August 2009

REPORT ON

FOUNDATION INVESTIGATION AND DESIGN REPORT PROPOSED TRICHORD OVERHEAD SIGNS, CANTILEVER SIGNS AND ATMS OVERHEAD CHANGEABLE MESSAGE SIGN
HIGHWAY 417 EXPANSION
EAGLESON ROAD TO HIGHWAY 7
G.W.P. 255-98-00

Submitted to:

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Golder Associates

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Golder Associates

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by McCormick Rankin Corporation on behalf of the Ministry of Transportation, Ontario (MTO) to carry out a foundation investigation associated with the 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/or replacement.

This report addresses the sixteen trichord overhead, cantilever and changeable message signs associated with the Highway 417 expansion under 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

A total of sixteen new signs are proposed along Highway 417 under G.W.P. 258-99-00. Eleven trichord overhead signs and two cantilever signs are located over a distance of approximately 5.9 km along Highway 417, extending from about 500 m east of the Carp Road bridge to 950 m east of the Castlefrank Road bridge, in Ottawa, Ontario. Three cantilever signs and one changeable message sign are also located along Highway 417 over a distance of about 1.7 km, extending from approximately 400 m west of the OCR overpass to 100 m west of the Moodie Drive bridge. The proposed sign locations are shown on Drawings 1 to 6 and are summarized in the following table:

Sign Type	Sign Number	Sign Location
Trichord Overhead Signs	OH1	Station 28+913, Huntley Twp., Highway 417 WBL
	OH2	Station 29+373, Huntley Twp., Highway 417 WBL
	OH3	Station 29+555, Huntley Twp., Highway 417 EBL
	OH4	Station 30+015, Huntley Twp., Highway 417 EBL
	OH5	Station 31+017, Huntley Twp., Highway 417 WBL
	OH6	Station 10+375, March Twp., Highway 417 WBL
	OH7	Station 10+902, March Twp., Highway 417 EBL
	OH8	Station 11+362, March Twp., Highway 417 EBL
	OH9	Station 12+335, March Twp., Highway 417 WBL
	OH10	Station 12+895, March Twp., Highway 417 WBL
	OH11	Station 13+730, March Twp., Highway 417 WBL
Cantilever Signs	C1	Station 30+115, Huntley Twp., Highway 417 EBL
	C2	Station 12+350, March Twp., Highway 417 EBL
	C3	Station 12+930, Nepean Twp., Highway 417 WBL
	C4	Station 13+430, Nepean Twp., Highway 417 WBL
	C5	Station 13+915, Nepean Twp., Highway 417 WBL
Changeable Message Sign	CMS1	Station 12+245, Nepean Twp., Highway 417 EBL

The ground surface along the highway alignment in the area of the proposed signs slopes downward from Carp Road east to the Carp River, varying in elevation from about 114 m to 94 m. The ground surface then rises to about Elevation 96 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 100 m, at the location of trichord overhead sign OH9. The ground surface along the remainder of the highway in the area of the proposed signs varies in elevation from about Elevation 92 m east of Castlefrank Drive to 95 m west of Eagleson Road. East of Eagleson Road, the ground surface varies from Elevation 98 m (east of the OCR) to 68 m west of Moodie Drive.

Previous foundation investigations were carried within the eastern portion of the site (i.e. east of Eagleson Road and west Moodie Drive) in 2006. The results of the first investigation are summarized in MTO's GEOCRES No. 31G5-205, *Foundation Investigation Report, High Mast Lights, Highway 417 From Eagleson Road to Moodie Drive, Ottawa, Ont., G. W.P. 302-89-00*. The results of the second investigation are summarized in MTO's GEOCRES No. 31G5-198, *Foundation Investigation and Design, Tall Rock Fill Embankment Widening, Highway 417, G.W.P. 4254-05-01*.

3.0 INVESTIGATION PROCEDURES

The subsurface investigation was carried out for the proposed trichord overhead and cantilever signs in July, August, and September 2008, at which time fifteen boreholes (numbered 08-601 to 08-611, inclusive for the trichord overhead signs and 08-701 to 08-704, inclusive for the cantilever signs). The boreholes were advanced at the proposed footing locations that were established in the field by J.D. Barnes Ltd. Land Surveyors, except at the locations of cantilever sign C5 and changeable message sign CMS1, as discussed below. Where a sign will require two footings, a borehole was advanced at the location of the footing in the median of Highway 417. The borehole locations are shown on Drawings 1 to 6.

The borehole at the location of cantilever sign C5 could not be drilled at the proposed footing location due to a conflict with a watermain, plus limited access as a result of construction for the adjacent MTO contract. The final location of the proposed changeable message sign CMS1 was selected in December 2008 at which time the field work for all of the other sign locations had already been completed. Based on discussions with MTO, it was decided that there was sufficient existing subsurface information in the area of signs C5 and CSM1 and no boreholes were drilled at these locations. Relevant boreholes from 2006 MTO investigations near the locations for signs C5 and CSM1 are shown on Drawings 5 and 6. Borehole 06-33 is located approximately 40 m east of C5, and Borehole 02-601 is located approximately 5 m west of CMS1.

The boreholes were advanced using 108 mm inside diameter continuous flight hollow stem augers on a track- or truck-mounted drill rig, supplied and operated by Marathon Drilling Ltd. of Ottawa, Ontario. The boreholes were advanced to depths of about 3.5 m to 8.4 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 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 a depth of 7 m below the ground surface, bedrock coring was carried out using NQ-size coring equipment (with the exception of Borehole 08-610, where the borehole was terminated when auger refusal was encountered due to artesian groundwater pressures).

The water levels in the open boreholes were observed throughout the drilling operations. 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 soil 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 tests 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 sign and borehole locations for the current investigation were established by J.D. Barnes Ltd. Land Surveyors. The borehole elevations were either surveyed by J.D. Barnes or determined by MRC from a digital terrain model based on the borehole locations. 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 6. This table also includes the northing and easting coordinates and ground surface elevations for the relevant boreholes adjacent to signs C5 and CMS1 from the previous 2006 MTO investigations.

Sign Number	Borehole Number	MTM NAD83 Northing (m)	MTM NAD83 Easting (m)	Ground Surface Elevation (m)
OH1	08-601	5016164.5	347747.6	113.6
OH2	08-602	5016474.4	348087.5	108.3
OH3	08-603	5016553.1	348200.4	107.5
OH4	08-604	5016867.1	348536.6	105.6
OH5	08-605	5017580.9	349303.4	100.6
OH6	08-606	5017866.4	349661.0	97.8
OH7	08-607	5018117.8	350133.1	93.9
OH8	08-608	5018333.0	350539.7	96.1
OH9	08-609	5018896.8	351321.7	99.7
OH10	08-610	5019262.0	351746.1	92.4
OH11	08-611	5019806.7	352379.0	94.9
C1	08-701	5016934.5	348610.4	105.1
C2	08-702	5018902.5	351338.8	99.7
C3	08-703	5021719.0	355474.7	86.2
C4	08-704	5021970.6	355906.9	73.3
C5	06-33	5022231.9	356362.8	68.3
CMS1	02-601	5021367.4	354881.0	98.2

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 Precambian 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 shaley partings and seams[2]. The shallow overburden soils are typically between 1 m and 3 m in thickness and are commonly comprised of sandy to gravelly till derived from the Precambrian Shield to the north, overlain by glaciofluvial sediments that consist of layered sands and gravels. 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 sheets and on Figures 1 to 9. 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 along Highway 417 vary over the project area and range from fill, peat, sandy silt and till overlying limestone bedrock, to extensive deposits of sensitive clayey silt, silty clay and clay, to shallow sandstone bedrock.

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

[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.

The following table summarizes the subsurface conditions encountered in the boreholes at each of the proposed sign locations, and a more detailed description of the soils and bedrock is provided in the subsections that follow.

Borehole Number and Sign Location	Summary of Subsurface Conditions Encountered in Borehole(s)
08-601 Station 28+913, Huntley Twp.	2.3 m of peat and sand fill, overlying 0.9 m of peat and 0.2 m of silty clay, overlying 1.8 m compact silty sand till, underlain by limestone bedrock at 5.2 m depth (Elevation 108.4 m)
08-602 Station 29+373, Huntley Twp.	0.8 m of peat fill, overlying 0.8 m of peat, underlain by 1.1 m of loose to compact sandy silt, overlying 0.1 m of sandy silt till, underlain by limestone bedrock at 2.8 m depth (Elevation 105.5 m)
08-603 Station 29+555, Huntley Twp.	0.7 m of peat fill, overlying 1.1 m of peat, overlying 2.2 m of loose sandy silt, underlain by very loose to very dense sand and silty sand till proven to a depth of 6.9 m
08-604 Station 30+015, Huntley Twp.	0.4 m of topsoil, underlain by 3.1 m of very loose to loose sandy silt to silt, some sand, overlying 0.5 m of very loose sandy silt till, underlain by limestone bedrock at 4.0 m depth (Elevation 101.6 m)
08-605 Station 31+017, Huntley Twp.	0.8 m of topsoil and silty clay fill, overlying topsoil and 0.2 m of clayey silt, underlain by 4.4 m of very stiff to stiff weathered silty clay, overlying firm to stiff unweathered silty clay to clay proven to a depth of 7.3 m
08-606 Station 10+375, March Twp.	0.2 m of topsoil, overlying 4.4 m of very stiff to stiff weathered silty clay to clay, underlain by firm unweathered silty clay to clay proven to a depth of 7.3 m
08-607 Station 10+902, March Twp.	1.1 m of organic sandy silt fill, overlying 0.6 m of organic clayey silt and 0.7 m very loose to loose sand, underlain by very stiff to soft unweathered silty clay to clay proven to a depth of 7.3 m
08-608 Station 11+362, March Twp.	2.2 m of very stiff to stiff weathered silty clay, underlain by soft to firm unweathered silty clay to clay proven to a depth of 7.3 m
08-609 Station 12+335, March Twp.	0.2 m of topsoil, underlain by 0.2 m of sandy silt, underlain by sandstone bedrock at 0.4 m depth (Elevation 99.3 m)
08-610 Station 12+895, March Twp.	0.2 m of topsoil, overlying 0.9 m of firm weathered silty clay to clay, underlain by 2.2 m of firm unweathered silty clay to clay, overlying 0.4 m of sand and 0.8 m of sandy silt till, underlain by sandstone bedrock at 4.5 m depth (Elevation 87.9 m)
08-611 Station 13+730, March Twp.	1.7 m of crushed stone, sandy silt and silty clay fill, overlying 2.7 m of very loose to dense layered sandy silt, sand, and sand and gravel, underlain by granite bedrock at 4.4 m depth (Elevation 90.5 m)
08-701 Station 30+115, Huntley Twp.	0.4 m of topsoil and sandy silt fill, underlain by limestone bedrock at 0.4 m depth (Elevation 104.7 m)
08-702 Station 12+350, March Twp.	0.2 m of topsoil, underlain by 0.2 m of silty sand, overlying sandstone bedrock at 0.4 m depth (Elevation 99.3 m)
08-703 Station 12+930, Nepean Twp.	1.1 m of crushed stone fill, underlain by sandstone rock fill proven to a depth of 7.2 m
08-704 Station 13+430, Nepean Twp.	1.2 m of crushed stone and sand and gravel fill, overlying 3.7 m of very stiff to stiff weathered silty clay to clay, underlain by firm to stiff unweathered silty clay proven to a depth of 7.3 m

Borehole Number and Sign Location	Summary of Subsurface Conditions Encountered in Borehole(s)
02-601 Station 12+250, Nepean Twp.	1.9 m of sandstone rock fill, underlain by sandstone bedrock at 1.9 m depth (Elevation 96.2 m)
06-33 Station 13+955, Nepean Twp.	0.1 m of topsoil, overlying 3.4 m of stiff weathered silty clay, underlain by unweathered silty clay proven to a depth of 10.1 m

4.2.1 Fill Material

Fill material, associated with the construction of the existing highway, was encountered at ground surface at about half of the borehole locations, as follows:

Borehole Number(s)	Fill Thickness	Fill Composition
08-601 to 08-603	0.7 m to 2.3 m	Peat containing varying amounts of silty sand, sand, and gravel. In Borehole 08-601, the lower 0.9 m of fill consists of loose sand. Cobbles and boulders were also encountered in the fill material at Borehole 08-601
08-605	0.8 m	Topsoil and silty clay
08-607	1.1 m	Loose organic sandy silt
08-701	0.4 m	Topsoil and sandy silt
08-703	7.2 m	Approximately 1.1 m of crushed stone fill overlying 6.1 m of sandstone rock fill
08-704	1.2 m	Crushed stone and compact sand and gravel

Standard Penetration Test (SPT) "N" values within the fill range from 6 to 40 blows per 0.3 m of penetration, indicative of a loose to dense relative density.

4.2.2 Topsoil, Peat and Organic Clayey Silt

Topsoil was encountered immediately below the ground surface in Boreholes 08-604, 08-606, 08-609, 08-610, 08-702 and 06-33, as well as beneath the fill material at Borehole 08-605. The topsoil thickness encountered in these boreholes ranges from about 100 mm to 400 mm.

A 0.8 m to 1.1 m thick layer of peat was encountered beneath the fill material at in Boreholes 08-601 to 08-603. The measured natural water contents of three samples of the peat are 90, 127 and 204 percent. The organic contents of two samples of the peat are 17 and 49 percent.

The fill material in Borehole 08-607 is underlain by a layer of 0.6 m thick organic clayey silt, which was encountered between about 1.1 m and 1.7 m depth.

4.2.3 Layered Sands and Silts

The peat, topsoil and fill material, where present, are underlain by a layered deposit of sandy silt, silt, sand, silty sand and/or sand and gravel, which was encountered in Boreholes 08-602 to 08-604, 08-607, 08-611 and 08-702. The layered deposit ranges in thickness from about 0.2 to 3.1 m as encountered in the boreholes advanced as part of this investigation.

The measured SPT "N" values within the layered deposit generally range from 3 to 35 blows per 0.3 m of penetration indicating a very loose to dense relative density.

Grain size distribution test results obtained from eight selected samples of the cohesionless soil strata are shown on Figure 1. The measured natural water contents of samples of the layered deposit range from 4 to 62 percent (below the groundwater level).

4.2.4 Sensitive Clayey Silt, Silty Clay and Clay

A deposit of clayey silt to clay was encountered in the boreholes at several of the sign sites, as follows:

- Below the fill and peat in Borehole 08-601, where the silty clay was encountered at a depth of 3.2 m and was about 0.2 m in thickness.
- Below the topsoil, fill and sand (where present) in Boreholes 08-605, 08-607 and 08-704, where the surface of the clayey silt to silty clay was encountered at depths of about 1 m to 2.4 m. The deposit was proven to a depth of about 7.3 m below the existing ground surface in these boreholes.
- Below a thin layer of topsoil or immediately below the ground surface in Boreholes 08-606, 08-608, and 08-610. The deposit was proven to a depth of about 7.3 m below the existing ground surface in Boreholes 08-606 and 08-608, and was fully penetrated at Borehole 08-610 to a depth of 3.3 m below the existing ground surface (Elevation 89.1 m). A 0.4 m thick sand layer was encountered within the deposit (between the weathered "crust" and the unweathered grey silty clay to clay) in Borehole 08-606, at a depth of about 4 m below ground surface.

