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REPORT ON

FOUNDATION INVESTIGATION AND DESIGN PROPOSED HIGH FILL EMBANKMENTS COUNTY ROAD 17 INTERCHANGE HIGHWAY 7 TWINNING FROM 2.5 KM WEST OF ASHTON STATION ROAD TO CARLETON PLACE W.P. 252-99-00

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PART A

FOUNDATION INVESTIGATION
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COUNTY ROAD 17 INTERCHANGE
HIGHWAY 7 TWINNING FROM 2.5 KM WEST
OF ASHTON STATION ROAD TO CARLETON PLACE
W.P. 252-99-00

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by McCormick Rankin Corporation on behalf of the Ministry of Transportation, Ontario (MTO) to carry out a foundation investigation associated with the twinning of Highway 7 from two to four lanes in former West Carleton Township which is now part of the City of Ottawa and in Beckwith Township in Lanark County. The section of Highway 7 included in this assignment (W.P. 252-99-00) extends from 2.5 km west of Ashton Station Road to Carleton Place.

Foundation investigation services are required for the following components:

- Two new structural culverts at Lavallee Creek and the Willows Municipal Drain; and,
- High fill embankments for the new County Road 17 interchange.

This report addresses the high fill embankments.

The terms of reference for the original scope of work are outlined in the MTO's Request for Proposal (RFP) dated October 2005. The work was carried out in accordance with Golder's Quality Control Plan dated February 2006.

2.0 SITE DESCRIPTION

The proposed County Road 17 interchange is located about 3.5 kilometres (km) east of Carleton Place in Beckwith Township, in Lanark County. North of Highway 7, County Road 17 is called Appleton Side Road, while south of Highway 7, County Road 17 is called Cemetery Side Road.

The terrain in the vicinity of the site is relatively flat, with the natural ground surface varying from about Elevation 129 metres (m) to 130 m, generally declining slightly toward the north.

The proposed site of the interchange is located about 30 m to 50 m east of the current intersection of County Road 17 and Highway 7 removing the existing "S"-curve in the alignment of Cemetery Side Road, immediately south of Highway 7. An existing commuter parking lot lies on the south side of Highway 7, in-line with Cemetery Side Road, and the existing "S"-curve runs along the west side of that facility.

The interchange will consist of five ramps and two approach embankments with heights of up to about 10 m. The following table summarizes the approximate locations of the high fill embankments:

Fill Area	Station
County Road 17 – North Approach	Station 9+730 to 9+960
County Road 17 – South Approach	Station 10+035 to 10+200
Ramp E-N/S	Station 17+370 to 17+480
Ramp N-E	Station 16+960 to 17+127
Ramp S-E	Station 17+365 to 17+525
Ramp S-W	Station 17+735 to 17+900
Ramp W-N/S	Station 17+435 to 17+510

The existing lanes of Highway 7 will be maintained and will form the new westbound lanes.

3.0 INVESTIGATION PROCEDURES

Subsurface investigations were carried out at the proposed high fill embankment locations in September 2006 and March 2007. At these times, 23 boreholes were advanced at the locations shown on Drawings 1 to 5.

The boreholes were advanced using 108 mm inside diameter (I.D.) continuous flight hollow stem augers on a track-mounted drill rig, supplied and operated by Marathon Drilling Ltd. of Ottawa, Ontario. The boreholes were advanced to auger refusal at depths ranging from 3.8 to 7.0 m below the existing ground surface.

Soil samples were obtained at intervals ranging from 0.75 m to 1.5 m of depth, using a 50 mm outer diameter (O.D.) split-spoon sampler in accordance with Standard Penetration Test (SPT) procedures. In-situ vane testing (N vane) was carried out within the cohesive deposits where possible. Relatively undisturbed, 75-millimetre diameter thin-walled Shelby tube (ASTM D1587) samples of the silty clay were retrieved using a fixed piston sampler.

All of the boreholes were advanced until auger refusal was encountered.

Standpipe piezometers were installed in boreholes 06-203, 06-207, 06-303, and 06-402 to monitor the groundwater levels at the site. The standpipes consist of 50 mm diameter rigid PVC pipe with a 0.7 m long slotted screen section, installed within silica sand backfill and sealed by bentonite pellet backfill. The water levels in the standpipe piezometers were measured on October 16, 2006, some 3 weeks after installation.

The boreholes were backfilled with bentonite pellets, mixed with native soils, and the site conditions restored following completion of work. The standpipe piezometers will be decommissioned, unless instructed otherwise by the Ministry.

The field work was supervised throughout by members of our engineering and technical staff, who located the boreholes, supervised the drilling, sampling and in-situ testing operations, logged the boreholes, and examined and cared for the soil samples. The soil samples were identified in the field, placed in labelled containers and transported to Golder's laboratories in Ottawa and Mississauga for further examination and laboratory testing. Index and classification tests consisting of water content determinations, Atterberg limits testing and grain size distribution analyses were carried out on selected soil samples at the Ottawa laboratory. Laboratory oedometer consolidation testing was carried out on two samples of the silty clay deposit from Boreholes 06-207 and 06-303, at the Mississauga laboratory.

The borehole locations were determined by Golder relative to existing site features. The borehole elevations were determined by MRC from a digital terrain model based on the locations provided

by Golder. The borehole locations, including MTM NAD83 northing and easting coordinates and ground surface elevations referenced to geodetic datum are summarized in the following table and are shown on Drawings 1 to 5.

Borehole No.	Borehole Location	MTM NAD83 Northing (m)	MTM NAD83 Easting (m)	Ground Surface Elevation (m)
06-201	County Road 17	5001075.1	337105.1	130.0
06-202	County Road 17	5001110.2	337074.8	130.0
06-203	County Road 17	5001143.8	337045.9	129.4
06-204	County Road 17	5001172.4	337017.4	130.4
06-205	County Road 17	5001285.3	336890.5	129.4
06-206	County Road 17	5001319.3	336853.9	129.1
06-207	County Road 17	5001339.8	336830.6	129.1
06-208	County Road 17	5001367.5	336802.4	129.0
07-209	County Road 17	5001415.9	336748.0	128.3
06-301	Ramp S-E	5001067.3	337144.0	129.8
06-302	Ramp S-E	5001094.1	337121.9	129.7
06-303	Ramp S-E	5001120.2	337107.7	129.4
06-304	Ramp S-E	5001154.1	337098.7	129.4
06-305	Ramp S-E	5001189.0	337096.1	129.7
06-306	Ramp S-E	5001213.9	337098.2	129.8
06-401	Ramp S-W	5001217.8	336913.7	129.7
06-402	Ramp S-W	5001303.5	336883.5	129.1
06-403	Ramp S-W	5001350.1	336869.2	128.7
07-404	Ramp S-W	5001411.2	336873.9	128.7
06-501	Ramp E-N/S	5001350.9	336824.2	129.2
06-502	Ramp E-N/S	5001380.4	336851.7	129.1
07-503	Ramp E-N/S	5001425.3	336859.7	128.9
06-601	Ramp N-E	5001154.4	337011.9	129.5

4.0 SITE GEOLOGY AND STRATIGRAPHY

4.1 Regional Geological Conditions

The study area for this assignment lies within the Smith Falls Limestone Plain, as delineated in *The Physiography of Southern Ontario*[1] that lies within the major physiographic region of the Ottawa-St. Lawrence Lowland.

The Smiths Falls Limestone Plain is characterized by shallow overburden deposits overlying sedimentary bedrock consisting of limestones, dolostones, sandstones and shales. The shallow overburden soils are typically between 1 m and 3 m in thickness and are commonly comprised of sandy to gravelly till derived from the Precambrian Shield to the north, overlain by glaciofluvial sediments that consist of layered sands and gravels. In the vicinity of and north of Carleton Place, clay has been deposited within depressions in the bedrock that have been caused by faulting. Large areas of the plain are covered with peat and muck, due to poor drainage as a consequence of the relatively flat topography and shallow depth to bedrock.[1]

4.2 Site Stratigraphy

The detailed subsurface soil and groundwater conditions as encountered in the boreholes advanced during this investigation, together with the results of the laboratory tests carried out on selected soil samples, are given on the attached Record of Borehole sheets. The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations.

In general, the subsurface conditions consist of up to about 1.6 m of fill material and/or up to 0.4 m of topsoil overlying up to 1.4 m of clayey silt. The clayey silt is underlain by a deposit of silty clay which is between 1.4 m and 4.9 m in thickness. The top portion or the complete deposit has been weathered to a grey brown colour and a very stiff consistency. The bottom portion of the silty clay is grey in colour and very stiff to stiff in consistency. The silty clay deposit is underlain by a thin sandy silt and silty sand till deposit, which was proven to depths of 4.7 m and 7.0 m below original ground surface level, where auger refusal was encountered.

A more detailed description of the subsurface conditions encountered in the boreholes put down at each high fill location is provided in the following sections, and stratigraphic profiles along the approach embankments and ramps are shown on Drawings 1 to 5.

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

4.2.1 County Road 17, Station 9+730 to 10+200

The borehole locations and ground surface elevations for Boreholes 06-201 to 06-208, inclusive, and Borehole 07-209 as well as the soil stratigraphy section projected along the County Road 17 high fill embankment are shown on Drawings 1 and 2.

4.2.1.1 Fill Material, Topsoil and Pavement Structure

Fill materials were encountered at ground surface at Boreholes 06-201, 06-202 and 06-203 (located along Cemetery Side Road, south of the commuter parking lot), with a thickness between about 0.5 m and 1.1 m. The fill materials consist of sand and gravel, crushed stone, and/or silty clay with traces of organic matter.

Borehole 06-204 was drilled through the pavement structure in the commuter parking lot, which consists of about 100 mm of asphalt overlying 0.5 m of crushed stone granular base and about 1 m of sandy silt fill material.

Topsoil was encountered at ground surface at the remaining boreholes, with a thickness that ranges from 0.2 m and 0.4 m. The topsoil layer at Borehole 06-205 is underlain by a 1 m thick deposit clayey silt fill material with some organic matter.

A buried topsoil layer was encountered beneath the fill materials at Boreholes 06-201, 06-202 and 06-203, with a thickness between about 0.2 m and 0.3 m.

4.2.1.2 Clayey Silt and Silty Sand

The fill materials, topsoil, and pavement structure, where present, are generally underlain by a deposit of clayey silt. The clayey silt ranges in thickness from approximately 0.3 m to 0.8 m.

The results of grain size distribution testing of one sample of the clayey silt from Borehole 06-201 are provided on Figure 1. The measured natural water content of one sample of the clayey silt is 21 percent.

The clayey silt contains numerous sand layers and Borehole 07-209, over the same stratigraphic depth interval immediately below the topsoil, encountered a layer of silty fine sand.

The measured SPT "N" values in this deposit ranged from 3 to 7 blows per 0.3 m of penetration, indicating a very stiff consistency.

4.2.1.3 Silty Clay to Clay

The thin surficial clayey silt deposit is underlain by a relatively thicker deposit of silty clay to clay. The silty clay deposit was fully penetrated in all of the boreholes to depths between about 4.5 m and 6.3 m below the existing ground surface level.

The upper portion of this deposit has been weathered to a grey brown crust and extends to depths between about 2.2 m and 4.6 m below the existing ground surface. The measured SPT "N" values within the weathered silty clay ranged from 5 to 18 blows per 0.3 m of penetration indicating a very stiff consistency.

The results of grain size distribution testing of two samples of the weathered silty clay to clay crust are provided on Figure 2.

The results of Atterberg limit testing on several samples of the weathered silty clay indicate a plasticity index of between 21 and 28 percent and a liquid limit of between 48 and 55 percent, as shown on Figure 3 (along with test results for boreholes along the ramps) indicating a weathered silty clay to clay of intermediate to high plasticity. The measured natural water content of the weathered crust ranges from 37 to 43 percent.

The unweathered silty clay below the depth of weathering is grey in colour. The measured SPT "N" values within the unweathered silty clay ranged between 4 and 12 blows per 0.3 m of penetration. In situ vane testing in this material measured undrained shear strengths of greater than 96 kilopascals. These results indicate a very stiff consistency for the unweathered silty clay. The results of grain size distribution testing on one sample of the weathered silty clay from Borehole 06-201 are provided on Figure 4.

The results of Atterberg limit testing on five samples of the unweathered silty clay indicate a plasticity index which varies from 23 to 29 percent and a liquid limit which varies from 44 to 51 percent, as shown on Figure 5, indicating a silty clay to clay of intermediate to high plasticity. The measured natural water content of the silty clay ranges from 33 to 39 percent.

Oedometer consolidation testing was carried out on one thin-walled Shelby tube sample of the silty clay to clay obtained just below the depth of weathering. The results of that testing, which are provided on Figure 6 and summarized in the table below, indicate that this material is overconsolidated, with a preconsolidation pressure about 800 kPa and an overconsolidation ratio of approximately 20 in the upper portion of the unweathered material.

Borehole/ Sample Number	Sample Depth/Elev. (m)	Unit Weight (kN/m^3)	σ_P' (kPa)	σ_{VO}' (kPa)	$\sigma_P' - \sigma_{vo}'$ (kPa)	Cc	Cr	e_o	OCR	Cv (cm^2/s)
06-207 / 5	3.7 - 4.1/ 125.4 - 125.0	18.8	800	40	760	0.31	0.007	0.924	20	0.07

Notes:

σ_P' - Apparent preconsolidation pressure
σ_{VO}' - Computed existing vertical effective stress
Cc - Compression index
Cr - Recompression index
e_o - Initial void ratio
OCR - Overconsolidation ratio
Cv - Coefficient of consolidation

4.2.1.4 Sandy Silt and Silty Sand Till

The silty clay is underlain by a deposit of sandy silt and silty sand till. The till deposit was proven to depths between 5.0 m and 6.7 m, below the existing ground surface (Elevation 122.7 m to 124.5 m) at the borehole locations. The till is considered to be a heterogeneous mixture of gravel, cobbles, and boulders in a matrix of sandy silt and silty sand with a trace to some clay. The results of grain size distribution testing on two samples of the till from boreholes 06-201 and 06-206 are provided on Figure 8. However, these samples were retrieved using a 50 mm diameter sampler and therefore do not reflect the cobble and boulder portions of the deposit.

The deposits was only penetrated for a thickness of about 0.1 to 0.9 m before encountering auger refusal. Standard penetration testing could not therefore be effectively carried out.

The measured natural water content of one sample of the glacial till is 8 percent.

4.2.1.5 Auger Refusal

Practical refusal to augering was encountered at all the boreholes. The depth to auger refusal and auger refusal elevations are summarized in the following table:

Borehole Number	Ground Surface Elevation (m)	Depth to Auger Refusal (m)	Auger Refusal Elevation (m)
06-201	130.0	5.9	124.1
06-202	130.0	6.1	123.9
06-203	129.4	5.1	124.3
06-204	130.4	5.9	124.5
06-205	129.4	6.7	122.7
06-206	129.1	6.4	122.7
06-207	129.1	5.9	123.2
06-208	129.0	5.0	124.0
07-209	128.3	6.5	121.8

4.2.1.6 Groundwater Conditions

The groundwater level in the piezometer in Boreholes 06-203 and 06-207 were measured on October 16, 2006. The piezometer was sealed into the silty clay and till deposit.

The groundwater levels in the piezometers are summarized in the table below:

Borehole	Ground Surface Elevation (m)	Water Level Depth (m)	Water Level Elevation (m)	Date
06-203	129.4	0.46	128.9	October 16, 2006
06-207	129.1	0.63	128.5	October 16, 2006

Upon completion of the drilling, the groundwater levels in boreholes 06-201 and 06-208 were between 1.1 and 2.4 m below the existing ground surface, during the short time they remained open prior to backfilling.

It should be noted that groundwater levels in the area are subject to fluctuations both seasonally and with precipitation events.

4.2.2 Ramp S-E, Station 17+365 to 17+525

The borehole locations and ground surface elevations for Boreholes 06-301 to 06-306, inclusive, as well as the soil stratigraphy section projected along the high fill embankment for S-E Ramp are shown on Drawing 3.

4.2.2.1 Topsoil and Fill Material

Crushed stone fill material was encountered at ground surface at Borehole 06-302. This fill material has a thickness of about 0.2 m.

Topsoil was encountered at ground surface at all of the borehole locations and beneath the fill materials at Borehole 06-302. The topsoil layer varies in thickness from about 0.2 m and 0.4 m.

4.2.2.2 Clayey Silt

The topsoil is underlain by a deposit of clayey silt. The clayey silt ranges in thickness from approximately 0.7 m to 1.4 m. The measured SPT "N" values in this deposit ranged from 6 to 9 blows per 0.3 m of penetration, indicating a very stiff consistency.

The results of grain size distribution testing on one sample of the clayey silt from Borehole 06-306 are provided on Figure 1. The measured natural water content of one sample of the clayey silt is 16 percent.

4.2.2.3 Silty Clay to Clay

The clayey silt is underlain by silty clay to clay, which was fully penetrated in all of the boreholes to depths between about 2.7 m and 5.0 m below the existing ground surface level (about Elevation 123.1 m to 124.9 m). The deposit thins to the north.

The upper portion of this deposit has been weathered to a grey brown crust with the exception of Boreholes 06-305 and 06-306 where the deposit is thinnest and the full thickness has been weathered. The weathered silty clay extends to depths between about 2.7 m and 3.1 m below the existing ground surface. The measured SPT "N" values within the weathered silty clay ranged from 2 to 18 blows per 0.3 m of penetration indicating at stiff to very stiff consistency.

The results of Atterberg limit testing on two samples of the weathered silty clay indicate a plasticity index of 22 and 25 percent and a liquid limit of 50 and 52 percent, as shown on Figure 3, indicating a weathered silty clay to clay of intermediate to high plasticity. The measured natural water content of the weathered clay ranges from 32 to 36 percent.

The unweathered silty clay below the depth of weathering is grey in colour. This unweathered silty clay is not present at Boreholes 06-305 and 06-306. The measured SPT "N" values within the unweathered silty clay ranged between 5 and 8 blows per 0.3 m of penetration. In situ vane testing in this material measured undrained shear strengths of greater than 96 kilopascals. These results indicate a very stiff consistency for the unweathered silty clay. The results of grain size distribution testing of one sample of the silty clay from Borehole 06-303 are provided on Figure 4.

