



December 2009

REPORT ON

FOUNDATION INVESTIGATION AND DESIGN REPORT PROPOSED HIGH MAST LIGHT POLES HIGHWAY 417 EXPANSION EAGLESON ROAD TO HIGHWAY 7 G.W.P. 255-98-00

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REPORT



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PART A

**FOUNDATION INVESTIGATION REPORT
PROPOSED HIGH MAST LIGHT POLES
HIGHWAY 417 EXPANSION
EAGLESON ROAD TO HIGHWAY 7
G.W.P. 255-98-00**



1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by McCormick Rankin Corporation (MRC) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out a foundation investigation associated with the expansion of Highway 417 from Eagleson Road westerly to Highway 7 in Ottawa, Ontario.

Foundation investigation services are required on this project for the following components:

- High Fill embankment widening and structure modifications at Carp Road;
- Replacement of Culverts 60 and 60D2 near Eagleson Road;
- New high mast light poles;
- New trichord overhead, cantilever and changeable message signs;
- High Fill embankments for the realigned E-N/S and N/S-W Ramps at Carp Road; and,
- Carp River bridge widening and replacement.

This report addresses the forty-nine high mast light poles associated with the Highway 417 expansion, as part of G.W.P. 255-98-00.

The terms of reference for the original scope of work are outlined in the MTO's Request for Proposal (RFP) dated February 2007 and in Section 6.8 (Foundations Engineering) of the *Technical Proposal* for this assignment. The work was carried out in accordance with Golder's Quality Control Plan dated November 2007.



2.0 SITE DESCRIPTION

The proposed high mast light (HML) poles are located over an approximate distance of 6.1 km along Highway 417, extending from about 95 m east of the Carp Road Underpass to 820 m west of the Eagleson Road Underpass, in Ottawa, Ontario.

The ground surface along the highway alignment in the area of the proposed HMLs slopes downward from Carp Road east to the Carp River, varying in elevation from about 110 m to 93 m (with the exception of Borehole 08-501 where the Elevation is 123 m at the Carp Road ramp). The ground surface then rises to about Elevation 100 m west of Terry Fox Drive. A rock outcrop is present directly east of Terry Fox Drive within the Highway 417 median, where the ground surface is at about Elevation 106 m. The ground surface along the remainder of the highway in the area of the proposed HMLs varies from about Elevation 102 m east of the rock outcrop to 92 m west of Eagleson Road.



3.0 INVESTIGATION PROCEDURES

The subsurface investigation was carried out at the proposed HML pole locations in June, July, August, and September 2008, at which time forty-nine boreholes (numbered 08-501 to 08-549) were advanced at the locations shown on Drawings 1 to 4. In addition, seven boreholes (numbered 08-521A to 08-525A, 08-544A and 08-545A) were put down at revised HML pole locations in July and October 2008, as shown on Drawings 2 to 4. The boreholes were advanced at each of the proposed HML pole locations that were established in the field by J.D. Barnes Ltd. Land Surveyors.

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 depths of about 3.3 to 11.9 m below the existing ground surface.

Soil samples were obtained at intervals ranging from 0.75 m to 1.5 m, using a 50 mm outer diameter (O.D.) split-spoon sampler in accordance with Standard Penetration Test (SPT) procedures. In-situ vane testing (using an MTO "N"-size vane) was carried out within the cohesive deposits where possible. Where bedrock was encountered within 10 m depth, bedrock coring was carried out in the boreholes using NQ-size coring equipment.

The water levels in the open boreholes were observed throughout the drilling operations, and standpipe piezometers were installed in six of the boreholes to permit monitoring of the groundwater levels across the site. The standpipes consist of 50 mm diameter rigid PVC pipe with a 1.2 m to 1.5 m long slotted screen section, installed within silica sand backfill and sealed by a minimum of 0.6 m of bentonite pellet backfill. The water levels in the standpipe piezometers were measured on either October 10 or December 8, 2008.

The boreholes were backfilled with bentonite pellets, mixed with native soils, and the site conditions restored following completion of work.

The field work was supervised throughout by members of Golder's technical staff, who located the boreholes, supervised the drilling, sampling and in situ testing operations, logged the boreholes, and examined and cared for the samples. The samples were identified in the field, placed in appropriate containers, labelled, and transported to Golder's laboratories in Ottawa and Mississauga for further examination. Index and classification tests consisting of grain size distribution, Atterberg limit and water content testing were carried out on selected soil samples in the Ottawa laboratory. Axial point load and unconfined compressive strength testing were carried out on selected rock core samples in the Mississauga laboratory. All of the laboratory tests were carried out to MTO and/or ASTM Standards as appropriate.

The borehole locations were established by J.D. Barnes Ltd. Land Surveyors. 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 4.

Borehole Number	MTM NAD83 Northing (m)	MTM NAD83 Easting (m)	Ground Surface Elevation (m)
08-501	5016001.0	347345.2	122.5
08-502	5016320.9	347932.5	110.5



Borehole Number	MTM NAD83 Northing (m)	MTM NAD83 Easting (m)	Ground Surface Elevation (m)
08-503	5016426.0	348047.7	109.0
08-504	5016529.8	348161.5	108.4
08-505	5016635.6	348277.5	107.7
08-506	5016742.7	348395.0	106.0
08-507	5016849.5	348512.1	105.4
08-508	5016966.9	348637.1	104.8
08-509	5017065.3	348745.0	104.2
08-510	5017164.9	348854.5	103.6
08-511	5016997.1	348841.7	104.8
08-512	5017043.3	348972.7	104.0
08-513	5017199.4	349037.8	103.0
08-514	5017266.3	348966.4	102.6
08-515	5017396.4	348858.0	106.2
08-516	5017425.2	348998.6	101.9
08-517	5017355.3	349063.9	102.4
08-518	5017438.8	349155.5	101.8
08-519	5017536.5	349262.6	100.8
08-520	5017632.3	349367.6	100.2
08-521	5017729.6	349480.8	98.5
08-521A	5017712.0	349459.2	98.7
08-522	5017821.2	349602.9	98.0
08-522A	5017806.3	349581.8	98.2
08-523	5017904.5	349730.8	96.5
08-523A	5017892.6	349711.4	96.7
08-524	5017978.5	349862.6	95.1
08-524A	5017970.0	349846.7	95.2
08-525	5018047.2	349992.6	94.2
08-525A	5018043.0	349984.6	94.2
08-526	5018115.7	350121.8	93.4
08-527	5018187.6	350257.7	94.0
08-528	5018257.7	350390.2	94.8
08-529	5018328.4	350523.7	95.7
08-530	5018400.9	350660.7	96.9



Borehole Number	MTM NAD83 Northing (m)	MTM NAD83 Easting (m)	Ground Surface Elevation (m)
08-531	5018457.7	350761.7	98.5
08-532	5018393.5	350847.0	102.1
08-533	5018409.5	350973.8	106.0
08-534	5018527.2	350871.4	100.3
08-535	5018577.9	350823.7	101.4
08-536	5018741.8	350898.1	101.5
08-537	5018765.5	351040.3	102.0
08-538	5018620.9	351001.2	104.7
08-539	5018731.1	351134.4	101.8
08-540	5018826.4	351245.0	100.2
08-541	5018928.8	351364.0	99.1
08-542	5019040.3	351493.7	96.5
08-543	5019138.8	351608.1	94.7
08-544	5019253.9	351693.8	93.3
08-544A	5019232.1	351716.5	92.5
08-545	5019321.8	351820.7	91.8
08-545A	5019334.5	351835.5	91.7
08-546	5019437.5	351955.2	92.2
08-547	5019539.9	352074.3	92.7
08-548	5019640.4	352191.0	92.3
08-549	5019730.4	352295.6	93.6



4.0 SITE GEOLOGY AND STRATIGRAPHY

4.1 Regional Geological Conditions

The study area for this assignment is located within two minor physiographic regions, the Smith Falls Limestone Plain and the Ottawa Valley Clay Plain, as delineated in *The Physiography of Southern Ontario*¹, that lies within the major physiographic region of the Ottawa-St. Lawrence Lowland. Most of both physiographic regions is underlain by a series of sedimentary rocks, consisting of sandstones, dolostones, limestones and shales that are in turn, underlain by igneous and metamorphic bedrock of the Precambrian Shield. The Shield rock generally outcrops to the north of the Ottawa River, and it is also present immediately below the overburden in a localized area between the Hazeldean Fault (approximately the location of the Carp River) and the Ottawa River.

The Smiths Falls Limestone Plain is characterized by shallow overburden deposits overlying limestone bedrock of the Ottawa Formation; this formation consists of grey limestone with some shaly partings and seams.² The shallow overburden soils are typically between 1 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. 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.²

The Ottawa Valley Clay Plain is characterized by relatively thick deposits of sensitive marine clay, silt and silty clay that were deposited within the Champlain Sea basin. These deposits, known as the Champlain Sea clay or Leda clay, overlie relatively thin, commonly reworked glacial till and glaciofluvial deposits, that in turn overlie bedrock.² West of the Carp River valley along Highway 417, the upper bedrock consists of limestone of the Ottawa Formation, as described above. Within and immediately east of the Carp River valley, the upper bedrock consists of sandstones and dolostones that have been cut by igneous and metamorphic rocks, controlled by faulting in the vicinity of the Carp River.²

4.2 Site Stratigraphy

The detailed subsurface soil, bedrock 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 and bedrock samples, are given on the attached Record of Borehole/Drillhole sheets and on Figures 1 to 8. 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.

The subsurface conditions at the proposed HML pole locations vary along Highway 417, as follows:

- Along the western portion of the site between Carp Road and Palladium Drive, the subsurface conditions generally consist of fill underlain by peat, silts, sands and till with occasional topsoil, clayey silt, silty clay and clay layers. Limestone bedrock was encountered beneath the overburden at depths between about 0.8 and 7.1 m below the existing ground surface within this portion of the site.

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.

² Belanger, J.R. "Urban Geology of Canada's National Capital Area", in *Urban Geology of Canadian Cities*, Geological Association of Canada Special Paper 42, Ed. P.F. Karrow and O.L. White, 1998.



- East of Palladium Drive to Terry Fox Drive, the subsurface conditions generally consist of topsoil underlain by a deposit of sensitive clayey silt, silty clay and clay.
- Between Terry Fox Drive and Castlefrank Drive the subsurface conditions typically consist of fill underlain by clayey silt and silty clay and/or till with occasional topsoil, sandy silt, silty sand and sand layers. Sandstone bedrock was encountered within this portion of the site at depths between about 0.0 and 8.1 m below the existing ground surface.
- East of Castlefrank Drive the subsurface conditions generally consist of topsoil or organic matter underlain by a deposit of silty clay and clay.

A more detailed description of the subsurface conditions encountered in the boreholes put down for the present investigation at the HML pole locations is provided in the following sections.

4.2.1 Carp Road to Palladium Drive – Station 28+500 to 30+485

Boreholes 08-501 to 08-512 were advanced along this section of the site. The borehole locations are shown on Drawings 1 and 2.

4.2.1.1 Fill Material

Fill material, associated with the construction of the existing highway embankments, was encountered at ground surface at most of the borehole locations. The fill material at Boreholes 08-502 to 08-505 ranges in thickness from about 0.9 to 1.7 m and consists of peat with silt sandy/sand, wood pieces and/or cobbles/boulders. This fill material was likely placed in this area during the construction of the eastbound and westbound lanes of Highway 417. The fill material at the remainder of the boreholes consists of topsoil, sandy silt or sand and varies in thickness from about 0.7 to 3.1 m. Cobbles were encountered in the fill material at Borehole 08-511.

Standard Penetration Test (SPT) “N” values within the fill range from 3 to 13 blows per 0.3 m of penetration indicate of a loose to compact relative density.

The measured natural water content of one sample of the peat fill from Borehole 08-502 is 103 percent.

4.2.1.2 Topsoil and Peat

Topsoil was encountered immediately below the ground surface at Boreholes 08-507 to 08-510, and beneath the fill material at Borehole 08-512. The topsoil thickness as encountered in these boreholes is about 200 mm.

A layer of peat was encountered beneath the fill material at Boreholes 08-502 to 08-505, and immediately below the ground surface at Borehole 08-506. The thickness of the peat varies from about 0.3 to 1.4 m. SPT “N” values within the peat range from 4 to 6 blows per 0.3 m of penetration, indicative of a firm consistency. The measured natural water contents of two samples of the peat are 101 and 348 percent. The organic contents of two samples of the peat are 33 and 74 percent.



4.2.1.3 Layered Sands, Silts and Clays

The fill material, peat and/or topsoil are underlain by a layered deposit of silty sand, sandy silt, silt, sand, and/or sand/silty sand and gravel. Clayey silt or silty clay layers were encountered at Boreholes 08-502, 08-510 and 08-511. The layered deposit ranges in thickness from about 0.2 to 4.0 m. The base of the deposit was encountered at about Elevation 115.4 m at Carp Road, declining eastward to about Elevation 100.8 m at Palladium Drive.

SPT “N” values within the layered deposit of sands and silts generally range from 5 to 54 blows per 0.3 m of penetration, indicating a variable, loose to very dense relative density. However a very dense layer of silty sand was encountered at Borehole 08-501, where an SPT “N” value of greater than 100 blows per 0.3 m of penetration was measured. An SPT “N” value of greater than 100 blows per 0.3 m of penetration was also encountered within the clayey silt deposit at Borehole 08-511; however this value reflects sampler refusal on the bedrock surface.

Grain size distribution test results obtained from samples of the cohesionless soil strata are shown on Figure 1. The measured natural water contents of samples of the layered deposit range from 23 to 52 percent.

4.2.1.4 Sand, Sandy Silt and Silty Sand Till

A till deposit, between about 0.1 and 3.0 m in thickness, was encountered below the layered sands, silts and clays in Boreholes 08-502 to 08-510 and 08-512. The till deposit where present immediately overlies the bedrock surface, which varies between Elevations 99.3 and 107.1 m.

The glacial till is a heterogeneous mixture of gravel, cobbles, and boulders in a matrix of sand, sandy silt and silty sand with trace to some clay. The results of grain size distribution testing on three samples of the glacial till are provided on Figure 2. It is noted that the samples were retrieved using a 50 mm diameter sampler and therefore the test results do not reflect the cobble and boulder portions of the deposit.

SPT “N” values of between 1 and 59 blows per 0.3 metres of penetration were measured in the glacial till, indicating a variable, very loose to very dense state of packing. Two SPT “N” values of greater than 100 blows per 0.3 m of penetration were also measured, but likely reflect the cobble and boulder content in the till or the bedrock surface.

The measured natural water content of the glacial till ranges from 7 to 11 percent.



4.2.1.5 Limestone Bedrock

The existing fill material and native soils are underlain by limestone bedrock with shale seams. The bedrock was cored at all of the borehole locations where auger refusal was encountered. The following table summarizes the bedrock surface depth and elevation as encountered at the borehole locations.

HML Pole No.	Borehole No.	Ground Surface Elevation at HML (m)	Ground Surface Elevation in Borehole (m)	Bedrock Depth ⁽¹⁾ (m)	Bedrock Surface Elevation (m)
P1	08-501	121.9	122.5	7.1	115.4
P2	08-502	110.5	110.5	3.4	107.1
P3	08-503	109.0	109.0	3.3	105.7
P4	08-504	108.4	108.4	6.3	102.1
P5	08-505	107.7	107.7	5.6	102.1
P6	08-506	106.0	106.0	1.7	104.3
P7	08-507	105.4	105.4	3.8	101.6
P8	08-508	104.7	104.8	0.8	104.0
P9	08-509	104.2	104.2	3.0	101.2
P10	08-510	103.6	103.6	4.3	99.3
P11	08-511	104.8	104.8	2.5	102.3
P12	08-512	104.0	104.0	4.4	99.6

Note: ⁽¹⁾ Depth below ground surface at borehole location.

The limestone bedrock is light grey to black, laminated to medium bedded (although typically thinly to medium bedded), and medium strong to very strong. The bedrock is generally slightly weathered to fresh with occasional near vertical joints. Rock Quality Designation (RQD) values measured on the recovered bedrock core samples ranged from 0 to 100, with an average of approximately 73 percent, indicating a generally fair quality rock.

Laboratory point load index testing was carried out, axially, on six selected specimens from the bedrock core, and laboratory unconfined compressive strength testing was carried out on two selected specimens of the bedrock core. The results from the point load index testing correlate with uniaxial compressive strengths that range from 97 to 154 MPa, as shown on Figure 7. The two unconfined compressive strength tests measured values of about 56 and 109 MPa. These compressive strengths indicate a medium strong to very strong rock.



4.2.1.6 Groundwater Conditions

Two piezometers were installed in this section of the Highway 417 alignment, in Boreholes 08-504 and 08-510. The water levels observed during drilling and measured in the piezometers are summarized in the following table:

Borehole No.	Water Level in Open Borehole During Drilling		Water Level in Piezometer on October 10, 2008	
	Depth (m)	Elevation (m)	Depth (m)	Elevation (m)
08-501	5.2	117.3	N/A	N/A
08-502	2.0	108.5	N/A	N/A
08-503	1.1	107.9	N/A	N/A
08-504	N/A	N/A	1.6	106.8
08-505	2.6	105.1	N/A	N/A
08-506	0.0	106.0	N/A	N/A
08-507	0.6	104.8	N/A	N/A
08-508	1.5	103.3	N/A	N/A
08-509	3.4	100.8	N/A	N/A
08-510	N/A	N/A	2.3	100.3
08-511	5.2	99.6	N/A	N/A
08-512	3.2	100.8	N/A	N/A

The water levels observed in the open borehole during drilling may not represent the stabilized groundwater level at each location; indeed, wet soil samples were noted in some of the boreholes above the observed water level, as shown on the borehole records. It should be noted that groundwater levels are expected to fluctuate seasonally, and are expected to rise during wet periods of the year.

4.2.2 Palladium Drive to Terry Fox Drive – Station 30+485 to 31+100/10+000 to 11+500

Boreholes 08-513 to 08-530 and 08-521A to 08-525A were advanced along this section of the Highway 417 alignment. The borehole locations are shown on Drawings 2 and 3.

4.2.2.1 Fill Material

Approximately 0.9 m to 3.7 m of fill material, associated with the construction of the existing highway embankments or structures, was encountered immediately below the ground surface at Boreholes 08-515, 08-516, 08-520 and 08-526. The fill material generally consists of topsoil, silty clay and clayey silt containing varying amounts of gravel, cobbles and organic matter. In Borehole 08-526 on the east bank of the Carp River, the 1.5 m thick fill layer consists of organic silt containing peat, silty sand and sand.



The measured SPT “N” values within the fill range from 1 to 10 blows per 0.3 m of penetration, indicative of a soft to stiff consistency.

The measured natural water content of one sample of the fill from Borehole 08-526 is 39 percent.

4.2.2.2 *Topsoil, Organic Matter and Alluvium*

About 100 to 400 mm of topsoil or organic matter was encountered immediately below the ground surface at most of the boreholes. A buried layer of topsoil was encountered beneath the fill at Boreholes 08-515 and 08-520 with thicknesses of about 300 and 200 mm, respectively.

A 0.7 m thick layer of alluvium was encountered beneath the fill material at Borehole 08-526. An SPT “N” value of 2 blows per 0.3 m of penetration was recorded in the alluvium, indicative of a very loose relative density. The measured natural water content of the sample of alluvium is 57 percent.

4.2.2.3 *Sensitive Clayey Silt, Silty Clay and Clay*

The fill material and/or topsoil are underlain by a thick deposit of clayey silt, silty clay and clay. The deposit was fully penetrated at Boreholes 08-513 to 08-517, 08-522A, 08-528 and 08-530, with the base of the deposit encountered at depths ranging from about 4.6 to 10.7 m below the existing ground surface level (Elevations 85.8 to 98.6 m). The silty clay deposit was proven to depths ranging from 10.7 to 10.8 m at the remaining boreholes (Elevations 82.7 to 91.1 m).

The upper 0.6 to 0.9 m of the deposit at Boreholes 08-514, 08-517 and 08-518 consists of clayey silt/silty clay containing sand to sandy silt seams/layers. At Boreholes 08-525 and 08-525A, an approximately 0.3 to 0.4 m thick layer of silty sand overlies the silty clay deposit. The upper portion of the silty clay deposit (i.e. about 1.2 m) at Borehole 08-526 consists of a organic clayey silt. The measured natural water content of the organic clayey silt is 57 percent.

The upper 0.6 to 4.2 m of the deposit (with the exception of Borehole 08-526) has been weathered to a grey-brown crust. The measured SPT “N” values in this material range from weight of hammer to 12 blows per 0.3 m of penetration. In situ vane tests carried out in this deposit measured undrained shear strengths that range from 50 to greater than 96 kPa. The results of this in situ testing indicate that the weathered crust has a stiff to very stiff consistency. The sensitivity of the weathered deposit ranges from 3 to 13 reflecting a sensitive to extrasensitive soil. A thin layer of silty sand underlies the weathered silty clay at Borehole 08-530.

The results of grain size distribution testing on samples of the weathered portion of the deposit are shown on Figure 3. Atterberg limits testing on two samples of the weathered material measured plasticity index values of 32 and 33 percent and liquid limit values of 66 and 52 percent, as shown on Figure 4, indicating a silty clay to clay soil of intermediate to high plasticity. The measured natural water content of the weathered material ranges from 28 to 58 percent.



The silty clay below the depth of weathering (with the exception of Boreholes 08-514 and 08-515), and beneath the organic clayey silt at Borehole 08-526, is grey. In situ vane testing carried out in this material measured undrained shear strengths that range from 19 to 54 kPa, indicating a soft to stiff consistency. However, the average undrained shear strength for this material is 34 kPa, indicating that the grey (unweathered) silty clay to clay has a generally firm consistency. The sensitivity of the unweathered deposit ranges from 3 to 23 reflecting a sensitive to extrasensitive soil.

The results of grain size distribution testing on samples of the unweathered portion of the deposit are shown on Figure 5. Atterberg limits testing on samples of the unweathered portion of the deposit measured plasticity index values that range from 9 to 46 percent and liquid limit values that range from 22 to 59 percent, as shown on Figure 6, confirming that this material varies from a clayey silty to silty clay to clay of low to high plasticity. The measured natural water content of the unweathered material ranges from 25 to 68 percent. These natural water contents are generally above the measured liquid limits.

The bottom 0.5 to 1.4 m of the deposit at Boreholes 08-514 to 08-517, 08-520, 08-521, 08-521A, 08-528 and 08-530 grades into a lower plasticity clayey silt, silty clay and clayey silt, or sandy silt and clayey silt. In situ vane testing carried out in these materials measured undrained shear strengths that range from 29 to greater than 96 kPa, indicating a firm to stiff consistency. The sensitivity of the this deposit ranges from 2 to 10 reflecting a sensitive to extrasensitive soil.

A measured natural water content in this deposit is 49 percent. A thin layer of sandy silt was encountered above the silty clay and clayey silt at Borehole 08-521A.

4.2.2.4 Sandy Silt and Silty Sand

The clayey silt to clay deposit is underlain by sandy silt or silty sand at Boreholes 08-513 to 08-517. The deposit extends to depths of between about 6.5 and 11.1 m below the existing ground surface (Elevations 91.9 to 96.1 m). The measured SPT 'N' values in this material range from weight of hammer to 16 blows per 0.3 m of penetration, indicating a very loose to compact state of packing. The results of grain size distribution testing on two samples of the deposit are included on Figure 1. The measured natural water contents of two sample of the sandy silt are 16 and 31 percent.

4.2.2.5 Sandy Silt to Silty Sand Till

A till deposit, which extends to depths of about 8.2 to 10.8 m below the existing ground surface (Elevations 87.4 to 95.5 m), underlies the silty clay or sandy silt/silty sand at Boreholes 08-513, 08-514, 08-515, 08-516, 08-522A, 08-528 and 08-530. The till deposit is about 0.5 m to 2.2 m in thickness where it was fully penetrated.

The glacial till consists of a heterogeneous mixture of gravel, cobbles, and boulders in a matrix of sandy silt and silty sand with trace to some clay. The results of grain size distribution testing on three samples of the glacial till are provided on Figure 2. It is noted that the samples were retrieved using a 50 mm diameter sampler and therefore the test results do not reflect the cobble and boulder portions of the deposit.



SPT “N” values of between 1 and 33 blows per 0.3 m of penetration were measured in the glacial till, indicating a very loose to very dense state of packing. One SPT “N” value of greater than 100 blows per 0.3 m of penetration was also measured, but likely reflects the cobble and boulder content in the till.

The measured natural water content of the glacial till ranges from 10 to 12 percent.

The till deposit at Borehole 08-528 is underlain by a layer of sand which was proven to a depth of about 10.6 m below the existing ground surface (Elevation 84.2 m). One SPT “N” value of 52 blows per 0.3 m of penetration was measured in the sand indicating a very dense state of packing. The results of grain size distribution testing on a sample of this deposit are included on Figure 1. The measured natural water content on the sample of the sand is 8 percent.

4.2.2.6 Limestone Bedrock

The till is underlain by limestone bedrock with shale seams and interbeds, as encountered at Boreholes 08-513, 08-514 and 08-530. The bedrock was cored after auger refusal was encountered at each of these borehole locations. The following table summarizes the bedrock surface depth and elevation as encountered at the borehole locations.

HML Pole No.	Borehole No.	Ground Surface Elevation at HML (m)	Ground Surface Elevation in Borehole (m)	Bedrock Depth ⁽¹⁾ (m)	Bedrock Surface Elevation (m)
P13	08-513	103.0	103.0	8.2	94.8
P14	08-514	102.6	102.6	8.7	93.9
P30	08-530	96.9	96.9	8.7	88.2

Note: ⁽¹⁾ Depth below ground surface at borehole location.

The limestone bedrock is light grey to black, laminated to medium bedded, and medium strong to very strong. The bedrock is generally slightly weathered to fresh, with occasional near vertical joints. RQD values measured on the recovered bedrock core samples ranged from 31 to 87 percent, with an average of approximately 68 percent, indicating a generally fair quality rock.

Laboratory point load index testing was carried out, axially, on two selected specimens from the bedrock core. The results are summarized on Figure 7 and indicate compressive strengths of 95 and 116 MPa, corresponding to a strong to very strong rock.



4.2.2.7 Groundwater Conditions

Two piezometers were installed in this section of the site, in Boreholes 08-522 and 08-529. The water levels observed during drilling and measured in the piezometers are summarized in the following table:

Borehole No.	Water Level in Open Borehole During Drilling		Water Level in Piezometer on October 10, 2008	
	Depth (m)	Elevation (m)	Depth (m)	Elevation (m)
08-513	1.7	101.3	N/A	N/A
08-514	3.4	99.2	N/A	N/A
08-522	N/A	N/A	1.4	96.6
08-528	1.5	93.3	N/A	N/A
08-529	N/A	N/A	0.9	94.8
08-530	0.9	96.0	N/A	N/A

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

4.2.3 Terry Fox Drive to Castlefrank Drive – Station 11+500 to 12+850

Boreholes 08-531 to 08-544 and 08-544A were advanced along this section of the Highway 417 alignment. The borehole locations are shown on Drawings 3 and 4.

4.2.3.1 Fill Material

Fill material associated with the construction of the existing highway embankments was encountered immediately below the ground surface at the majority of the boreholes. The fill material ranges in thickness from about 0.2 to 1.7 m, and generally consists of topsoil, silty clay, clayey silt, sandy silt or silty sand with varying amounts of organic matter and gravel. Topsoil and crushed stone fill material was encountered at Borehole 08-544.

The measured SPT “N” values within the fill range from 4 to 9 blows per 0.3 m of penetration, indicative of a firm to stiff consistency/loose relative density.

4.2.3.2 Topsoil and Organic Matter

A layer of topsoil, organic matter, or sandy silt with organic matter was encountered at ground surface at Boreholes 08-531, 08-534, 08-542 and 08-544A. These materials range in thickness from 100 to 300 mm.

About 100 to 200 mm of buried topsoil was encountered beneath the fill at Boreholes 08-532, 08-533 and 08-537.



4.2.3.3 Silty Sand and Sandy Silt

Silty sand or sandy silt underlies the topsoil or fill at Boreholes 08-532, 08-533, 08-537 and 08-539 and ranges in thickness from about 0.1 to 0.5 m.

4.2.3.4 Silty Clay to Clay

A deposit of silty clay to clay underlies the fill, topsoil and organic matter, and surficial silty sand and sandy silt, where present, in Boreholes 08-531 to 08-535, 08-540, 08-542, 08-544 and 08-544A. The deposit was fully penetrated at all of these locations and extends to depths of about 0.5 to 6.0 m below the existing ground surface (Elevations 91.1 to 104.8 m).

The full deposit thickness at Boreholes 08-533 to 08-535, 08-540 and 08-542 has been weathered to a grey-brown colour. The upper 2.0 m at Borehole 08-532 and the upper 0.4 m at Boreholes 08-544 and 08-544A have also been weathered to a grey-brown crust. Although the measured SPT “N” values in this material range from 3 to 9 blows per 0.3 m of penetration, the weathered crust has a stiff to very stiff consistency.

Atterberg limits testing on one sample of the weathered material measured a plasticity index of 25 percent and a liquid limit of 47 percent, as shown on Figure 4, confirming that this material is a silty clay of intermediate plasticity. The natural water content of three selected samples of the weathered material was measured to be 26, 33 and 53 percent.

About 1.7 m of layered sand and sandy silt underlies the weathered portion of the silty clay at Borehole 08-532. The results of grain size distribution testing on one sample of the sand are included on Figure 1. The measured natural water content of the sand is 26 percent.

The bottom 0.3 m of the weathered deposit at Borehole 08-535 grades into a layered clayey silt and sandy silt.

For the full thickness (0.6 m) of the silty clay in Borehole 08-531, and below the depth of weathering at Boreholes 08-532, 08-544 and 08-544A, the silty clay is unweathered and grey in colour. Atterberg limits testing on two samples of the unweathered silty clay measured plasticity indices of 21 percent and liquid limits of 39 and 65 percent, as shown on Figure 6, indicating that this material varies from silty clay of intermediate plasticity to clay of high plasticity. The measured natural water contents on selected samples of the unweathered material are typically about 50 to 55 percent, which is near or above the measured liquid limit.

The measured SPT “N” values in the unweathered portion of the silty clay to clay deposit were “weight of hammer”. In situ vane testing was completed in Borehole 08-532, and measured an undrained shear strength of 35 kPa, indicative of a firm consistency.