At Boreholes 08-607 and 08-608 about the upper 3.0 and 0.2 m of the deposit, respectively, consists of silty clay containing organic matter. The measured natural water content of the silty clay with organic matter at Borehole 08-607 is 23 percent.

In all boreholes excluding Boreholes 08-601 and 08-607, the upper 0.9 to 4.4 m of the silty clay to clay deposit has been weathered to a grey-brown crust. The measured SPT "N" values in the "crust" range from 1 to 11 blows per 0.3 m of penetration. In situ vane shear tests carried out in this material measured undrained shear strengths that range from about 61 kPa 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 results of grain size distribution testing on two samples of the weathered silty clay to clay deposit are shown on Figure 2. Atterberg limits testing was conducted on four samples of the weathered material and measured plasticity indices ranging of 27 to 44 percent and liquid limits of 46 to 69 percent, as shown on Figure 3; these results confirm that this material is a silty clay to clay soil of intermediate to high plasticity. The measured natural water content of the weathered material ranges from 33 to 54 percent.

The silty clay below the depth of weathering and beneath the silty clay with organic matter at Borehole 08-607 is grey. The measured SPT "N" values in the unweathered silty clay range from "weight of hammer" and "manual pressure" to 2 blows per 0.3 m of penetration. In situ vane shear testing carried out in this portion of the deposit measured undrained shear strengths that range from 17 to 81 kPa, indicating a soft to stiff consistency. However, the average undrained shear strength for this material is 40 kPa, indicating that the grey silty clay to clay has a generally firm consistency.

The result of grain size distribution testing on one sample of the unweathered silty clay to clay deposit is shown on Figure 4. Atterberg limits testing was completed on four samples of the unweathered silty clay to clay and measured plasticity indices of 26 to 34 percent and liquid limits of 45 to 58 percent, as shown on Figure 5; these results confirm that this portion of the deposit is a silty clay to clay of intermediate to high plasticity. The measured natural water content of the unweathered material ranges from 26 to 70 percent.

4.2.5 Sand, Sandy Silt and Silty Sand Till

A till deposit was encountered beneath the layered sands and silts and the silty clay to clay deposits. The till deposit was fully penetrated in Boreholes 08-601, 08-602 and 08-604, where its surface was encountered at depths of 2.7 m to 3.5 m, and was found to be between 0.2 m and 0.5 m in thickness. In Boreholes 08-603 and 08-610, the surface of the till deposit was encountered at depths of 4.0 m and 3.7 m, respectively, and the borehole was terminated in the till which was proven to depths of about 6.9 m and 4.5 m, corresponding to thicknesses of at least 2.9 m and 0.8 m, respectively.

The glacial till is a heterogeneous mixture of gravel, cobbles, and boulders in a matrix of sand, sandy silt and silty sand containing trace to some clay. The results of grain size distribution testing on four selected samples of the glacial till are provided on Figure 6; 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. A sand layer was encountered within the till deposit at Borehole 08-603 with a thickness of about 0.4 m. An approximately 0.4 m thick layer of silty sand and gravel overlies the till deposit at Borehole 08-610.

The measured SPT "N" values vary from "weight of hammer" to greater than 100 blows per 0.3 metres of penetration in the till, indicating a very loose to very dense state of packing. The higher SPT "N" values (i.e. greater than 100 blows per 0.3 m of penetration) are considered to reflect cobble and boulder content in the till (e.g., in Borehole 08-603, where diamond drilling techniques were required to advance through cobbles and boulders in the till deposit), or refusal on the bedrock surface (e.g., in Borehole 08-604). Cobbles and boulders have also been inferred to be present within the till in Borehole 08-601, based on auger grinding during drilling.

The measured natural water content of the glacial till ranges from 8 to 16 percent.

4.2.6 Limestone, Sandstone and Granite Bedrock

The existing fill material and native soils are underlain by limestone, sandstone or granite bedrock. The bedrock was cored at all of the borehole locations where auger refusal was encountered, with the exception of Borehole 08-610. The following table summarizes the bedrock surface depth and elevation as encountered at the borehole locations.

Sign Location	Borehole No.	Bedrock Depth (1) (m)	Bedrock Surface Elevation (m)
OH1 Station 28+913, Huntley Twp.	08-601	5.2	108.4 (Cored)
OH2 Station 29+373, Huntley Twp.	08-602	2.8	105.5 (Cored)
OH4 Station 30+015, Huntley Twp.	08-604	4.0	101.6 (Cored)
OH9 Station 12+335, March Twp.	08-609	0.4	99.3 (Cored)
OH10 Station 12+895, March Twp.	08-610	4.5	87.9
OH11 Station 13+730, March Twp.	08-611	4.4	90.5 (Cored)
C1 Station 30+115, Huntley Twp.	08-701	0.4	104.7 (Cored)
C2 Station 12+350, March Twp.	08-702	0.4	99.3 (Cored)
CMS1 Station 12+245, Nepean Twp.	02-601	1.9	98.2 (Cored)

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

The limestone bedrock encountered in Boreholes 08-601, 08-602, 08-604 and 08-701 is light grey to black, laminated to medium bedded, and medium strong. The bedrock is generally slightly weathered to fresh. Rock Quality Designation (RQD) values measured on the recovered bedrock core samples ranged from 0 to 95 percent, with an average of approximately 60 percent indicating a generally fair quality rock. Laboratory point load index testing was carried out, axially, on four selected specimens from the limestone bedrock core. The results from the point load index testing correlate with uniaxial compressive strengths from the point load index testing which that range from 32 to 147 MPa, as shown on Figure 7. These compressive strengths are representative of a medium strong to very strong rock.

The sandstone bedrock encountered in Boreholes 08-609, 08-702 and 02-601 is light grey to brown, generally laminated to thickly bedded, and medium strong. The bedrock is typically slightly weathered to fresh. RQD values measured on the recovered bedrock core samples ranged from 27 to 100 percent, with an average of approximately 71 percent indicating a generally fair quality rock. Laboratory point load index testing was carried out, axially, on two selected specimens from the sandstone bedrock core. The results from the point load testing correlate with uniaxial compressive strengths of 67 and 71 MPa, as shown on Figure 8. These results are representative of a generally strong rock.

The granite bedrock at Borehole 08-611 is pink, grey, white and green, generally coarse-grained and medium strong. The bedrock is moderately weathered. RQD values measured on the recovered bedrock core samples were 20, 44 and 53 per cent, with an average of approximately 39 percent, indicating a poor quality rock. Laboratory point load index testing was carried out, axially, on two selected specimens from the granite bedrock core. Laboratory unconfined compressive strength testing was also carried out on one selected specimen of the bedrock core. The correlated point load test results are summarized on Figure 9 and indicate compressive strengths of 55 and 117 MPa. The unconfined compressive strength test measured a compressive strength value of about 25 MPa. These results indicate a generally medium strong to very strong rock.

4.2.7 Groundwater Conditions

Wet soils were encountered during drilling and are noted on the Record of Boreholes sheets. The water levels in the open borehole during drilling operations were measured to be between 1.1 and 4.1 m below the ground surface at the boreholes locations. The water level observations and measurements are noted on the borehole records and are summarized in the following table:

Borehole No.	Sign Number and Location	Water Level in Open Borehole During Drilling	
		Depth (m)	Elevation (m)
08-601	OH1 Station 28+913, Huntley Twp.	1.7	111.9
08-602	OH2 Station 29+373, Huntley Twp.	1.5	106.8
08-604	OH4 Station 30+015, Huntley Twp.	1.1	104.5
08-609	OH9 Station 12+335, March Twp.	2.5	97.2
08-611	OH11 Station 13+730, March Twp.	4.1	90.8
08-701	C1 Station 30+115, Huntley Twp.	1.2	103.9
08-702	C2 Station 12+350, March Twp.	2.2	97.5

It is noted that a minor amount of artesian groundwater flow was encountered within the sandstone bedrock at a high mast light pole location adjacent to OH10.

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 report was prepared by Ms. Susan Trickey under the direction of the Project Manager, Ms. Lisa Coyne, P.Eng. This report was reviewed by Mr. Fintan J. Heffernan, P.Eng., the Designated MTO Contact for this project.

Yours truly,

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PART B

FOUNDATION DESIGN REPORT
PROPOSED TRICHORD OVERHEAD, CANTILEVER AND CHANGEABLE MESSAGE SIGNS
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 foundation design recommendations for the proposed trichord overhead signs, cantilever signs and changeable message sign foundations along Highway 417, extending from about 500 m east of the Carp Road bridge to 100 m west of the Moodie Drive bridge in Ottawa, Ontario. The recommendations are based on interpretation of the factual data obtained during a subsurface investigation at the proposed sign sites.

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 only 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.

A comparison of the foundation alternatives for all sign types is provided in Table 1.

6.2 Design of Sign Foundations

Caisson foundations for sign supports should be designed in accordance with the requirements in MTO's *Sign Support Manual*. The *Sign Support Manual* includes standard caisson foundation designs for each sign type as follows:

- **Trichord Overhead Signs:** Tri-Chord Static Sign Supports, Section 4 and Standard Drawings SS118-3, SS118-4 and SS118-5.
- **Cantilever Signs:** Cantilever Static Sign Supports, Section 3 and Standard Drawings SS118-3, SS118-4 and SS118-5.
- **Changeable Message Sign:** Changeable Message Sign Supports, Section 8 and Standard Drawings SS118-6, SS118-7 and SS118-8.

The standard sign foundation designs presented on the Standard Drawings have been developed based on the minimum soil conditions given below; where weaker soils are encountered, such as at OH5, OH6, OH7 and OH8 (where silty clay of lower strength is present), a site-specific design is required.

- **Case 1 (Cohesionless Soils):** Sand with a friction angle of 28 degrees surrounding the upper two-thirds of the portion of the caisson foundation below the frost depth, and sand with a friction angle of 30 degrees surrounding the lower third of the portion of the caisson below the design frost depth.
- **Case 2 (Cohesive Soils):** Soft clay with an undrained shear strength of 25 kPa surrounding the upper two-thirds of the portion of the caisson foundation below the frost depth, and "soft" clay with an undrained shear strength of 50 kPa surrounding the lower third of the portion of the caisson below the design frost depth.

In the standard design, the caissons are extended 5 m below the design frost depth, unless bedrock is encountered within this depth. For sign foundation design, the frost depth in the Ottawa area may be taken as 1.8 m. The typical caisson founding level would therefore be 6.8 m below the ground surface, except where bedrock is encountered within this depth as is the case at the locations for nine of the proposed signs (six trichord overhead signs, two cantilever signs and the changeable message sign).

Where caisson foundations are adopted, it is recommended that MTO's Special Provision SP903S01 be included in the Contract Documents for the construction of caisson piles.

The following table summarizes the depth to bedrock and the bedrock surface elevation in the boreholes at each of the proposed sign support locations where bedrock was encountered within 6.8 metres depth, as determined by bedrock coring (or inferred from auger refusal for OH10):

Sign Location	Borehole No.	Bedrock Depth (1) (m)	Bedrock Surface Elevation (m)
OH1 Station 28+913, Huntley Twp.	08-601	5.2	108.4 (Cored)
OH2 Station 29+373, Huntley Twp.	08-602	2.8	105.5 (Cored)
OH4 Station 30+015, Huntley Twp.	08-604	4.0	101.6 (Cored)
OH9 Station 12+335, March Twp.	08-609	0.4	99.3 (Cored)
OH10 Station 12+895, March Twp.	08-610	4.5	87.9
OH11 Station 13+730, March Twp.	08-611	4.4	90.5 (Cored)
C1 Station 30+115, Huntley Twp.	08-701	0.4	104.7 (Cored)
C2 Station 12+350, March Twp.	08-702	0.4	99.3 (Cored)
CMS1 Station 12+245, Nepean Twp.	02-601	1.9	98.2 (Cored)

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

The depth to bedrock at OH9, C1, C2 and CMS1 is fairly shallow, varying from approximately 0.4 m to 1.9 m; foundations for the sign supports at these four locations could consist of a caisson embedded into the bedrock, or a spread footing or caisson anchored/dowelled to the surface of the bedrock. Recommendations pertaining to these foundation alternatives are provided in Sections 6.2.2 and 6.2.3.

The depth to bedrock at OH1, OH2, OH4, OH10 and OH11 is less than 5 m below the design frost depth (i.e. between 2.8 and 5.2 m depth below existing ground surface). At these five sites, the overburden soils may not be sufficient to provide the required lateral resistance, and a nominal socket into the rock may be required, as discussed in Section 6.2.2.

At all other sign locations, where the bedrock depth is greater than 6.8 m, the foundation for the sign supports should be designed as caissons in soil, as discussed in Section 6.2.1.

6.2.1 Caisson Foundations in Soil

The stratigraphy and design parameters for the subsurface conditions encountered in the boreholes at the sign support locations are given in Table 2.

6.2.1.1 Cohesive Soils

For cohesive soils, as encountered at the proposed locations for OH5, OH6, OH7, C4 and C5, 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, based on the stratigraphy and design parameters given in Table 2 for these sign locations:

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

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

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.

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. For both the drained and undrained cases, a resistance factor of 0.5 should be applied to the calculated lateral resistance in order to obtain the factored lateral geotechnical resistance.

The foundation design for these sign 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 2; and,
B is the caisson diameter (m).

6.2.1.2 Cohesionless Soils

For cohesionless soils, as encountered at OH3 and C3, the unfactored passive lateral earth pressure, P_p (kPa), distributed along the caisson may be calculated using the following equation, based on the stratigraphy and parameters given in Table 2 for these sign locations:

$P_p = K_p \gamma z$ Above the groundwater table; and,

$P_p = K_p \gamma z_w - K_p (z - z_w) \gamma'$ 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); 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. 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. A resistance factor of 0.5 should be applied to this calculated lateral resistance in order to obtain the factored lateral geotechnical resistance.

The foundation design for the OH3 and C3 sign 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 below;
z Is the depth (m); and,
B Is the pile diameter (m).

The following values of n_h may be assumed in the structural analysis for the OH3 and C3 sign locations, based on the subsurface conditions encountered in the boreholes:

Sign	Borehole No.	Soil Layer	Depth	Elevation	n_h
OH3	08-603	Fill/Peat	0.0 – 1.8	107.5 – 105.7	-
		Sandy Silt	1.8 – 4.0	105.7 – 103.5	1.3 MPa/m
		Sand and Silty Sand Till	Below 4.0	Below 103.5	4.4 MPa/m
C3	08-703	Fill (Crushed Stone)	0.0 – 1.1	86.2 – 85.1	6.6 MPa/m
		Rockfill (Sandstone)	Below 1.1	Below 85.1	6.6 MPa/m

A minor amount of artesian groundwater flow was encountered within the sandstone bedrock at a high mast light pole location (P44) adjacent to OH10. Therefore, consideration should be given to the potential for artesian flow conditions to be encountered during excavation and foundation construction at OH10. Further recommendations regarding control of artesian groundwater conditions during caisson installation are provided in Section 6.3.