The results of Atterberg limit testing on two samples of the unweathered silty clay indicate a plasticity index of 19 and 21 percent and a liquid limit of 37 and 38 percent, as shown on Figure 5, indicating a silty clay of intermediate plasticity. The measured natural water content of the silty clay ranges from 32 to 53 percent.

Oedometer consolidation testing was carried out on one thin-walled Shelby tube sample of the silty clay obtained just below the depth of weathering. The results of that testing, which are provided on Figure 7 and summarized in the table below, indicate that this material is overconsolidated, with a preconsolidation pressure about 650 kPa and an overconsolidation ratio of approximately 16 in the upper portion of the unweathered material.

Borehole/ Sample Number	Sample Depth/Elev. (m)	Unit Weight (kN/m^3)	σ_P' (kPa)	σ_{VO}' (kPa)	$\sigma_P' - \sigma_{vo}'$ (kPa)	Cc	Cr	e_o	OCR	Cv (cm^2/s)
06-303/5	3.7 - 4.1/ 125.7 - 125.3	18.6	650	40	610	0.34	0.007	0.912	16	0.16

Notes:

σ_P' - Apparent preconsolidation pressure
σ_{VO}' - Computed existing vertical effective stress
Cc - Compression index
Cr - Recompression index
e_o - Initial void ratio
OCR - Overconsolidation ratio
Cv - Coefficient of consolidation

4.2.2.4 Sandy Silt Till

The silty clay is underlain by a deposit of sandy silt till. The till deposit was proven to depths between 3.8 m and 5.2 m below the existing ground surface (Elevation 124.2 m to 126.0 m) at the borehole locations. The thickness of till that was penetrated ranges from about 0.2 to 1.9 m.

The till is considered to be a heterogeneous mixture of gravel, cobbles, and boulders in a matrix of sandy silt with some clay. The results of grain size distribution testing on one sample of the till from Borehole 06-306 are provided on Figure 8. However, these samples were retrieved using a 50 mm diameter sampler and therefore do not reflect the cobble and boulder portions of the deposit.

Standard penetration test N value range between 6 to greater than 50 blows per 0.3 metres of penetration indicates a loose to very dense state of packing, although the higher N values likely reflect the cobble and boulder content of the deposit, rather than the actual state of packing of the soil matrix.

The measured natural water content of one sample of the glacial till is 9 percent.

4.2.2.5 Auger Refusal

Practical refusal to augering was encountered at all the boreholes. The depth to auger refusal and auger refusal elevations are summarized in the following table:

Borehole Number	Ground Surface Elevation (m)	Depth to Auger Refusal (m)	Auger Refusal Elevation (m)
06-301	129.8	4.7	125.1
06-302	129.7	5.0	124.7
06-303	129.4	5.2	124.2
06-304	129.4	5.2	124.2
06-305	129.7	5.0	124.7
06-306	129.8	3.8	126.0

4.2.2.6 Groundwater Conditions

The groundwater level in the piezometer in Borehole 06-303 was measured on October 16, 2006. The piezometer was sealed into the silty clay deposit.

The groundwater level in the piezometer is summarized in the table below:

Borehole	Ground Surface Elevation (m)	Water Level Depth (m)	Water Level Elevation (m)	Date
06-303	129.4	0.77	128.6	October 16, 2006

Upon completion of drilling, the groundwater levels in boreholes 06-301, 06- 302, 06-305, and 06-306 were between 1.5 and 2.0 m below the existing ground surface, during the short time they remained open prior to backfilling.

It should be noted that groundwater levels in the area are subject to fluctuations both seasonally and with precipitation events.

4.2.3 Ramp S-W, Station 17+735 to 17+900

The borehole locations and ground surface elevations at Boreholes 06-401 to 06-403, inclusive, and Borehole 07-404, as well as the soil stratigraphy section projected along the high fill embankment for S-W Ramp are shown on Drawing 4.

4.2.3.1 Pavement Structure, Topsoil and Fill Material

Borehole 06-401 was drilled through the existing pavement structure along Appleton Side Road which consists of about 90 mm of asphalt overlying 0.2 m of crushed stone granular base and about 0.8 m of sand and gravel granular subbase.

Topsoil was encountered at ground surface at Boreholes 06-402, 06-403 and 07-404. The topsoil ranges in thickness between 0.2 m and 0.4 m.

The topsoil at Borehole 06-402 is underlain by fill material consisting of sandy silt with varying amounts of gravel, clay, peat, organic matter, cobbles and glass. The fill material is approximately 1.3 m thick.

4.2.3.2 Clayey Silt, Silty Sand, and Sandy Silt

The topsoil at Borehole 06-403 is underlain by a deposit of clayey silt with a thickness of about 0.2 m.

The fill material at Borehole 06-401 is underlain by a layered silty clay and clayey silt deposit that is approximately 0.7 m thick. The results of grain size distribution testing on one sample of the silty clay and clayey silt deposit from Borehole 06-401 are provided on Figure 1. The measured natural water content of the silty clay and clayey silt is 22 percent.

Borehole 07-404, over the same stratigraphic depth interval, encountered 0.5 m of silty sand and sandy silt.

4.2.3.3 Silty Clay to Clay

The topsoil, fill materials, and surficial clayey silt are underlain by silty clay. The silty clay deposit was fully penetrated in all of the boreholes to depths between about 5.1 m and 6.3 m below the existing ground surface level.

The upper portion of this deposit has been weathered to a grey brown crust which extends to depths between about 2.1 m and 3.6 m below the existing ground surface. The measured SPT "N" values within the weathered silty clay ranged from 5 to 16 blows per 0.3 m of penetration indicating a very stiff consistency.

The results of Atterberg limit testing on three samples of the weathered silty clay indicate a plasticity index between 17 and 28 percent and a liquid limit between 43 and 52 percent, as shown on Figure 3, indicating a weathered silty clay to clay of intermediate to high plasticity. The measured natural water content of the weathered crust ranges from 33 to 41 percent.

The unweathered silty clay below the depth of weathering is grey in colour. The measured SPT "N" values within the unweathered silty clay ranged between 3 and 10 blows per 0.3 m of penetration. In situ vane testing in this material measured undrained shear strengths of greater than 96 kilopascals. These results indicate a very stiff consistency for the unweathered silty clay.

The measured natural water content of one sample of the unweathered silty clay is 38 percent.

The bottom 1.3 m of the unweathered silty clay deposit at Borehole 07-404 grades into a layered silty clay and clayey silt. The results of Atterberg limit testing on one sample of the this deposit indicates a plasticity index of 25 percent and a liquid limit of 45 percent, as shown on Figure 5, indicating a unweathered silty clay of intermediate plasticity. The measured natural water content of one sample of the layered deposit is 33 percent.

4.2.3.4 Sandy Silt Till

The silty clay is underlain by a deposit of sandy silt till. The till deposit was proven to depths between 6.1 m and 7.0, below the existing ground surface. The deposit was penetrated for a thickness of 0.5 to 1.2 m. The till is considered to be a heterogeneous mixture of gravel, cobbles, and boulders in a matrix of sandy silt with trace to some clay

Standard penetration test N values ranging between 4 and 22 blows per 0.3 metres of penetration indicate a very loose to compact state of packing.

The measured natural water content of one sample of the sandy silt till deposit is 8 percent.

4.2.3.5 Auger Refusal

Practical refusal to augering was encountered at all the boreholes. The depth to auger refusal and auger refusal elevations are summarized in the following table:

Borehole Number	Ground Surface Elevation	Depth to Auger Refusal	Auger Refusal Elevation
06-401	129.7	6.8	122.9
06-402	129.1	7.0	122.1
06-403	128.7	6.1	122.6
07-404	128.7	6.6	122.1

4.2.3.6 Groundwater Conditions

The groundwater level in the piezometer in Borehole 06-402 was measured on October 16, 2006. The piezometer was sealed into the silty clay and till deposits.

The groundwater level in the piezometer is summarized in the table below:

Borehole	Ground Surface Elevation (m)	Water Level Depth (m)	Water Level Elevation (m)	Date
06-402	129.1	0.25	128.9	October 16, 2006

Upon completion of drilling, the groundwater level in borehole 06-401 was at about 1.3 m depth below the existing ground surface, during the short time it remained open prior to backfilling.

It should be noted that groundwater levels in the area are subject to fluctuations both seasonally and with precipitation events.

4.2.4 Ramp E-N/S, Station 17+370 to 17+480

The borehole locations and ground surface elevations at Boreholes 06-501, 06-502 and 07-503, as well as the soil stratigraphy section projected along the high fill embankment for E-N/S Ramp are shown on Drawing 5.

4.2.4.1 Topsoil and Fill Material

Topsoil was encountered at ground surface at both borehole locations with a thickness between 0.4 m and 0.6 m. A thin layer of silty sand with some gravel fill material was encountered within the topsoil layer at Borehole 06-501.

4.2.4.2 Clayey Silt

The topsoil is underlain by a 0.3 m to 0.9 m thick deposit of clayey silt. One measured SPT "N" value within the clayey silt was 7 blows per 0.3 m of penetration indicating a very stiff consistency. The clayey silt layer was not encountered at Borehole 07-503.

4.2.4.3 Silty Clay to Clay

The clayey silt is underlain by silty clay. The silty clay deposit was fully penetrated at all of the boreholes to depths between about 4.9 m and 5.2 m below the existing ground surface level.

The upper portion of this deposit has been weathered to a grey brown crust which extends to depths between about 2.7 m and 3.7 m below the existing ground surface. The measured SPT "N" values within the weathered silty clay ranged from 7 to 15 blows per 0.3 m of penetration indicating a very stiff consistency.

The results of Atterberg limit testing on one sample of the weathered silty clay from Borehole 06-502 indicate a plasticity index of 31 percent and a liquid limit of 52 percent, as shown on Figure 3, indicating a weathered clay of high plasticity. The measured natural water contents of two samples of the weathered crust are 35 percent.

The unweathered silty clay below the depth of weathering is grey in colour. Measured SPT "N" values within the unweathered silty clay ranged from 5 to 9 blows per 0.3 m of penetration. In situ vane testing in this material measured undrained shear strengths of greater than 96 kilopascals. These results indicate a very stiff consistency for the unweathered silty clay.

The results of Atterberg limit testing on one sample of the unweathered silty clay from Borehole 06-502 indicate a plasticity index of 29 percent and a liquid limit of 49 percent, as shown on Figure 5, indicating a silty clay of intermediate plasticity. The measured natural water content of one sample of the silty clay is 33 percent.

The bottom 0.5 m of the silty clay deposit at Borehole 07-503 grades into a layered silty clay and clayey silt.

4.2.4.4 Sandy Silt Till

The silty clay is underlain by a deposit of sandy silt till. The till deposit was proven to depths between 5.6 m and 6.1 m, below the existing ground surface. The till ranges from 0.7 to 1.0 m in thickness.

The till is considered to be a heterogeneous mixture of gravel, cobbles, and boulders in a matrix of sandy silt with trace to some clay. The results of grain size distribution testing of one sample of the till from borehole 06-502 are provided on Figure 8. However, this sample was retrieved using a 50 mm diameter sampler and therefore the results do not reflect the cobble and boulder portions of the deposit.

Standard penetration test N values between 22 and greater than 50 blows per 0.3 metres of penetration indicate a compact to very dense state of packing, though the higher N values likely reflect the cobble and boulder content of the deposit.

The measured natural water content of one sample of the glacial till is 8 percent.

4.2.4.5 Auger Refusal

Practical refusal to augering was encountered at both boreholes. The depth to auger refusal and auger refusal elevations are summarized in the following table:

Borehole Number	Ground Surface Elevation (m)	Depth to Auger Refusal (m)	Auger Refusal Elevation (m)
06-501	129.2	6.1	123.1
06-502	129.1	5.6	123.5
07-503	128.9	5.9	123.0

4.2.4.6 Groundwater Conditions

Upon completion of drilling, the groundwater level in borehole 06-501 was 1 m below the existing ground surface, during the short time it remained open prior to backfilling.

It should be noted that groundwater levels in the area are subject to fluctuations both seasonally and with precipitation events.

4.2.5 Ramp N-E, Station 16+960 to 17+127

The subsurface soil and groundwater conditions at Borehole 06-601 for the high fill embankment for the N-E Ramp are given on the attached Record of Borehole sheet. The borehole location is shown on Drawing1.

4.2.5.1 Fill Material

Fill material was encountered at ground surface at Borehole 06-601, with a thickness of about 0.6 m. The fill material consists of silty sand and gravel with some clay.

4.2.5.2 Clayey Silt

The fill material is underlain by a 0.5 m thick deposit of clayey silt.

4.2.5.3 Silty Clay to Clay

The clayey silt is underlain by silty clay. The silty clay deposit was fully penetrated to a depth of about 4.6 m below the existing ground surface level.

The upper portion of this deposit has been weathered to a grey brown crust which extends to a depth of 4.0 m below the existing ground surface. The measured SPT "N" values within the weathered silty clay ranged from 5 to 7 blows per 0.3 m of penetration indicating a very stiff consistency.

The results of Atterberg limit testing on two samples of the weathered silty clay indicate a plasticity index of 30 percent and a liquid limit of between 55 and 59 percent, as shown on Figure 3, indicating a weathered clay of high plasticity. The measured natural water content of the weathered crust ranges between 39 and 47 percent.

The unweathered silty clay below the depth of weathering is grey in colour. In situ vane testing in this material measured undrained shear strengths of greater than 96 kilopascals. These results indicate a very stiff consistency for the unweathered silty clay.

4.2.5.4 Sandy Silt Till

The silty clay is underlain by a deposit of sandy silt till. The till deposit was proven to a depth of 4.7 m, below the existing ground surface. The deposit was penetrated to a thickness of 0.1 m.

The till is considered to be a heterogeneous mixture of gravel, cobbles, and boulders in a matrix of sandy silt with some clay.

4.2.5.5 Auger Refusal

Practical refusal to augering was encountered in the borehole. The depth to auger refusal and auger refusal elevation is summarized in the following table:

Borehole Number	Ground Surface Elevation	Depth to Auger Refusal	Auger Refusal Elevation
06-601	129.5	4.7	124.8

5.0 CLOSURE

This report was prepared by Ms. Susan Trickey, EIT under the direction of the Project Manager, Mr. Michael Cunningham, P.Eng. This report was reviewed by Mr. Fintan J. Heffernan P.Eng., the designated MTO contact for this project.

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PART B

FOUNDATION DESIGN
PROPOSED HIGH FILL EMBANKMENTS
COUNTY ROAD 17 INTERCHANGE
HIGHWAY 7 TWINNING FROM 2.5 KM WEST
OF ASHTON STATION ROAD TO CARLETON PLACE
W.P. 252-99-00

6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides foundation design recommendations for the high fill embankments at the County Road 17 interchange associated with the twinning of Highway 7 from two to four lanes. The recommendations are based on interpretation of the factual data obtained from the boreholes advanced during the subsurface investigation at this site. The interpretation and recommendations provided are intended only to provide the designers with sufficient information to assess and design the proposed high fill embankments. As such, where comments are made on construction they are provided only in order to highlight those aspects which could affect the design of the project. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods, scheduling and the like.

It is understood that the five ramps and two approach embankments will be up to about 8.5 m in height above existing the centreline ground surface level (although approaching 10 m in height above the native subgrade level beneath the surficial fills). It is also understood that the embankment will have side slopes of either 2 horizontal to 1 vertical (2H:1V) if constructed with earth fill or 1.25H:1V if constructed with rock fill.

The following sections address subgrade preparation requirements, embankment stability under both static and seismic conditions, embankment settlement, and construction requirements.

6.2 Embankment Design and Construction

The proposed grade for the County Road 17 interchange approach embankments and ramps is understood to be up to about Elevation 138 m within the high fill sections. This indicates that the embankment construction will require placement of up to about 8.5 to 10 m of fill (the actual height will depend on the ground surface level at the embankment toe, which is not known). Based on the borehole results, the embankment subgrade soils, following removal of the topsoil, will consist of surficial fill materials followed by up to about 1.4 m of clayey silt, overlying up to 4.9 m of silty clay to clay, underlain by glacial till.

6.2.1 Subgrade Preparation and Embankment Construction

Any topsoil, organic matter, and softened/loosened soils should be stripped from below the embankment areas, and all subgrade soils should be proof-rolled prior to fill placement in accordance with MTO's Special Provision 105S10.

The subgrade in all embankment areas should be inspected following stripping to ensure that all of the above mentioned materials have been fully removed. The existing granular fill materials can remain in-place, provided some modest settlement of the subgrade can be tolerated (i.e. , settlement of less than about 25 mm expected to occur within a one month period), except where they are underlain by a buried topsoil layer (e.g., Boreholes 06-201 to 06-203 along Cemetery Side Road south of the commuter parking lot, and Borehole 06-302 at the entrance laneway to the adjacent field); the fill material and underlying topsoil should be removed from these areas. Similar conditions and/or fill materials containing organic matter also exist in the area of the former retail fuel outlet on the north side of Highway 7 (Boreholes 06-205, 06-402, and 06-501) These fill materials and underlying topsoil should also be removed. However, where the fill material will remain in-place, the surface of the fill material should be recompacted to at least 95 percent of its standard Proctor maximum dry density in accordance with MTO's Special Provision 105S10. The existing pavement structure within the commuter parking lot can also remain in-place, but the asphalt surface should be removed.

The clayey silt and silty clay to clay that will be exposed within the embankment footprints will be sensitive to disturbance from ponded water and construction traffic. Following fill and topsoil removal, travelling over the subgrade soils should be minimized to limit the disturbance. The initial layers of embankment fill should also be placed as soon as possible following the fill and topsoil removal. These requirements can be addressed with an Operational Constraint (OC). A sample OC to address this requirement is included in Appendix A.

