/2016 9:31:14 AM

+7, ×5: Numbers refer to Sensitivity (%) STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No E8

1 OF 1 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4849831.7 ;E 293897.9 | ORIGINATED BY CR
W.O. 05-20012 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | COMPILED BY PKS/VA
DIST Central HWY 427 | DATE April 1, 2009 | CHECKED BY SMM
DATUM Geodetic

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED) (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
186.7	GROUND SURFACE										
0.0	TOPSOIL										
0.2	CLAYEY SILT, trace sand, trace gravel, containing rootlets (Reworked) Firm Brown Moist		1	SS	7				41		
186.1							186				
0.6	CLAYEY SILT, some sand, trace gravel (TILL) Very stiff to hard Brown, becoming grey at 3.7 m depth Moist		2	SS	21						
			3	SS	29		185				
			4	SS	28		184				
			5	SS	39		183				
			6	SS	20						
			7	SS	32		182				
							181				
180.0			8	SS	27						
6.7	END OF BOREHOLE						180				

NOTES:

1. Open borehole dry upon completion of drilling.
2. Borehole backfilled with bentonite

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No E9

1 OF 1 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4849764.3 ;E 293357.4 | ORIGINATED BY JEB
W.O. 05-20012 | BOREHOLE TYPE 108 mm Diameter Solid Stem Augers | COMPILED BY PKS/VA
DIST Central HWY 427 | DATE April 14, 2009 | CHECKED BY SMM
DATUM Geodetic

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED) (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
181.4	GROUND SURFACE										
0.0	ASPHALT										
0.1	Sand and gravel (FILL) Brown Moist										
180.8							181				
0.6	Clayey silt, trace sand, trace gravel, containing rootlets (FILL) Stiff Brown Moist		1	SS	9						
179.3			2	SS	15		180				
2.1	Organic SILTY CLAY, trace sand, trace gravel, containing root fibres Firm Black and grey Moist		3	SS	7	▽			45		OC = 6.5%
178.5							179				
2.9	CLAYEY SILT, trace sand Stiff Brown Moist		4	SS	8						
177.6							178				
3.8	CLAYEY SILT, trace sand, trace gravel (TILL) Hard Grey Moist to wet		5	SS	79						
			6	SS	10/0.23		177				
175.9											
5.5	SAND and SILT, some gravel, trace clay (TILL) Very dense Grey Wet		7	SS	05/0.15		176				19 45 30 6
174.1											
7.3	CLAYEY SILT, some sand, trace gravel (TILL) Hard Grey Wet		8	SS	102		175				
173.2											
8.2	END OF BOREHOLE						174				

NOTES:

1. Water level in open borehole at a depth of 3.0 m below ground surface (Elev. 178.4 m) upon completion of drilling.
2. Borehole backfilled with bentonite.

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No E10

1 OF 1 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4849798.1 ;E 293450.1 | ORIGINATED BY JEB
W.O. 05-20012 | | COMPILED BY PKS/VA
DIST Central HWY 427 | BOREHOLE TYPE 108 mm Diameter Solid Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE April 14, 2009

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	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
185.6	GROUND SURFACE							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100						
0.0	ASPHALT													
0.1	Sand and gravel (FILL) Brown Moist													
185.0							185							
0.6	CLAYEY SILT, some sand, trace gravel (TILL) Stiff to very hard Brown Moist		1	SS	10									
			2	SS	21		184							
			3	SS	21		183							
	Becoming grey at 3.8 m depth		4	SS	24		182							3 21 51 25
			5	SS	16									
			6	SS	18		181							
			7	SS	18		180							
							179							
			8	SS	32		178							
177.4														
8.2	END OF BOREHOLE													

NOTES:

1. Open borehole dry upon completion of drilling.
2. Borehole backfilled with bentonite.

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No E11

1 OF 1 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4849822.2 ;E 293543.2 | ORIGINATED BY JEB
W.O. 05-20012 | | COMPILED BY PKS/VA
DIST Central HWY 427 | BOREHOLE TYPE 108 mm Diameter Solid Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE April 14, 2009

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	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
186.9	GROUND SURFACE							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100						
0.0	ASPHALT													
0.2	CLAYEY SILT, trace sand, trace gravel (TILL) Stiff to hard Brown Moist		1	SS	10		186							
			2	SS	21		185							
			3	SS	33									
			4	SS	31		184							
			5	SS	22		183							
	Becoming grey at 4.6 m depth		6	SS	22		182							
			7	SS	25		181							
							180							
			8	SS	28		179							
178.7														
8.2	END OF BOREHOLE													

NOTES:

1. Open borehole dry upon completion of drilling.
2. Borehole backfilled with bentonite.

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No E12

1 OF 1 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4849857.5 ;E 293640.7
BOREHOLE TYPE 108 mm Diameter Solid Stem Augers
DATE April 14, 2009

ORIGINATED BY JEB
COMPILED BY PKS/VA
CHECKED BY SMM

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	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
187.4	GROUND SURFACE							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100						
0.0	ASPHALT													
0.1	CLAYEY SILT, trace sand, trace gravel (TILL) Stiff to hard Brown to grey Moist													
			1	SS	11									
			2	SS	22									
			3	SS	24									
			4	SS	33									
	Becoming grey at a depth of 3.8 m													
			5	SS	19									
			6	SS	24									
			7	SS	23									
			8	SS	34									
179.2														
8.2	END OF BOREHOLE													

NOTES:

1. Open borehole dry upon completion of drilling.
2. Borehole backfilled with bentonite.

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

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RECORD OF BOREHOLE No E13

1 OF 1 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4849920.9 ;E 293844.6
BOREHOLE TYPE 108 mm Diameter Solid Stem Augers
DATE April 13, 2009

ORIGINATED BY JEB
COMPILED BY PKS/VA
CHECKED BY SMM

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	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
187.3	GROUND SURFACE							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100						
0.0	ASPHALT													
0.1	Sand and gravel (FILL) Brown Moist													
186.7														
0.6	SILTY CLAY, some sand, trace gravel (TILL) Stiff to hard Brown Moist													
			1	SS	11									
			2	SS	23									
			3	SS	29									1 20 44 35
			4	SS	31									
			5	SS	22									
182.8														
4.5	CLAYEY SILT, some sand, trace gravel (TILL) Very stiff to hard Brown, becoming grey at a depth of 6.1 m Moist													
			6	SS	32									
			7	SS	25									
			8	SS	29									
179.1														
8.2	END OF BOREHOLE													

NOTES:

1. Open borehole dry upon completion of drilling.
2. Borehole backfilled with bentonite.

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S10

1 OF 1 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4849726.6 ;E 293235.7 | ORIGINATED BY SB
W.O. 05-20012 | | COMPILED BY VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 20, 2009

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	GR SA SI CL
183.4	GROUND SURFACE						
0.0	Asphalt						
0.2	Sand, trace gravel (FILL) Brown Moist						
182.6							
0.8	CLAYEY SILT, some sand, trace gravel, containing cobbles (TILL) Stiff to hard Brown Moist		1	SS	11		
			2	SS	30		
	Becoming grey at a depth of 2.3 m		3	SS	27		
			4	SS	61		
178.9			5	SS	38		
4.5	SAND and SILT, trace gravel, trace clay (TILL) Very dense Grey Moist		6	SS	102		
177.5							
5.9	CLAYEY SILT Hard Grey Moist		7	SS	101		
175.3			8	SS	171		0 0 80 20
8.1	END OF BOREHOLE						

NOTES:

1. Open borehole dry upon completion of drilling.
2. Borehole backfilled with bentonite.

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)
PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)
UNIT WEIGHT γ kN/m³
REMARKS & GRAIN SIZE DISTRIBUTION (%)

ELEVATION SCALE: 183, 182, 181, 180, 179, 178, 177, 176

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S11

1 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4849750.6 ;E 293294.6 | ORIGINATED BY SB
W.O. 05-20012 | | COMPILED BY VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 20, 2009

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	GR SA SI CL
180.9	GROUND SURFACE						
0.0	Asphalt						
0.2	Sand, trace gravel (FILL) Brown Moist						
180.1							
0.8	CLAYEY SILT, some sand, trace gravel, slightly organic, containing rootlets Stiff Dark grey Moist		1	SS	8		
178.7			2	SS	8		0 17 61 22
2.2	CLAYEY SILT with sand, trace gravel Firm Brown Moist		3	SS	6		
177.9							
3.0	CLAYEY SILT, some sand, trace gravel, containing cobbles (TILL) Hard Grey Moist		4	SS	88		
177.0							
3.9	SAND and SILT, trace gravel, trace clay (TILL) Very dense Grey Moist		5	SS	148		6 36 50 8
			6	SS	86		
			7	SS	100/0.1		
173.9							
7.0	CLAYEY SILT, some sand, trace gravel (TILL) Hard Grey and brown Moist		8	SS	107/0.1	▽	
			9	SS	55		
170.5							
10.4	CLAYEY SILT with sand, trace to some gravel, containing shale fragments (TILL) Hard Grey Moist		10	SS	109		8 30 49 13
168.7							
12.2	SHALE (BEDROCK) Grey		11	SS	125/0.1		
167.1							
13.8	END OF BOREHOLE		12	SS	100/0.0		

Continued Next Page

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)
PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)
UNIT WEIGHT γ kN/m³
REMARKS & GRAIN SIZE DISTRIBUTION (%)

ELEVATION SCALE: 180, 179, 178, 177, 176, 175, 174, 173, 172, 171, 170, 169, 168

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S11

2 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4849750.6 ;E 293294.6
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 20, 2009

ORIGINATED BY SB
COMPILED BY VA
CHECKED BY SMM

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 (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED			
	END OF BOREHOLE NOTE: 1. A 50 mm diameter monitoring well was installed at a depth of 13.7 m (Elev. 167.2 m). Water level measurements Date — Depth — Elev. On Completion 7.8 m 173.1 m April 24/09 0.0 m 180.9 m May 13/09 0.0 m 180.9 m June 15/09 0.0 m 180.9 m July 09/ 09 0.0 m 180.9 m										

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S12

1 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4849869.7 ;E 293699.8
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 26, 2009

ORIGINATED BY CR
COMPILED BY PKS/VA
CHECKED BY SMM

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 (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
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED			
187.5	GROUND SURFACE										
0.0	ASPHALT										
	Silty sand, some gravel (FILL) Compact Brown to grey Moist		1	SS	29						
0.4											
	Clayey silt, trace gravel, trace sand, containing rootlets (FILL) Stiff to very stiff Brown Moist		2	SS	13						
186.1											
1.5	SILTY CLAY, trace gravel, trace sand (TILL) Hard Brown Moist		3	SS	32						
			4	SS	30						
			5	SS	32						
			6	SS	37						
182.9											
4.6	CLAYEY SILT, some sand, trace gravel, containing cobbles (TILL) Very stiff to hard Grey Moist		7	SS	25	▽					
			8	SS	22						
			9	SS	26						
			10	SS	42						
			11	SS	31						
	Augers grinding at 11.4 m depth										
			12	SS	51						
			13	SS	35						1 18 58 23

Continued Next Page

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S12

2 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4849869.7 ;E 293699.8
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 26, 2009

ORIGINATED BY CR
COMPILED BY PKS/VA
CHECKED BY SMM

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 × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —										
	CLAYEY SILT, some sand, trace gravel, containing cobbles (TILL) Very stiff to hard Grey Moist		14	SS	39		172				
170.1							171				
17.4	SAND, trace gravel, trace silt, trace clay Compact Grey Wet Augers grinding between 17.6 m and 18.0 m depth		15	SS	12		170				2 91 4 3
168.6							169				
18.9	SILTY CLAY, some sand, trace gravel (TILL) Hard Grey Wet		16	SS	155		168				
166.6			17	SS	112		167				
20.9	CLAYEY SILT, trace gravel, trace sand, containing cobbles (TILL) Hard Grey Wet Augers grinding between 22.1 m and 22.5 m depth		18	SS	102		166				
							165				
164.4			19	SS	00/0.1						
23.1	END OF BOREHOLE										

NOTES:

1. A 50 mm diameter monitoring well was installed at a depth of 18.9 m (Elev. 168.6 m).

Water level measurements

Date	Depth	Elev.
On Completion	5.2 m	182.3 m
May 13, 2009	6.9 m	180.6 m
June 15, 2009	6.7 m	180.8 m
July 09, 2009	6.3 m	181.3 m

2. At 18.3 m depth (Elev. 169.2 m) 1.2 m of sand was up inside the augers during drilling due to "blowing" sands.

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Foundation Design

Golder Associates

RECORD OF BOREHOLE No S13

1 OF 3 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4849885.0 ;E 293730.1
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 30 & 31, 2009

ORIGINATED BY CR
COMPILED BY PKS/VA
CHECKED BY SMM

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 × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
187.7	GROUND SURFACE										
0.0	ASPHALT										
0.2	Silty sand, some gravel (FILL) Compact Brown Moist		1	SS	15		187				
186.9											
0.8	Clayey silt, some sand, trace gravel (FILL) Very stiff Brown Moist		2	SS	12		186				
	SILTY CLAY, trace sand, trace gravel (TILL) Stiff to hard Brown Moist		3	SS	29						
			4	SS	27		185				
			5	SS	35		184				
			6	SS	31						
183.1							183				
4.6	CLAYEY SILT, some sand, trace gravel, containing cobbles (TILL) Very stiff to hard Grey Moist Augers grinding at 5.2 m depth		7	SS	21						
			8	SS	22		182				
							181				
			9	SS	43	▽	180				
	Augers grinding at 8.4 m depth										
			10	SS	43		179				
							178				
			11	SS	55		177				
							176				
			12	SS	48		175				
174.0											
13.7	Silty SAND, trace gravel Very dense Grey Wet		13	SS	59		174				
							173				

Continued Next Page

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S13

2 OF 3 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4849885.0 ;E 293730.1
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 30 & 31, 2009

ORIGINATED BY CR
COMPILED BY PKS/VA
CHECKED BY SMM

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 ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
172.5							172				
15.2	CLAYEY SILT, some sand, trace gravel (TILL) Very stiff Grey Wet		14	SS	28		171				
170.0							170				
17.7	SAND, trace to some silt, trace gravel Compact Grey Wet		15	SS	22		169		○		1 87 9 3
167.9							168				
19.8	CLAYEY SILT, some sand, trace gravel (TILL) Hard Grey Wet						167				
	Augers grinding at 21.0 m depth		16	SS	199		166		○		
	Augers grinding at 22.0 m depth						165				
			17	SS	80		164				
163.9							163				
23.8	SHALE (BEDROCK) Grey		18	SS	150/0.10		162				
			19	SS	60/0.05		161				
160.2											
27.5	END OF BOREHOLE		20	SS	100/0.08						

Continued Next Page

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

Foundation Design

Golder Associates

RECORD OF BOREHOLE No S13

3 OF 3 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4849885.0 ;E 293730.1
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 30 & 31, 2009

ORIGINATED BY CR
COMPILED BY PKS/VA
CHECKED BY SMM

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 ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	NOTES: 1. A hydrostatic head of water was required inside the augers at 18.3 m depth (Elev. 169.4 m) in order to advance the borehole due to "blowing" sands. 2. Water level in open borehole at a depth of 7.8 m below ground surface (Elev. 179.9 m) upon completion of drilling. 3. Borehole backfilled with bentonite.										

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

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RECORD OF BOREHOLE No S14

1 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4849893.4 ;E 293775.6
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE April 2, 2009

ORIGINATED BY CR
COMPILED BY PKS/VA
CHECKED BY SMM

ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
187.7	GROUND SURFACE						187
0.0	ASPHALT						
0.3	Silty sand, some gravel (FILL) Dense Brown Moist		1	SS	41		
186.9							186
0.8	Clayey silt, some sand, trace gravel (FILL) Hard Brown Moist		2	SS	16		
			3	SS	18		
	CLAYEY SILT, some sand, trace gravel (TILL) Stiff to hard Brown Moist		4	SS	24		185
			5	SS	30		
	Becoming grey below a depth of 3.8 m		6	SS	17		184
			7	SS	19		183
			8	SS	24		182
			9	SS	30		181
			10	SS	41		180
			11	SS	30		179
			12	SS	21		178
			13	SS	38		177
							176
							175
							174
							173

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

SHEAR STRENGTH kPa (20 40 60 80 100)
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S14

2 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4849893.4 ;E 293775.6
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE April 2, 2009

ORIGINATED BY CR
COMPILED BY PKS/VA
CHECKED BY SMM

ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
	— CONTINUED FROM PREVIOUS PAGE —						
	CLAYEY SILT, some sand, trace gravel (TILL) Stiff to hard Brown Moist		14	SS	12		172
170.0						▽	
17.7	Silty SAND, trace to some silt, trace gravel, trace clay Dense Grey Wet						171
169.3							
18.4			15	SS	46		170
168.8	SILTY CLAY, some sand, trace gravel (TILL) Hard Grey Wet						
18.9	END OF BOREHOLE						169

NOTES:

1. Water level in open borehole at a depth of 17.7 m below ground surface (Elev. 170.0 m) upon completion of drilling.

2. An additional borehole was drilled adjacent to Borehole S14; See Record of Borehole S14A for details.

3. Borehole backfilled with bentonite.

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

SHEAR STRENGTH kPa (20 40 60 80 100)
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

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

Golder Associates

RECORD OF BOREHOLE No S14A

1 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4849893.4 ;E 293776.6
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE April 13, 2009

ORIGINATED BY JEB
COMPILED BY PKS/VA
CHECKED BY SMM

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 (20 40 60 80 100): O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
187.7 0.0	GROUND SURFACE						187				
	Unsampled, see Record of Borehole S14 for stratigraphy above a depth of 19.8 m.						186 185 184 183 182 181 180 179 178 177 176 175 174 173				

Continued Next Page

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

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RECORD OF BOREHOLE No S14A

2 OF 2 **METRIC**

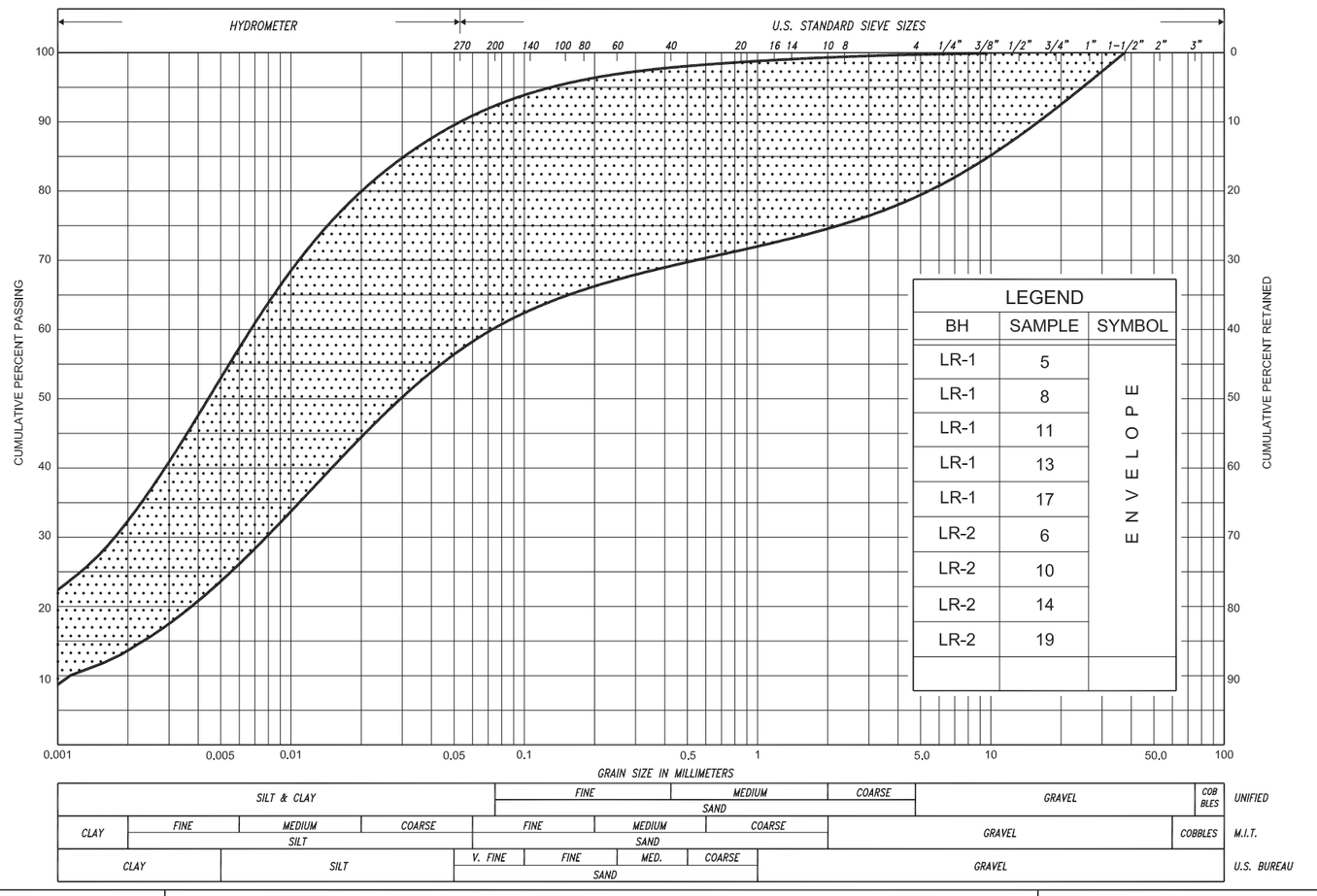
PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4849893.4 ;E 293776.6
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE April 13, 2009

ORIGINATED BY JEB
COMPILED BY PKS/VA
CHECKED BY SMM

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 (20 40 60 80 100): O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —						172				
	Unsampled, see Record of Borehole S14 for stratigraphy above a depth of 19.8 m.						171 170 169				
167.9 19.8	SILTY CLAY, trace gravel, trace sand (TILL) Very stiff to hard Grey Moist		1	SS	22		168		42		
			2	SS	33	▽	167				
165.9 21.8	SAND and SILT, some gravel, trace clay (TILL) Dense to very dense Grey Wet		3	SS	70		166 165				12 40 39 9
164.0 23.7	SHALE (BEDROCK) Grey						164				
163.2 24.5	END OF BOREHOLE NOTES: 1. Water level in open borehole at a depth of 21.8 m below ground surface (Elev. 165.9 m) upon completion of drilling. 2. Borehole backfilled with bentonite.		4	SS	10/0.10						

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

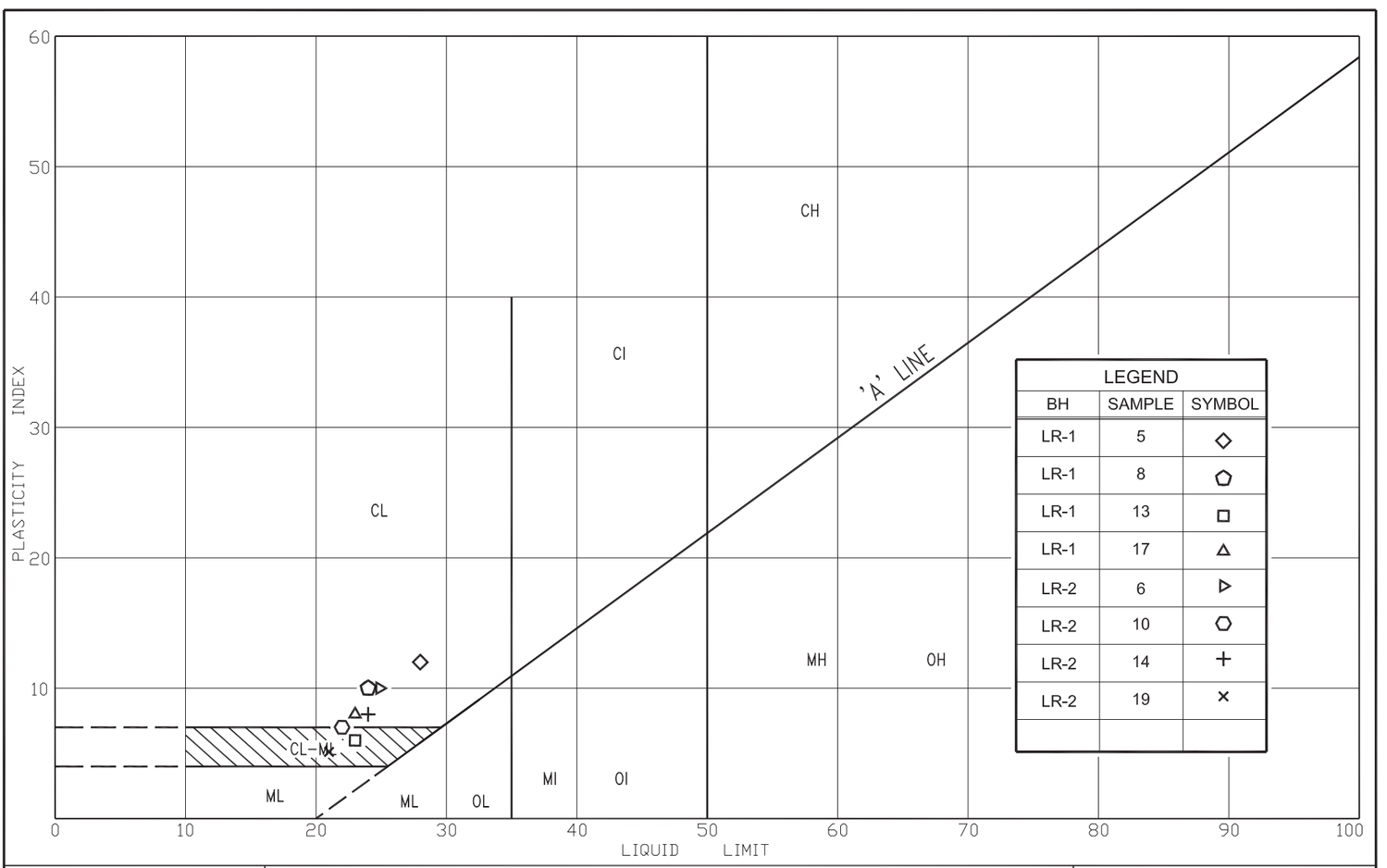


Ontario

GRAIN SIZE DISTRIBUTION

CLAYEY SILT (with sand) (TILL)

FIG No.	D-1
HWY:	427
G.W.P. No.	

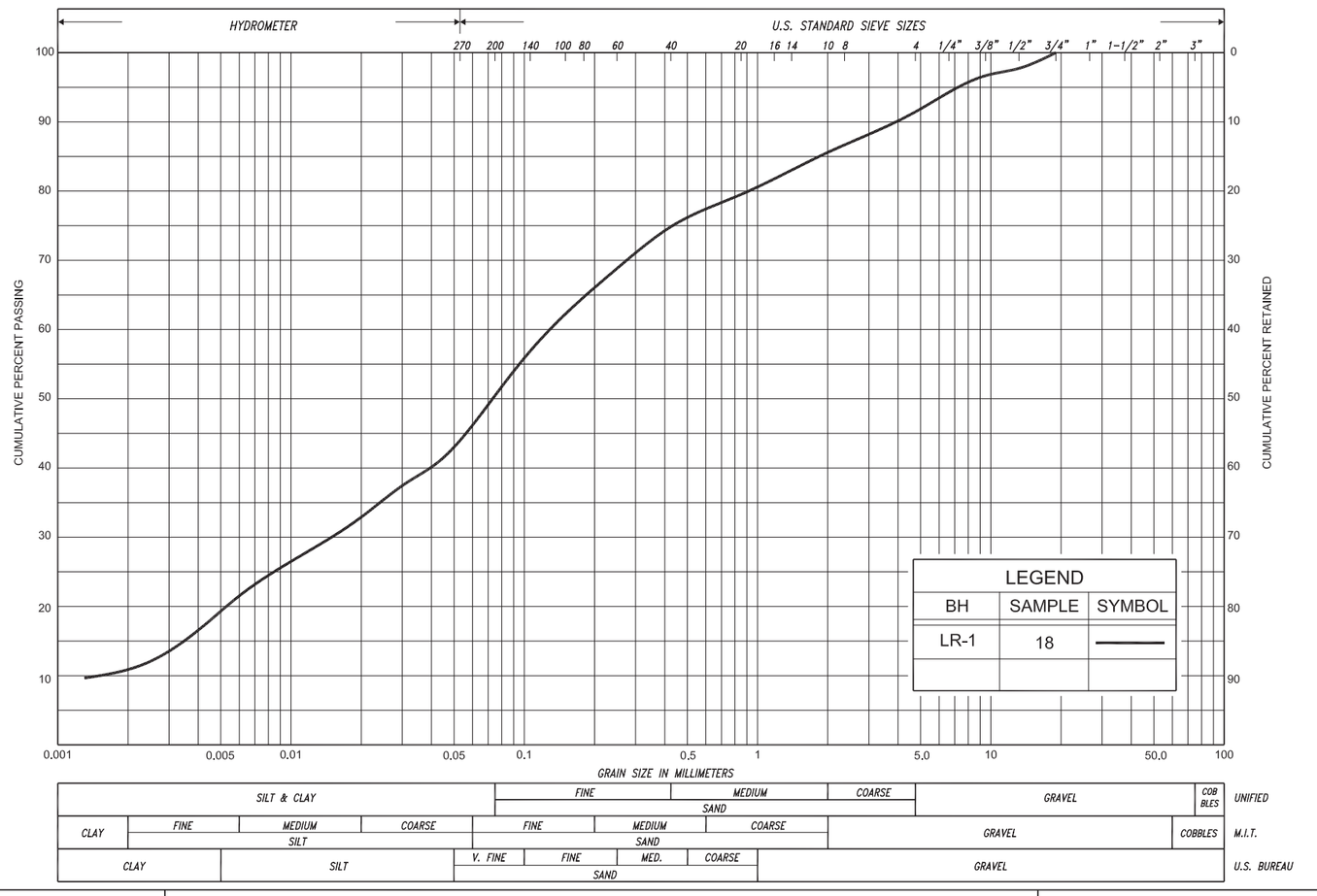


Ontario

PLASTICITY CHART

CLAYEY SILT (TILL)

FIG No.	D-2
HWY:	427
G.W.P. No.	

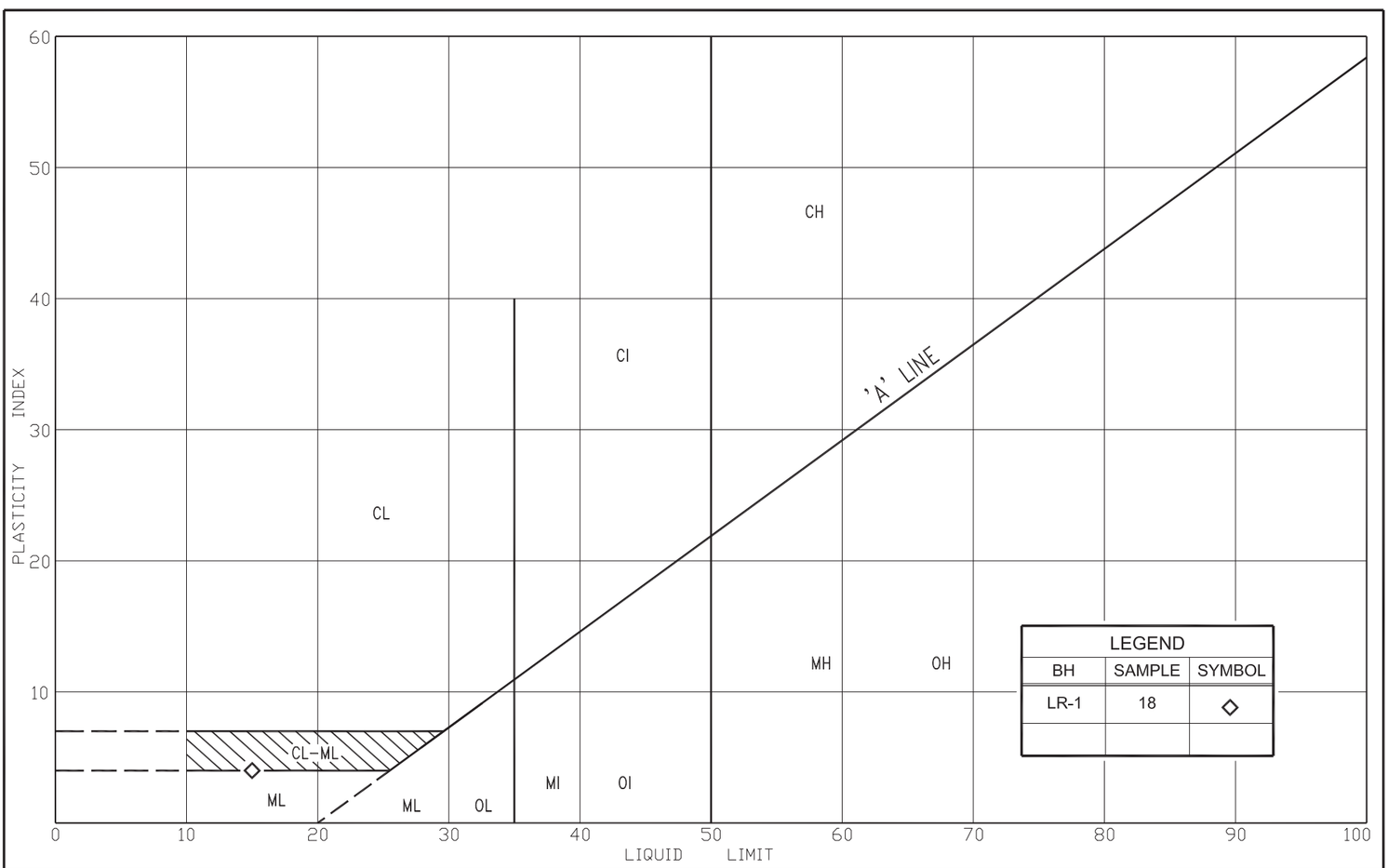


Ontario

GRAIN SIZE DISTRIBUTION

SAND and SILT (TILL)

FIG No.	D-3
HWY:	427
G.W.P. No.	