6.2.2 Caisson Foundations Embedded or Socketted in Rock

In accordance with Standard Drawing SS118-3 (for ground-mounted trichord overhead sign supports) and SS118-6 (for ground-mounted changeable message sign supports) of MTO's Sign Support Manual, where bedrock is encountered at a depth, z (in metres), of less than 5 m below the bottom of the frost layer, the required depth of the foundation below the frost layer may be taken as follows:

$$z + [(5 - z) / 2]$$

It is noted that Note 8 on Standard Drawing SS118-3 is considered to be a note to the designer, and should be deleted from the drawing in the Contract Documents. Further, Note 9 is not applicable to this project and has resulted in delays and claims on past MTO projects; it is therefore recommended that Note 9 also be deleted from the drawing in the Contract Documents.

For OH9, C1, C2 and CMS1, the depth to the surface of the bedrock is less than or close to the frost depth of 1.8 m. Based on the above, the caissons at these locations would require a minimum socket length of 2.5 m in the bedrock. However, the limestone, sandstone and granite bedrock at the site are generally medium strong to very strong, and coring or churn drilling will be necessary to advance the socket into the bedrock. Since a socket length of about 2.5 m would be required in the rock at the locations for OH9, C1, C2 and CMS1, it is recommended that spread footing foundations anchored to the rock be used at these locations to avoid the requirement for large-diameter coring and/or churn drilling for caisson installation. Recommendations for rock anchors are provided in Section 6.2.3.

For OH1, OH2, OH4, OH10 and OH11, the depth to bedrock is less than 5 m below the design frost depth. The depth of rock socket required can be determined based on the equation above or, alternatively, site specific design could be carried out for these locations (using the parameters given in Table 2) to determine whether the overburden soils can provide the required lateral resistance. The factored passive lateral resistance of the limestone, sandstone and granite may be taken as 4 MPa at ULS in this assessment. From a geotechnical perspective, the rock sockets could have a diameter less than the "standard" caisson diameter of 1200 mm; in this case, the actual rock socket diameter should be determined based on site-specific design by the structural engineers, using the passive lateral resistance for the rock mass as given above.

As mentioned previously, slight artesian groundwater pressures are expected to be encountered in the bedrock during construction of the bedrock socket (if adopted) at OH10; if a bedrock socket is adopted for this sign site, special procedures will be required during construction, and a permanent filter layer is recommended at ground surface; these aspects are discussed further in Section 6.3 (Construction Considerations), and a sample NSSP is included in Appendix A for inclusion in the Contract Documents. Alternatively, to avoid having to address artesian groundwater flows during construction, the foundation for OH10 could consist of a spread footing founded on the bedrock surface. A factored vertical bearing resistance of 2 MPa may be assumed for the sandstone bedrock at OH10. If rock anchors are required to achieve sufficient uplift and lateral resistance, the length of the anchors should be minimized to lessen the impact of the artesian groundwater conditions at this location.

6.2.3 Foundations Anchored to Rock

Where the bedrock is particularly shallow (for example, at OH-9, C1 and C2, where the bedrock is at about 0.4 m depth), it may be necessary to embed the caisson deeper within the bedrock to allow sufficient foundation length for the anchorage assembly. For spread footings a factored vertical bearing resistance of 2 MPa may be assumed for the limestone, sandstone and granite bedrock.

The horizontal resistance of the dowels will be dependent on the strength of the bedrock, grout and steel. The dowels may be designed based on a factored lateral resistance for the rock mass at ULS of 4 MPa. 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 700 kPa may be assumed 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, as discussed further in Section 6.3. A sample Special Provision for Dowels into Rock is also provided in Appendix A.

6.3 Construction Considerations

It is recommended that a Non-Standard Special Provision (NSSP) be included in the Contract Documents to warn the Contractor of the following items which are expected to affect the installation of the sign foundations:

- **Control of artesian groundwater conditions:** If a rock-socketted caisson is adopted for the sign foundation at OH10, it is expected that the excavation will encounter slight artesian groundwater conditions in the bedrock, based on the results from a nearby borehole advanced for a HML pole. It is recommended that concrete for the caisson foundations at this site be placed using tremie methods while maintaining a balancing head of water. Further, to mitigate the risk of permanent groundwater flow around the foundation and the associated risk of long-term soil erosion around the caisson (with potential loss of lateral support), it is recommended that a 0.3 m thick layer of OPSS 1010 Granular A be placed at ground surface to act as a filter. A sample NSSP has been included in Appendix A to warn the contractor of the slight artesian conditions, to require use of appropriate construction procedures and equipment to control the groundwater during drilling and concrete placement for caisson foundations, and to require placement of a 0.3 m of thick filter layer of OPSS 1010 Granular A.

- **Control of overburden soils and groundwater:** Excavations for some of the sign foundations will be advanced through cohesionless soils, which 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, in order to minimize ground loss during drilling and concrete placement.
- **Cobbles and boulders/Zones of fractured rock and rock fill:** Cobbles and boulders have been encountered within the till deposit and fill material. Rock fill was also encountered at two borehole locations. Appropriate equipment and procedures will be required to penetrate these obstructions during excavation for foundation construction.
- **Bedrock strength:** Some of the sign 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.
- **Pull-out testing for rock dowels:** If rock anchors/dowels are adopted for some of the sign foundations, the contract should include an SP to address this requirement.

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

7.0 CLOSURE

This report was prepared by Ms. Susan Trickey under the direction of the Project Manager, Ms. Lisa Coyne, P.Eng. This report was reviewed by Mr. Fintan J. Heffernan, P.Eng., the Designated MTO Contact for this project.

Yours truly,

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TABLE 1: COMPARISSON OF FOUNDATION DESIGN ALTERNATIVES
HIGHWAY 417 EXPANSION, EAGLESON ROAD TO HIGHWAY 7, G.W.P. 255-98-00

Sign No.	Sign Type	Caisson Foundation in Soil	Caisson Foundation in Soil with Rock Socket	Caisson Foundations in Soil with Rock Dowels	Spread Footings on Rock with Rock Dowels
OH1	Trichord Overhead	N/A – Rock too shallow	Preferred Alternative	Feasible, but not preferred	Not practical due to depth to bedrock surface
OH2	Trichord Overhead	N/A – Rock too shallow	Preferred Alternative	Feasible, but not preferred	Not practical due to depth to bedrock surface
OH3	Trichord Overhead	Preferred Alternative	N/A	N/A	N/A
OH4	Trichord Overhead	N/A – Rock too shallow	Preferred Alternative	Feasible, but not preferred	Not practical due to depth to bedrock surface
OH5	Trichord Overhead	Preferred Alternative	N/A	N/A	N/A
OH6	Trichord Overhead	Preferred Alternative	N/A	N/A	N/A
OH7	Trichord Overhead	Preferred Alternative	N/A	N/A	N/A
OH8	Trichord Overhead	Preferred Alternative	N/A	N/A	N/A
OH9	Trichord Overhead	N/A – Rock too shallow	Feasible, but not economic	Feasible, but not economic	Preferred Alternative
OH10	Trichord Overhead	N/A – Rock too shallow	Preferred Alternative	Feasible, but not preferred	Not practical due to depth to bedrock surface
OH11	Trichord Overhead	N/A – Rock too shallow	Preferred Alternative	Feasible, but not preferred	Not practical due to depth to bedrock surface
C1	Cantilever	N/A – Rock too shallow	Feasible, but not economic	Feasible, but not economic	Preferred Alternative
C2	Cantilever	N/A – Rock too shallow	Feasible, but not economic	Feasible, but not economic	Preferred Alternative
C3	Cantilever	Preferred Alternative	N/A	N/A	N/A
C4	Cantilever	Preferred Alternative	N/A	N/A	N/A
C5	Cantilever	Preferred Alternative	N/A	N/A	N/A
CMS1	Changeable Message	N/A – Rock too shallow	Feasible, but not economic	Feasible, but not economic	Preferred Alternative

N/A – Not an applicable/appropriate design option

TABLE 2: DESIGN PARAMETERS FOR SIGN FOUNDATIONS
HIGHWAY 417 EXPANSION, EAGLESON ROAD TO HIGHWAY 7, G.W.P. 255-98-00

Sign No.	Borehole No.	Borehole Location	Stratum	Depth^1 (m)	Elevation (m)	Groundwater Elevation (m)	Design Parameters^{2,3}					
							C_u	c'	φ'	γ	γ'	K_p
OH1	08-601	N 5016164.5 E 347747.6	Fill^4 (Peat with cobbles and boulders)	0.0 – 1.4	113.6 – 112.2	111.9	-	-	-	14	4	-
			Fill^4 (Sand)	1.4 – 2.3	112.2 – 111.3		-	-	28	19	9	-
			Peat^4	2.3 – 3.2	111.3 – 110.4		-	-	-	12	2	-
			Silty Clay	3.2 – 3.4	110.4 – 110.2		75	5	32	17	7	3.3
			Silty Sand Till	3.4 – 5.2	110.2 – 108.4		-	-	35	20	10	3.7
			Limestone (bedrock)	Below 5.2	Below 108.4							
OH2	08-602	N 5016474.4 E 348087.5	Fill/Peat^4	0.0 – 1.6	108.3 – 106.7	106.8	-	-	-	12	2	-
			Sandy Silt	1.6 – 2.7	106.7 – 105.6		-	-	28	19	9	2.8
			Sandy Silt Till	2.7 – 2.8	105.6 – 105.5		-	-	32	20	10	3.0
			Limestone (bedrock)	Below 2.8	Below 105.5							
OH3	08-603	N 5016553.1 E 348200.4	Fill/Peat^4	0.0 – 1.8	107.5 – 105.7	105.7^5	-	-	-	12	2	-
			Sandy Silt	1.8 – 4.0	105.7 – 103.5		-	-	28	19	8	2.8
			Sand and Silty Sand Till	Below 4.0	Below 103.5		-	-	32	22	12	3.3
OH4	08-604	N 5016867.1 E 348536.6	Sandy Silt to Silt, Some Sand	0.0 – 3.5	105.6 – 102.1	104.5	-	-	28	19	9	2.8
			Sandy Silt Till	3.5 – 4.0	102.1 – 101.6		-	-	32	20	10	3.3
			Limestone (bedrock)	Below 4.0	Below 101.6							
OH5	08-605	N 5017580.9 E 349303.4	Fill	0.0 – 0.9	100.6 – 99.7	98.8^5	-	-	25	17	7	2.5
			Clayey Silt/Weathered Silty Clay	0.9 – 5.5	99.7 – 95.1		75	5	32	17	7	3.3
			Silty Clay to Clay	Below 5.5	Below 95.1		42	7.5	30	16.5	6.5	3.0
OH6	08-606	N 5017866.4 E 349661.0	Weathered Silty Clay to Clay	0.0 – 4.0	97.8 – 93.8	96.0^5	75	5	32	17	7	3.3
			Silty Sand	4.0 – 4.4	93.8 – 93.4		-	-	30	19	9	3.0
			Silty Clay to Clay	Below 4.4	Below 93.4		30	7.5	30	16.5	6.5	3.0
OH7	08-607	N 5018117.8 E 350133.1	Fill	0.0 – 1.1	93.9 – 92.8	92.4^5	-	-	28	18	8	2.8
			Organic Clayey Silt	1.1 – 1.7	92.8 – 92.2		50	5	30	17	7	3.0
			Sand	1.7 – 2.4	92.2 – 91.5		-	-	28	19	9	2.8
			Silty Clay to Clay	Below 2.4	Below 91.5		25	7.5	30	16.5	6.5	3.0
OH8	08-608	N 5018333.0 E 350539.7	Weathered Silty Clay	0.0 – 2.4	96.1 – 93.7	94.3^5	75	5	32	17	7	3.3
			Silty Clay to Clay	Below 2.4	Below 93.7		30	7.5	30	16.5	6.5	3.0

TABLE 2: DESIGN PARAMETERS FOR HIGH MAST LIGHT POLE FOUNDATIONS
HIGHWAY 417 EXPANSION, EAGLESON ROAD TO HIGHWAY 7, G.W.P. 255-98-00—CONTINUED

Sign No.	Borehole No.	Borehole Location	Stratum	Depth[1] (m)	Elevation (m)	Groundwater Elevation (m)	Design Parameters [2,3]					
							C_u	c'	φ'	γ	γ'	K_p
OH9	08-609	N 5018896.8 E 351321.7	Sandy Silt Sandstone (bedrock)	0.0 – 0.4 Below 0.4	99.7 – 99.3 Below 99.3	97.2	-	-	28	19	9	2.8
OH10	08-610	N 5019262.0 E 351746.1	Weathered Silty Clay to Clay Silty Clay to Clay Sand and Gravel Sandy Silt Till Sandstone (bedrock)	0.0 – 1.1 1.1 – 3.3 3.3 – 3.7 3.7 – 4.5 Below 4.5	92.4 – 91.3 91.3 – 89.1 89.1 – 88.7 88.7 – 87.9 Below 87.9	92.4[5]	75 34 - -	5 7.5 - -	32 30 30 30	17 16.5 19 20	7 6.5 9 10	3.3 3.0 3.0 3.0
OH11	08-611	N 5019806.7 E 352379.0	Fill Sandy Silt, Sand, Sand and Gravel, Some Silt Granite (bedrock)	0.0 – 1.7 1.7 – 4.4 Below 4.4	94.9 – 93.2 93.2 – 90.5 Below 90.5	90.8	- -	- -	25 30	19 19	9 9	2.5 3.0
C1	08-701	N 5016934.5 E 348610.4	Fill Limestone (bedrock)	0.0 – 0.4 Below 0.4	105.1 – 104.7 Below 104.7	103.9	-	-	28	19	9	2.8
C2	08-702	N 5018902.5 E 351338.8	Silty Sand Sandstone (bedrock)	0.0 – 0.4 Below 0.4	99.7 – 99.3 Below 99.3	97.5	-	-	28	19	9	2.8
C3	08-703	N 5021719.0 E 355474.7	Fill (Crushed Stone) Rockfill (Sandstone)	0.0 – 1.1 Below 1.1	86.2 – 85.1 Below 85.1	N/A	- -	- -	30 38	21.5 21.5	11.5 11.5	3.0 4.2
C4	08-704	N 5021970.6 E 355906.9	Fill Weathered Silty Clay to Clay Silty Clay	0.0 – 1.2 1.2 – 4.9 Below 4.9	73.3 – 72.1 72.1– 68.4 Below 68.4	71.0[5]	- 75 54	- 5 7.5	30 32 30	21.5 17 16.5	11.5 17 6.5	3.0 3.3 3.0
C5	06-33	N 5022231.9 E 356362.8	Weathered Silty Clay Silty Clay	0.0 – 3.5 Below 3.5	68.3 – 64.8 Below 64.8	66.8	75 65	5 7.5	32 30	17 16.5	7 6.5	3.3 3.0
CMS1	02-601	N 5021367.4 E 354881.0	Rockfill (Sandstone) Sandstone (bedrock)	0.0 – 1.9 Below 1.9	98.2 – 96.2 Below 96.2	96.3	-	-	38	21.5	11.5	4.2

TABLE 2: DESIGN PARAMETERS FOR HIGH MAST LIGHT POLE FOUNDATIONS
HIGHWAY 417 EXPANSION, EAGLESON ROAD TO HIGHWAY 7, G.W.P. 255-98-00—CONTINUED

NOTES:

1. Depth to bedrock 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 to “sound” bedrock adjusted accordingly.
2. Design parameters: C_u = Undrained shear strength (kPa);
   c' = Cohesion (kPa);
   φ' = Effective friction angle (degrees);
   γ = Bulk unit weight (kN/m^3);
   γ' = Effective unit weight below the groundwater level (kN/m^3); and,
   K_p = Passive earth pressure coefficient.
3. 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 sign locations.
4. Assume no contribution to passive lateral resistance from the peat/fill.
5. Assumed groundwater level based on the site stratigraphy and soil samples.