Construction of the embankment above the prepared subgrade may be carried out using clean earth fill meeting specification OPSS 212, or Select Subgrade Material (SSM) meeting specification OPSS 1010 or rock fill. Embankment fill (clean earth fill or SSM) should be placed in regular lifts with loose thickness not exceeding 300 mm and be compacted to at least 95 percent of the material's Standard Proctor maximum dry density in accordance with MTO's Special Provision 105S10. The final lift prior to placement of the granular subbase and base courses should be compacted to 100 percent of the Standard Proctor dry density. Inspection and field density testing should be carried out by qualified personnel during placement operations to ensure that appropriate materials are used and that adequate levels of compaction have been achieved. Rock embankments should be constructed and compacted in accordance with SP206S03.

For integral abutments, rock fill should not be placed within the active wedge zone. Since rock fill contains numerous voids into which finer material can migrate due to water action and/or repeated loading, a filter material is required at the transition between the rock fill and the abutment backfill or other earth embankment fill. In this regard, Granular B Type II (OPSS 1010) meets the criteria for filtration and drainage and therefore could be used as backfill to the abutment without additional filter requirements (per MTO's directive, "Backfill to Structures

Adjacent to Rock Embankment Approaches", dated November 2002). A layer of Granular B Type II should also be provided at the transition between the rock fill and earth fill embankment.

Where the approach embankment height is equal to or greater than 8 m if constructed with earth fill or SSM, a mid-height berm at least 2 m in width is required for maintenance purposes, though not for embankment stability. To reduce surface water erosion on the embankment side slopes, placement of topsoil and seeding or pegged sod is recommended. A mid height berm at least 2 m in width is also required for maintenance purposes for approach embankments that are constructed with rock fill and are 10 m or greater in height.

6.2.2 Embankment Stability

Static and seismic slope stability analyses for the embankment configurations were carried out using the commercially available program SLOPE-W produced by Geo-Slope International Ltd. The soil parameters given in the following table were used in the analysis. The undrained shear strength of the silty clay deposits was measured to be typically greater than 96 kPa. The value of 94 kPa, as used in the analyses, reflects the lower bound of the expected *mobilized* shear strength based on correlations with the Atterberg Limit testing.

The results of the analyses indicate that up to 10 m high approach embankments with side slopes maintained at 2H:1V if constructed with soil or 1.25H:1V if constructed with rock fill will have a factor of safety (greater than 1.3) against deep-seated slope instability under static loading conditions and greater than 1.1 under seismic loading, assuming appropriate subgrade preparation and proper placement and compaction of embankment fill materials. The following parameters were used for the stability analyses:

Soil Deposit	Bulk Unit Weight	Effective Friction Angle	Undrained Shear Strength
Embankment Fill			
- Clean Earth Fill - Select Subgrade Material	21.5 kN/m^3	30°	-
- Rock Fill	23 kN/m^3	40°	-
Silty Clay to Clay	18 kN/m^3	-	94 kPa
Sandy Silt and Silty Sand Till	N/A (see note)		

NOTE: Due to the significant difference in shear strength and stress-strain response of the silty clay versus the underlying granular till deposit, the critical failure surface for a deep-seated instability of the embankment does not penetrate the till deposit.

6.2.3 Embankment Settlement

Settlement of the embankments will occur as a result of compression of the new embankment fill itself, as well as consolidation of the clayey soils on which the embankments will be founded.

Provided that the embankment material consists of Select Subgrade Material or clean earth fill the settlement of the embankment fill itself is expected to be less than 25 mm. The use of granular fill for the new embankment construction would reduce this magnitude of post-construction settlement (likely to less that half that value) since the majority of settlement of these fills will occur during construction.

Where rock fill is used, settlement of the rock fill itself will depend on the type of rock, and on the method and sequence of placement and compaction of the fill. Long term post-construction settlement may occur as a result of time-dependent creep due to rearrangement of rock particles under load and breakage of rock particles (i.e. local crushing and degradation). Assuming that the rock fill is not end-dumped into its final position and that it is placed in accordance with the requirements outlined in the SP206S03, the settlement of the rock fill in embankments is estimated to be about 1 percent of the embankment height and it is anticipated that the majority of this settlement will occur during the first year following construction.

Some settlement of the embankment subgrade can be expected due to compression of the clayey soils (i.e. the clayey silt, silty clay and clay). The results of the oedometer consolidation testing indicate that the effective stress level in the clayey deposits will remain well below the deposit's preconsolidation pressure. The resulting consolidation settlements therefore correspond solely to recompression of the clayey deposits (i.e. no consolidation into the virgin compression range).

The total estimated magnitude of the primary consolidation settlements resulting from this recompression is about 25 mm, based on the recompression index value indicated by the consolidation testing. The results of that testing also indicate a relatively high coefficient of consolidation and, considering the relatively limited thickness of this deposit, a relatively rapid rate of settlement. It is expected that most of the settlement should be completed within about 3 months. Consideration should be given to constructing the embankments in the early part of the construction schedule and delay the final paving as much as possible, preferably by 3 months. Secondary compression should result in no more than about 5 mm of additional settlement over a 50 year time frame following construction.

7.0 CLOSURE

This report was prepared by Ms. Susan Trickey, EIT under the direction of the Project Manager, Mr. Michael Cunningham, P.Eng. This report was reviewed by Mr. Fintan J. Heffernan, P.Eng., the designated MTO contact for this project.

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LIST OF ABBREVIATIONS

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

I. SAMPLE TYPE

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

II. PENETRATION RESISTANCE

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

Dynamic Penetration Resistance; N_d:
The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive Uncased a 50 mm (2 in.) diameter, 60^0 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

Peizo-Cone Penetration Test (CPT):
An electronic cone penetrometer with a 60^0 conical tip and a projected 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	$C_{u2}S_u$ Kpa	Psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	Over 200	Over 4,000

IV. SOIL TESTS

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

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

LIST OF SYMBOLS

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

I. GENERAL

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

II. STRESS AND STRAIN

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

III. SOIL PROPERTIES

(a) Index Properties

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

* Density symbol is p. Unit weight symbol is γ where γ=pg(i.e. mass density x acceleration due to gravity)

(a) Index Properties (cont'd.)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

(d) Shear Strength

$\tau_p\tau_r$	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 (ϕ=0 analysis)
p	mean total stress $(\sigma_1+\sigma_3)/2$
p'	mean effective stress $(\sigma'_1+\sigma'_3)/2$
q	$(\sigma_1-\sigma_3)/2$ or $(\sigma'_1-\sigma_3)/2$
q_u	compressive strength $(\sigma_1-\sigma_3)$
S_t	sensitivity

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

2. Shear strength=(Compressive strength)/2

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERING STATE

Fresh: no visible sign of weathering

Faintly Weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock texture and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	>2 m
Thickly bedded	0.6 m to 2m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	<6 mm

JOINT OR FOLIATION SPACING

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

GRAIN SIZE

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

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

O:\ Templates\Rock Description Terminology

CORE CONDITION

Total Core Recovery

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varies from 0% for completely broken core 100% for core in solid sticks.

DISCONTINUITY DATA

Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to (W.R.T.) Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90^0 angle is horizontal.

Description and Notes

An abbreviated description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

B –	Bedding	Ca-	Calcite
FO-	Foliation/Schistosity	P-	Polished
CL -	Cleavage	S-	Slickensided
SH -	Shear Plane/Zone	SM-	Smooth
VN-	Vein	R-	Ridged/Rough
F -	Fault	ST-	Stepped
CO-	Contact	PL-	Planar
J -	Joint	FL-	Flexured
FR-	Fracture	UE-	Uneven
MF -	Mechanical	W-	Wavy
A-	Angular	C-	Curved
BP-	Bedding Plane	H-	Hackly
BL-	Blast Induced	SL-	Sludge Coated
ll	Parallel To	TCA-	To Core Axis
	Perpendicular To	STR-	Stress Induced

RECORD OF BOREHOLE No 06-201

1 OF 1 **METRIC**

PROJECT 06-1120-014-2000 | W.P. 252-99-00 | DIST ____ HWY 7 | DATUM Geodetic

LOCATION N 5001075.1; E 337105.1 | BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem Auger | DATE September 20, 2006

ORIGINATED BY D.J.S. | COMPILED BY N.B.H.S. | CHECKED BY M.I.C.

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): ○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
130.0	GROUND SURFACE										
0.0 / 129.8	Sand and gravel (FILL) Dark brown										
0.2	Crushed stone (FILL) Compact Grey										
128.9			1	SS	12		129				
1.1 / 128.6	Silty TOPSOIL Dark brown Moist										
1.4	CLAYEY SILT with silty sand layers Very stiff Brown Wet		2	SS	7				○		2 44 36 18
128.0							128				
2.0	SILTY CLAY (Weathered Crust) Very stiff Grey brown Wet		3	SS	5	▼			○		
			4	SS	8		127		⊢○⊣		
126.2											
3.8	SILTY CLAY Very stiff Grey Wet		5	SS	5		126		○		0 1 46 53
			6	SS	5		125		⊢○⊣		
124.6											
5.4	Sandy SILT, trace to some gravel and clay (TILL) Loose Grey Wet		7	SS	>50				○		10 38 41 11
124.1											
5.9	End of Borehole Auger Refusal										

Note: Water level in open hole at 2.44m depth below ground surface upon completion of drilling Sept. 20, 2006.

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

Golder Associates

RECORD OF BOREHOLE No 06-202

1 OF 1 **METRIC**

PROJECT 06-1120-014-2000 | W.P. 252-99-00 | DIST ____ HWY 7 | DATUM Geodetic

LOCATION N 5001110.2; E 337074.8 | BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem Auger | DATE September 20, 2006

ORIGINATED BY D.J.S. | COMPILED BY N.B.H.S. | CHECKED BY M.I.C.

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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
130.0	GROUND SURFACE										
0.0 / 129.8	Sand and gravel (FILL) Dark brown										
0.2	Sand and gravel and silty clay, trace organic matter (FILL) Brown										
129.0							129				
128.8	Clayey silt TOPSOIL Dark grey		1	SS	6						
1.2	Moist to wet										
128.5	CLAYEY SILT, some sand Light brown										
1.5	Moist										
	SILTY CLAY (Weathered Crust) Very stiff Grey brown Moist		2	SS	18		128				
			3	SS	16						
126.8							127				
3.2	SILTY CLAY Very stiff Grey Moist to wet		4	SS	9						
			5	SS	6		126				
			6	SS	5		125				
124.2			7	SS	9						
5.8 / 123.9	Sandy SILT, some gravel and clay (TILL) Compact Grey Wet						124				
6.1	End of Borehole Auger Refusal										

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

Golder Associates

RECORD OF BOREHOLE No 06-203

1 OF 1 **METRIC**

PROJECT 06-1120-014-2000 | W.P. 252-99-00 | DIST _____ HWY 7 | DATUM Geodetic

LOCATION N 5001143.8; E 337045.9 | BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem Auger | DATE September 19, 2006

ORIGINATED BY D.J.S. | COMPILED BY N.B.H.S. | CHECKED BY M.I.C.

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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
129.4	GROUND SURFACE										
0.0 / 128.9	Silty clay, trace gravel (FILL) Grey brown										
128.7	TOPSOIL										
0.7 / 128.2	CLAYEY SILT with silty sand layers Very stiff Brown Moist to wet		1	SS	6						
1.2	SILTY CLAY (Weathered Crust) Very stiff Grey brown Wet		2	SS	9						
			3	SS	17						
			4	SS	9						
125.6											
3.8	SILTY CLAY Very stiff Grey Wet		5	SS	10						
124.4			6	SS	12						
5.1	Sandy SILT (TILL) Grey Wet										
	End of Borehole Auger Refusal										

Note:
Water level in well screen at 0.46m depth below ground surface on Oct. 16, 2006.

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

Golder Associates

RECORD OF BOREHOLE No 06-204

1 OF 1

METRIC

PROJECT 06-1120-014-2000
W.P. 252-99-00
DIST HWY 7
DATUM Geodetic
LOCATION N 5001172.4; E 337017.4
BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem Auger
DATE September 19, 2006
ORIGINATED BY D.J.S.
COMPILED BY N.B.H.S.
CHECKED BY M.I.C.

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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
130.4	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
0.1	Crushed stone (FILL) Grey										
129.8							130				
0.6	Sandy silt, some gravel and crushed stone (FILL) Compact Grey and dark grey Moist		1	SS	18						
128.8							129				
1.6	CLAYEY SILT with silty sand layers Very stiff Grey brown Wet		2	SS	3						
128.3											
2.1	SILTY CLAY (Weathered Crust) Very stiff Grey brown Wet		3	SS	9		128				
			4	SS	12		127				0 1 33 64
			5	SS	7						
125.8							126				
4.6	SILTY CLAY Very stiff Grey Wet		6	SS	7						
124.9							125				
5.5	Sandy SILT, some gravel and clay (TILL) Loose Grey		7	SS	5						
124.5											
5.9	End of Borehole Auger Refusal										

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

Golder Associates

RECORD OF BOREHOLE No 06-205

1 OF 1

METRIC

PROJECT 06-1120-014-2000 | W.P. 252-99-00 | LOCATION N 5001285.3; E 336890.5 | ORIGINATED BY D.J.S.

DIST | HWY 7 | BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem Auger | COMPILED BY N.B.H.S.

DATUM Geodetic | DATE September 26, 2006 | CHECKED BY M.I.C.

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, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED; 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
129.4	GROUND SURFACE										
0.0 / 129.2	TOPSOIL										
0.2	Clayey silt, some organic matter (FILL) Dark brown Moist						129				
128.2			1	SS	2						
1.2	CLAYEY SILT with silty sand layers Brown Moist to wet						128				
127.7											
1.7	SILTY CLAY (Weathered Crust) Very stiff Grey brown Wet		2	SS	9						
			3	SS	12		127				
125.9			4	SS	9		126				
3.5	SILTY CLAY Very stiff Grey Wet							+			
								+			
							125				
			5	SS	4						
							124	+			
								+			
123.1											
6.3	Sandy SILT, some gravel and clay (TILL) Compact Grey Wet		6	SS	26		123				
122.7											
6.7	End of Borehole Auger Refusal										

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

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

MISS_MTO 06-1120-014-2000.GPJ ON_MOT GDT 7/25/07

Golder Associates

RECORD OF BOREHOLE No 06-206

1 OF 1 **METRIC**

PROJECT 06-1120-014-2000 | W.P. 252-99-00 | LOCATION N 5001319.3; E 336853.9 | ORIGINATED BY D.J.S.

DIST _____ HWY 7 | BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem Auger | COMPILED BY N.B.H.S.

DATUM Geodetic | DATE September 28, 2006 | CHECKED BY M.I.C.

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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
129.1	GROUND SURFACE						129				
0.0 / 128.8	Silty TOPSOIL, Dark brown										
0.3 / 128.5	CLAYEY SILT, trace sand, Brown										
0.6	SILTY CLAY (Weathered Crust), Very stiff, Grey brown, Moist to wet		1	SS	11		128				
			2	SS	11						
			3	SS	9		127				
125.8											
3.3	SILTY CLAY, Very stiff, Grey, Wet		4	SS	7		126				
			5	SS	8		125				
123.6							124				
5.5	Silty SAND, some gravel and clay, occasional cobbles (TILL), Compact, Grey, Wet		6	SS	14						15 39 37 9
122.7							123				
6.4	End of Borehole, Auger Refusal										

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

MISS_MTO 06-1120-014-2000.GPJ ON_MOT.GDT 7/25/07

RECORD OF BOREHOLE No 06-207

1 OF 1 **METRIC**

PROJECT 06-1120-014-2000
W.P. 252-99-00
DIST ____ HWY 7
DATUM Geodetic
LOCATION N 5001339.8; E 336830.6
BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem Auger
DATE September 27, 2006
ORIGINATED BY D.J.S.
COMPILED BY N.B.H.S.
CHECKED BY M.I.C.

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): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
129.1	GROUND SURFACE						129				
0.0 / 128.7	Silty TOPSOIL Dark brown										
0.4 / 127.9	CLAYEY SILT with sand and silty sand layers Very stiff Brown Moist		1	SS	4		128				
1.2 / 125.9	SILTY CLAY (Weathered Crust) Very stiff Grey brown Moist to wet		2	SS	15		127				
			3	SS	14						
3.2 / 123.8	SILTY CLAY Very stiff Grey Wet		4	SS	10		126				
			5	TP	PH		125	+		18.8	
			6	SS	6		124				
5.3 / 123.2	Sandy SILT, some gravel and clay (TILL) Compact to very dense Grey		7	SS	>50						
5.9	End of Borehole Auger Refusal Note: Water level in well screen at 0.63m depth below ground surface on Oct. 16, 2006.										

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

Golder Associates

RECORD OF BOREHOLE No 06-208

1 OF 1

METRIC

PROJECT 06-1120-014-2000 | W.P. 252-99-00 | DIST _____ HWY 7 | DATUM Geodetic

LOCATION N 5001367.5; E 336802.4 | BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem Auger | DATE September 27, 2006

ORIGINATED BY D.J.S. | COMPILED BY N.B.H.S. | CHECKED BY M.I.C.

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, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED; 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
129.0	GROUND SURFACE										
0.0 / 128.7	Silty TOPSOIL, Dark brown										
0.3 / 128.2	CLAYEY SILT with silty sand, Brown										
0.8	SILTY CLAY (Weathered Crust), Very stiff, Grey brown, Moist		1	SS	7	▼	128				
			2	SS	7						0 0 35 65
126.8							127				
2.2	SILTY CLAY, Very stiff, Grey, Moist to Wet		3	SS	8						
			4	SS	9		126				
124.5							125				
4.5	Sandy SILT, some gravel and clay (TILL), Very dense, Grey, Wet		5	SS	88						
124.0							124				
5.0	End of Borehole, Auger Refusal										

Note: Water level in open hole at 1.13m depth below ground surface upon completion of drilling Sept. 27, 2006.

+ ³, × ³: Numbers refer to Sensitivity

o ³% STRAIN AT FAILURE

MISS_MTO 06-1120-014-2000.GPJ ON_MOT.GDT 7/25/07

RECORD OF BOREHOLE No 07-209

1 OF 1

METRIC

PROJECT 06-1120-014-2000

W.P. 252-99-00

DIST _____ HWY 7

DATUM Geodetic

LOCATION N 5001415.9; E 336747.9

BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem Auger

DATE March 20, 2007

ORIGINATED BY J.D.

COMPILED BY J.M.

CHECKED BY M.I.C.