4.2.3.5 Sandy Silt to Silty Sand Till

A till deposit was encountered below the existing fill (Boreholes 08-536 and 08-543), surficial sandy silt (Borehole 08-539) and/or silty clay to clay deposit (Boreholes 08-531 to 08-535, 08-540, 08-542, 08-544 and 08-544A). The deposit was absent in Boreholes 08-537 to 08-539 and 08-541. The till was fully penetrated at all of these borehole locations and extends to depths of about 1.4 to 8.1 m (Elevations 90.4 to 104.6 m).



The glacial till consists of a heterogeneous mixture of gravel, cobbles, and boulders in a matrix of sandy silt to silty sand with trace to some clay. An approximately 0.3 m thick layer of sand was encountered within the till at Borehole 08-535, and the bottom 0.4 m of the till at Borehole 08-531 grades into a sand. The results of grain size distribution testing on samples of the glacial till are provided on Figure 2. However, the samples were retrieved using a 50 mm diameter sampler and therefore the test results do not reflect the cobble and boulder portions of the deposit. The measured natural water content of the glacial till ranges from 10 to 20 percent.

SPT “N” values ranging from weight of hammer to 25 blows per 0.3 metres of penetration were measured in the glacial till, indicating a very loose to compact state of packing. Diamond drilling techniques were required at Borehole 08-543 to advance the through boulders in the till deposit.

4.2.3.6 Sandstone Bedrock

Sandstone bedrock was encountered below the fill and native soils in all the boreholes in this area of Highway 417, except Borehole 08-539 (located on a rock outcrop) where bedrock was encountered at ground surface. The bedrock was cored at all of the borehole locations after auger refusal was encountered. The following table summarizes the bedrock surface depth and elevation as encountered at the borehole locations.

HML Pole No.	Borehole No.	Ground Surface Elevation at HML (m)	Ground Surface Elevation in Borehole (m)	Bedrock Depth ⁽¹⁾ (m)	Bedrock Surface Elevation (m)
P31	08-531	98.5	98.5	2.5	96.0
P32	08-532	102.1	102.1	8.1	94.0
P33	08-533	106.0	106.0	1.4	104.6
P34	08-534	100.3	100.3	1.9	98.4
P35	08-535	101.4	101.4	3.6	97.8
P36	08-536	101.5	101.5	1.6	99.9
P37	08-537	102.0	102.0	1.5	100.5
P38	08-538	104.7	104.7	0.0	104.7
P39	08-539	101.8	101.8	1.0	100.8
P40	08-540	100.2	100.2	2.2	98.0
P41	08-541	99.1	99.1	0.2	98.9
P42	08-542	96.5	96.5	2.9	93.6
P43	08-543	94.7	94.7	1.9	92.8
P44	08-544	93.3	93.3	2.9	90.4
P44A	08-544A	92.5	92.5	1.7	90.8

Note: ⁽¹⁾ Depth below ground surface at borehole location.



The sandstone bedrock is light grey to dark grey, generally laminated to medium bedded, and medium strong to very strong. The bedrock is typically slightly weathered to fresh, with occasional near vertical joints. RQD values measured on the recovered bedrock core samples ranged from 0 to 100 percent, with an average of approximately 65 percent indicating a fair quality rock.

Laboratory point load index testing was carried out, axially, on selected specimens from the bedrock core, and laboratory unconfined compressive strength testing was carried out on one selected specimen of the bedrock core. The results are summarized on Figure 8 and indicate compressive strengths from the point load index testing of 9 to 192 MPa; one unconfined compressive strength test indicates a value of about 65 MPa. These results correspond to a medium strong to very strong rock.

4.2.3.7 Groundwater Conditions

One piezometer was installed in this section of the Highway 417 alignment, in Borehole 08-542. The water levels observed during drilling and measured in the piezometer are summarized in the following table:

Borehole No.	Water Level in Open Borehole During Drilling		Water Level in Piezometer on October 10, 2008	
	Depth/Height (m)	Elevation (m)	Depth (m)	Elevation (m)
08-531	+ 0.2 ⁽¹⁾	98.7	N/A	N/A
08-532	2.0	100.1	N/A	N/A
08-533	1.5	104.5	N/A	N/A
08-534	0.8	99.5	N/A	N/A
08-535	1.7	99.7	N/A	N/A
08-536	1.8	99.7	N/A	N/A
08-537	2.0	100.0	N/A	N/A
08-538	3.8	100.9	N/A	N/A
08-539	1.5	100.3	N/A	N/A
08-540	1.5	98.7	N/A	N/A
08-541	2.4	96.7	N/A	N/A
08-542	N/A	N/A	0.8	95.7
08-543	0.9	93.8	N/A	N/A
08-544	+ 0.1 ⁽¹⁾	93.3	N/A	N/A
08-544A	+ 0.1 ⁽¹⁾	92.6	N/A	N/A

Note: ⁽¹⁾ Indicates a groundwater level above the existing ground surface (i.e., artesian flow condition).

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



4.2.4 East of Castlefrank Drive – Stations 12+850 to 13+615

Boreholes 08-545 to 08-549 and 08-545A were advanced along this section of the Highway 417 alignment. The borehole locations are shown on Drawing 4.

4.2.4.1 *Fill Material and Topsoil*

Approximately 0.7 m of fill material was encountered at ground surface at Borehole 08-545. The fill material consists of about 0.1 m of organic matter underlain by crushed stone.

Topsoil was encountered immediately below the ground surface at the remaining boreholes and ranges in thickness from 100 to 300 mm.

4.2.4.2 *Sensitive Clayey Silt, Silty Clay and Clay*

The fill material or topsoil is underlain by a deposit of clayey silt to silty clay at all of the borehole location with the exception of Borehole 08-549. The deposit was fully penetrated at Boreholes 08-545 and 08-545A, where its base was encountered at a depth of about 7.6 m below the existing ground surface level (Elevations 84.2 and 84.1 m, respectively). The silty clay deposit was proven to depths of about 10.7 m (Elevations 81.5 to 82.0 m) at the remaining boreholes.

The upper 0.8 to 1.8 m of the deposit at Boreholes 08-546, 08-547 and 08-548 has been weathered to a grey-brown crust. The measured SPT “N” values in this material range from weight of hammer to 2 blows per 0.3 m of penetration.

The silty clay below the depth of weathering and below the fill material/topsoil at Boreholes 08-545 and 08-545A is grey in colour. In situ vane testing carried out in this material measured undrained shear strengths ranging from 19 to 57 kPa, indicating a soft to stiff consistency. However, the average undrained shear strength for this material is 39 kPa, indicating a generally firm consistency of the grey silty clay.

The results of grain size distribution testing on two samples of the unweathered portion of the deposit are shown on Figure 5. The results of Atterberg limit testing on two samples of the unweathered silty clay indicate plasticity indices of 26 and 36 percent and liquid limits of 48 and 58 percent, as shown on Figure 6, confirming that this material is a silty clay to clay of intermediate to high plasticity. The measured natural water content of the unweathered material ranges from 51 to 66 percent. These natural water contents are generally at or above the measured liquid limits.

The bottom 0.6 and 0.7 m of the deposit at Boreholes 08-545 and 08-545A, respectively, grade into a layered silty clay and clayey silt. In situ vane testing carried out in this portion of the deposit measured undrained shear strengths that range from 27 to 42 kPa, indicating a firm to stiff consistency.

4.2.4.3 *Sandy Silt Till*

The silty clay at Boreholes 08-545 and 08-545A and the topsoil at Borehole 08-549 are underlain by a till deposit. The sandy silt till ranges in thickness from 0.1 to 0.2 m and is directly underlain by the bedrock surface, which was encountered in the boreholes between Elevations 84.0 and 93.2 m.



4.2.4.4 Sandstone and Amphibole-Rich Metasediment Bedrock

The till is underlain by sandstone bedrock at Borehole 08-545 and amphibole-rich metasediment bedrock at Borehole 08-549. The following table summarizes the bedrock surface depth and elevation as encountered at the borehole locations. The bedrock at Borehole 08-545A was inferred from auger refusal.

HML Pole No.	Borehole No.	Ground Surface Elevation at HML (m)	Ground Surface Elevation in Borehole (m)	Bedrock Depth ⁽¹⁾ (m)	Bedrock Surface Elevation (m)
P45	08-545	91.8	91.8	7.7	84.1
P45	08-545A	91.7	91.7	7.7	84.0 ⁽²⁾
P49	08-549	93.6	93.6	0.4	93.2

Notes: ⁽¹⁾ Depth below ground surface at borehole location.

⁽²⁾ Based on auger refusal on probable bedrock.

The sandstone bedrock is light grey, very thinly to medium bedded, medium strong and slightly weathered, with occasional near vertical joints. RQD values measured on the recovered sandstone bedrock core samples ranged from 65 to 94 percent, indicating a fair to excellent quality rock.

The amphibole-rich metasediment bedrock is black, highly fractured and moderately weathered, with occasional near vertical joints. RQD values measured on the recovered bedrock core samples ranged from 0 to 46 percent, indicating a very poor to poor quality rock.

4.2.4.5 Groundwater Conditions

One piezometer was installed in this section of the site, in Borehole 08-549. The water levels observed during drilling and measured in the piezometer are summarized in the following table:

Borehole No.	Water Level in Open Borehole During Drilling		Water Level in Piezometer on December 8, 2008	
	Depth/Height (m)	Elevation (m)	Depth (m)	Elevation (m)
08-545	+ 2.1 ⁽¹⁾	93.9	N/A	N/A
08-548	N/A	N/A	1.0	91.3
08-549	1.8	91.8	N/A	N/A

Note: ⁽¹⁾ Indicates a groundwater level above the existing ground surface (i.e. artesian flow condition).

Artesian groundwater flow conditions were encountered at a depth of about 8.0 m (Elevation 83.8 m) within the sandstone bedrock at Borehole 08-545.

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

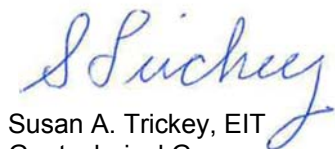


5.0 CLOSURE

This Foundation Investigation Report was prepared by Ms. Susan Trickey, EIT, and reviewed by Ms. Lisa Coyne, P.Eng., an Associate and geotechnical engineer with Golder. Mr. Fin Heffernan, P.Eng., Golder's Designated MTO Foundations Contact for this project, conducted an independent quality review of the report.


Yours truly,

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DECEMBER 2009

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PART B

**FOUNDATION DESIGN REPORT
PROPOSED HIGH MAST LIGHT POLES
HIGHWAY 417 EXPANSION
EAGLESON ROAD TO HIGHWAY 7
G.W.P. 255-98-00**



6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides recommendations for the geotechnical aspects of design of the high mast light (HML) pole foundations along Highway 417, between approximately 95 m east of the Carp Road underpass and 820 m west of the Eagleson Road underpass in Ottawa, Ontario. The recommendations are based on interpretation of the factual data obtained during the subsurface investigation at the proposed HML locations.

It should be noted that the interpretation and recommendations are intended for use only by the design engineer. Where comments are made on construction, they are provided to highlight those aspects that could affect the design of the project, and for which special provisions or operational constraints may be required in the Contract Documents. 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 method and scheduling.

The subsurface conditions within the limits of the proposed HML pole installations are variable:

- Between Carp Road and Palladium Drive the subsurface conditions generally consist of fill underlain by peat, silts, sands and till with occasional topsoil, clayey silt, silty clay and clay layers. Limestone bedrock was encountered beneath the overburden at depths between about 0.8 and 7.1 m within this section of the site.
- Between Palladium Drive and Terry Fox Drive, the subsurface conditions typically consist of topsoil, underlain by a deposit of sensitive clayey silt, silty clay and clay.
- East of Terry Fox Drive towards Castlefrank Drive, the subsurface conditions generally consist of fill underlain by clayey silt and silty clay and/or till with occasional topsoil, sandy silt, silty sand and sand layers. Sandstone bedrock was encountered within this portion of the site at depths between about 0.0 and 8.1 m depth.

HML pole foundations typically consist of reinforced, cast-in-place concrete caissons constructed within the soil, nominally socketted into bedrock (where the overburden soils do not provide sufficient lateral resistance), or embedded into the bedrock (where bedrock is present at relatively shallow depth). As an alternative to embedding a caisson into the bedrock where bedrock is shallow, the HML foundations could be anchored to the bedrock. The advantage to anchored foundations is that no embedment within the bedrock is required, versus a minimum of 2.5 m of embedment which is required for “embedded” caissons; however, the time and costs associated with mobilizing anchor installation equipment, drilling anchor holes and installing the dowels could be similar to those associated with deeper coring in the medium strong to very strong limestone and sandstone bedrock.

It is noted that either caissons or spread footings could be anchored where the bedrock is shallow.

6.2 Design of High Mast Light Pole Foundations

The HML pole foundations should be designed in accordance with MTO's *Guidelines for the Design of High Mast Pole Foundations, Fourth Edition*, dated May 2004. The parameters to be used in the design of the HML pole foundations are provided in Table 1 following the text of this report, and are discussed further in the following subsections.



6.2.1 Caisson Foundations in Soil

6.2.1.1 Cohesive Soils

The subsoils east of Palladium Drive to Terry Fox Drive and east of Castlefrank Drive generally consist of cohesive soils and as such the lateral resistance should be checked under drained and undrained conditions to determine which case will govern.

For drained conditions, the unfactored passive lateral earth pressure, P_p (kPa), distributed along the caisson may be calculated using the following equation:

$$P_p = K_p \gamma z + 2 c' \sqrt{K_p} \quad \text{Above the groundwater table; and,}$$

$$P_p = K_p \gamma z_w - K_p (z - z_w) \gamma' + 2 c' \sqrt{K_p} \quad \text{Below the groundwater table.}$$

Where:

- K_p Is the passive earth pressure coefficient;
- γ Is the bulk unit weight (kN/m^3);
- γ' Is the effective unit weight below the groundwater level (kN/m^3);
- z Is the depth below the ground surface (m);
- z_w Is the depth to the groundwater level (m); and,
- c' Is the cohesion (kPa).

For the drained case, the unfactored lateral resistance should be calculated assuming an equivalent pile width equal to three times the caisson diameter.

For the undrained case, the passive resistance should be calculated assuming it is limited to $2C_u$ at the surface and increases linearly to $9C_u$ at a depth of three pile diameters and beyond, acting over the actual width of the caisson.

The stratigraphy and design parameters for the subsurface conditions encountered in the boreholes at each of the HML pole locations investigated are given in Table 1.

In the design of the foundations for both the drained and undrained cases, the passive resistance within the upper 1.8 m below ground surface should be neglected to account for frost action. A resistance factor of 0.5 should be applied to the calculated lateral resistance for both the drained and undrained cases, in order to obtain the factored lateral geotechnical resistance.

Artesian flow conditions were encountered at a depth of approximately 8.0 m below the existing ground surface (i.e., 0.3 m into the sandstone bedrock, Elevation 83.8 m) at Borehole 08-545. It is likely that similar artesian flow would be encountered at the location of P45 (Borehole 08-545A). If standard construction is undertaken at this location (i.e., a caisson socketted into the rock) groundwater inflow would likely be encountered during construction. The risks associated with this standard foundation design under artesian flow could include difficulties during construction (e.g., tremying the concrete into the caisson under approximately 2.1 m of head),



permanent groundwater flow around the foundation, and long-term soil erosion around the caisson with loss of lateral support. An alternative option would be to anchor the caisson foundation into the bedrock using dowels. However, as with the socketed foundation, there is still a high risk that artesian flow would be encountered during the construction of the rock anchors which would extend deeper into the bedrock than the caisson socket (although the anchor holes would be smaller in diameter). The risks associated with this design are similar to those mentioned previously for the socketted caisson foundation. In order to decrease the risk of encountering the artesian flow conditions, a non-standard foundation design such as a larger diameter caisson founded at least 1 m above the bedrock surface (i.e. Elevation 85 m) is recommended at this HML location.

For drained conditions with artesian groundwater flow, for all foundations types, the unfactored passive lateral earth pressure, P_p (kPa), distributed along the caisson may be calculated using the following equation:

$$P_p = K_p \gamma z - K_p (z + h_w) \gamma_w + 2 c' \sqrt{K_p}$$

Where: γ_w Is the unit weight of water (kN/m³); and,
 h_w Is the height of the artesian head above the ground surface (m).

All other guidelines regarding lateral resistances as provided above should also be applied.

The foundation design for the HML pole locations can also be modelled by the structural designers using subgrade reaction theory, where the coefficient of horizontal subgrade reaction, k_h , is based on the equation given below for cohesive soils.

$$k_h = \frac{67C_u}{B}$$

Where: k_h Is the coefficient of horizontal subgrade reaction (kPa/m);
 C_u Is the undrained shear strength of the soil (kPa), as given in Table 1; and,
 B Is the caisson diameter (m).

6.2.1.2 Cohesionless Soils

Cohesionless soils were also encountered at some locations within the site. The unfactored passive lateral earth pressure, P_p (kPa), distributed along the caisson within cohesionless soils may be calculated using the following equation:

$$\begin{aligned} P_p &= K_p \gamma z && \text{Above the groundwater table; and,} \\ P_p &= K_p \gamma z_w - K_p (z - z_w) \gamma' && \text{Below the groundwater table.} \end{aligned}$$

Where: K_p Is the passive earth pressure coefficient;
 γ Is the bulk unit weight (kN/m³);
 γ' Is the effective unit weight below the groundwater level (kN/m³);



z Is the depth below the ground surface (m); and,

z_w Is the depth to the groundwater level (m).

The lateral earth pressure may be assumed to act over an equivalent width equal to three times the caisson diameter. A resistance factor of 0.5 should be applied to this calculated lateral resistance in order to obtain the factored lateral geotechnical resistance.

The stratigraphy and design parameters for the subsurface conditions encountered in the boreholes at each of the HML pole locations investigated are given in Table 1. In the design of the foundations, the passive resistance within the upper 1.8 m below the ground surface should be neglected to account for frost action.

The foundation design for the HML pole locations can also be modelled by the structural designers using subgrade reaction theory, where the coefficient of horizontal subgrade reaction, k_h , is based on the equation given below for cohesionless soils.

$$k_h = \frac{n_h z}{B}$$

Where: n_h Is the constant of subgrade reaction, as given in Table 1;

z Is the depth (m); and,

B Is the pile diameter (m).

6.2.2 Caisson Foundations Embedded into Rock

For HML poles P6, P8, P33, P34, P36, P37, P38, P39, P40, P41, P43, P44 and P49, the surface of the bedrock is less than or slightly deeper than the frost depth of 1.8 m. Based on the recovered bedrock core samples from the boreholes, the bedrock is typically slightly weathered to fresh. The depth to the surface of the rock may be used for V (the depth to resisting soil or rock) where less than 1.8 m; otherwise, the thickness of the soil above the rock, T_w , should be used where greater than 1.8 m, using the solutions given in Section 6.1 of MTO's *Guidelines for the Design of High Mast Pole Foundations, Fourth Edition*, dated May 2004. As per Section 6.1 of *Guidelines for the Design of High Mast Pole Foundations*, a minimum caisson embedment length in the rock of 2.5 m should be used. The lateral bearing resistance should be taken as the lesser of the strength of the rock or the compressive strength of the concrete in the caisson. For design, a factored lateral bearing resistance at ULS of 4 MPa may be used for the limestone and sandstone bedrock and 2 MPa for the amphibole-rich metasediment bedrock.

It is noted that the limestone and sandstone bedrock at the site is generally medium strong to very strong, and coring or churn drilling will be necessary to advance the socket into the bedrock. Since a minimum socket length of 2.5 m would be required in the rock for HML poles P6, P8, P33, P34, P36, P37, P38, P39, P40, P41, P43, P44 and P49 (as well as possibly P2, P3, P9, P11, P31 and P42) owing to the shallow overburden depth at these locations, consideration could be given to the use of caisson or spread footing foundations anchored to the rock. As discussed previously, due to artesian groundwater flow conditions rock anchors are not recommended at P45. Recommendations for the rock anchors are provided in the Section 6.2.3.



6.2.3 Foundations Anchored to Rock

As per Section 6.2 of *Guidelines for the Design of High Mast Pole Foundations, Fourth Edition*, dated May 2004, a minimum concrete foundation length of 1.75 m is required to allow sufficient length for the anchorage assembly. Since the compressive strength of the caisson concrete is lower than the compressive strength of the bedrock at this site, the vertical bearing resistance should be taken as the compressive strength of the concrete in the caisson. For spread footings a factored vertical bearing resistance of 2 MPa may be used for the limestone and sandstone bedrock and 1 MPa may be used for the amphibole-rich metasediment bedrock at P49 (Borehole 08-549). The factored vertical bearing resistance for spread footings given above is less than that of the intact rock because it has been factored to account for the bedding planes and vertical joints within the bedrock mass.

The horizontal resistance of the dowels is dependent on the strength of the bedrock, grout and steel. At this site, the rock mass is stronger than concrete, and so the design of the dowels in the rock should be handled in the same way as the dowel embedment into the concrete, assuming that the unconfined compressive strength of the grout is similar to that of the concrete. The rock dowels should have a minimum embedded length within the bedrock of 1 m, and the structural strength of the dowel and the compressive strength of the grout should not be exceeded.

For uplift of the dowels, a factored value of 800 kPa may be used for the grout-to-rock bond stress for ULS design. The actual bond stress along the rock-grout interface may vary from the design value given and it should, therefore, be verified in the field by pull-out testing; in this case, a Special Provision will have to be included in the Contract Documents to cover this testing. A sample Special Provision for Dowels into Rock is also provided in Appendix A.

A slight artesian flow condition was encountered at Boreholes 08-531 and 08-544A (i.e. P31 and P44) within the sandstone bedrock. Therefore some groundwater inflow would likely be encountered during construction of the rock anchors. The risk associated with artesian groundwater conditions during construction would include tremying/pouring the concrete under 0.1 to 0.2 m of head, permanent groundwater flow around the foundation, and long-term soil erosion around the caisson/footing with loss of lateral support. However the soil erosion around the caisson/footing could be reduced if a minimum 0.3 metre thick layer of OPSS 1010 Granular A is placed at ground surface for the full width of the excavation to act a filter.

6.2.4 Caisson Foundations Socketed into Rock

For some of the HML pole locations, the overburden thickness may not be sufficient to provide the required lateral resistance and a nominal socket into the rock may be needed. In this case, the socket depth, S , into the rock must not be less than 0.5 times the caisson diameter. The lateral bearing resistance should be taken as the lesser of the strength of the rock or the compressive strength of the concrete in the caisson. For design, a lateral bearing resistance at ULS of 4 MPa may be used for the limestone and sandstone bedrock and 2 MPa may be used for the amphibole-rich metasediment bedrock.

The soil resistances for this case are identical to the cohesive and cohesionless soil cases using the soil parameters provided in Table 1.



6.3 Construction Considerations

It is recommended that a Non-Standard Special Provision (NSP) be included in the Contract Documents to warn the Contractor of the following items that are expected to affect the installation of the high mast light pole foundations:

- Due to the nature of the cohesive soils in the Ottawa area there are no restrictions to the installation the caisson liners by vibration, regardless of the sensitivity of the soil.
- Control of overburden soils and groundwater: Excavations for the HML pole foundations will be advanced through generally cohesionless soils between Carp Road and Palladium Drive, and these soils should be expected to be unstable below the groundwater level. It should be anticipated that the caisson holes will have to be advanced using a temporary liner, possibly in conjunction with fluid support, to minimize ground loss during drilling and concrete placement.
- The preferred method of caisson installation in cohesionless soils and fractures/jointed weathered or unweathered bedrock is the tremie concrete method as opposed to dewatering. Dewatering of the bedrock, particularly in the highly permeable sandstone bedrock, will have a large radius of groundwater drawdown that could result in environmental or settlement issues.
- Artesian groundwater pressure: Excavations within the bedrock for the HML pole foundations at P31, P44 and P45 will likely encountered a slight artesian groundwater flow condition. Appropriate construction methods and equipment should be used during construction to contain the artesian pressure.
- Cobbles, boulders and rock slabs: Cobbles, boulders and rock slabs have been encountered within the till deposit or sandy silt overlying the bedrock surface. Appropriate equipment and procedures will be required to penetrate these obstructions during excavation for foundation construction.
- Bedrock strength: Some of the high mast light foundations will require sockets to be formed within the bedrock, which is medium strong to very strong. It is anticipated that it will be necessary to use rock coring or churn drilling techniques to advance the caisson holes into the bedrock.
- If the caisson encounters a joint or fracture which is oriented between 0 to 15 degrees of vertical, the lateral bearing resistance values provided in this report are acceptable, however, if joints or fractures exceed 15 degrees additional considerations will need to be provided.
- Pull-out testing for rock dowels: If rock anchors/dowels are adopted for some of the HML pole foundations, the contract should include an SP to address this requirement.
- The caisson for HML poles should be carried out in accordance with OPSS 631.

Sample NSSPs are included in Appendix A for inclusion in the contract documents.



7.0 CLOSURE

This Foundation Design Report was prepared by Ms. Susan Trickey, EIT, and reviewed by Ms. Lisa Coyne, P.Eng., an Associate and geotechnical engineer with Golder. Mr. Fin Heffernan, P.Eng., Golder's Designated MTO Foundations Contact for this project, conducted an independent quality review of the report.

Yours truly,

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**TABLE 1: DESIGN PARAMETERS FOR HIGH MAST LIGHT POLE FOUNDATIONS
HIGHWAY 417 EXPANSION, EAGLESON ROAD TO HIGHWAY 7, G.W.P. 255-98-00**

HML Pole No.	Borehole No.	Borehole Location	Stratum	Depth ² (m)	Elevation (m)	Groundwater Elevation (m)	T _w ^{1,2} (m)	Design Parameters ^{3,4}						
								n _H	C _u	c'	φ'	γ	γ'	K _p
P1	08-501	N 5016001.0 E 347345.2	Very loose fill	0.0 – 3.1	122.5 – 119.5	117.3	7.1	-	-	-	28	19	9	2.8
			Dense to very dense silty sand to sand and gravel	3.1 – 7.1	119.5 – 115.4			11.0	-	-	32	21	11	3.3
			Limestone (Bedrock)	Below 7.1	Below 115.4									
P2	08-502	N 5016320.9 E 347932.5	Firm fill/peat ⁵	0.0 – 2.1	110.5 – 108.4	108.5	3.4	-	-	-	-	12	2	-
			Firm clayey silt	2.1 – 2.4	108.4 – 108.1			-	75	5	32	17	7	3.3
			Loose sand	2.4 – 2.9	108.1 – 107.6			1.3	-	-	28	19	9	2.8
			Very dense sandy silt till	2.9 – 3.4	107.6 – 107.1			11.0	-	-	35	21	10	3.7
			Limestone (Bedrock)	Below 3.4	Below 107.1									
P3	08-503	N 5016426.0 E 348047.7	Firm fill/peat ⁵	0.0 – 2.3	109.0 – 106.7	107.9	3.3	-	-	-	-	12	2	-
			Loose to compact silty sand to sandy silt	2.3 – 3.3	106.7 – 105.7			1.3	-	-	28	19	9	2.8
			Limestone (Bedrock)	Below 3.3	Below 105.7									
P4	08-504	N 5016529.8 E 348161.5	Firm fill/peat ⁵	0.0 – 2.7	108.4 – 105.7	106.8	6.3	-	-	-	-	12	2	-
			Compact to dense sandy silt/sand	2.7 – 5.8	105.7 – 102.6			4.4	-	-	30	19	9	3.0
			Loose sandy silt till	5.8 – 6.3	102.6 – 102.1			1.3	-	-	35	20	10	3.7
			Limestone (Bedrock)	Below 6.3	Below 102.1									
P5	08-505	N 5016635.6 E 348277.5	Firm fill/peat ⁵	0.0 – 2.0	107.7 – 105.7	105.1	5.6	-	-	-	-	12	2	-
			Loose to compact silty sand to sand	2.0 – 5.6	105.7 – 102.1			1.3	-	-	30	19	9	3.0
			Limestone (Bedrock)	Below 5.6	Below 102.1									
P6	08-506	N 5016742.7 E 348935.0	Peat ⁵	0.0 – 0.9	106.0 – 105.1	106.0	1.7	-	-	-	-	12	2	-
			Compact to dense silty sand/sandy silt till	0.9 – 1.7	105.1 – 104.3			4.4	-	-	35	22	10	3.7
			Limestone (Bedrock)	Below 1.7	Below 104.3									
P7	08-507	N 5016849.5 E 348512.1	Loose to compact sandy silt/clayey silt/silt	0.0 – 2.6	105.4 – 102.8	104.8	3.8	1.3	-	-	30	19	9	3.0
			Very loose silty sand till	2.6 – 3.8	102.8 – 101.6			1.3	-	-	30	20	10	3.0
			Limestone (Bedrock)	Below 3.8	Below 101.6									
P8	08-508	N 5016966.9 E 348637.1	Sandy silt	0.0 – 0.4	104.8 – 104.4	103.3	0.8	2.2	-	-	28	19	9	2.8
			Sandy silt till	0.4 – 0.8	104.4 – 104.0			2.2	-	-	30	20	10	3.0
			Limestone (Bedrock)	Below 0.8	Below 104.0									



**TABLE 1: DESIGN PARAMETERS FOR HIGH MAST LIGHT POLE FOUNDATIONS
HIGHWAY 417 EXPANSION, EAGLESON ROAD TO HIGHWAY 7, G.W.P. 255-98-00—CONTINUED**