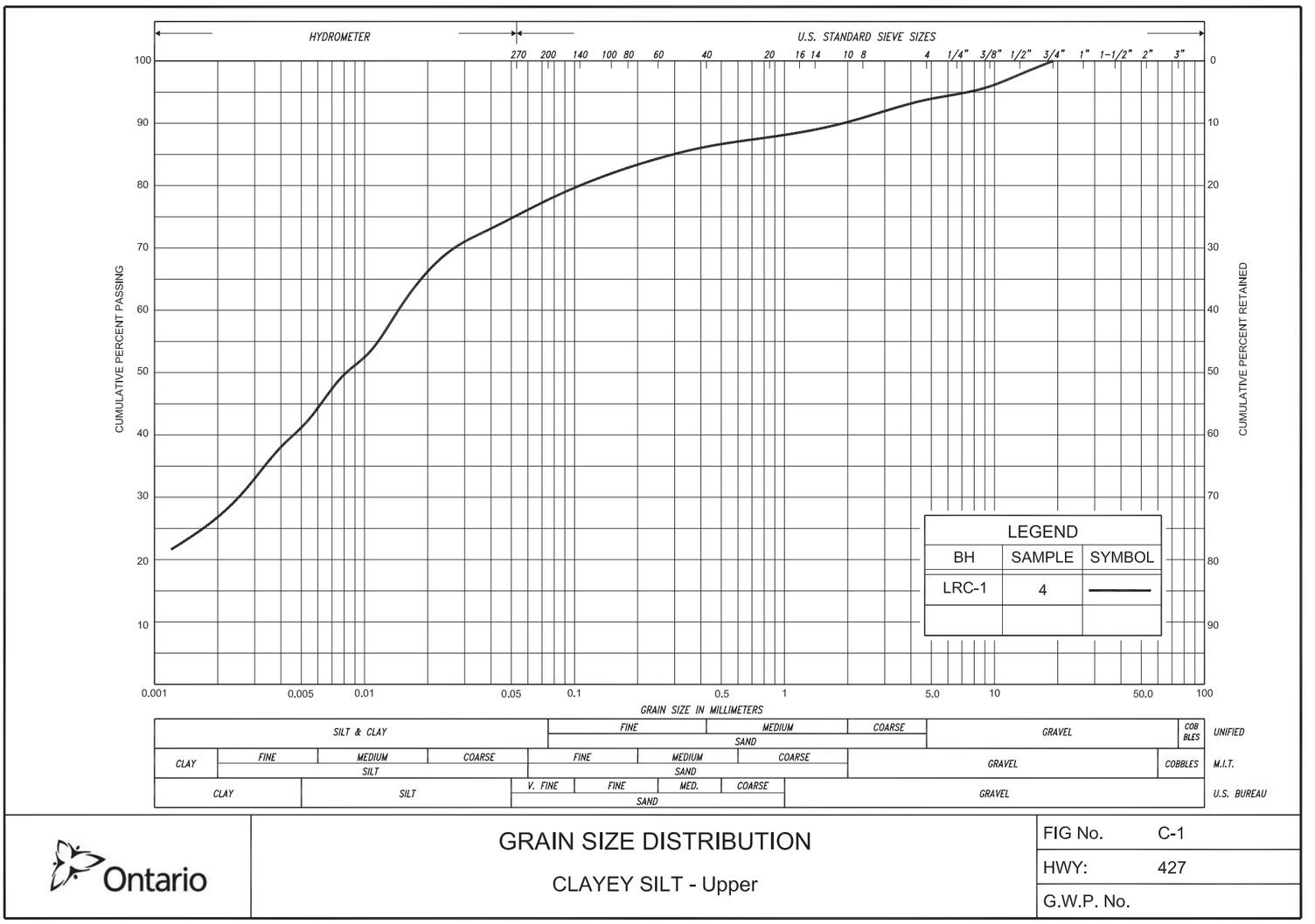


Ontario

PLASTICITY CHART

SAND and SILT (TILL)

FIG No.	D-4
HWY:	427
G.W.P. No.	

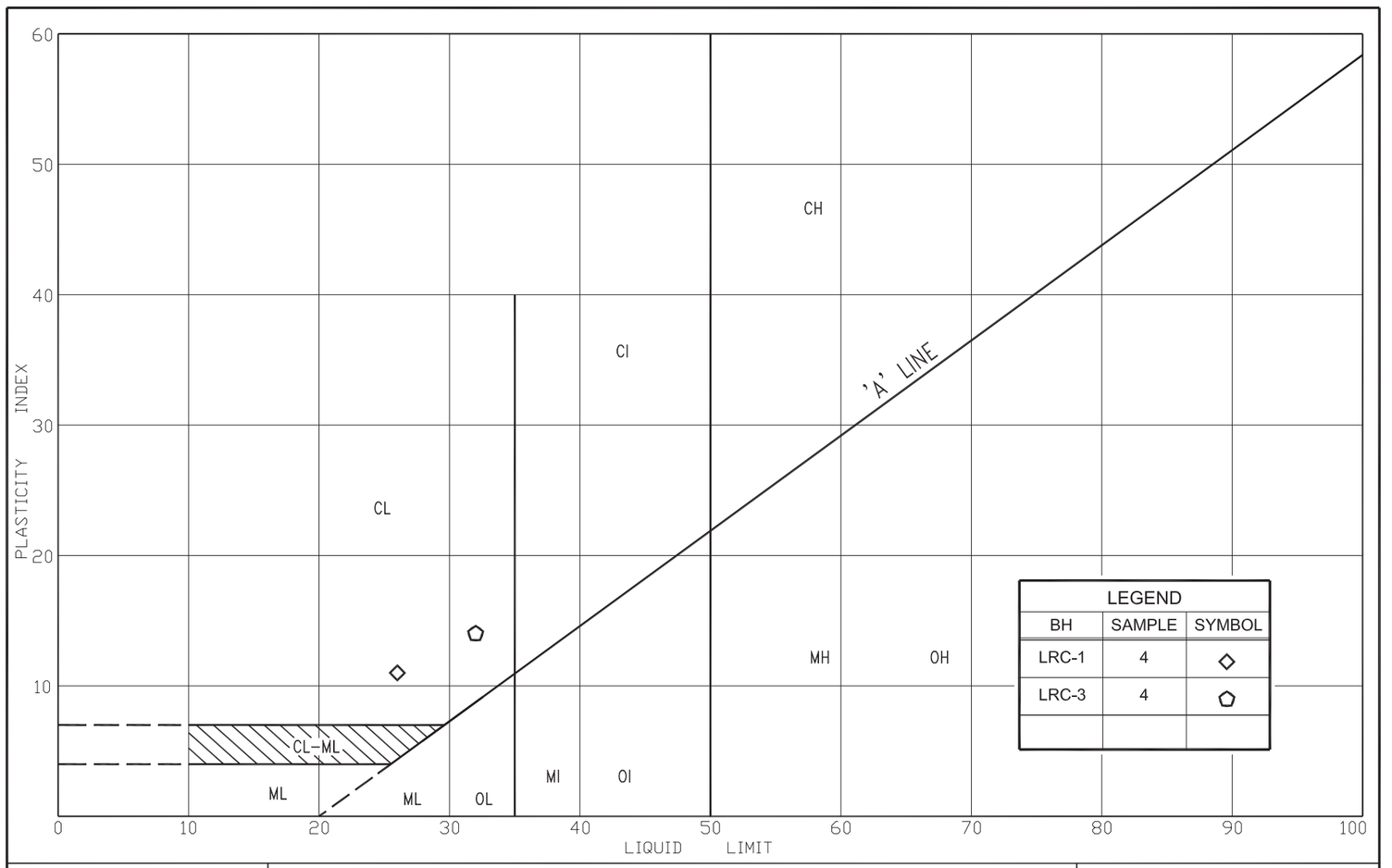


Ontario

GRAIN SIZE DISTRIBUTION

CLAYEY SILT - Upper

FIG No.	C-1
HWY:	427
G.W.P. No.	

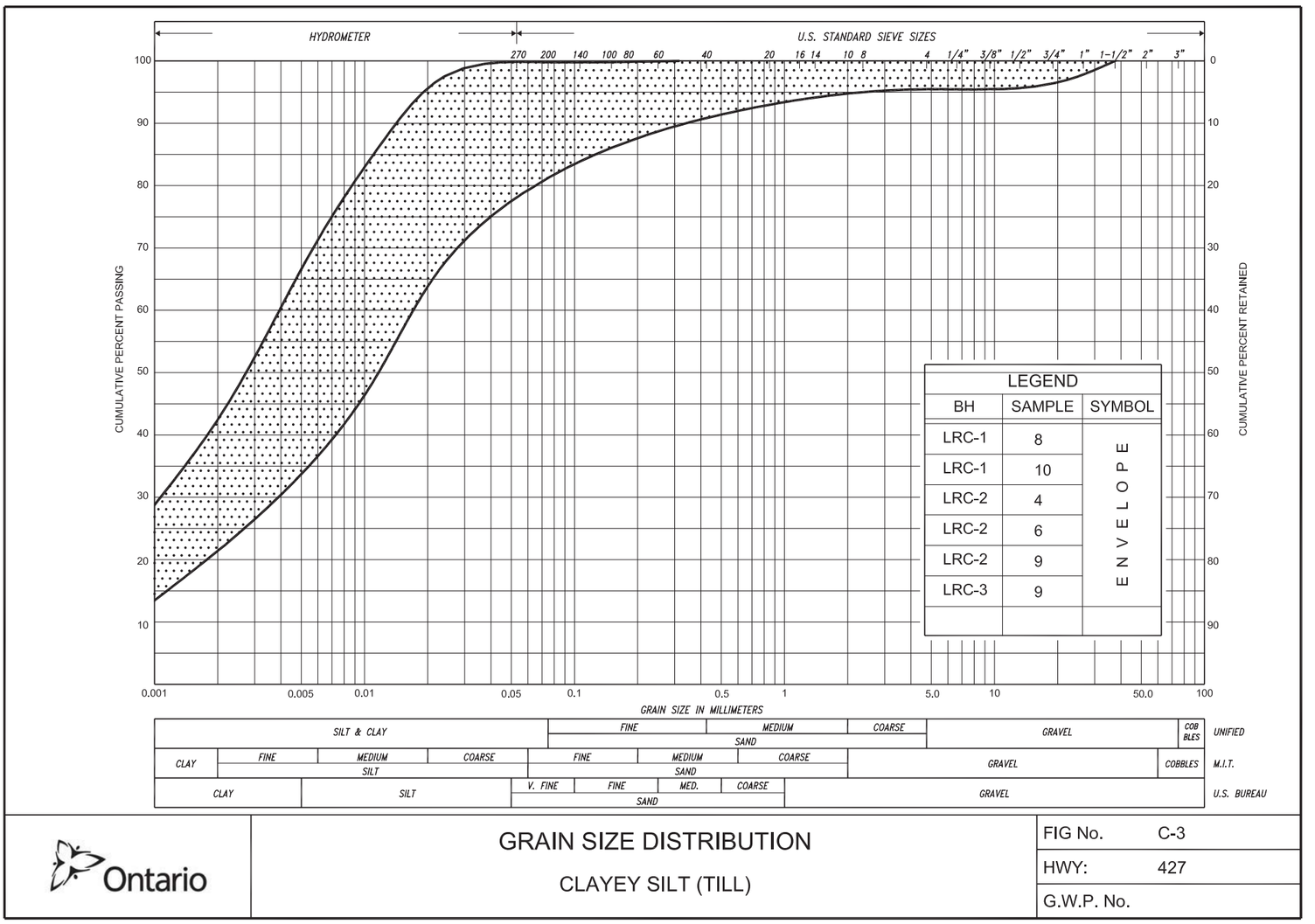


Ontario

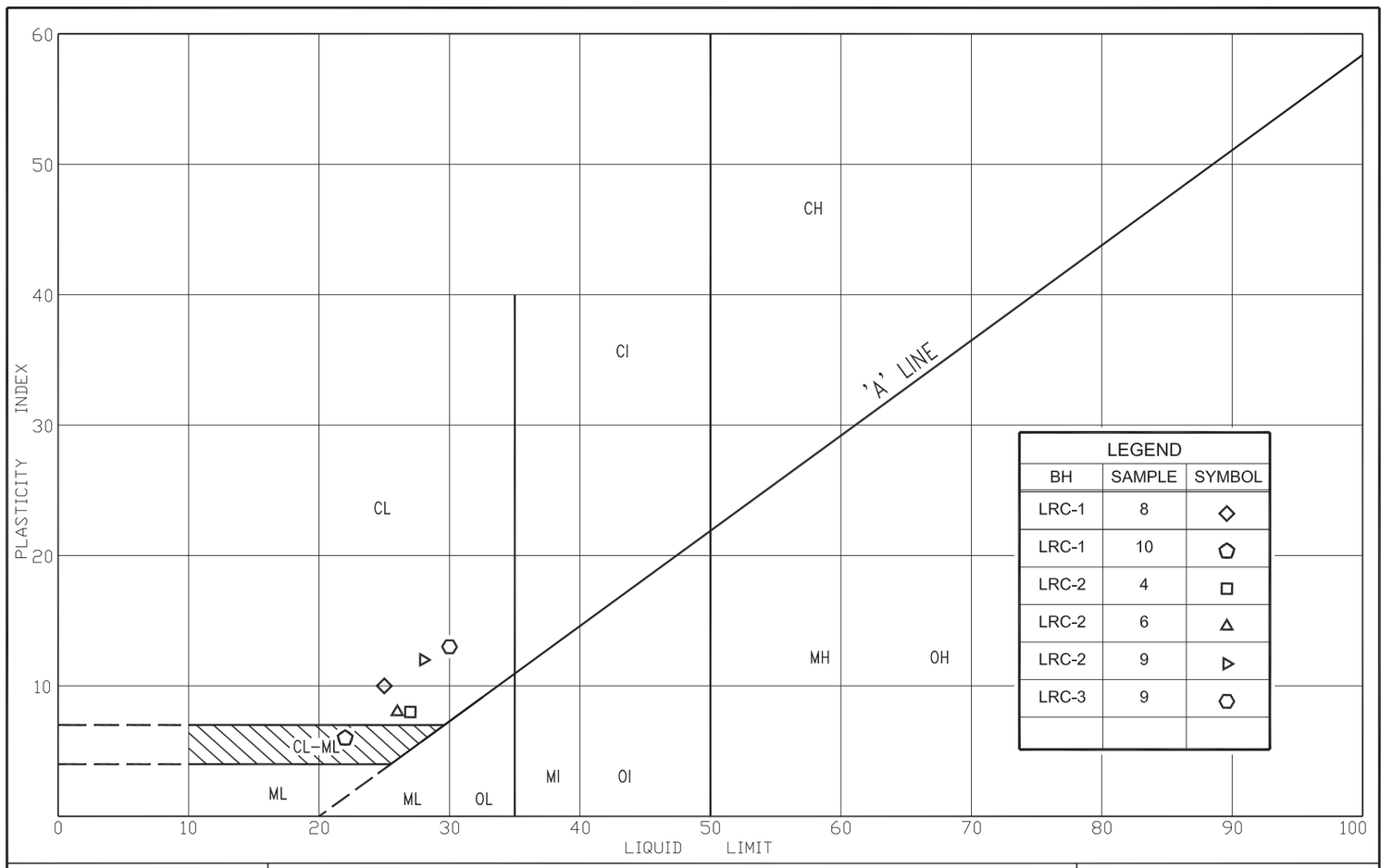
PLASTICITY CHART

CLAYEY SILT - Upper

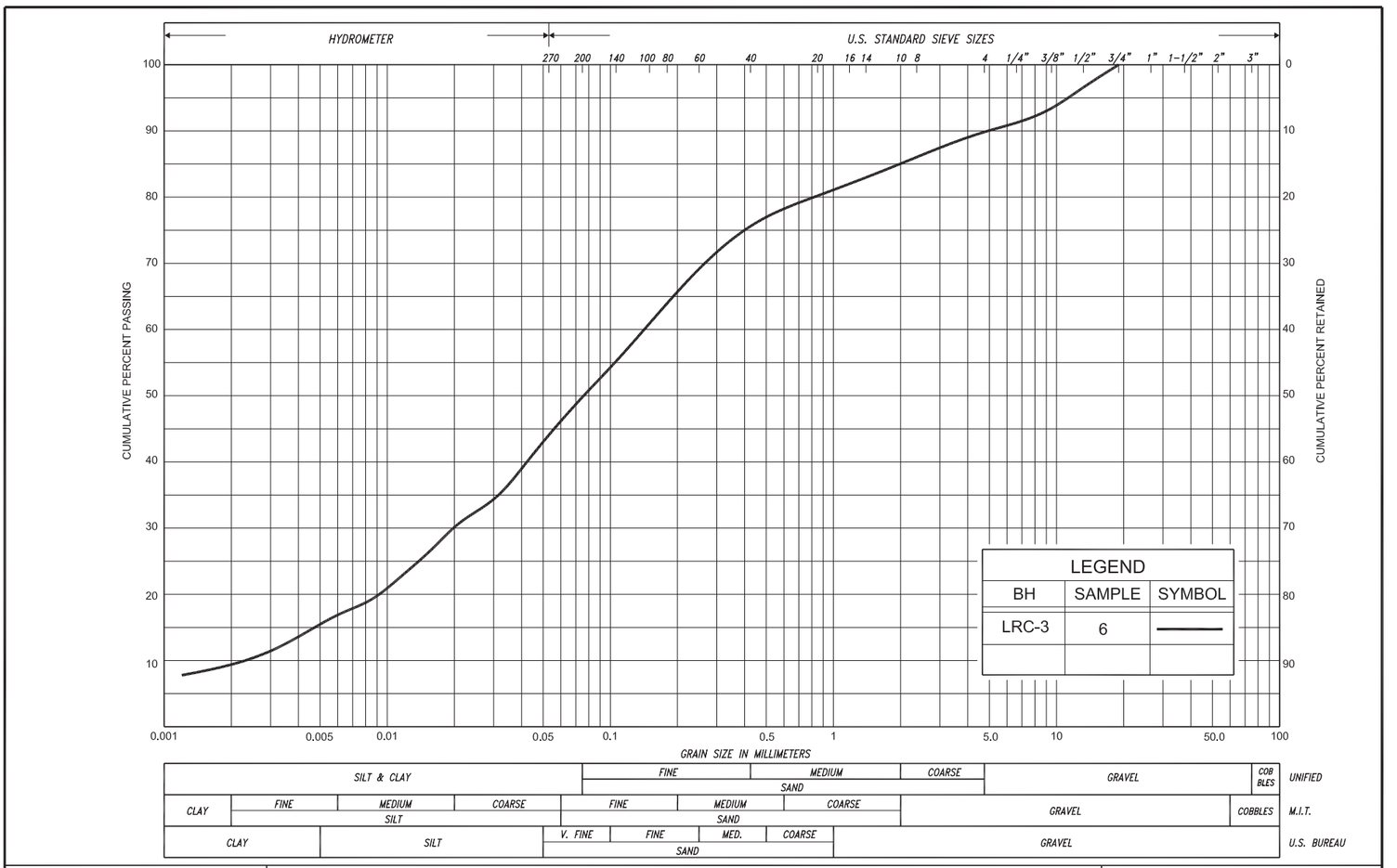
FIG No.	C-2
HWY:	427
G.W.P. No.	



Ontario	GRAIN SIZE DISTRIBUTION CLAYEY SILT (TILL)	FIG No. C-3 HWY: 427 G.W.P. No.



Ontario	PLASTICITY CHART CLAYEY SILT (TILL)	FIG No. C-4 HWY: 427 G.W.P. No.

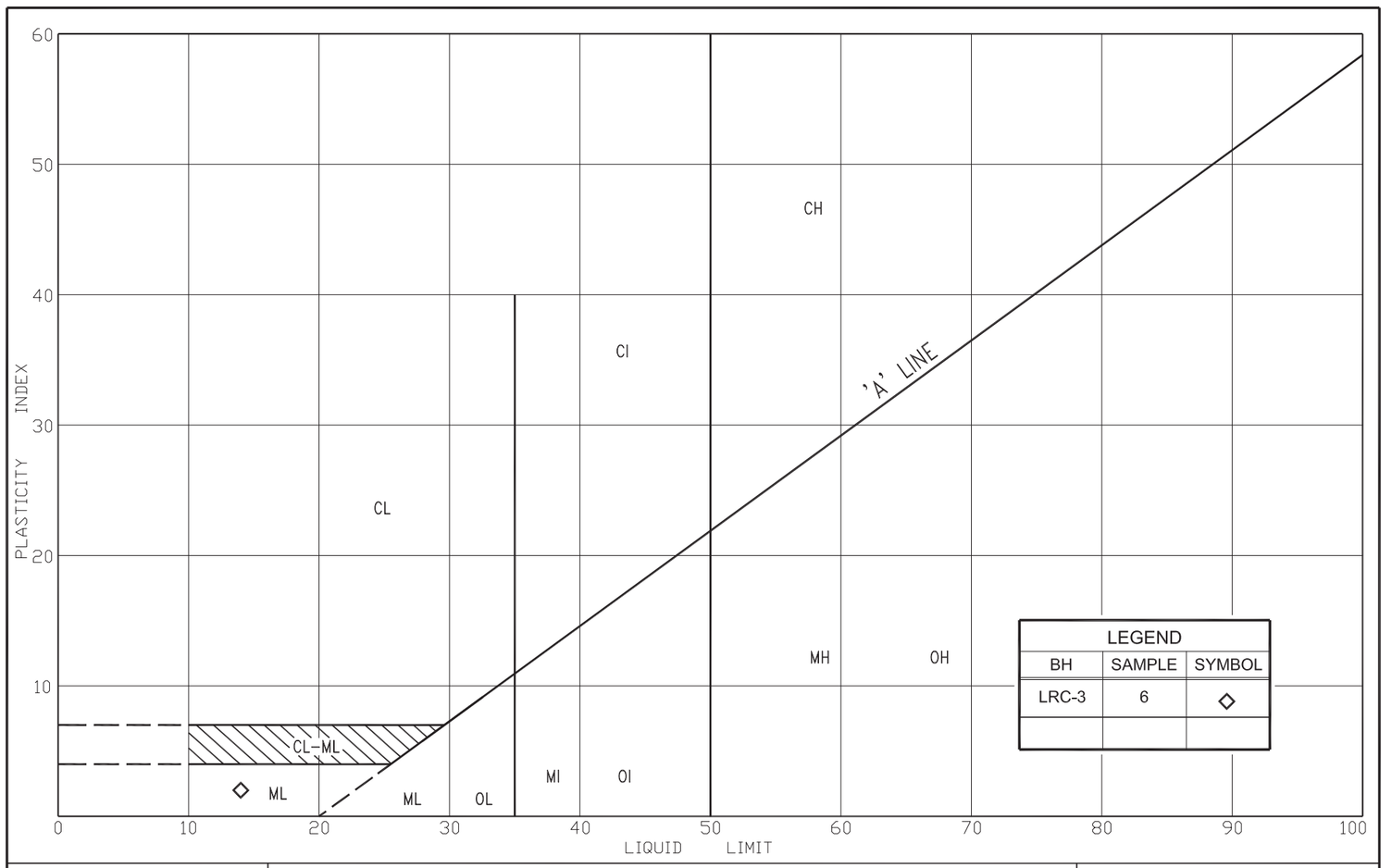


Ontario

GRAIN SIZE DISTRIBUTION

SILT and SAND (TILL)

FIG No.	C-5
HWY:	427
G.W.P. No.	

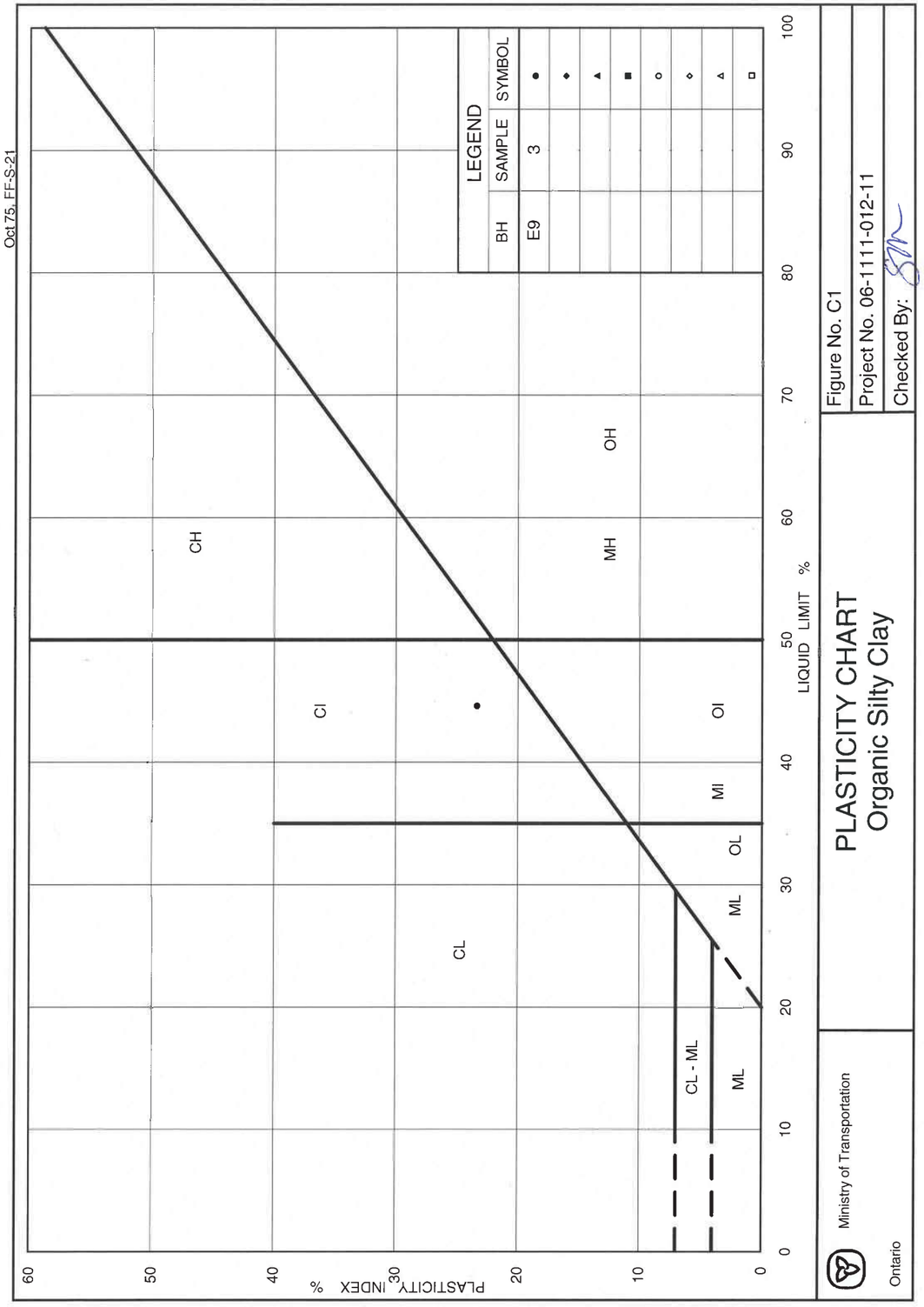


Ontario

PLASTICITY CHART

SAND and SILT (TILL) - Fine Contents

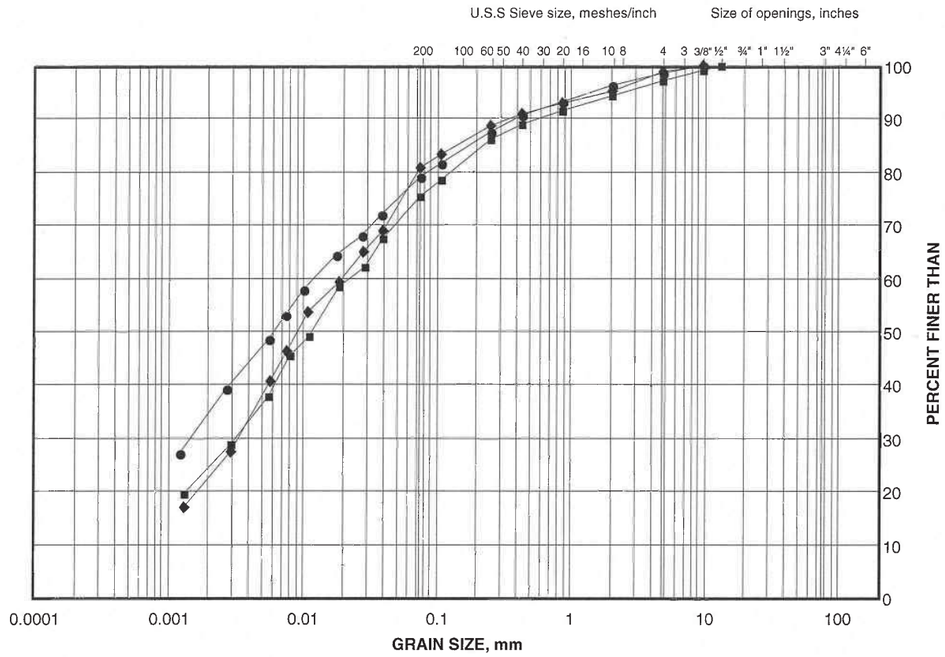
FIG No.	C-6
HWY:	427
G.W.P. No.	



GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt to Silty Clay Till

FIGURE C2



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	E13	3	184.6
■	E10	4	182.2
◆	S12	8	174.5

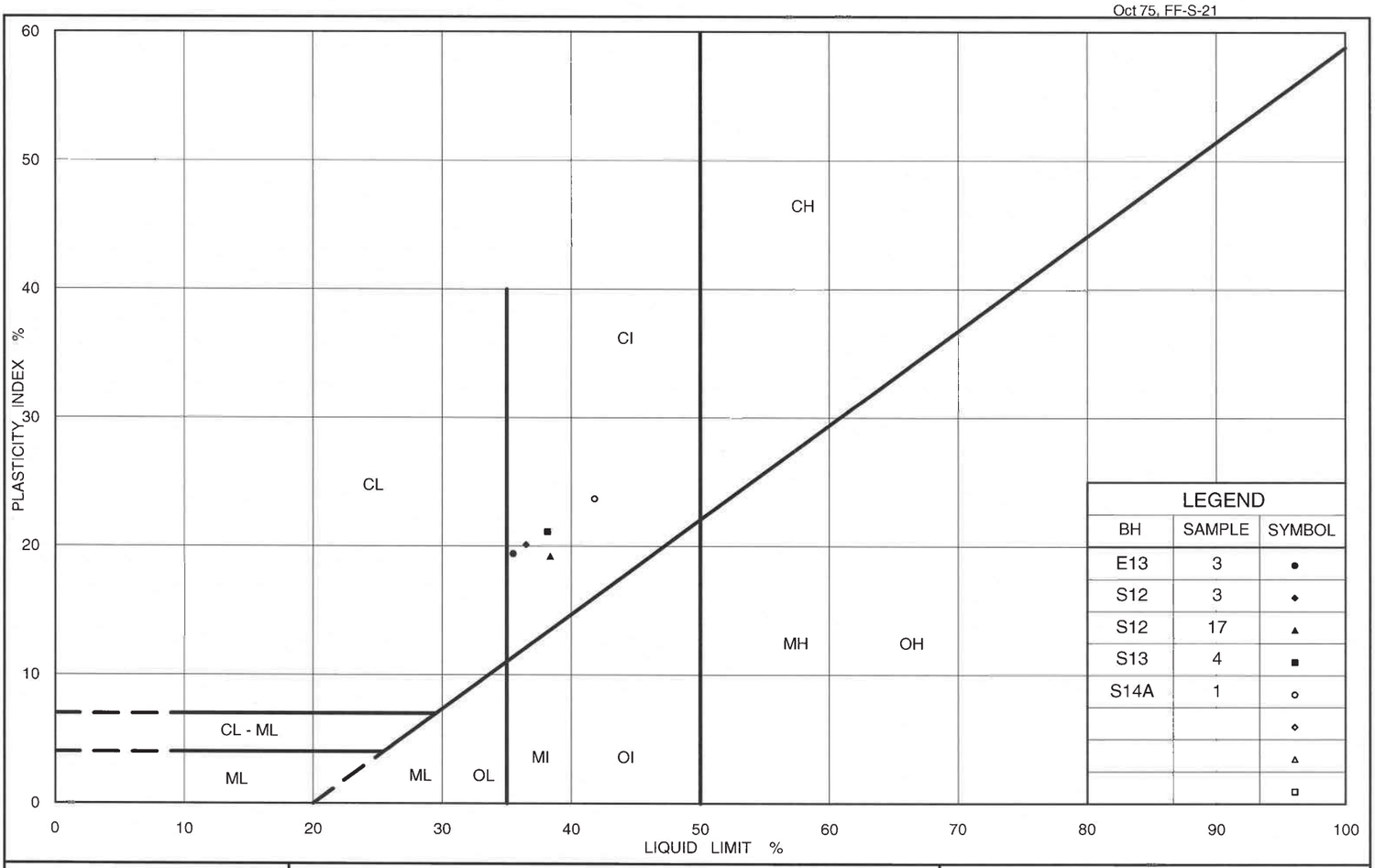
Project Number: 06-1111-012-11

Checked By: SM

Golder Associates

Date: 22-Jul-09

Oct 75, FF-S-21

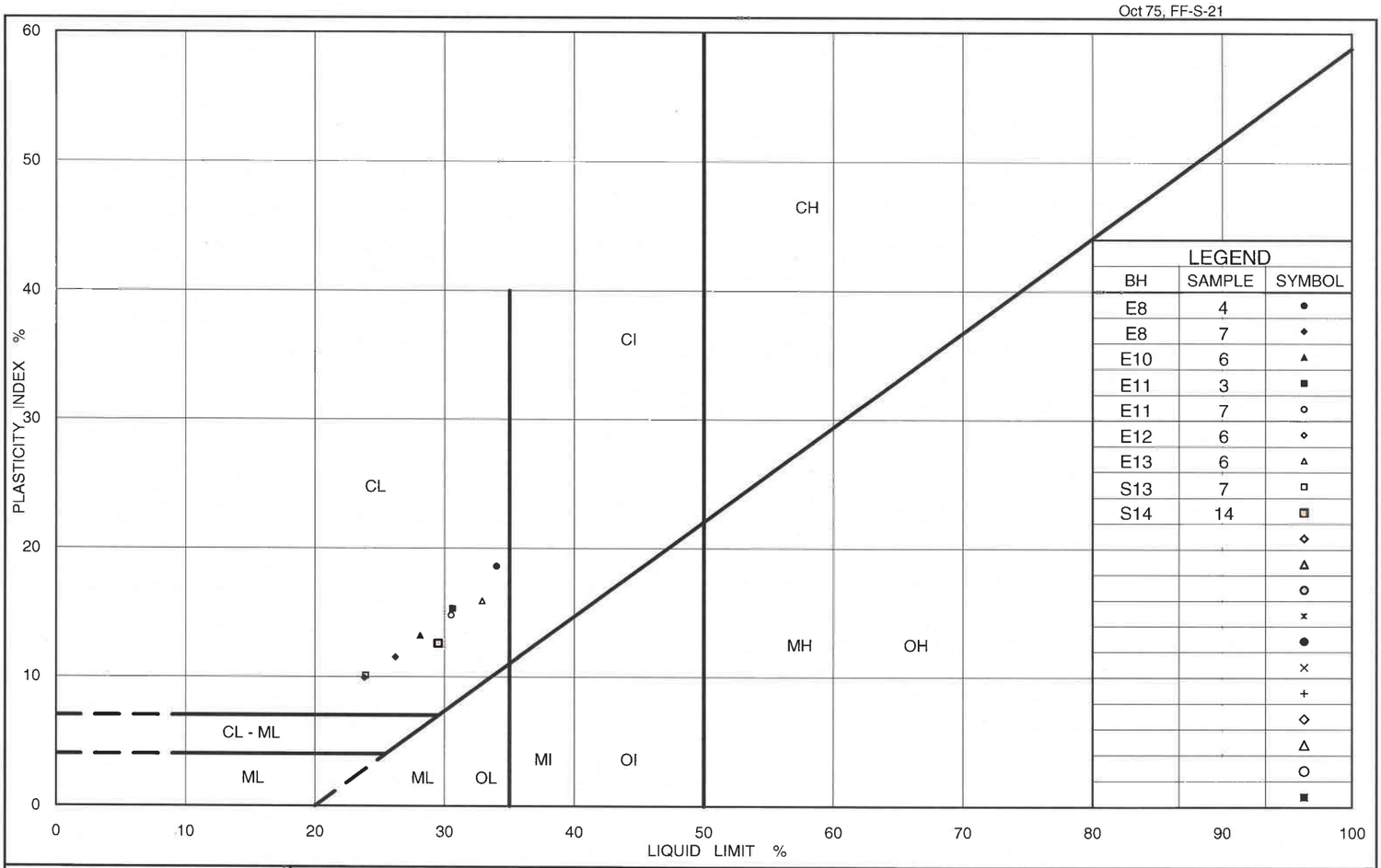


Ministry of Transportation
Ontario

PLASTICITY CHART
Silty Clay Till

Figure No. C-3
Project No. 06-1111-012-11
Checked By: SM

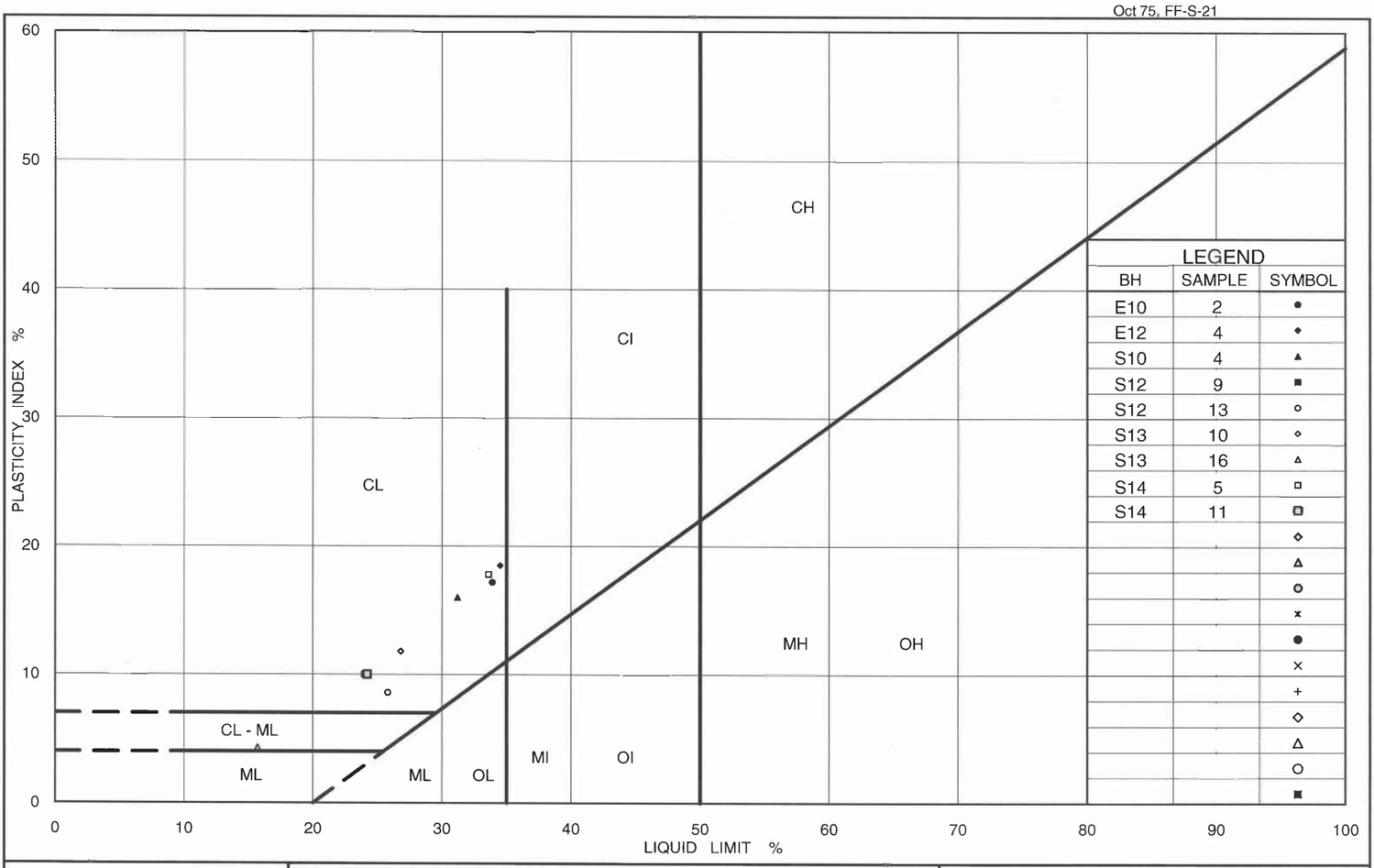
Oct 75, FF-S-21



Ministry of Transportation
Ontario

PLASTICITY CHART
Clayey Silt Till

Figure No. C4-A
Project No. 06-1111-012-11
Checked By: SM



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PLASTICITY CHART
Clayey Silt Till

Figure No. C4-B

Project No. 06-1111-012-11

Checked By: SM

J4 – RUTHERFORD ROAD OVERPASSES

Record of Current and Previous Borehole Sheets
Laboratory Test Results – Current and Previous Investigations

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No RR-1 1 of 3 METRIC

G.W.P. _____ LOCATION Coords: 4 851 865.3 N; 293 055.2 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 02, 2015 CHECKED BY A.V.

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 (○ 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 (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.6	Ground Surface										
0.0	SILTY CLAY trace organics		1	SS	5		194				
194.0	Firm Brown Moist										
0.6	SILTY CLAY, some sand, trace gravel containing sand seams		2	SS	17						
	Very stiff Brown Moist (TILL)		3	SS	20		193				2 12 36 50
			4	SS	24						
			5	SS	20		192				
			6	SS	22						
190.2							191				
4.4	SANDY SILT, trace gravel		7	SS	51						
	Very dense Brown Moist						190				
189.0											
5.6	CLAYEY SILT, some sand, trace gravel		8	SS	13		189				5 21 50 24
	Stiff to very stiff Grey Moist to wet (TILL)										
							188				
	sand and gravel seams		9	SS	19		187				
							186				
			10	SS	12						4 14 55 27
							185				
	rock fragments		11	SS	58/18cm		184				Sampler bouncing
							183				
			12	SS	15		182				
181.4											
13.2	SANDY SILT, trace clay containing sand and gravel seams		13A	SS	39		181				
	Dense to very dense Grey Moist to wet (TILL)		13B	SS							
179.6	Cont'd						180				

+7, ×5: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No RR-1 2 of 3 METRIC

G.W.P. _____ LOCATION Coords: 4 851 865.3 N; 293 055.2 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 02, 2015 CHECKED BY A.V.

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 (○ 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 (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
179.6											
15.0	(Cont'd) Sandy SILT, trace clay		14	SS	64/10cm		179				0 31 66 3
	Dense to very dense Grey Moist to wet (TILL)										
			15	SS	114		178				
176.8											
17.8	CLAYEY SILT, trace sand						177				
	Very stiff Grey Wet		16	SS	81		176				
							175				
							174				
			17	SS	27		173				0 3 70 27
							172				
							171				
			18	SS	18		170				
							169				
168.5											
26.1	CLAYEY SILT, with sand, trace gravel						168				
	Hard Grey Moist (TILL)		19	SS	59		167				8 23 46 23
							166				
165.4											
29.2	SHALE BEDROCK						165				
	Highly weathered Grey										
164.6	Cont'd										

+7, ×5: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No RR-1 3 of 3 METRIC

G.W.P. _____ LOCATION Coords: 4 851 865.3 N; 293 055.2 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 02, 2015 CHECKED BY A.V.

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 (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
164.6											
30.0	(Cont'd)										
	SHALE BEDROCK										
	Highly weathered Grey		20	SS	7575cm		164				
							163				
							162				
161.0											
33.6	End of borehole		21	SS	7573cm		161				
	Note: 1. Groundwater level cannot be measured upon completion of drilling due to utilization of mud rotary drilling technique.										

+7, ×5: Numbers refer to Sensitivity 20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No RR-2 1 of 3 METRIC

G.W.P. _____ LOCATION Coords: 4 851 881.3 N; 293 098.9 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 01, 2015 CHECKED BY A.V.

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 (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.6	Ground Surface										
0.0 193.3	TOPSOIL		1	SS	6		193				
0.3 193.0	SILTY CLAY, trace sand										
0.6	Firm Brown Moist		2	SS	15						
	CLAYEY SILT, trace to some sand, trace gravel						192				
	Stiff to very stiff Brown becoming grey below 2.2m Moist		3	SS	20						
	(TILL)		4A	SS			191				1 12 54 33
			4B	SS	22						
			5	SS	17		190				
			6	SS	13						1 9 45 45
			7	SS	11		189				
			8	SS	14		188				
			9	SS	12		187				
			10	SS	15		186				
			11	SS	17		185				
181.9 11.7	SANDY CLAYEY SILT, trace gravel						184				
	Stiff to hard Grey Moist						183				
	(TILL)		12	SS	14		182				5 33 36 26
180.4 13.2	SAND, with gravel						181				
	Dense Grey Moist		13	SS	42		180				28 61 (11)
	Cont'd						179				

+7, ×5: Numbers refer to Sensitivity 20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No RR-2 2 of 3 METRIC

G.W.P. _____ LOCATION Coords: 4 851 881.3 N; 293 098.9 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 01, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
178.6						*					
177.9			14	SS	40		178				
15.7	CLAYEY SILT, trace sand, trace gravel Hard Grey Moist (TILL)		15	SS	59		177				
175.8							176				
17.8	CLAYEY SILT, trace sand, trace gravel Hard Grey Moist		16	SS	46		175				1 2 68 29
174.3							174				
19.3	SILT, trace sand, trace gravel, containing clayey silt seams Compact to dense Grey Moist to wet		17	SS	31		173				
			18	SS	34		172				
							171				
							170				
			19	SS	23		169				2 2 81 15
167.5							168				
26.1	SHALE BEDROCK Highly weathered Grey						167				
			20	SS	75/3cm		166				Sampler bouncing
	Cont'd.						165				
							164				

+⁷ ,×⁵ : Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No RR-2 3 of 3 METRIC

G.W.P. _____ LOCATION Coords: 4 851 881.3 N; 293 098.9 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 01, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
163.6						*					
163.1			21	SS	75/3cm						
30.5	End of borehole Note: 1. Groundwater level cannot be measured upon completion of drilling due to utilization of mud rotary drilling technique.										

+⁷ ,×⁵ : Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No C9

1 OF 1 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4851338.9 ;E 293427.6 | ORIGINATED BY JEB
W.O. 05-20012 | | COMPILED BY PKS/VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 27, 2009

ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED)	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
188.3	GROUND SURFACE						188				
0.0	TOPSOIL										
0.2	CLAYEY SILT, trace gravel, trace sand, containing rootlets (Reworked) Firm Brown Moist		1	SS	4						
187.7							187				
0.6	CLAYEY SILT, some sand, trace gravel (TILL) Stiff to hard Brown to grey Moist		2	SS	12						
			3	SS	25		186				1 15 63 21
			4	SS	36						
			5	SS	37		185				
	Becoming grey below a depth of 3.8 m		6	SS	26						
			7	SS	15		184				
			8	SS	16		183				
	Containing sand partings at a depth of 7.5 m		9	SS	52		182				
			10	SS	49		181				
							180				
178.6							179				
9.8	END OF BOREHOLE										

NOTES:

1. Open borehole dry upon completion of drilling.
2. Borehole backfilled with bentonite.

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No C10

1 OF 1 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4851421.5 ;E 293435.4 | ORIGINATED BY JEB
W.O. 05-20012 | | COMPILED BY PKS/VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 30, 2009

ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED)	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
188.6	GROUND SURFACE						188				
0.0	CLAYEY SILT, trace sand, containing rootlets (Reworked) Firm Brown Moist		1	SS	4						
188.0							187				
0.6	CLAYEY SILT, some sand, trace gravel, containing cobbles (TILL) Very stiff to hard Brown to grey Moist Augers grinding at a depth of 1.5 m		2	SS	106*						
			3	SS	27						5 20 52 23
			4	SS	22		186				
			5	SS	36		185				
	Becoming grey below a depth of 3.8 m		6	SS	23						
			7	SS	23		184				
			8	SS	20		183				
	Cobbles encountered at a depth of 8.5 m		9	SS	69		182				
			10	SS	99		181				
							180				
178.9							179				
9.8	END OF BOREHOLE										

NOTES:

1. A 50 mm diameter monitoring well was installed at a depth of 9.1 m (Elev. 179.5 m).

Water level measurements

Date	Depth	Elev.
On Completion	Dry	
April 24, 2009	7.6 m	181.0 m
May 13, 2009	8.0 m	180.6 m
May 21, 2009	7.9 m	180.7 m
June 15, 2009	7.9 m	180.7 m
July 09, 2009	7.6 m	181.0 m

* High SPT "N" value as a result of split spoon bouncing on cobbles

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No C13

1 OF 1 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4851936.1 ; E 293054.4 | ORIGINATED BY JEB
W.O. 05-20012 | | COMPILED BY PKS
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE April 6, 2009

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS
193.8	GROUND SURFACE					
0.0	TOPSOIL					
0.2	CLAYEY SILT, trace sand, trace gravel, containing rootlets (Reworked)		1	SS	8	
192.9	Stiff					
0.9	Brown Moist		2	SS	18	
	SILTY CLAY, trace sand, trace gravel (TILL) Very stiff to hard Brown Moist		3	SS	33	
			4	SS	32	
			5	SS	48	
189.2			6	SS	28	
4.6	CLAYEY SILT, trace to some sand, trace gravel (TILL) Stiff to hard Grey Moist		7	SS	35	
			8	SS	14	
			9	SS	15	
184.1			10	SS	18	
9.8	END OF BOREHOLE					

NOTES:

1. Open borehole dry upon completion of drilling.
2. Borehole backfilled with bentonite.

ELEVATION SCALE: 193, 192, 191, 190, 189, 188, 187, 186, 185

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No C14

1 OF 1 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4851913.5 ; E 293008.0 | ORIGINATED BY JEB
W.O. 05-20012 | | COMPILED BY PKS
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE April 3, 2009

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.5	GROUND SURFACE						
0.0	TOPSOIL						
0.2	CLAYEY SILT, trace sand, trace gravel, containing rootlets (Reworked)		1	SS	7		
193.9	Firm						
0.6	Brown Moist		2	SS	17		
	CLAYEY SILT, with sand, trace gravel (TILL) Stiff to very stiff Brown Moist		3	SS	23		
			4	SS	25		
			5	SS	19		
			6	SS	18		
			7	SS	14		
			8	SS	12		6 30 46 18
	Containing sand seams below a depth of 9.14 m		9	SS	12		
			10	SS	14		
			11	SS	17		
183.2							
11.3	END OF BOREHOLE						

NOTES:

1. Open borehole dry upon completion of drilling.
2. Borehole backfilled with bentonite.

ELEVATION SCALE: 194, 193, 192, 191, 190, 189, 188, 187, 186, 185, 184

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30

UNIT WEIGHT γ kN/m³

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No E14

1 OF 1 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4851566.2 ;E 293346.5
BOREHOLE TYPE 108 mm Diameter Solid Stem Augers
DATE March 25, 2009

ORIGINATED BY JEB
COMPILED BY VA
CHECKED BY SMM

ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
191.5	GROUND SURFACE										
0.0	CLAYEY SILT, trace sand, trace gravel, containing rootlets (Reworked) Stiff Brown Moist		1	SS	10		191				
190.9											
0.6	CLAYEY SILT, some sand, some gravel (TILL), containing oxidation zones to a depth of 1.4 m Very stiff to hard Brown, becoming grey at 3.7 m depth Moist		2	SS	27						
			3	SS	35		190				
			4	SS	29		189				
			5	SS	33		188				
			6	SS	20		187				18 15 45 22
	Containing cobbles at a depth of 4.4 m		7	SS	17						
	Containing cobbles at a depth of 5.5 m		8	SS	21		186				
							185				
	Containing cobbles at a depth of 7.3 m						184				
183.3			9	SS	18						
8.2	END OF BOREHOLE										

NOTES:

1. Open borehole dry upon completion of drilling.
2. Borehole backfilled with bentonite.

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No E15

1 OF 1 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4851627.8 ;E 293257.3
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 25 & 26, 2009

ORIGINATED BY JEB
COMPILED BY VA
CHECKED BY SMM

ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
192.2	GROUND SURFACE										
0.0	TOPSOIL										
0.7	CLAYEY SILT, trace sand, trace gravel, containing rootlets and oxidation zones (Reworked) Firm to very stiff Brown Moist		1	SS	7		192				
190.8			2	SS	18						
1.5	SILTY CLAY, trace sand, trace gravel (TILL) Very stiff to hard Brown Moist		3	SS	31		191		43		
	Containing sand seams between depths of 2.3 m and 3.7 m		4	SS	29	▽					
			5	SS	29		190				
187.6			6	SS	29						
4.6	CLAYEY SILT, some sand, trace gravel (TILL) Stiff to very stiff Grey Moist		7	SS	21		189				
			8	SS	14		188				
			9	SS	17		187				
			10	SS	20		186				
182.5							185				
9.8	END OF BOREHOLE						184				
							183				

NOTES:

1. Water level in open borehole at a depth of 2.7 m below ground surface (Elev. 189.5 m) upon completion of drilling.
2. Borehole backfilled with bentonite.

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No E16

1 OF 1 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4851722.2 ;E 293228.0 | ORIGINATED BY JEB
W.O. 05-20012 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | COMPILED BY TB/VA
DIST Central HWY 427 | DATE March 20, 2009 | CHECKED BY SMM
DATUM Geodetic

ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS
193.2	GROUND SURFACE					
0.0	CLAYEY SILT, trace sand, trace gravel, containing rootlets and organics, containing sand seams between depths of 0.8 m and 1.4 m Firm to very stiff Brown Moist		1	SS	5	
			2	SS	16	
191.7						
1.5	SILTY CLAY, trace sand, trace gravel, (TILL) Very stiff to hard Brown Moist Containing sand seams between depths of 1.5 m and 2.1 m		3	SS	32	
			4	SS	27	
			5	SS	32	
			6	SS	28	
			7	SS	21	
187.4						
5.8	CLAYEY SILT, trace sand, trace gravel (TILL) Stiff to very stiff Grey Moist		8	SS	16	
			9	SS	14	
183.5			10	SS	14	
9.8	END OF BOREHOLE NOTES: 1. Open borehole dry upon completion of drilling. 2. Borehole backfilled with bentonite.					

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)
PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%): 10 20 30
UNIT WEIGHT γ kN/m³
REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

ELEVATION SCALE: 193 192 191 190 189 188 187 186 185 184

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No E18

1 OF 1 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4851727.6 ;E 293147.0 | ORIGINATED BY JEB
W.O. 05-20012 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | COMPILED BY TB/VA
DIST Central HWY 427 | DATE March 25, 2009 | CHECKED BY SMM
DATUM Geodetic

ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS
193.2	GROUND SURFACE					
0.0	CLAY, some silt, trace sand, containing rootlets and organics to a depth of 0.6 m Firm Brown, becoming grey at a depth of 0.6 m Moist		1	SS	6	
			2	SS	9	
			3	SS	8	
190.8						
2.4	CLAYEY SILT, trace sand, trace gravel (TILL) Stiff to very stiff Brown, becoming grey below a depth of 3.1 m Moist		4	SS	18	
			5	SS	28	
			6	SS	18	
			7	SS	14	
186.8			8A 8B	SS	21	
6.4	GRAVEL, trace sand, trace silt Compact Grey Wet					
185.9						
7.3	CLAYEY SILT, trace to some sand, trace gravel (TILL) Stiff to very stiff Grey Moist		9	SS	16	
			10	SS	14	
			11	SS	13	
			12	SS	11	▽
180.4						
12.8	END OF BOREHOLE NOTES: 1. Water level in open borehole at a depth of 12.5 m below ground surface (Elev. 180.7 m) upon completion of drilling. 2. Borehole backfilled with bentonite.					

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)
PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%): 10 20 30
UNIT WEIGHT γ kN/m³
REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

ELEVATION SCALE: 193 192 191 190 189 188 187 186 185 184 183 182 181

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No E19

1 OF 1 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4852013.6 ;E 292935.7
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE April 1, 2009

ORIGINATED BY JEB
COMPILED BY TB/VA
CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS
195.3	GROUND SURFACE					
0.0	SILTY CLAY, trace to some sand, trace gravel, containing rootlets to a depth of 0.6 m and organics Firm to stiff Brown, becoming dark brown at a depth of 0.3 m Moist		1	SS	7	
			2	SS	12	
193.9						
1.4	SILTY CLAY, trace to some sand, trace gravel (TILL) Stiff to very stiff Brown to grey Moist		3	SS	15	
			4	SS	25	
			5	SS	21	
			6	SS	14	
			7	SS	13	
189.5						
5.8	CLAYEY SILT, some sand, trace gravel (TILL) Firm to stiff Grey Moist		8	SS	9	
			9	SS	7	▽
186.2						
9.1	Silty SAND, trace gravel, trace clay Compact Grey Wet		10	SS	18	
185.6						
9.8	END OF BOREHOLE					

NOTES:

1. Water level in open borehole at a depth of 7.9 m below ground surface (Elev. 187.4 m) upon completion of drilling.
2. Borehole backfilled with bentonite.

ELEVATION SCALE: 195, 194, 193, 192, 191, 190, 189, 188, 187, 186

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED
20 40 60 80 100

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L
WATER CONTENT (%): 10 20 30

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

42
>120

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S16

1 OF 3 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4851817.3 ;E 293152.1
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 20, 2009

ORIGINATED BY JEB
COMPILED BY TB/VA
CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS
194.6	GROUND SURFACE					
0.0	CLAYEY SILT, some sand, containing rootlets (REWORKED) Firm Brown Moist		1	SS	6	
194.0						
0.6	CLAYEY SILT, some sand, trace gravel (TILL) Stiff to very stiff Brown Moist		2	SS	17	
			3	SS	25	
			4	SS	19	
			5	SS	25	
			6	SS	14	
			7	SS	14	
			8	SS	20	▽
			9	SS	18	
			10	SS	12	
			11	SS	15	
			12	SS	20	
181.2						
13.4	SAND and SILT, some gravel, trace clay (TILL) Very dense Grey Wet		13	SS	58	
179.7						

Continued Next Page

ELEVATION SCALE: 194, 193, 192, 191, 190, 189, 188, 187, 186, 185, 184, 183, 182, 181, 180

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED
20 40 60 80 100

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L
WATER CONTENT (%): 10 20 30

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

2 18 56 24
19 30 46 5

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S16

2 OF 3 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4851817.3 ;E 293152.1 | ORIGINATED BY JEB
W.O. 05-20012 | | COMPILED BY TB/VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 20. 2009

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	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —							SHEAR STRENGTH kPa: o UNCONFINED + FIELD VANE; ● QUICK TRIAXIAL × REMOULDED; 20 40 60 80 100						
14.9	CLAYEY SILT, trace to some sand, trace gravel, containing cobbles (TILL) Hard Grey Wet to moist		14	SS	20/0.15		179							
175.1			15	SS	117		178							
			16	SS	89		177							
19.5	SILT, trace to some sand, trace clay Compact to very dense Grey Moist		17	SS	73		176							
			18	SS	51		175							
			19	SS	52		174							
			20	SS	24		173							0 0 90 10
167.5							172							
27.1	CLAYEY SILT, some sand, some gravel (TILL) Hard Grey Moist		21	SS	65		171							
165.0							170							
29.6	SHALE (BEDROCK) Grey						169							
							168							
							167							
							166							
							165							

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S16

3 OF 3 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4851817.3 ;E 293152.1 | ORIGINATED BY JEB
W.O. 05-20012 | | COMPILED BY TB/VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 20. 2009

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	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —							SHEAR STRENGTH kPa: o UNCONFINED + FIELD VANE; ● QUICK TRIAXIAL × REMOULDED; 20 40 60 80 100						
	SHALE (BEDROCK) Grey		22	SS	20/0.10		164							
			23	SS	20/0.10		163							
161.0							162							
33.6	END OF BOREHOLE NOTES: 1. Water level in open borehole at a depth of 6.0 m below ground surface (Elev. 188.6 m) upon completion of drilling. 2. Borehole backfilled with bentonite.		24	SS	50/0.05									

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

Golder Associates

RECORD OF BOREHOLE No S18

1 OF 3 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4851863.9 ;E 293113.0 | ORIGINATED BY SB
W.O. 05-20012 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | COMPILED BY VA
DIST Central HWY 427 | DATE March 23, 2009 | CHECKED BY SMM
DATUM Geodetic

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS
194.3	GROUND SURFACE					
0.0	TOPSOIL					
0.1	Silty sand, some gravel (FILL) Brown Moist					
193.5						
0.8	SAND, some gravel, trace silt Compact to dense Brown Moist		1	SS	36	
192.5			2	SS	10	
1.8	CLAYEY SILT, some sand, trace gravel (TILL) Stiff to hard Brown to grey Moist		3	SS	26	
			4	SS	30	
	Becoming grey below a depth of 3.8 m		5	SS	21	
			6	SS	20	
			7	SS	28	
			8	SS	24	
			9	SS	16	
			10	SS	29	
181.8			11	SS	49	
12.5	SAND and SILT, some gravel, trace clay (TILL) Dense Grey Wet					
180.9						
13.4	CLAYEY SILT, some sand, trace gravel (TILL) Very stiff to hard Grey Moist		12	SS	17	

ELEVATION SCALE: 194, 193, 192, 191, 190, 189, 188, 187, 186, 185, 184, 183, 182, 181, 180

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED; 20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL
1	23	48	28
2	11	55	31

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S18

2 OF 3 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4851863.9 ;E 293113.0 | ORIGINATED BY SB
W.O. 05-20012 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | COMPILED BY VA
DIST Central HWY 427 | DATE March 23, 2009 | CHECKED BY SMM
DATUM Geodetic

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS
	— CONTINUED FROM PREVIOUS PAGE —					
	CLAYEY SILT, some sand, trace gravel (TILL) Very stiff to hard Grey Moist		13	SS	170	
			14	SS	63	
176.5						
17.8	SILT, trace to some clay Compact to very dense Grey Moist		15	SS	13/0.15	
			16	SS	78	
			17	SS	58	
			18	SS	20	
165.7						
28.7	SHALE (BEDROCK) Grey		19	SS	100/0.10	

ELEVATION SCALE: 179, 178, 177, 176, 175, 174, 173, 172, 171, 170, 169, 168, 167, 166, 165

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED; 20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL
0	0	84	16
0	6	89	5