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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
128.3	GROUND SURFACE										
0.0 / 127.9	TOPSOIL										
0.4 / 127.5	Silty fine SAND Grey brown Moist										
0.8	SILTY CLAY (Weathered Crust) Very stiff Grey brown Moist to wet		1	SS	7		128				
			2	SS	10		127				
125.4			3	SS	8		126				
2.9	SILTY CLAY Very stiff Grey Moist to wet		4	SS	7		125				
			5	SS	8		124				
			6	SS	5		123				
122.7											
5.6	Sandy SILT, some gravel, trace to some clay (TILL) Compact Grey Wet		7	SS	15						
121.8			8	SS	18		122				
6.5	End of Borehole Auger Refusal										

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

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

Golder Associates

RECORD OF BOREHOLE No 06-301

1 OF 1

METRIC

PROJECT 06-1120-014-2000
W.P. 252-99-00
DIST HWY 7
DATUM Geodetic
LOCATION N 5001067.3; E 337144.0
BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem Auger
DATE September 22, 2006
ORIGINATED BY D.J.S.
COMPILED BY N.B.H.S.
CHECKED BY M.I.C.

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 (%) 25 50 75	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
129.8	GROUND SURFACE										
0.0 / 129.4	Silty TOPSOIL Dark brown										
0.4 / 128.3	CLAYEY SILT with silty sand seams and layers Very stiff Brown Moist		1	SS	7		129				
1.5 / 127.1	SILTY CLAY (Weathered Crust) Very stiff Grey brown Wet		2	SS	2	▼	128				
			3	SS	3						
2.7 / 125.5	SILTY CLAY Stiff Grey Wet		4	TP	PH		127				
4.3 / 125.1	Sandy SILT, some gravel and clay, occasional cobbles (TILL) Grey						126	+ at 80 kPa + at 80 kPa			
4.7	End of Borehole Auger Refusal Note: Water level in open hole at 1.65m depth below ground surface upon completion of drilling Sept. 22, 2006.										

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

Golder Associates

RECORD OF BOREHOLE No 06-302

1 OF 1 **METRIC**

PROJECT 06-1120-014-2000 | W.P. 252-99-00 | DIST | HWY 7 | DATUM Geodetic

LOCATION N 5001094.1; E 337121.9 | BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem Auger | DATE September 22, 2006

ORIGINATED BY D.J.S. | COMPILED BY N.B.H.S. | CHECKED BY M.I.C.

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
129.7	GROUND SURFACE										
0.0 / 129.5	Crushed stone (FILL) Grey										
0.2 / 129.2	Silty TOPSOIL Dark brown										
0.5 / 128.5	CLAYEY SILT with silty sand seams and layers Very stiff Brown Moist		1	SS	6						
1.2 / 126.7	SILTY CLAY (Weathered Crust) Very stiff Grey brown Wet		2	SS	6	▼					
			3	SS	10						
3.0 / 125.3	SILTY CLAY Very stiff Grey Wet		4	SS	5			+ +			
4.4 / 124.7	Sandy SILT, some gravel and clay (TILL) Loose Grey Wet		5	SS	6						
5.0	End of Borehole Auger Refusal Note: Water level in open hole at 1.49m depth below ground surface upon completion of drilling Sept. 22, 2006.										

ELEVATION SCALE: 129, 128, 127, 126, 125

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: 20 40 60 80 100

WATER CONTENT (%): 25 50 75

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

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

RECORD OF BOREHOLE No 06-303

1 OF 1

METRIC

PROJECT 06-1120-014-2000

W.P. 252-99-00

DIST _____ HWY 7

DATUM Geodetic

LOCATION N 5001120.2; E 337107.7

BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem Auger

DATE September 21, 2006

ORIGINATED BY D.J.S.

COMPILED BY N.B.H.S.

CHECKED BY M.I.C.

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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
129.4	GROUND SURFACE										
0.0 / 129.1	Silty TOPSOIL, Dark brown										
0.3 / 128.4	CLAYEY SILT with silty sand seams and layers, Brown, Moist										
1.0 / 126.3	SILTY CLAY (Weathered Crust), Very stiff, Grey brown, Moist		1	SS	6						
			2	SS	18						
			3	SS	14						
3.1 / 124.4	SILTY CLAY, Very stiff, Grey, Wet		4	SS	6						0 0 49 51
			5	TP	PH					18.6	
			6	SS	5						
124.2 / 5.2	Sandy SILT (TILL), Grey, Wet										
	End of Borehole, Auger Refusal										

Note:
Water level in well screen at 0.77m depth below ground surface on Oct. 16, 2006.

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

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

Golder Associates

RECORD OF BOREHOLE No 06-304

1 OF 1 **METRIC**

PROJECT 06-1120-014-2000 | W.P. 252-99-00 | DIST ____ HWY 7 | DATUM Geodetic

LOCATION N 5001154.1; E 337098.7 | BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem Auger | DATE September 21, 2006

ORIGINATED BY D.J.S. | COMPILED BY N.B.H.S. | CHECKED BY M.I.C.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS
129.4	GROUND SURFACE					
0.0 / 129.2	Silty TOPSOIL, Dark brown					
0.2	CLAYEY SILT with silty sand seams and layers, Very stiff, Brown, Moist					
			1	SS	7	
128.2						
1.2	SILTY CLAY (Weathered Crust), Very stiff, Grey brown, Wet					
			2	SS	8	
			3	SS	8	
126.3						
3.1	SILTY CLAY, Very stiff, Grey, Wet					
			4	SS	7	
			5	SS	8	
124.8						
4.6	Sandy SILT, some gravel and clay (TILL), Compact, Grey, Wet		6	SS	14	
124.2						
5.2	End of Borehole, Auger Refusal					

ELEVATION SCALE: 129, 128, 127, 126, 125

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 (%): 25 50 75

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%): GR SA SI CL

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

Golder Associates

RECORD OF BOREHOLE No 06-305

1 OF 1

METRIC

PROJECT 06-1120-014-2000
W.P. 252-99-00
DIST _____ HWY 7
DATUM Geodetic

LOCATION N 5001189.0; E 337096.1
BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem Auger
DATE September 21, 2006

ORIGINATED BY D.J.S.
COMPILED BY N.B.H.S.
CHECKED BY M.I.C.

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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
129.7	GROUND SURFACE										
0.0 / 129.4	Silty TOPSOIL Dark brown										
0.3	CLAYEY SILT with silty sand layers Very stiff Brown Moist		1	SS	7		129				
128.0											
1.7	SILTY CLAY (Weathered Crust) Very stiff Grey brown Wet		2	SS	8	▼	128				
			3	SS	7		127				
126.6											
3.1	Sandy SILT, some gravel and clay, occasional sand seam and cobble (TILL) Loose to compact Grey Wet		4	SS	9		126				
			5	SS	11						
124.7			6	SS	27		125				
5.0	End of Borehole Auger Refusal Note: Water level in open hole at 1.95m depth below ground surface upon completion of drilling Sept. 21, 2006.										

SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED

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

Golder Associates

RECORD OF BOREHOLE No 06-306

1 OF 1

METRIC

PROJECT 06-1120-014-2000 | W.P. 252-99-00 | DIST ____ HWY 7 | DATUM Geodetic

LOCATION N 5001213.9; E 337098.2 | BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem Auger | DATE September 21, 2006

ORIGINATED BY D.J.S. | COMPILED BY N.B.H.S. | CHECKED BY M.I.C.

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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
129.8	GROUND SURFACE										
0.0 / 129.6	Silty TOPSOIL, Dark brown										
0.2	CLAYEY SILT with silty sand layers, Very stiff, Brown, Moist										
			1	SS	9		129		○		0 54 33 13
128.5											
1.3	SILTY CLAY, occasional silty sand seam (Weathered Crust), Very stiff, Grey brown, Wet		2	SS	7	▼	128		⊖		
			3	SS	8				○		
127.1							127				
2.7	Sandy SILT, some gravel and clay, occasional cobble (TILL), Compact to dense, Brown to grey, Wet		4	SS	>50				○		12 34 42 12
126.0											
3.8	End of Borehole, Auger Refusal										

Note: Water level in open hole at 1.83m depth below ground surface upon completion of drilling Sept. 21, 2006.

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

Golder Associates

RECORD OF BOREHOLE No 06-401

1 OF 1

METRIC

PROJECT 06-1120-014-2000
W.P. 252-99-00
DIST HWY 7
DATUM Geodetic
LOCATION N 5001217.8; E 336913.7
BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem Auger
DATE September 25, 2006
ORIGINATED BY D.J.S.
COMPILED BY N.B.H.S.
CHECKED BY M.I.C.

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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
129.7	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
0.2	Crushed stone (FILL) Grey										
128.7	Sand and gravel, occasional cobble (FILL) Loose Brown						129				
1.0	SILTY CLAY and CLAYEY SILT with silty sand layers Very stiff Brown Moist		1	SS	6	▼			○		0 13 63 24
128.0											
1.7	SILTY CLAY (Weathered Crust) Very stiff Grey brown Wet		2	SS	13		128		⊢○⊣		
			3	SS	5				○		
126.1			4	SS	6		127		⊢○⊣		
3.6	SILTY CLAY Very stiff Grey Wet		5	TP	PH		126				
			6	SS	3		125	+	○		
123.4							124	+ +			
6.3	Sandy SILT, some gravel and clay (TILL) Loose Grey Wet		7	SS	9		123				
122.9											
6.8	End of Borehole Auger Refusal										

Note:
Water level in open hole at 1.34m depth below ground surface upon completion of drilling Sept. 25, 2006.

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

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

MISS_MTO 06-1120-014-2000.GPJ ON_MOT.GDT 7/25/07

Golder Associates

RECORD OF BOREHOLE No 06-402

1 OF 1 **METRIC**

PROJECT 06-1120-014-2000 | W.P. 252-99-00 | DIST ____ HWY 7 | DATUM Geodetic

LOCATION N 5001303.5; E 336883.5 | BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem Auger | DATE September 15, 2006

ORIGINATED BY D.J.S. | COMPILED BY N.B.H.S. | CHECKED BY M.I.C.

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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
129.1	GROUND SURFACE						129				
0.0 / 128.9	Silty TOPSOIL, Brown										
0.2 / 128.0	Sandy silt, gravel and peat, some clay, occasional cobble (FILL), Loose, Brown, Moist		1	SS	5		128				
1.1 / 127.6	Sandy silt, trace clay, organic matter, glass and gravel (FILL), Loose, Dark grey, Moist										
1.5 / 125.8	SILTY CLAY (Weathered Crust), Very stiff, Grey brown, Moist		2	SS	12		127				
			3	SS	9						
			4	SS	7		126				
3.3 / 123.3	SILTY CLAY, Very stiff, Grey, Wet		5	SS	5		125				
			6	SS	7		124	+			
5.8 / 122.1	Sandy SILT, some gravel and clay, occasional cobble, Loose, Grey, Wet		7	SS	4		123	+			
7.0	End of Borehole, Auger Refusal										

Note:
Water level in well screen at 0.25m depth below ground surface on Oct. 16, 2006.

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

PROJECT 06-1120-014-2000

RECORD OF BOREHOLE No 06-403

1 OF 1

METRIC

W.P. 252-99-00 LOCATION N 5001350.1; E 336869.2 ORIGINATED BY D.J.S.

DIST HWY 7 BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem Auger COMPILED BY N.B.H.S.

DATUM Geodetic DATE September 26, 2006 CHECKED BY M.I.C.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS
128.7	GROUND SURFACE					
0.0 / 128.3	PEAT Dark brown					
128.1	CLAYEY SILT, some sand Brown					
0.6	SILTY CLAY (Weathered Crust) Very stiff Grey brown Moist		1	SS	16	
			2	SS	8	
126.6						
2.1	SILTY CLAY Stiff to very stiff Grey Wet		3	SS	6	
			4	SS	5	
			5	SS	10	
123.6						
5.1	Sandy SILT, some gravel and clay, occasional cobble (TILL) Loose Grey Wet		6	SS	9	
122.6						
6.1	End of Borehole Auger Refusal					

ELEVATION SCALE: 128, 127, 126, 125, 124, 123

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 (%) 25 50 75

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

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

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

Golder Associates

RECORD OF BOREHOLE No 07-404

1 OF 1

METRIC

PROJECT 06-1120-014-2000
W.P. 252-99-00
DIST HWY 7
DATUM Geodetic
LOCATION N 5001411.2; E 336873.9
BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem Auger
DATE March 19, 2007
ORIGINATED BY J.D.
COMPILED BY J.M.
CHECKED BY M.I.C.

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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
128.7	GROUND SURFACE										
0.0 / 128.3	TOPSOIL										
0.4 / 128.0	Silty fine SAND Brown										
127.8 / 0.9	Sandy SILT Brown Moist		1	SS	14		128		○		
	SILTY CLAY (Weathered Crust) Very stiff Grey brown Moist to wet		2	SS	15		127		○		
126.6											
2.1	SILTY CLAY Very stiff Grey Moist to wet		3	SS	10		126		○		
			4	SS	7				○		
124.5			5	SS	7		125		○		
4.2	Layered SILTY CLAY and CLAYEY SILT Very stiff Grey Wet		6	SS	5		124		○		
123.2											
5.5	Sandy SILT, some gravel, trace to some clay (TILL) Compact to dense Grey Wet		7	SS	22		123		○		
			8	SS	44						
122.2											
6.6	End of Borehole Auger Refusal										

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

Golder Associates

RECORD OF BOREHOLE No 06-501

1 OF 1

METRIC

PROJECT 06-1120-014-2000 | W.P. 252-99-00 | DIST | HWY 7 | DATUM Geodetic

LOCATION N 5001350.9; E 336824.2 | BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem Auger | DATE September 27, 2006

ORIGINATED BY D.J.S. | COMPILED BY N.B.H.S. | CHECKED BY M.I.C.

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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
129.2	GROUND SURFACE										
0.0 / 129.0	TOPSOIL						129				
0.3 / 128.6	Silty sand, some gravel (FILL) Brown / Silty TOPSOIL Dark brown										
0.6 / 127.7	CLAYEY SILT with sand and silty sand layers Very stiff Brown Moist to wet		1	SS	7	▼	128				
1.5 / 125.5	SILTY CLAY (Weathered Crust) Very stiff Grey brown Wet		2	SS	8		127				
			3	SS	15						
			4	SS	7		126				
3.7 / 124.0	SILTY CLAY Very stiff Grey Wet		5	SS	7		125	+ at 100 kPa			
5.2 / 123.1	Sandy SILT, some gravel and clay, occasional cobble (TILL) Very dense Grey Wet		6	SS	>50		124				
6.1	End of Borehole Auger Refusal Note: Water level in open hole at 1.01m depth below ground surface upon completion of drilling Sept. 27, 2006.										

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

MISS_MTO 06-1120-014-2000.GPJ ON_MOT.GDT 7/25/07

Golder Associates

RECORD OF BOREHOLE No 06-502

1 OF 1 **METRIC**

PROJECT 06-1120-014-2000 | W.P. 252-99-00 | DIST | HWY 7 | DATUM Geodetic

LOCATION N 5001380.4; E 336851.7 | BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem Auger | DATE September 26, 2006

ORIGINATED BY D.J.S. | COMPILED BY N.B.H.S. | CHECKED BY M.I.C.

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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
129.1	GROUND SURFACE						129				
0.0 / 128.7	Silty TOPSOIL, Dark grey										
0.4 / 128.4	CLAYEY SILT, some sand, Brown										
0.7	SILTY CLAY (Weathered Crust), Very stiff, Grey brown, Moist		1	SS	8		128				
			2	SS	10						
126.4			3	SS	9		127				
2.7	SILTY CLAY, Very stiff, Grey, Wet		4	SS	7		126				
							125	+			
124.2			5	SS	14				o		10 48 33 9
4.9	Sandy SILT, some gravel and clay (TILL), Compact, Grey, Wet		6	SS	22		124				
123.5											
5.6	End of Borehole, Auger Refusal										

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

Golder Associates

RECORD OF BOREHOLE No 07-503 1 OF 1 METRIC

PROJECT 06-1120-014-2000 | W.P. 252-99-00 | DIST | HWY 7 | DATUM Geodetic

LOCATION N 5001425.3; E 336859.7 | BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem Auger | DATE March 19, 2007

ORIGINATED BY J.D. | COMPILED BY J.M. | CHECKED BY M.I.C.