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, 60^0 cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

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

Peizo-Cone Penetration Test (CPT):

An electronic cone penetrometer with a 60^0 conical tip and a projected end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded Electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Cohesionless Soils

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

(b) Cohesive Soils

Consistency **C_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 (LV-laboratory vane test)
γ	unit weight

Note:

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

LIST OF SYMBOLS

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

I. GENERAL

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

II. STRESS AND STRAIN

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

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight*)
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma'=\gamma-\gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = p_s/p_w$) formerly (G_s)
e	void ratio
n	porosity
S	degree of saturation
*	Density symbol is p. Unit weight symbol is γ where γ=pg(i.e. mass density x acceleration due to gravity)

(a) Index Properties (cont'd.)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

(d) Shear Strength

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

Notes: 1. $\tau=c'\sigma'$ tan |'
2. Shear strength=(Compressive strength)/2

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERING STATE

Fresh: no visible sign of weathering

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

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

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

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

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

BEDDING THICKNESS

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

JOINT OR FOLIATION SPACING

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

GRAIN SIZE

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

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

O:\ Templates\Rock Description Terminology

CORE CONDITION

Total Core Recovery

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

Solid Core Recovery (SCR)

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

Rock Quality Designation (RQD)

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

DISCONTINUITY DATA

Fracture Index

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

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

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

Description and Notes

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

Abbreviations

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

RECORD OF BOREHOLE No 08-601

1 OF 1 **METRIC**

PROJECT 07-1121-0151
W.P. 255-98-00
DIST Eastern HWY 417
DATUM Geodetic
LOCATION N 5016164.5; E 347747.6
BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem
DATE Aug. 7, 2008
ORIGINATED BY D.J.S.
COMPILED BY J.M.
CHECKED BY S.A.T.

ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	WATER CONTENT (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
113.6	GROUND SURFACE						
0.0	Peat with cobbles and boulders, trace sand and gravel (FILL) Dark brown Moist	1	SS	6			
112.2 1.4	Sand, trace gravel (FILL) Loose Brown Wet	2	SS	7	∇		
111.3 2.3	PEAT with wood Very loose Dark brown Wet	3	SS	2		127	
110.4 3.4	SILTY CLAY Grey-brown Wet	4	SS	31			
	Silty SAND, some gravel, trace clay, with cobbles and boulders (TILL) Compact Grey Wet	5	SS	29			
		6	SS	11		○	30 47 18 5
108.4 5.2	Limestone with shale interbeds (BEDROCK) Slightly weathered Light to dark grey Very thinly to medium bedded Medium strong *- Near vertical fracture from 6.4 m to 6.6 m depth* *- Containing calcite crystal from 7.5 m to 7.8 m depth* *- Highly fractured zones from 6.2 m to 6.4 m and from 7.3 m to 7.5 m depths*	7	NQ RC	REC 100%			RQD = 76%
		8	NQ RC	REC 90%			RQD = 19%
		9	NQ RC	REC 100%			RQD = 22%
105.2 8.4	End of Borehole Note: Water level in open borehole at 1.7 m depth (Elev. 111.9 m) upon completion of drilling on Aug. 7, 2008.						

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED: 20 40 60 80 100
PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L; WATER CONTENT (%): 25 50 75
UNIT WEIGHT γ kN/m³
ELEVATION SCALE: 113, 112, 111, 110, 109, 108, 107, 106

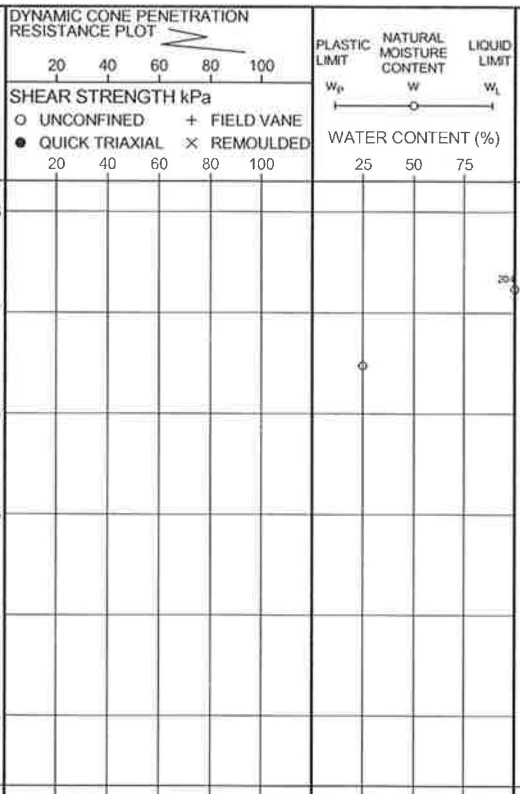
+3, ×3: Numbers refer to Sensitivity ○3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 08-602

1 OF 1 **METRIC**

PROJECT 07-1121-0151
W.P. 255-98-00
DIST Eastern HWY 417
DATUM Geodetic
LOCATION N 5016474.4; E 348087.5
BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem
DATE Aug. 8, 2008
ORIGINATED BY D.J.S.
COMPILED BY J.M.
CHECKED BY S.A.T.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES				
108.3	GROUND SURFACE							
0.0	Peat, trace gravel and sand (FILL) Dark brown					108		
107.5 0.8	PEAT Very loose Dark brown Wet	1	SS	WH	▽	107		
106.7 1.6	Sandy SILT, trace gravel Loose to compact Grey-brown Wet	2	SS	7				0 33 64 3
		3	SS	15		106		
105.6 2.8	Sandy SILT (TILL) Grey Wet Limestone with shale interbeds (BEDROCK) Fresh Dark grey Very thinly to medium bedded Medium strong	4	NQ RC	REC 100%		105 104		RQD = 70%
		5	NQ RC	REC 100%		103		RQD = 95%
102.3 6.0	End of Borehole Note: Water level in open borehole at 1.5 m depth (Elev. 106.8 m) upon completion of drilling on Aug. 8, 2008.							



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

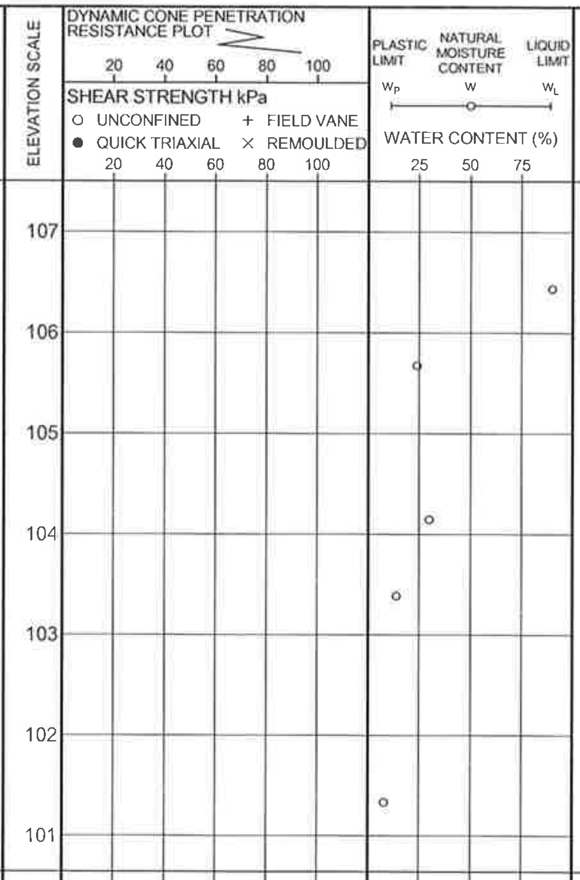
RECORD OF BOREHOLE No 08-603

1 OF 1 **METRIC**

PROJECT 07-1121-0151
W.P. 255-98-00
DIST Eastern HWY 417
DATUM Geodetic
LOCATION N 5016553.1; E 348200.4
BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem
DATE Aug. 11, 2008
ORIGINATED BY D.J.S.
COMPILED BY J.M.
CHECKED BY S.A.T.

ELEV DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	GR	SA	SI	CL
107.5 0.0	GROUND SURFACE Peat, some silty sand and wood (FILL) Dark brown							
106.8 0.7	PEAT Very loose Dark brown Moist to wet	1	SS	1				
105.7 1.8	Sandy SILT with sand seams Loose Grey Wet	2	SS	3				
		3	SS	5				
		4	SS	4	0	19	79	2
103.5 4.0	SAND, some silt and gravel, trace clay (TILL) Very loose Grey Wet	5	SS	WH	22	49	23	6
102.9 4.6	SAND, some silt and gravel Compact Grey Wet	6	SS	22				
102.5 5.0	Silty SAND, some gravel and clay, with cobbles (TILL) Dense to very dense Grey Wet	7	NQ RC	DD				
		8	SS	>100	12	48	29	11
		9	SS	>100				
100.6 6.9	End of Borehole							

Column headings: SOIL PROFILE (ELEV/DEPTH, DESCRIPTION, STRAT PLOT); SAMPLES (NUMBER, TYPE, "N" VALUES); GROUND WATER CONDITIONS; ELEVATION SCALE; UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL



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

RECORD OF BOREHOLE No 08-604

1 OF 1 **METRIC**

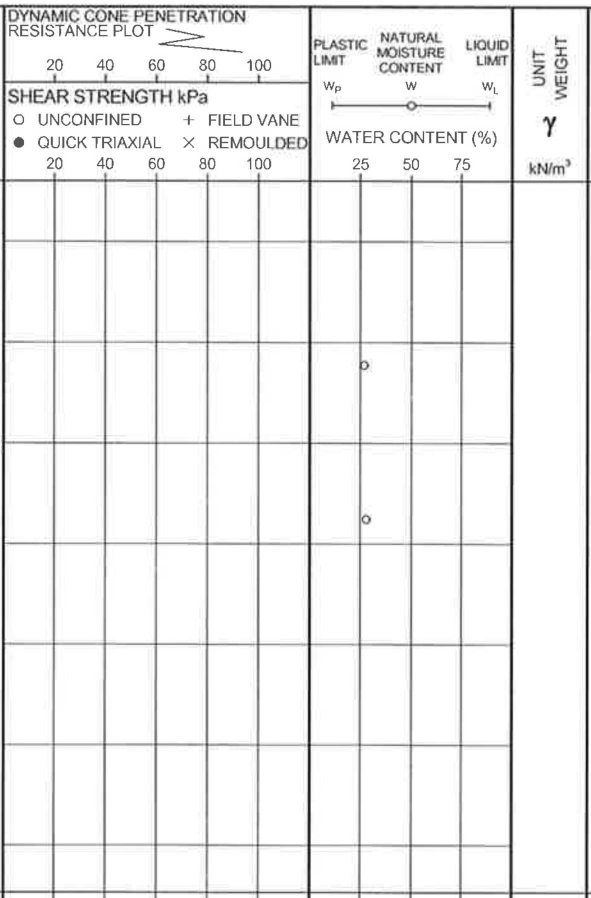
PROJECT 07-1121-0151

W.P. 255-98-00 LOCATION N 5016867.1; E 348536.6 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. 6, 2008 CHECKED BY S.A.T.

ELEV / DEPTH	DESCRIPTION	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
105.6	GROUND SURFACE						
0.0	TOPSOIL						
105.2 0.4	Sandy SILT to SILT, some sand Very loose to loose Grey-brown to grey Moist to wet					105	
		1	SS	8	∇		
		2	SS	5		104	0 12 85 3
		3	SS	3		103	
		4	SS	3			0 11 85 4
102.1 3.5	Sandy SILT, some gravel and clay (TILL) Very loose Grey Wet	5	SS	>100		102	
101.6 4.0	Limestone with shale interbeds (BEDROCK) Slightly weathered to fresh Dark grey to black Laminated to medium bedded Medium strong *- Near vertical calcite seam from 4.6 m to 5.1 m depth*	6	NQ RC	REC 100%		101	RQD = 67%
		7	NQ RC	REC 100%		100	RQD = 60%
		8	NQ RC	REC 100%		99	RQD = 86%
98.5 7.1	End of Borehole Note: Water level in open borehole at 1.1 m depth (Elev. 104.5 m) upon completion of drilling on Aug. 6, 2008.						



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

Golder Associates

RECORD OF BOREHOLE No 08-605

1 OF 1 **METRIC**

PROJECT	07-1121-0151		
W.P.	255-98-00	LOCATION	N 5017580.9; E 349303.4
DIST	Eastern HWY 417	BOREHOLE TYPE	Power Auger 108mm I.D. Hollow Stem
DATUM	Geodetic	DATE	July 29, 2008

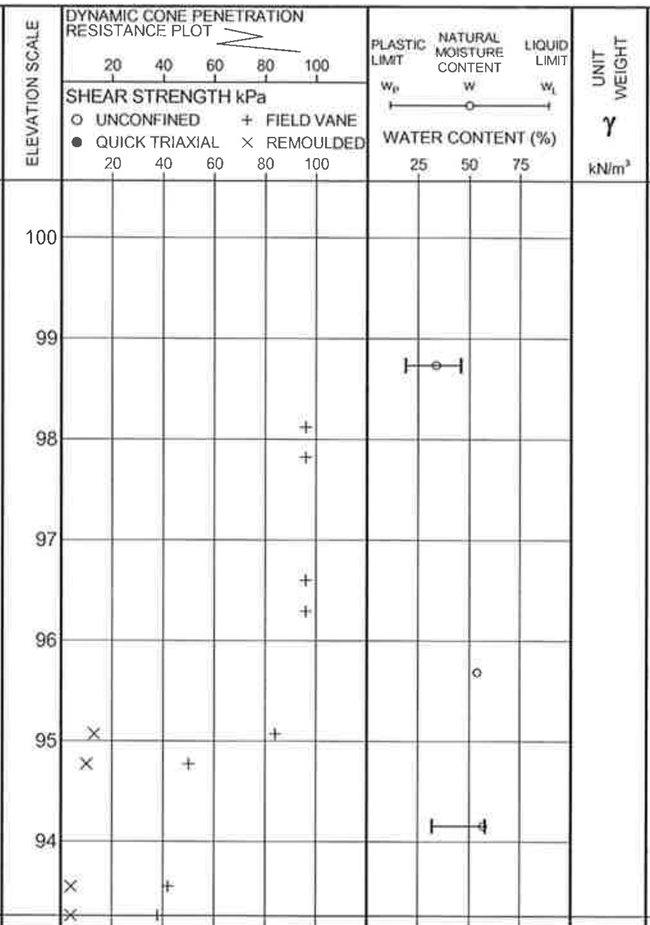
ORIGINATED BY D.J.S.
COMPILED BY J.M.
CHECKED BY S.A.T.