HML Pole No.	Borehole No.	Borehole Location	Stratum	Depth ² (m)	Elevation (m)	Groundwater Elevation (m)	T _w ^{1,2} (m)	Design Parameters ^{3,4}						
								n _H	C _u	c'	φ'	γ	γ'	K _p
P9	08-509	N 5017065.3 E 348745.0	Loose sandy silt/silty sand	0.0 – 2.5	104.2 – 101.7	100.8	3.0	2.2	-	-	28	19	9	2.8
			Loose to compact sand till	2.5 – 3.0	101.7 – 101.2			2.2	-	-	30	21	10	3.0
			Limestone (Bedrock)	Below 3.0	Below 101.2									
P10	08-510	N 5017164.9 E 348854.5	Stiff silty clay (weathered crust)	0.0 – 0.5	103.6 – 103.1	101.3	4.3	-	75	5	32	17	7	3.3
			Loose to compact silty sand to sandy silt	0.5 – 1.3	103.1 – 102.3		-	2.2	-	-	30	19	9	3.0
			Loose to very dense silty sand till	1.3 – 4.3	102.3 – 99.3		-	1.3	-	-	32	21	11	3.3
			Limestone (Bedrock)	Below 4.3	Below 99.3									
P11	08-511	N 5016997.1 E 348841.7	Compact fill	0.0 – 2.2	104.8 – 102.6	99.6	2.5	-	-	-	30	20	10	3.0
			Clayey silt	2.2 – 2.5	102.6 – 102.3			-	75	5	32	17	7	3.3
			Limestone (Bedrock)	Below 2.5	Below 102.3									
P12	08-512	N 5017043.3 E 348972.7	Fill	0.0 – 0.7	104.0 – 103.3	100.5 ⁶	4.4	-	-	-	28	19	9	2.8
			Compact sandy silt/silty sand	0.7 – 3.2	103.3 – 100.8			6.6	-	-	30	19	9	3.0
			Very loose to compact sandy silt till	3.2 – 4.4	100.8 – 99.6			1.3	-	-	30	21	10	3.0
			Limestone (Bedrock)	Below 4.4	Below 99.6									
P13	08-513	N 5017199.4 E 349037.8	Stiff to very stiff silty clay (weathered crust)	0.0 – 3.7	103.0 – 99.3	101.3	8.2	-	75	5	32	17	7	3.3
			Firm silty clay	3.7 – 4.7	99.3 – 98.3			-	36	7.5	30	16.5	6.5	3.0
			Very loose to loose sandy silt	4.7 – 6.6	98.3 – 96.4			1.3	-	-	28	19	9	2.8
			Very loose silty sand till	6.6 – 8.2	96.4 – 94.8			1.3	-	-	30	20	10	3.0
			Limestone (Bedrock)	Below 8.2	Below 94.8									
P14	08-514	N 5017266.3 E 348966.4	Stiff to very stiff clayey silt and sandy silt/silty clay (weathered crust)	0.0 – 3.6	102.6 – 99.0	99.2	8.7	-	75	5	32	17	7	3.3
			Firm silty clay and clayey silt	3.6 – 4.6	99.0 – 98.0			-	40	7.5	30	16.5	6.5	3.0
			Very loose silty sand/sandy silt	4.6 – 6.5	98.0 – 96.1			1.3	-	-	28	19	9	2.8
			Compact to dense sandy silt till	6.5 – 8.7	96.1 – 93.9			4.4	-	-	35	21	11	3.7
			Limestone (Bedrock)	Below 8.7	Below 93.9									



**TABLE 1: DESIGN PARAMETERS FOR HIGH MAST LIGHT POLE FOUNDATIONS
HIGHWAY 417 EXPANSION, EAGLESON ROAD TO HIGHWAY 7, G.W.P. 255-98-00—CONTINUED**

HML Pole No.	Borehole No.	Borehole Location	Stratum	Depth ² (m)	Elevation (m)	Groundwater Elevation (m)	T _w ^{1,2} (m)	Design Parameters ^{3,4}						
								n _H	C _u	c'	φ'	γ	γ'	K _p
P15	08-515	N 5017396.4 E 348858.0	Stiff to very stiff fill	0.0 - 4.0	106.2 - 102.2	102.5 ⁶	N/A	-	-	-	25	18	8	2.5
			Stiff to very stiff silty clay (weathered crust)	4.0 - 7.0	102.2 - 99.2			-	75	5	32	17	7	3.3
			Firm silty clay and clayey silt	7.0 - 7.6	99.2 - 98.6			-	54	7.5	30	16.5	6.5	3.0
			Very loose sandy silt and clayey silt	7.6 - 10.1	98.6 - 96.1			1.3	-	-	28	19	9	2.8
			Very loose sandy silt till	Below 10.1	Below 96.1			1.3	-	-	30	20	10	3.0
P16	08-516	N 5017425.2 E 348998.6	Stiff fill	0.0 - 1.8	101.9 - 100.1	100.0 ⁶	N/A	-	-	-	25	18	8	2.5
			Stiff silty clay (weathered crust)	1.8 - 4.4	100.1 - 97.5			-	65	5	32	17	7	3.3
			Firm silty clay/silty clay and clayey silt	4.4 - 9.0	97.5 - 92.9			-	40	7.5	30	16.5	6.5	3.0
			Compact sandy silt	9.0 - 9.5	92.9 - 92.4			4.4	-	-	30	19	9	3.0
			Compact sandy silt till	Below 9.5	Below 92.4			4.4	-	-	35	21	11	3.7
P17	08-517	N 5017355.3 E 349063.9	Stiff to very stiff clayey silt/silty clay (weathered crust)	0.0 - 4.3	102.4 - 98.1	100.4 ⁶	N/A	-	75	5	32	17	7	3.3
			Firm silty clay/clayey silt	4.3 - 10.5	98.1 - 91.9			-	36	7.5	30	16.5	6.5	3.0
			Compact silty sand	Below 10.5	Below 91.9			4.4	-	-	30	19	9	3.0
P18	08-518	N 5017438.8 E 349155.5	Very stiff to stiff clayey silt and silty clay/ silty clay (weathered crust)	0.0 - 4.3	101.8 - 97.5	99.8 ⁶	N/A	-	70	5	32	17	7	3.3
			Firm silty clay	Below 4.3	Below 97.5			-	36	7.5	30	16.5	6.5	3.0
P19	08-519	N 5017536.5 E 349262.6	Very stiff to stiff silty clay (weathered crust)	0.0 - 4.4	100.8 - 96.4	98.8 ⁶	N/A	-	75	5	32	17	7	3.3
			Firm silty clay	Below 4.4	Below 96.4			-	34	7.5	30	16.5	6.5	3.0
P20	08-520	N 5017632.3 E 349367.6	Fill	0.0 - 1.1	100.2 - 99.1	97.2 ⁶	N/A	-	-	-	25	18	8	2.5
			Very stiff to stiff silty clay (weathered crust)	1.1 - 4.9	99.1 - 95.3			-	75	5	32	17	7	3.3
			Firm to stiff silty clay/clayey silt	Below 4.9	Below 95.3			-	46	7.5	30	16.5	6.5	3.0
P21	08-521A	N 5017712.0 E 349459.2	Very stiff to stiff silty clay (weathered crust)	0.0 - 4.0	98.7 - 94.0	96.7 ⁶	N/A	-	75	5	32	17	7	3.3
			Firm silty clay	4.0 - 9.1	94.0 - 89.6			-	36	7.5	30	16.5	6.5	3.0
			Sandy silt	9.1 - 9.5	89.6 - 89.2			1.3	-	-	28	19	9	2.8
			Silty clay and clayey silt	Below 9.5	Below 89.2			-	36	7.5	30	16.5	6.5	3.0



**TABLE 1: DESIGN PARAMETERS FOR HIGH MAST LIGHT POLE FOUNDATIONS
HIGHWAY 417 EXPANSION, EAGLESON ROAD TO HIGHWAY 7, G.W.P. 255-98-00—CONTINUED**

HML Pole No.	Borehole No.	Borehole Location	Stratum	Depth ² (m)	Elevation (m)	Groundwater Elevation (m)	T _w ^{1,2} (m)	Design Parameters ^{3,4}						
								n _H	C _u	c'	φ'	γ	γ'	K _p
P22	08-522A	N 5017806.3 E 349581.8	Very stiff to stiff silty clay (weathered crust)	0.0 – 4.2	98.2 – 94.0	96.2 ⁶	N/A	-	75	5	32	17	7	3.3
			Firm silty clay	4.2 – 10.7	94.0 – 87.5			-	40	7.5	30	16.5	6.5	3.0
			Sandy silt till	Below 10.7	Below 87.5			1.3	-	-	30	20	10	3.0
P23	08-523A	N 5017892.6 E 349711.4	Very stiff to stiff silty clay (weathered crust)	0.0 – 3.2	96.7 – 93.5	94.7 ⁶	N/A	-	65	5	32	17	7	3.3
			Firm silty clay	Below 3.2	Below 93.5			-	34	7.5	30	16.5	6.5	3.0
P24	08-524A	N 5017970.0 E 349846.7	Stiff silty clay (weathered crust)	0.0 – 2.7	95.2 – 92.5	93.7 ⁶	N/A	-	50	5	32	17	7	3.3
			Firm silty clay	Below 2.7	Below 92.5			-	30	7.5	30	16.5	6.5	3.0
P25	08-525A	N 5018043.0 E 349984.6	Silty sand	0.0 – 0.6	94.2 – 93.6	92.7 ⁶	N/A	2.2	-	-	28	19	9	2.8
			Very stiff to stiff silty clay (weathered crust)	0.6 – 2.9	93.6 – 91.3			-	60	5	32	17	7	3.3
			Firm silty clay	Below 2.9	Below 91.3			-	30	7.5	30	16.5	6.5	3.0
P26	08-526	N 5018115.7 E 350121.8	Loose fill	0.0 – 1.5	93.4 – 91.9	92.6 ⁶	N/A	-	-	-	-	12	2	-
			Very loose alluvium	1.5 – 2.2	91.9 – 91.2			-	-	-	-	12	2	-
			Stiff organic clayey silt	2.2 – 3.4	91.2 – 90.1			-	50	5	30	17	7	3.0
			Soft to firm silty clay	Below 3.4	Below 90.0			-	29	7.5	30	16.5	6.5	3.0
P27	08-527	N 5018187.6 E 350257.7	Stiff silty clay (weathered crust)	0.0 – 2.5	94.0 – 91.5	93.3 ⁶	N/A	-	55	5	32	17	7	3.3
			Firm silty clay	Below 2.5	Below 91.5			-	35	7.5	30	16.5	6.5	3.0
P28	08-528	N 5018257.7 E 350390.2	Stiff silty clay (weathered crust)	0.0 – 2.7	94.8 – 92.1	93.3	N/A	-	50	5	32	17	7	3.3
			Firm silty clay/silty clay and clayey silt	2.7 – 7.9	92.1 – 86.9			-	30	7.5	30	16.5	6.5	3.0
			Loose silty sand till	7.9 – 9.0	86.9 – 85.8			1.3	-	-	32	20	10	3.3
			Dense to very dense sand	Below 9.0	Below 85.8			11.0	-	-	32	19	9	3.3
P29	08-529	N 5018328.4 E 350523.7	Very stiff to stiff silty clay (weathered crust)	0.0 – 2.1	95.7 – 93.6	94.8	N/A	-	75	5	32	17	7	3.3
			Firm silty clay	Below 2.1	Below 93.6			-	30	7.5	30	16.5	6.5	3.0
P30	08-530	N 5018400.9 E 350660.7	Stiff silty clay (weathered crust)	0.0 – 1.0	96.9 – 95.9	96.0	8.7	-	75	5	32	17	7	3.3
			Firm silty clay/silty clay and clayey silt	1.0 – 7.8	95.9 – 89.1			-	32	7.5	30	16.5	6.5	3.0
			Very loose silty sand till	7.8 – 8.7	89.1 – 88.2			1.3	-	-	30	21	11	3.0
			Limestone (Bedrock)	Below 8.7	Below 88.2									
P31	08-531	N 5018457.7 E 350761.7	Firm silty clay	0.0 – 0.9	98.5 – 97.6	98.7	2.5	-	75	5	32	17	7	3.3
			Very loose sandy silt till	0.9 – 2.1	97.6 – 96.4			1.3	-	-	30	21	11	3.0
			Sand	2.1 – 2.5	96.4 – 96.0			1.3	-	-	28	19	9	2.8
			Sandstone (Bedrock)	Below 2.5	Below 96.0									



**TABLE 1: DESIGN PARAMETERS FOR HIGH MAST LIGHT POLE FOUNDATIONS
HIGHWAY 417 EXPANSION, EAGLESON ROAD TO HIGHWAY 7, G.W.P. 255-98-00—CONTINUED**

HML Pole No.	Borehole No.	Borehole Location	Stratum	Depth ² (m)	Elevation (m)	Groundwater Elevation (m)	T _w ^{1,2} (m)	Design Parameters ^{3,4}						
								n _H	C _u	c'	φ'	γ	γ'	K _p
P32	08-532	N 5018393.5 E 350847.0	Fill	0.0 – 0.7	102.1 – 101.4	100.1	8.1	-	-	-	25	18	8	2.5
			Very stiff silty clay (weathered crust)	0.7 – 2.0	101.4 – 100.1			-	75	5	32	17	7	3.3
			Sand/sandy silt	2.0 – 3.7	100.1 – 98.4			1.3	-	-	28	19	9	2.8
			Firm silty clay	3.7 – 6.0	98.4 – 96.1			-	34	7.5	30	16.5	6.5	3.0
			Very loose to compact silty sand till	6.0 – 8.1	96.1 – 94.0			1.3	-	-	30	20	10	3.0
			Sandstone (Bedrock)	Below 8.1	Below 94.0									
P33	08-533	N 5018409.5 E 350973.8	Fill	0.0 – 0.7	106.0 – 105.3	104.5	1.4	-	-	-	25	18	8	2.5
			Stiff to very stiff silty clay (weathered crust)	0.7 – 1.2	105.3 – 104.8			-	75	5	32	17	7	3.3
			Compact sandy silt till	1.2 – 1.4	104.8 – 104.6			4.4	-	-	30	20	10	3.0
			Sandstone (Bedrock)	Below 1.4	Below 104.6									
P34	08-534	N 5018527.2 E 350871.4	Very stiff silty clay (weathered crust)	0.0 – 1.5	100.3 – 98.8	99.5	1.9	-	75	5	32	17	7	3.3
			Compact silty sand till	1.5 – 1.9	98.8 – 98.4			4.4	-	-	30	20	10	3.0
			Sandstone (Bedrock)	Below 1.9	Below 98.4									
P35	08-535	N 5018577.9 E 350823.7	Loose/stiff fill	0.0 – 1.7	101.4 – 99.7	99.7	3.6	-	-	-	28	18	8	2.8
			Very stiff silty clay (weathered crust)	1.7 – 2.4	99.7 – 99.0			-	75	5	32	17	7	3.3
			Loose clayey silt and sandy silt	2.4 – 2.7	99.0 – 98.7			1.3	-	-	28	18	8	2.8
			Loose sandy silt till/sand	2.7 – 3.6	98.7 – 97.8			1.3	-	-	30	20	10	3.0
			Sandstone (Bedrock)	Below 3.6	Below 97.8									
P36	08-536	N 5018741.8 E 350898.1	Loose fill	0.0 – 1.3	101.5 – 100.2	99.7	1.6	-	-	-	28	18	8	2.8
			Sandy silt till	1.3 – 1.6	100.2 – 99.9			2.2	-	-	30	20	10	3.0
			Sandstone (Bedrock)	Below 1.6	Below 99.9									
P37	08-537	N 5018765.5 E 351040.3	Loose fill	0.0 – 1.4	102.0 – 100.6	100.0	1.5	-	-	-	28	19	9	2.8
			Sandy silt	1.4 – 1.5	100.6 – 100.5			1.3	-	-	28	19	9	2.8
			Sandstone (Bedrock)	Below 1.5	Below 100.5									
P38	08-538	N 5018620.9 E 351001.2	Sandstone (Bedrock)	Below 0.0	Below 104.7	100.9	0.0							
P39	08-539	N 5018731.1 E 351134.4	Loose fill	0.0 – 0.5	101.8 – 101.3	100.3	1.0	-	-	-	28	19	9	2.8
			Compact sandy silt	0.5 – 1.0	101.3 – 100.8			6.6	-	-	32	19	9	3.3
			Sandstone (Bedrock)	Below 1.0	Below 100.8									



**TABLE 1: DESIGN PARAMETERS FOR HIGH MAST LIGHT POLE FOUNDATIONS
HIGHWAY 417 EXPANSION, EAGLESON ROAD TO HIGHWAY 7, G.W.P. 255-98-00—CONTINUED**

HML Pole No.	Borehole No.	Borehole Location	Stratum	Depth ² (m)	Elevation (m)	Groundwater Elevation (m)	T _w ^{1,2} (m)	Design Parameters ^{3,4}						
								n _H	C _u	c'	φ'	γ	γ'	K _p
P40	08-540	N 5018826.4 E 351245.0	Stiff fill	0.0 – 0.5	100.2 – 99.7	98.7	2.2	-	-	-	25	18	8	2.5
			Very stiff silty clay (weathered crust)	0.5 – 1.9	99.7 – 98.3			-	75	5	32	17	7	3.3
			Compact sandy silt till	1.9 – 2.2	98.3 – 98.0			4.4	-	-	30	20	10	3.0
			Sandstone (Bedrock)	Below 2.2	Below 98.0									
P41	08-541	N 5018928.8 E 351364.0	Fill	0.0 – 0.2	99.1 – 98.9	96.7	0.2	-	-	-	25	18	8	2.5
			Sandstone (Bedrock)	Below 0.2	Below 98.9									
P42	08-542	N 5019040.3 E 351493.7	Stiff silty clay (weathered crust)	0.0 – 0.5	96.5 – 96.0	95.7	2.9	-	75	5	32	17	7	3.3
			Loose to compact sandy silt till	0.5 – 2.9	96.0 – 93.6			1.3	-	-	30	21	11	3.0
			Sandstone (Bedrock)	Below 2.9	Below 93.6									
P43	08-543	N 5019138.8 E 351608.1	Fill	0.0 – 0.4	94.7 – 94.3	93.8	1.9	-	-	-	25	18	8	2.5
			Dense sandy silt till	0.4 – 1.9	94.3 – 92.8			11.0	-	-	35	21	11	3.7
			Sandstone (Bedrock)	Below 1.9	Below 92.8									
P44	08-544A	N 5019232.1 E 351716.5	Silty sand	0.0 – 0.2	92.5 – 92.3	92.5	2.1	1.3	-	-	28	19	9	2.8
			Stiff silty clay (weathered crust)	0.2 – 0.6	92.3 – 91.9			-	75	5	32	17	7	3.3
			Firm silty clay	0.6 – 1.4	91.9 – 91.1			-	60	7.5	30	16.5	6.5	3.0
			Loose sandy silt till	1.4 – 1.7	91.1 – 90.8			1.3	-	-	30	20	10	3.0
			Sandstone (Bedrock)	Below 1.7	Below 90.8									
P45	08-545A	N 5019334.5 E 351835.5	Firm to stiff silty clay/clayey silt	0.0 – 7.7	91.7 – 84.0	93.8 ⁷	7.7	-	40	7.5	30	16.5	6.5	3.0
P46	08-546	N 5019437.5 E 351955.2	Stiff silty clay (weathered crust)	0.0 – 1.0	92.2 – 91.2	90.8 ⁶	N/A	-	75	5	32	17	7	3.3
			Firm to stiff silty clay	Below 1.0	Below 91.2			-	38	7.5	30	16.5	6.5	3.0
P47	08-547	N 5019539.9 E 352074.3	Stiff silty clay (weathered crust)	0.0 – 1.2	92.7 – 91.5	91.3 ⁶	N/A	-	75	5	32	17	7	3.3
			Soft to stiff silty clay	Below 1.2	Below 91.5			-	38	7.5	30	16.5	6.5	3.0
P48	08-548	N 5019640.4 E 352191.0	Stiff silty clay (weathered crust)	0.0 – 2.1	92.3 – 90.2	91.3	N/A	-	75	5	32	17	7	3.3
			Firm to stiff silty clay	Below 2.1	Below 90.2			-	38	7.5	30	16.5	6.5	3.0
P49	08-549	N 5019730.4 E 352295.6	Sandy silt till	0.0 – 0.4	93.6 – 93.2	91.8	0.4/2.3	2.2	-	-	30	20	10	3.0
			Amphibole-rich metasediment (Bedrock)	Below 0.4	Below 93.2									

- Notes:
1. T_w = thickness of soil above rock, as per MTO *Guidelines for the Design of High Mast Light Pole Foundations, Fourth Edition*, dated May 2004.
 2. The thickness of soil above rock is given for the borehole location; the ground surface elevation at the borehole location should be compared to the ground surface elevation at the actual HML pole location, and the thickness of soil above rock adjusted accordingly.



**TABLE 1: DESIGN PARAMETERS FOR HIGH MAST LIGHT POLE FOUNDATIONS
HIGHWAY 417 EXPANSION, EAGLESON ROAD TO HIGHWAY 7, G.W.P. 255-98-00—CONTINUED**

Notes Continued:

3. Design parameters:
 - n_H Is the constant of subgrade reaction;
 - C_u Is the undrained shear strength (kPa);
 - c' Is the cohesion (kPa);
 - ϕ' Is the effective friction angle (degrees);
 - γ Is the bulk unit weight (kN/m³);
 - γ' Is the effective unit weight below the groundwater level (kN/m³); and,
 - K_p Is the passive earth pressure coefficient.
4. Although the passive resistance in the upper 1.8 m is neglected to account for frost action, ϕ' and K_p parameters are given in the event that the ground surface elevation varies significantly between the borehole and high mast light pole locations.
5. Assume no contribution to passive lateral resistance from the peat/fill.
6. Assumed groundwater level based on the site stratigraphy and soil samples.
7. Assumed groundwater level based on Borehole 08-545.
8. W = depth of weathered rock. The depth of weathered rock is given for the borehole location; the ground surface elevation at the borehole location should be compared to the ground surface elevation at the actual HML pole location and the depth of weathered rock adjusted accordingly.

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
DT	Dual Tube 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° 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° conical tip and a projected end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded Electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a)

Cohesionless Soils

Density Index (Relative Density)

Very loose
Loose
Compact
Dense
Very dense

N
Blows/300 mm
Or Blows/ft.
0 to 4
4 to 10
10 to 30
30 to 50
over 50

(b)

Consistency

Cohesive Soils C_u or 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 (L.V-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'_{v0}	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 $\gamma = pg$ (i.e. mass density \times 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'_{v0}

(d) Shear Strength

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

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

2. Shear strength = (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

<u>Description</u>	<u>Bedding Plane Spacing</u>
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

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

GRAIN SIZE

<u>Term</u>	<u>Size*</u>
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° 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 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
-	Parallel To	TCA-	To Core Axis
⊥ -	Perpendicular To	STR-	Stress Induced

PROJECT 07-1121-0151		RECORD OF BOREHOLE No 08-501		1 OF 1 METRIC									
G.W.P. 255-98-00		LOCATION N 5016001.0; E 347345.2		ORIGINATED BY D.J.S.									
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem		COMPILED BY J.M.									
DATUM Geodetic		DATE July 9, 2008		CHECKED BY S.A.T.									
SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
122.5	GROUND SURFACE												
0.0	Topsoil and gravel (FILL)												
0.1	Sand, trace gravel and silt (FILL)												
	Very loose												
	Light brown												
	Moist												
			1	SS	4								
			2	SS	3								
119.4													
3.1	Silty SAND and GRAVEL, with cobbles		3	SS	54								38 49 11 2
	Very dense												
	Dark brown												
	Moist												
117.8													
4.7	Silty SAND		4	SS	>100								
	Dense to very dense												
	Light brown												
	Moist												
117.2													
5.3	SAND and GRAVEL, trace silt, with cobbles												
	Dense												
	Brown												
	Wet												
			5	SS	36								
115.4													
7.1	Crystalline Limestone with thin black shale seams (BEDROCK)		6	NQ RC	REC 100%								RQD = 70%
	Slightly weathered to fresh												
	Light grey to grey												
	Thinly to medium bedded												
	Strong												
	- Mud seam from 7.4 m to 7.5 m depth		7	NQ RC	REC 100%								RQD = 78%
	- Fractured zone from 7.5 m to 8.1 m depth												
			8	NQ RC	REC 100%								RQD = 78%
111.9													
10.6	End of Borehole												
	Note: Water level in open borehole at 5.2 m depth (Elev. 117.3 m) upon completion of drilling on July 9, 2008.												

MIS-MTO 001 07-1121-0151 GPJ GAL-MISS GDI 7/23/09

PROJECT 07-1121-0151		RECORD OF BOREHOLE No 08-502		1 OF 1 METRIC	
G.W.P. 255-98-00		LOCATION N 5016320.9; E 347932.5		ORIGINATED BY D.J.S.	
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem		COMPILED BY J.M.	
DATUM Geodetic		DATE June 5, 2008		CHECKED BY S.A.T.	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	WATER CONTENT (%)					
110.5	GROUND SURFACE													
0.0	Peat with silty sand and wood (FILL) Firm Dark brown Moist													
109.3			1	SS	5									
1.2	PEAT Firm Dark brown Moist to wet													
108.4			2	SS	6									
108.1	CLAYEY SILT Firm Grey-brown Wet													
2.4			3	SS	5									
107.6	SAND , some silt, trace gravel and clay Loose Brown Wet													
2.9			4	SS	>100									
107.1														
3.4	SANDY SILT , some gravel and clay, with cobbles (TILL) Very dense Grey Wet													
			5	NQ RC	REC 100%									
	Limestone with shale interbeds (BEDROCK) Fresh Grey Very thinly to medium bedded Medium strong - Highly fractured from 3.3 m to 3.4 m depth													
			6	NQ RC	REC 100%									
			7	NQ RC	REC 100%									
103.9														
6.6	End of Borehole Note: Water level in open borehole at 2.0 m depth (Elev. 108.5 m) upon completion of drilling on June 5, 2008.													

PROJECT <u>07-1121-0151</u>		RECORD OF BOREHOLE No 08-503		1 OF 1 METRIC	
G.W.P. <u>255-98-00</u>	LOCATION <u>N 5016426.0; E 348047.7</u>	ORIGINATED BY <u>D.J.S.</u>			
DIST <u>Eastern</u> HWY <u>417</u>	BOREHOLE TYPE <u>Power Auger 108mm I.D. Hollow Stem</u>	COMPILED BY <u>J.M.</u>			
DATUM <u>Geodetic</u>	DATE <u>June 6, 2008</u>	CHECKED BY <u>S.A.T.</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)	
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × REMOULDED							
109.0	GROUND SURFACE							20 40 60 80 100	20 40 60 80 100							
0.0	Peat with cobbles and boulders (FILL) Dark brown					▽	108									
108.1	PEAT Firm Dark brown Moist to wet		1	SS	6											
0.9		2	SS	4												
106.7																
2.3	Silty SAND Loose															
106.3	Grey-brown to grey Wet		3	SS	6											
2.7	Sandy SILT Loose to compact Grey Wet		4	SS	>50											
105.8	Sandy SILT (TILL) Compact Grey Wet		5	NQ RC	REC 100%								RQD = 65%			
3.3	Limestone with shale interbeds (BEDROCK) Fresh Grey Laminated to medium bedded Medium strong		6	NQ RC	REC 98%								RQD = 53%			
	- Highly fractured zone from 3.3 m to 3.4 m depth															
	- 45° fracture from 5.5 m to 5.6 m depth		7	NQ RC	REC 100%									RQD = 95%		
102.4	End of Borehole															
6.6	Note: Water level in open borehole at 1.1 m depth (Elev. 107.9 m) upon completion of drilling on June 6, 2008.															

PROJECT <u>07-1121-0151</u>		RECORD OF BOREHOLE No 08-504		1 OF 1 METRIC	
G.W.P. <u>255-98-00</u>		LOCATION <u>N5016529.8; E 348161.5</u>		ORIGINATED BY <u>D.J.S.</u>	
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Power Auger 108mm I.D. Hollow Stem</u>		COMPILED BY <u>J.M.</u>	
DATUM <u>Geodetic</u>		DATE <u>June 4, 2008</u>		CHECKED BY <u>S.A.T.</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
108.4	GROUND SURFACE													
0.0	Peat and sand, trace wood fragments (FILL) Firm Dark brown Moist		1	SS	7									
106.7	PEAT Firm Dark brown Wet		2	SS	5									
105.7	Sandy SILT Compact Grey Wet		3	SS	12									0 33 67 0
104.3	SAND, some silt Dense Grey Wet		4	SS	47									0 80 20 0
102.6	Sandy SILT (TILL) Loose Grey Wet		5	SS	>50									
102.1	Limestone with shale interbeds (BEDROCK) Fresh Grey to dark grey Thinly to medium bedded Medium strong		6	NQ RC	REC 100%									RQD = 87%
6.3			7	NQ RC	REC 100%									RQD = 66%
			8	NQ RC	REC 100%									RQD = 83%
98.9	End of Borehole													
9.5	Note: Water level in well screen at 1.6 m depth (Elev. 106.8 m) on Oct. 10, 2008.													

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PROJECT <u>07-1121-0151</u>		RECORD OF BOREHOLE No 08-505		1 OF 1 METRIC	
G.W.P. <u>255-98-00</u>	LOCATION <u>N 5016635.6; E 348277.5</u>	ORIGINATED BY <u>D.J.S.</u>			
DIST <u>Eastern</u> HWY <u>417</u>	BOREHOLE TYPE <u>Power Auger 108mm I.D. Hollow Stem</u>	COMPILED BY <u>J.M.</u>			
DATUM <u>Geodetic</u>	DATE <u>June 3, 2008</u>	CHECKED BY <u>S.A.T.</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE						
								● QUICK TRIAXIAL	× REMOULDED						
107.7	GROUND SURFACE					20	40	60	80	100	25	50	75	GR SA SI CL	
0.0	Peat with silty sand (FILL) Firm to stiff/Loose Dark brown Wet														
106.5			1	SS	9										
1.2	Wood and peat (FILL) Wet														
106.0															
105.7	PEAT Firm Dark brown Wet		2	SS	4										
2.0															
105.3	Silty SAND Compact Grey-brown Wet														
2.4	SAND, trace to some silt Compact Grey Wet		3	SS	15										
103.0															
4.7	Silty SAND, with sandy silt seams Loose Grey Wet		4	SS	7										
102.2															
5.6	Probable Sandy Silt (Till) Limestone with shale interbeds (BEDROCK) Fresh Dark grey to black Thinly to medium bedded Medium strong - 45° fracture from 5.6 m to 5.9 m depth		5	NQ RC	REC 100%									RQD = 0%	
			6	NQ RC	REC 100%									RQD = 92%	
			7	NQ RC	REC 100%									RQD = 85%	
98.7															
9.0	End of Borehole Note: Water level in open borehole at 2.6 m depth (Elev. 105.1 m) upon completion of drilling on June 3, 2008.														

PROJECT		07-1121-0151		RECORD OF BOREHOLE No 08-506		1 OF 1 METRIC													
G.W.P.		255-98-00		LOCATION		N 5016742.7; E 348395.0													
DIST		Eastern HWY 417		BOREHOLE TYPE		Power Auger 108mm I.D. Hollow Stem													
DATUM		Geodetic		DATE		June 2, 2008													
				ORIGINATED BY		D.J.S.													
				COMPILED BY		J.M.													
				CHECKED BY		S.A.T.													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa			WATER CONTENT (%)			γ			GR SA SI CL		
106.0	GROUND SURFACE							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED			W _p W W _L 25 50 75			kN/m ³					
0.0	PEAT Dark brown Wet																		
105.1	Silty SAND Compact Grey Wet		1	SS	28		105												
1.1																			
104.3	Sandy SILT, some gravel, trace clay, with boulders (TILL)		2	SS	>100		104										RQD = 23%		
1.7	Dense Grey Wet		3	NQ RC	REC 91%														
	Limestone with shale interbeds (BEDROCK)		4	NQ RC	REC 95%		103										RQD = 39%		
	Slightly weathered																		
	Thinly to medium bedded																		
	Medium strong																		
	- Highly fractured zone from 1.8 m to 3.3 m depth		5	NQ RC	REC 88%		102										RQD = 51%		
100.9			6	NQ RC	REC 100%		101										RQD = 65%		
5.1	End of Borehole																		
	Note: Water level in open borehole at ground surface (Elev. 106.0 m) upon completion of drilling on June 3, 2008.																		