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
128.9	GROUND SURFACE										
0.0 / 128.5	TOPSOIL										
0.4	SILTY CLAY (Weathered Crust) Very stiff Grey brown Moist		1	SS	10		128				
			2	SS	9		127				
			3	SS	7						
126.0											
2.9	SILTY CLAY Very stiff Grey Moist		4	SS	5		126				
			5	SS	9		125				
124.5											
4.4	Layered SILTY CLAY and CLAYEY SILT Grey Moist to wet		6	SS	8		124				
124.0											
4.9	Sandy SILT, some gravel, trace to some clay (TILL) Compact to dense Grey Wet		7	SS	33						
123.0											
5.9	End of Borehole Auger Refusal										

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

Golder Associates

RECORD OF BOREHOLE No 06-601

1 OF 1

METRIC

PROJECT 06-1120-014-2000
W.P. 252-99-00
DIST HWY 7
DATUM Geodetic
LOCATION N 5001154.4; E 337011.9
BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem Auger
DATE September 19, 2006
ORIGINATED BY D.J.S.
COMPILED BY N.B.H.S.
CHECKED BY M.I.C.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS
129.5	GROUND SURFACE					
0.0	Silty sand and gravel, some clay (FILL) Dark brown					
128.9						
0.6	CLAYEY SILT Very stiff Brown Wet		1	SS	4	
128.4						
1.1	SILTY CLAY (Weathered Crust) Very stiff Grey brown Wet		2	SS	7	
			3	SS	7	
			4	SS	5	
125.5						
4.0	Inferred SILTY CLAY Very stiff Grey Wet					
124.9						
	Sandy SILT, some gravel and clay		5	SS	>50	
4.7	(TILL) Grey Wet End of Borehole Auger Refusal					

ELEVATION SCALE: 129, 128, 127, 126, 125

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 (%)
25 50 75

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

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

MISS_MTO 06-1120-014-2000.GPJ ON_MOT.GDT 7/25/07

HWY. 7

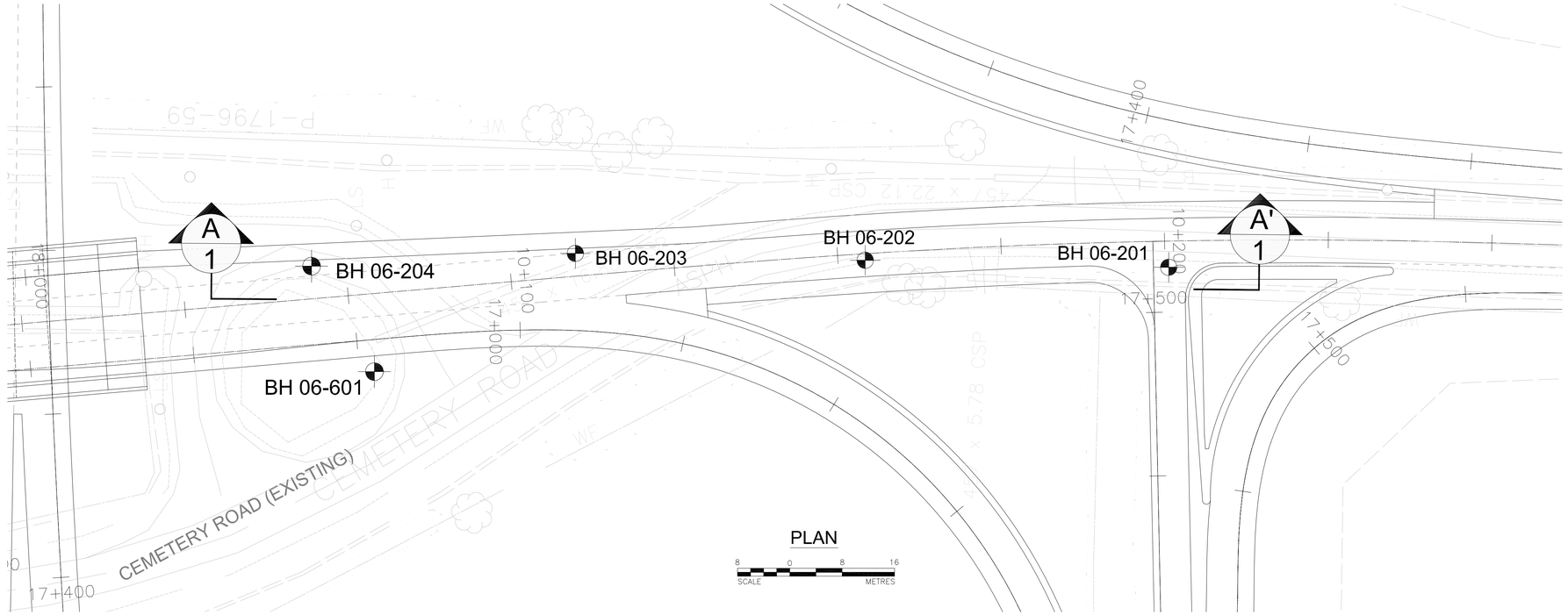
WP No. 252-99-00

COUNTY ROAD 17
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

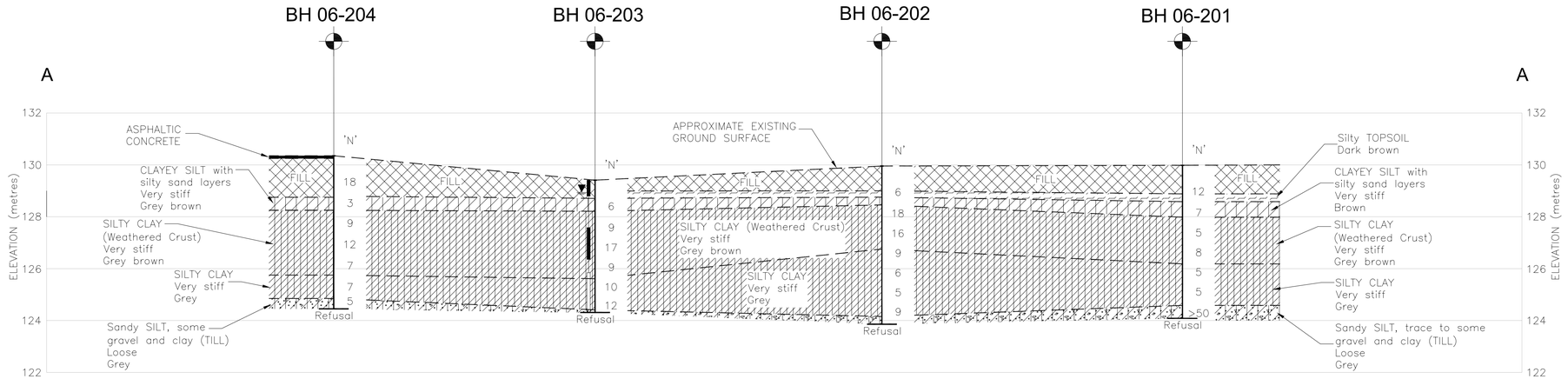
Golder Associates

Golder Associates Ltd.
OTTAWA, ONTARIO, CANADA



PLAN

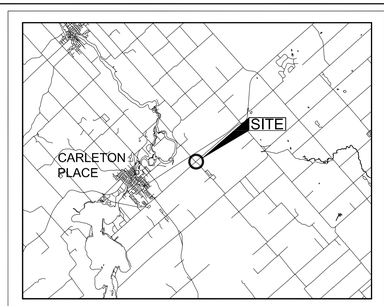
SCALE 8 0 8 16 METRES



SECTION A-A'

SCALE (HORIZONTAL) 8 0 8 16 METRES

SCALE (VERTICAL) 2 0 2 4 METRES



KEY PLAN

LEGEND

- Borehole – Current Golder Associates Ltd. Investigation
- A 2 — Location of cross-section
- Seal
- Piezometer
- N — Standard Penetration Test value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- Water Level in Piezometer

No.	ELEVATION	LOCATION	
		NORTHING	EASTING
06-201	130.0	5001075.1	337105.1
06-202	130.0	5001110.2	337074.8
06-203	129.4	5001143.8	337045.9
06-204	130.4	5001172.4	337017.4
06-205	129.4	5001285.3	336890.5
06-206	129.1	5001319.3	336853.9
06-207	129.1	5001339.8	336830.6
06-208	129.0	5001367.5	336802.4
07-209	128.3	5001415.9	336747.9
06-301	129.8	5001067.3	337144.0
06-302	129.7	5001094.1	337121.9
06-303	129.4	5001120.2	337107.7
06-304	129.4	5001154.1	337098.7
06-305	129.7	5001189.0	337096.1
06-306	129.8	5001213.9	337098.2
06-401	129.7	5001271.8	336913.7
06-402	129.1	5001303.5	336883.5
06-403	128.7	5001350.1	336869.2
06-404	128.7	5001411.2	336873.9
06-501	129.2	5001350.9	336824.2
06-502	129.1	5001380.4	336851.7
06-503	128.9	5001425.3	336859.7
06-601	129.5	5001154.4	337011.9

NOTES

This drawing is for subsurface information only. Any surface details are for conceptual illustration.
The boundaries between soil strata have been established only at borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

Base plan provided in electronic format by McCormick Rankin Corporation

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

NO.	DATE	BY	REVISION

Geocres No. 31F-161

HWY. 7	PROJECT NO. 06-1120-014-2000		DIST.
SUBM'D. M.I.C.	CHKD. M.I.C.	DATE: NOVEMBER 2006	SITE:
DRAWN: N.B.H.S.	CHKD.	APPD.	DWG. 1

061120014-2000-02_MTM_NAD83.dwg

1:1

HWY. 7

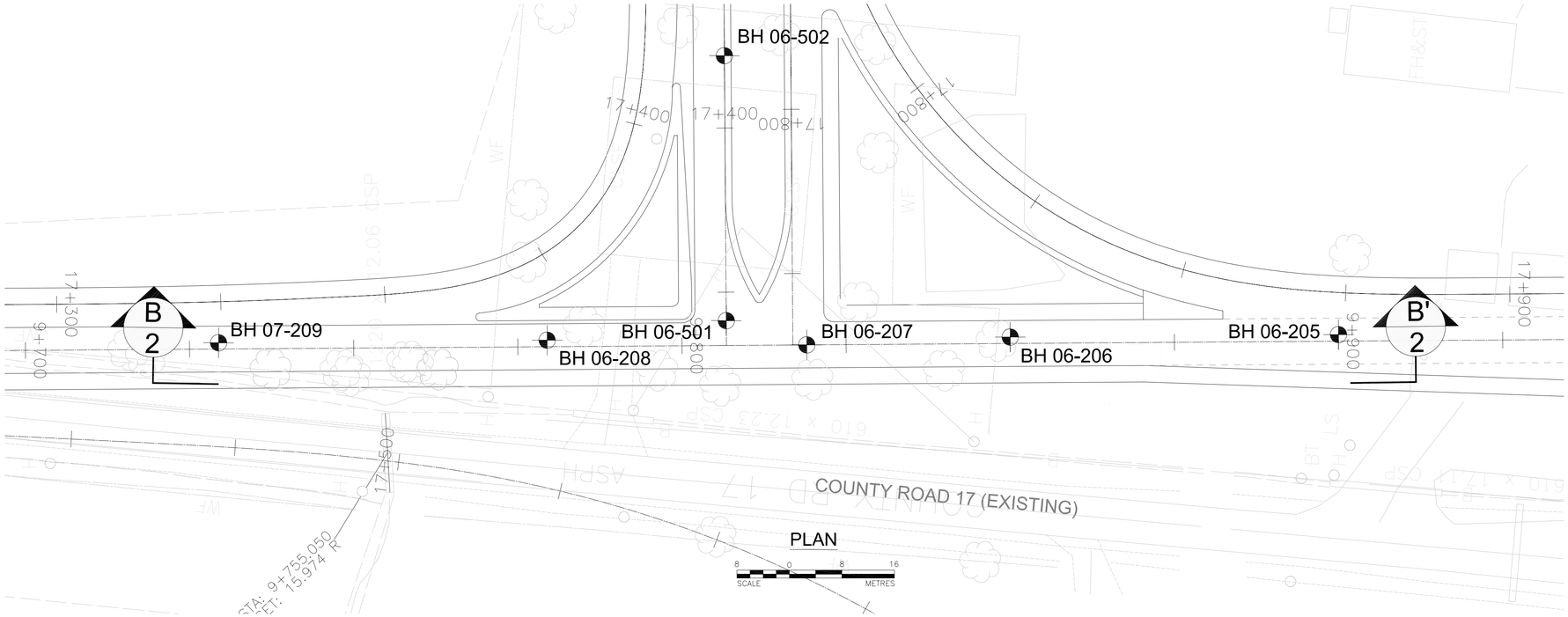
WP No. 252-99-00

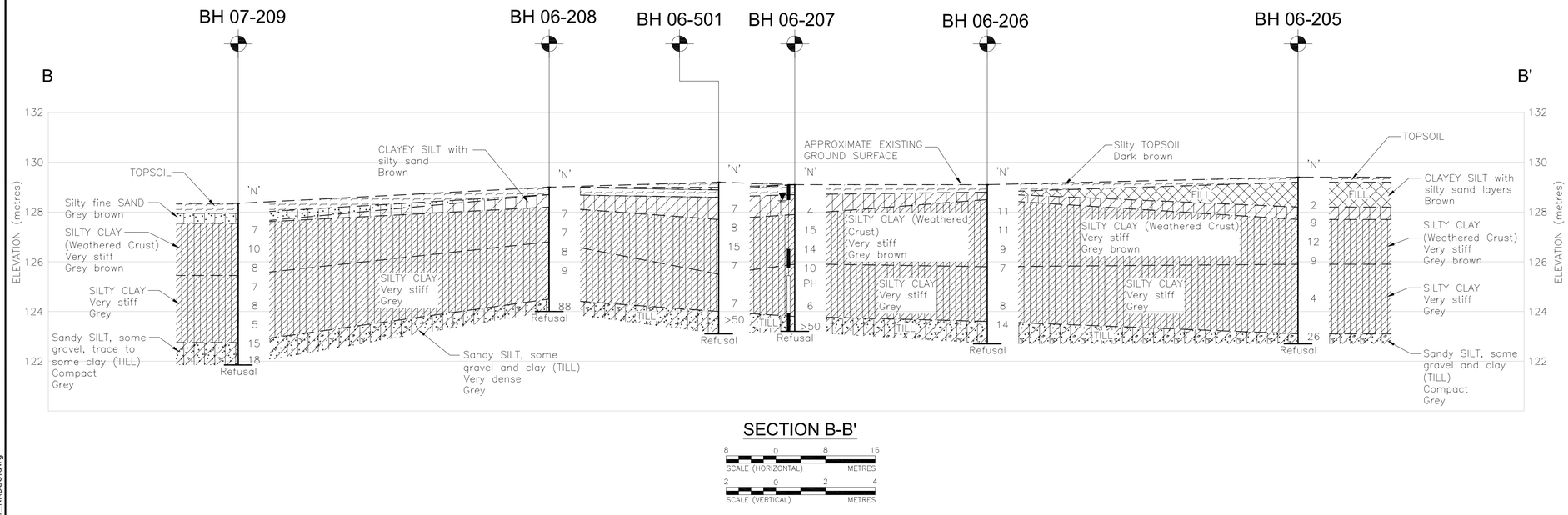
COUNTY ROAD 17
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

Golder Associates

Golder Associates Ltd.
OTTAWA, ONTARIO, CANADA

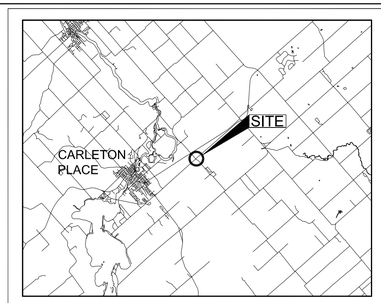




SECTION B-B'

8 0 8 16
SCALE (HORIZONTAL) METRES

2 0 2 4
SCALE (VERTICAL) METRES



LEGEND

- Borehole – Current Golder Associates Ltd. Investigation
- A/2 Location of cross-section
- Seal
- Piezometer
- N Standard Penetration Test value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- Water Level in Piezometer

No.	ELEVATION	LOCATION	
		NORTHING	EASTING
06-201	130.0	5001075.1	337105.1
06-202	130.0	5001110.2	337074.8
06-203	129.4	5001143.8	337045.9
06-204	130.4	5001172.4	337017.4
06-205	129.4	5001285.3	336890.5
06-206	129.1	5001319.3	336853.9
06-207	129.1	5001339.8	336830.6
06-208	129.0	5001367.5	336802.4
07-209	128.3	5001415.9	336747.9
06-301	129.8	5001067.3	337144.0
06-302	129.7	5001094.1	337121.9
06-303	129.4	5001120.2	337107.7
06-304	129.4	5001154.1	337098.7
06-305	129.7	5001189.0	337096.1
06-306	129.8	5001213.9	337098.2
06-401	129.7	5001271.8	336913.7
06-402	129.1	5001303.5	336883.5
06-403	128.7	5001350.1	336869.2
06-404	128.7	5001411.2	336873.9
06-501	129.2	5001350.9	336824.2
06-502	129.1	5001380.4	336851.7
06-503	128.9	5001425.3	336859.7
06-601	129.5	5001154.4	337011.9

NOTES

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Base plan provided in electronic format by McCormick Rankin Corporation

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

NO.	DATE	BY	REVISION

Geocres No. 31F-161

HWY. 7		PROJECT NO. 06-1120-014-2000	DIST.
SUBM'D. M.I.C.	CHKD. M.I.C.	DATE: NOVEMBER 2006	SITE:
DRAWN: N.B.H.S.	CHKD.	APPD.	DWG. 2