Continued Next Page

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

Golder Associates

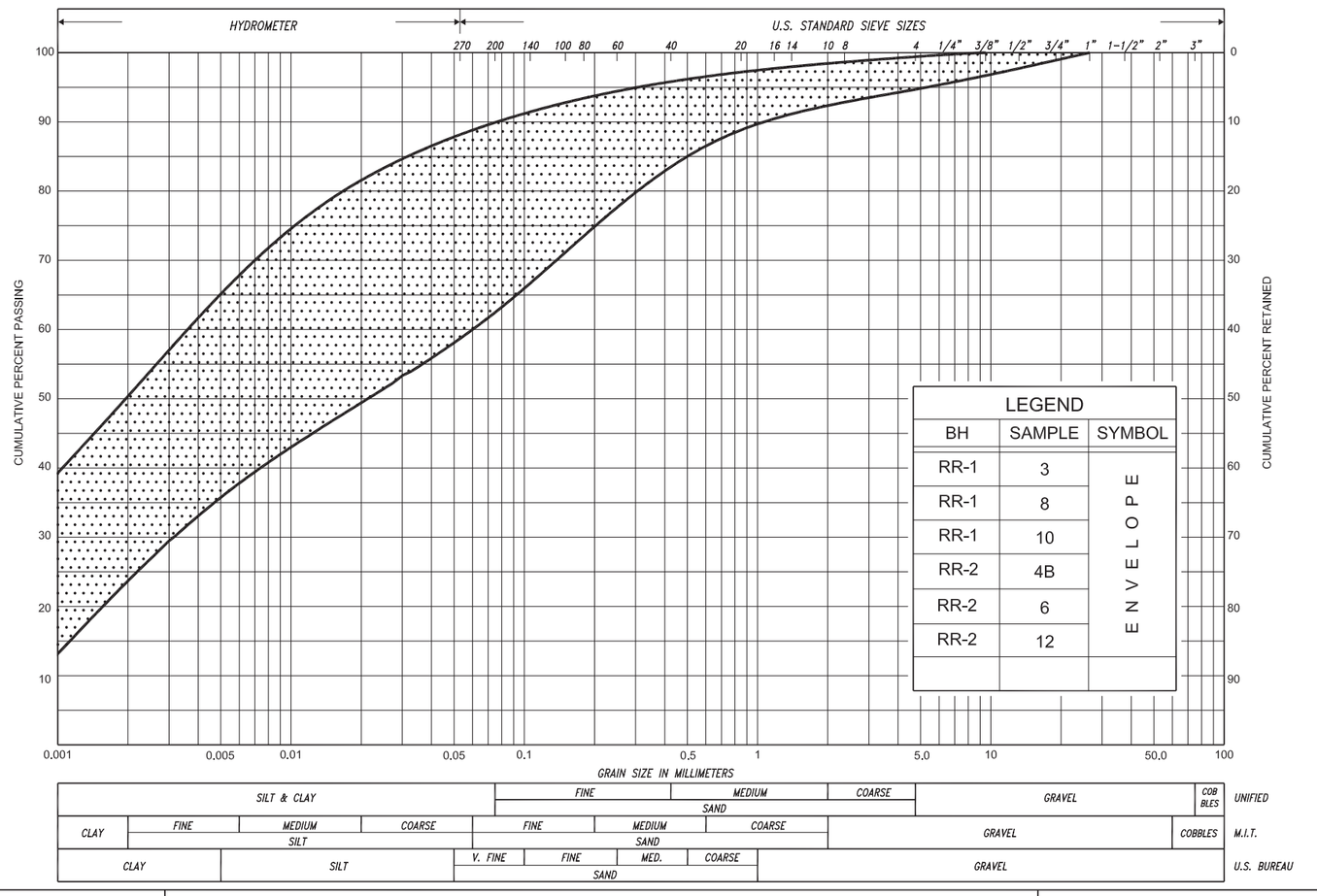
RECORD OF BOREHOLE No S18

3 OF 3 **METRIC**

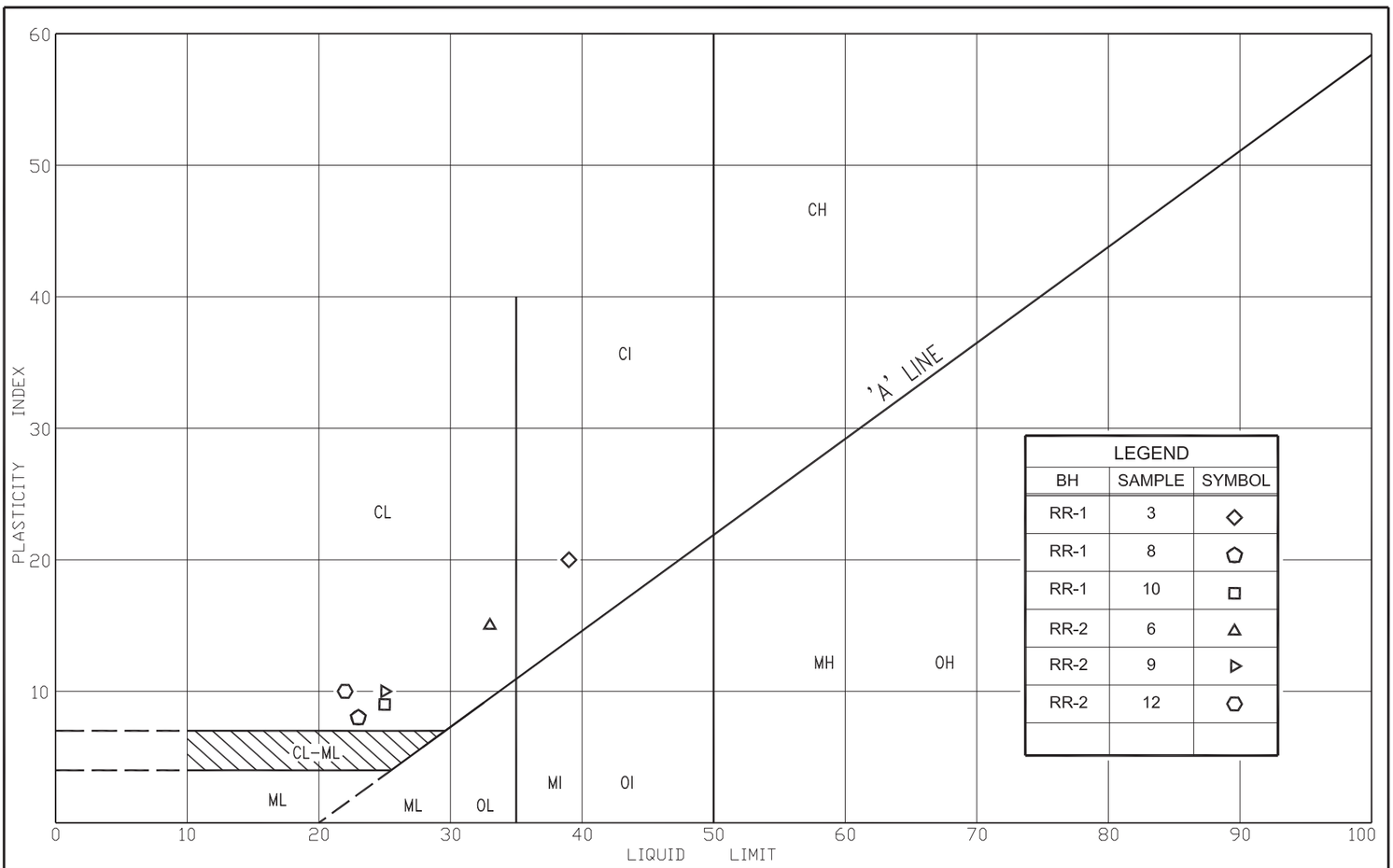
PROJECT 06-1111-012 | W.O. 05-20012 | LOCATION N 4851863.9 ;E 293113.0 | ORIGINATED BY SB
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | COMPILED BY VA
DATUM Geodetic | DATE March 23, 2009 | CHECKED BY SMM

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 × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SHALE (BEDROCK) Grey		20	SS	20/0.10		164				
							163				
162.2			21	SS	00/0.05						
32.1	END OF BOREHOLE NOTES: 1. Water level in open borehole at a depth of 7.6 m below ground surface (Elev. 186.7 m) upon completion of drilling. 2. Borehole backfilled with bentonite.										

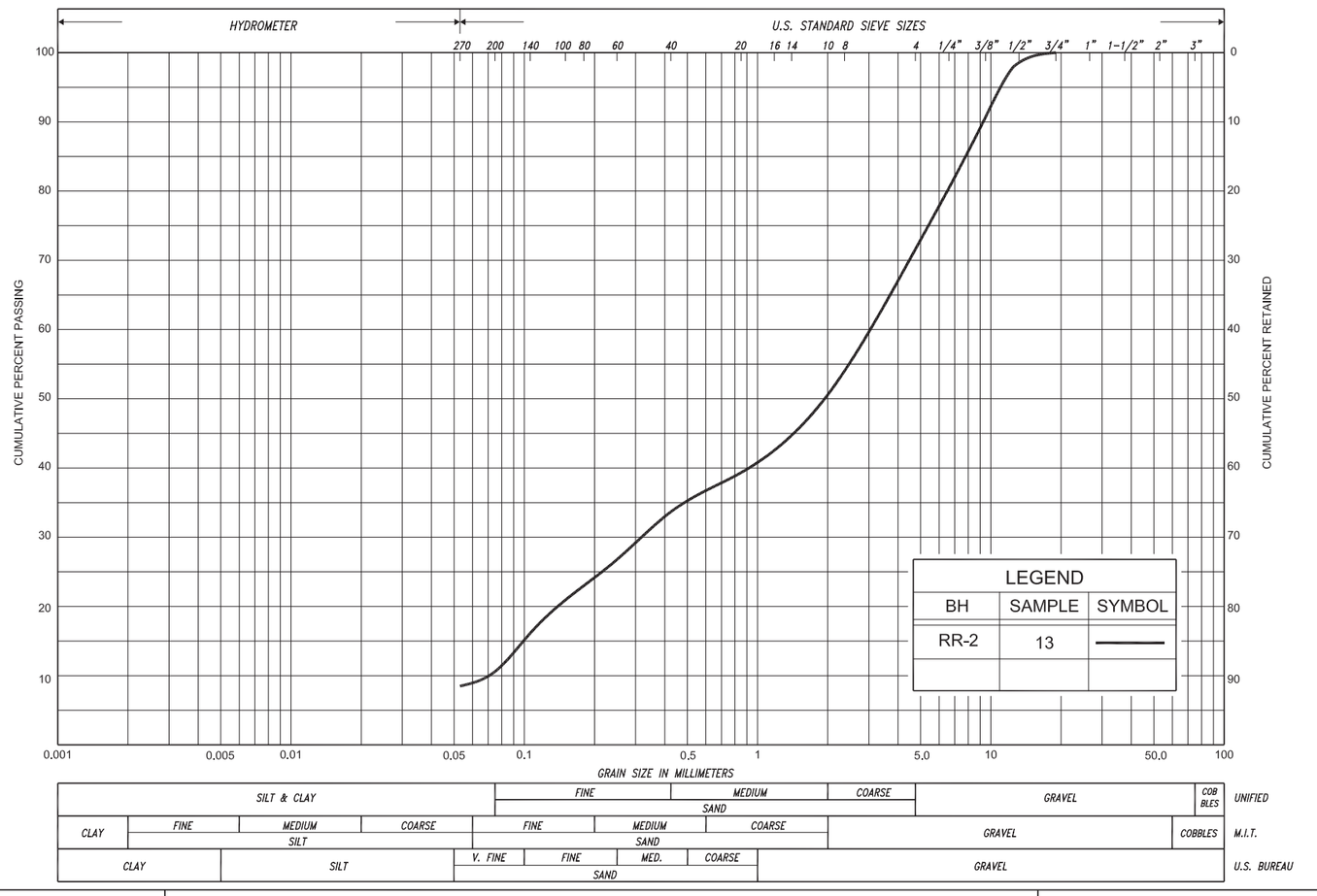
$+^3$, $\times^3$: Numbers refer to Sensitivity $\circ^{3\%}$ STRAIN AT FAILURE



Ontario	GRAIN SIZE DISTRIBUTION (SANDY) CLAYEY SILT to SILTY CLAY (TILL) - Upper	FIG No. E-1 HWY: 427 G.W.P. No.



Ontario	PLASTICITY CHART CLAYEY SILT to SILTY CLAY (TILL) - Upper	FIG No. E-2 HWY: 427 G.W.P. No.

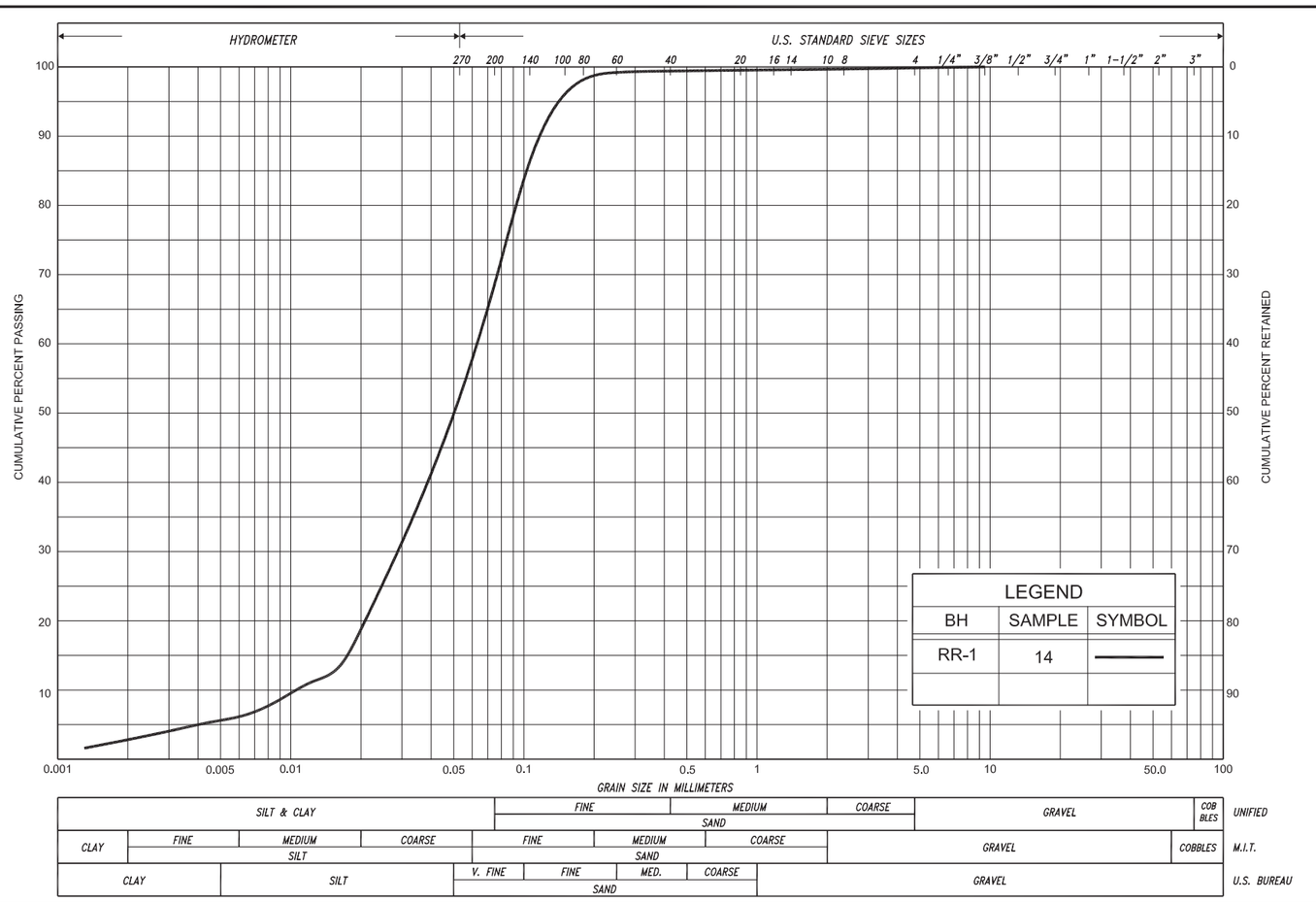


Ontario

GRAIN SIZE DISTRIBUTION

SAND, with gravel

FIG No.	E-3
HWY:	427
G.W.P. No.	

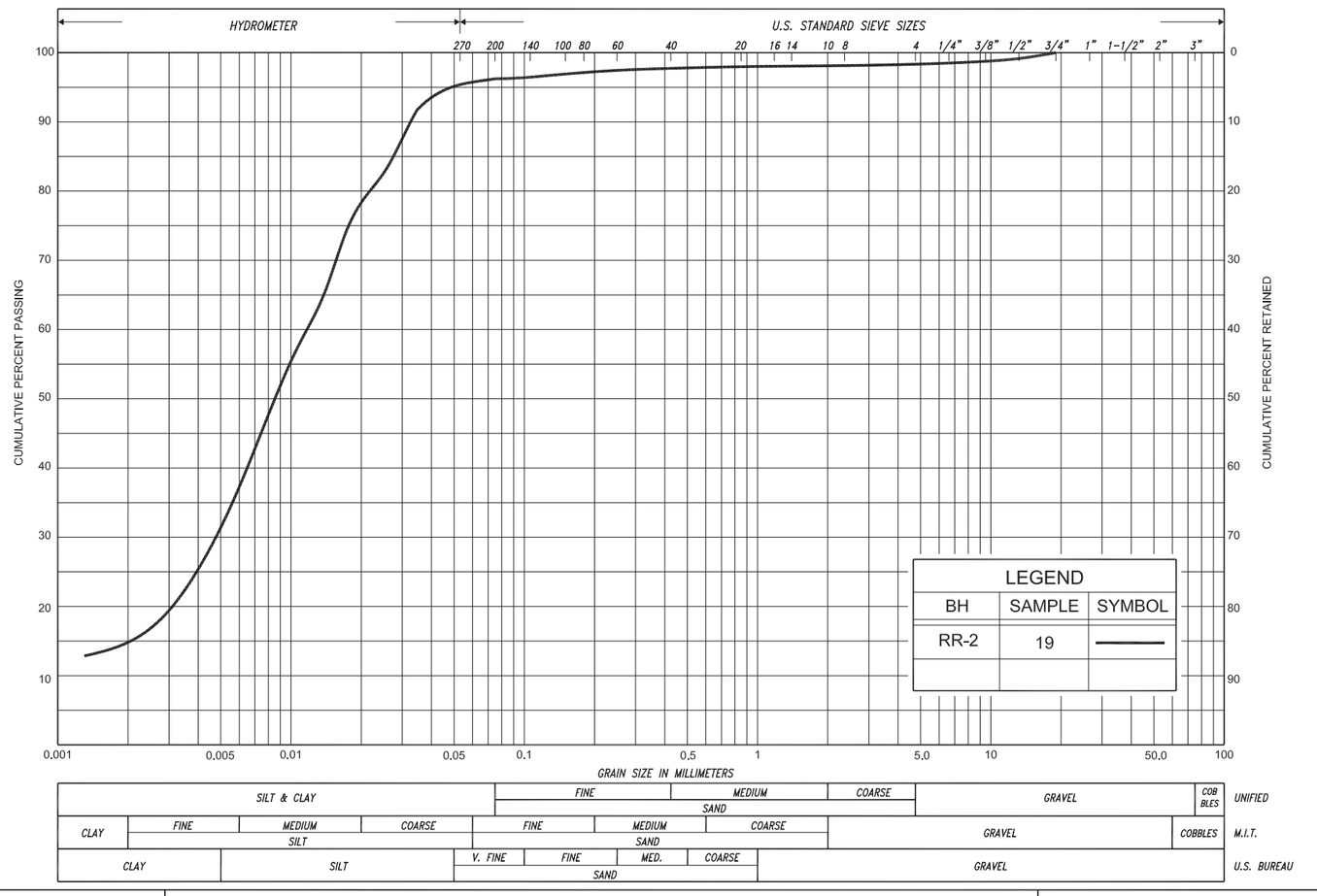


Ontario

GRAIN SIZE DISTRIBUTION

SANDY SILT (TILL)

FIG No.	E-4
HWY:	427
G.W.P. No.	



Ontario

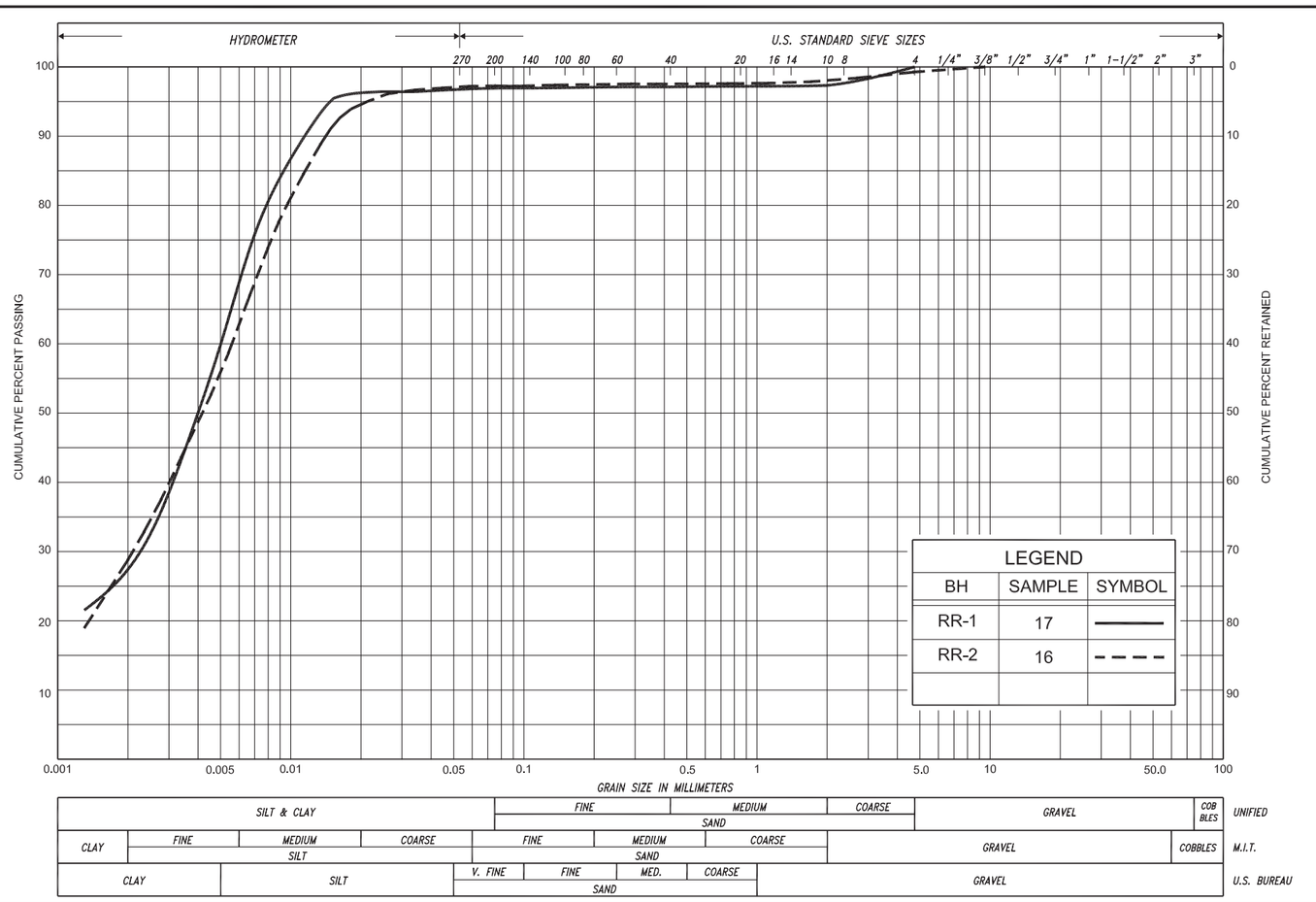
GRAIN SIZE DISTRIBUTION

SILT

FIG No. E-5

HWY: 427

G.W.P. No.



Ontario

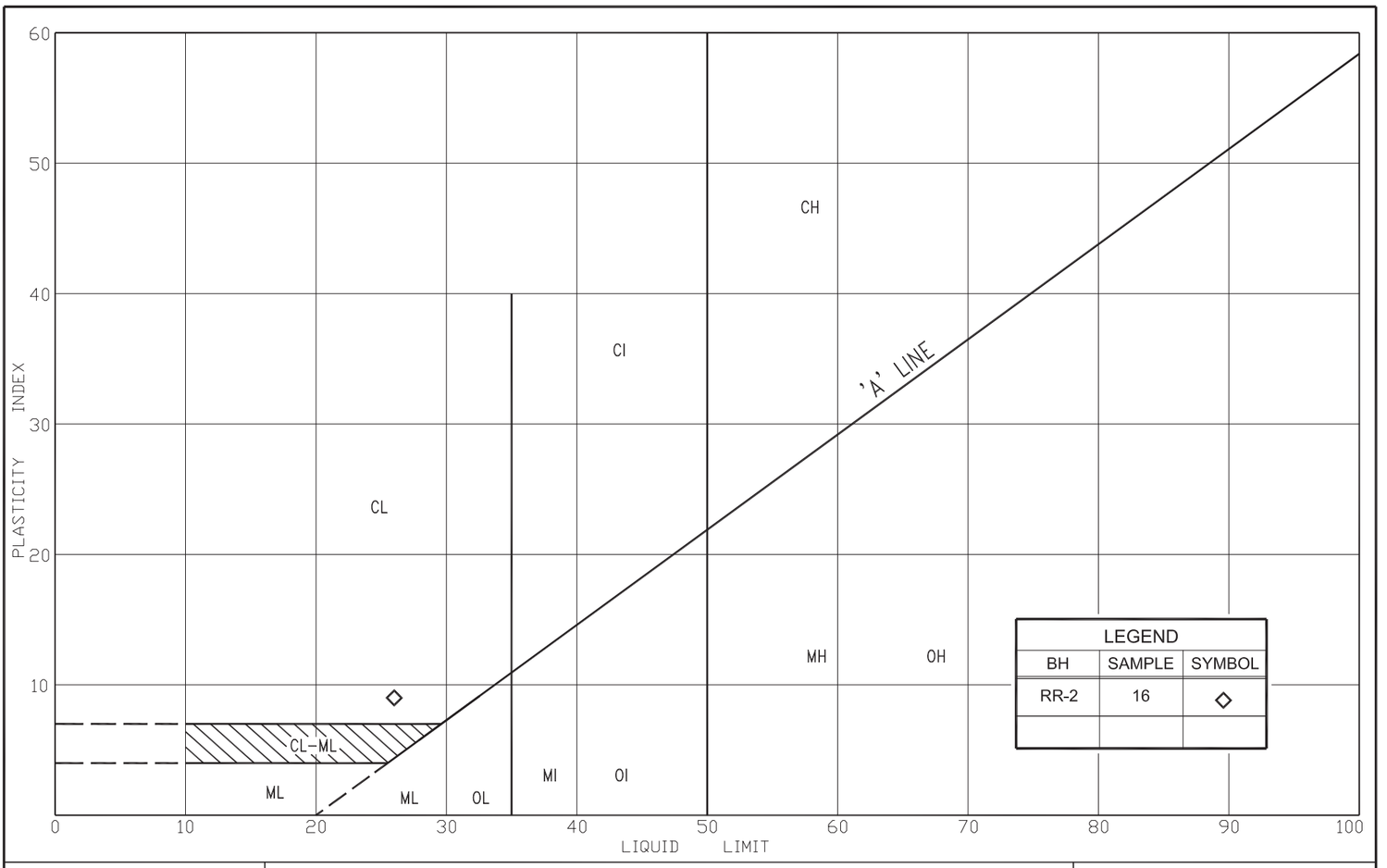
GRAIN SIZE DISTRIBUTION

CLAYEY SILT

FIG No. E-6

HWY: 427

G.W.P. No.



Ontario

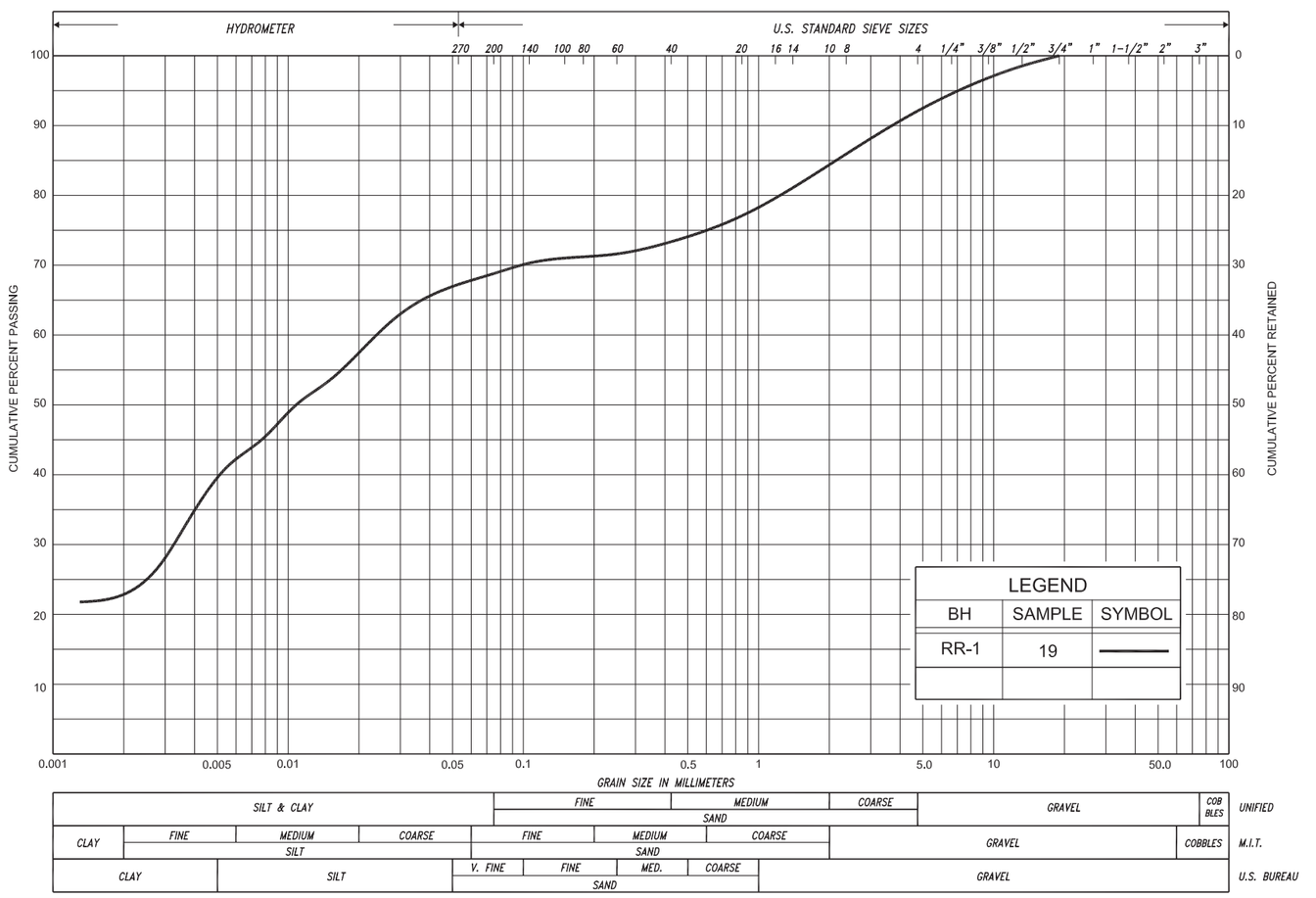
PLASTICITY CHART

CLAYEY SILT

FIG No. E-7

HWY: 427

G.W.P. No.



Ontario

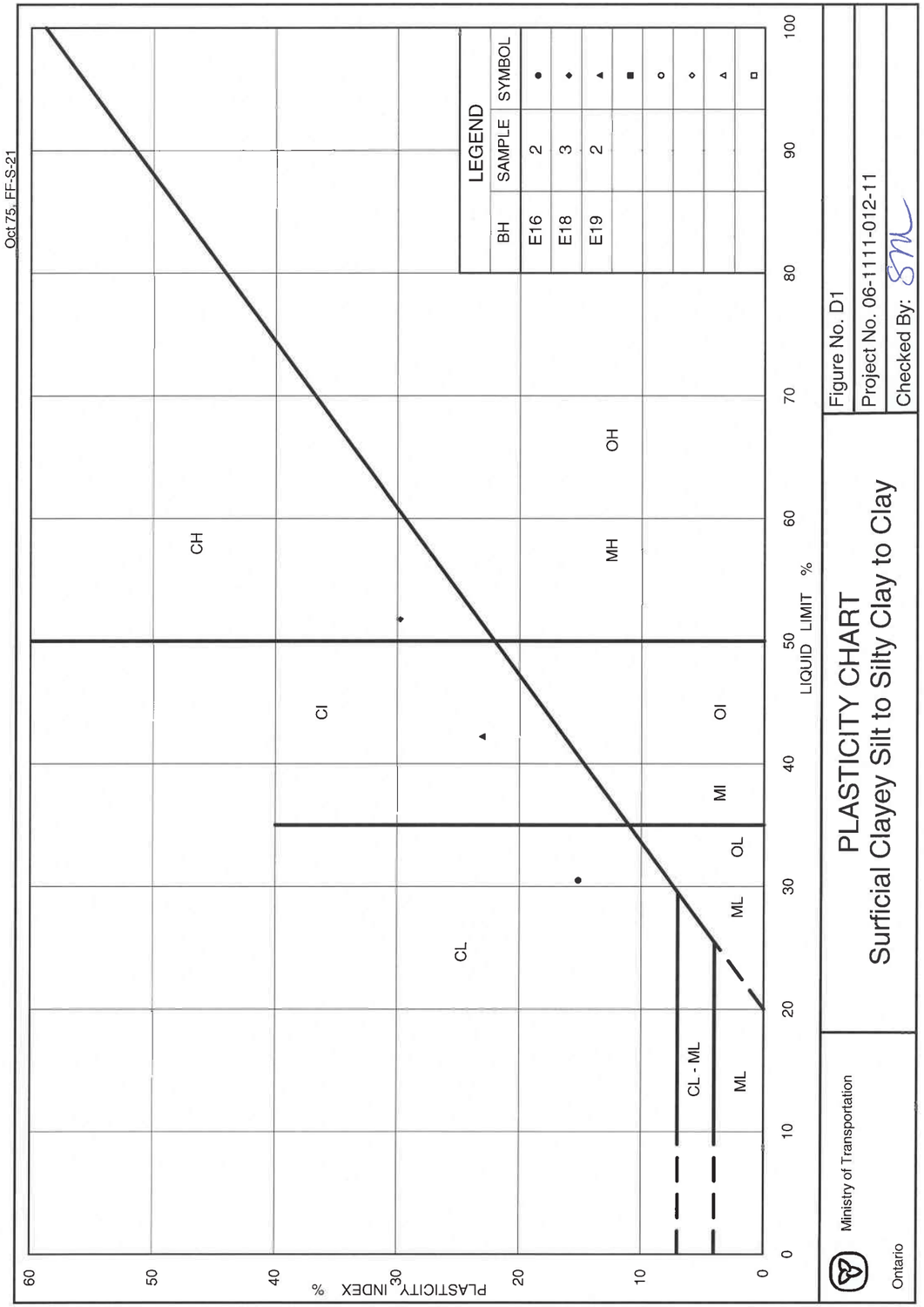
GRAIN SIZE DISTRIBUTION

CLAYEY SILT, with sand (TILL) - Lower

FIG No. E-8

HWY: 427

G.W.P. No.