PROJECT 07-1121-0151		RECORD OF BOREHOLE No 08-507		1 OF 1 METRIC	
G.W.P. 255-98-00		LOCATION N 5016849.5; E 348512.1		ORIGINATED BY D.J.S.	
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem		COMPILED BY J.M.	
DATUM Geodetic		DATE June 2, 2008		CHECKED BY S.A.T.	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								20 40 60 80 100		25 50 75				
105.4	GROUND SURFACE													GR SA SI CL
0.0	TOPSOIL													
0.2	Sandy SILT and CLAYEY SILT Light brown Wet						105							
104.4														
1.0	SILT, some sand, trace gravel Compact Brown to grey Wet		1	SS	16		104							10 25 64 1
			2	SS	11									
102.8							103							
2.6	Silty SAND, trace gravel and clay (TILL) Very loose Grey Wet		3	SS	1		102							8 56 33 3
101.6														
3.8	Limestone with shale interbeds (BEDROCK) Slightly weathered to fresh Grey to dark grey Very thinly to medium bedded Medium strong - Highly fractured zone from 4.0 m to 4.2 m depth		4	NQ RC	REC 96%		101							RQD = 46%
			5	NQ RC	REC 100%		100							RQD = 88%
			6	NQ RC	REC 100%		99							RQD = 81%
98.3														
7.1	End of Borehole Note: Water level in open borehole at 0.6 m depth (Elev. 104.8 m) upon completion of drilling on June 2, 2008.													

PROJECT		RECORD OF BOREHOLE		No 08-508		1 OF 1		METRIC					
G.W.P.		LOCATION		N 5016966.9; E 348637.1		ORIGINATED BY		D.J.S.					
DIST		BOREHOLE TYPE		Power Auger 108mm I.D. Hollow Stem		COMPILED BY		J.M.					
DATUM		DATE		Aug. 5, 2008		CHECKED BY		S.A.T.					
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	GR SA SI CL
104.8	GROUND SURFACE												
0.0	TOPSOIL												
0.4	Sandy SILT with rock slabs												
104.0	Dark brown												
0.8	Sandy SILT (TILL)												
	Light brown to grey												
	Crystalline Limestone with thin black shale seams (BEDROCK)		1	NQ RC	REC 100%		104						RQD = 58%
	Slightly weathered Grey		2	NQ RC	REC 100%		103						RQD = 79%
	Thinly to medium bedded		3	NQ RC	REC 100%		102						RQD = 67%
	Medium grained						101						
100.8	End of Borehole												
4.0	Note: Water level in open borehole at 1.5 m depth (Elev. 103.3 m) upon completion of drilling on Aug. 5, 2008.												

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

PROJECT 07-1121-0151		RECORD OF BOREHOLE No 08-510		1 OF 1 METRIC	
G.W.P. 255-98-00		LOCATION N 5017164.9; E 348854.5		ORIGINATED BY D.J.S.	
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem		COMPILED BY J.M.	
DATUM Geodetic		DATE Aug. 12, 2008		CHECKED BY S.A.T.	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
							20	40	60	80	100			
103.6	GROUND SURFACE													
0.0	TOPSOIL													
103.1	SILTY CLAY (Weathered Crust) Grey-brown													
0.7	Silty SAND Loose Brown		1	SS	15									
102.3	Moist Sandy SILT Compact Brown		2	SS	59									
1.3	Moist Silty SAND, some gravel, trace clay, with cobbles (TILL) Loose to very dense Brown to grey Moist to wet		3	SS	5									12 52 28 8
			4	SS	>100									
			5	SS	29									
99.3	Crystalline Limestone with thin black shale seams (BEDROCK) Fresh Grey Medium strong		6	NQ RC	REC 100%									RQD = 95%
97.0	Crystalline Limestone with thin black shale seams (BEDROCK) Fresh to slightly weathered Dark grey Strong		7	NQ RC	REC 100%									RQD = 79%
6.6														
96.2														
7.4	End of Borehole													
	Note: Water level in well screen at 2.3 m depth (Elev. 101.3 m) on Oct. 10, 2008.													

PROJECT		07-1121-0151		RECORD OF BOREHOLE No 08-511				1 OF 1 METRIC									
G.W.P.		255-98-00		LOCATION		N 5016997.1; E 348841.7		ORIGINATED BY D.J.S.									
DIST		Eastern HWY 417		BOREHOLE TYPE		Power Auger 108mm I.D. Hollow Stem		COMPILED BY J.M.									
DATUM		Geodetic		DATE		Aug. 26, 2008		CHECKED BY S.A.T.									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
104.8	GROUND SURFACE																
0.0	Topsoil (FILL)																
0.1	Sandy silt, some gravel, trace clay, with cobbles and organic matter (FILL) Compact Brown Moist		1	SS	10												
			2	SS	13												
102.6																	
102.3	CLAYEY SILT with silty sand seams Brown Wet		3	SS	>100												
2.5	Crystalline Limestone with thin black shale seams (BEDROCK) Slightly weathered to fresh Grey Medium strong - Highly fractured from 3.0 m to 3.1 m depth<->		4	NQ RC	REC 100%												RQD = 86%
			5	NQ RC	REC 100%												RQD = 99%
			6	NQ RC	REC 98%												RQD = 83%
99.2																	
5.6	End of Borehole Note: Water level in open borehole at 5.2 m depth (Elev. 99.6 m) upon completion of drilling on Aug. 26, 2008.																

RECORD OF BOREHOLE No 08-512

1 OF 1 **METRIC**

PROJECT 07-1121-0151
G.W.P. 255-98-00 LOCATION N 5017043.3; E 348972.7 ORIGINATED BY D.J.S.
DIST Eastern HWY 417 BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem COMPILED BY J.M.
DATUM Geodetic DATE Aug. 15, 2008 CHECKED BY S.A.T.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED										
								20 40 60 80 100	25 50 75									
104.0	GROUND SURFACE																	
0.0	Topsoil (FILL)																	
0.1	Sandy silt, trace gravel (FILL)																	
103.5	Brown																	
	TOPSOIL																	
0.7	Sandy SILT		1	SS	12		103											
	Compact																	
	Light brown																	
	Moist																	
102.2																		
1.8	Silty SAND with sandy silt seams and layers		2	SS	15		102											
	Compact																	
	Brown to grey		3	SS	17													
	Wet																	
100.8							101											
3.2	Sandy SILT, some gravel and clay, with cobbles (TILL)		4	SS	10													
	Very loose to compact																	
	Grey																	
	Wet		5	SS	2		100											
99.6																		
4.4	Crystalline Limestone with thin black shale seams (BEDROCK)																	
99.0	Slightly weathered to fresh																	
5.0	Light grey		6	NQ RC	REC 97%		99								RQD = 70%			
	Thinly to medium bedded																	
	Medium strong																	
	<u>Mud seam at 4.9 m depth</u>																	
	Crystalline Limestone with thin black shale seams (BEDROCK)																	
	Slightly weathered to fresh																	
	Dark grey to black																	
	Thinly to medium bedded		7	NQ RC	REC 97%		98								RQD = 76%			
	Strong																	
97.2	End of Borehole																	
6.8																		

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PROJECT 07-1121-0151		RECORD OF BOREHOLE No 08-513		1 OF 1 METRIC																			
G.W.P. 255-98-00		LOCATION N 5017199.4; E 349037.8		ORIGINATED BY D.J.S.																			
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem		COMPILED BY J.M.																			
DATUM Geodetic		DATE Aug. 21, 2008		CHECKED BY S.A.T.																			
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES																		
103.0	GROUND SURFACE																						
0.0	TOPSOIL																						
102.6																							
0.4	SILTY CLAY (Weathered Crust) Very stiff to stiff Grey-brown Moist to wet		1	SS	10																		
			2	SS	4																		
			3	SS	2																		
99.3	SILTY CLAY with clayey silt seams Firm Grey Wet																						
3.7																							
98.3	Sandy SILT, trace gravel Very loose to loose Grey Wet		4	SS	6																		
			5	SS	1																		
			6	SS	WH																		
96.4	Silty SAND, some gravel, trace clay (TILL) Very loose Grey Wet		7	SS	1																		
6.6			8	SS	4																		
94.8	Crystalline Limestone with occasional thin black shale seams (BEDROCK) Slightly weathered Dark grey to black Thinly to medium bedded Strong		9	NQ RC	REC 100%																		
8.2			10	NQ RC	REC 100%																		
			11	NQ RC	REC 100%																		
91.6																							
11.4	End of Borehole Note: Water level in open borehole at 1.7 m depth (Elev. 101.3 m) upon completion of drilling on Aug. 21, 2008.																						

MIS-MTO 001 07-1121-0151 GPJ GAL-MISS GDT 7/23/09

PROJECT 07-1121-0151		RECORD OF BOREHOLE No 08-514		1 OF 1 METRIC	
G.W.P. 255-98-00		LOCATION N 5017266.3; E 348966.4		ORIGINATED BY D.J.S.	
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem		COMPILED BY J.M.	
DATUM Geodetic		DATE Aug. 12, 2008		CHECKED BY S.A.T.	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE						
								● QUICK TRIAXIAL	× REMOULDED						
102.6	GROUND SURFACE														
0.0	TOPSOIL														
0.2	CLAYEY SILT and Sandy SILT Brown Moist														
101.8															
0.9	SILTY CLAY (Weathered Crust) Very stiff to stiff Grey-brown Moist to wet		1	SS	8										
			2	SS	5										
			3	SS	2										
99.0															
3.6	SILTY CLAY and CLAYEY SILT Firm Grey Wet														
98.0															
4.6	Silty SAND with sandy silt seams Very loose Grey Wet		4	SS	2										
			5	SS	2										
96.7															
5.9	Sandy SILT with clayey silt and sand seams Very loose Grey Wet		6	SS	3										
96.1															
6.5	Sandy SILT, some gravel and clay, with cobbles (TILL) Compact to dense Grey Wet		7	SS	15										
			8	SS	27										
			9	SS	33										
93.9															
8.7	Crystalline Limestone with shale interbeds (BEDROCK) Slightly weathered Dark grey Very thinly to medium bedded Strong - Vertical fracture from 10.1 m to 11.1 m depth		10	NQ RC	REC 100%									RQD = 57%	
			11	NQ RC	REC 100%									RQD = 78%	
			12	NQ RC	REC 100%									RQD = 31%	
91.1															
90.7	Limestone with calcite seams (BEDROCK) Highly fractured (near vertical) Grey-white Medium strong														
11.9	End of Borehole Note: Water level in open borehole at 3.4 m depth (Elev. 99.2 m) upon completion of drilling on Aug. 13, 2008.														

MIS-MTO 001 07-1121-0151 GPJ GAL-MISS GDT 7/23/09

PROJECT 07-1121-0151			RECORD OF BOREHOLE No 08-515			1 OF 1 METRIC																					
G.W.P. 255-98-00			LOCATION N 5017396.4; E 348858.0			ORIGINATED BY D.J.S.																					
DIST Eastern HWY 417			BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem			COMPILED BY J.M.																					
DATUM Geodetic			DATE Aug. 22, 2008			CHECKED BY S.A.T.																					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			WATER CONTENT (%)			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES																						
106.2	GROUND SURFACE																										
106.2	Topsoil (FILL)																										
	Silty clay and clayey silt, trace gravel and organic matter, with silty sand seams (FILL). Very stiff to stiff. Grey-brown and grey. Moist to wet.		1	SS	6																						
			2	SS	7																						
			3	SS	6																						
			4	SS	1																						
102.5	TOPSOIL																										
4.0	SILTY CLAY (Weathered Crust)		5	SS	12																						
	Very stiff to stiff. Grey-brown. Wet.		6	SS	9																						
			7	SS	4																						
			8	SS	2																						
99.2	SILTY CLAY and CLAYEY SILT																										
7.0	Firm. Grey. Wet.																										
98.6	SANDY SILT and CLAYEY SILT																										
7.6	Very loose. Grey. Wet.		9	SS	WH																						
98.1	SANDY SILT with silty sand seams																										
8.1	Very loose to loose. Grey. Wet.		10	SS	8																						
			11	SS	3																						
96.1	SANDY SILT, some gravel and clay (TILL)																										
10.1	Very loose. Grey. Wet.		12	SS	2																						
95.5	End of Borehole																										
10.7																											

MIS-MTO 001 07-1121-0151 GPJ GAL-MISS GDT 7/23/09

PROJECT		RECORD OF BOREHOLE		No 08-516		1 OF 1		METRIC					
G.W.P.		LOCATION		ORIGINATED BY		D.J.S.							
DIST		BOREHOLE TYPE		COMPILED BY		J.M.							
DATUM		DATE		CHECKED BY		S.A.T.							
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	GR SA SI CL
101.9	GROUND SURFACE												
0.0	Topsoil (FILL)												
0.1	Silly clay, trace gravel, with cobbles (FILL)												
	Grey-brown												
	Moist to wet												
100.1			1	SS	10		101						
1.8	SILTY CLAY with clayey silt seams (Weathered Crust)		2	SS	3		100						
	Stiff												
	Grey-brown												
	Wet												
97.5			3	SS	1		99						
4.4	SILTY CLAY												
	Firm												
	Grey												
	Wet												
93.4			4	SS	WH		98						
8.5	SILTY CLAY and CLAYEY SILT												
92.9	Firm												
9.0	Grey												
	Wet												
92.4	Sandy SILT												
9.5	Compact												
	Grey												
	Wet												
	Sandy SILT, some gravel and clay, with cobbles (TILL)												
	Compact												
91.2	Grey												
	Wet												
10.7	End of Borehole												

WIS-MTO 001 07-1121-0151 GPJ GAL-MISS GDT 7/23/09

+ 3, X 3 Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 08-518
1 OF 1 METRIC

PROJECT 07-1121-0151

G.W.P. 255-98-00

LOCATION N 5017438.8, E 349155.5

ORIGINATED BY D.J.S.

DIST Eastern HWY 417

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

COMPILED BY J.M.

DATUM Geodetic

DATE Aug. 14, 2008

CHECKED BY S.A.T.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w_p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
								20 40 60 80 100							
								○ UNCONFINED + FIELD VANE							
								● QUICK TRIAXIAL × REMOULDED							
101.8	GROUND SURFACE														
0.0	TOPSOIL														
0.1	CLAYEY SILT and SILTY CLAY, with sandy silt seams Very stiff Brown Moist		1	SS	4		101								
100.8	SILTY CLAY (Weathered Crust) Very stiff to stiff Grey-brown Wet		2	SS	1		100								
1.0															
			3	SS	2		99								
							98								
97.5	SILTY CLAY Firm Grey Wet		4	SS	WH		97								
4.3															
			5	SS	WH		96								
							95								
			6	SS	PM		94								
							93								
			7	SS	PM		92								

MIS-MTO 001 07-1121-0151 GPJ GAL-MISS GDT 7/23/09

PROJECT 07-1121-0151		RECORD OF BOREHOLE No 08-519		1 OF 1 METRIC	
G.W.P. 255-98-00		LOCATION N 5017536.5; E 349262.6		ORIGINATED BY D.J.S.	
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem		COMPILED BY J.M.	
DATUM Geodetic		DATE Aug. 1, 2008		CHECKED BY S.A.T.	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
100.8	GROUND SURFACE													
0.0	TOPSOIL													
0.2	SILTY CLAY (Weathered Crust) Very stiff to stiff Grey-brown Moist to wet		1	SS	5									
			2	SS	4									
			3	SS	1									
96.4	SILTY CLAY, trace black organic matter Firm Grey Wet		4	SS	WH									
4.4														
			5	SS	WH									
92.7	SILTY CLAY with clayey silt seams Firm Grey Wet		6	SS	PM									0 2 56 42
8.1														
			7	SS	PM									
90.1	End of Borehole													
10.7														

MIS-MTO 001 07-1121-0151 GPJ GAL-MISS GDT 7/23/09

PROJECT 07-1121-0151		RECORD OF BOREHOLE No 08-520		1 OF 1 METRIC	
G.W.P. 255-98-00		LOCATION N 5017632.3; E 349367.6		ORIGINATED BY D.J.S.	
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem		COMPILED BY J.M.	
DATUM Geodetic		DATE July 29, 2008		CHECKED BY S.A.T.	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
100.2	GROUND SURFACE													
0.0	Topsoil (FILL)						100							
0.2	Silty clay, trace gravel (FILL)													
	Grey-brown Moist													
99.3	TOPSOIL													
1.1	SILTY CLAY (Weathered Crust)		1	SS	8		99							
	Very stiff to stiff													
	Grey-brown		2	SS	5		98							
	Moist to wet													
							97							
			3	SS	4									
							96							
95.3	SILTY CLAY		4	SS	WH		95							
4.9	Firm to stiff													
	Grey													
	Wet													
			5	SS	WH		94							
							93							
			6	SS	WH									
							92							
			7	SS	PM		91							
90.0							90							
10.2	Layered SILTY CLAY and CLAYEY SILT													
89.5	Wet													
10.7	End of Borehole													

M/S-MTO 001 07-1121-0151 GPJ GAL-MISS GDT 7/23/09

RECORD OF BOREHOLE No 08-521

1 OF 1 **METRIC**

PROJECT 07-1121-0151
 G.W.P. 255-98-00 LOCATION N 5017729.6; E 349480.8 ORIGINATED BY D.J.S.
 DIST Eastern HWY 417 BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem COMPILED BY J.M.
 DATUM Geodetic DATE July 28, 2008 CHECKED BY S.A.T.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
98.5	GROUND SURFACE							20	40	60	80	100		
0.0	TOPSOIL							20	40	60	80	100		
0.2	SILTY CLAY (Weathered Crust) Very stiff to stiff Grey-brown Moist to wet		1	SS	7									
			2	SS	3									
			3	SS	WH									
94.5	SILTY CLAY Firm Grey Wet		4	SS	PM									
4.0														
			5	SS	WH									
			6	SS	PM									
89.2	Layered CLAYEY SILT and SILTY CLAY Grey Wet		7	SS	PM									
9.3			8	SS	PM									
87.8	End of Borehole													
10.7														

+ ³, X ³: Numbers refer to Sensitivity
 O 3% STRAIN AT FAILURE

PROJECT <u>07-1121-0151</u>		RECORD OF BOREHOLE No 08-521A		1 OF 1 METRIC	
G.W.P. <u>255-98-00</u>	LOCATION <u>N 5017712.0; E 349459.2</u>	ORIGINATED BY <u>D.J.S.</u>			
DIST <u>Eastern</u> HWY <u>417</u>	BOREHOLE TYPE <u>Power Auger 108mm I.D. Hollow Stem</u>	COMPILED BY <u>J.M.</u>			
DATUM <u>Geodetic</u>	DATE <u>July 31, 2008</u>	CHECKED BY <u>S.A.T.</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
							20 40 60 80 100							
98.7	GROUND SURFACE													
0.0	TOPSOIL													
98.4														
0.3	SILTY CLAY (Weathered Crust) Very stiff to stiff Grey-brown Wet													
			1	SS	4									
			2	SS	2									
94.7														
4.0	SILTY CLAY Firm Grey Wet													
			3	SS	WH									
			4	SS	PM									
89.6														
89.2	Sandy SILT Grey Wet		5	SS	2									
9.5	Layered SILTY CLAY and CLAYEY SILT Grey Wet													
			6	SS	PM									
87.9														
10.8	End of Borehole													

MIS-MTO 001 07-1121-0151 GPJ GAL-MISS GDT 7/23/09

RECORD OF BOREHOLE No 08-522

1 OF 1 **METRIC**

PROJECT 07-1121-0151

G.W.P. 255-98-00

LOCATION

N 5017821.2; E 349602.9

ORIGINATED BY D.J.S.

DIST Eastern HWY 417

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

COMPILED BY J.M.

DATUM Geodetic

DATE

July 28, 2008

CHECKED BY S.A.T.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × REMOULDED						
98.0	GROUND SURFACE							20 40 60 80 100							
0.0	TOPSOIL														
0.2	SILTY CLAY (Weathered Crust) Very stiff to stiff Grey-brown Moist to wet		1	SS	4										
			2	SS	4										
			3	SS	2										
94.0	SILTY CLAY Firm Grey Wet		4	SS	WH										
4.0															
			5	SS	PM										
			6	SS	PM										
			7	SS	PM										
87.3	End of Borehole														
10.7	Note: Water level in well screen at 1.4 m depth (Elev. 96.6 m) on Oct. 10, 2008.														

MIS-MTO 001 07-1121-0151 GPJ GAL-MISS GDT 7/23/09

+ 3, X 3

Numbers refer to Sensitivity

O 3% STRAIN AT FAILURE

MIS-MTO 001 07-1121-0151 GPJ GAL-MISS GDT 7/23/09

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

PROJECT 07-1121-0151		RECORD OF BOREHOLE No 08-523		1 OF 1 METRIC	
G.W.P. 255-98-00		LOCATION N 5017904.5; E 349730.8		ORIGINATED BY D.J.S.	
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem		COMPILED BY J.M.	
DATUM Geodetic		DATE July 25, 2008		CHECKED BY S.A.T.	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)	W _p	W	W _L		
96.5	GROUND SURFACE													
0.0	TOPSOIL													
0.2	SILTY CLAY (Weathered Crust) Very stiff to stiff Grey-brown Moist to wet		1	SS	3									
			2	SS	3									
93.3	SILTY CLAY Firm Grey Wet		3	SS	WH									
3.2														
			4	SS	WH									
			5	SS	PM									
			6	SS	PM									
			7	SS	WH									
85.8	End of Borehole													
10.7														

MIS-MTO 001 07-1121-0151 GPJ GAL-MISS GDT 7/23/09

PROJECT 07-1121-0151			RECORD OF BOREHOLE No 08-523A			1 OF 1 METRIC													
G.W.P. 255-98-00			LOCATION N 5017892.6; E 349711.4			ORIGINATED BY D.J.S.													
DIST Eastern HWY 417			BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem			COMPILED BY J.M.													
DATUM Geodetic			DATE July 30, 2008			CHECKED BY S.A.T.													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa			WATER CONTENT (%)			γ			GR SA SI CL		
96.7	GROUND SURFACE							20 40 60 80 100	○ UNCONFINED + FIELD VANE	W _p W W _L	25 50 75	KN/m ³							
0.0	TOPSOIL							20 40 60 80 100	● QUICK TRIAXIAL × REMOULDED										
0.2	SILTY CLAY (Weathered Crust) Very stiff to stiff Grey-brown Wet		1	SS	4		96												
							95												
							94	×	+										
93.5							93												
3.2	SILTY CLAY Firm Grey Wet		2	SS	WH		92												
							91												
			3	SS	PM		90												
							89												
			4	SS	PM		88												
							87												
							86												
85.9			5	SS	PM														
10.8	End of Borehole																		

MIS-MTO 001 07-1121-0151 GPJ GAL-MISS GDT 7/23/09

PROJECT <u>07-1121-0151</u>		RECORD OF BOREHOLE No 08-524		1 OF 1 METRIC	
G.W.P. <u>255-98-00</u>		LOCATION <u>N 5017978.5; E 349862.6</u>		ORIGINATED BY <u>D.J.S.</u>	
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Power Auger 108mm I.D. Hollow Stem</u>		COMPILED BY <u>J.M.</u>	
DATUM <u>Geodetic</u>		DATE <u>July 24, 2008</u>		CHECKED BY <u>S.A.T.</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE LIQUID LIMIT LIMIT CONTENT LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	w _p w w _L					
95.1	GROUND SURFACE							20 40 60 80 100		25 50 75				
0.0	TOPSOIL													
0.2	SILTY CLAY (Weathered Crust) Stiff to firm Grey-brown Wet		1	SS	WH									
			2	SS	WH									
92.3														
2.8	SILTY CLAY Firm Grey		3	SS	PM									
			4	SS	PM									
			5	SS	PM									
			6	SS	PM									
			7	SS	PM									
84.4														
10.7	End of Borehole													

MIS-MTO 001 07-1121-0151 GPJ GAL-MISS GDT 7/23/09

PROJECT 07-1121-0151			RECORD OF BOREHOLE No 08-524A			1 OF 1 METRIC															
G.W.P. 255-98-00			LOCATION N 5017970.0; E 349846.7			ORIGINATED BY D.J.S.															
DIST Eastern HWY 417			BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem			COMPILED BY J.M.															
DATUM Geodetic			DATE July 30, 2008			CHECKED BY S.A.T.															
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ					
95.2	GROUND SURFACE							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					25 50 75 W _p W W _L			20 40 60 80 100 25 50 75			GR SA SI CL		
0.0	TOPSOIL						95														
0.2	SILTY CLAY (Weathered Crust) Stiff Grey-brown Wet		1	SS	WH		94														
							93														
92.5	SILTY CLAY Firm Grey Wet		2	SS	PM		92														
2.7							91														
			3	SS	PM		90														
							89														
			4	SS	PM		88														
							87														
							86														
			5	SS	PM		85														
84.4	End of Borehole																				
10.8																					

MIS-MTO 001 07-1121-0151 GPJ GAL-MISS GDT 7/23/09

PROJECT <u>07-1121-0151</u>		RECORD OF BOREHOLE No 08-525		1 OF 1 METRIC	
G.W.P. <u>255-98-00</u>		LOCATION <u>N 5018047.2; E 349992.6</u>		ORIGINATED BY <u>D.J.S.</u>	
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Power Auger 108mm I.D. Hollow Stem</u>		COMPILED BY <u>J.M.</u>	
DATUM <u>Geodetic</u>		DATE <u>July 24, 2008</u>		CHECKED BY <u>S.A.T.</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
94.2	GROUND SURFACE													
0.0	TOPSOIL													
93.7	SILTY SAND Brown													
0.5	SILTY CLAY (Weathered Crust) Very stiff Grey-brown Moist to wet		1	SS	2									
			2	SS	1									
91.3														
2.9	SILTY CLAY Soft to firm Grey Wet		3	SS	WH									
			4	SS	WH									
			5	SS	PM									
			6	SS	PM									
			7	SS	PM									
83.5														
10.7	End of Borehole													

MIS-MTO 001 07-1121-0151 GPJ GAL-MISS GDT 7/23/09



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

PROJECT <u>07-1121-0151</u>		RECORD OF BOREHOLE No 08-526		1 OF 1 METRIC	
G.W.P. <u>255-98-00</u>		LOCATION <u>N 5018115.7; E 350121.8</u>		ORIGINATED BY <u>D.J.S.</u>	
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Power Auger 108mm I.D. Hollow Stem</u>		COMPILED BY <u>J.M.</u>	
DATUM <u>Geodetic</u>		DATE <u>June 11, 2008</u>		CHECKED BY <u>S.A.T.</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w_p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
							20 40 60 80 100	20 40 60 80 100						
93.4	GROUND SURFACE													
0.0	Organic silt, with peat, silty sand and sand (FILL) Loose Dark brown Wet		1	SS	5									
91.9														
1.5	Organic sandy silt, trace silty clay and gravel (ALLUVIUM) Very loose Dark brown Wet		2	SS	2									
91.2														
2.2	Organic CLAYEY SILT Stiff Dark brown Wet		3	SS	WH									
90.0														
3.4	SILTY CLAY Soft to firm Grey Wet		4	SS	WH									
			5	SS	WH									
			6	SS	WH									
			7	SS	WH									
			8	SS	WH									
82.7														
10.7	End of Borehole													

MIS-MTO 001 07-1121-0151 GPU GAL-MISS GDT 7/23/09

PROJECT <u>07-1121-0151</u>		RECORD OF BOREHOLE No 08-527		1 OF 1 METRIC	
G.W.P. <u>255-98-00</u>		LOCATION <u>N 5018187.6; E 350257.7</u>		ORIGINATED BY <u>D.J.S.</u>	
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Power Auger 108mm I.D. Hollow Stem</u>		COMPILED BY <u>J.M.</u>	
DATUM <u>Geodetic</u>		DATE <u>June 10, 2008</u>		CHECKED BY <u>S.A.T.</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE						● QUICK TRIAXIAL
94.0	GROUND SURFACE														
0.0	ORGANIC MATTER														
0.2	SILTY CLAY with sand seams (Weathered Crust) Stiff Grey-brown Wet		1	SS	WH										
			2	SS	WH										
91.5	SILTY CLAY Firm Grey Wet		3	SS	WH										
2.5															
			4	SS	PM										
			5	SS	PM										
	</														

MIS-MTO 001 07-1121-0151 GPJ GAL-MISS GDT 7/23/09

PROJECT 07-1121-0151		RECORD OF BOREHOLE No 08-528		1 OF 1 METRIC						
G.W.P. 255-98-00		LOCATION N 5018257.7; E 350390.2		ORIGINATED BY D.J.S.						
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem		COMPILED BY J.M.						
DATUM Geodetic		DATE June 10, 2008		CHECKED BY S.A.T.						
SOIL PROFILE			SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
94.8	GROUND SURFACE									
0.0	ORGANIC MATTER									
0.2	SILTY CLAY with sand seams (Weathered Crust) Stiff Grey-brown Wet		1	SS	1					
			2	SS	WH					0 12 55 33
92.1	SILTY CLAY Firm Grey Wet		3	SS	WH					
2.7			4	SS	WH					0 1 49 50
			5	SS	WH					
36.9	Layered SILTY CLAY and CLAYEY SILT Firm Grey Wet		6	SS	WH					0 4 42 54
85.8	Silty SAND, trace to some gravel, trace clay (TILL) Loose Grey Wet		7	SS	25					10 48 33 9
85.3			8	SS	52					33 53 13 1
84.2	SAND, some gravel and silt Dense to very dense Grey Wet									
10.6	End of Borehole									
Note: Water level in open borehole at 1.5 m depth (Elev. 93.3 m) upon completion of drilling on June 10, 2008.										