061120014-2000-02_MTM_NAD83.dwg

1:1

HWY. 7

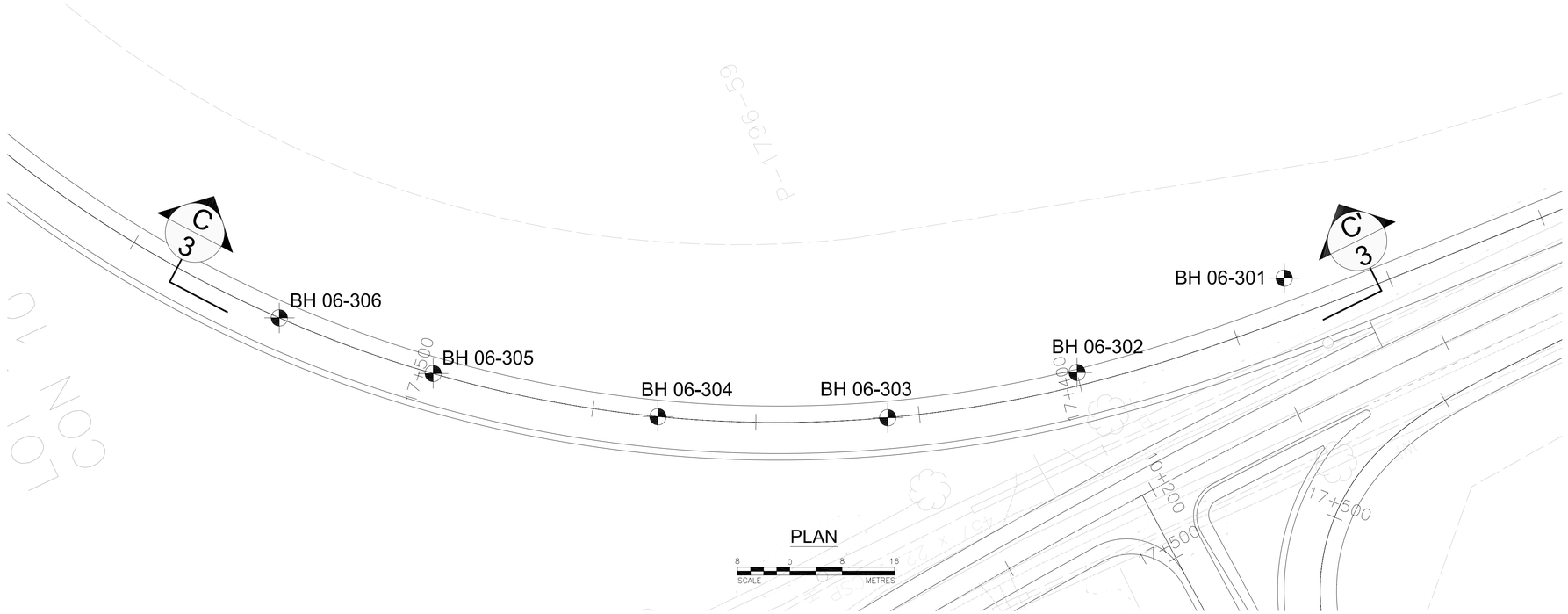
WP No. 252-99-00

RAMP S-E

BOREHOLE LOCATIONS AND SOIL STRATA

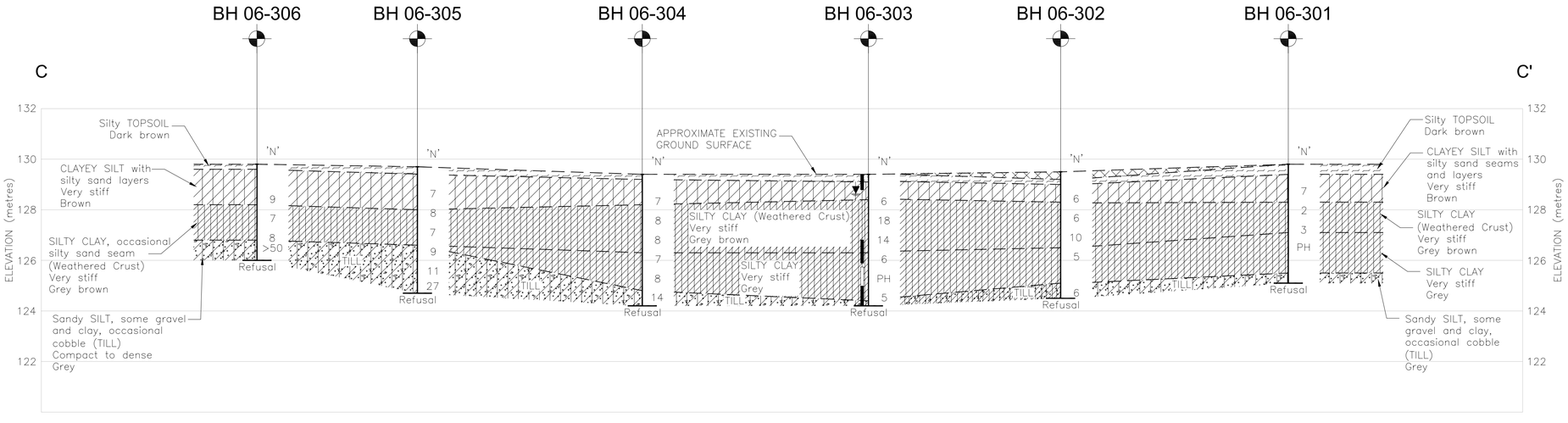
SHEET

Golder Associates Ltd.
OTTAWA, ONTARIO, CANADA



PLAN

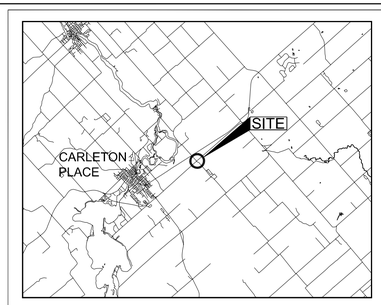
SCALE 8 0 8 16 METRES



SECTION C-C'

SCALE (HORIZONTAL) 8 0 8 16 METRES

SCALE (VERTICAL) 2 0 2 4 METRES



KEY PLAN

LEGEND

- Borehole – Current Golder Associates Ltd. Investigation
- A/2 Location of cross-section
- Seal
- Piezometer
- N Standard Penetration Test value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- Water Level in Piezometer

No.	ELEVATION	LOCATION	
		NORTHING	EASTING
06-201	130.0	5001075.1	337105.1
06-202	130.0	5001110.2	337074.8
06-203	129.4	5001143.8	337045.9
06-204	130.4	5001172.4	337017.4
06-205	129.4	5001285.3	336890.5
06-206	129.1	5001319.3	336853.9
06-207	129.1	5001339.8	336830.6
06-208	129.0	5001367.5	336802.4
07-209	128.3	5001415.9	336747.9
06-301	129.8	5001067.3	337144.0
06-302	129.7	5001094.1	337121.9
06-303	129.4	5001120.2	337107.7
06-304	129.4	5001154.1	337098.7
06-305	129.7	5001189.0	337096.1
06-306	129.8	5001213.9	337098.2
06-401	129.7	5001271.8	336913.7
06-402	129.1	5001303.5	336883.5
06-403	128.7	5001350.1	336869.2
06-404	128.7	5001411.2	336873.9
06-501	129.2	5001350.9	336824.2
06-502	129.1	5001380.4	336851.7
06-503	128.9	5001425.3	336859.7
06-601	129.5	5001154.4	337011.9

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METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

NO.	DATE	BY	REVISION

Geocres No. 31F-161

HWY. 7	PROJECT NO. 06-1120-014-2000		DIST.
SUBM'D. M.I.C.	CHKD. M.I.C.	DATE: NOVEMBER 2006	SITE:
DRAWN: N.B.H.S.	CHKD.	APPD.	DWG. 3

061120014-2000-02_MTM_NAD83.dwg

1:1

HWY. 7

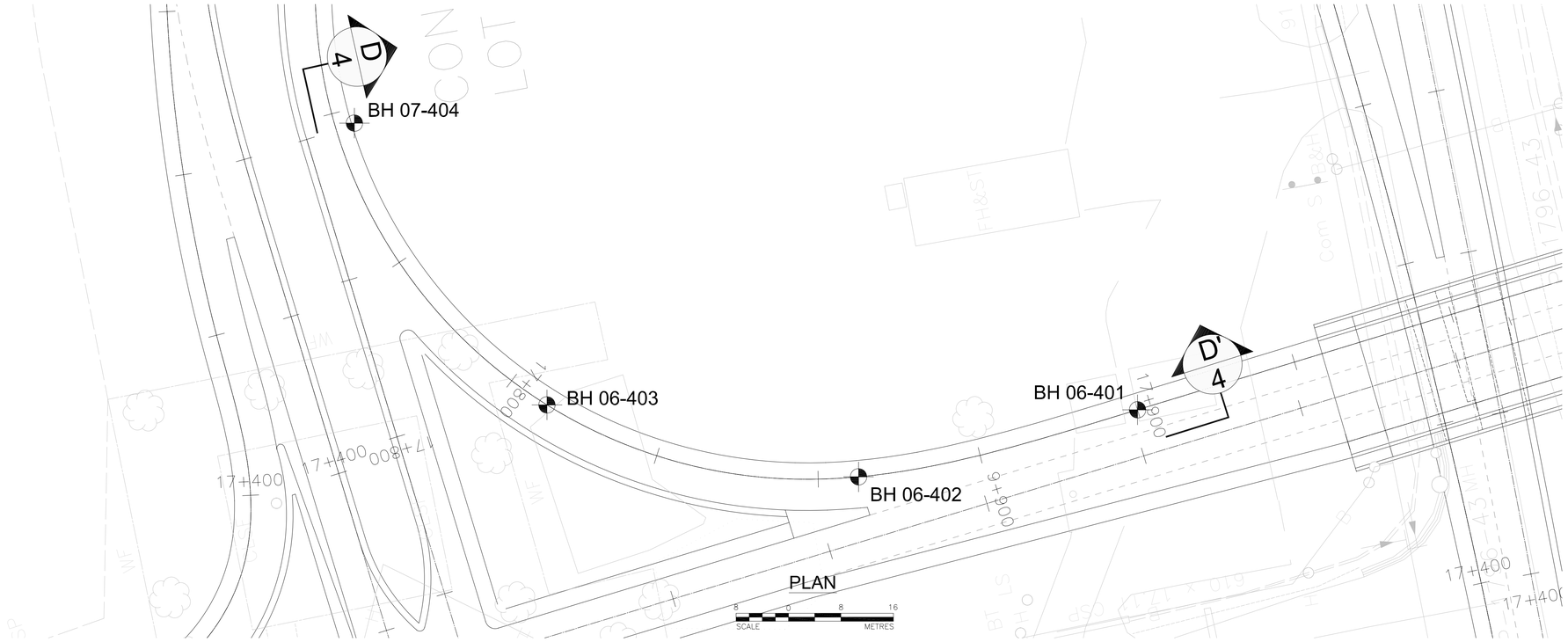
WP No. 252-99-00

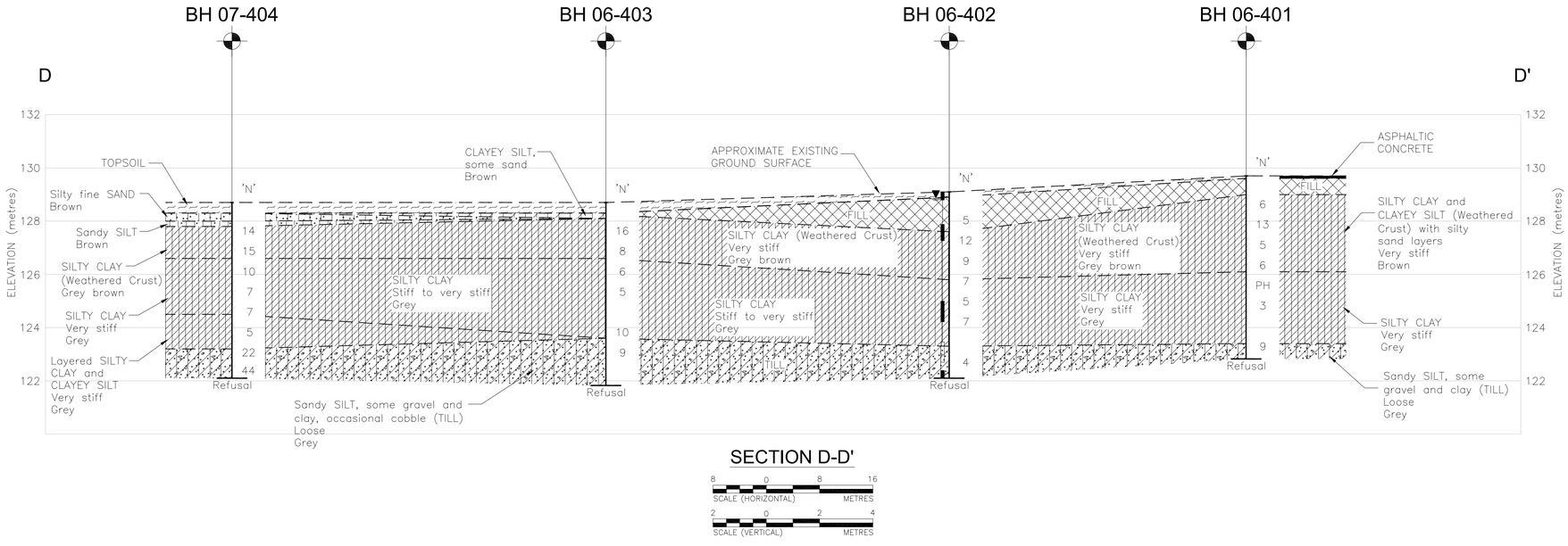
RAMP S-W
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

Golder Associates

Golder Associates Ltd.
OTTAWA, ONTARIO, CANADA

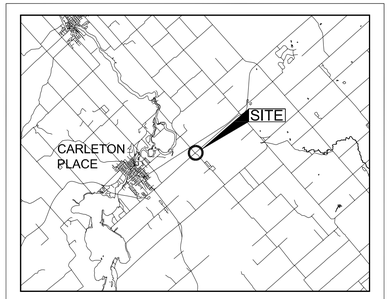




SECTION D-D'

8 0 8 16
SCALE (HORIZONTAL) METRES

2 0 2 4
SCALE (VERTICAL) METRES



KEY PLAN

LEGEND

- Borehole – Current Golder Associates Ltd. Investigation
- A/2 Location of cross-section
- Seal
- Piezometer
- N Standard Penetration Test value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- Water Level in Piezometer

No.	ELEVATION	LOCATION	
		NORTHING	EASTING
06-201	130.0	5001075.1	337105.1
06-202	130.0	5001110.2	337074.8
06-203	129.4	5001143.8	337045.9
06-204	130.4	5001172.4	337017.4
06-205	129.4	5001285.3	336890.5
06-206	129.1	5001319.3	336853.9
06-207	129.1	5001339.8	336830.6
06-208	129.0	5001367.5	336802.4
07-209	128.3	5001415.9	336747.9
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06-503	128.9	5001425.3	336859.7
06-601	129.5	5001154.4	337011.9

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

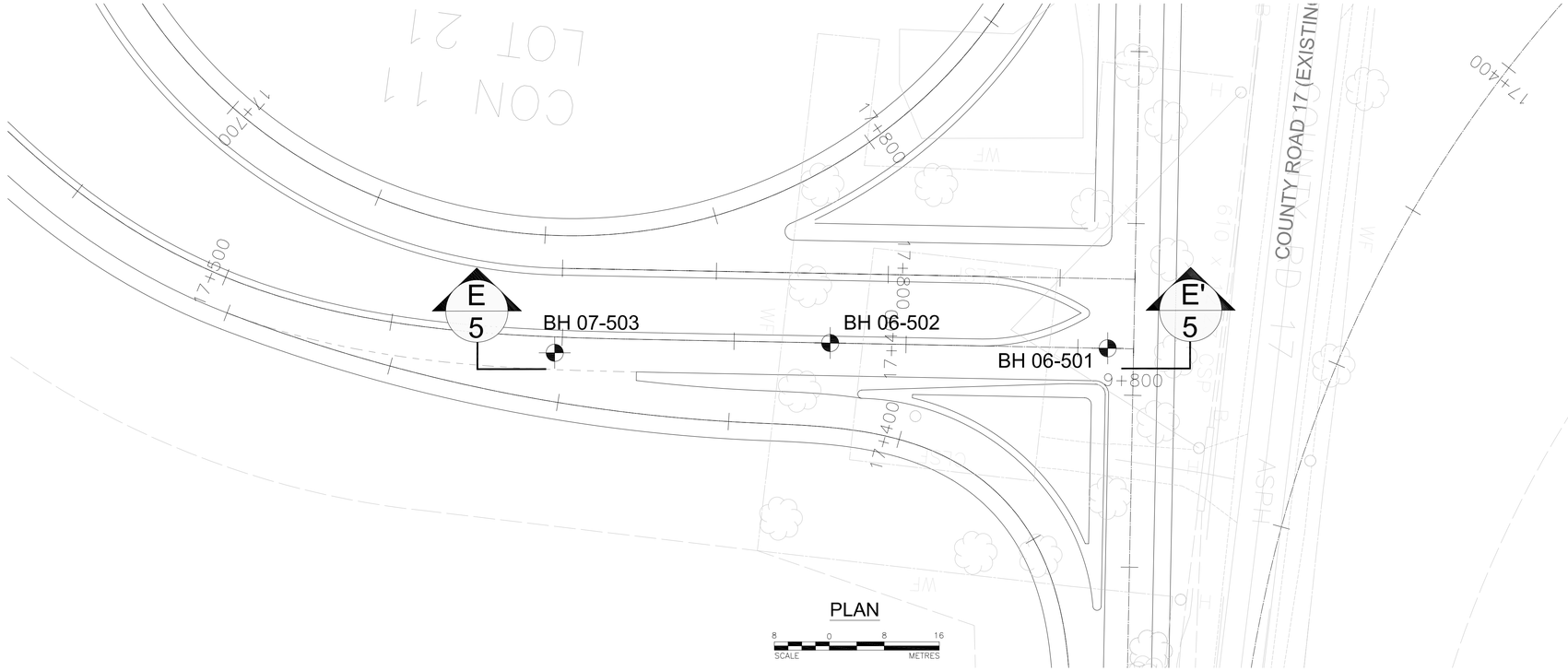
NO.	DATE	BY	REVISION

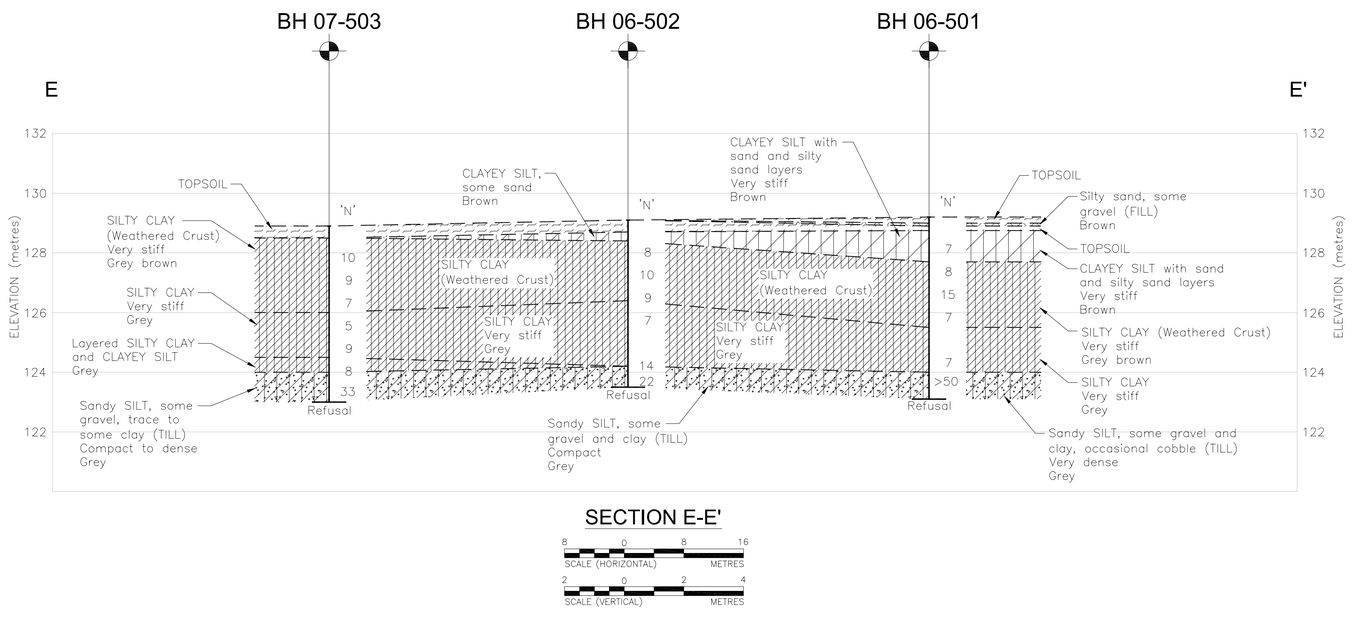
Geocres No. 31F-161

HWY. 7	PROJECT NO. 06-1120-014-2000		DIST.
SUBM'D. M.I.C.	CHKD. M.I.C.	DATE: NOVEMBER 2006	SITE:
DRAWN: N.B.H.S.	CHKD.	APPD.	DWG. 4