SOIL PROFILE

ELEV DEPTH	DESCRIPTION
100.6	GROUND SURFACE
0.0	Topsoil (FILL)
0.2	Silty clay, trace gravel and organic matter (FILL)
99.9	Grey-brown
	TOPSOIL
	CLAYEY SILT Light brown Moist
1.1	SILTY CLAY (Weathered Crust) Very stiff to stiff Grey-brown Wet
95.1 5.5	SILTY CLAY to CLAY Firm to stiff Grey Wet
93.3 7.3	End of Borehole

SAMPLES

NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
1	SS	6					
2	SS	5					
3	SS	4					
4	SS	1		0	0	53	47
5	SS	WH					



+3, ×3: Numbers refer to Sensitivity

O3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No 08-606

1 OF 1 **METRIC**

PROJECT 07-1121-0151

W.P. 255-98-00

LOCATION N 5017866.4; E 349661.0

ORIGINATED BY D.J.S.

DIST Eastern HWY 417

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

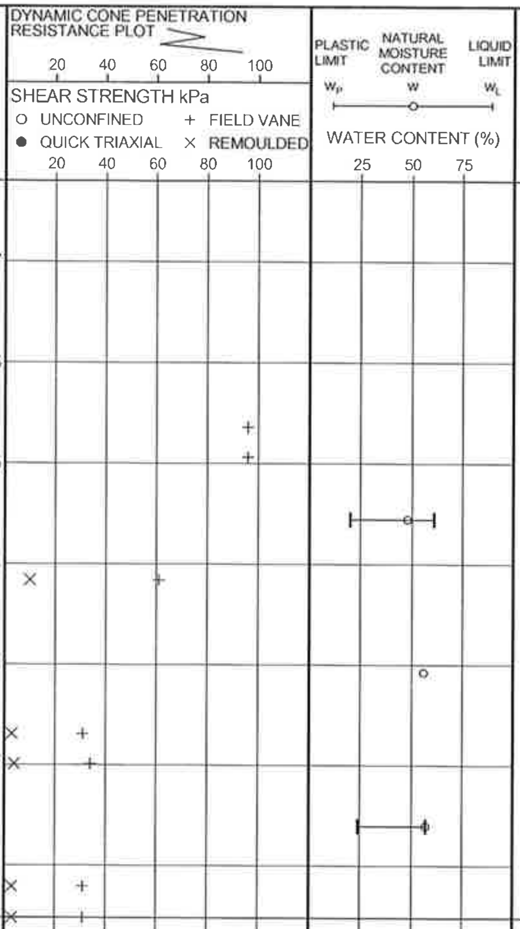
COMPILED BY J.M.

DATUM Geodetic

DATE July 28, 2008

CHECKED BY S.A.T.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES				GR	SA	SI	CL
97.8	GROUND SURFACE											
0.0	TOPSOIL											
0.2	SILTY CLAY (Weathered Crust) Very stiff to stiff Grey-brown Moist to wet						97					
			1	SS	4							
			2	SS	5		96					
							95					
			3	SS	2		94					
93.8 4.0	Silty SAND Compact Grey Wet		4	SS	18							
93.4 4.4	SILTY CLAY to CLAY, with fine sand seams Firm Grey Wet		5	SS	WH		93		0	1	50	49
							92					
			6	SS	PM		91					
90.5 7.3	End of Borehole											



+³, ×³: Numbers refer to Sensitivity

O³% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No 08-607

1 OF 1 **METRIC**

PROJECT 07-1121-0151
W.P. 255-98-00
DIST Eastern HWY 417
DATUM Geodetic

LOCATION N 5018117.8; E 350133.1
BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem
DATE June 12, 2008

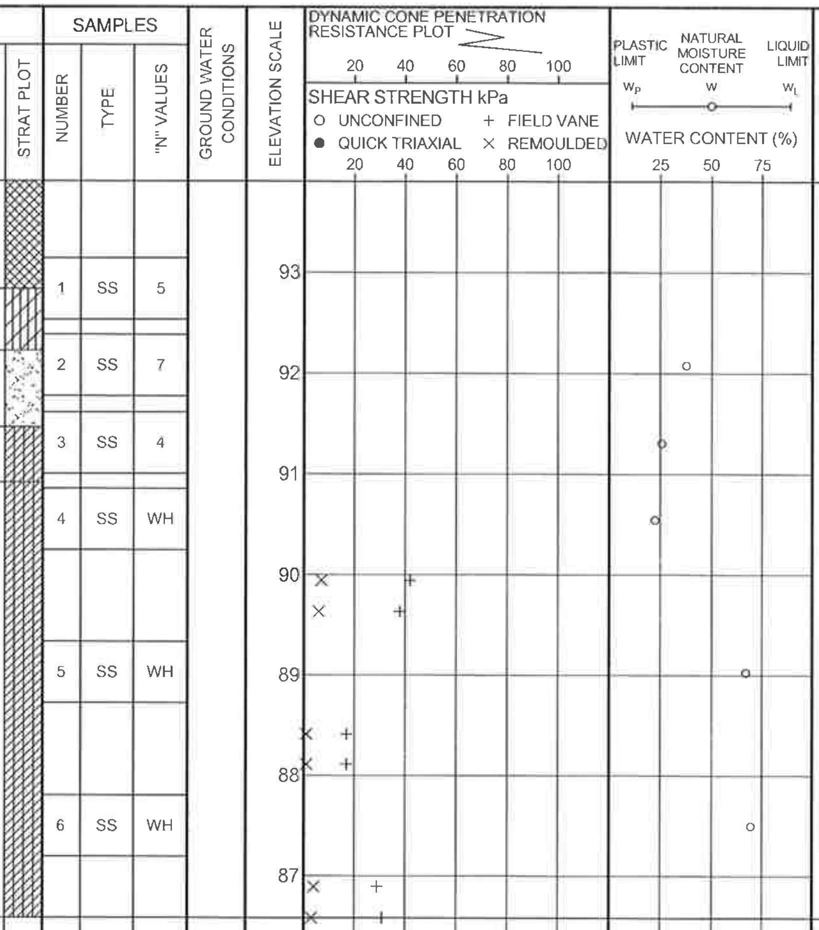
ORIGINATED BY D.J.S.
COMPILED BY J.M.
CHECKED BY S.A.T.

SOIL PROFILE

ELEV DEPTH	DESCRIPTION
93.9	GROUND SURFACE
0.0	Organic sandy silt (FILL) Loose Dark brown Moist
92.8 1.1	Organic CLAYEY SILT Dark brown Moist to wet
92.2 1.7	SAND, some silt, with organic matter Very loose to loose Dark grey-brown Wet
91.5 2.4	SILTY CLAY, trace sand and organic matter Very stiff Grey-green Wet
90.9 3.0	SILTY CLAY to CLAY, with sand seams Soft to firm Grey Wet
86.6 7.3	End of Borehole

SAMPLES

NUMBER	TYPE	"N" VALUES	GR	SA	SI	CL
1	SS	5				
2	SS	7	2	72	23	3
3	SS	4				
4	SS	WH				
5	SS	WH				
6	SS	WH				



UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

+³, ×³: Numbers refer to Sensitivity

O³% STRAIN AT FAILURE

RECORD OF BOREHOLE No 08-608

1 OF 1 **METRIC**

PROJECT 07-1121-0151
W.P. 255-98-00
DIST Eastern HWY 417
DATUM Geodetic

LOCATION N 5018333.0; E 350539.7
BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem
DATE June 12, 2008

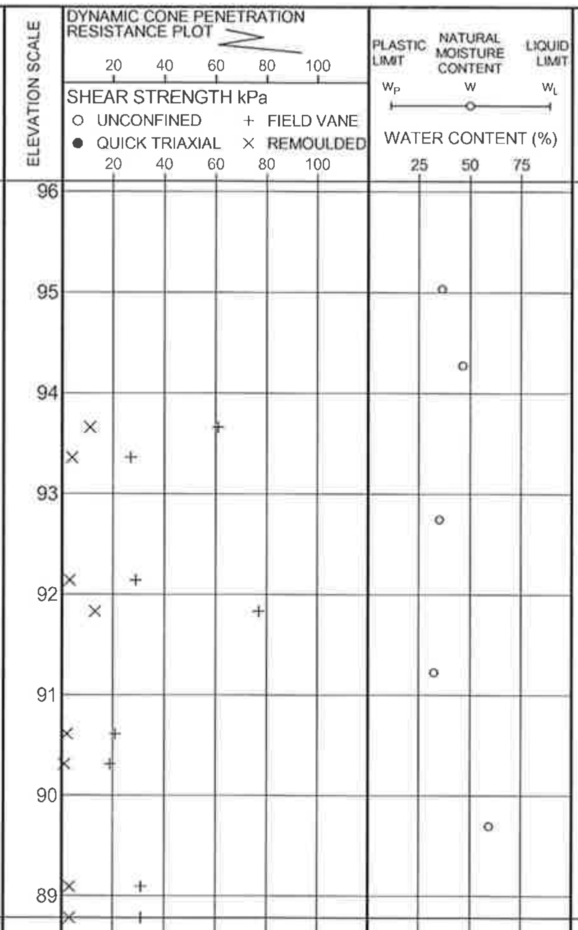
ORIGINATED BY D.J.S.
COMPILED BY J.M.
CHECKED BY S.A.T.

SOIL PROFILE

ELEV DEPTH	DESCRIPTION
96.1	GROUND SURFACE
0.0	SILTY CLAY with organic matter Grey
0.2	SILTY CLAY, occasional sand seam (Weathered Crust) Very stiff to stiff Grey-brown Wet
93.7 2.4	SILTY CLAY with sand seams Soft to firm Grey Wet
90.2 5.9	SILTY CLAY to CLAY Firm Grey Wet
88.8 7.3	End of Borehole

SAMPLES

NUMBER	TYPE	"N" VALUES	GR	SA	SI	CL
1	SS	8	0	7	55	38
2	SS	3				
3	SS	WH				
4	SS	PM				
5	SS	WH				



UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

+3, ×3: Numbers refer to Sensitivity

○3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 08-609

1 OF 1 **METRIC**

PROJECT 07-1121-0151			
W.P. 255-98-00	LOCATION N 5018896.8; E 351321.7	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 18, 2008	CHECKED BY S.A.T.	

SOIL PROFILE ELEV DEPTH	SOIL PROFILE DESCRIPTION	SOIL PROFILE STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%) 25 50 75	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
99.7	GROUND SURFACE										
0.0	TOPSOIL										
	Sandy SILT, some gravel Brown										
0.4	Sandstone (BEDROCK) Fresh Light grey Very thinly to thickly bedded Medium strong		1	NQ RC	REC 89%		99				RQD = 47%
			2	NQ RC	REC 95%	▽	98 97				RQD = 85%
			3	NQ RC	REC 100%		96				RQD = 90%
95.9 3.8	End of Borehole Note: Water level in open borehole at 2.5 m depth (Elev. 97.2 m) upon completion of drilling on July 18, 2008.										

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

RECORD OF BOREHOLE No 08-610

1 OF 1 **METRIC**

PROJECT	07-1121-0151				
W.P.	255-98-00	LOCATION	N 5019262.0; E 351746.1	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	Sept. 4, 2008	CHECKED BY	S.A.T.

SOIL PROFILE

ELEV DEPTH	DESCRIPTION
92.4	GROUND SURFACE
0.0	TOPSOIL
0.2	SILTY CLAY to CLAY (Weathered Crust) Firm Grey-brown Wet
91.3 1.1	SILTY CLAY to CLAY Firm Grey Wet
89.1	Silty SAND and GRAVEL Loose Grey Wet
88.7 3.7	Sandy SILT, trace gravel and clay (TILL) Very loose to loose Grey Wet
87.9 4.5	End of Borehole Auger Refusal

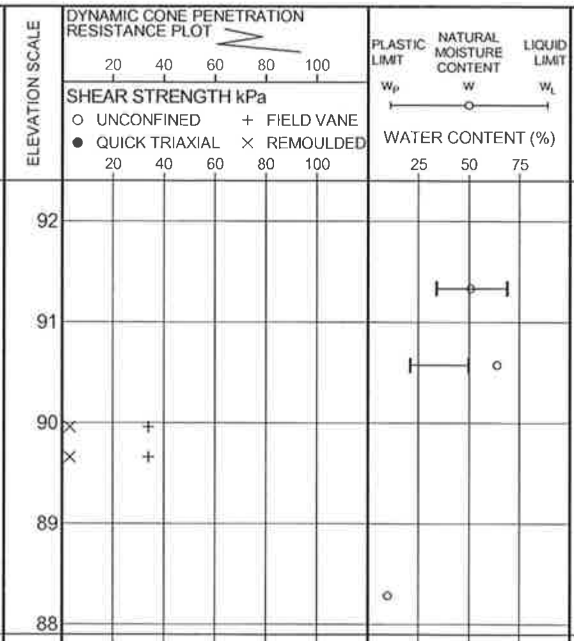
SAMPLES

NUMBER	TYPE	"N" VALUES	GR	SA	SI	CL
1	SS	WH				
2	SS	WH				
3	SS	3				
4	SS	5	9	41	41	9

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GROUND WATER CONDITIONS

UNIT WEIGHT γ kN/m³



+³, ×³: Numbers refer to Sensitivity

○³% STRAIN AT FAILURE

PROJECT 07-1121-0151

RECORD OF BOREHOLE No 08-611

1 OF 1 **METRIC**

W.P. 255-98-00

LOCATION N 5019806.7; E 352379.0

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 Sept. 3, 2008

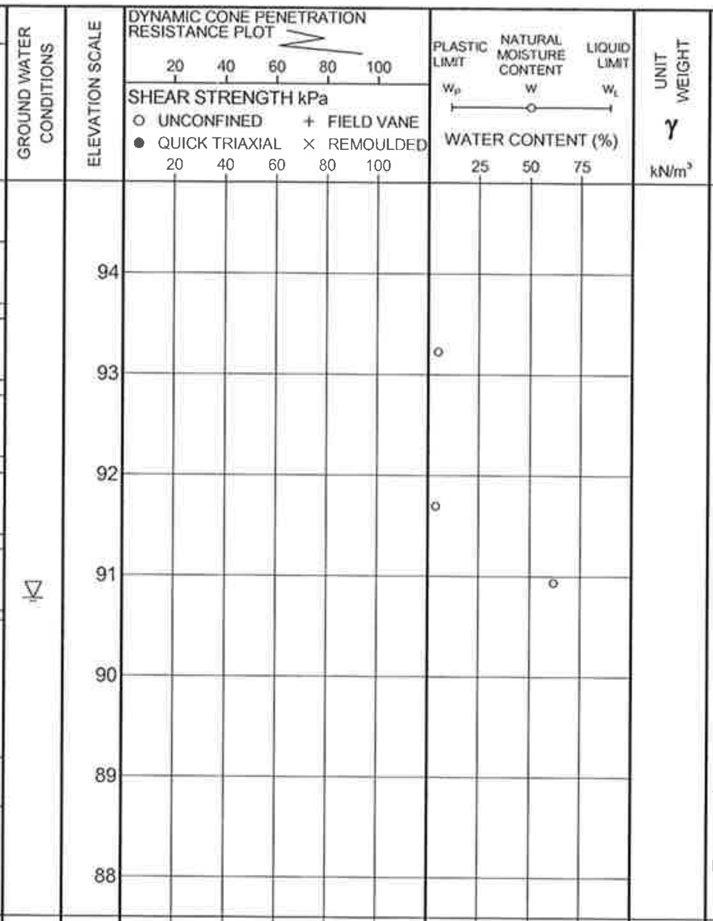
CHECKED BY S.A.T.