PLASTICITY CHART
Surficial Clayey Silt to Silty Clay to Clay

Figure No. D1

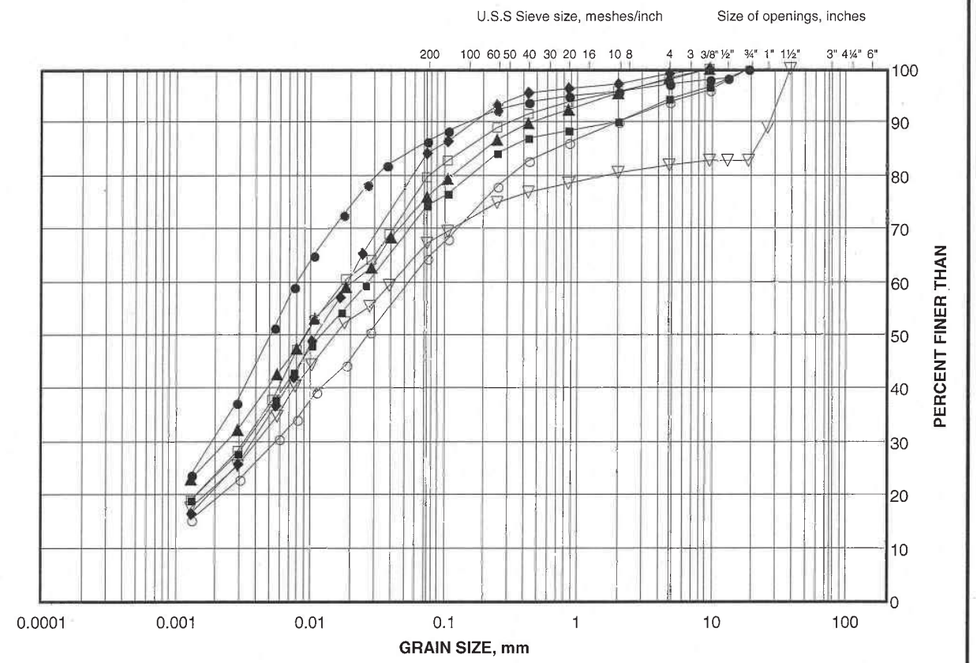
Project No. 06-1111-012-11

Checked By: SNL

Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION TEST RESULTS
Clayey Silt to Silty Clay Till

FIGURE D2



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

LEGEND

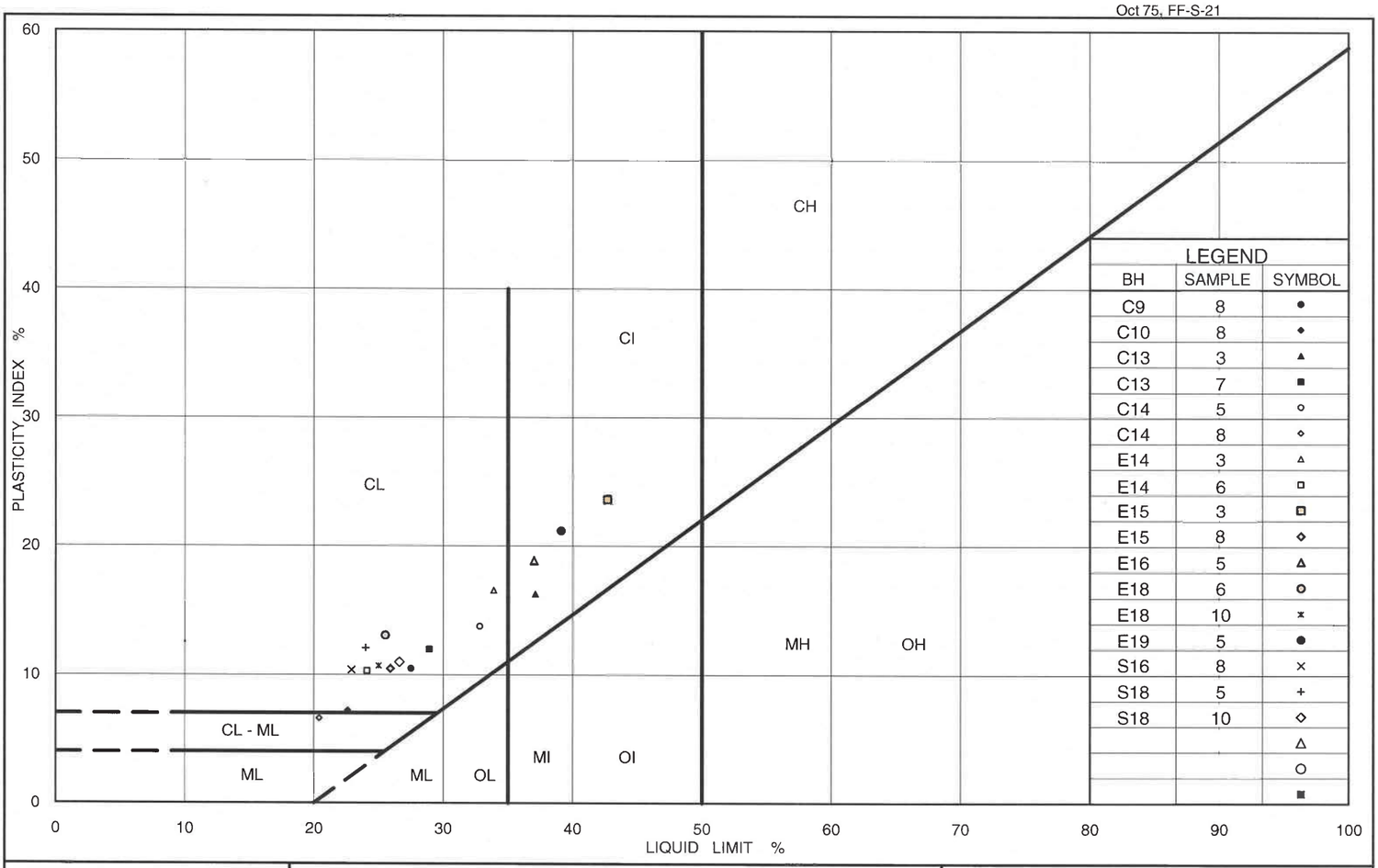
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S18	10	182.2
■	C10	3	186.8
◆	C9	3	186.5
▲	S18	5	189.8
▽	E14	6	187.4
○	C14	8	189.6
□	S16	8	188.2

Project Number: 06-1111-012-11

Checked By: SNL

Golder Associates

Date: 22-Jul-09



Ministry of Transportation
Ontario

PLASTICITY CHART
Clayey Silt to Silty Clay Till

Figure No. D3
Project No. 06-1111-012-11
Checked By: SM

J5 – CPR / MCGILLIVRAY ROAD OVERHEADS

Record of Current and Previous Borehole Sheets
Laboratory Test Results – Current and Previous Investigations

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No MGR-1 1 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 853 463.3 N; 292 187.8 E ORIGINATED BY F.P.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 3.5m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE November 11, 2015 CHECKED BY A.V.

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 ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (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
202.1	Ground Surface										
0.0 / 201.8	TOPSOIL		1	SS	6		202				
0.3	SILTY CLAY Firm to stiff Brown and grey Moist to wet		2	SS	10		201				
200.7											
1.4	CLAYEY SILT to SILTY CLAY, trace to with sand, trace gravel Stiff to hard Brown becoming grey below a depth of 3.8m Moist (TILL)		3	SS	30						7 9 43 41
			4	SS	29		200				
			5	SS	20		199				
			6	SS	18		198				
			7	SS	15		197				5 10 41 44
			8	SS	26						
			9	SS	19		196				
			10	SS	9		195				
				FV			194	+			
			11	SS	15		193				
							192				
			12	SS	29		191			46	5 24 48 23
			13	SS	41		190				
188.9							189				
13.2	SILT and SAND, trace clay, trace gravel Very dense Grey Moist (TILL)		14	SS	101/25cm		188				5 38 49 8
187.1	Cont'd										

ON MTO_NEW LOGO HWY 427 15TF013A-REV.GPJ ON_MOT.GDT 14/01/2016 10:29:16 AM

+7, ×5: Numbers refer to Sensitivity (20, 15, 10, 5) (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No MGR-1 2 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 853 463.3 N; 292 187.8 E ORIGINATED BY F.P.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 3.5m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE November 11, 2015 CHECKED BY A.V.

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 ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (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
187.1											
15.0	(Cont'd) SAND and SILT, trace clay, trace gravel Very dense Grey Moist (TILL)		15	SS	103/15cm		187				
185.0			16	SS	100/23cm		186				
17.1	End of borehole Note: 1. Groundwater level cannot be measured upon completion of drilling due to utilization of mud rotary drilling technique.						185				

ON MTO_NEW LOGO HWY 427 15TF013A-REV.GPJ ON_MOT.GDT 14/01/2016 10:29:16 AM

+7, ×5: Numbers refer to Sensitivity (20, 15, 10, 5) (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No MGR-2 1 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 853 474.8 N; 292 244.6 E ORIGINATED BY F.P.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 3.8m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE November 10, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
201.5	Ground Surface										
0.0 / 201.2	TOPSOIL		1	SS	7		201				
0.3 / 200.7	SILTY CLAY, trace sand Firm Brown and grey Moist		2	SS	34						
0.8	CLAYEY SILT to SILTY CLAY, trace to with sand, trace gravel Stiff to hard Brown becoming grey below a depth of 3.0m Moist to wet (TILL)		3	SS	28		200				
			4	SS	26		199				2 3 32 63
			5	SS	18						
			6	SS	19		198				
			7	SS	14		197				1 6 43 50
			8	SS	13		196				
			9	SS	11		195				4 21 48 27
				FV				+			
			10	SS	11		194				
			11	SS	15		193				
			12	SS	23		192				
			13	SS	64		191				
188.3							190				
13.2	SILT and SAND, trace clay, trace gravel Very dense Grey Wet (TILL)		14	SS	75		189				
186.5	Cont'd						188				
							187				

+7, ×5: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No MGR-2 2 of 2 METRIC

G.W.P. _____ LOCATION Coords: 4 853 474.8 N; 292 244.6 E ORIGINATED BY F.P.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 3.8m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE November 10, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
186.5											
15.0	(Cont'd) SILT and SAND, trace clay, trace gravel Very dense Grey Wet (TILL)		15	SS	50/15cm		186				
183.8			16	SS	50/8cm		185				
17.7	CLAYEY SILT, some sand, trace gravel Hard Grey Moist (TILL)		17	SS	103/23cm		184				
182.8							183				3 11 67 19
18.7	End of borehole Note: 1. Groundwater level cannot be measured upon completion of drilling due to utilization of mud rotary drilling technique.										

ON MTO_NEW LOGO HWY 427 15TF013A-REV.GPJ ON_MOT.GDT 14/01/2016 10:29:17 AM

+7, ×5: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Ontario

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Foundation Design

RECORD OF BOREHOLE No MMD-1 1 of 4 METRIC

G.W.P. _____ LOCATION Coords: 4 853 836.0 N; 291 910.8 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 5 to 7, 2015 CHECKED BY A.V.

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 (○ 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 (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
204.9	Ground Surface										
0.0 / 204.6	TOPSOIL										
0.3	CLAYEY SILT to SILTY CLAY, trace to some sand, trace gravel Firm to very stiff Brown becoming grey below a depth of 2.3m Moist		1	SS	6		204				
			2	SS	18						
			3	SS	15		203				
			4	SS	28						
			5	SS	20		202				
			6	SS	17		201				0 3 44 53
			7	SS	21		200				
197.8			8	SS	22		199				1 10 48 41
7.1	SILT and SAND, trace clay, trace gravel Dense Grey Moist (TILL)		9	SS	41		198				Auger grinding at a depth of 7.3m
			10	SS	40		197				9 40 43 8
194.8							196				
10.1	CLAYEY SILT, trace sand, trace gravel Very stiff to hard Grey Moist (TILL)		11	SS	18		195				
							194				
			12	SS	23		193				
							192				
			13	SS	39		191				1 9 67 23
189.9	Cont'd						190				

+7, ×5: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No MMD-1 2 of 4 METRIC

G.W.P. _____ LOCATION Coords: 4 853 836.0 N; 291 910.8 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 5 to 7, 2015 CHECKED BY A.V.

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 (○ 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 (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
189.9											
15.0	(Cont'd) CLAYEY SILT, trace sand, trace gravel Very stiff to hard Grey Moist (TILL)		14	SS	39		189				
			15	SS	58		188				
187.1											
17.8	SANDY CLAYEY SILT, trace gravel Hard Grey Moist (TILL)		16	SS	75/13cm		187				Auger grinding at a depth of 18.7m
							186				
							185				
							184				
			17	SS	117/28cm		183				2 32 46 20
181.8											
23.1	CLAYEY SILT, trace sand to sandy Stiff to hard Grey Moist to wet		18	SS	44		182				
							181				
							180				
							179				
							178				
			19	SS	27		177				
							176				
174.9	Cont'd						175				

+7, ×5: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No MMD-1 3 of 4 METRIC

G.W.P. _____ LOCATION Coords: 4 853 836.0 N; 291 910.8 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 5 to 7, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
174.9											
30.0	(Cont'd) CLAYEY SILT, trace sand to sandy Stiff to hard Grey Moist to wet		20	SS	20		174				0 0 83 17
			21	SS	17		171				
			22	SS	13		168				
166.6											
38.3	SILT, trace clay Compact Grey Moist to wet		23*	SS	13		165				
			24	SS	18		162		non-plastic		1 10 82 7
159.9	Cont'd						160				Hard drilling below a depth of 38.4m

+⁷ ,×⁵ : Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No MMD-1 4 of 4 METRIC

G.W.P. _____ LOCATION Coords: 4 853 836.0 N; 291 910.8 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 5 to 7, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
45.0	(Cont'd) SILT, trace clay Compact Grey Moist to wet		25*	SS	32		159				
157.6											
47.3	SILT and SAND, trace clay, trace to some gravel Compact to very dense Grey Moist to wet		26	SS	33		156				0 51 42 7
	containing shale fragments below a depth of 54.9m		27	SS	18		153				
			28	SS	122		150				
148.3											
56.6	SHALE BEDROCK Highly weathered Grey		29	SS	100/13cm		147				Hard drilling below a depth of 55.3m
146.9											
58.0	End of borehole *no recovery in split-spoon sampler Notes: 1. Groundwater level cannot be measured upon completion of drilling due to utilization of mud rotary drilling technique.										

+⁷ ,×⁵ : Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No MMD-2 1 of 3 METRIC

G.W.P. _____ LOCATION Coords: 4 853 805.7 N; 291 861.1 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 7 and 8, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	WATER CONTENT (%) (10 20 30)				GR SA SI CL
204.5	Ground Surface												
0.0 / 204.2	TOPSOIL		1	SS	10		204						
0.3	SILTY CLAY, trace to some sand, trace gravel Stiff to very stiff Brown becoming grey below a depth of 3.1m Moist		2	SS	16								3 17 35 45
			3	SS	15		203						
			4	SS	28		202						
			5	SS	18		201						
			6	SS	17								
			7	SS	26		200						1 7 39 53
			8	SS	18		199						Hard drilling at a depth of 5.5m
			9	SS	10		198						
			10	SS	12		197						
			11	SS	13		196						
192.8 / 11.7	CLAYEY SILT, trace to with sand, trace gravel Very stiff to hard Grey Moist (TILL)		12	SS	22		195						4 26 52 18
			13	SS	32		194						
189.5	Cont'd						193						
							192						
							191						
							190						

+7, ×5: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No MMD-2 2 of 3 METRIC

G.W.P. _____ LOCATION Coords: 4 853 805.7 N; 291 861.1 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 7 and 8, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	WATER CONTENT (%) (10 20 30)				GR SA SI CL
189.5													
15.0	(Cont'd) CLAYEY SILT, trace to with sand, trace gravel Very stiff to hard Grey Moist (TILL)		14	SS	103		189						
			15	SS	34		188						0 2 73 25
			16	SS	92		187						
			17	SS	36		186						
			18	SS	42		185						
178.4							184						
26.1	CLAYEY SILT Very stiff Grey Moist		19	SS	26		183						Hard drilling at a depth of 21.8m
							182						
							181						
							180						0 3 73 24
							179						
							178						
							177						
							176						
174.5	Cont'd						175						

+7, ×5: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No MMD-2 3 of 3 METRIC

G.W.P. _____ LOCATION Coords: 4 853 805.7 N; 291 861.1 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 7 and 8, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE; ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	WATER CONTENT (%) (10 20 30)				GR SA SI CL
174.5						*							
30.0	(Cont'd) CLAYEY SILT Very stiff Grey Moist		20	SS	19		174			○			
173.6							173						
30.9	Switched to Dynamic Cone Penetration Test						172						
							171						
							170						
							169						
							168	144 320					
167.3													
37.2	End of Dynamic Cone Penetration Test												

Monitoring Well Legend:

- Bentonite seal
- Native
- Filter sand
- 50mm dia. screen
- Bentonite
- Water level measured in piezometer

Notes:

1. Groundwater level cannot be measured upon completion of drilling due to utilization of mud rotary drilling technique.

Monitoring Well Readings:

Date	Depth (m)	Elev. (m)
16/11/15	10.2	194.3
23/12/15	9.3	195.2

+7, ×5: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

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Peto MacCallum Ltd. CONSULTING ENGINEERS
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RECORD OF BOREHOLE No MMD-3 1 of 3 METRIC

G.W.P. _____ LOCATION Coords: 4 853 879.3 N; 291 858.6 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 8 and 9, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE; ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	WATER CONTENT (%) (10 20 30)				GR SA SI CL
204.9	Ground Surface					*							
0.0	TOPSOIL		1	SS	6		204						
204.6													
0.3	SAND, trace silt Loose Brown Moist		2	SS	17		203						
204.1													
0.8	SILTY CLAY, trace sand Very stiff Brown becoming grey below 2.3m Moist		3	SS	17		202						
			4	SS	25		201		41				0 5 42 53
			5	SS	16		200						
			6	SS	15		199						
			7	SS	20		198						
199.3							197						
5.6	CLAYEY SILT, some sand, trace gravel Stiff to hard Grey Moist to wet (TILL)		8	SS	12		196						
			9	SS	15		195						2 11 50 37
			10	SS	12		194						
			11	SS	11		193						
			12	SS	11		192						
			13	SS	37		191						Hard drilling at a depth of 13.1m
189.9	Cont'd						190						

+7, ×5: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No MMD-3 2 of 3 METRIC

G.W.P. _____ LOCATION Coords: 4 853 879.3 N; 291 858.6 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 8 and 9, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
189.9											
15.0	(Cont'd) CLAYEY SILT, some sand, trace gravel Stiff to hard Grey Moist to wet (TILL)		14	SS	76		189				9 18 54 19
			15	SS	68		188				
	sand and gravel seams		16	SS	100		187				4 15 53 28
			17	SS	52		184				
			18	SS	46		183				2 5 69 24
							182				
							181				
							180				
178.8							179				
26.1	CLAYEY SILT Very stiff Grey Wet		19	SS	21		178				
	Cont'd						177				
							176				
							175				

+7, ×5: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No MMD-3 3 of 3 METRIC

G.W.P. _____ LOCATION Coords: 4 853 879.3 N; 291 858.6 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 8 and 9, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
174.9											
174.0			20	SS	17		174				
30.9	Switched to Dynamic Cone Penetration Test						173				
							172				
							171				
							170	128 130 235			
169.2											
35.7	End of Dynamic Cone Penetration Test Notes: 1. Groundwater level cannot be measured upon completion of drilling due to utilization of mud rotary drilling technique.										

ON MTO_NEW LOGO HWY 427 15TF013A-REV.GPJ ON_MOT.GDT 14/01/2016 12:29:46 PM

+7, ×5: Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No MMD-4 1 of 4 METRIC

G.W.P. _____ LOCATION Coords: 4 853 841.2 N; 291 818.4 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 13 and 14, 2015 CHECKED BY A.V.

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 (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
204.7	Ground Surface														
204.5	TOPSOIL														
0.2	CLAYEY SILT to SILTY CLAY, trace to some sand, trace gravel Firm to hard Brown Moist		1	SS	7		204								
			2	SS	15										
			3	SS	23		203								2 19 55 24
			4	SS	32										
			5	SS	17		202								
			6	SS	14		201								1 7 43 49
			7	SS	25		200								
199.1															
5.6	CLAYEY SILT, some sand, trace gravel Stiff to hard Grey Moist (TILL)		8	SS	16		199								
			9	SS	11		198								
							197								
			10	SS	11		196								2 11 49 38
			11	SS	10		195								
							194								
			12	SS	19		193								
							192								
			13	SS	28		191								1 11 58 30
189.7	Cont'd						190								

ON MTO_NEW LOGO HWY 427 15TF013A-REV.GPJ ON_MOT.GDT 14/01/2016 12:29:47 PM

+7, ×5: Numbers refer to Sensitivity (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No MMD-4 2 of 4 METRIC

G.W.P. _____ LOCATION Coords: 4 853 841.2 N; 291 818.4 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 13 and 14, 2015 CHECKED BY A.V.

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 (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
189.7															
15.0	(Cont'd) CLAYEY SILT, some sand, trace gravel Stiff to hard Grey Moist (TILL)		14	SS	41		189								
							188								
			15	SS	47										
							187								Hard drilling at a depth of 17.7m
			16	SS	96		186								7 14 58 21
							185								Hard drilling at a depth of 19.8m
			17	SS	75/10cm		184								
							183								Sampler bouncing
							182								
			18	SS	38		181								
							180								
178.6							179								
26.1	SILT, trace sand, trace clay Compact Grey Moist to wet						178								
			19	SS	20		177								non-plastic 0 7 85 8
							176								
							175								
174.7	Cont'd														

ON MTO_NEW LOGO HWY 427 15TF013A-REV.GPJ ON_MOT.GDT 14/01/2016 12:29:47 PM

+7, ×5: Numbers refer to Sensitivity (%) STRAIN AT FAILURE

Ontario

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RECORD OF BOREHOLE No MMD-4 3 of 4 METRIC

G.W.P. _____ LOCATION Coords: 4 853 841.2 N; 291 818.4 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 13 and 14, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	*					GR SA SI CL
174.7 30.0	CLAYEY SILT, trace sand Stiff to very stiff Grey Moist to wet		20	SS	17		174				
			21	SS	15		171				
			22	SS	16		168				0 1 82 17
			23	SS	13		165				
			24	SS	27		162				
159.7	Cont'd						160				

+7, ×5: Numbers refer to Sensitivity (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No MMD-4 4 of 4 METRIC

G.W.P. _____ LOCATION Coords: 4 853 841.2 N; 291 818.4 E ORIGINATED BY D.W.

DIST Central HWY 427 BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone COMPILED BY N.L.

DATUM Geodetic DATE October 13 and 14, 2015 CHECKED BY A.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	*					GR SA SI CL
45.0	(Cont'd) CLAYEY SILT, trace sand Stiff to very stiff Grey Moist		25	SS	30		159				
157.9 46.8	SAND and Gravel, trace silt Very dense Grey Moist		26	SS	68		157				13 54 29 4
154.2 50.5	SHALE BEDROCK Highly weathered Grey		27	SS	75/8cm		154				Hard drilling at a depth of 51.2m Sampler bouncing
			28	SS	92/5cm		150				Sampler bouncing
147.1 57.6	End of borehole * no recovery in split-spoon sampler Notes: 1. Groundwater level cannot be measured upon completion of drilling due to the utilization of mud rotary drilling technique		29	SS	100/3cm		148				

+7, ×5: Numbers refer to Sensitivity (%) STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No E21

1 OF 1 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4853342.4 ;E 292288.1 | ORIGINATED BY CR
W.O. 05-20012 | | COMPILED BY VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMW
DATUM Geodetic | DATE March 11, 2009

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 × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
202.2	GROUND SURFACE						202				
0.0 201.9	TOPSOIL		1A	SS	6						
201.5	SILTY CLAY, contains rootlets and oxidation zones (REWORKED) Firm Brown Moist		1B								
0.7	SILTY CLAY, trace to some sand, trace gravel, containing oxidation zones and sand seams (TILL) Very stiff Brown Moist		2	SS	22		201				
200.0			3	SS	22						
2.2	CLAYEY SILT, some sand, trace gravel (TILL) Very stiff Brown Moist		4	SS	19		200				3 18 51 28
199.2 3.0	SILTY CLAY, trace to some sand, trace gravel (TILL) Very stiff Brown, becoming grey below a depth of 3.8 m Moist		5	SS	25		199				
			6	SS	17		198				
197.0			7	SS	21						
5.2	END OF BOREHOLE										

NOTES:

1. Open borehole dry upon completion of drilling.
2. Borehole backfilled with bentonite.

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No E22

1 OF 1 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4853513.4 ;E 292144.2 | ORIGINATED BY JEB
W.O. 05-20012 | | COMPILED BY PKS
DIST Central HWY 427 | BOREHOLE TYPE 108 mm Diameter Solid Stem Augers | CHECKED BY SMW
DATUM Geodetic | DATE April 29, 2009

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 × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
202.4	GROUND SURFACE						202				
0.0	TOPSOIL										
0.2	CLAYEY SILT, trace sand, trace gravel, trace topsoil (Reworked) Stiff Brown m osit		1	SS	12				41		
201.6 0.8	SILTY CLAY, trace sand, trace gravel (TILL) Stiff to hard Brown grey Moist		2	SS	26		201				
			3	SS	27						
			4	SS	24		200				
			5	SS	31		199				
	Becoming grey below a depth of 3.8 m		6	SS	19		198				
			7	SS	12				41		
			8	SS	14		196				
			9	SS	12		195				
			10	SS	19		194				
			11	SS	25		193				
191.1 11.3	END OF BOREHOLE						192				

NOTES:

1. Open borehole dry upon completion of drilling.
2. Borehole backfilled with bentonite.

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

RECORD OF BOREHOLE No E23

1 OF 1 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4853605.7 ;E 292135.4 | ORIGINATED BY JEB
W.O. 05-20012 | | COMPILED BY PKS
DIST Central HWY 427 | BOREHOLE TYPE 108 mm Diameter Solid Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE April 29, 2009

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 × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
203.0	GROUND SURFACE										
0.0	TOPSOIL										
0.2	CLAYEY SILT, some sand, trace gravel (TILL) Stiff to very stiff Brown Moist		1	SS	9						
			2	SS	29		202				
			3	SS	25						
200.8							201				
2.2	SILTY CLAY, trace sand, trace gravel (TILL) Very stiff to hard Brown, becoming grey below a depth of 3.0 m Moist		4	SS	33						
			5	SS	20		200				
			6	SS	19		199				
			7	SS	16		198				
			8	SS	21		197				
			9	SS	16		196				
			10	SS	19		195				
			11	SS	45		194				
191.7							193				
11.3	END OF BOREHOLE						192				

NOTES:

1. Open borehole dry upon completion of drilling.
2. Borehole backfilled with bentonite.

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

RECORD OF BOREHOLE No E24

1 OF 1 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4853674.7 ;E 292003.8 | ORIGINATED BY CR
W.O. 05-20012 | | COMPILED BY VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 17, 2009

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 × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
203.8	GROUND SURFACE										
0.0	TOPSOIL		1A 1B	SS	5						
0.3	Silty clay, some sand, trace gravel (FILL) Firm Mottled brown and grey Moist										
203.1							203				
0.7	SILTY CLAY, trace sand, trace gravel (TILL), containing oxidation zones to a depth of 3.1 m Stiff to hard Brown, becoming grey at 3.7 m depth Moist		2	SS	24						
			3	SS	34		202				
			4	SS	31						
	Containing silt seams between depths of 3.0 m and 3.7 m		5	SS	36		201				
			6	SS	9		200				
			7	SS	12		199				0 4 44 52
	Containing cobbles		8	SS	22		198				
			9	SS	24		197				
	Containing cobbles		10	SS	14		196				
			11	SS	14		195				
			12	SS	27	▽	194				
191.0							193				
12.8	END OF BOREHOLE						192				
							191				

NOTES:

1. Water level in open borehole at a depth of 11.9 m below ground surface (Elev. 191.9 m) upon completion of drilling.
2. Borehole backfilled with bentonite.

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No E25

1 OF 1 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4853706.3 ;E 292116.8
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 18, 2009

ORIGINATED BY CR
COMPILED BY VA
CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
203.8	GROUND SURFACE						
0.0	TOPSOIL		1	SS	8		
0.2	Silty clay, trace gravel, trace sand, containing rootlets and oxidation zones (FILL)						
203.1	Firm		2	SS	23		
0.7	Brown						
	Moist						
	SILTY CLAY, some gravel, some sand, containing cobbles, sand pockets (TILL) and oxidation zones to a depth of 4.0 m		3	SS	21		
	Stiff to hard						
	Brown to grey		4	SS	25		
	Moist						
			5	SS	33		
			6	SS	18		
			7	TO	PH		
			8	SS	10		
			9	SS	14		
			10	TO	PH		
			11	SS	11		
193.6							
10.2	CLAYEY SILT, some sand, some gravel (TILL)		12	SS	8		
	Very stiff						
	Grey						
	Moist to wet		13	SS	19	▽	
191.0							
12.8	END OF BOREHOLE						

NOTES:

1. Water level in open borehole at a depth of 12.5 m below ground surface (Elev. 191.3 m) upon completion of drilling.
2. Borehole backfilled with bentonite.

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

SHEAR STRENGTH kPa
O UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED
(20 40 60 80 100)

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

40

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No E26

1 OF 1 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4853709.4 ;E 291872.6
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 18, 2009

ORIGINATED BY SB
COMPILED BY VA
CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
204.3	GROUND SURFACE						
0.0	Asphalt						
0.1	Sand and gravel (FILL), containing organics						
203.7	Compact						
0.6	Brown						
	Moist		1	SS	10		
	SILTY CLAY, trace to some sand, trace gravel (TILL)						
	Stiff to very stiff		2	SS	17		
	Brown and grey						
	Moist		3	SS	24		
			4	SS	20		
			5	SS	15		
	Becoming grey below a depth of 4.6 m		6	SS	7		
			7	TO	PH		
			8	SS	8		
			9	SS	8		
194.0							
10.3	CLAYEY SILT, trace to some sand, trace gravel (TILL)		10	SS	4		
	Firm to hard						
	Grey						
	Moist		11	SS	44		
191.5							
12.8	END OF BOREHOLE						

NOTES:

1. Open borehole dry upon completion of drilling.
2. Borehole backfilled with bentonite.

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

SHEAR STRENGTH kPa
O UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED
(20 40 60 80 100)

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

45
>120
>120
>120
>120
>120
0 10 69 21

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No E27

1 OF 1 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4853771.2 ;E 291968.0
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 18, 2009

ORIGINATED BY CR
COMPILED BY VA
CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS
203.8	GROUND SURFACE					
0.0 / 203.4	TOPSOIL		1	SS	7	
203.1 / 0.7	SILTY CLAY, trace gravel, trace sand, containing rootlets (REWORKED) Firm Brown Wet		2	SS	7	
	SILTY CLAY, some sand, trace to some gravel, containing oxidation zones (TILL) Firm to very stiff Grey Moist		3	SS	12	
			4	SS	20	
			5	SS	20	
			6	SS	12	
			7	SS	17	
			8	SS	12	
196.6						
7.2	CLAYEY SILT, some sand, trace gravel (TILL) Very stiff Grey Moist to wet		9	SS	19	
			10	SS	16	▽
			11	SS	23	
			12	SS	18	
191.0 / 12.8	END OF BOREHOLE					

NOTES:

1. Water level in open borehole at a depth of 9.8 m below ground surface (Elev. 194.0 m) upon completion of drilling.
2. Borehole backfilled with bentonite.