061120014-2000-02_MTM_NAD83.dwg

1:1





SECTION E-E'

8 0 8 16
SCALE (HORIZONTAL) METRES

2 0 2 4
SCALE (VERTICAL) METRES

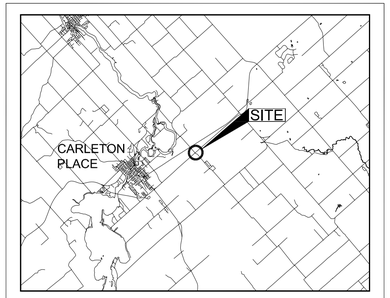
HWY. 7

WP No. 252-99-00

RAMP E-N/S
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

Golder Associates Ltd.
OTTAWA, ONTARIO, CANADA



KEY PLAN

LEGEND

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- Piezometer
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		NORTHING	EASTING
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06-304	129.4	5001154.1	337098.7
06-305	129.7	5001189.0	337096.1
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06-403	128.7	5001350.1	336869.2
06-404	128.7	5001411.2	336873.9
06-501	129.2	5001350.9	336824.2
06-502	129.1	5001380.4	336851.7
06-503	128.9	5001425.3	336859.7
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METRIC
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NO.	DATE	BY	REVISION

Geocres No. 31F-161

HWY. 7		PROJECT NO. 06-1120-014-2000	DIST.
SUBM'D. M.I.C.	CHKD. M.I.C.	DATE: NOVEMBER 2006	SITE:
DRAWN: J.M.	CHKD.	APPD.	DWG. 5

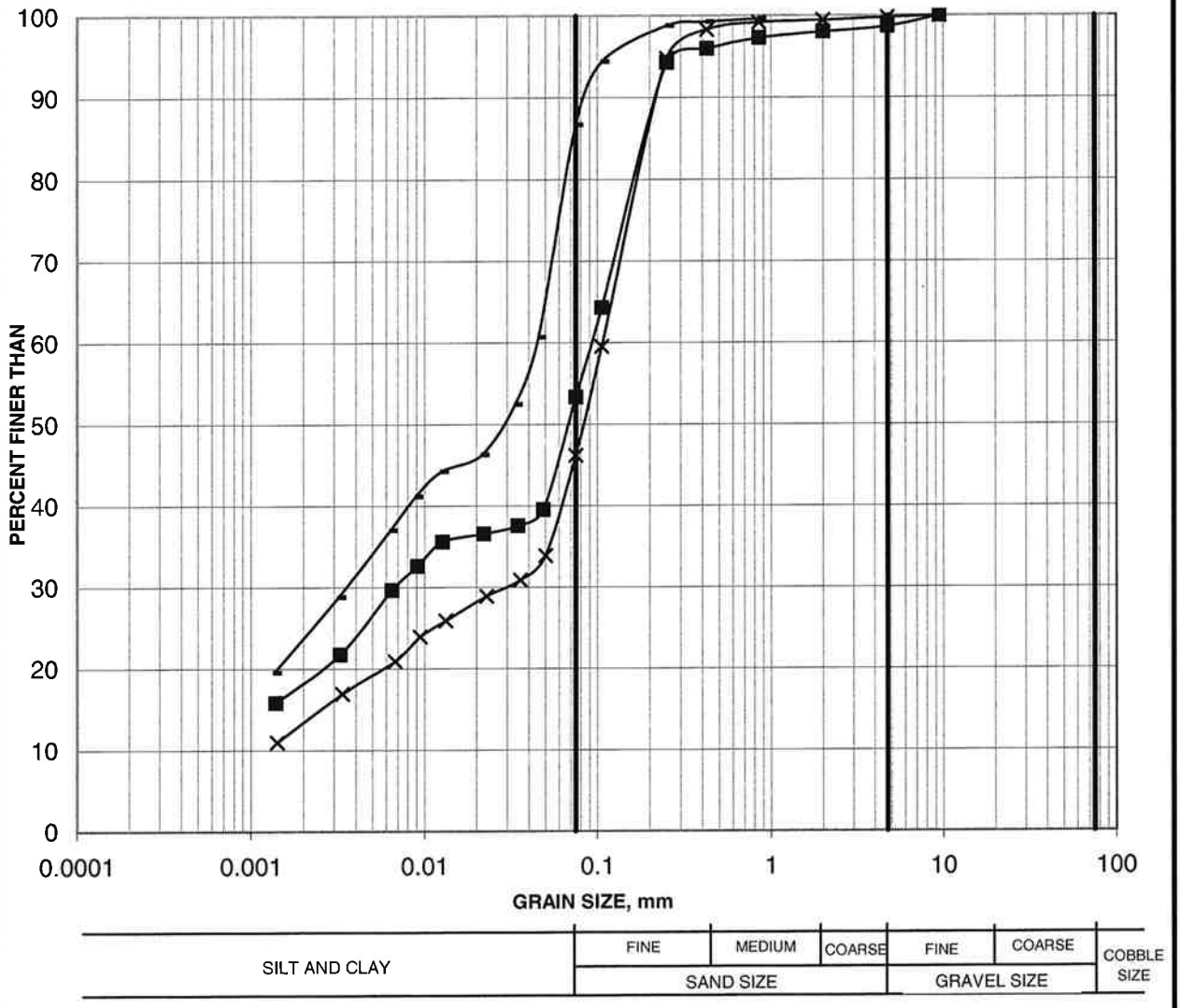
061120014-2000-02_MTM_NAD83.dwg

1:1

GRAIN SIZE DISTRIBUTION

FIGURE 1

Clayey Silt



Borehole	Sample	Depth (m)
06-201	2	1.52-2.13
06-306	1	0.76-1.37
06-401	1	0.76-1.37

Received:

Project: 061120014

Golder Associates

25-Jul-07

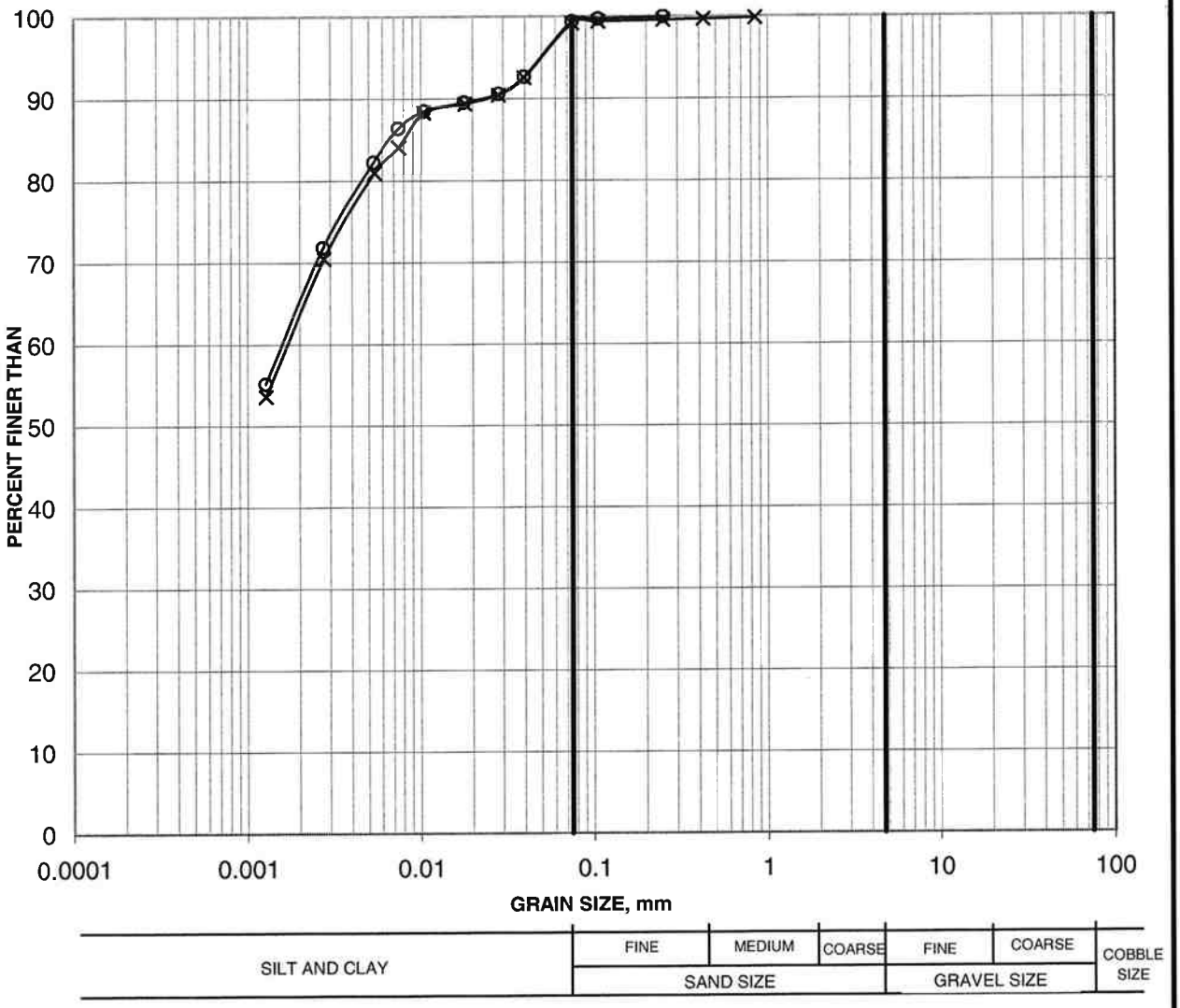
Created by: MaD

Checked by: BaJ

GRAIN SIZE DISTRIBUTION

FIGURE 2

Weathered Silty Clay to Clay



Borehole	Sample	Depth (m)
06-204	4	3.05-3.66
06-208	2	1.52-2.13

Received:

Project: 061120014

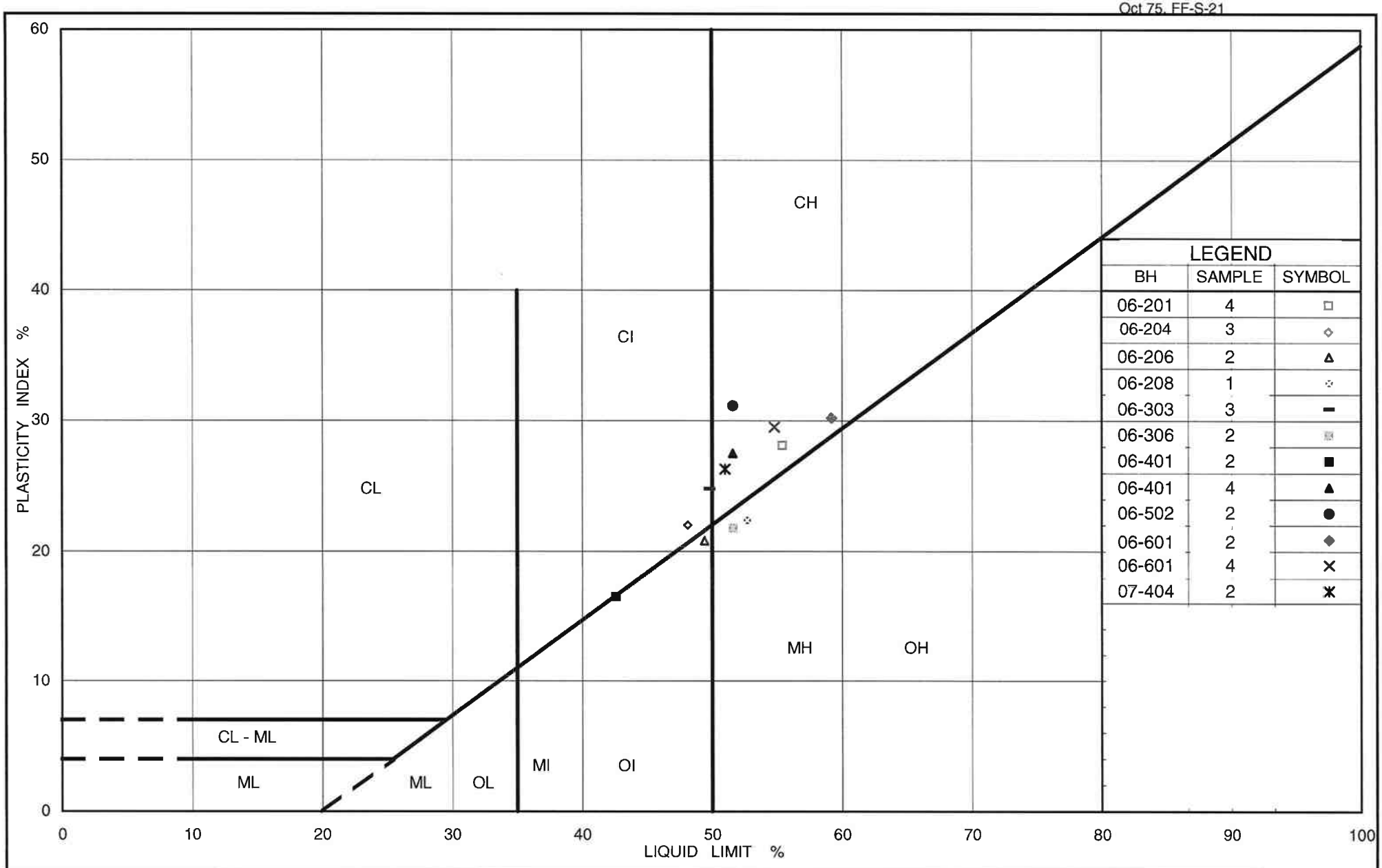
Golder Associates

25-Jul-07

Created by: MaD

Checked by: BaJ

Oct 75. FF-S-21



Ministry of Transportation
Ontario

PLASTICITY CHART
Weathered Silty Clay to Clay

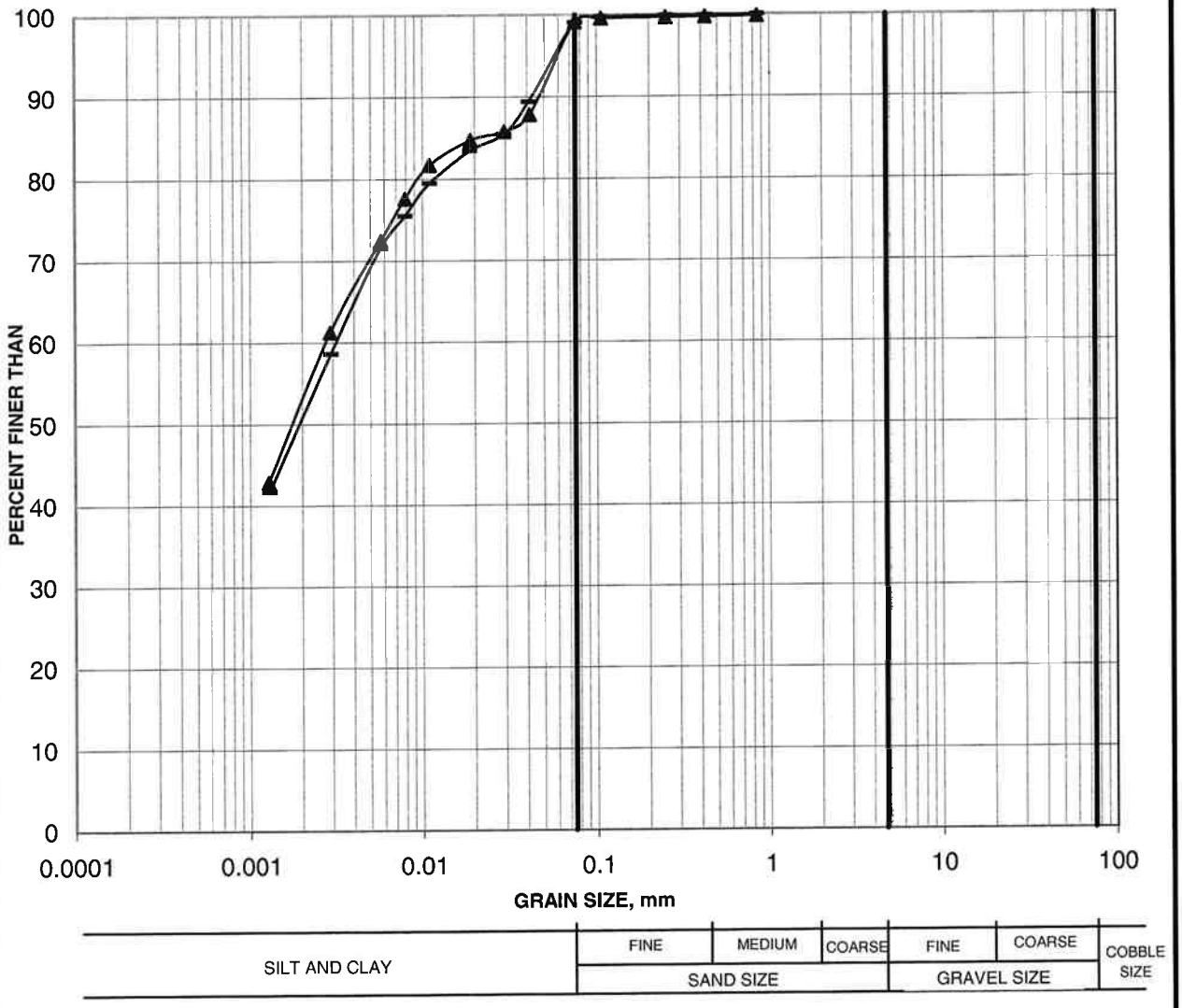
FIG No.3

Project No. 061-120014

GRAIN SIZE DISTRIBUTION

FIGURE 4

Unweathered Silty Clay to Clay



Borehole	Sample	Depth (m)
06-201	5	3.81-4.42
06-303	4	3.05-3.66

Received:

Project: 061120014

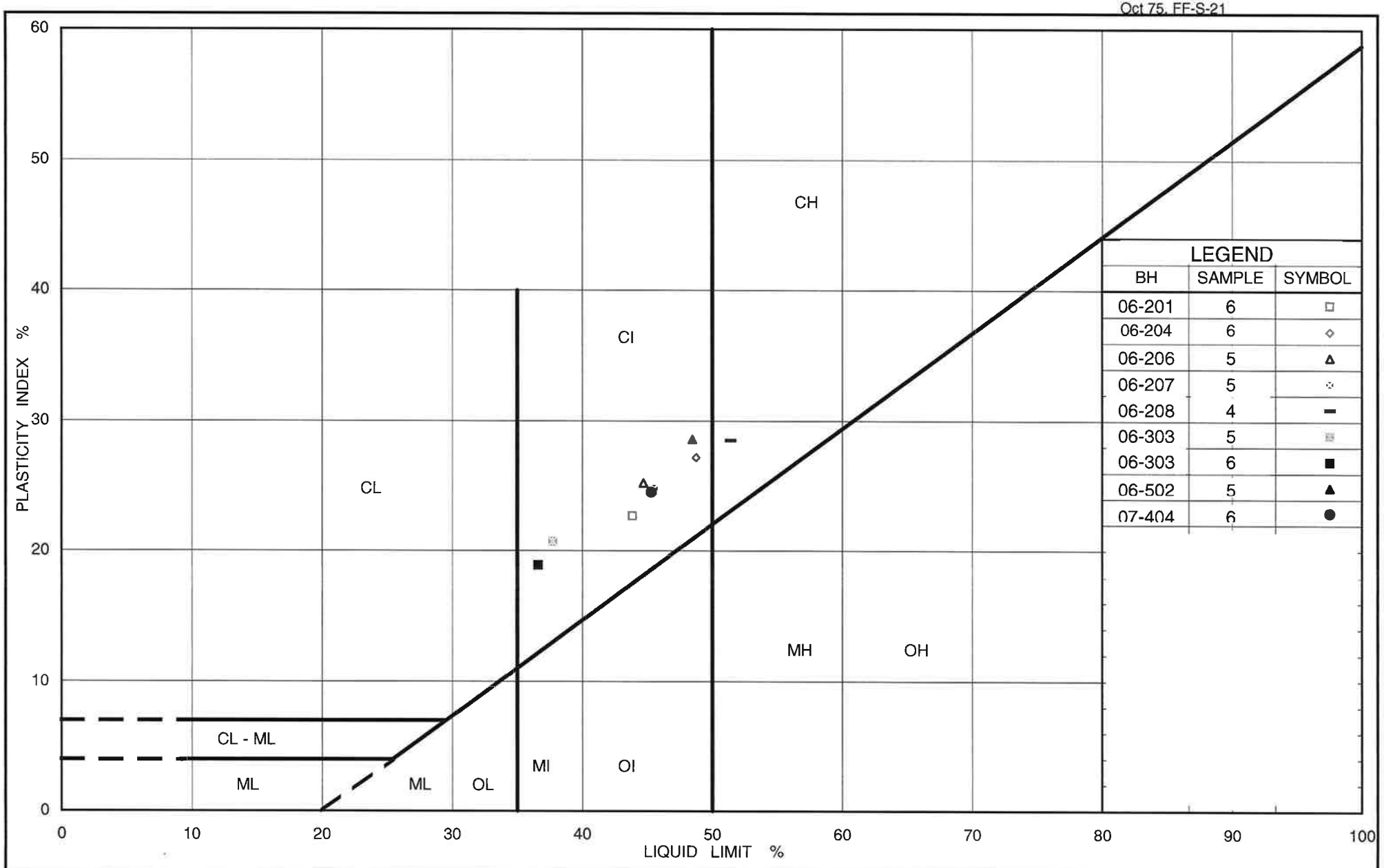
Golder Associates

25-Jul-07

Created by: MaD

Checked by: BaJ

Oct 75, FF-S-21

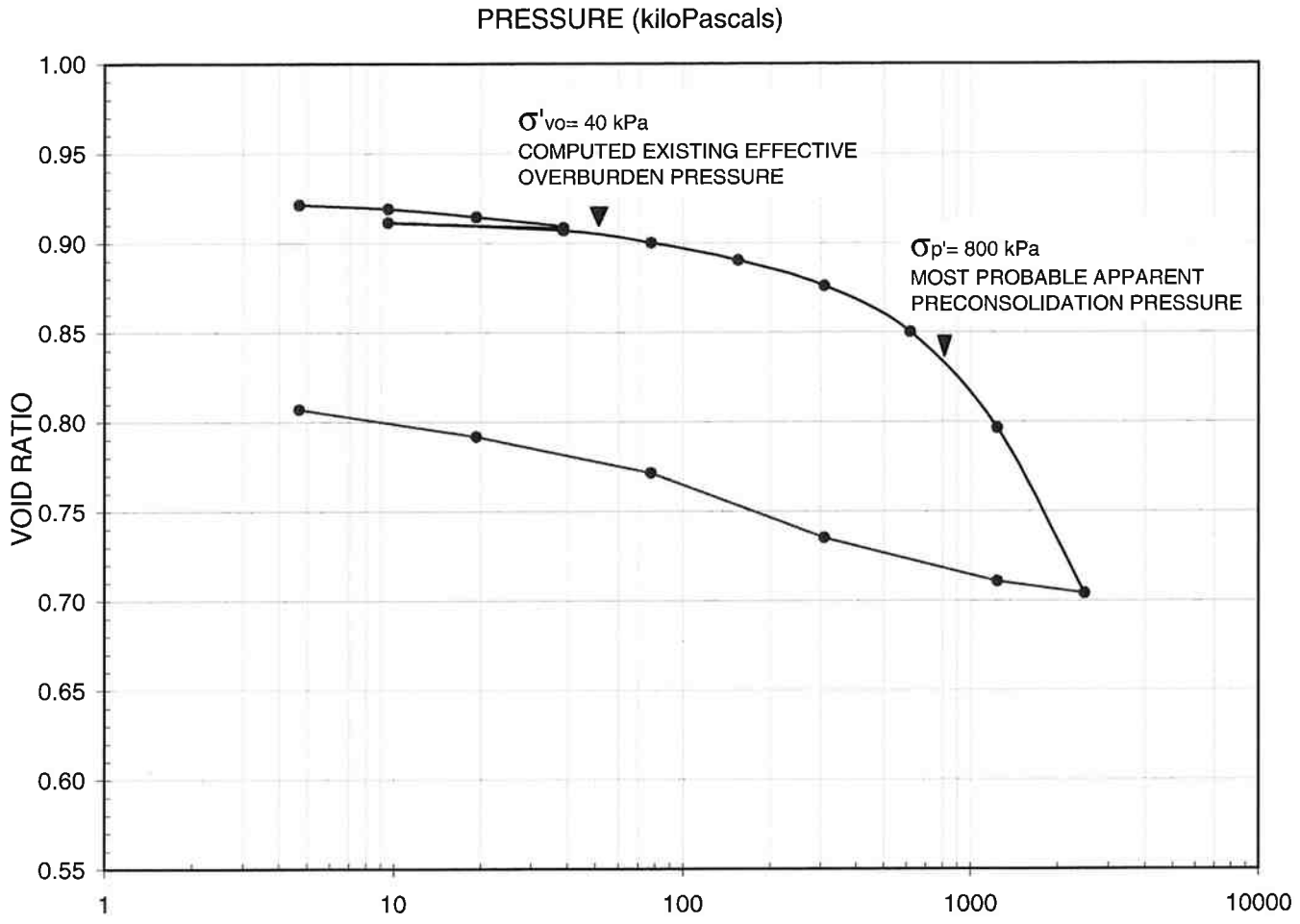


Ministry of Transportation
Ontario

PLASTICITY CHART
Unweathered Silty Clay to Clay

FIG No. 5

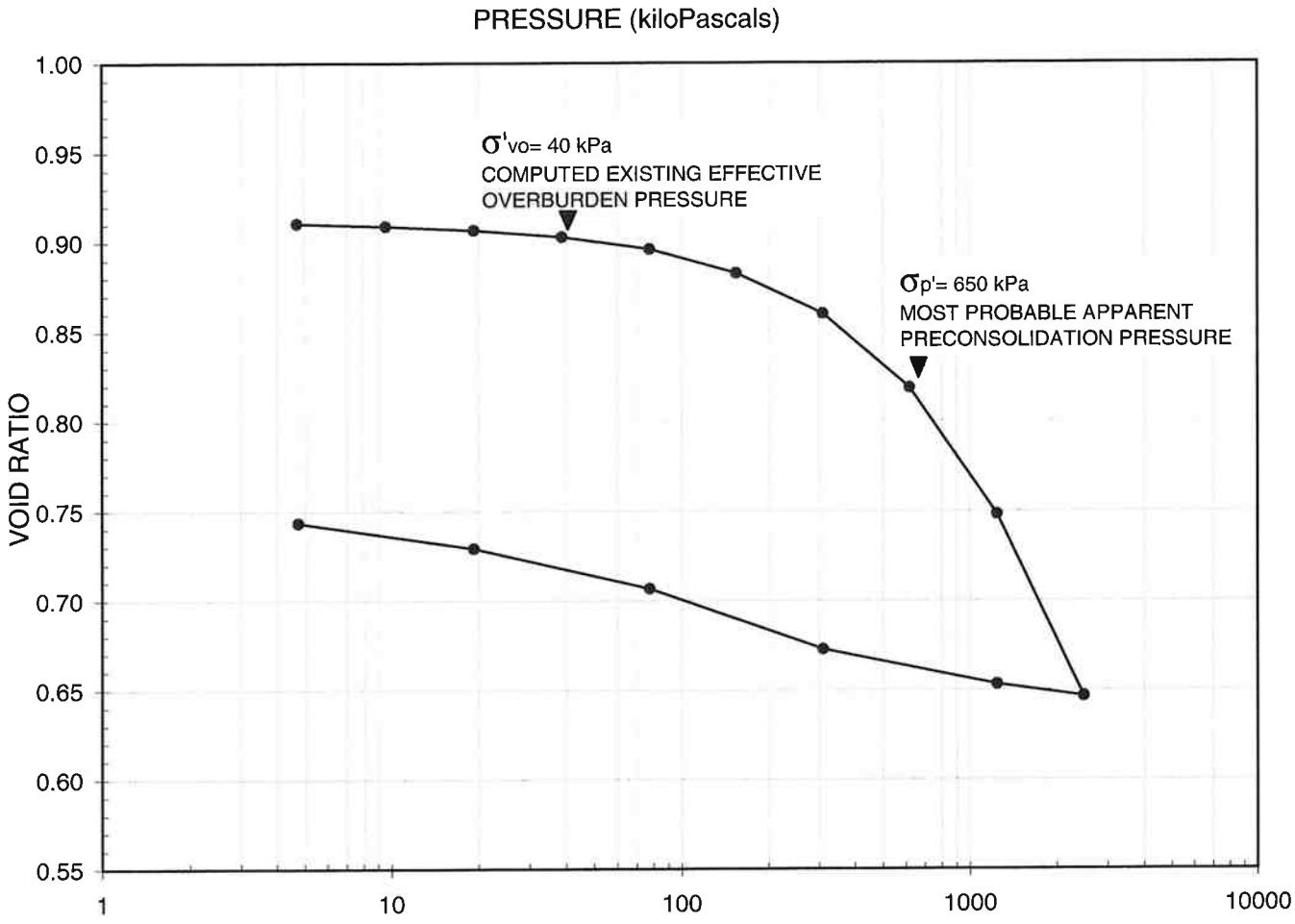
Project No. 06-1120014



LEGEND

Borehole:	06-207	w_i = 32%	S_o = 96%
Sample:	5	w_f = 30%	C_c = 0.31
Depth (m):	3.7-4.1	w_l = 46%	C_r = 0.007
		w_p = 21%	

Golder Associates		SCALE: AS SHOWN	TITLE: **CONSOLIDATION TEST RESULTS**
		DATE: 07/25/07	
		DESIGN: NA	
		CADD: NA	
FILE No.: Consolidation summary		CHECK:	
PROJECT No.: 061120014	REV.: 0	REVIEW:	FIGURE: 6



LEGEND

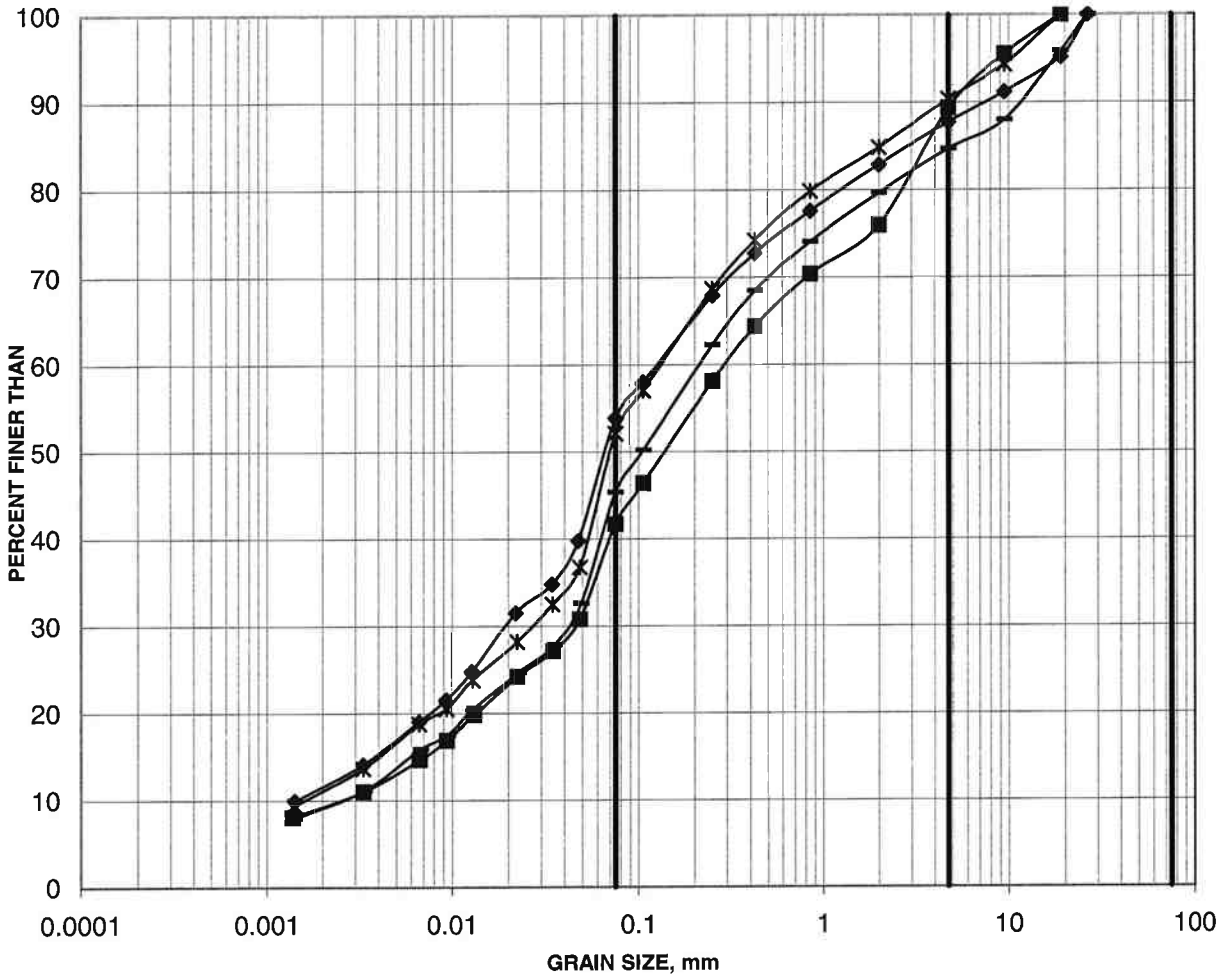
Borehole:	06-303	w_i = 32%	S_o = 95%
Sample:	5	w_f = 28%	C_c = 0.34
Depth (m):	3.7-4.1	w_l = 38%	C_r = 0.007
		w_p = 17%	

Golder Associates		SCALE: AS SHOWN	TITLE: **CONSOLIDATION TEST RESULTS**
		DATE: 07/25/07	
		DESIGN: NA	
		CADD: NA	
FILE No.: Consolidation summary		CHECK:	
PROJECT No.: 061120014	REV.: 0	REVIEW:	FIGURE: 7

GRAIN SIZE DISTRIBUTION

FIGURE 8

Sandy Silt and Silty Sand Till



Borehole	Sample	Depth (m)
06-201	7	5.49-5.91
06-206	6	5.33-5.94
06-306	4	3.05-3.44
06-502	5	4.57-5.18

Received:

Project: 061120014

Golder Associates

25-Jul-07

Created by: MaD

Checked by: BaJ

APPENDIX A

OPERATIONAL CONSTRAINT

OPERATIONAL CONSTRAINT

Special Provision

Protection of Subgrade Soils at the County Road 17 Interchange

In order to limit disturbance to the sensitive clayey subgrade soils that will be exposed within the embankment footprints at the County Road 17 Interchange site, following stripping of any fill material or topsoil:

- The Contractor shall minimize travelling over the clayey subgrade soils.
- The initial layers of embankment fill should be placed as soon as possible following the stripping of fill material or topsoil.