MIS-MTO 001 07-1121-0151 GPJ GAL-MISS GDT 7/23/09

PROJECT <u>07-1121-0151</u>		RECORD OF BOREHOLE No 08-529		1 OF 1 METRIC	
G.W.P. <u>255-98-00</u>	LOCATION <u>N 5018328.4; E 350523.7</u>	ORIGINATED BY <u>D.J.S.</u>			
DIST <u>Eastern</u> HWY <u>417</u>	BOREHOLE TYPE <u>Power Auger 108mm I.D. Hollow Stem</u>	COMPILED BY <u>J.M.</u>			
DATUM <u>Geodetic</u>	DATE <u>June 9, 2008</u>	CHECKED BY <u>S.A.T.</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED						
95.7	GROUND SURFACE													
0.0 95.4	ORGANIC MATTER													
0.3	SILTY CLAY with sand seams (Weathered Crust) Very stiff to stiff Grey-brown Wet		1	SS	4									
			2	SS	WH									
93.6														
2.1	SILTY CLAY with sand seams Firm Grey Wet													
			3	SS	WH									
			4	SS	WH									
			5	SS	WH									
			6	SS	WH									
			7	SS	WH									
85.0														
10.7	End of Borehole													
	Note: Water level in well screen at 0.9 m depth (Elev. 94.8 m) upon completion of drilling on Oct. 10, 2008.													

MIS-MTO 001 07-1121-0151 GPJ GAL-MISS GDT 7/23/09

PROJECT		RECORD OF BOREHOLE		No 08-530		1 OF 1		METRIC					
G.W.P. 255-98-00		LOCATION		N 5018400.9; E 350660.7		ORIGINATED BY		D.J.S.					
DIST Eastern HWY 417		BOREHOLE TYPE		Power Auger 108mm I.D. Hollow Stem		COMPILED BY		J.M.					
DATUM Geodetic		DATE		Sept. 8, 2008		CHECKED BY		S.A.T.					
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	GR SA SI CL
96.9	GROUND SURFACE												
96.8	ORGANIC MATTER												
0.3	SILTY CLAY with sand seams (Weathered Crust) Grey-brown												
96.1	Silty SAND Brown Wet		1	SS	3		96						
1.0	Silty CLAY with sand seams, trace black organic matter Firm Grey Wet		2	SS	WH		95						
							94						
			3	SS	WH		93						
							92						
91.7	Silty CLAY Firm Grey Wet		4	SS	WH		91						
5.2							90						
90.1	Silty CLAY and CLAYEY SILT, trace gravel Firm to stiff Grey Wet		5	SS	WH		89						
6.8							88						
89.1	Silty SAND, some gravel, trace clay, with cobbles (TILL) Very loose Grey Wet		6	SS	5		87						
7.8			7	SS	>100		86						
88.2	Limestone with thin shale interbeds (BEDROCK) Slightly weathered Light grey Laminated to medium bedded Medium strong		8	NQ RC	REC 98%								
8.7	- Highly fractured from 9.4 m to 9.7 m depth												
	- Mud seam at 11.3 m depth		9	NQ RC	REC 100%								
85.4													
11.5	End of Borehole												
	Note: Water level in open borehole at 0.9 m depth (Elev. 96.0 m) upon completion of drilling on Sept. 8, 2008.												

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PROJECT 07-1121-0151			RECORD OF BOREHOLE No 08-531			1 OF 1 METRIC													
G.W.P. 255-98-00			LOCATION N 5018457.7; E 350761.7			ORIGINATED BY D.J.S.													
DIST Eastern HWY 417			BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem			COMPILED BY J.M.													
DATUM Geodetic			DATE Sept. 5, 2008			CHECKED BY S.A.T.													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa			WATER CONTENT (%)			γ			GR SA SI CL		
98.5	GROUND SURFACE							20 40 60 80 100	○ UNCONFINED	+ FIELD VANE	W _p — W — W _L								
98.2	ORGANIC MATTER							20 40 60 80 100	● QUICK TRIAXIAL	x REMOULDED									
0.3	SILTY CLAY Grey Wet						98												
97.6	Sandy SILT, some gravel and clay, with cobbles (TILL) Very loose Grey Wet		1	SS	1		97												
0.9																			
96.4			2	SS	WH														
2.1	SAND Grey Wet		3	SS	>50		96												
96.0																			
2.5	Sandstone (BEDROCK) Slightly weathered Light grey and dark grey Very thinly to medium bedded Medium strong - Highly fractured from 2.5 m to 2.9 m depth		4	NQ RC	REC 100%		95										RQD = 0%		
			5	NQ RC	REC 100%		94										RQD = 89%		
			6	NQ RC	REC 100%		93										RQD = 100%		
			7	NQ RC	REC 100%												RQD = 92%		
92.8																			
5.7	End of Borehole Note: Water level in open borehole at 0.2 m above ground surface (Elev. 98.7 m) upon completion of drilling on Sept. 5, 2008.																		

PROJECT 07-1121-0151		RECORD OF BOREHOLE No 08-532		1 OF 1 METRIC	
G.W.P. 255-98-00		LOCATION N 5018393.5; E 350847.0		ORIGINATED BY D.J.S.	
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem		COMPILED BY J.M.	
DATUM Geodetic		DATE Aug. 28, 2008		CHECKED BY S.A.T.	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
102.1	GROUND SURFACE													
0.0	Topsoil (FILL)													
101.6	Silty clay, trace gravel (FILL) Brown													
	TOPSOIL													
0.9	Silty SAND Brown		1	SS	9									
	Moist													
100.1	SILTY CLAY with silty sand seams (Weathered Crust) Very stiff Grey-brown		2	SS	4									
	Moist to wet													
2.0	SAND, some silt, trace clay Very loose Brown		3	SS	1									
	Wet													
98.9														
	SAND Brown		4	SS	PH									
98.4	Wet													
3.7	Sandy SILT, some clay, with silty clay layers Grey		5	SS	WH									
	Wet													
	SILTY CLAY to CLAY, with sand seams Firm Grey													
	Wet													
			6	SS	WH									
96.1														
6.0	Silty SAND, trace to some gravel and clay, with sand seams and layers (TILL) Very loose to compact Grey		7	SS	6									
	Wet													
			8	SS	3									
94.0			9	SS	16									
8.1	Sandstone (BEDROCK) Fresh Light grey Thinly to thickly bedded Medium strong		10	NQ RC	REC 100%									
	- 1/8" clay seam at 10.9 m depth													
	- Near vertical fracture at 11.0 m depth		11	NQ RC	REC 100%									
			12	NQ RC	REC 100%									
90.9														
11.2	End of Borehole													
	Note: Water level in open borehole at 2.0 m depth (Elev. 100.1 m) upon completion of drilling on Aug. 29, 2008.													

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

PROJECT 07-1121-0151		RECORD OF BOREHOLE No 08-534		1 OF 1 METRIC	
G.W.P. 255-98-00		LOCATION N 5018527.2; E 350871.4		ORIGINATED BY D.J.S.	
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem		COMPILED BY J.M.	
DATUM Geodetic		DATE Sept. 4, 2008		CHECKED BY S.A.T.	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × REMOULDED						
100.3	GROUND SURFACE						20 40 60 80 100	20 40 60 80 100	25 50 75						
0.0	TOPSOIL														
0.2	SILTY CLAY (Weathered Crust) Very stiff Grey-brown Moist		1	SS	3										
98.8															
98.4	Silty SAND, some gravel, trace clay (TILL) Compact Brown Wet		2	SS	>25									12 47 32 9	
1.9	Sandstone with thin black shale seams and interbeds (BEDROCK) Slightly weathered to fresh Light grey to grey with occasional brown staining Laminated to medium bedded Medium strong		3	NQ RC	REC 100%									RQD = 83%	
			4	NQ RC	REC 100%									RQD = 78%	
			5	NQ RC	REC 100%									RQD = 74%	
95.3	End of Borehole														
5.0	Note: Water level in open borehole at 0.8 m depth (Elev. 99.5 m) upon completion of drilling on Sept. 5, 2008.														

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PROJECT 07-1121-0151		RECORD OF BOREHOLE No 08-535		1 OF 1 METRIC	
G.W.P. 255-98-00		LOCATION N 5018577.9; E 350823.7		ORIGINATED BY D.J.S.	
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem		COMPILED BY J.M.	
DATUM Geodetic		DATE Aug. 27, 2008		CHECKED BY S.A.T.	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	WATER CONTENT (%) W	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						
101.4	GROUND SURFACE														
0.0	Topsoil (FILL)														
0.1	Sandy silt, some gravel and clay, with cobbles (FILL)														
100.3	Loose Brown Moist		1	SS	9										
1.1	Topsoil and clayey silt, trace gravel (FILL)														
99.7	Stiff														
1.7	Dark grey and brown Moist		2	SS	9										
99.0	SILTY CLAY (Weathered Crust)														
98.7	Very stiff Grey-brown Moist to wet		3	SS	5										
98.3	Layered CLAYEY SILT and Sandy SILT														
98.0	Loose Grey-brown Wet		4	SS	6										
3.6	Sandy SILT, some gravel (TILL)														
	Loose Brown Wet		5	NQ RC	REC 100%										
	SAND, some gravel														
	Loose Grey Wet		6	NQ RC	REC 100%										
	Silty SAND, trace gravel and clay (TILL)														
	Grey Wet		7	NQ RC	REC 100%										
	Sandstone (BEDROCK)														
	Slightly weathered														
	Light grey														
	Laminated to medium bedded														
	Medium strong		8	NQ RC	REC 100%										
94.6	- Near vertical fracture in upper 0.6 m														
6.8	- Highly fractured zones from 4.8 m to 4.9 m and 5.3 m to 5.5 m depths														
	- Brown staining up to 6.0 m depth														
	End of Borehole														
	Note: Water level in open borehole at 1.7 m depth (Elev. 99.7 m) upon completion of drilling on Aug. 27, 2008.														

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RECORD OF BOREHOLE No 08-536

1 OF 1 **METRIC**

PROJECT 07-1121-0151
 G.W.P. 255-98-00 LOCATION N 5018741.8; E 350898.1 ORIGINATED BY D.J.S.
 DIST Eastern HWY 417 BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem COMPILED BY J.M.
 DATUM Geodetic DATE Aug. 27, 2008 CHECKED BY S.A.T.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
101.5	GROUND SURFACE														GR SA SI CL
0.0	Topsoil (FILL)														
0.1	Sandy silt, some gravel, trace organic matter (FILL) Loose Brown Moist		1	SS	4										
100.2	Sandy silt, some gravel (TILL) Light brown Moist														
1.6	Sandstone (BEDROCK)														
99.4	Slightly weathered Grey-brown Laminated to thinly bedded Medium strong		2	NQ RC	REC 96%										RQD = 64%
2.1	Highly fractured in upper 0.9 m Sandstone (BEDROCK) Slightly weathered to fresh Light grey with dark grey bands Very thinly to medium bedded Medium strong		3	NQ RC	REC 100%										RQD = 90%
			4	NQ RC	REC 100%										RQD = 84%
96.5	End of Borehole														
5.0	Note: Water level in open borehole at 1.8 m depth (Elev. 99.7 m) upon completion of drilling on Aug. 27, 2008.														

PROJECT 07-1121-0151		RECORD OF BOREHOLE No 08-537		1 OF 1 METRIC								
G.W.P. 255-98-00		LOCATION N 5018765.5; E 351040.3		ORIGINATED BY D.J.S.								
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem		COMPILED BY J.M.								
DATUM Geodetic		DATE Aug. 28, 2008		CHECKED BY S.A.T.								
SOIL PROFILE			SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE							"N" VALUES	GROUND WATER CONDITIONS
102.0	GROUND SURFACE											
0.0	Topsoil (FILL)											
0.1	Sandy silt, some gravel, trace organic matter (FILL)											
	Loose											
	Dark brown											
	Moist											
100.8	TOPSOIL		1	SS	4							
	Sandy SILT, trace gravel		2	SS	>50							
1.5	Brown											
	Moist											
	Sandstone (BEDROCK)		3	SS	REC 96%							
	Slightly weathered											
	Light grey to grey-brown with dark grey bands											
	Laminated to medium bedded											
	Medium strong											
	- Highly fractured zones at 1.5 m, 1.9 m, and 2.3 m depth		4	SS	REC 100%							
97.4	End of Borehole		5	SS	REC 100%							
4.6	Note: Water level in open borehole at 2.0 m depth (Elev. 100.0 m) upon completion of drilling on Aug. 28, 2008.											

PROJECT 07-1121-0151		RECORD OF BOREHOLE No 08-538		1 OF 1 METRIC								
G.W.P. 255-98-00		LOCATION N 5018620.9; E 351001.2		ORIGINATED BY D.J.S.								
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem		COMPILED BY J.M.								
DATUM Geodetic		DATE July 17, 2008		CHECKED BY S.A.T.								
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	"N" VALUES					
104.7	GROUND SURFACE											
0.0	Sandstone (BEDROCK) Fresh Light grey with brown staining Laminated to thinly bedded Medium strong - Highly fractured zone in upper 0.5 m and at 3.8 m depth		1	NQ RC	REC 100%							RQD = 0%
			2	NQ RC	REC 97%	104						RQD = 15%
			3	NQ RC	REC 100%	103						RQD = 44%
			4	NQ RC	REC 98%	102						RQD = 67%
			5	NQ RC	REC 97%	101						RQD = 75%
			6	NQ RC	REC 100%	99						RQD = 94%
97.5	End of Borehole					98						
7.2	Note: Water level in open borehole at 3.8 m depth (Elev. 100.9 m) upon completion of drilling on Jul. 17, 2008.											

PROJECT		07-1121-0151		RECORD OF BOREHOLE No 08-539		1 OF 1 METRIC																			
G.W.P.		255-98-00		LOCATION		N 5018731.1; E 351134.4																			
DIST		Eastern HWY 417		BOREHOLE TYPE		Power Auger 108mm I.D. Hollow Stem																			
DATUM		Geodetic		DATE		July 16, 2008																			
						ORIGINATED BY D.J.S.																			
						COMPILED BY J.M.																			
						CHECKED BY S.A.T.																			
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES																				
101.8	GROUND SURFACE																								
0.0	Topsoil (FILL)																								
101.3	Sandy silt, trace gravel (FILL)		1	SS	7																				
0.5	Loose Brown Moist		2	SS	32																				
100.8	Sandy SILT, trace to some clay		3	NQ RC	REC 88%																				
1.0	Compact Light brown Moist																								
	Sandstone (BEDROCK)																								
	Slightly weathered																								
	Light grey to dark grey with brown bands		4	NQ RC	REC 98%																				
99.2	Laminated to thinly bedded Medium strong																								
2.6	Sandstone (BEDROCK)																								
	Slightly weathered																								
	Light grey																								
	Thinly laminated to medium bedded Medium strong		5	NQ RC	REC 98%																				
97.6																									
4.2	End of Borehole																								
Note: Water level in open borehole at 1.5 m depth (Elev. 100.3 m) upon completion of drilling on Jul. 17, 2008.																									

PROJECT 07-1121-0151			RECORD OF BOREHOLE No 08-540			1 OF 1 METRIC																				
G.W.P. 255-98-00			LOCATION N 5018826.4; E 351245.0			ORIGINATED BY D.J.S.																				
DIST Eastern HWY 417			BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem			COMPILED BY J.M.																				
DATUM Geodetic			DATE July 17, 2008			CHECKED BY S.A.T.																				
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)											
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					W _p — W — W _L			WATER CONTENT (%)			γ			GR SA SI CL				
100.2	GROUND SURFACE							20 40 60 80 100																		
0.0	Topsoil (FILL)							20 40 60 80 100																		
99.7	Silty clay and silty sand, trace gravel (FILL)		1	SS	7			20 40 60 80 100																		
0.5	Dark brown Moist SILTY CLAY (Weathered Crust) Very stiff Grey-brown Moist to wet		2	SS	7			20 40 60 80 100																		
98.3			3	SS	11			20 40 60 80 100																		
98.0	Sandy SILT, some gravel and clay (TILL) Compact Brown to grey Sandstone (BEDROCK) Slightly weathered Light grey Laminated to medium bedded Medium strong		4	NQ RC	REC 96%			20 40 60 80 100																		
2.2			5	NQ RC	REC 98%			20 40 60 80 100																		
	- Near vertical fracture from 3.5 m to 3.8 m depth		6	NQ RC	REC 100%			20 40 60 80 100																		
94.7	End of Borehole							20 40 60 80 100																		
5.5								20 40 60 80 100																		

PROJECT <u>07-1121-0151</u>		RECORD OF BOREHOLE No 08-541		1 OF 1 METRIC	
G.W.P. <u>255-98-00</u>		LOCATION <u>N 5018928.8; E 351364.0</u>		ORIGINATED BY <u>D.J.S.</u>	
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Power Auger 108mm I.D. Hollow Stem</u>		COMPILED BY <u>J.M.</u>	
DATUM <u>Geodetic</u>		DATE <u>July 21, 2008</u>		CHECKED BY <u>S.A.T.</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w_p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								<div><div><div>○ UNCONFINED</div><div>● QUICK TRIAXIAL</div></div><div><div>+ FIELD VANE</div><div>× REMOULDED</div></div></div>										<div><div></div><div></div><div></div></div>		
99.1	GROUND SURFACE							20	40	60	80	100								
0.0	Silty clay, trace gravel (FILL) Dark grey-brown						99													
0.2	Sandstone (BEDROCK) Slightly weathered Light grey to grey Laminated to medium bedded Medium strong - Near vertical fractures at 1.4 m and 3.1 m depth		1	NQ RC	REC 90%		98										RQD = 35%			
			2	NQ RC	REC 97%		97										RQD = 49%			
			3	NQ RC	REC 100%		96										RQD = 96%			
95.5	End of Borehole																			
3.6	Note: Water level in open borehole at 2.4 m depth (Elev. 96.7 m) upon completion of drilling on Jul. 21, 2008.																			

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PROJECT 07-1121-0151		RECORD OF BOREHOLE No 08-542				1 OF 1 METRIC										
G.W.P. 255-98-00		LOCATION N 5019040.3; E 351493.7		ORIGINATED BY D.J.S.												
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem		COMPILED BY J.M.												
DATUM Geodetic		DATE July 21, 2008		CHECKED BY S.A.T.												
SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa							WATER CONTENT (%)	
96.5	GROUND SURFACE						20	40	60	80	100					
0.0	TOPSOIL															
96.0	Silty CLAY (Weathered Crust) Grey-brown															
0.5	Sandy SILT, some gravel and clay, with cobbles (TILL) Loose to compact Brown to grey Moist to wet		1	SS	25											
			2	SS	12											15 43 32 10
			3	SS	4											
93.6	Sandstone (BEDROCK) Slightly weathered Light grey to grey Laminated to medium bedded Medium strong		4	NQ RC	REC 100%											RQD = 81%
2.9			5	NQ RC	REC 100%											RQD = 63%
			6	NQ RC	REC 100%											RQD = 46%
90.5	End of Borehole															
6.0	Note: Water level in well screen at 0.8 m depth (Elev. 95.7 m) upon completion of drilling on Oct. 10, 2008.															

PROJECT 07-1121-0151			RECORD OF BOREHOLE No 08-543			1 OF 1 METRIC								
G.W.P. 255-98-00			LOCATION N 5019138.8; E 351608.1			ORIGINATED BY D.J.S.								
DIST Eastern HWY 417			BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem			COMPILED BY J.M.								
DATUM Geodetic			DATE July 22, 2008			CHECKED BY S.A.T.								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
94.7	GROUND SURFACE													
0.0	Topsoil (FILL)													
94.3	Silty clay, some gravel (FILL)													
0.4	Grey-brown Sandy SILT, some gravel and clay, with cobbles and boulders (TILL) Dense Grey Wet		1	SS	48									
92.8			2	NQ RC	DD									
1.9	Sandstone (BEDROCK) Slightly weathered Light grey to grey Laminated to medium bedded Medium strong		3	NQ RC	REC 97%									RQD = 61%
			4	NQ RC	REC 100%									RQD = 59%
89.7	End of Borehole													
5.0	Note: Water level in open borehole at 0.9 m depth (Elev. 93.8 m) upon completion of drilling on Jul. 23, 2008.													

PROJECT		07-1121-0151		RECORD OF BOREHOLE No 08-544		1 OF 1 METRIC													
G.W.P.		255-98-00		LOCATION		N 5019253.9; E 351693.8													
DIST		Eastern HWY 417		BOREHOLE TYPE		Power Auger 108mm I.D. Hollow Stem													
DATUM		Geodetic		DATE		Sept. 17, 2008													
						ORIGINATED BY D.J.S.													
						COMPILED BY J.M.													
						CHECKED BY S.A.T.													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED			W _p — W — W _L WATER CONTENT (%)			γ kN/m ³			GR SA SI CL		
93.3	GROUND SURFACE							20 40 60 80 100											
0.0	Organic matter (FILL)																		
	Crushed stone (FILL)																		
92.6	SILTY CLAY (Weathered Crust)																		
0.7	Grey-brown SILTY CLAY Firm Grey Wet		1	SS	WH														
			2	SS	WH														
91.2																			
2.1	Sandy SILT, some gravel and clay (TILL)																		
	Compact Grey Wet		3	SS	21														
90.4																			
2.9	Sandstone (BEDROCK)																		
	Fresh Very thinly to medium bedded Light grey Medium strong Near vertical fractures from 5.6 m to 5.9 m depth		4	NQ RC	REC 100%													RQD = 81%	
			5	NQ RC	REC 100%													RQD = 58%	
87.4																			
5.9																			

PROJECT		RECORD OF BOREHOLE		No 08-544A		1 OF 1		METRIC															
G.W.P. 255-98-00		LOCATION		N 5019232.1; E 351716.5		ORIGINATED BY		D.J.S.															
DIST Eastern HWY 417		BOREHOLE TYPE		Power Auger 108mm I.D. Hollow Stem		COMPILED BY		J.M.															
DATUM Geodetic		DATE		Oct. 10, 2008		CHECKED BY		S.A.T.															
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES																		
92.5	GROUND SURFACE																						
0.0	Silty SAND with organic matter Brown																						
91.9	SILTY CLAY (Weathered Crust) Grey brown																						
0.6	SILTY CLAY Firm Grey Wet		1	SS	WH																		
91.1																							
90.8	Sandy SILT, some gravel and clay (TILL) Loose Grey Wet		2	SS	3																		
1.7																							
90.4			3	NQ RC	REC 74%																		
2.1	Sandstone with shale interbeds (BEDROCK) Fractured and moderately weathered Light grey Laminated to thinly bedded		4	NQ RC	REC 100%																		
	Sandstone with shale interbeds (BEDROCK) Fresh Light grey Thinly bedded Medium strong		5	NQ RC	REC 100%																		
			6	NQ RC	REC 100%																		
			7	NQ RC	REC 100%																		
87.5																							
5.0	End of Borehole																						
	Note: Water level in open borehole at 0.1 m above ground surface (Elev. 92.6 m) upon completion of drilling on Oct. 14, 2008.																						

RECORD OF BOREHOLE No 08-545

1 OF 1 **METRIC**

PROJECT 07-1121-0151

G.W.P. 255-98-00

LOCATION

N 5019321.8; E 351820.7

ORIGINATED BY D.J.S.

DIST Eastern HWY 417

BOREHOLE TYPE

Power Auger 108mm I.D. Hollow Stem

COMPILED BY J.M.

DATUM Geodetic

DATE

July 14, 2008

CHECKED BY S.A.T.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE	×						
								● QUICK TRIAXIAL	×	REMOULDED						
91.8	GROUND SURFACE							20	40	60	80	100				
90.9	Organic matter (FILL)															
90.1	Crushed stone (FILL)															
91.1	Grey															
0.7	SILTY CLAY															
	Firm		1	SS	WH		91									
	Grey		2	SS	PM		90									
	Wet															
			3	SS	PM		89									
			4	SS	PM		88									
			5	SS	PM		87									

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

PROJECT 07-1121-0151			RECORD OF BOREHOLE No 08-545A			1 OF 1 METRIC																		
G.W.P. 255-98-00			LOCATION N 5019334.5; E 351835.5			ORIGINATED BY D.J.S.																		
DIST Eastern HWY 417			BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem			COMPILED BY J.M.																		
DATUM Geodetic			DATE Oct. 9, 2008			CHECKED BY S.A.T.																		
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES																			
91.7	GROUND SURFACE																							
0.0	ORGANIC MATTER																							
0.2	SILTY CLAY Firm to stiff Grey Wet																							
			1	SS	WH																			
			2	SS	WH																			
			3	SS	WH																			
			4	SS	WH																			
			5	SS	WH																			
84.8	Layered SILTY CLAY and CLAYEY SILT Firm Grey Wet																							
6.9																								
84.1	Sandy SILT (TILL) Loose Grey Wet End of Borehole Auger Refusal		6	SS	>100																			
7.7																								

PROJECT 07-1121-0151		RECORD OF BOREHOLE No 08-546		1 OF 1 METRIC	
G.W.P. 255-98-00		LOCATION N 5019437.5; E 351955.2		ORIGINATED BY D.J.S.	
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem		COMPILED BY J.M.	
DATUM Geodetic		DATE July 14, 2008		CHECKED BY S.A.T.	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100			W _p
92.2	GROUND SURFACE														
0.0	TOPSOIL														
0.2	SILTY CLAY (Weathered Crust) Firm to stiff Grey-brown Moist to wet														
91.2															
1.0	SILTY CLAY Firm to stiff Grey Wet		1	SS	1										
			2	SS	PM										
			3	SS	PM										
			4	SS	PM										
			5	SS	PM										
			6	SS	PM										
			7	SS	PM										
81.5															
10.7	End of Borehole														

MIS-MTO 001 07-1121-0151 GPJ GAL-MISS GDT 7/23/09

PROJECT 07-1121-0151		RECORD OF BOREHOLE No 08-547		1 OF 1 METRIC	
G.W.P. 255-98-00		LOCATION N 5019539.9; E 352074.3		ORIGINATED BY D.J.S.	
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem		COMPILED BY J.M.	
DATUM Geodetic		DATE July 11, 2008		CHECKED BY S.A.T.	



SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
92.7	GROUND SURFACE													
92.0	TOPSOIL													
91.5	SILTY CLAY with sand seams (Weathered Crust) Stiff Grey-brown Moist to wet		1	SS	2									
91.2	SILTY CLAY with sand seams Soft to stiff Grey Wet		2	SS	PM									
			3	SS	PM									
			4	SS	PM									
			5	SS	PM									
			6	SS	PM									
			7	SS	PM									
82.0	End of Borehole													

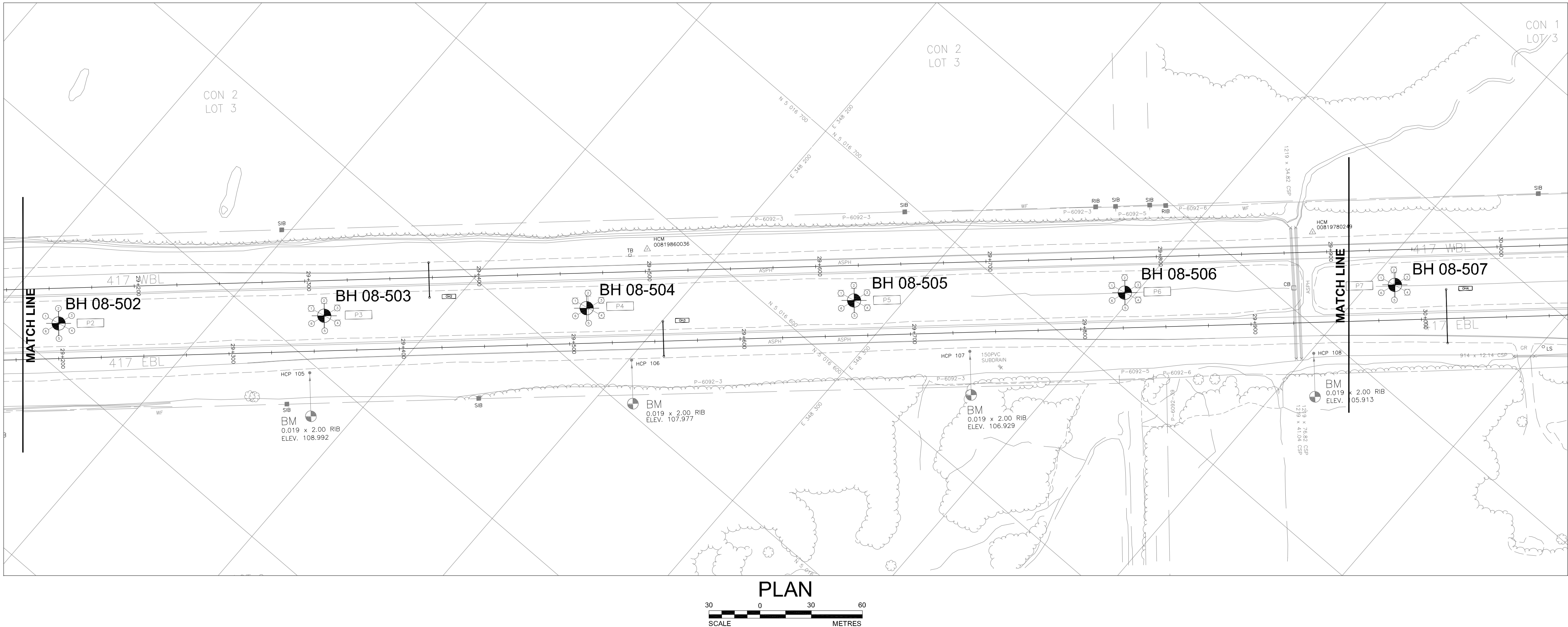
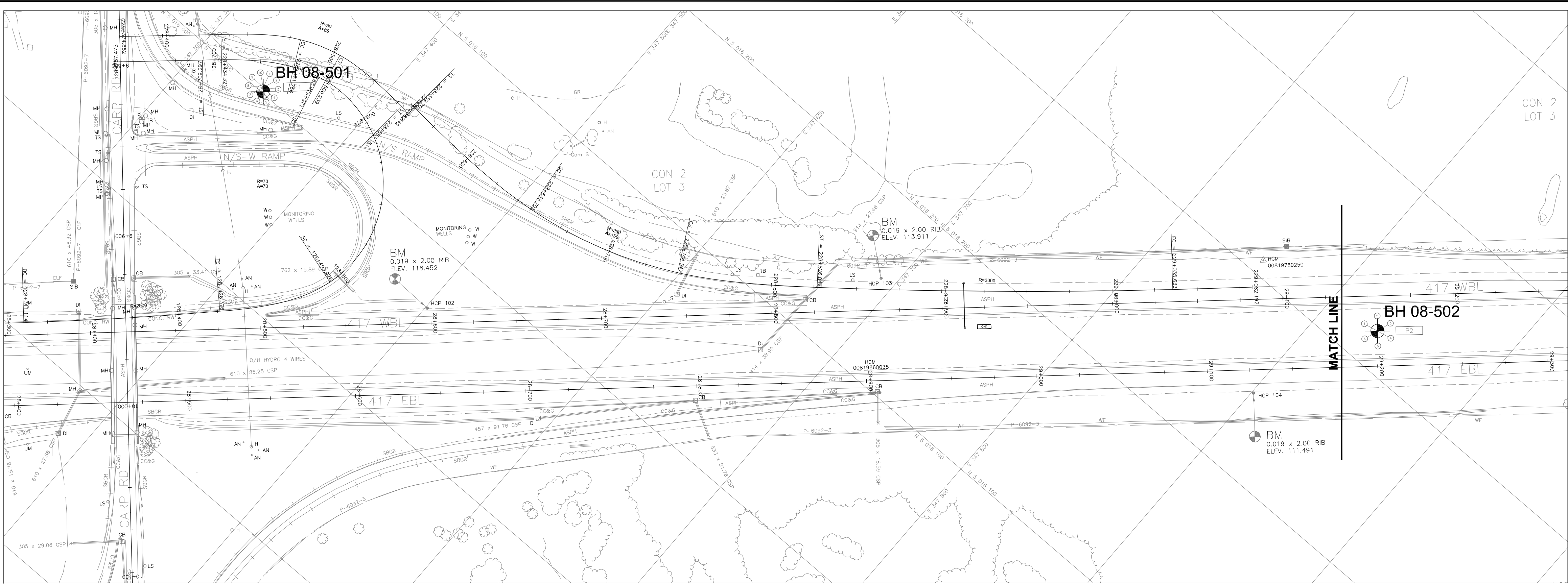
MIS-MTO 001 07-1121-0151 GPJ GAL-MISS GDT 7/23/09

PROJECT 07-1121-0151		RECORD OF BOREHOLE No 08-548			1 OF 1 METRIC	
G.W.P. 255-98-00		LOCATION N 5019640.4; E 352191.0			ORIGINATED BY D.J.S.	
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem			COMPILED BY J.M.	
DATUM Geodetic		DATE July 10, 2008			CHECKED BY S.A.T.	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
92.3	GROUND SURFACE													
92.0	TOPSOIL													
0.3	SILTY CLAY (Weathered Crust) Stiff to firm Grey-brown Moist to wet		1	SS	2									
			2	SS	WH									
90.2														
2.1	SILTY CLAY Firm to stiff Grey Wet		3	SS	WH									
			4	SS	WH									
			5	SS	WH									
			6	SS	WH									
			7	SS	PM									
81.6	End of Borehole													
10.7	Note: Water level in well screen at 1.0 m depth (Elev. 91.3 m) upon completion of drilling on Dec. 8, 2008.													