SOIL PROFILE

ELEV / DEPTH	DESCRIPTION
94.9	GROUND SURFACE
0.0	Crushed stone (FILL) Grey
94.4 0.5	Sandy silt, some gravel (FILL) Compact Brown Moist
93.9 1.0	Silty clay (FILL) Very stiff Dark brown and brown Moist
93.2 1.7	Sandy SILT, some clay Loose Brown and dark brown Moist to wet
92.5 2.6	SAND Loose Brown Moist to wet
91.7 3.2	SAND and GRAVEL, some silt Very loose to dense Dark brown to brown Wet to moist
90.9	Stratified SAND Compact Brown Moist
90.5 4.4	SAND and GRAVEL, some silt Dense Brown Moist
	Granite (BEDROCK) Moderately weathered Pink, grey, white and green Coarse grained Medium strong *- Highly fractured zones from 4.3 m to 4.7 m, 5.7 m to 5.8 m, and 6.1 m to 7.3 m depths*
87.6 7.3	End of Borehole Note: Water level in open borehole at 4.1 m depth (Elev. 90.8 m) upon completion of drilling on Sept. 3, 2008.

SAMPLES

NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
1	SS	14					
2	SS	17		0	35	48	17
3	SS	3					
4	SS	33		40	43	15	2
5	SS	35	▽	36	43	19	2
6	NQ RC	REC 96%		RQD = 44%			
7	NQ RC	REC 95%		RQD = 53%			
8	NQ RC	REC 100%		RQD = 20%			



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

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

RECORD OF BOREHOLE No 08-701

1 OF 1 **METRIC**

PROJECT 07-1121-0151
W.P. 255-98-00
LOCATION N 5016934.5; E 348610.4
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. 5, 2008
CHECKED BY S.A.T.

SOIL PROFILE			SAMPLES					DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%) 25 50 75	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE				
105.1	GROUND SURFACE										
0.0	Topsoil (FILL)						105				
	Sandy silt (Fill) Dark brown										
0.4	Crystalline Limestone with shale interbeds (BEDROCK) Slightly weathered to fresh Light grey to grey Laminated to medium bedded Medium strong *- Highly fractured zones from 0.4 m to 0.7 m and 3.4 m to 3.5 m depth*		1	NQ RC	REC 100%						RQD = 0%
			2	NQ RC	REC 100%	▽	104				RQD = 19%
			3	NQ RC	REC 100%		103				RQD = 76%
			4	NQ RC	REC 100%		102				RQD = 71%
101.6 3.5	End of Borehole Note: Water level in open borehole at 1.2 m depth (Elev. 103.9 m) upon completion of drilling on Aug. 5, 2008.										

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

RECORD OF BOREHOLE No 08-702

1 OF 1 **METRIC**

PROJECT	07-1121-0151				
W.P.	255-98-00	LOCATION	N 5018902.5; E 351338.8	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 18, 2008	CHECKED BY	S.A.T.

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100

PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L; WATER CONTENT (%) 25 50 75

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE / SHEAR STRENGTH	WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
99.7	GROUND SURFACE										
0.0	TOPSOIL										
	Silty SAND, some gravel Brown										
0.4	Sandstone (BEDROCK) Slightly weathered to fresh Light grey to brown with dark grey zones Laminated to thickly bedded Medium strong		1	NQ RC	REC 93%		99				RQD = 27%
	- Highly fractured at 0.4 m depth		2	NQ RC	REC 100%	∇	98 97				RQD = 92%
			3	NQ RC	REC 100%						RQD = 100%
96.0 3.7	End of Borehole Note: Water level in open borehole at 2.2 m depth (Elev. 97.5 m) upon completion of drilling on July 18, 2008.						96				

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

RECORD OF BOREHOLE No 08-703

1 OF 1 **METRIC**

PROJECT 07-1121-0151
W.P. 255-98-00
LOCATION N 5021719.0; E 355474.7
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. 9, 2008
CHECKED BY S.A.T.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	WATER CONTENT (%) 25 50 75	γ kN/m³	GR	SA	SI	CL
86.2	GROUND SURFACE													
0.0	Crushed stone (FILL) Grey						86							
			1	SS	38									
85.1 1.1	Sandstone ROCKFILL Loose to dense Light brown Moist						85							
			2	SS	26									
							84							
			3	SS	16									
			4	SS	40		83							
			5	SS	11									
							82							
			6	SS	8									
							81							
			7	SS	25									
							80							
			8	SS	10									
			9	SS	22									
79.0 7.2	End of Borehole Note: Open borehole dry upon completion of drilling on Aug. 9, 2008.													

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

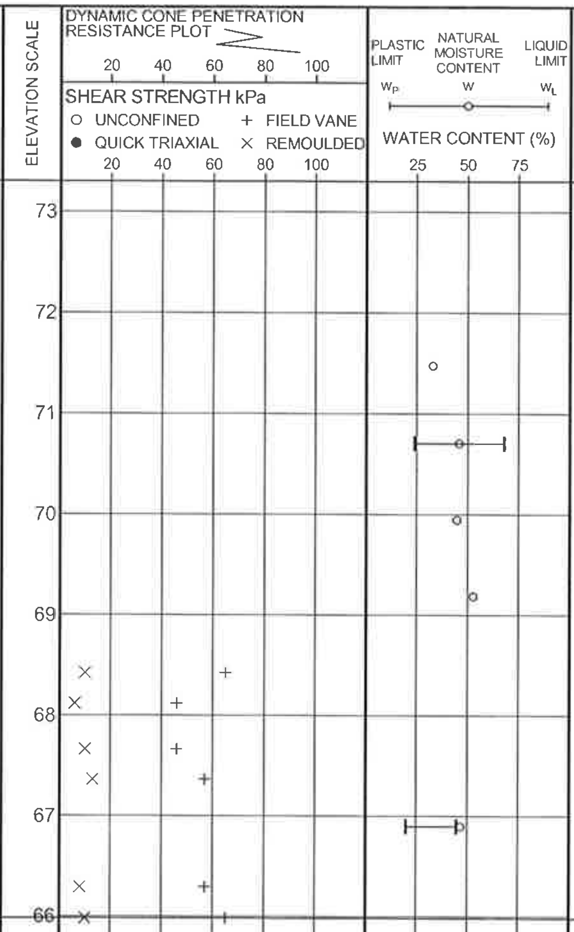
RECORD OF BOREHOLE No 08-704

1 OF 1 **METRIC**

PROJECT 07-1121-0151
W.P. 255-98-00
DIST Eastern HWY 417
DATUM Geodetic
LOCATION N 5021970.6; E 355906.9
BOREHOLE TYPE Power Auger 108mm I.D. Hollow Stem
DATE Aug. 9, 2008
ORIGINATED BY D.J.S.
COMPILED BY J.M.
CHECKED BY S.A.T.

ELEV DEPTH	DESCRIPTION
73.3	GROUND SURFACE
0.0	Crushed stone (FILL) Compact Grey Moist
72.3 1.2	Sand and gravel (FILL) Compact Brown Moist
	SILTY CLAY to CLAY (Weathered Crust) Very stiff to stiff Grey-brown Moist to wet
68.4 4.9	SILTY CLAY, occasional very thin silt seams Firm to stiff Grey Wet
66.0 7.3	End of Borehole

NUMBER	TYPE	"N" VALUES	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
1	SS	19				
2	SS	8	0	1	49	50
3	SS	5				
4	SS	6				
5	SS	1				
6	SS	WH				



UNIT WEIGHT γ kN/m³

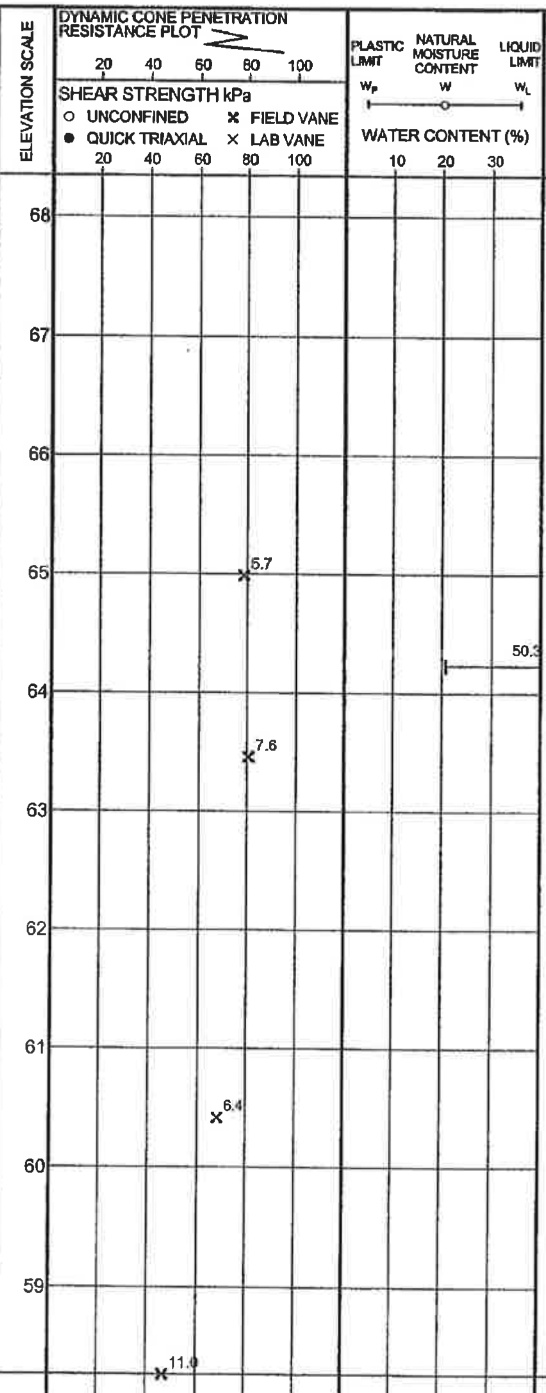
+ 3, × 3: Numbers refer to Sensitivity   O 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 06-33

1 OF 1 **METRIC**

W.P. GWP 302-89-00
LOCATION Highway 417 - Eagleson Road to Moodie Drive
ORIGINATED BY JF
DIST 42 HWY 417
BOREHOLE TYPE HS Augers, Split Spoons
COMPILED BY JF
DATUM Geodetic
DATE 24.01.06 - 24.01.06
CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
68.3	Grass										
68.2 0.1	100 mm TOPSOIL Silty CLAY, stiff, greyish brown (CH)						68				
			1	SS	11		67				
			2	SS	7	▼					
			3	SS	2		66				
64.8 3.5	Silty CLAY, firm to stiff, grey (CH)						65	✕ 5.7			
			4	SS	1		64		50.3		
							63	✕ 7.6			
			5	SS	2		62				
							61				
							60	✕ 6.4			
			6	SS	1		59				
58.3 10.1	End of Borehole Standpipe Installed							✕ 11.0			



+ ³, × ³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 02-601

1 OF 1 **METRIC**

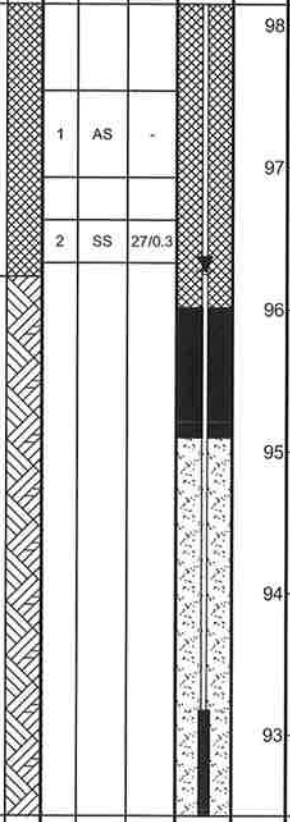
PROJECT 021-1155-5100
W.P. 4254-05-01
DIST 9 HWY 417
DATUM Geodetic

LOCATION N 5021367.4 ;E 354881.0
BOREHOLE TYPE CME 55 Bombardier
DATE December 05, 2002

ORIGINATED BY PAH
COMPILED BY CN
CHECKED BY JPD

SOIL PROFILE		SAMPLES		
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES
98.2	Ground Surface			
0.0	Sandstone slabs, cobbles and boulders, containing sand and gravel (ROCK FILL) Very dense Brown Moist			
		1	AS	-
		2	SS	27/0.3
96.2 1.9	Sandstone (BEDROCK) Fresh Thinly-bedded Medium-grained Light grey with some brown stained seams Bedrock cored between 1.9 m and 5.7 m depth. For bedrock coring details refer to Record of Drillhole 02-601			
92.4 5.7	End of Borehole Note: Water level in piezometer at 1.9 m depth (Elevation 96.3 m) on January 8, 2003			

STRAT PLOT / GROUND WATER CONDITIONS / ELEVATION SCALE



DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH kPa
O UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED
20 40 60 80 100

PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L

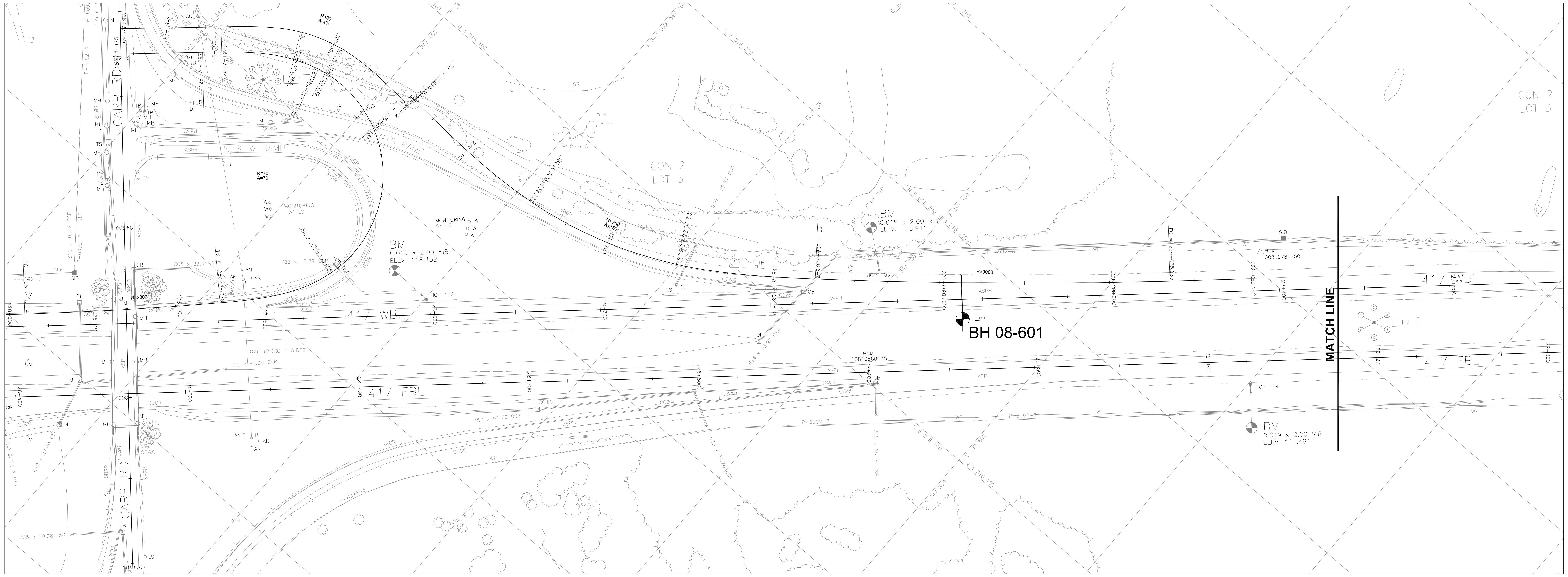
WATER CONTENT (%)
25 50 75

UNIT WEIGHT γ kN/m³

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

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

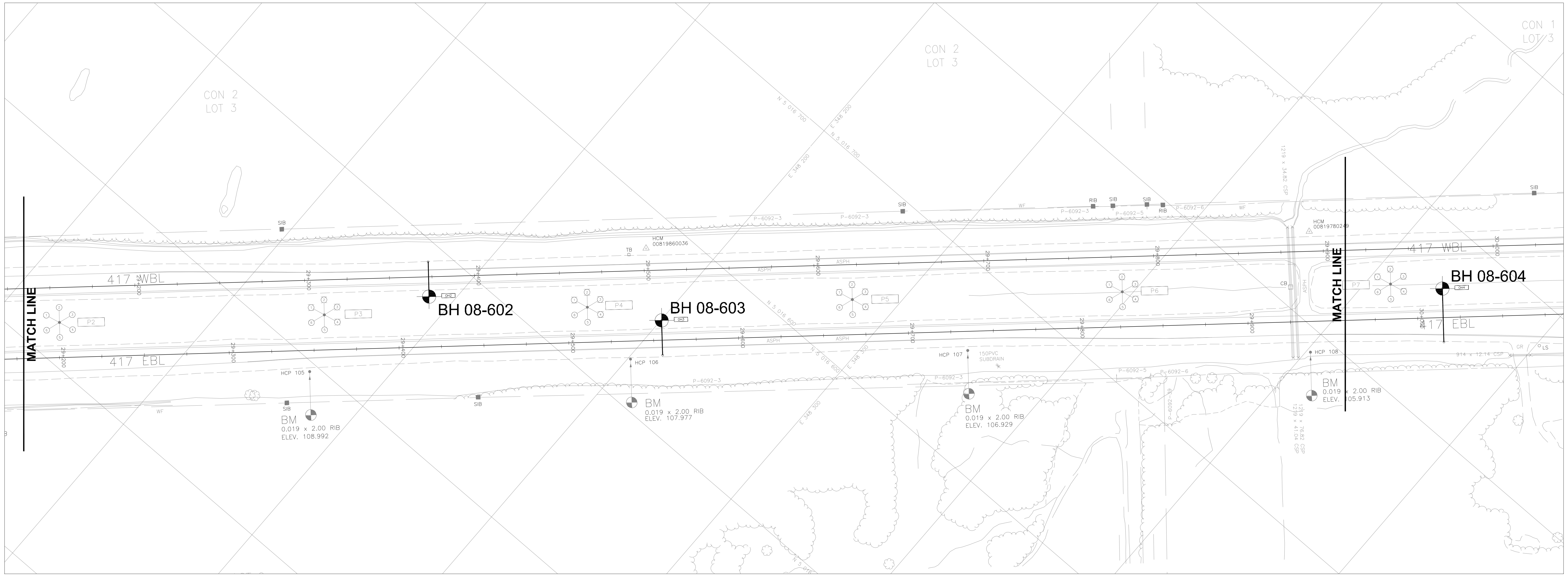
MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

30 0 30 60
SCALE METRES

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



PLAN

30 0 30 60
SCALE METRES

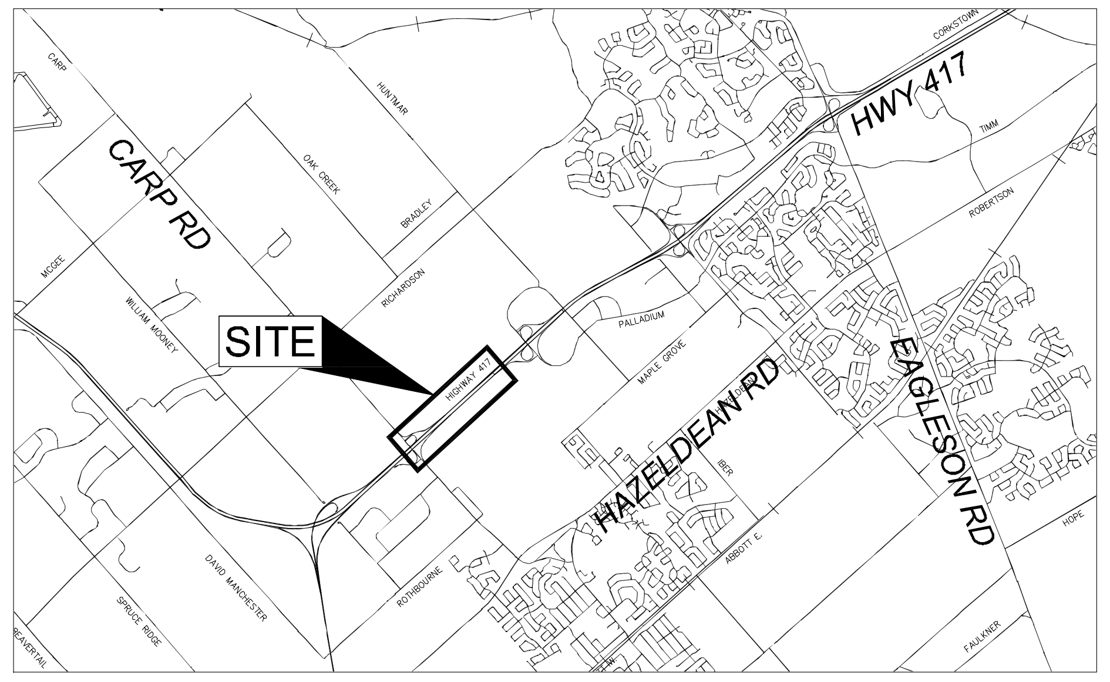
REFERENCE
Base plan supplied by the McCormick Rankin Corporation

WP No. 255-98-00

SHEET 1

HWY 417 EXPANSION
TRICHORD OVERHEAD SIGNS, CANTILEVER SIGNS
AND ATMS OVERHEAD CHANGEABLE MESSAGE SIGN
BOREHOLE LOCATIONS

Golder Associates Ltd.
OTTAWA, ONTARIO, CANADA



KEY PLAN

2 0 2 4
SCALE KM

LEGEND

◑ Borehole – Current Golder Associates Ltd. Investigation

● Borehole – Previous MTO Investigation Geocres No. 31G5–205

⌖ Borehole – Previous MTO Investigation Geocres No. 31G5–198

No.	ELEVATION	CO–ORDINATES	
		NORTHING	EASTING
08–601	113.6	5016164.5	347747.6
08–602	108.3	5016474.4	348087.5
08–603	107.5	5016553.1	348200.4
08–604	105.6	5016867.1	348536.6
08–605	100.6	5017580.9	349303.4
08–606	97.8	5017866.4	349661.0
08–607	93.9	5018117.8	350133.1
08–608	96.1	5018333.0	350539.7
08–609	99.7	5018896.8	351321.7
08–610	92.4	5019262.0	351746.1
08–611	94.9	5019806.7	352379.0
08–701	105.1	5016934.5	348610.4
08–702	99.7	5018902.5	351338.8
08–703	86.2	5021719.0	355474.7
08–704	73.3	5021970.6	355906.9
06–33	67.8	5022231.9	356362.8
02–601	98.2	5021367.4	354881.0

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. 31G5–226

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. F.J.H.	DWG. 1

PLOT DATE: September 02, 2009
FILENAME: N:\Active\2007\1121 – Geotechnical\07–1121–0151 MRC Hwy 417 Ottawa\ACAD\Phase 4000 (OHS)\071121015 1–4000–01.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

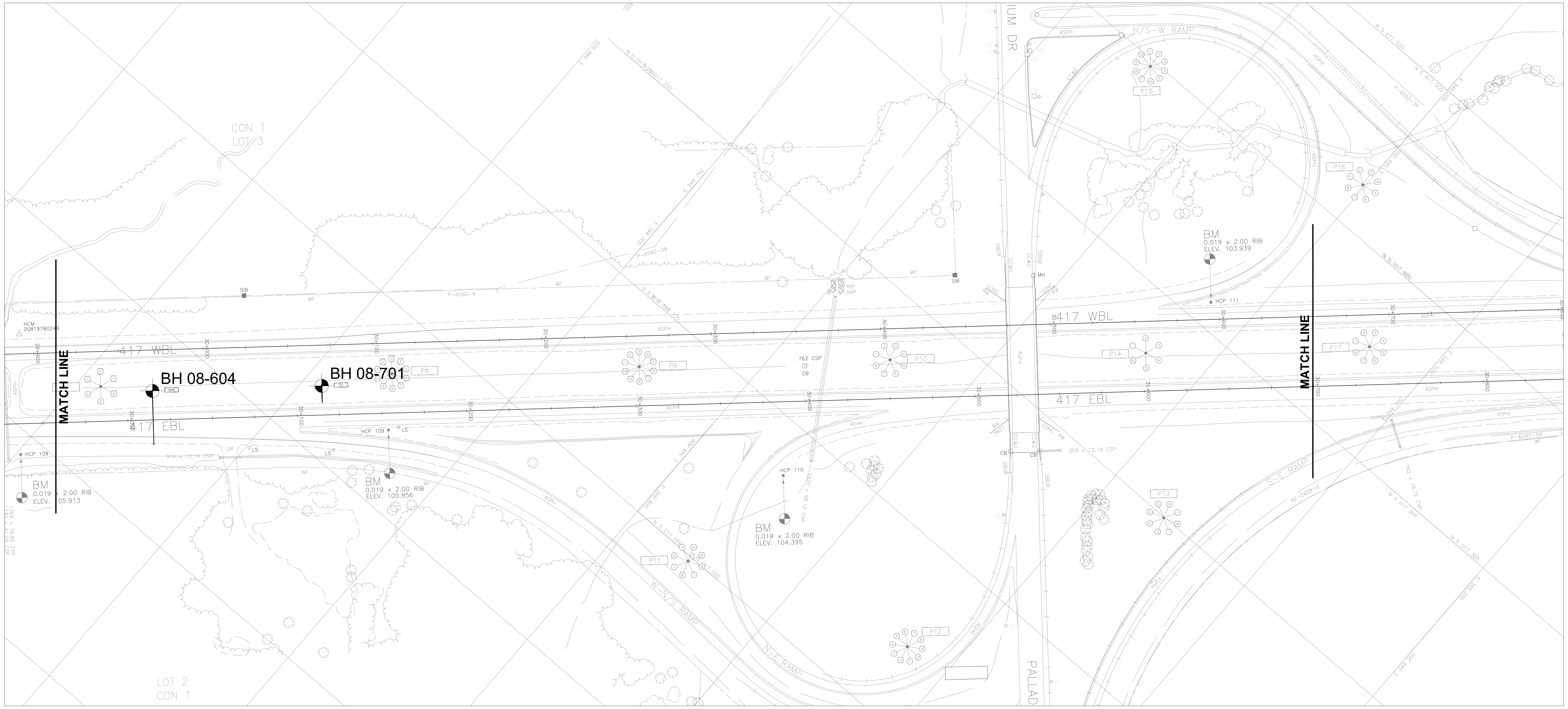
WP No. 255-98-00

SHEET 1

HWY 417 EXPANSION

TRICHORD OVERHEAD SIGNS, CANTILEVER SIGNS
AND ATMS OVERHEAD CHANGEABLE MESSAGE SIGN
BOREHOLE LOCATIONS

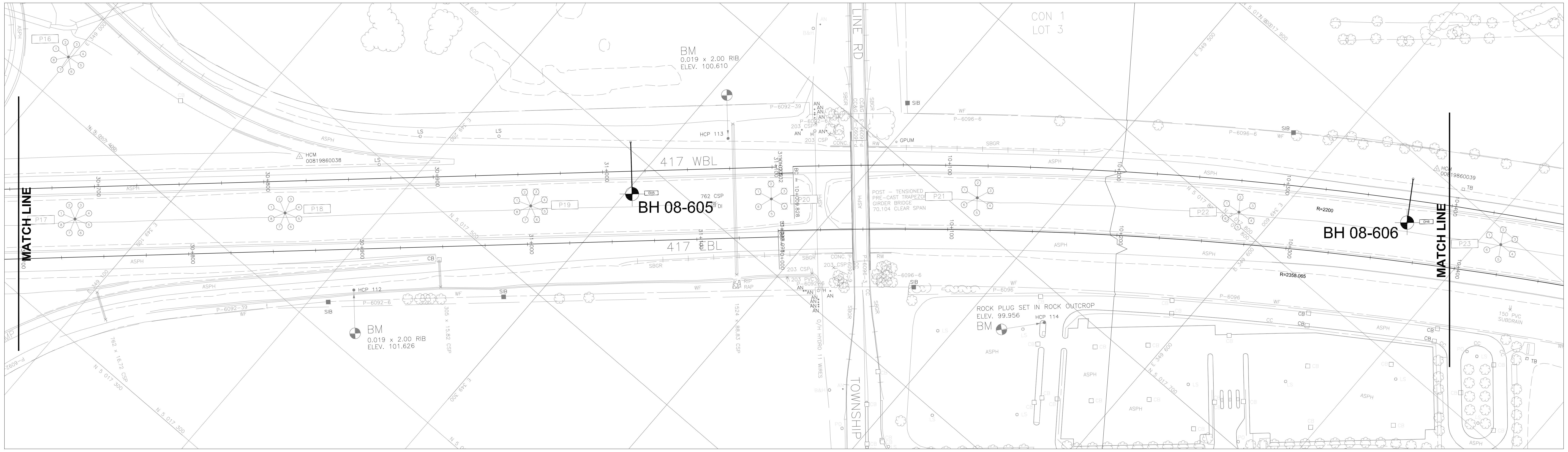
Golder Associates Ltd.
OTTAWA, ONTARIO, CANADA