ELEVATION SCALE: 203, 202, 201, 200, 199, 198, 197, 196, 195, 194, 193, 192, 191

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)	GR	SA	SI	CL
	4	20	49	27

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S26

1 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4853413.1 ;E 292274.0
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 11 & 12, 2009

ORIGINATED BY CR
COMPILED BY VA
CHECKED BY SMM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS
201.5	GROUND SURFACE					
0.0 / 201.2	TOPSOIL		1	SS	15	
0.3	SILTY CLAY, some gravel, some sand, containing organics and rootlets (Reworked to a depth of 0.8 m) Stiff Brown Moist		2	SS	10	
200.1 / 1.4	CLAYEY SILT, some sand, trace to some gravel (TILL), containing oxidation zones Stiff to very stiff Brown Moist		3	SS	12	
			4	SS	27	
197.8			5	SS	21	
3.7	SILTY CLAY, trace to some sand, trace gravel (TILL) Stiff to very stiff Grey Moist to wet		6	SS	17	
			7	SS	14	
	Wet below a depth of 6.1 m		8	SS	7	
			9	TO	PH	
			10	SS	13	
192.8						
8.7	CLAYEY SILT, some sand, trace gravel, containing cobbles and boulders (TILL) Very stiff to hard Grey Moist		11	SS	21	
			12	SS	67	▽
189.6						
11.9	SAND and SILT, trace clay, trace gravel (TILL) Very dense Grey Moist		13	SS	128	
			14	SS	185	

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ELEVATION SCALE: 201, 200, 199, 198, 197, 196, 195, 194, 193, 192, 191, 190, 189, 188, 187

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)	GR	SA	SI	CL
	0	17	57	26

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S26

2 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4853413.1 ;E 292274.0
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 11 & 12, 2009

ORIGINATED BY CR
COMPILED BY VA
CHECKED BY SMM

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	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100		WATER CONTENT (%) 10 20 30			
	SAND and SILT, trace clay, trace gravel (TILL) Very dense Grey Moist		15	SS	168		186						
185.7 15.9	END OF BOREHOLE												
	NOTES: 1. Water level in open borehole at a depth of 11.5 m below ground surface (Elev. 190.0 m) upon completion of drilling. 2. Borehole caved to a depth of 13.0 m below ground surface (Elev. 188.5 m) upon removal of augers and backfilled with bentonite.												

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

Golder Associates

RECORD OF BOREHOLE No S28

1 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4853435.3 ;E 292253.3
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 17, 2009

ORIGINATED BY SB
COMPILED BY JB/VA
CHECKED BY SMM

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	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
200.8	GROUND SURFACE							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100		WATER CONTENT (%) 10 20 30			
0.0	Asphalt												
0.3	Sand and gravel, trace silt (FILL) Brown Moist												
	CLAYEY SILT, trace gravel, trace sand (TILL) Very stiff Brown and grey Moist		1	SS	23								
			2	SS	21								
197.8			3	SS	21								
3.1	SILTY CLAY, trace sand, trace gravel (TILL) Stiff Grey Moist		4	SS	8								
			5	TO	PH								
			6	SS	8								
			7	SS	9								
192.0													
8.8	CLAYEY SILT, with sand, trace gravel (TILL) Very stiff to hard Grey Moist		8	SS	18								
			9	SS	64								3 30 55 12
			10	SS	56								
			11	SS	113								
186.3													
14.5													

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S28

2 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4853435.3 ;E 292253.3 | ORIGINATED BY SB
W.O. 05-20012 | | COMPILED BY JB/VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 17, 2009

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 × REMOULDED, 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —										
	SAND and SILT, trace gravel, trace clay (TILL) Very dense Grey Moist		12	SS	95		185		H		
184.8 16.0	CLAYEY SILT, some sand, trace gravel (TILL) Hard Grey Moist		13	SS	132		184		○		2 12 59 27
183.6 17.2	END OF BOREHOLE										

NOTES:

1. A 50 mm diameter monitoring well was installed at a depth of 16.8 m (Elev. 184.0 m).

Water level measurements

Date	Depth	Elev.
On Completion	12.8 m	188.0 m
April 27, 2009	8.5 m	192.3 m
May 13, 2009	8.5 m	192.3 m
May 25, 2009	8.6 m	192.2 m
June 15, 2009	9.1 m	191.7 m
July 09, 2009	9.1 m	191.7 m

2. Borehole backfilled with bentonite.

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

Golder Associates

RECORD OF BOREHOLE No S29

1 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4853505.8 ;E 292191.2 | ORIGINATED BY JEB
W.O. 05-20012 | | COMPILED BY PKS/VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE April 27, 2009

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 × REMOULDED, 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
202.0	GROUND SURFACE										
0.0 201.7	TOPSOIL		1	SS	9				○		
0.3	SILTY CLAY, trace sand, trace gravel (Reworked to a depth of 0.8 m) Stiff Brown Moist		2	SS	10		201		○		
200.6 1.4	CLAYEY SILT, trace to some sand, trace gravel (TILL) Stiff to hard Brown becoming grey below a depth of 2.3 m Moist		3	SS	11		200				
			4	SS	23		199		○		
			5	SS	18		198		○		
	Auger grinding between a depth of 3.8 m to 4.4 m		6	SS	18		197				0 5 41 54
			7	SS	12		196				
			8	SS	10		195				
			9	SS	8		194	× + ×	○		
			10	SS	14		193		○		
			11	SS	32		192		○		
			12	SS	79		191		○		
188.3 13.7	SAND and SILT, trace gravel, trace clay (TILL) Very dense Grey Moist		13	SS	20/0.25		190 189 188		○		1 29 62 8

Continued Next Page

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

RECORD OF BOREHOLE No S29

2 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4853505.8 ;E 292191.2 | ORIGINATED BY JEB
W.O. 05-20012 | | COMPILED BY PKS/VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE April 27, 2009

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 (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	-- CONTINUED FROM PREVIOUS PAGE --							O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED			
	SAND and SILT, trace gravel, trace clay (TILL) Very dense Grey Moist Becoming wet below a depth of 15.2 m		14	SS	80	▽	186 185 184				
183.7											
183.4	CLAYEY SILT, trace sand, trace gravel (TILL) Hard Grey Wet		15	SS	00/0.13		183				
18.7	END OF BOREHOLE										
182.4								140 240			
19.7	End of DCPT Dynamic Cone Penetration Test (DCPT) below a depth of 18.7 m NOTES: 1. At 15.2 m depth (Elev. 186.8 m) 1.0 m of sand was up inside the augers during drilling due to "blowing" sands. 2. Water level in open borehole at a depth of 15.2 m below ground surface (Elev. 186.8 m) upon completion of drilling. 3. Borehole backfilled with bentonite.										

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

RECORD OF BOREHOLE No S30

1 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4853513.2 ;E 292239.8 | ORIGINATED BY JEB
W.O. 05-20012 | | COMPILED BY PKS/VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE April 27, 2009

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 (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
								O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED			
202.3	GROUND SURFACE										
0.0 202.0	TOPSOIL		1	SS	8		202				
0.3 201.5	CLAYEY SILT, some sand, trace gravel, containing organics (Reworked) Stiff Brown Moist		2	SS	22						
0.8	SILTY CLAY, trace sand, trace gravel (TILL) Stiff to very stiff Brown grey Moist		3	SS	27		201				
			4	SS	28		200				
			5	SS	29		199				
			6	SS	14		198				48
	Becoming grey below a depth of 4.6 m		7	SS	13		197				
196.7											
5.6	CLAYEY SILT, some sand, trace gravel (TILL) Stiff to very stiff Grey Moist		8	SS	9		196				
			9	SS	9		195				
							194				
			10	SS	18		193				
191.9											
10.4	Silty SAND, trace gravel, trace clay Dense Grey Wet		11	SS	32	▽	192				
191.1 11.2	CLAYEY SILT, with sand, trace gravel (TILL) Hard Grey Moist						191				
			12	SS	126		190				3 26 59 12
	Auger grinding at a depth of 13.4 m						189				
188.6 13.7	SAND and SILT, some gravel, trace clay (TILL) Very dense Grey Wet		13	SS	140		188				13 31 52 4

Continued Next Page

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

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

Golder Associates

RECORD OF BOREHOLE No S30

2 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4853513.2 ;E 292239.8 | ORIGINATED BY JEB
W.O. 05-20012 | | COMPILED BY PKS/VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE April 27, 2009

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)	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)						
	SAND and SILT, some gravel, trace clay (TILL) Very dense Grey Wet Auger grinding at a depth of 14.6 m		14	SS	20/0.23		187							
186.7 15.6	END OF BOREHOLE													

NOTES:

1. Water level in open borehole at a depth of 10.7 m below ground surface (Elev. 191.6 m) upon completion of drilling.
2. Borehole backfilled with bentonite.

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

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

Golder Associates

RECORD OF BOREHOLE No S36

1 OF 2 **METRIC**

PROJECT 06-1111-012 | LOCATION N 4853883.4 ;E 291922.9 | ORIGINATED BY SB
W.O. 05-20012 | | COMPILED BY VA
DIST Central HWY 427 | BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers | CHECKED BY SMM
DATUM Geodetic | DATE March 12, 2009

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)	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
205.2	GROUND SURFACE						205	SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)						
0.0	Asphalt													
0.2	Sand with gravel (FILL) Silty sand, trace gravel, trace clay (FILL) Compact Brown Moist		1	SS	10		204					o		
203.7 1.5	SILTY CLAY, trace sand, trace gravel (TILL) Stiff to very stiff Brown becoming grey below a depth of 2.3 m Wet		2	SS	15		203							
			3	SS	16									
			4	SS	13		202							
			5	SS	17		201							
			6	SS	13		200							
			7	TO	PH	▼	199					41	c	1 4 43 52
198.1 7.1	CLAYEY SILT, some sand, trace gravel (TILL) Stiff to hard Grey Wet						198	>120						
			8	SS	11							o		1 14 52 33
							197	× +						
			9	TO	PH		196	>120						
			10	SS	10		195							
							194							
			11	SS	6		193	>120						
							192	× + >120				o		1 17 59 23
			12	SS	64		191							

Continued Next Page

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

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

Golder Associates

RECORD OF BOREHOLE No S36

2 OF 2 **METRIC**

PROJECT 06-1111-012
W.O. 05-20012
DIST Central HWY 427
DATUM Geodetic

LOCATION N 4853883.4 ;E 291922.9
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE March 12, 2009

ORIGINATED BY SB
COMPILED BY VA
CHECKED BY SMM

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 (20 40 60 80 100): O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —										
	CLAYEY SILT, some sand, trace gravel (TILL) Stiff to hard Grey Wet		13	SS	34		190		o—I		0 8 68 24
189.4 15.9	END OF BOREHOLE										

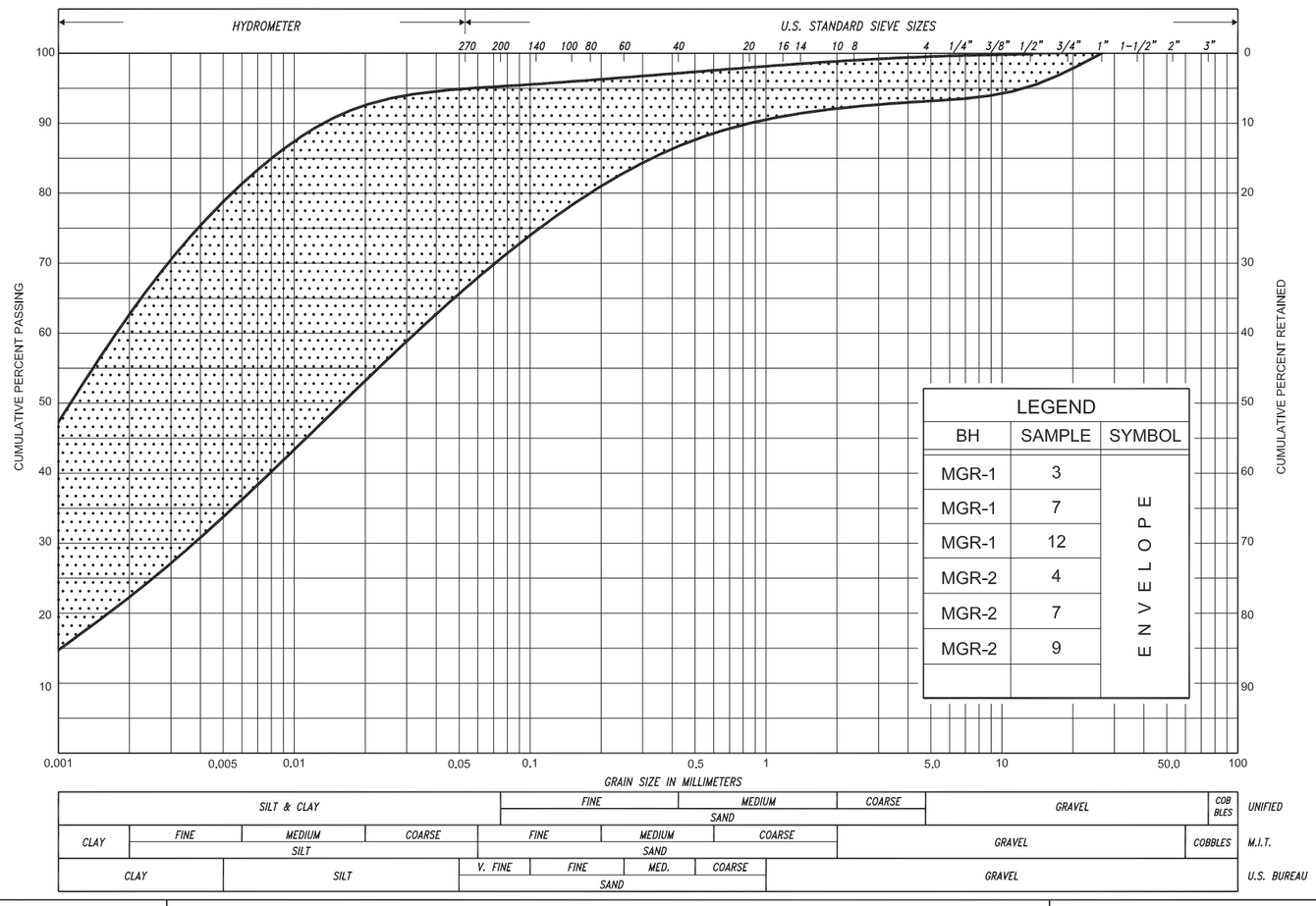
NOTES:

1. A 50 mm diameter monitoring well was installed at a depth of 13.9 m (Elev. 191.3 m).

Water level measurements:

Date	Depth	Elev.
On Completion	Dry	
April 27, 2009	7.3 m	197.9 m
May 25, 2009	6.4 m	198.8 m
June 15, 2009	6.2 m	199.0 m
July 09, 2009	6.2 m	199.0 m

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

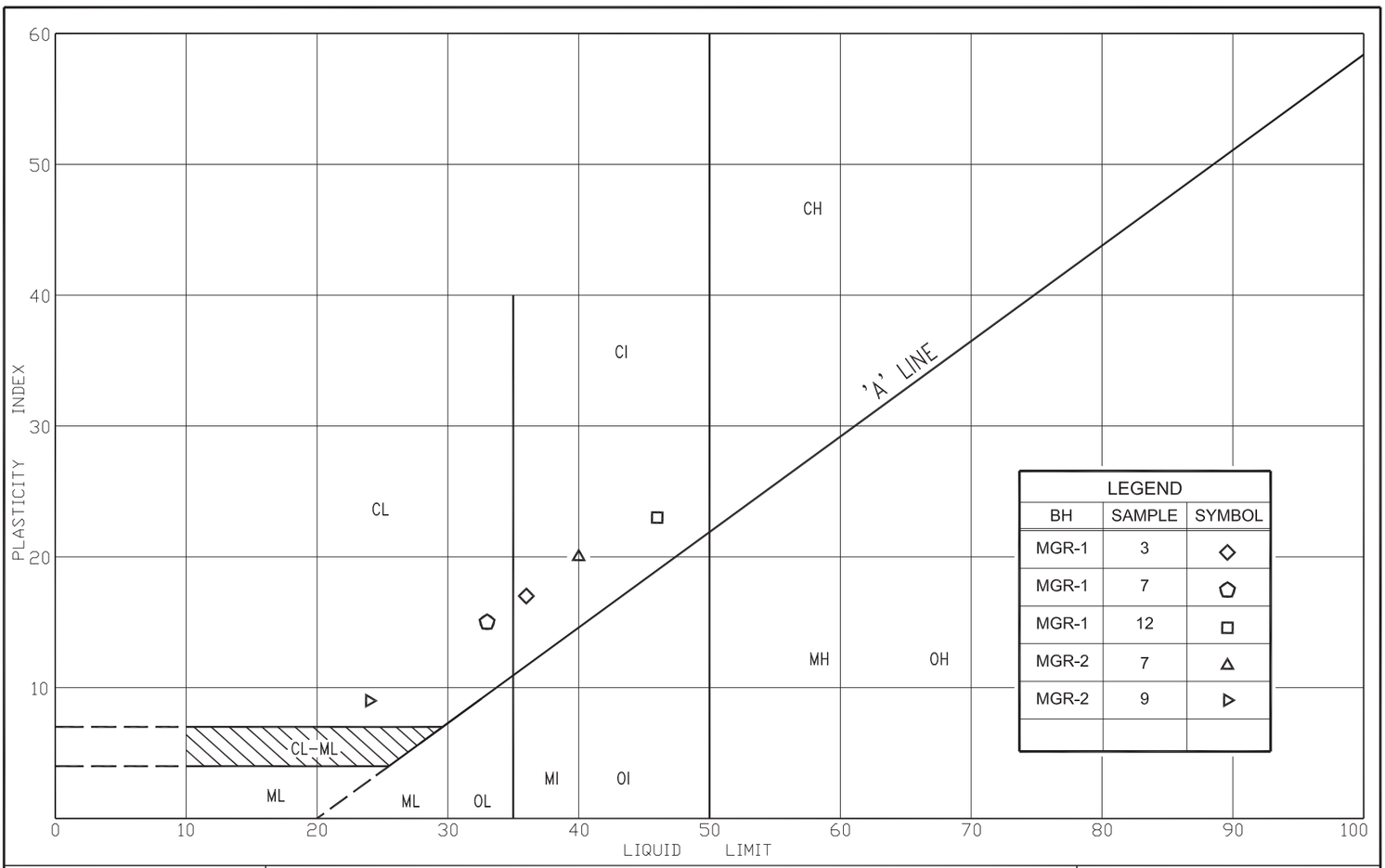


Ontario

GRAIN SIZE DISTRIBUTION

CLAYEY SILT to SILTY CLAY (TILL) - Upper

FIG No.	G-1
HWY:	427
G.W.P. No.	

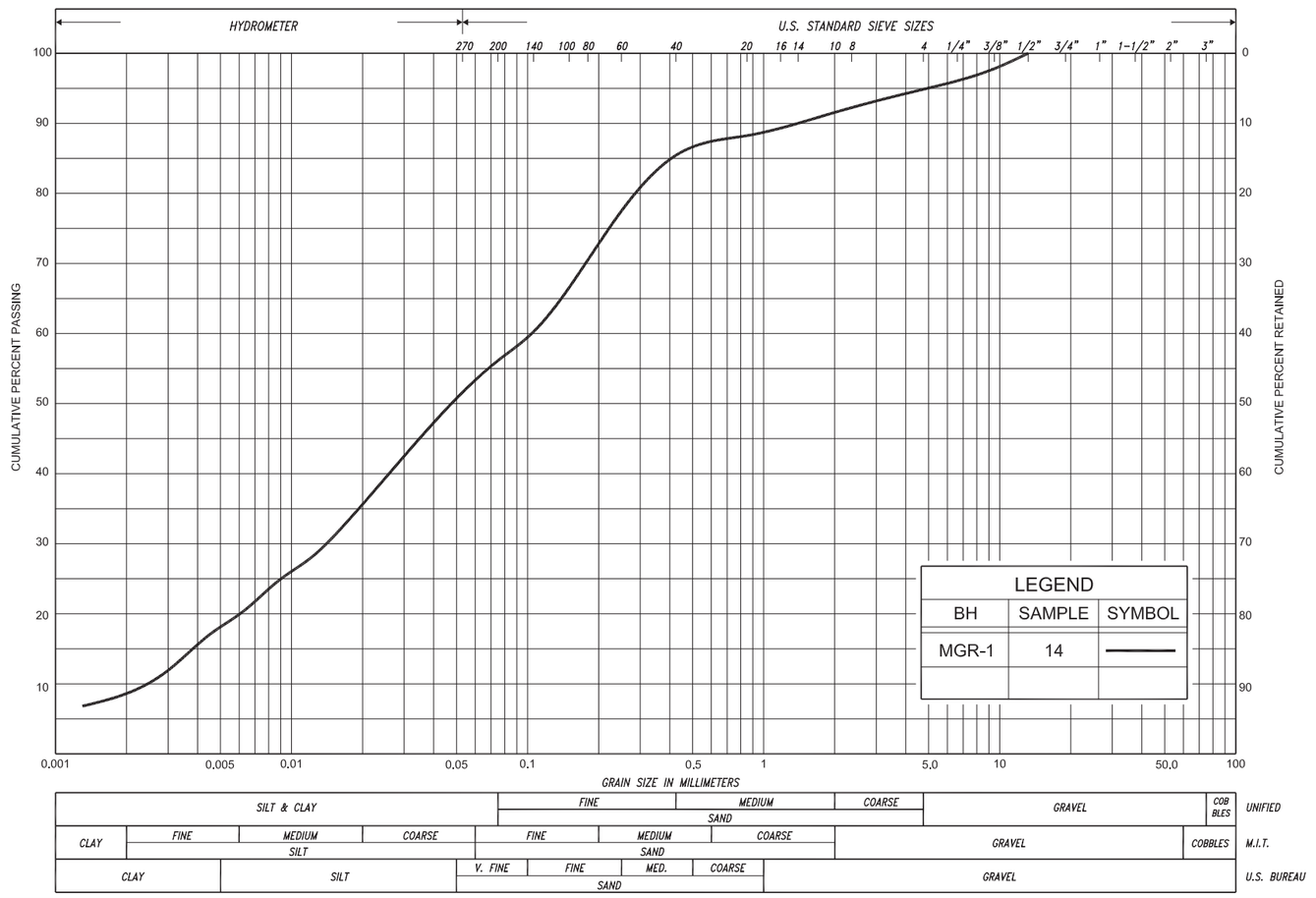


Ontario

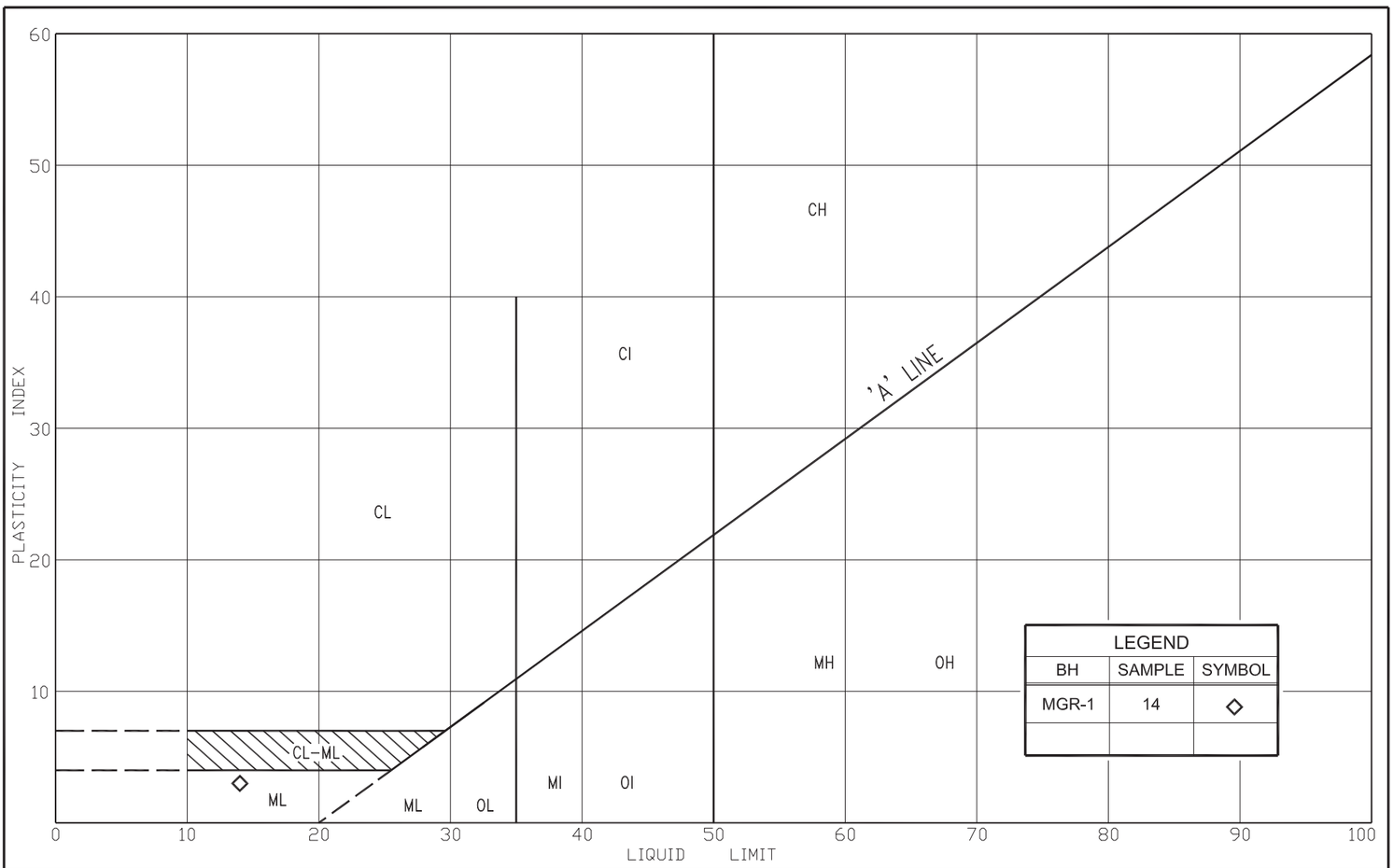
PLASTICITY CHART

CLAYEY SILT to SILTY CLAY (TILL) - Upper

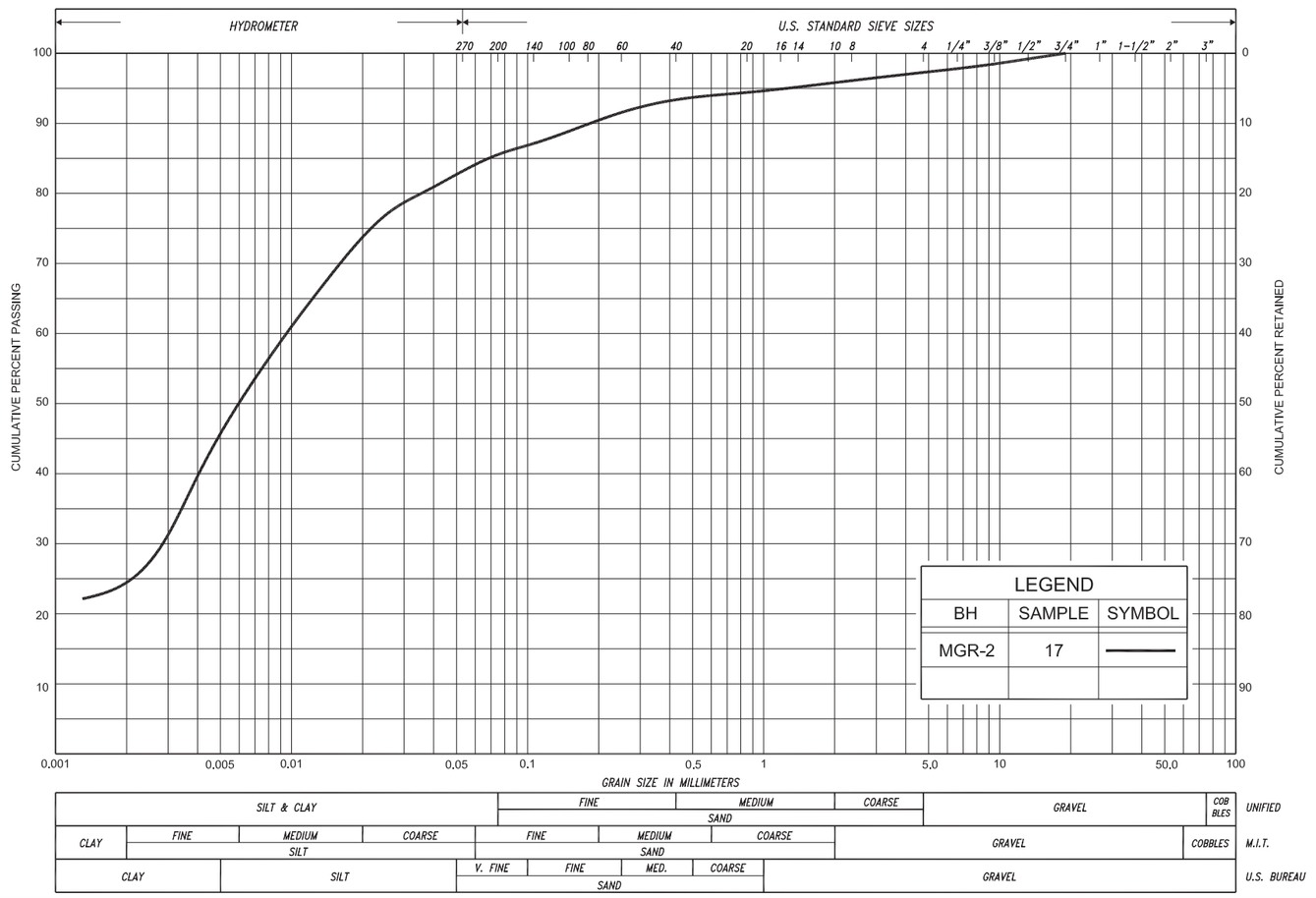
FIG No.	G-2
HWY:	427
G.W.P. No.	



Ontario	GRAIN SIZE DISTRIBUTION SILT and SAND (TILL)	FIG No. G-3 HWY: 427 G.W.P. No.



Ontario	PLASTICITY CHART SILT and SAND (TILL) - Fine Contents	FIG No. G-4 HWY: 427 G.W.P. No.

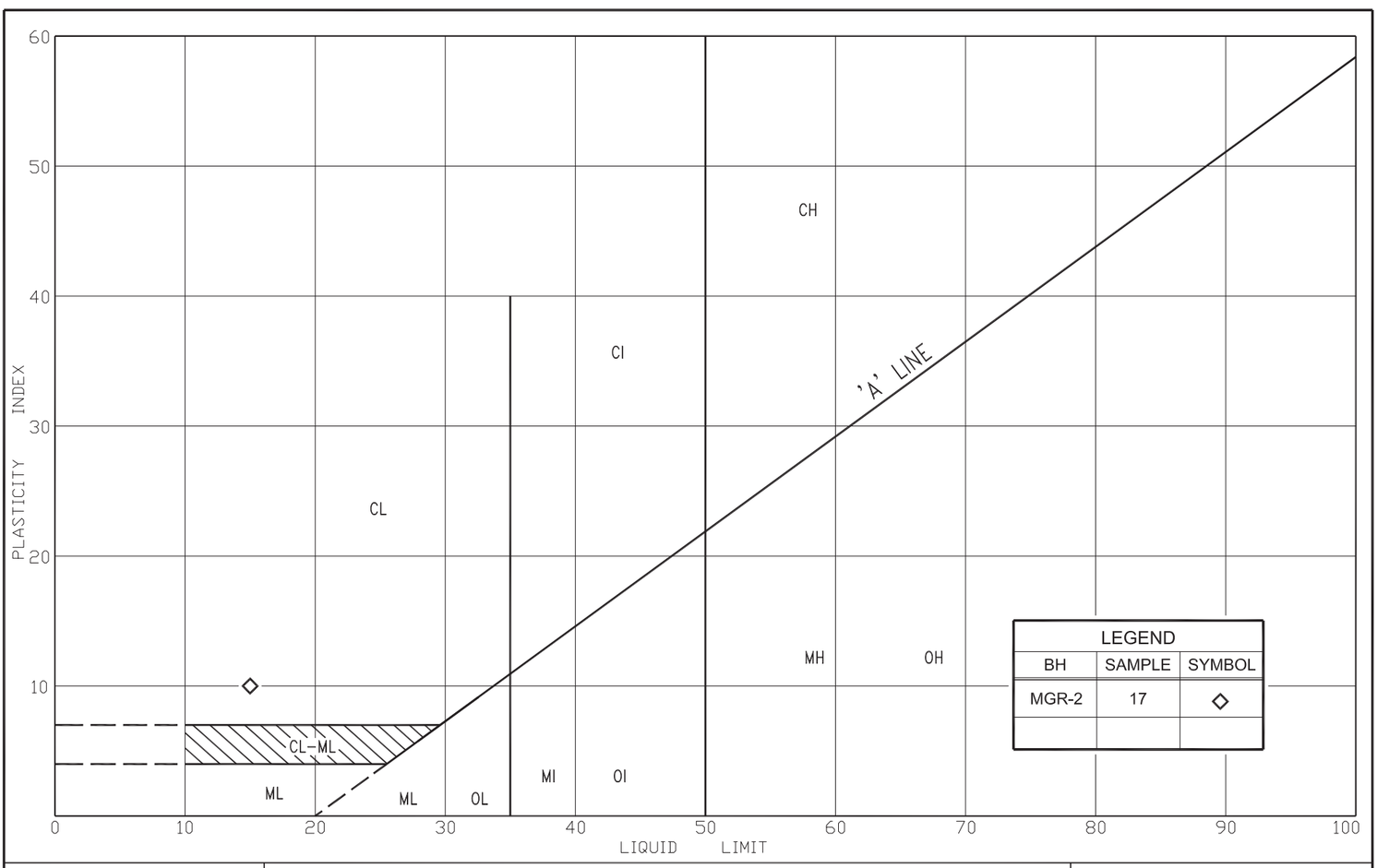


Ontario

GRAIN SIZE DISTRIBUTION

CLAYEY SILT (TILL) - Lower

FIG No.	G-5
HWY:	427
G.W.P. No.	