MIS-MTO 001 07-1121-0151 GPJ GAL-MISS GDT 7/23/09

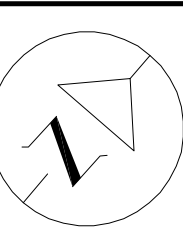
PROJECT 07-1121-0151		RECORD OF BOREHOLE No 08-549				1 OF 1 METRIC							
G.W.P. 255-98-00		LOCATION N 5019730.4; E 352295.6				ORIGINATED BY D.J.S.							
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem				COMPILED BY J.M.							
DATUM Geodetic		DATE July 10, 2008				CHECKED BY S.A.T.							
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa		WATER CONTENT (%)		γ	GR SA SI CL
93.6	GROUND SURFACE												
0.0	TOPSOIL							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					
0.4	Sandy SILT, some gravel (TILL) Brown Amphibole Rich Metasediments (BEDROCK) Highly fractured and moderately weathered Black - Near vertical calcite seams from 2.9 m to 3.1 m depth		1	NQ RC	REC 100%		93						RQD = 0%
			2	NQ RC	REC 100%								RQD = 0%
			3	NQ RC	REC 100%		92						RQD = 14%
			4	NQ RC	REC 100%		91						RQD = 46%
90.3			5	NQ RC	REC 100%								RQD = 0%
3.3	End of Borehole Note: Water level in open borehole at 1.8 m depth (Elev. 91.8 m) upon completion of drilling on Jul. 10, 2008.												



REFERENCE
Base plan supplied by the McCormick Rankin Corporation

WP No. 255-98-00

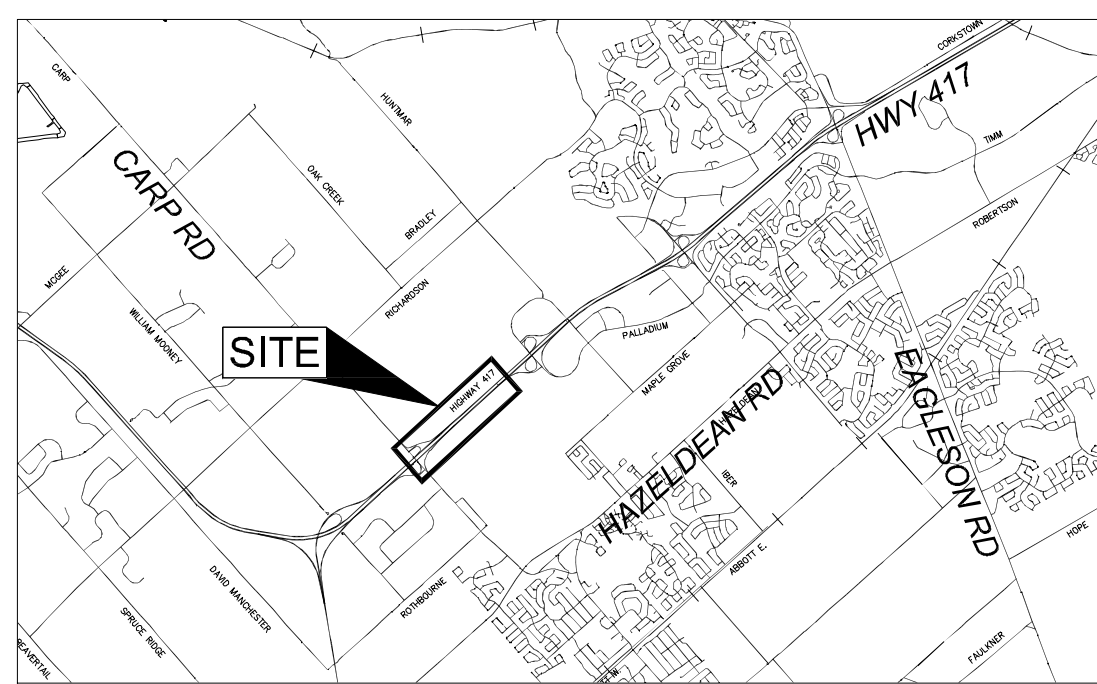
HWY 417 EXPANSION
HIGH MAST LIGHT POLES
BOREHOLE LOCATIONS



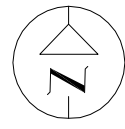
SHEET
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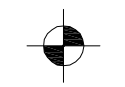


KEY PLAN



SCALE
0 2 4
KM

LEGEND



Borehole – Current Golder Associates Ltd.
Investigation

No.	ELEVATION	CO–ORDINATES	
		NORTHING	EASTING
08–501	122.5	5016001.0	347345.2
08–502	110.5	5016320.9	347932.5
08–503	109.0	5016426.0	348047.7
08–504	108.4	5016529.8	348161.5
08–505	107.7	5016635.6	348277.5
08–506	106.0	5016742.7	348395.0
08–507	105.4	5016849.5	348512.1

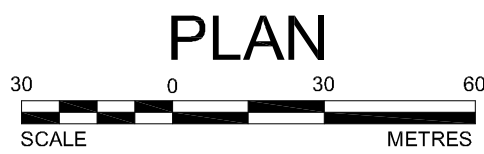
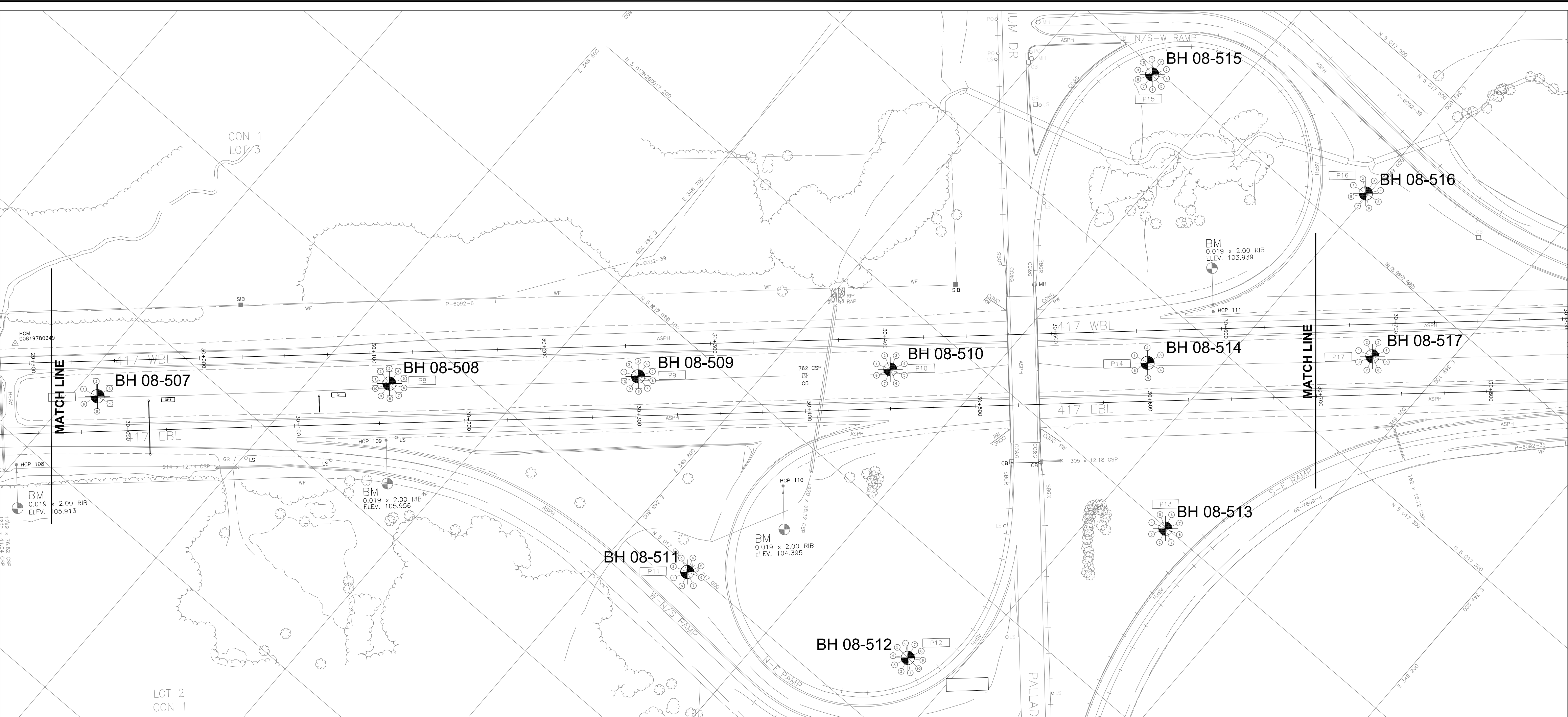
NOTES

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

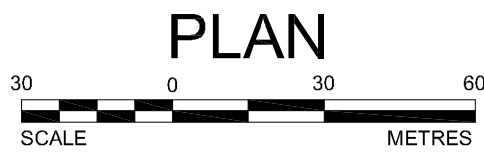
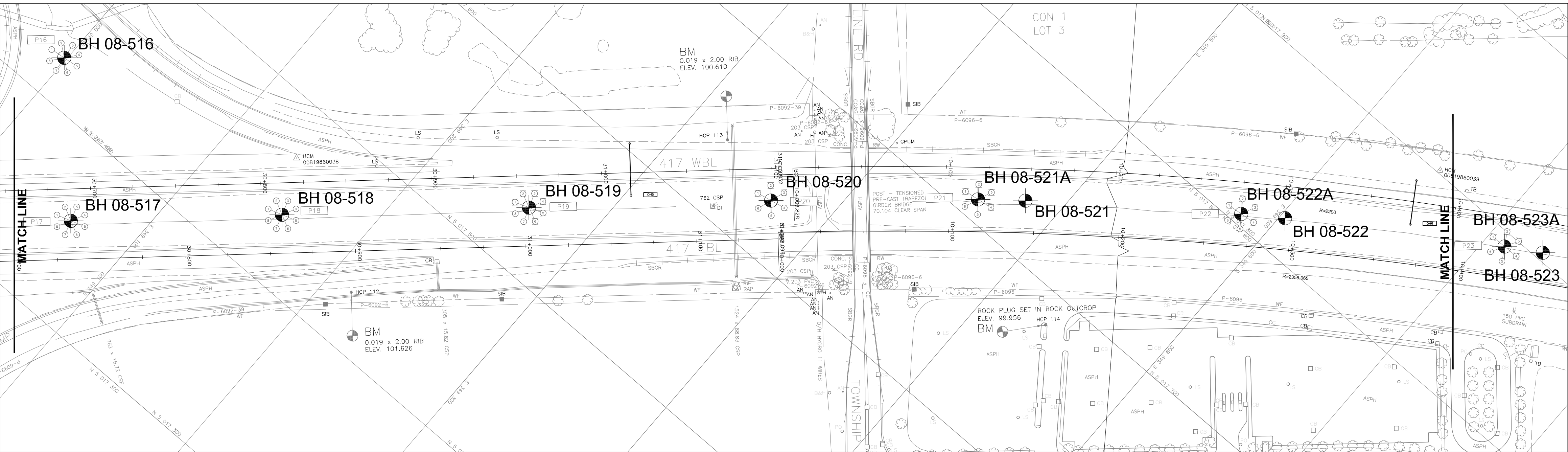
The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS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

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

NO.	DATE	BY	REVISION	
Geocres No. 31G5-228				
HWY. 417		PROJECT NO.07-1121-0151		DIST.
SUBM'D. S.A.T.		CHKD. S.A.T.	DATE: DEC. 2008	SITE:
DRAWN: J.M.		CHKD. L.C.C.	APPD.	DWG. 1



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

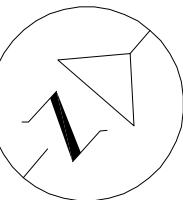


REFERENCE

Base plan supplied by the McCormick Rankin Corporation

WP No. 255-98-00

HWY 417 EXPANSION
HIGH MAST LIGHT POLES
BOREHOLE LOCATIONS

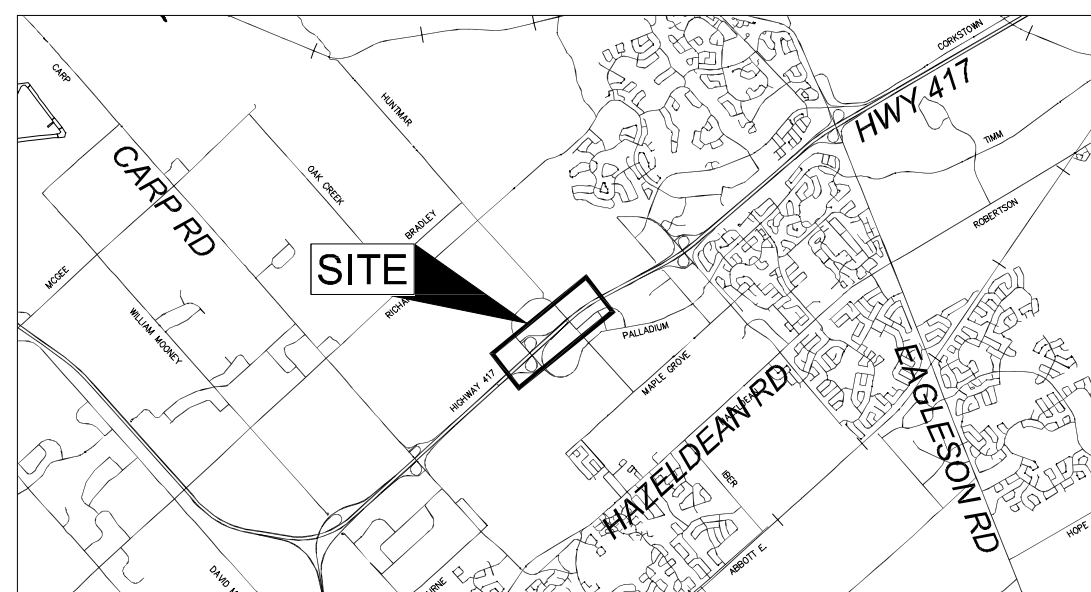


SHEET

1



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OTTAWA, ONTARIO, CANADA



LEGEND

Borehole — Current Golder Associates Ltd.
Investigation

No.	ELEVATION	CO—ORDINATES	
		NORTHING	EASTING
08—507	105.4	5016849.5	348512.1
08—508	104.8	5016966.9	348637.1
08—509	104.2	5017065.3	348745.0
08—510	103.6	5017164.9	348854.5
08—511	104.8	5016997.1	348841.7
08—512	104.0	5017043.3	348972.7
08—513	103.0	5017199.4	349037.8
08—514	102.6	5017266.3	348966.4
08—515	106.2	5017396.4	348858.0
08—516	101.9	5017425.2	348998.6
08—517	102.4	5017355.3	349063.9
08—518	101.8	5017438.8	349155.5
08—519	100.8	5017536.5	349262.6
08—520	100.2	5017632.3	349367.6
08—521	98.5	5017729.6	349480.8
08—521A	98.7	5017712.0	349459.2
08—522	98.0	5017821.2	349602.9
08—522A	98.2	5017806.3	349581.8
08—523	96.5	5017904.5	349730.8
08—523A	96.7	5017892.6	349711.4

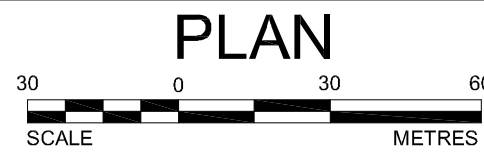
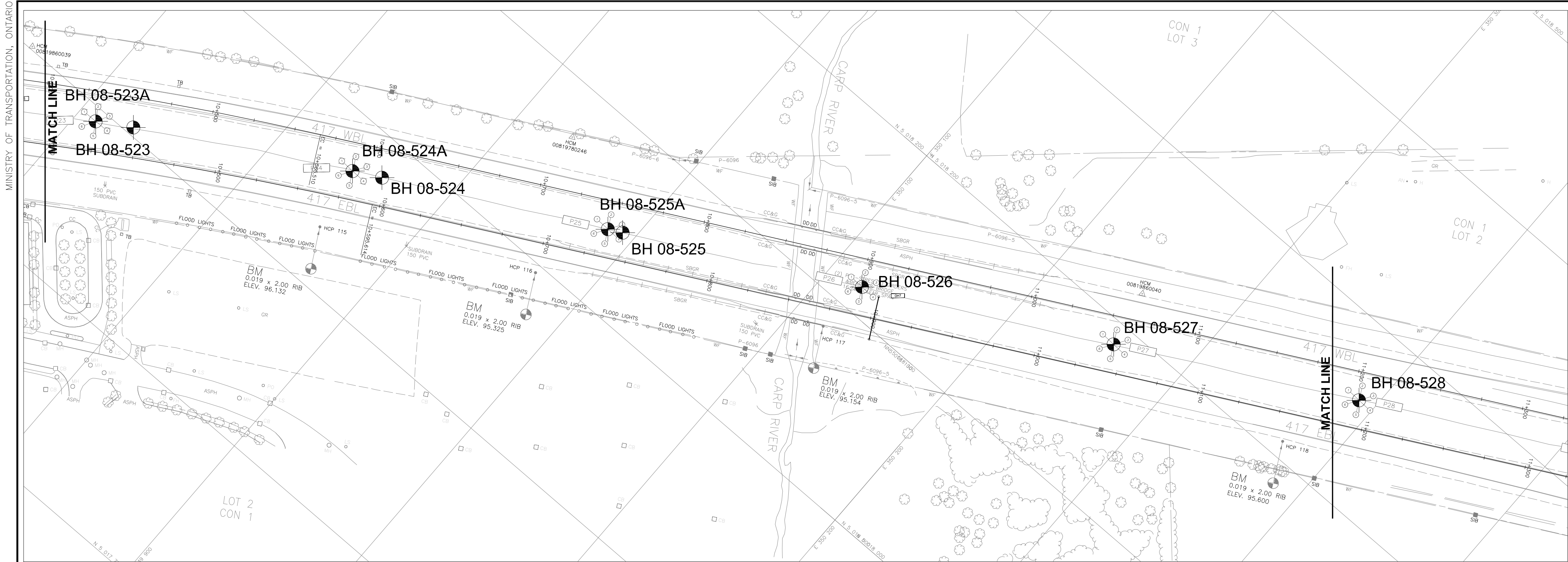
NOTES

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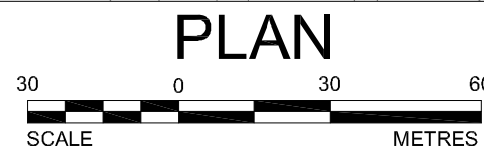
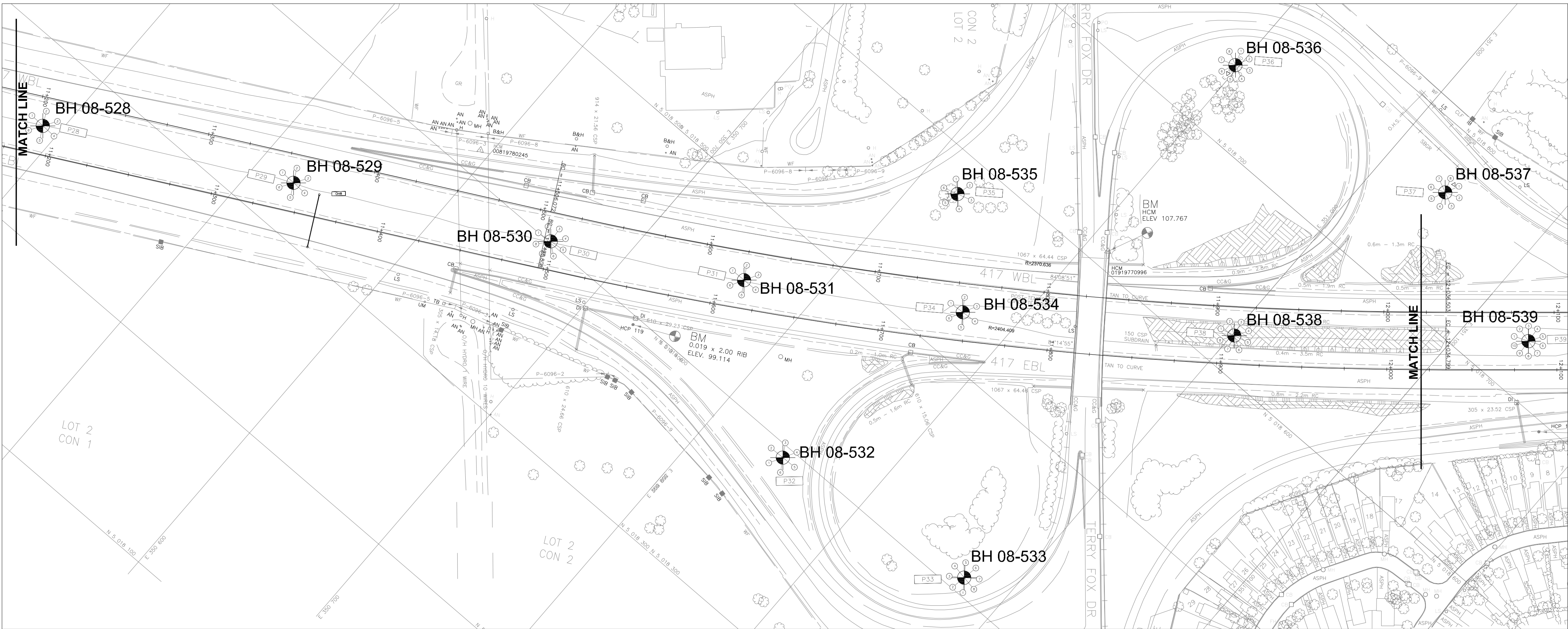
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NO.	DATE	BY	REVISION	
Geocres No. 31G5—228				
HWY. 417		PROJECT NO.07—1121—0151		DIST.
SUBM'D. S.A.T.		CHKD. S.A.T.	DATE: DEC. 2008	SITE:
DRAWN: J.M.		CHKD. L.C.C.	APPD.	DWG. 2



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

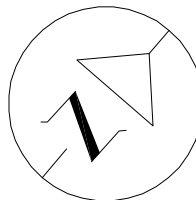


REFERENCE

Base plan supplied by the McCormick Rankin Corporation

WP No. 255-98-00

HWY 417 EXPANSION
HIGH MAST LIGHT POLES
BOREHOLE LOCATIONS

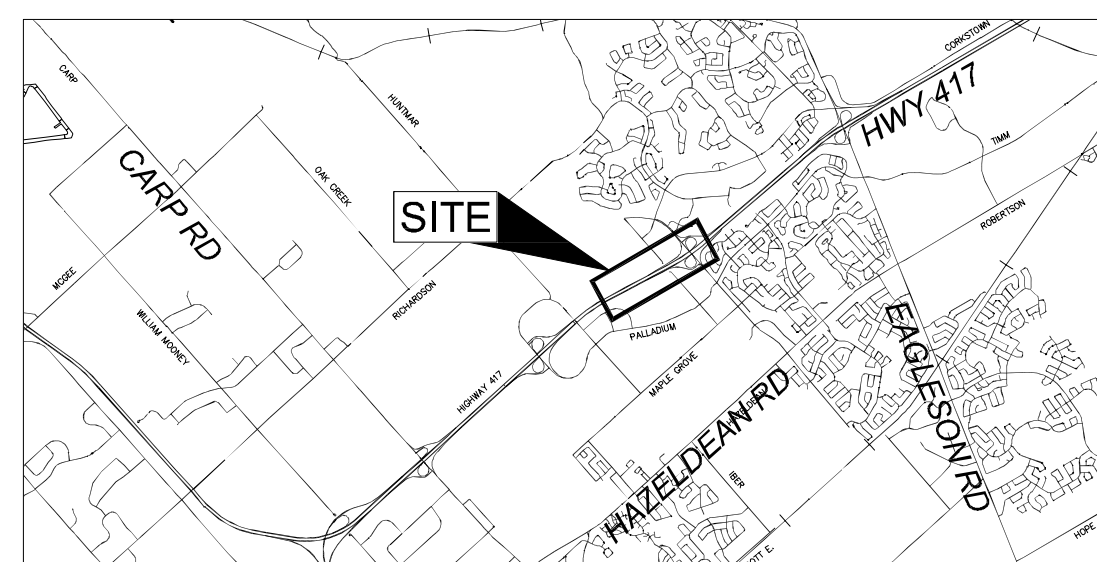


SHEET

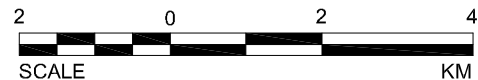
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Golder Associates Ltd.
OTTAWA, ONTARIO, CANADA



KEY PLAN



LEGEND



Borehole — Current Golder Associates Ltd.
Investigation

No.	ELEVATION	CO—ORDINATES	
		NORTHING	EASTING
08—523	96.5	5017904.5	349730.8
08—523A	96.7	5017892.6	349711.4
08—524	95.1	5017978.5	349862.6
08—524A	95.2	5017970.0	349846.7
08—525	94.2	5018047.2	349992.6
08—525A	94.2	5018043.0	349984.6
08—526	93.4	5018115.7	350121.8
08—527	94.0	5018187.6	350257.7
08—528	94.8	5018257.7	350390.2
08—529	95.7	5018328.4	350523.7
08—530	96.9	5018400.9	350660.7
08—531	98.5	5018457.7	350761.7
08—532	102.1	5018393.5	350847.0
08—533	106.0	5018409.5	350973.8
08—534	100.3	5018527.2	350871.4
08—535	101.4	5018577.9	350823.7
08—536	101.5	5018741.8	350898.1
08—537	102.0	5018765.5	351040.3
08—538	104.7	5018620.9	351001.2
08—539	101.8	5018731.1	351134.4

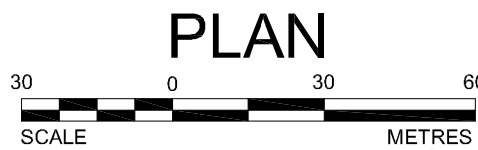
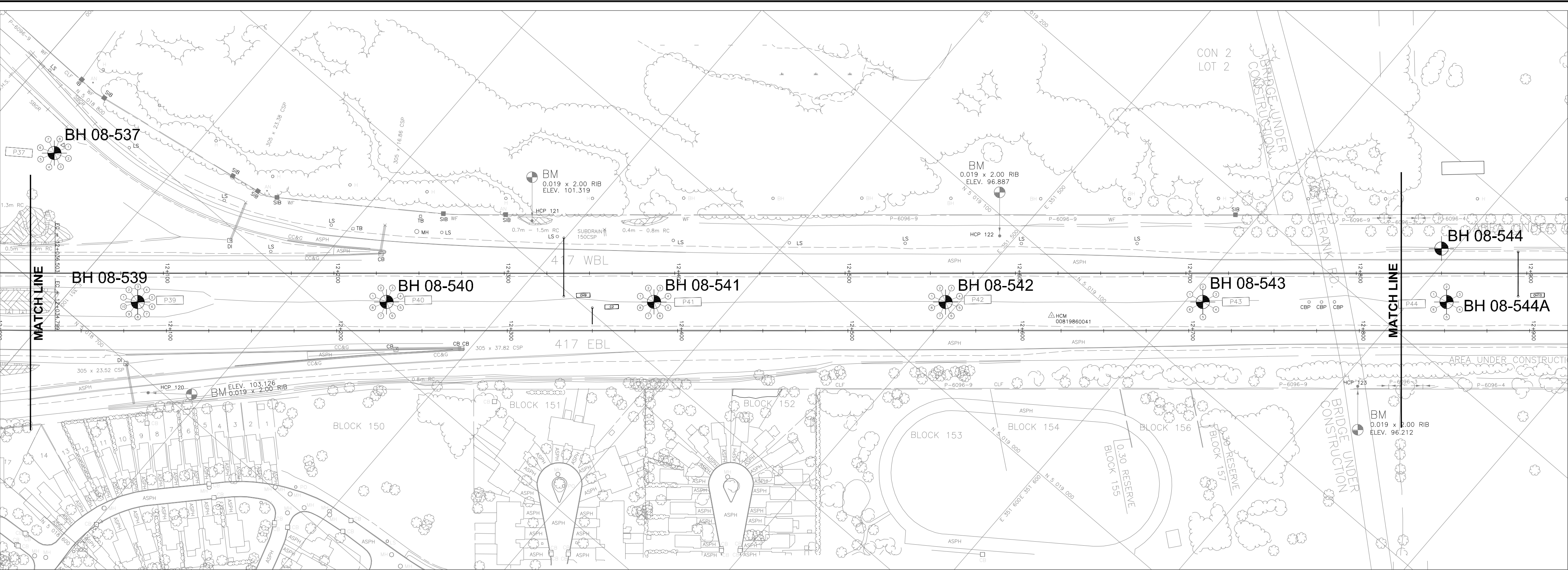
NOTES

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

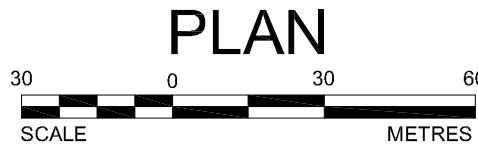
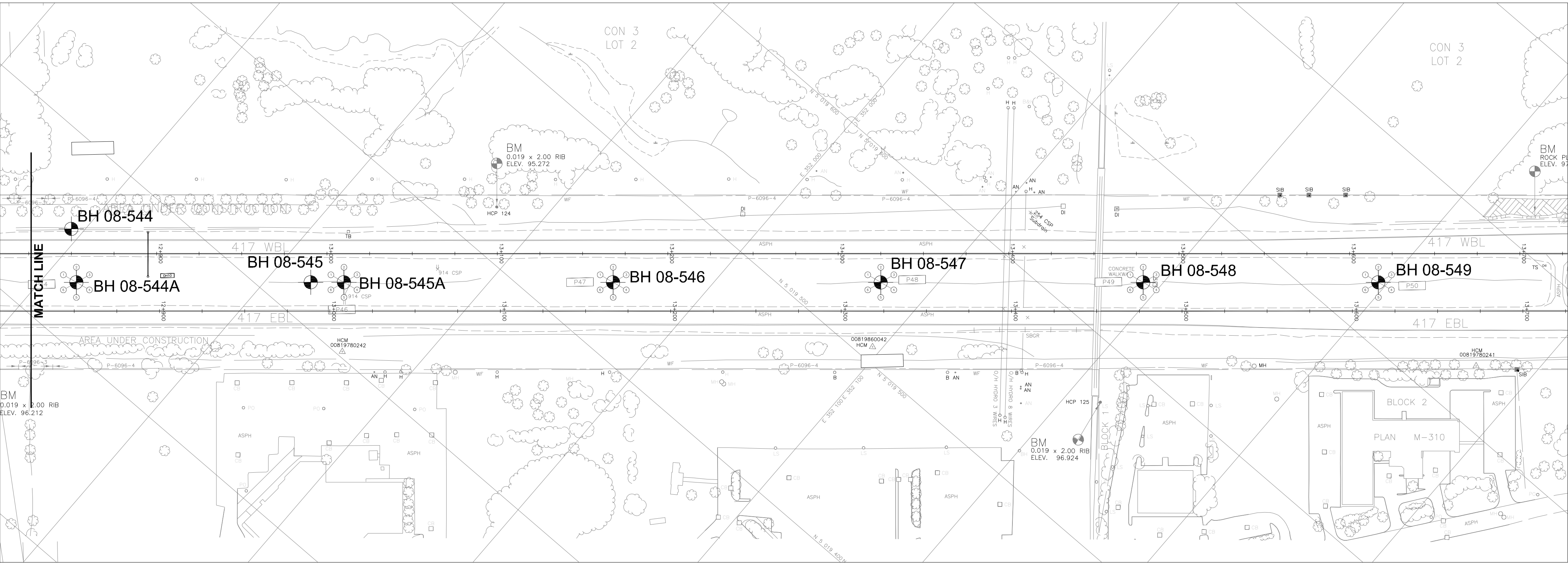
The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS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

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

NO.	DATE	BY	REVISION	
Geocres No. 31G5-228				
HWY. 417		PROJECT NO.07-1121-0151		DIST.
SUBM'D. S.A.T.		CHKD. S.A.T.	DATE: DEC. 2008	SITE:
DRAWN: J.M.		CHKD. L.C.C.	APPD.	DWG. 3



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



REFERENCE

Base plan supplied by the McCormick Rankin Corporation

WP No. 255-98-00

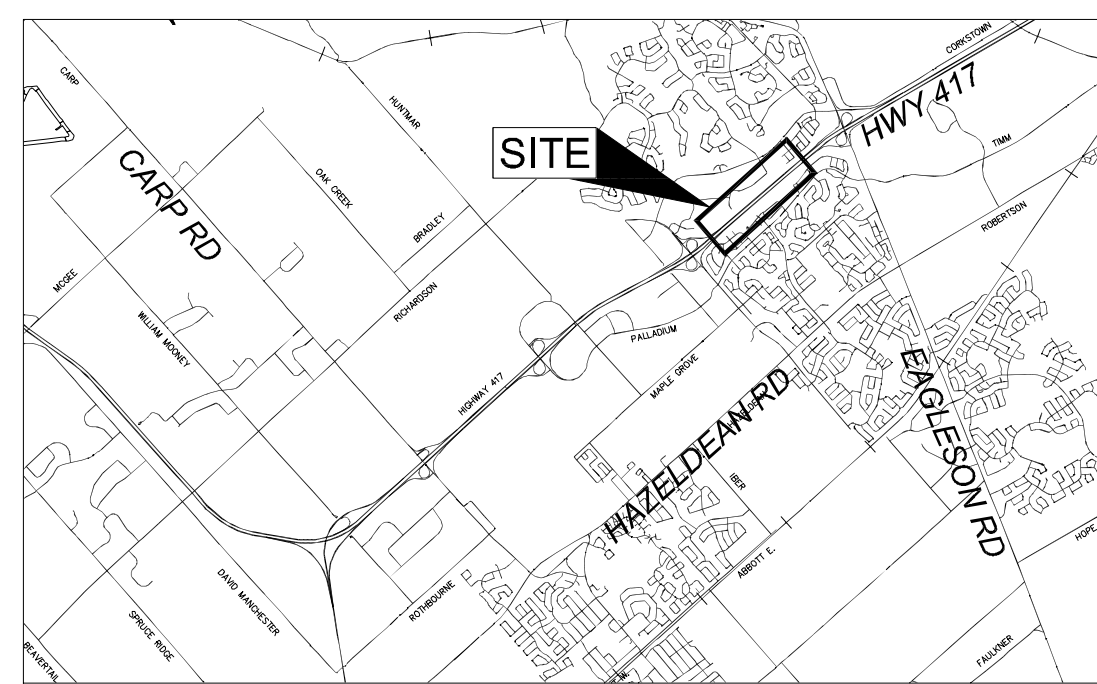
HWY 417 EXPANSION
HIGH MAST LIGHT POLES
BOREHOLE LOCATIONS

SHEET

1



Golder Associates Ltd.
OTTAWA, ONTARIO, CANADA



KEY PLAN



LEGEND



Borehole - Current Golder Associates Ltd.
Investigation

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
08-537	102.0	5018765.5	351040.3
08-539	101.8	5018731.1	351134.4
08-540	100.2	5018826.4	351245.0
08-541	99.1	5018928.8	351364.0
08-542	96.5	5019040.3	351493.7
08-543	94.7	5019138.8	351608.1
08-544	93.3	5019253.9	351693.8
08-544A	92.5	5019232.1	351716.5
08-545	91.8	5019321.8	351820.7
08-545A	91.7	5019334.5	351835.5
08-546	92.2	5019437.5	351955.2
08-547	92.7	5019539.9	352074.3
08-548	92.3	5019640.4	352191.0
08-549	93.6	5019730.4	352295.6

NOTES

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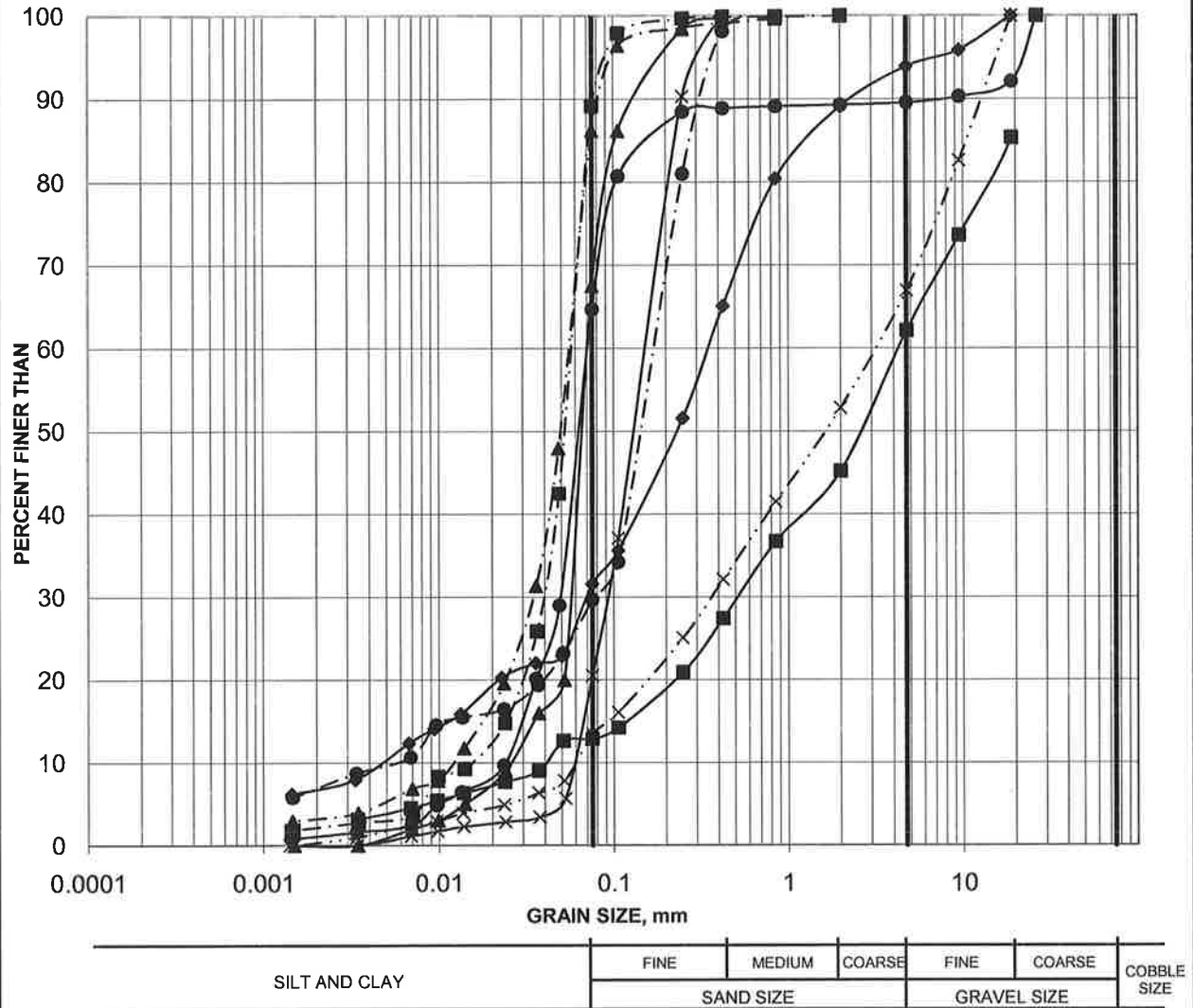
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DRAWN: J.M.		CHKD. L.C.C.	APPD.	DWG. 4

GRAIN SIZE DISTRIBUTION

FIGURE 1

Sands and Silts

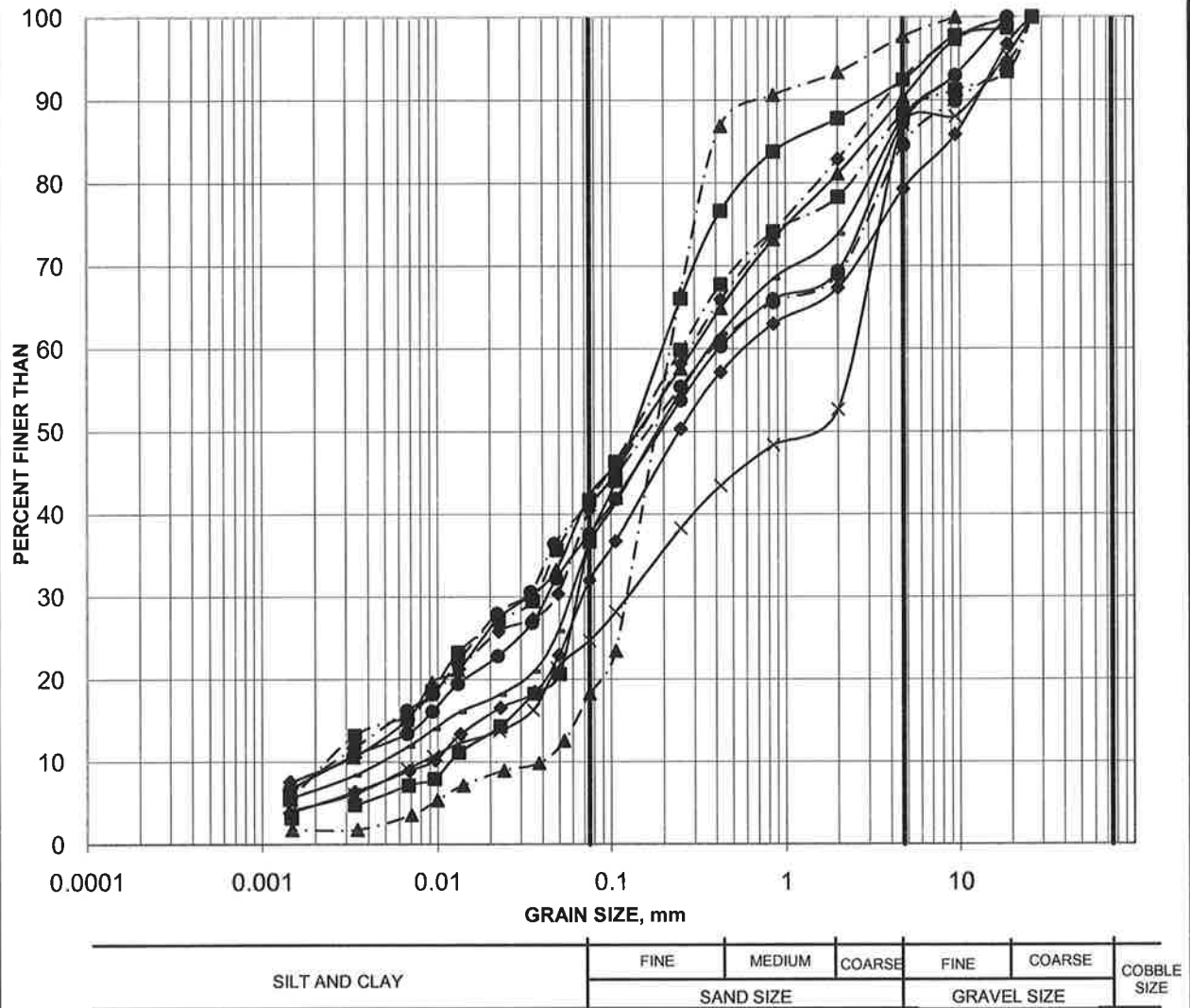


Borehole	Sample	Depth (m)
08-501	3	3.05-3.66
08-502	3	2.29-2.90
08-504	3	3.05-3.66
08-504	4	4.57-5.18
08-507	2	1.52-2.13
08-513	5	5.34-5.95
08-515	10	8.38-8.99
08-528	7B	9.14-9.75
08-532	3	2.29-2.90

GRAIN SIZE DISTRIBUTION

FIGURE 2

Sand, Silty Sand and Sandy Silt Till

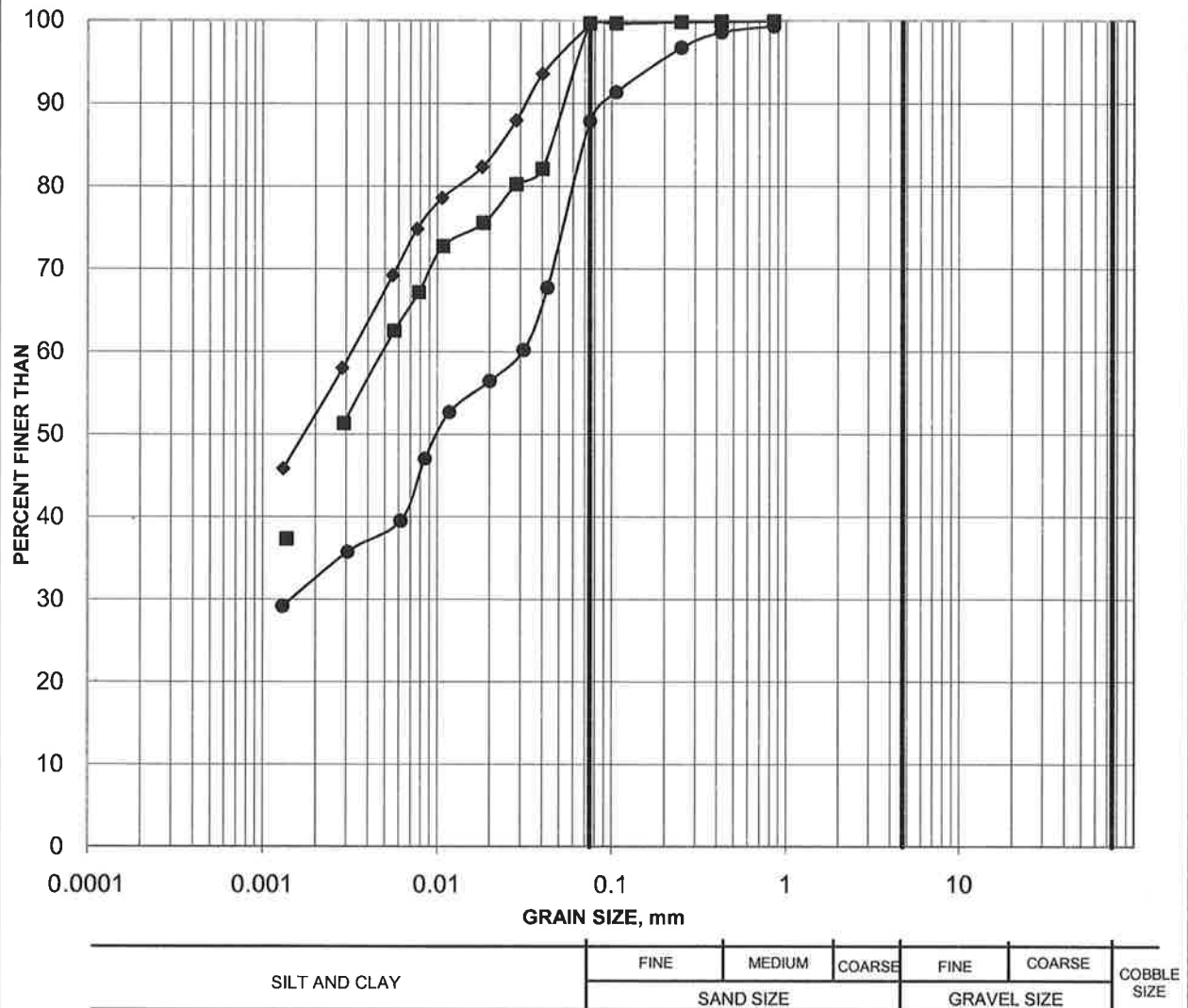


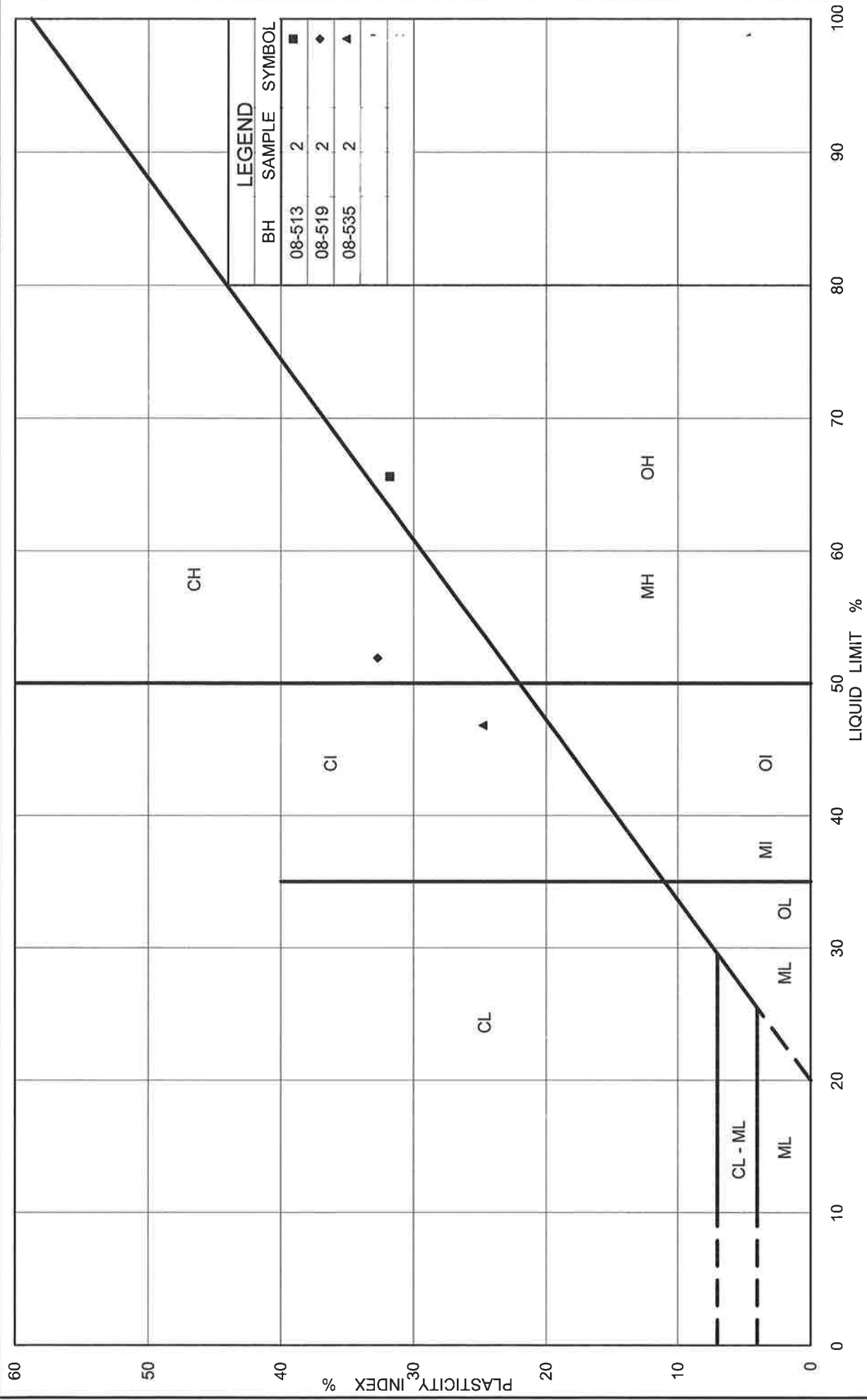
Borehole	Sample	Depth (m)
08-507	3	3.05-3.66
08-509	3	2.13-2.74
08-510	3	2.13-2.74
08-513	7	6.86-7.47
08-528	7A	9.14-9.75
08-530	6	7.62-8.23
08-532	8	6.86-7.47
08-534	2	1.52-1.91
08-535	4	3.05-3.66
08-542	2	1.52-2.13

GRAIN SIZE DISTRIBUTION

FIGURE 3

Weathered Clayey Silt to Silty Clay



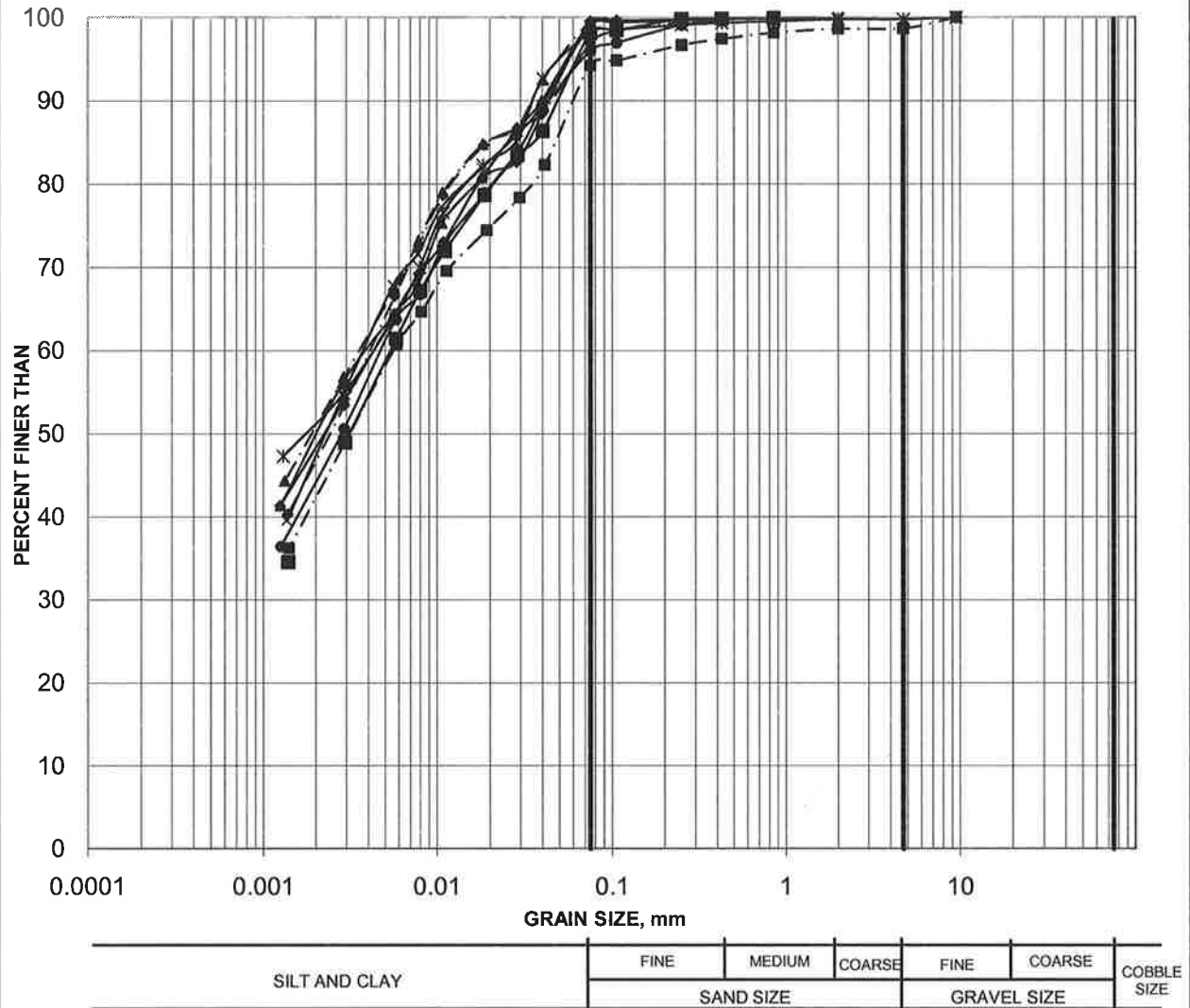


PLASTICITY CHART
Weathered Silty Clay to Clay

GRAIN SIZE DISTRIBUTION

FIGURE 5

Unweathered Clayey Silt to Silty Clay



Borehole	Sample	Depth (m)
08-519	6	7.62-8.23
08-521A	6	10.21-10.82
08-526	6	6.10-6.71
08-528	4	4.57-5.18
08-528	6	7.62-8.23
08-532	6	5.34-5.95
08-545A	3	3.05-3.66
08-545A	5	6.10-6.71
08-548	4	4.57-5.18