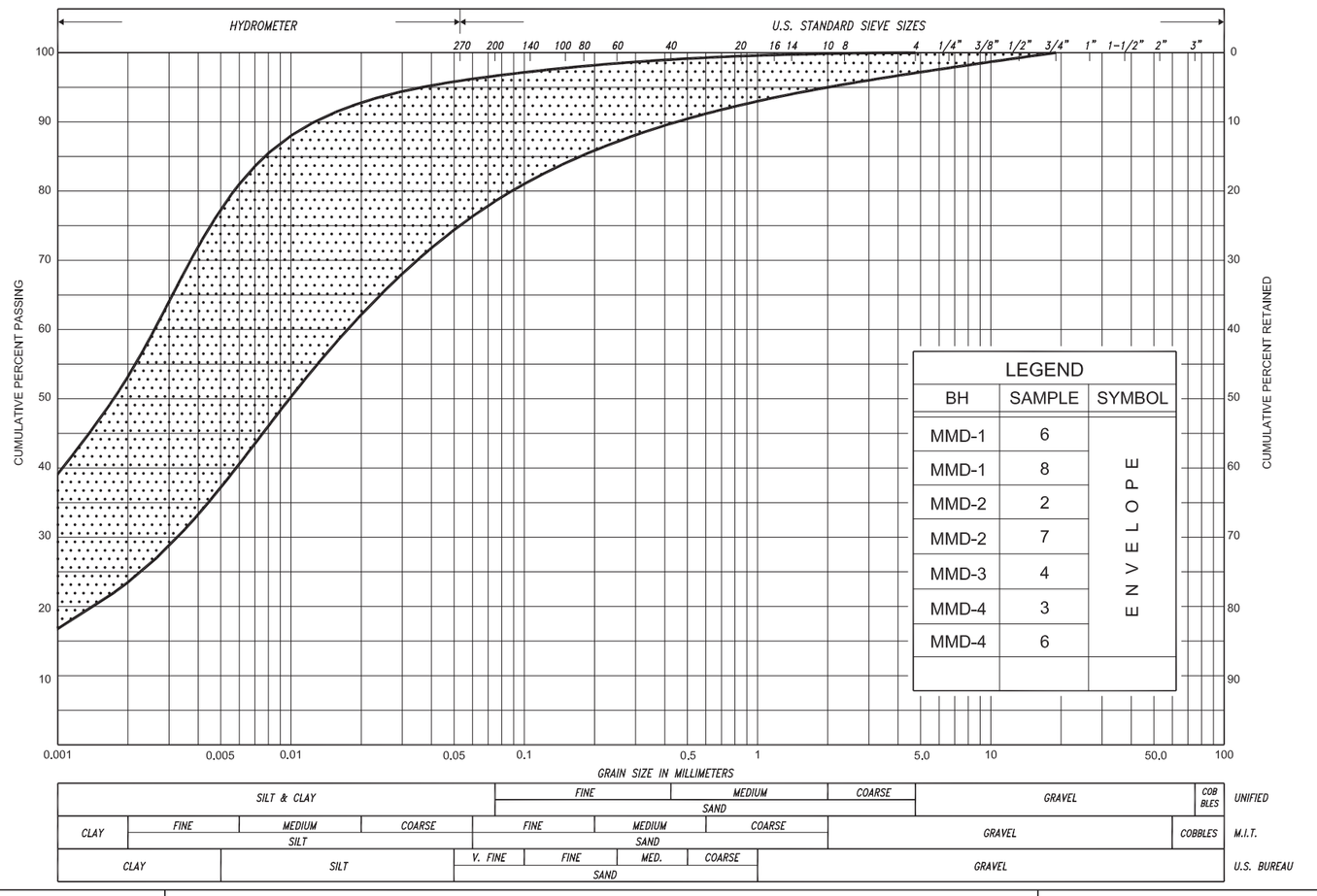


Ontario

PLASTICITY CHART

CLAYEY SILT (TILL) - Lower

FIG No.	G-6
HWY:	427
G.W.P. No.	

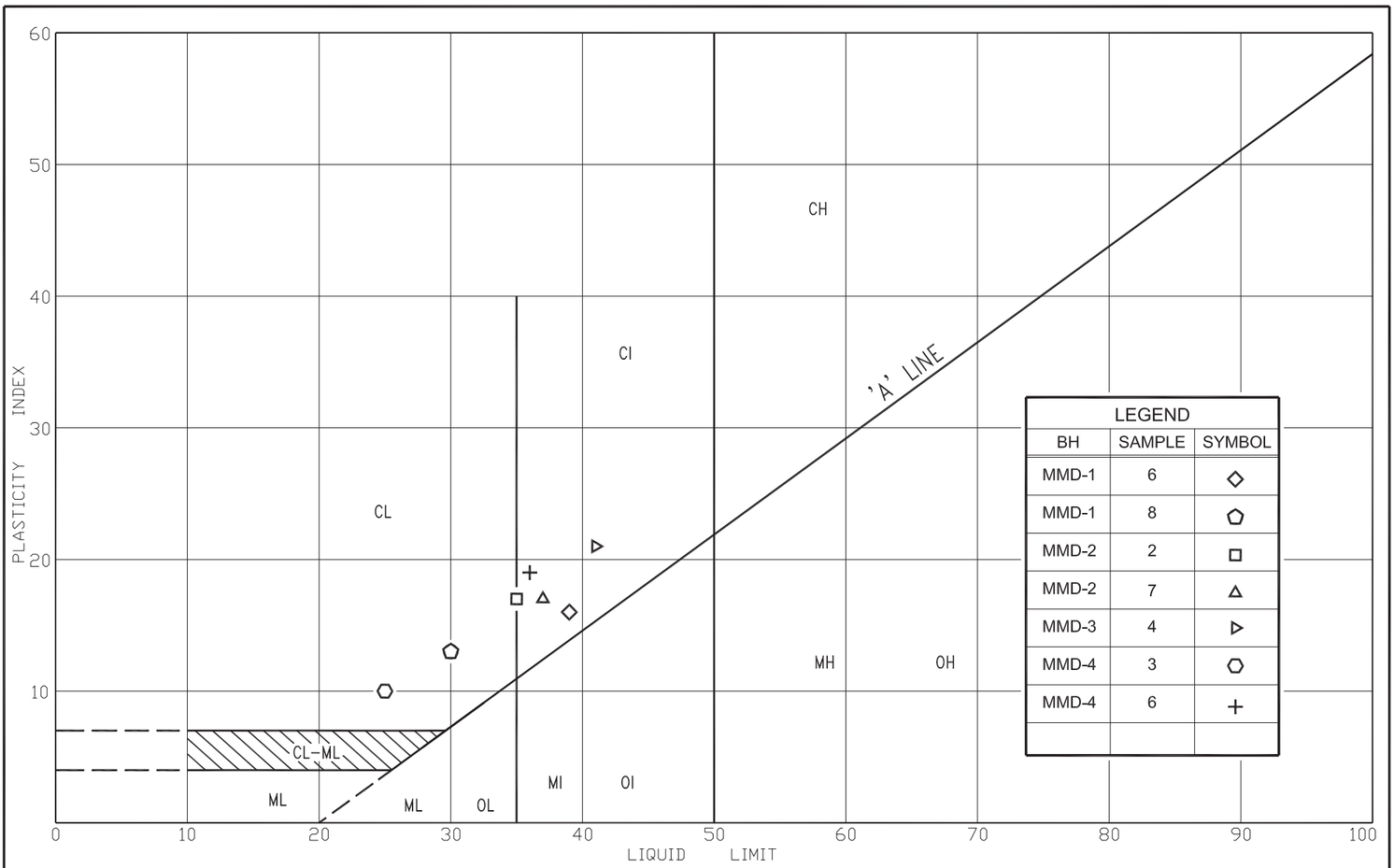


Ontario

GRAIN SIZE DISTRIBUTION

CLAYEY SILT to SILTY CLAY - Upper

FIG No.	H-1
HWY:	427
G.W.P. No.	

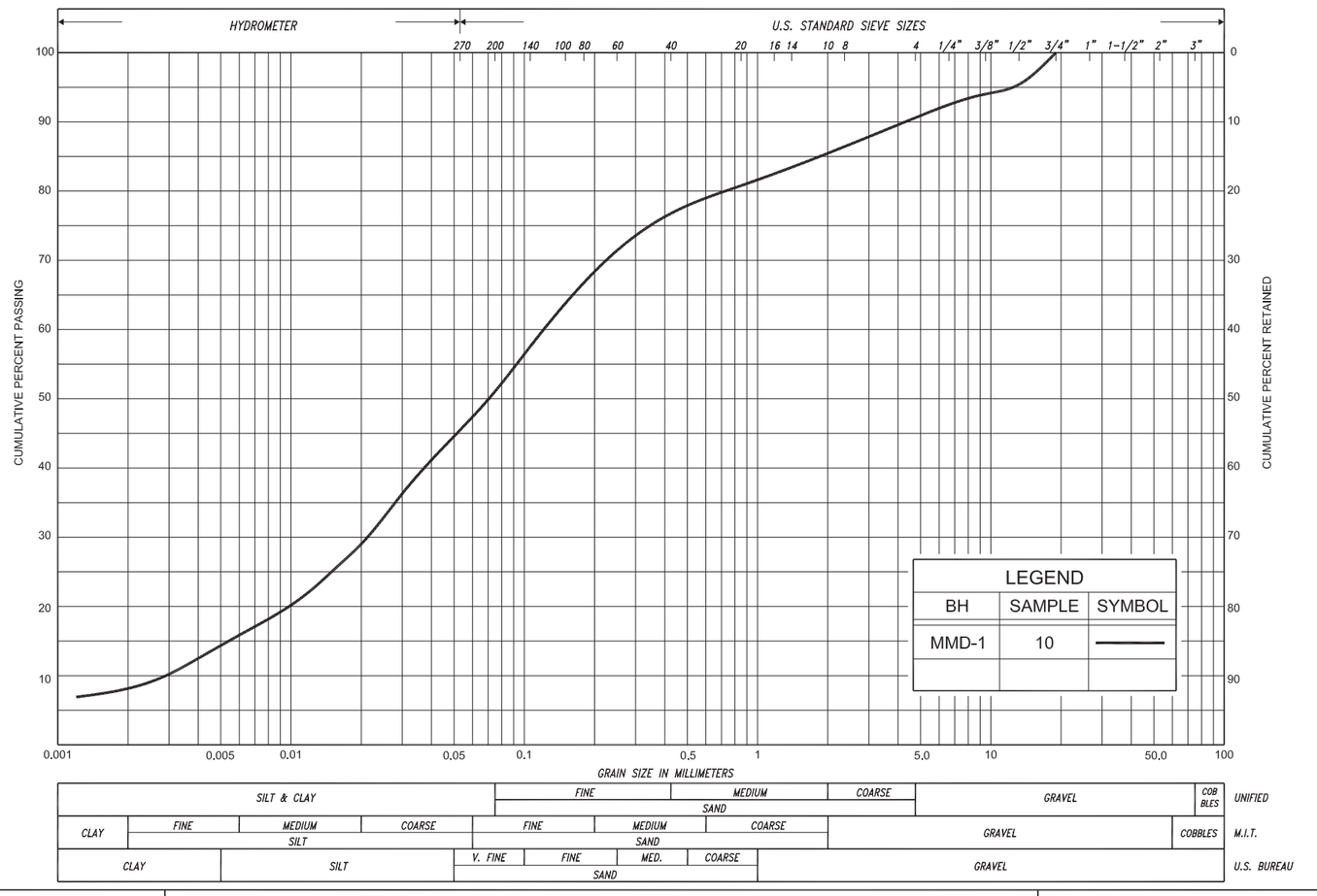


Ontario

PLASTICITY CHART

CLAYEY SILT to SILTY CLAY - Upper

FIG No.	H-2
HWY:	427
G.W.P. No.	

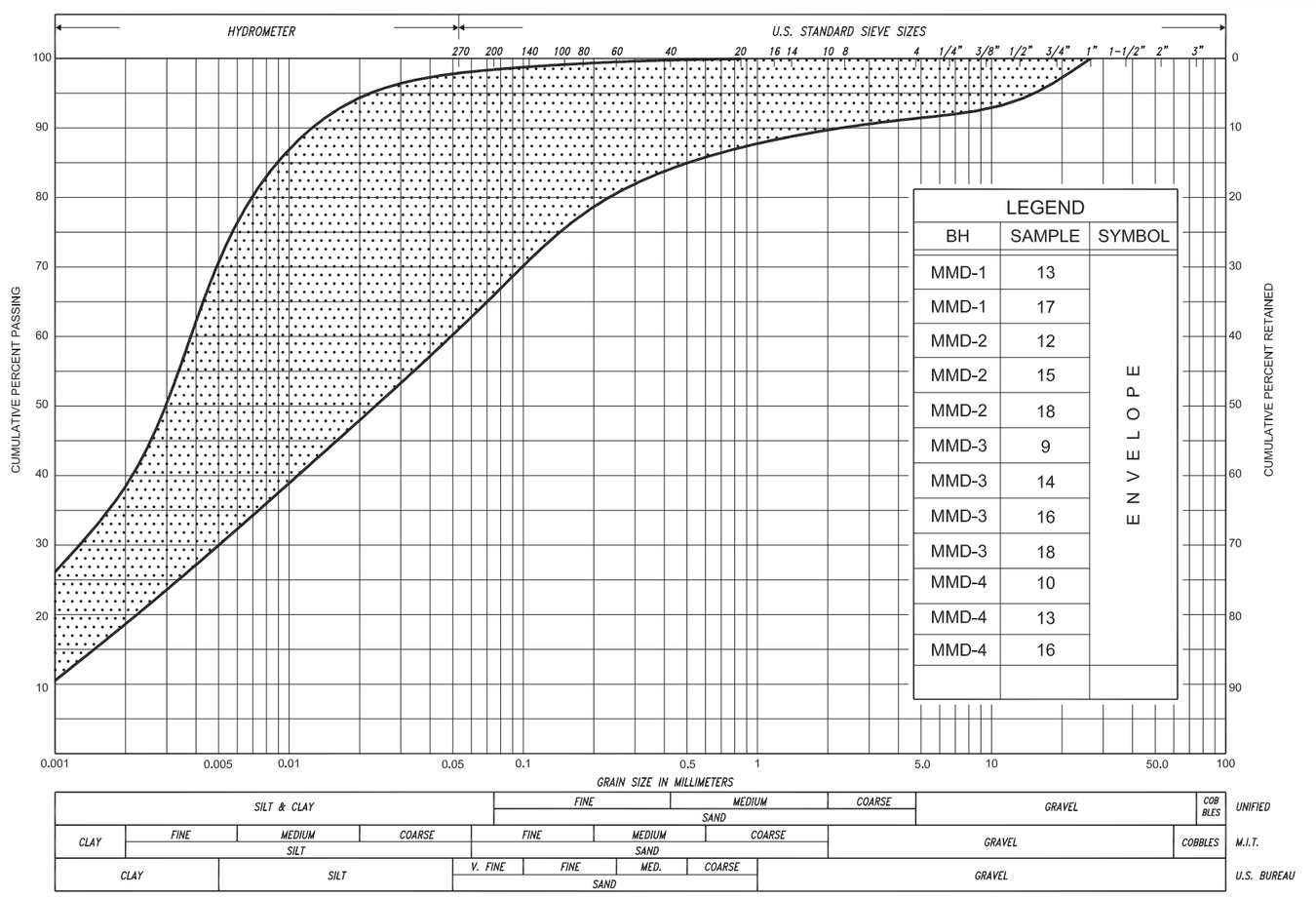


Ontario

GRAIN SIZE DISTRIBUTION

SILT and SAND (TILL)

FIG No.	H-3
HWY:	427
G.W.P. No.	

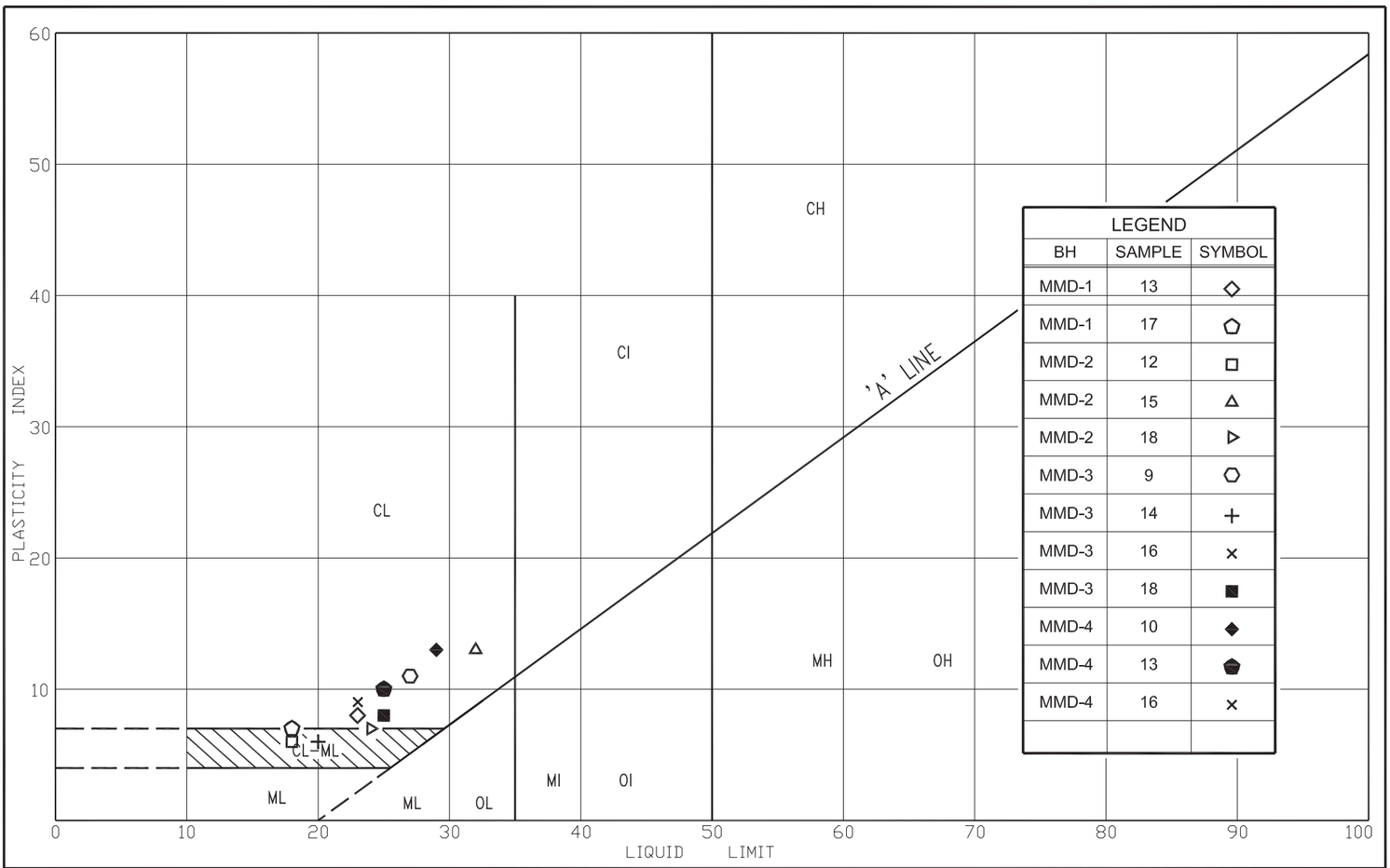


Ontario

GRAIN SIZE DISTRIBUTION

(SANDY) CLAYEY SILT (TILL)

FIG No.	H-4
HWY:	427
G.W.P. No.	

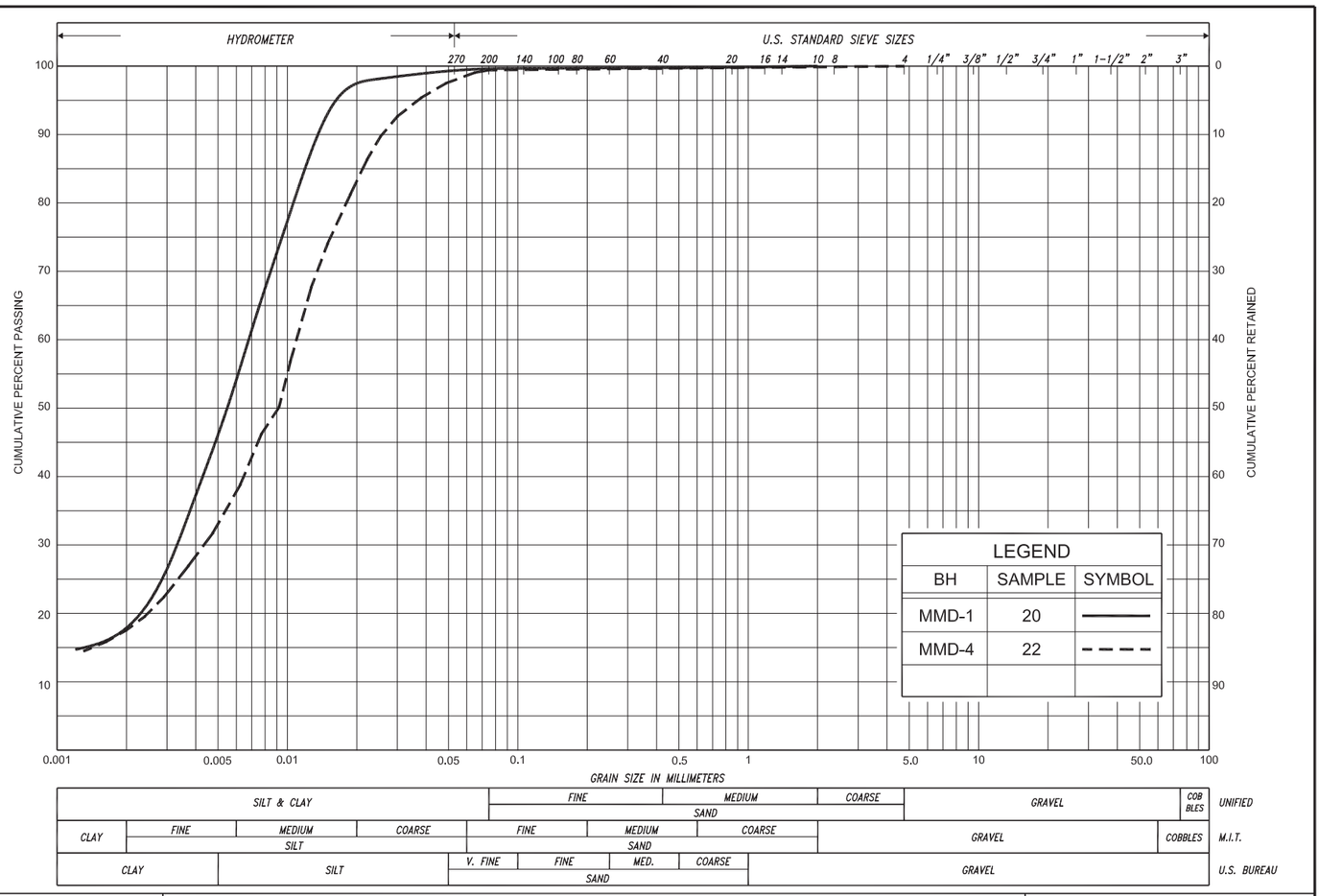


Ontario

PLASTICITY CHART

CLAYEY SILT (TILL)

FIG No.	H-5
HWY:	427
G.W.P. No.	

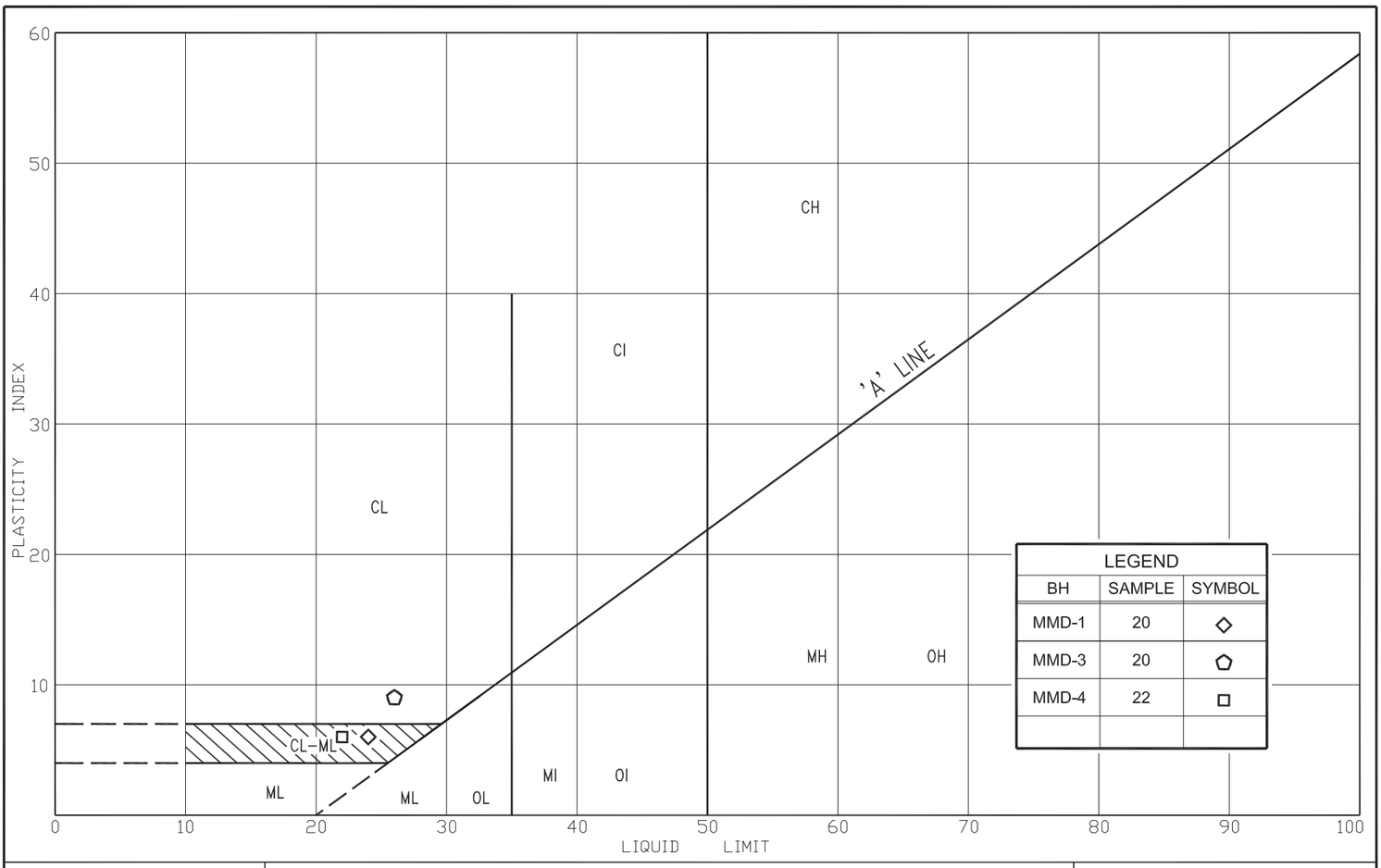


Ontario

GRAIN SIZE DISTRIBUTION

CLAYEY SILT - Lower

FIG No.	H-6
HWY:	427
G.W.P. No.	



Ontario

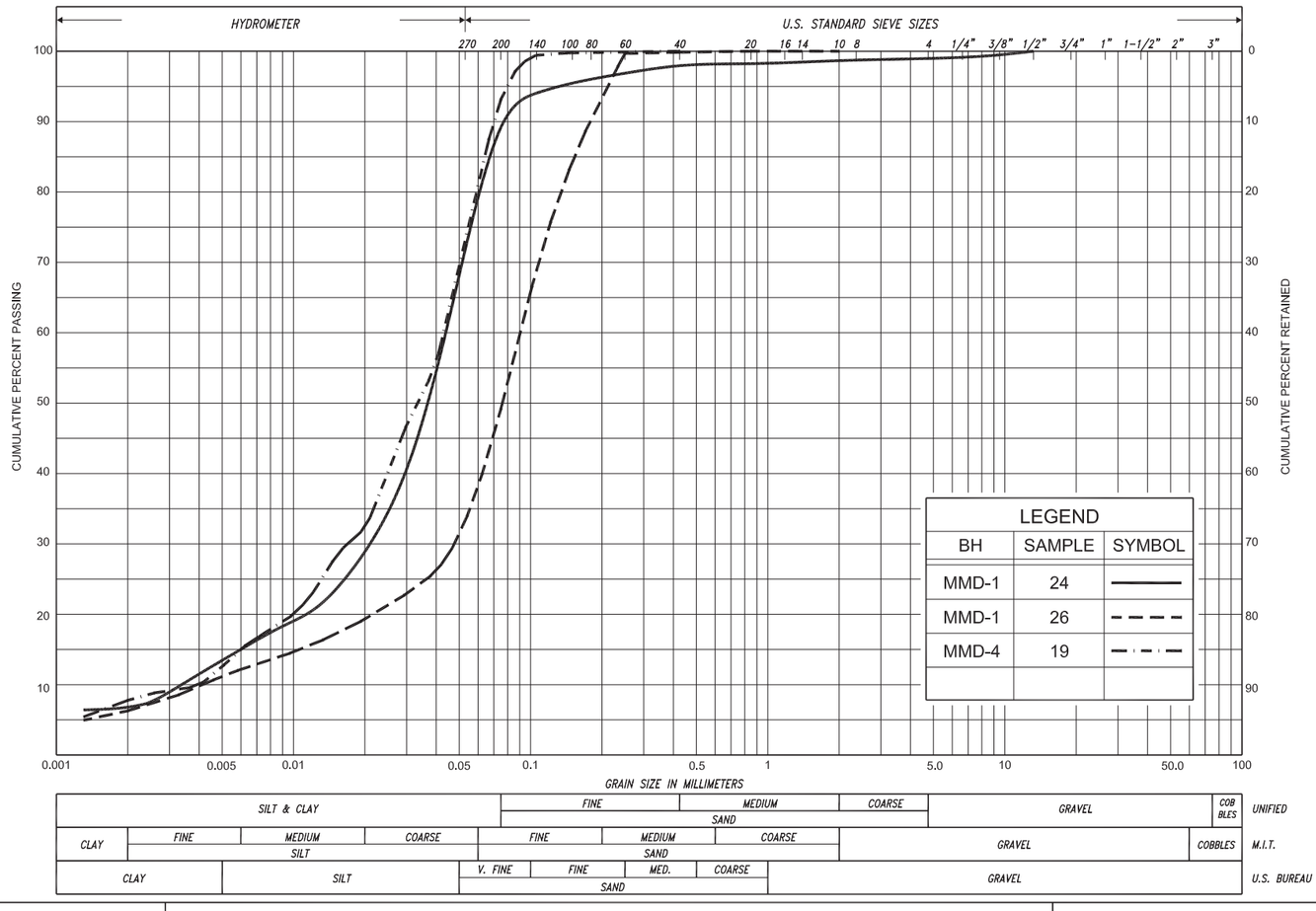
PLASTICITY CHART

CLAYEY SILT - Lower

FIG No. H-7

HWY: 427

G.W.P. No.