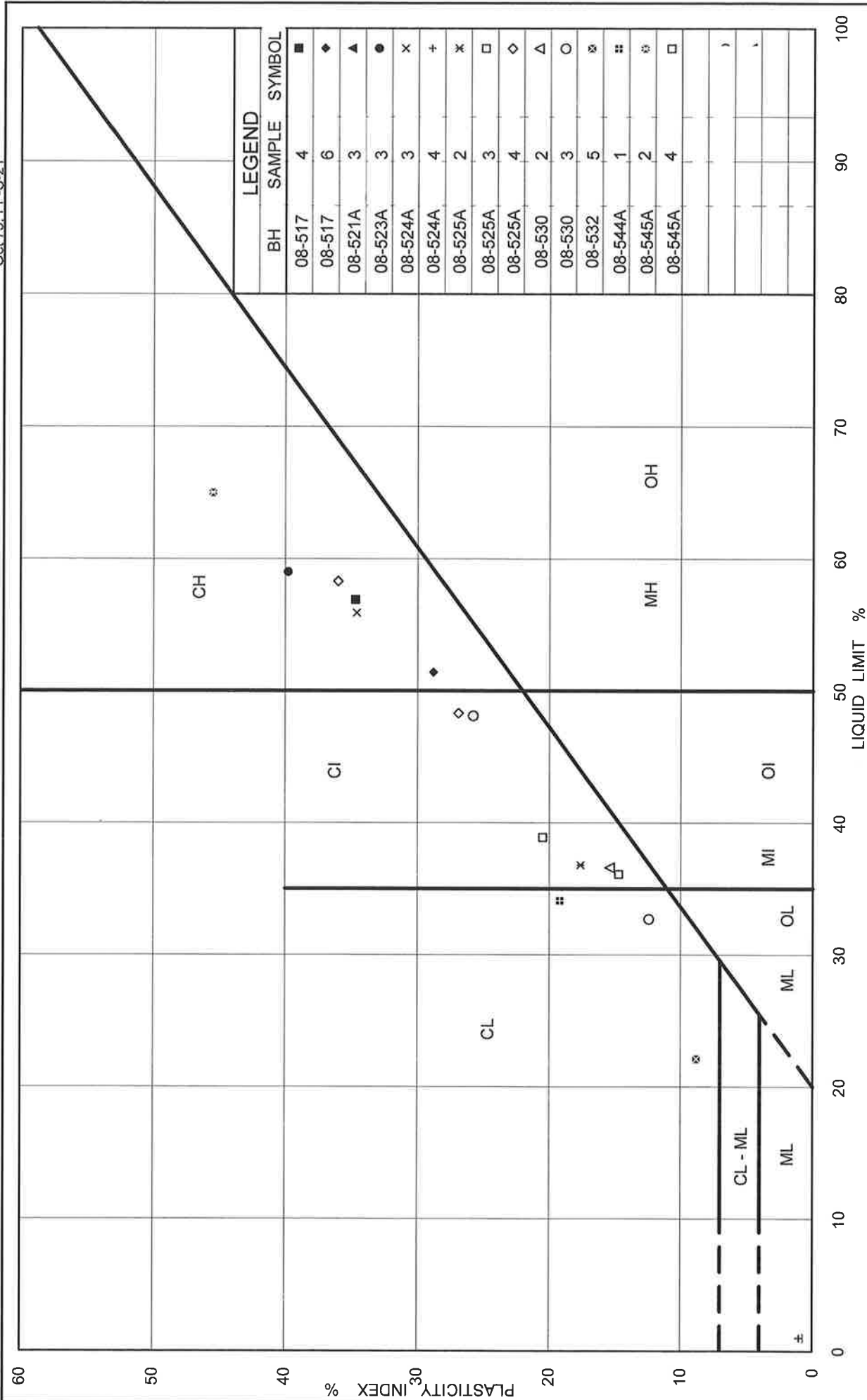


FIG No. 6

Project No. 07-1121-0151-05

PLASTICITY CHART

Unweathered Clayey Silt to Silty Clay to Clay

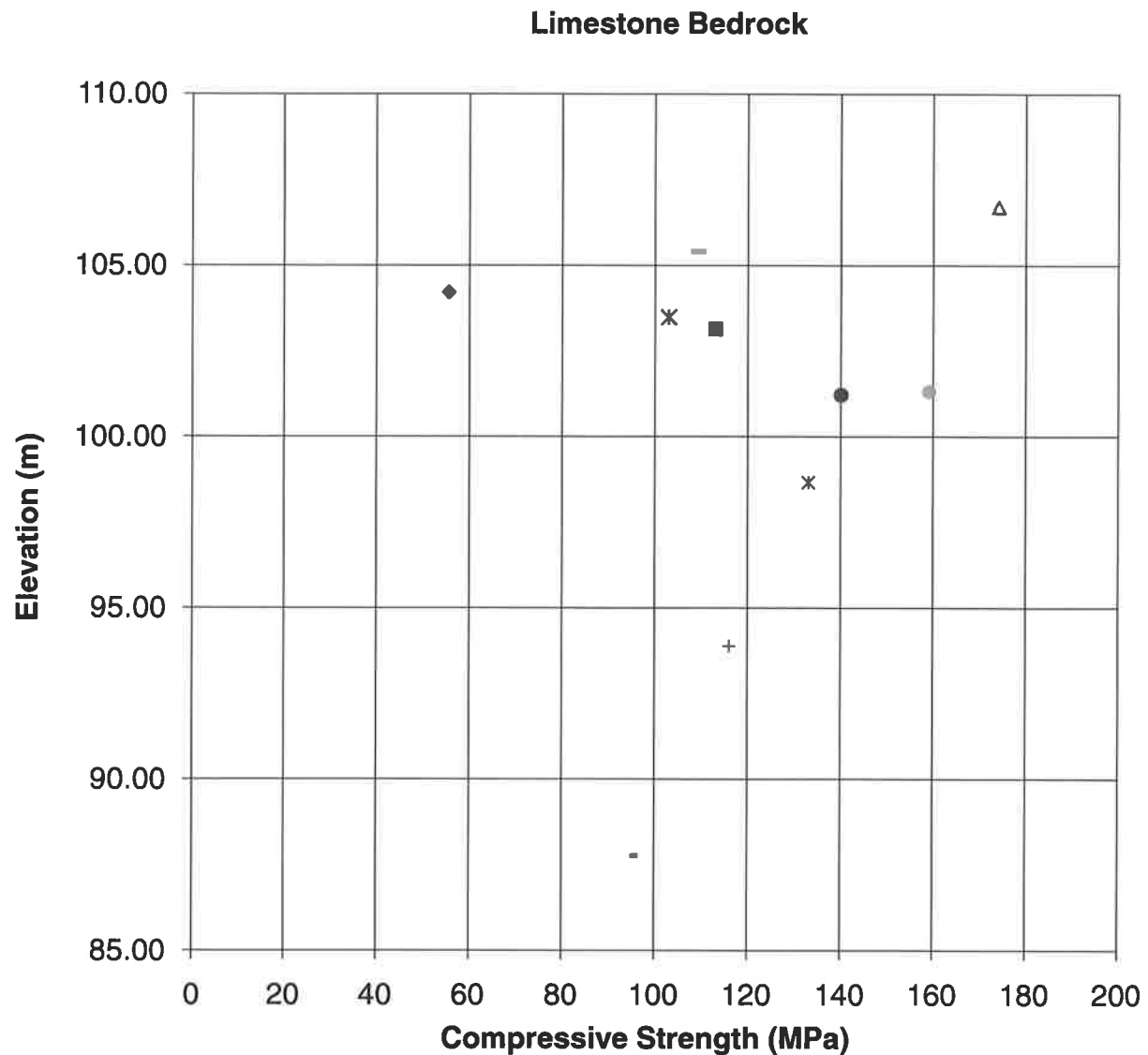
Ministry of Transportation



Ontario

SUMMARY OF LABORATORY COMPRESSIVE STRENGTH MEASUREMENTS

FIGURE 7



- △ BH 08-502 Point Load Test
- BH 08-504 Point Load Test
- × BH 08-506 Point Load Test
- BH 08-508 Point Load Test
- × BH 08-510 Point Load Test
- BH 08-511 Point Load Test
- + BH 08-513 Point Load Test
- BH 08-530 Point Load Test
- BH 08-507 Unconfined Compression Test
- ◆ BH 08-509 Unconfined Compression Test

Project: 07-1121-015-05

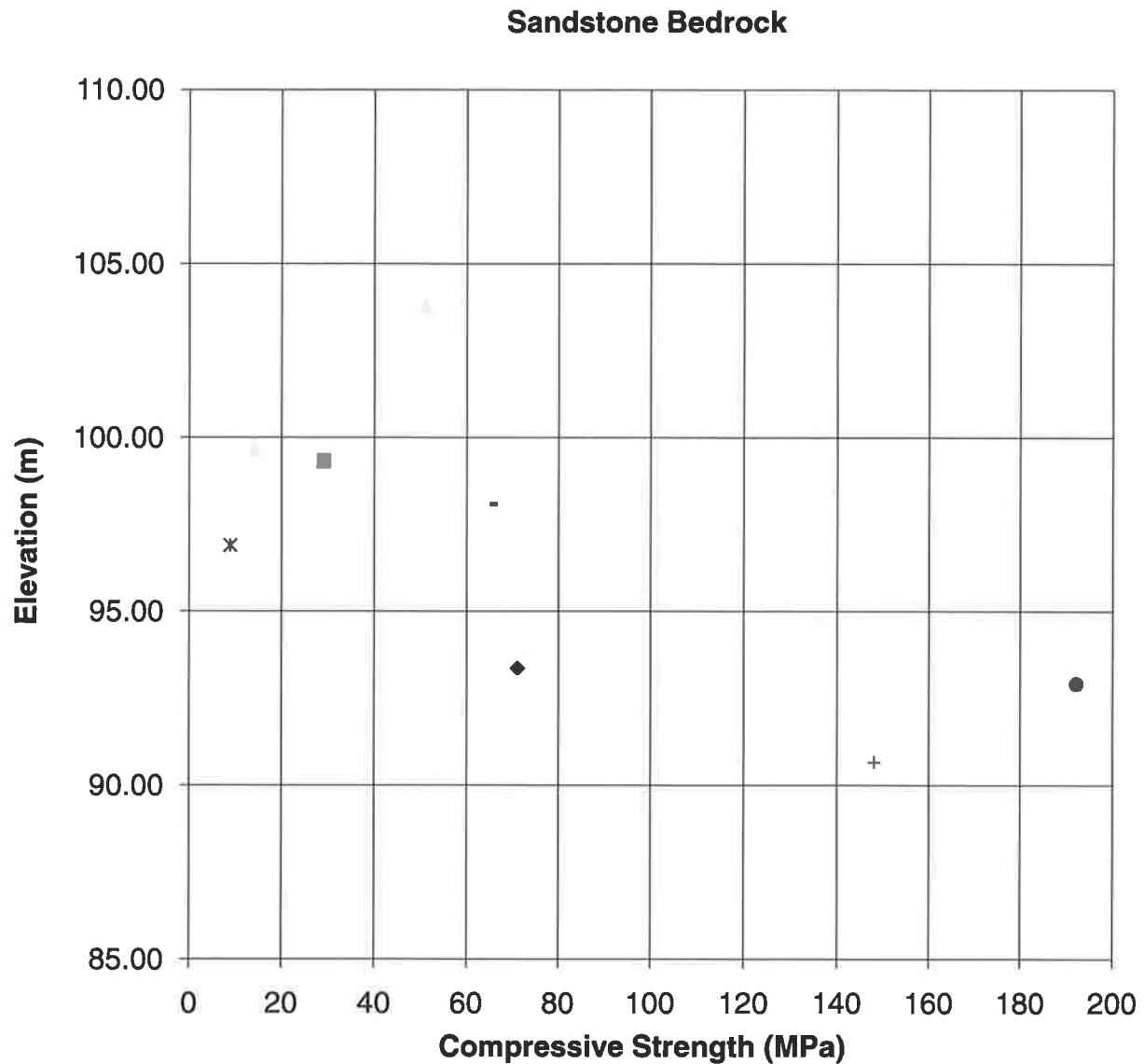
Golder Associates

Created by: SAT

Checked by: FJH

SUMMARY OF LABORATORY COMPRESSIVE STRENGTH MEASUREMENTS

FIGURE 8



- ◆08-532 Point Load Test
- 08-536 Point Load Test
- ▲08-538 Point Load Test
- ×08-540 Point Load Test
- 08-542 Point Load Test
- +08-544A Point Load Test
- 08-534 Unconfined Compression Test

Project: 07-1121-015-05

Golder Associates

Created by: SAT
Checked by: FJH



APPENDIX A

Sample Non-Standard Special Provisions

**CONTROL OF OVERBURDEN SOILS AND GROUNDWATER DURING CAISSON
INSTALLATION - Item No.**

Special Provision

Excavations for the HML poles will be advanced through generally cohesionless soils between Carp Road and Palladium Drive. These soils are unstable below the groundwater level. Appropriate construction procedures and equipment will be required to control sloughing and flowing during drilling and concrete placement for caisson foundations.

Basis of Payment

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

END OF SECTION

BOULDERS/OBSTRUCTIONS DURING CAISSON INSTALLATION FOR HML POLES - Item No.

Special Provision

Cobbles, boulders and rock slabs were encountered within the till deposit and/or sandy silt, overlying the bedrock surface at some of the HML pole locations, as noted on the borehole records. Appropriate equipment and procedures will be required to penetrate these obstructions during excavation for foundation construction.

Basis of Payment

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

END OF SECTION

CAISSON SOCKETS IN BEDROCK - Item No.

Special Provision

The limestone and sandstone bedrock, where present at the proposed HML locations, varies from medium strong to very strong. Appropriate construction equipment and procedures will be required for construction of caisson foundation sockets within the bedrock.

Basis of Payment

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

END OF SECTION

DOWELS INTO ROCK – Item No.

Special Provision

SCOPE

This special provision addresses the supply, installation and testing of dowels installed into bedrock for the HML pole foundations. The work for this item shall be in accordance with OPSS 904, including all special provisions, except as extended herein.

The Contractor shall supply equipment, materials and skilled personnel to install production Dowels into Rock and conduct the specified acceptance tests. A total of one test dowel into rock is required for each HML pole foundation.

It shall be the responsibility of the Contractor to monitor the acceptance tests, maintain specified test loads and record test measurements as specified by the Contract Administrator.

The Contractor is responsible for materials and workmanship. Any remedial measures, required because of defects in materials or workmanship, shall be completed by the Contractor at no cost to the Owner.

DEFINITIONS

Dowels into Rock: reinforcing steel bar and non-shrink grout.

Design Engineer: An Engineer who has a minimum of five years experience in all aspects associated with the installation of Dowels into Rock, including drilling, grouting and doweling work. The Design Engineer shall be retained by the Contractor to design various components for the installation and testing for the Dowels into Rock.

Quality Verification Engineer: An Engineer who has a minimum of five years experience in all aspects associated with the installation of Dowels into Rock, including drilling, grouting and doweling work. The Quality Verification Engineer shall be retained by the Contractor to ensure conformance with the contract documents and issue certificate(s) of conformance.

SUBMISSIONS AND DESIGN REQUIREMENTS

Working Drawings

The Contractor shall submit Working Drawings to the Contract Administrator as follows:

- All Working Drawings that include drawing, testing and installation procedures and reports, and work plans shall be sealed and signed by the Design Engineer.
- All Working Drawings that include testing and installation results and reports shall be signed and sealed by the Quality Verification Engineer.

Upon completion of testing or installation and testing for each component, the Contractor shall submit to the Contract Administrator a Certificate of Conformance sealed and signed by a Quality Verification Engineer. The Certificate shall state that the work has been carried out in conformance with the Working Drawings and in general conformance with the contract documents.

Working Drawings consisting of testing an installation records and reports shall be submitted within four days after completion of testing and installation. All other Working Drawings shall be submitted at least two weeks prior to construction.

Working Drawings to be submitted include the following with further details outlined in the remainder of this specification:

- Design calculations, specifications and shop drawings covering all aspects of fabrication, installation and acceptance testing of Dowels into Rock.
- Test results verifying the 28 day strength of non-shrink grout.
- The method for constructing of the holes, maintaining the holes, and placing reinforcing steel bars, grout and other materials in the holes, including casing sizes, bit sizes and tremie grouting methods.
- The procedures to verify hole length. Records of measurements that verify the hole length.
- Records of all drilling procedures, rock conditions encountered, and installation times.
- Test procedures for Dowels into Rock.
- Drawings and design calculations for a suitable reaction system for the applied test loads.
- Records of vertical and horizontal movements of the reaction system, and elongation of the reinforcing steel bar.
- Drawings and details for reference system arrangement.
- Current calibration curves shall be provided for all gauges.
- Complete test records for all tests including plots of dowel movement versus dowel load, dowel load versus time, and dowel movement versus time.
- Remedial measures for unacceptable stressing results.

Qualifications

All work shall be performed under the direction of Contractor or Sub-contractor personnel experienced with all aspects associated with the installation of Dowels into Rock. Such experience shall have been obtained within the preceding five years on projects of similar nature and scope to the work required for this project.

Quality Verification Engineer: A resume of the work experience of the Quality Verification Engineer shall be submitted to the Contract Administrator for record purposes. The Quality Verification Engineer shall be a Professional Engineer licensed in the Province of Ontario having a minimum of five years of experience on projects of similar nature and scope to the work required for this project.

Design Engineer: A resume of the work experience of the Design Engineer shall be submitted to the Contract Administrator for record purposes. The Design Engineer shall be a Professional Engineer licensed in the Province of Ontario having a minimum of five years of experience of projects of similar nature and scope to the work required for this project.

MATERIALS

Non-shrink grout shall be an approved DSM 9.10.35 non-shrink grout. The Contractor shall provide manufacturer's data sheets for the non-shrink grout, and installation procedures for the non-shrink grout.

EQUIPMENT

All equipment for the installation of the Dowels into Rock shall be suitable for the intended purposes and capable of working on the site under the prevailing access and clearance conditions.

The equipment shall not cause damage to the reinforcing steel bars.

INSTALLATION

All work for the installation of Dowels into Rock shall be inspected by the Quality Verification Engineer.

Construction of Holes

The sides and end of the hole shall not be disturbed. The Contractor shall submit Working Drawings to the Contract Administrator that include the method for constructing of the holes, maintaining the holes, and placing reinforcing steel bar, grout and other materials in the holes. All excavated material shall be removed from the site.

The hole diameters and hole length for this project are as specified on the Contract Drawings. Prior to commencing drilling operations, the Contractor shall submit Working Drawings to the Contract Administrator outlining devised procedures to verify hole length. The Contractor shall submit Working Drawings that include drilling operations records to the Contract Administrator that include the above noted records.

At all times, the Contractor shall keep a record of all drilling procedures, rock conditions encountered, and installation times. The Contractor shall submit Working Drawings to the Contract Administrator that include the above noted records.

Installation of Reinforcing Steel Bar

Reinforcing steel bar shall be installed in strict accordance with the Contract Drawings and installation procedures.

Centering devices shall be provided to ensure that the reinforcing steel bar is located centrally in the hole.

Reinforcing steel bar shall be installed after the dowel hole has been filled with non-shrink grout.

Grout

The non-shrink grout shall entirely fill the annular space between the reinforcing steel bar and side for the dowel hole, and shall be placed into the dowel hole using tremie placement methods.

The placement of grout for the test Dowels into Rock shall be identical to the production Dowels into Rock.

TESTING REQUIREMENTS

All work for the testing of Dowels into Rock shall be inspected by the Quality Verification Engineer.

General Testing Requirements

The Contractor shall install the number of Dowels into Rock specified in the contract documents for testing purposes. The purpose of testing the Dowels into Rock is to prove the adequacy of the proposed anchor configuration and installation procedures under the site conditions, and to provide design parameters.

The Dowels into Rock for testing shall be 30M dowels grouted into 100 mm diameter holes filled with an approved non-shrink grout with a minimum 1,500 mm embedment into the limestone bedrock.

The Contractor shall submit Working Drawings that include proposed procedures for testing of the dowels into Rock to the Contract Administrator. Such testing shall be executed in strict accordance with the proposed procedures of the Contractor.

The Quality Verification Engineer shall supervise the testing of the Dowels into Rock. The Contractor will notify the Contract Administrator of the testing schedule at least 10 days prior to commencement of the testing program. Testing for Dowels into Rock shall be conducted concurrently, as scheduled by the Contract Administrator. The tests shall normally be conducted between 8:00 hrs and 20:00 hrs from Monday to Friday, unless otherwise directed by the Contract Administrator.

The Contractor shall supply materials and skilled personnel to conduct the tests for the Dowels into Rock. The equipment and materials shall be capable of stressing the Dowels into Rock to the specified loads. It shall be the responsibility of the Contractor to constantly monitor the test, maintain specified test loads and to record test measurements as specified by the Quality Verification Engineer.

The test site shall be restored to its pre-test condition. Reinforcing steel bars used in tests shall be cut down 25 mm below the top of the bedrock.

Testing Equipment

The dowels into rock will be carried out generally in accordance with the prevailing requirements of ASTM Designation D1143-81, superseded where applicable by the procedures specified in this document.

The Contractor shall submit Working Drawings for a suitable reaction system for the applied test loads to the Contract Administrator. Jacks must be secured with chains to provide adequate protection for the personnel in the event of breakage of the reinforcing steel bar or stressing system.

The Contractor shall submit Working Drawings for the reference system arrangement to the Contract Administrator. All reference beams shall be as follows:

- The beams shall be independently supported with the support firmly embedded in the ground.
- The testing device shall not apply compression to the bedrock surrounding the test for the Dowels into Rock, within a circle concentric with the dowel hole and a diameter equal to 4.0 m.
- Reference beams shall be sufficiently rigid to support instrumentation such that variations in readings do not occur.

The Contractor shall construct suitable enclosures to provide complete protection for equipment and instruments from variations in the weather conditions and disturbances during the test program. These provisions must meet the approval of the Quality Verification Engineer and will include that the test enclosures must be weather-proof and provide a consistent temperature in order to eliminate temperature variations that could affect instrumentation.

Testing for Dowels Into Rock and Report

At all times, the Contractor shall keep records of vertical and horizontal movements of the reaction system, elongation of reinforcing steel bar, and the record of test enclosure temperature. The movements shall be recorded with respect to an independent fixed reference point. The Contractor shall submit Working Drawings that include the above noted records to the Contract Administrator.

Dial gauges shall have at least a 76.2 mm (3.0 in.) travel. Longer gauge stems or sufficient gauge blocks shall be provided to allow for greater travel if required. Gauges shall have precision of at least 0.025 mm (0.001 in.). The dial gauges shall be placed on smooth bearing surfaces mounted perpendicular to the direction of movement. All gauges, scales or reference points attached to the test anchor shall be mounted so as to prevent movement relative to the test anchor during the test. The Contractor shall submit Working Drawings that include details for current calibration and curves for all gauges to the Contract Administrator.

Jacks used for reinforcing steel bars shall have a minimum ram dimension of 152.6 mm (6.0 in.). The Contractor shall submit Working Drawings that include details for current calibration and curves for all gauges to the Contract Administrator.

Requirements for Clauses 5.4.1 to 5.4.4 shall be repeated as required at different testing locations.

Testing Loading

Rock dowels shall be loaded and unloaded in 3 cycles and measurements of the displacement of the dowel shall be carried out at each load increment (step) in accordance with the following schedule:

Cycle-Step	1-1	1-2	1-3	2-1	2-2	2-3	2-4
% Design Load	50	75	25	50	75	100	25
Cycle-Step	3-1	3-2	3-3	3-4	3-5		
% Design Load	50	75	100	110	25		

The load shall be increased beyond the design load as directed by the Quality Verification Engineer.

Each load shall be maintained for a minimum time of 15 minutes and until the rate of displacement is not greater than 0.25 mm (0.01 inches) per hour.

Acceptance Criteria

The following acceptance criteria apply:

The testing of dowels shall be carried out in advance of the instalment of Dowels into Rock at the HML pole footings.

The Quality Verification Engineer shall report on the acceptance of the tests for Dowels into Rock, including recommendations for increasing embedment depth, if necessary.

BASIS OF PAYMENT

Payment at the contract unit price for the above tender item shall include full compensation for all labour, equipment, and materials to do the work. No additional payment will be made for tests for Dowels into Rock which are deemed as included as part of the work for the above noted item.

END OF SECTION



APPENDIX A

Sample Non-Standard Special Provisions

**CONTROL OF OVERBURDEN SOILS AND GROUNDWATER DURING CAISSON
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- Drawings and details for reference system arrangement.
- Current calibration curves shall be provided for all gauges.
- Complete test records for all tests including plots of dowel movement versus dowel load, dowel load versus time, and dowel movement versus time.
- Remedial measures for unacceptable stressing results.

Qualifications

All work shall be performed under the direction of Contractor or Sub-contractor personnel experienced with all aspects associated with the installation of Dowels into Rock. Such experience shall have been obtained within the preceding five years on projects of similar nature and scope to the work required for this project.

Quality Verification Engineer: A resume of the work experience of the Quality Verification Engineer shall be submitted to the Contract Administrator for record purposes. The Quality Verification Engineer shall be a Professional Engineer licensed in the Province of Ontario having a minimum of five years of experience on projects of similar nature and scope to the work required for this project.

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MATERIALS

Non-shrink grout shall be an approved DSM 9.10.35 non-shrink grout. The Contractor shall provide manufacturer's data sheets for the non-shrink grout, and installation procedures for the non-shrink grout.

EQUIPMENT

All equipment for the installation of the Dowels into Rock shall be suitable for the intended purposes and capable of working on the site under the prevailing access and clearance conditions.

The equipment shall not cause damage to the reinforcing steel bars.

INSTALLATION

All work for the installation of Dowels into Rock shall be inspected by the Quality Verification Engineer.

Construction of Holes

The sides and end of the hole shall not be disturbed. The Contractor shall submit Working Drawings to the Contract Administrator that include the method for constructing of the holes, maintaining the holes, and placing reinforcing steel bar, grout and other materials in the holes. All excavated material shall be removed from the site.

The hole diameters and hole length for this project are as specified on the Contract Drawings. Prior to commencing drilling operations, the Contractor shall submit Working Drawings to the Contract Administrator outlining devised procedures to verify hole length. The Contractor shall submit Working Drawings that include drilling operations records to the Contract Administrator that include the above noted records.

At all times, the Contractor shall keep a record of all drilling procedures, rock conditions encountered, and installation times. The Contractor shall submit Working Drawings to the Contract Administrator that include the above noted records.

Installation of Reinforcing Steel Bar

Reinforcing steel bar shall be installed in strict accordance with the Contract Drawings and installation procedures.

Centering devices shall be provided to ensure that the reinforcing steel bar is located centrally in the hole.

Reinforcing steel bar shall be installed after the dowel hole has been filled with non-shrink grout.

Grout

The non-shrink grout shall entirely fill the annular space between the reinforcing steel bar and side for the dowel hole, and shall be placed into the dowel hole using tremie placement methods.

The placement of grout for the test Dowels into Rock shall be identical to the production Dowels into Rock.

TESTING REQUIREMENTS

All work for the testing of Dowels into Rock shall be inspected by the Quality Verification Engineer.

General Testing Requirements

The Contractor shall install the number of Dowels into Rock specified in the contract documents for testing purposes. The purpose of testing the Dowels into Rock is to prove the adequacy of the proposed anchor configuration and installation procedures under the site conditions, and to provide design parameters.

The Dowels into Rock for testing shall be 30M dowels grouted into 100 mm diameter holes filled with an approved non-shrink grout with a minimum 1,500 mm embedment into the limestone bedrock.

The Contractor shall submit Working Drawings that include proposed procedures for testing of the dowels into Rock to the Contract Administrator. Such testing shall be executed in strict accordance with the proposed procedures of the Contractor.

The Quality Verification Engineer shall supervise the testing of the Dowels into Rock. The Contractor will notify the Contract Administrator of the testing schedule at least 10 days prior to commencement of the testing program. Testing for Dowels into Rock shall be conducted concurrently, as scheduled by the Contract Administrator. The tests shall normally be conducted between 8:00 hrs and 20:00 hrs from Monday to Friday, unless otherwise directed by the Contract Administrator.

The Contractor shall supply materials and skilled personnel to conduct the tests for the Dowels into Rock. The equipment and materials shall be capable of stressing the Dowels into Rock to the specified loads. It shall be the responsibility of the Contractor to constantly monitor the test, maintain specified test loads and to record test measurements as specified by the Quality Verification Engineer.

The test site shall be restored to its pre-test condition. Reinforcing steel bars used in tests shall be cut down 25 mm below the top of the bedrock.

Testing Equipment

The dowels into rock will be carried out generally in accordance with the prevailing requirements of ASTM Designation D1143-81, superseded where applicable by the procedures specified in this document.

The Contractor shall submit Working Drawings for a suitable reaction system for the applied test loads to the Contract Administrator. Jacks must be secured with chains to provide adequate protection for the personnel in the event of breakage of the reinforcing steel bar or stressing system.

The Contractor shall submit Working Drawings for the reference system arrangement to the Contract Administrator. All reference beams shall be as follows:

- The beams shall be independently supported with the support firmly embedded in the ground.
- The testing device shall not apply compression to the bedrock surrounding the test for the Dowels into Rock, within a circle concentric with the dowel hole and a diameter equal to 4.0 m.
- Reference beams shall be sufficiently rigid to support instrumentation such that variations in readings do not occur.

The Contractor shall construct suitable enclosures to provide complete protection for equipment and instruments from variations in the weather conditions and disturbances during the test program. These provisions must meet the approval of the Quality Verification Engineer and will include that the test enclosures must be weather-proof and provide a consistent temperature in order to eliminate temperature variations that could affect instrumentation.

Testing for Dowels Into Rock and Report

At all times, the Contractor shall keep records of vertical and horizontal movements of the reaction system, elongation of reinforcing steel bar, and the record of test enclosure temperature. The movements shall be recorded with respect to an independent fixed reference point. The Contractor shall submit Working Drawings that include the above noted records to the Contract Administrator.

Dial gauges shall have at least a 76.2 mm (3.0 in.) travel. Longer gauge stems or sufficient gauge blocks shall be provided to allow for greater travel if required. Gauges shall have precision of at least 0.025 mm (0.001 in.). The dial gauges shall be placed on smooth bearing surfaces mounted perpendicular to the direction of movement. All gauges, scales or reference points attached to the test anchor shall be mounted so as to prevent movement relative to the test anchor during the test. The Contractor shall submit Working Drawings that include details for current calibration and curves for all gauges to the Contract Administrator.

Jacks used for reinforcing steel bars shall have a minimum ram dimension of 152.6 mm (6.0 in.). The Contractor shall submit Working Drawings that include details for current calibration and curves for all gauges to the Contract Administrator.

Requirements for Clauses 5.4.1 to 5.4.4 shall be repeated as required at different testing locations.

Testing Loading

Rock dowels shall be loaded and unloaded in 3 cycles and measurements of the displacement of the dowel shall be carried out at each load increment (step) in accordance with the following schedule:

Cycle-Step	1-1	1-2	1-3	2-1	2-2	2-3	2-4
% Design Load	50	75	25	50	75	100	25
Cycle-Step	3-1	3-2	3-3	3-4	3-5		
% Design Load	50	75	100	110	25		

The load shall be increased beyond the design load as directed by the Quality Verification Engineer.

Each load shall be maintained for a minimum time of 15 minutes and until the rate of displacement is not greater than 0.25 mm (0.01 inches) per hour.

Acceptance Criteria

The following acceptance criteria apply:

The testing of dowels shall be carried out in advance of the instalment of Dowels into Rock at the HML pole footings.

The Quality Verification Engineer shall report on the acceptance of the tests for Dowels into Rock, including recommendations for increasing embedment depth, if necessary.

BASIS OF PAYMENT

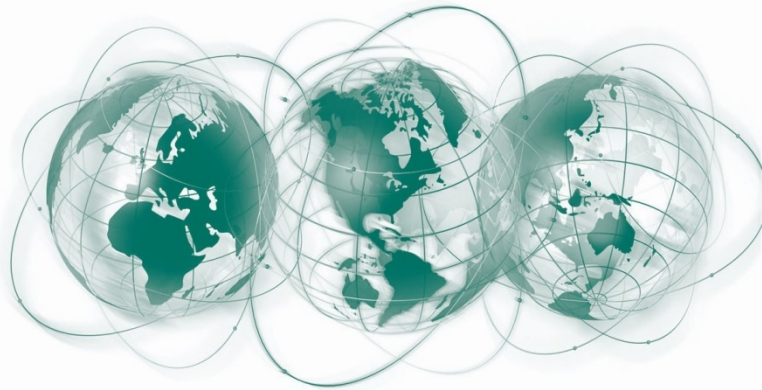
Payment at the contract unit price for the above tender item shall include full compensation for all labour, equipment, and materials to do the work. No additional payment will be made for tests for Dowels into Rock which are deemed as included as part of the work for the above noted item.

END OF SECTION

At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

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