Ontario

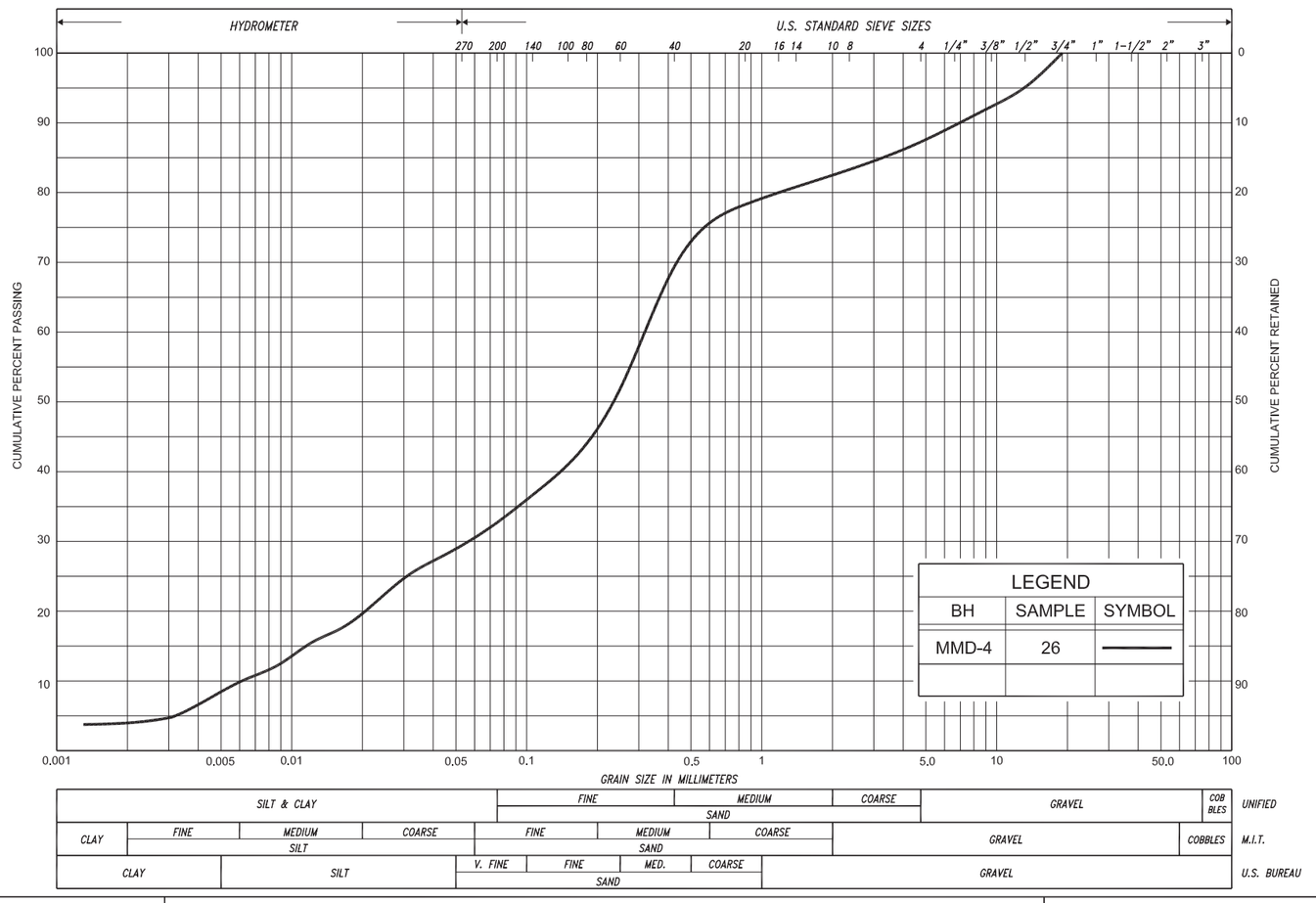
GRAIN SIZE DISTRIBUTION

SILT to SILT and SAND

FIG No. H-8

HWY: 427

G.W.P. No.



Ontario

GRAIN SIZE DISTRIBUTION

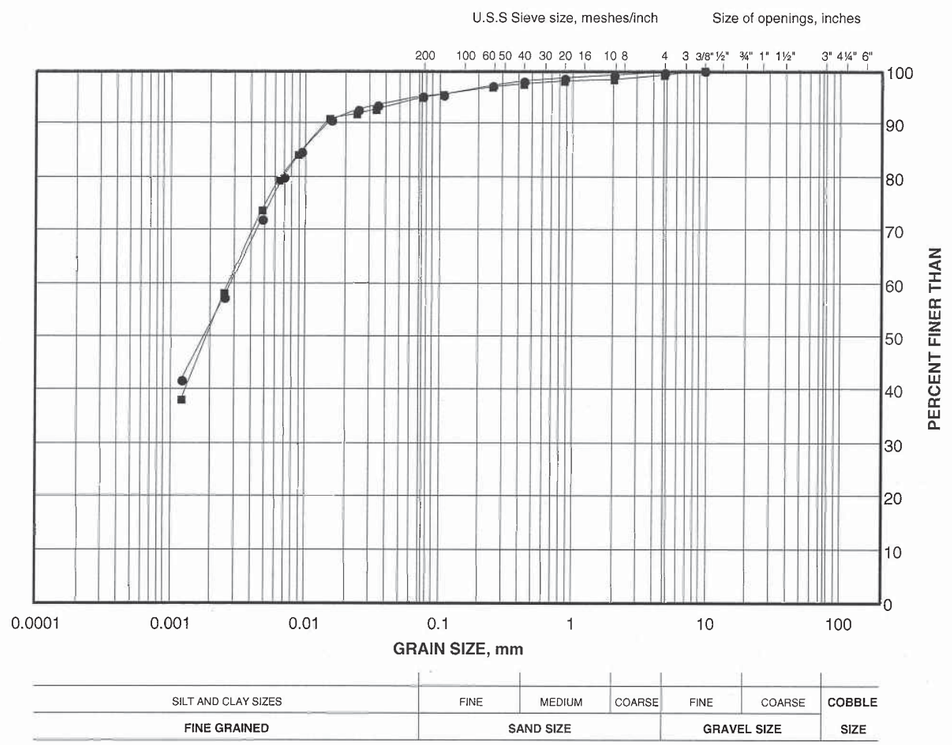
SAND and GRAVEL

FIG No.	H-9
HWY:	427
G.W.P. No.	

GRAIN SIZE DISTRIBUTION TEST RESULTS

Silty Clay Till

FIGURE E1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	E24	7	198.9
■	S36	7	198.8

Project Number: 06-1111-012-11

Checked By: SNL

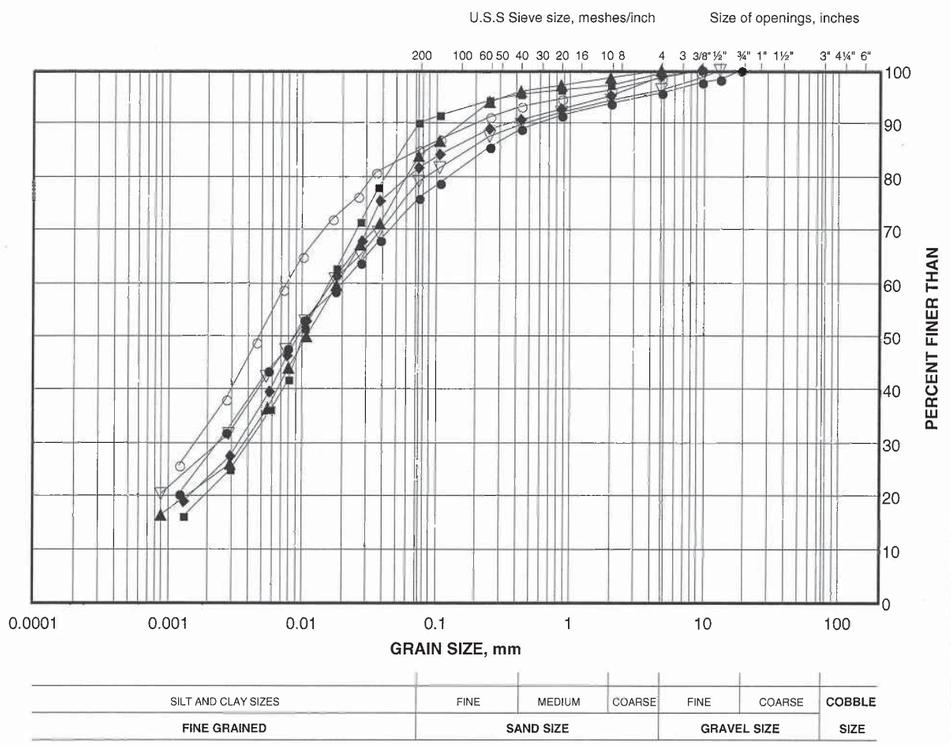
Golder Associates

Date: 21-Jul-09

GRAIN SIZE DISTRIBUTION

Clayey Silt Till

FIGURE E2-A



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	E27	10	194.4
■	E26	11	191.8
◆	S36	12	191.2
▲	S26	12	190.5
▽	E21	4	199.6
❍	S36	8	197.3

Project Number: 06-1111-012-11

Checked By: SNL

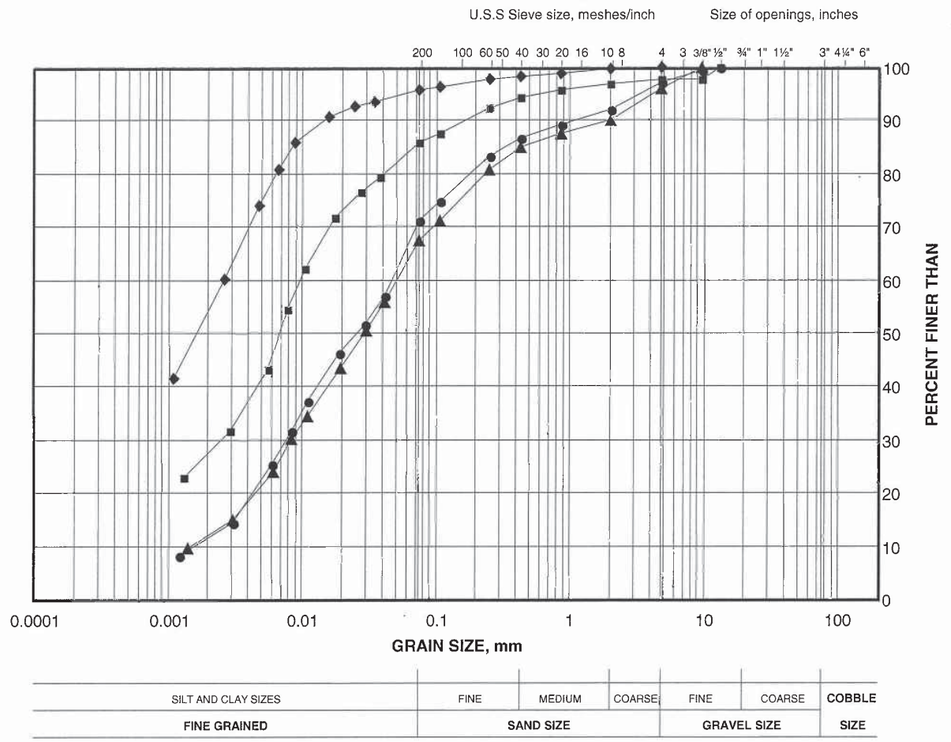
Golder Associates

Date: 22-Jul-09

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt Till

FIGURE E2-B



LEGEND

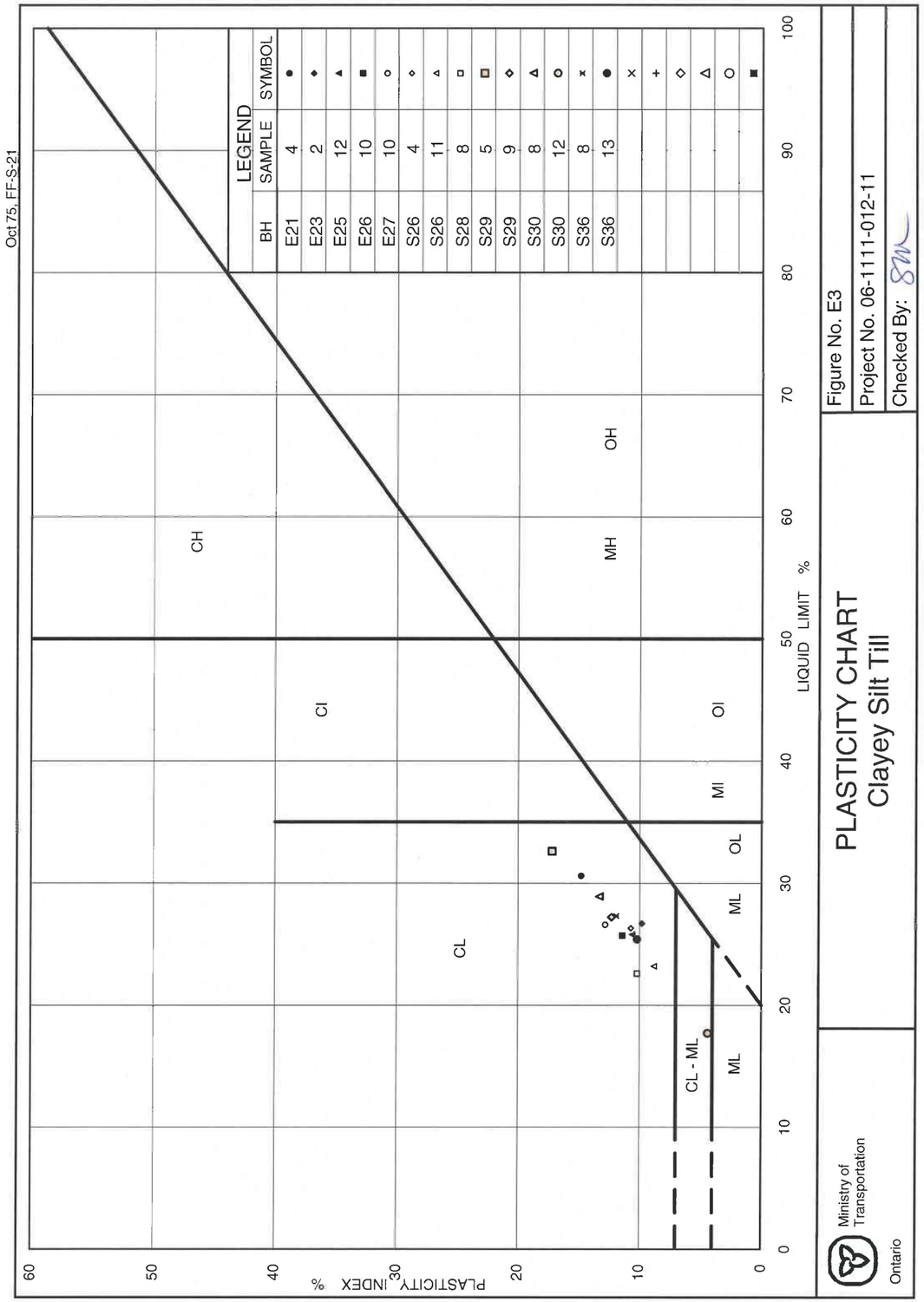
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S30	12	189.8
■	S28	13	183.8
◆	S29	7	197.1
▲	S28	9	189.8

Project Number: 06-1111-012-11

Checked By: SM

Golder Associates

Date: 16-Jul-09



PLASTICITY CHART

Clayey Silt Till

Figure No. E3

Project No. 06-1111-012-11

Checked By: SM

Ministry of Transportation Ontario

OEDOMETER CONSOLIDATION SUMMARY

Silty Clay Till

FIGURE 4

(Sheet 1 of 4)

SAMPLE IDENTIFICATION

Project Number	06-1111-012-11	Sample Number	7
Borehole Number	S36	Sample Depth, m	6.1-6.7

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	3		
Date Started	03/27/2009		
Date Completed	04/10/2009		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.54	Unit Weight, kN/m^3	20.23
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m^3	16.33
Area, cm^2	31.62	Specific Gravity, measured	2.77
Volume, cm^3	80.28	Solids Height, cm	1.526
Water Content, %	23.94	Volume of Solids, cm^3	48.25
Wet Mass, g	165.65	Volume of Voids, cm^3	32.03
Dry Mass, g	133.65	Degree of Saturation, %	99.9

TEST COMPUTATIONS

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t_{90} sec	cv. cm^2/s	mv m^2/kN	k cm/s
0.00	2.539	0.664	2.539				
4.70	2.529	0.657	2.534	1	1.36E+00	8.38E-04	1.12E-04
9.55	2.515	0.648	2.522	2	6.74E-01	1.18E-03	7.78E-05
19.44	2.514	0.647	2.514	12	1.12E-01	3.98E-05	4.36E-07
38.70	2.508	0.644	2.511	9	1.48E-01	1.15E-04	1.67E-06
77.55	2.495	0.635	2.501	9	1.47E-01	1.31E-04	1.89E-06
154.93	2.476	0.623	2.485	8	1.64E-01	9.72E-05	1.56E-06
309.49	2.448	0.604	2.462	8	1.61E-01	7.21E-05	1.13E-06
619.14	2.403	0.575	2.425	23	5.42E-02	5.70E-05	3.03E-07
1239.29	2.323	0.522	2.363	60	1.97E-02	5.09E-05	9.85E-08
2500.36	2.229	0.460	2.276	29	3.79E-02	2.94E-05	1.09E-07
1239.29	2.237	0.466	2.233				
309.49	2.294	0.503	2.265				
77.50	2.352	0.541	2.323				
19.44	2.403	0.575	2.378				
4.76	2.436	0.597	2.420				

Note:
k calculated using cv based on t_{90} values.

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

Sample Height, cm	2.44	Unit Weight, kN/m^3	21.02
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m^3	17.01
Area, cm^2	31.62	Specific Gravity, measured	2.77
Volume, cm^3	77.04	Solids Height, cm	1.526
Water Content, %	23.55	Volume of Solids, cm^3	48.25
Wet Mass, g	165.13	Volume of Voids, cm^3	28.79
Dry Mass, g	133.65		

Prepared By: LH

Golder Associates

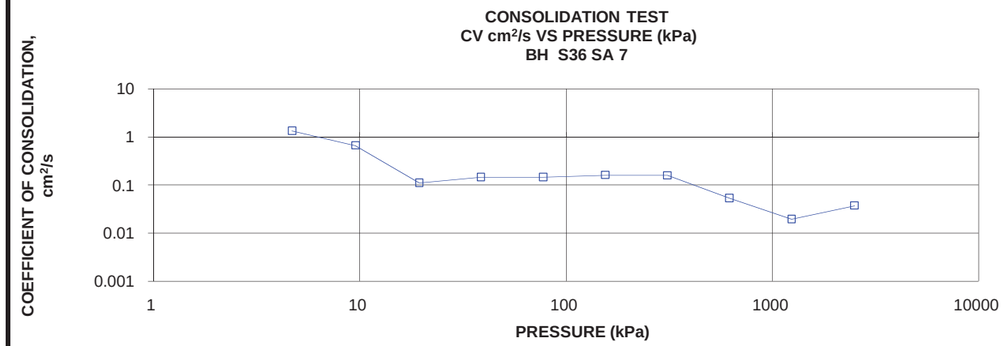
Checked By: MM

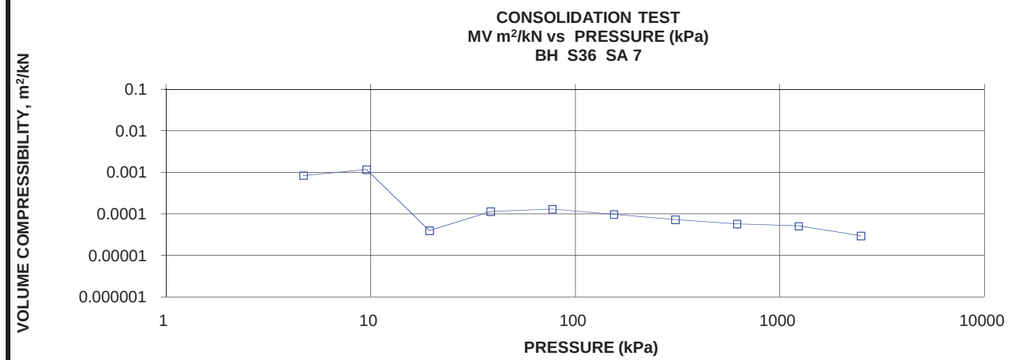
OEDOMETER CONSOLIDATION SUMMARY

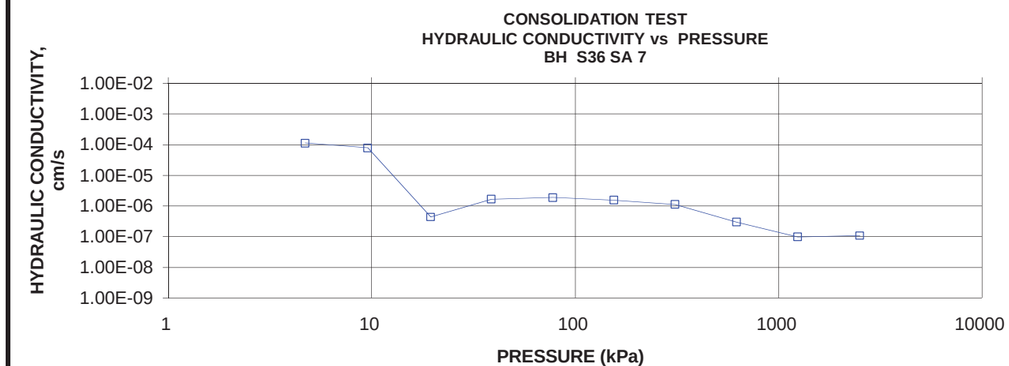
Silty Clay Till

FIGURE 4

(Sheet 2 of 4)







Project No. 06-1111-012-11

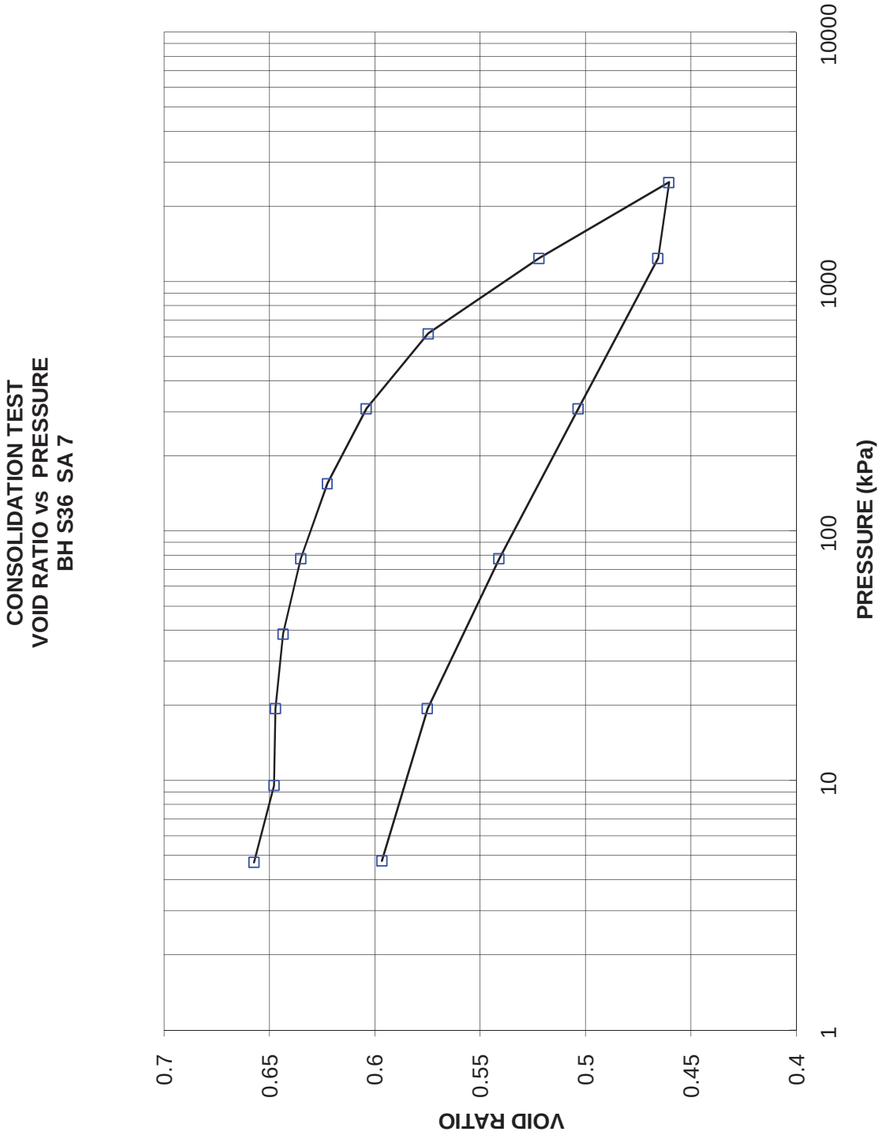
Prepared By: LH

Golder Associates

Checked By: MM

CONSOLIDATION TEST
VOID RATIO VS. LOG PRESSURE
Silty Clay Till

FIGURE 4
(Sheet 3 of 4)



Project No. 06-1111-012 -11

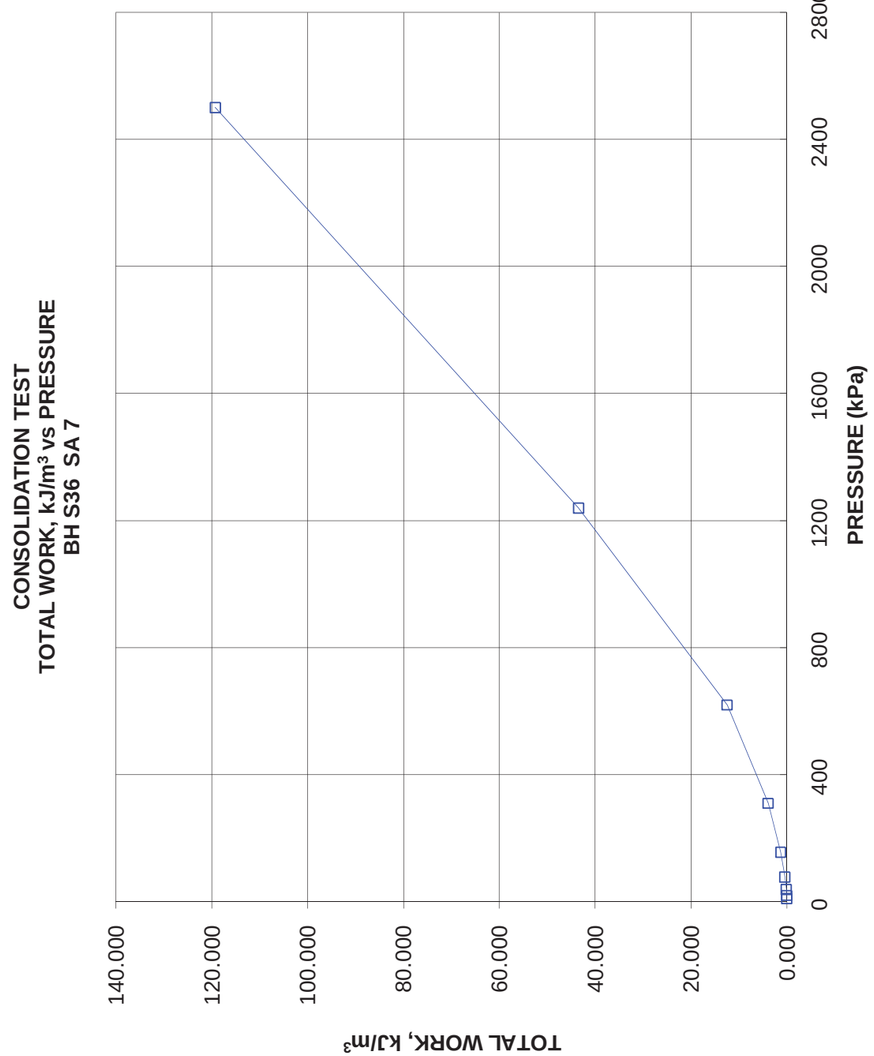
Prepared By: LH

Golder Associates

Checked By: MM

CONSOLIDATION TEST
TOTAL WORK VS. PRESSURE
Silty Clay Till

FIGURE 4
(Sheet 4 of 4)



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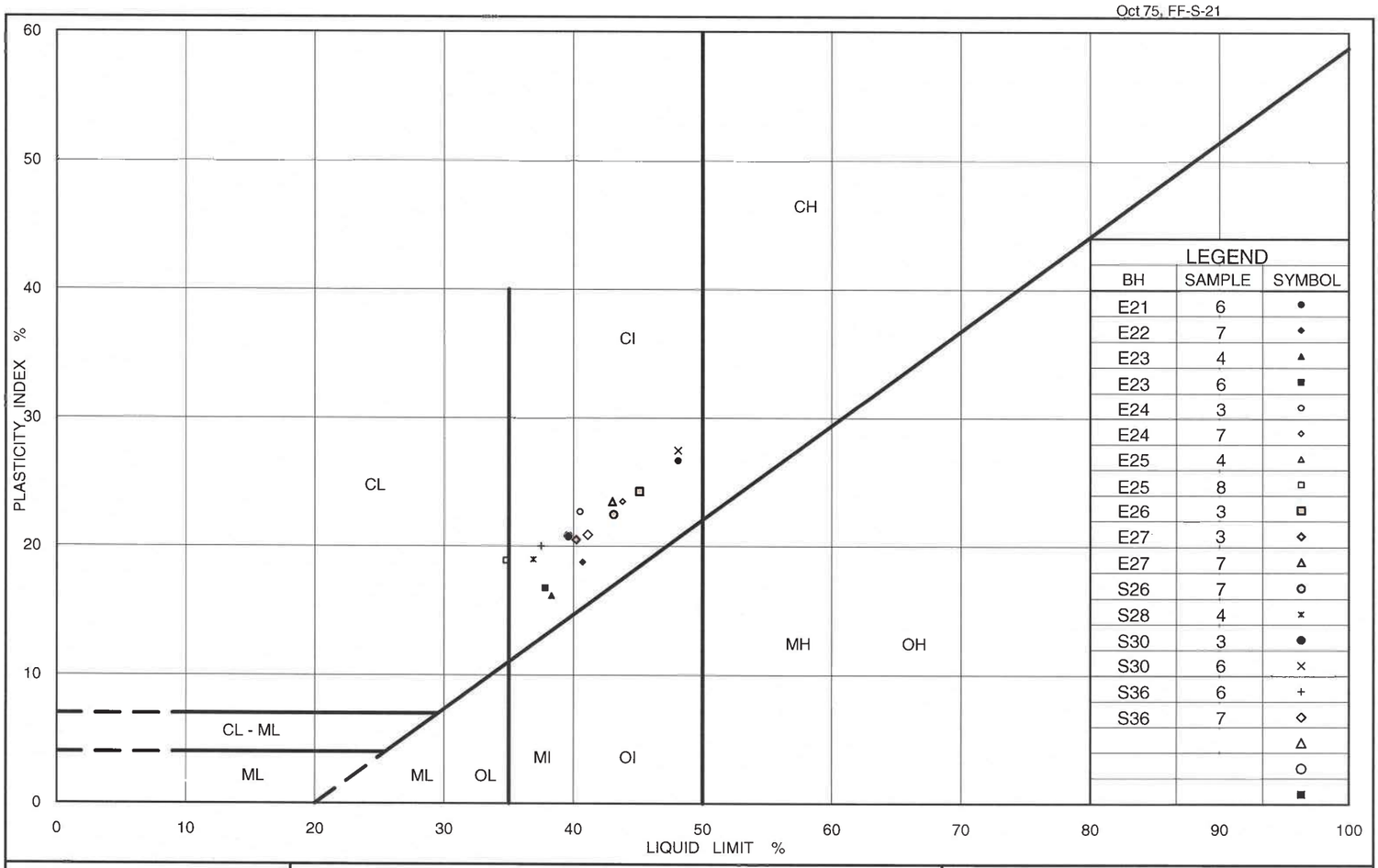
Golder Associates

Checked By: MM

Oct 75, FF-S-21



Ministry of Transportation
Ontario

PLASTICITY CHART
Silty Clay Till

Figure No. E5

Project No. 06-1111-012-11

Checked By: SM