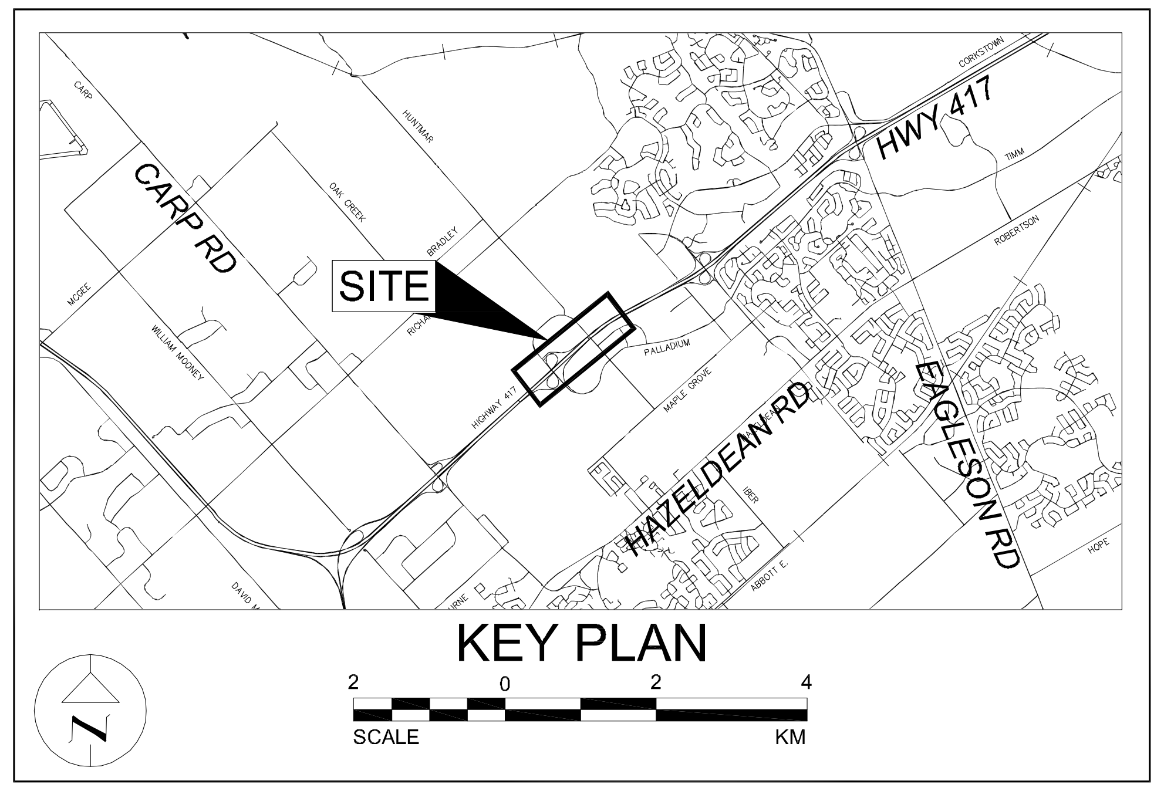
PLAN

METRIC

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



PLAN



KEY PLAN

LEGEND

◐	Borehole – Current Golder Associates Ltd. Investigation
●	Borehole – Previous MTO Investigation Geocres No. 31G5–205
⊕	Borehole – Previous MTO Investigation Geocres No. 31G5–198

No.	ELEVATION	CO–ORDINATES	
		NORTHING	EASTING
08–601	113.6	5016164.5	347747.6
08–602	108.3	5016474.4	348087.5
08–603	107.5	5016553.1	348200.4
08–604	105.6	5016867.1	348536.6
08–605	100.6	5017580.9	349303.4
08–606	97.8	5017866.4	349661.0
08–607	93.9	5018117.8	350133.1
08–608	96.1	5018333.0	350539.7
08–609	99.7	5018896.8	351321.7
08–610	92.4	5019262.0	351746.1
08–611	94.9	5019806.7	352379.0
08–701	105.1	5016934.5	348610.4
08–702	99.7	5018902.5	351338.8
08–703	86.2	5021719.0	355474.7
08–704	73.3	5021970.6	355906.9
06–33	67.8	5022231.9	356362.8
02–601	98.2	5021367.4	354881.0

NOTES

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REFERENCE

Base plan supplied by the McCormick Rankin Corporation

NO.	DATE	BY	REVISION

Geocres No. 31G5–226

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. F.J.H.	DWG. 2

PLOT DATE: September 02, 2009

MINISTRY OF TRANSPORTATION, ONTARIO

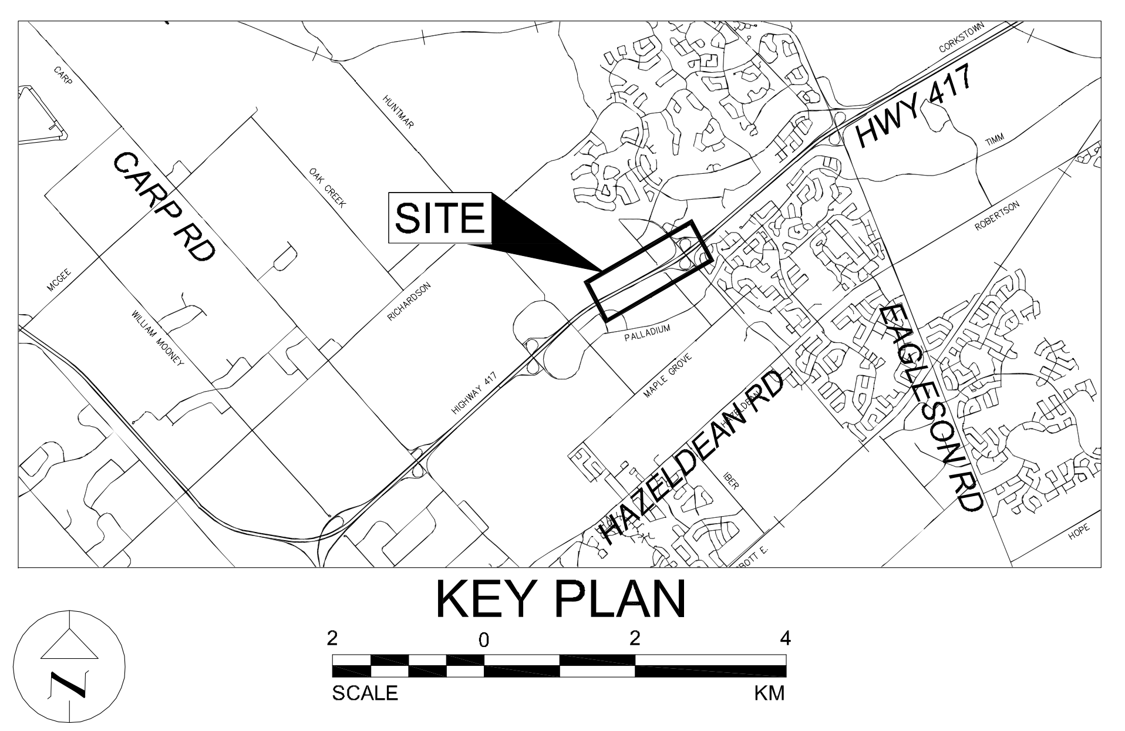
WP No. 255-98-00

SHEET 1

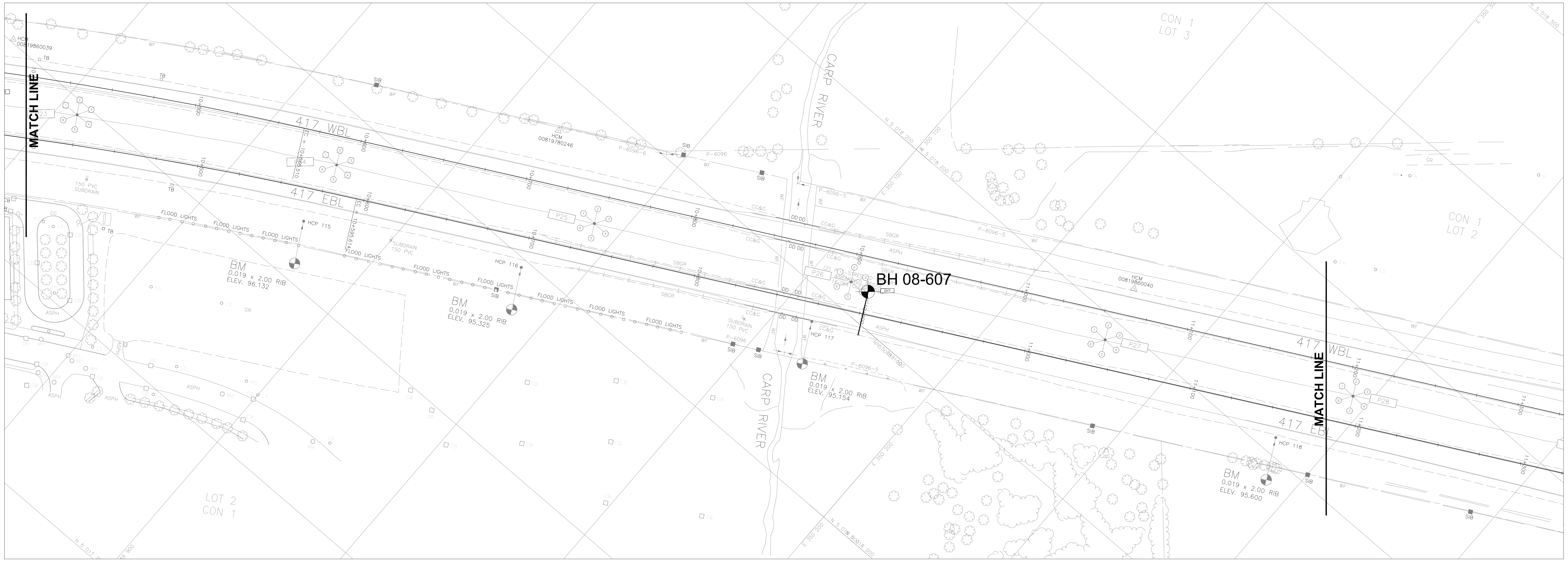
HWY 417 EXPANSION

TRICHORD OVERHEAD SIGNS, CANTILEVER SIGNS
AND ATMS OVERHEAD CHANGEABLE MESSAGE SIGN
BOREHOLE LOCATIONS

Golder Associates Ltd.
OTTAWA, ONTARIO, CANADA



KEY PLAN

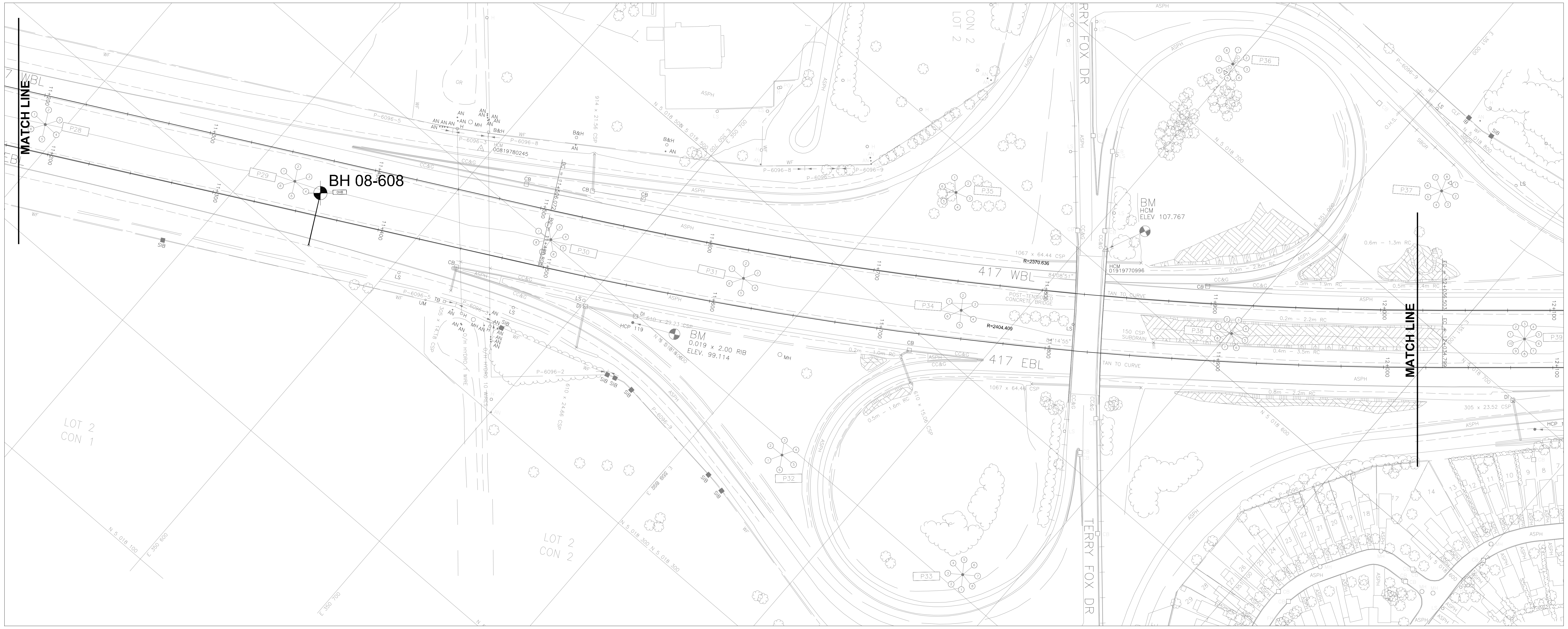


PLAN

30 0 30 60
SCALE METRES

METRIC

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



PLAN

30 0 30 60
SCALE METRES

REFERENCE

Base plan supplied by the McCormick Rankin Corporation

LEGEND

◐	Borehole – Current Golder Associates Ltd. Investigation
●	Borehole – Previous MTO Investigation Geocres No. 31G5–205
⌖	Borehole – Previous MTO Investigation Geocres No. 31G5–198

No.	ELEVATION	CO–ORDINATES	
		NORTHING	EASTING
08–601	113.6	5016164.5	347747.6
08–602	108.3	5016474.4	348087.5
08–603	107.5	5016553.1	348200.4
08–604	105.6	5016867.1	348536.6
08–605	100.6	5017580.9	349303.4
08–606	97.8	5017866.4	349661.0
08–607	93.9	5018117.8	350133.1
08–608	96.1	5018333.0	350539.7
08–609	99.7	5018896.8	351321.7
08–610	92.4	5019262.0	351746.1
08–611	94.9	5019806.7	352379.0
08–701	105.1	5016934.5	348610.4
08–702	99.7	5018902.5	351338.8
08–703	86.2	5021719.0	355474.7
08–704	73.3	5021970.6	355906.9
06–33	67.8	5022231.9	356362.8
02–601	98.2	5021367.4	354881.0

NOTES

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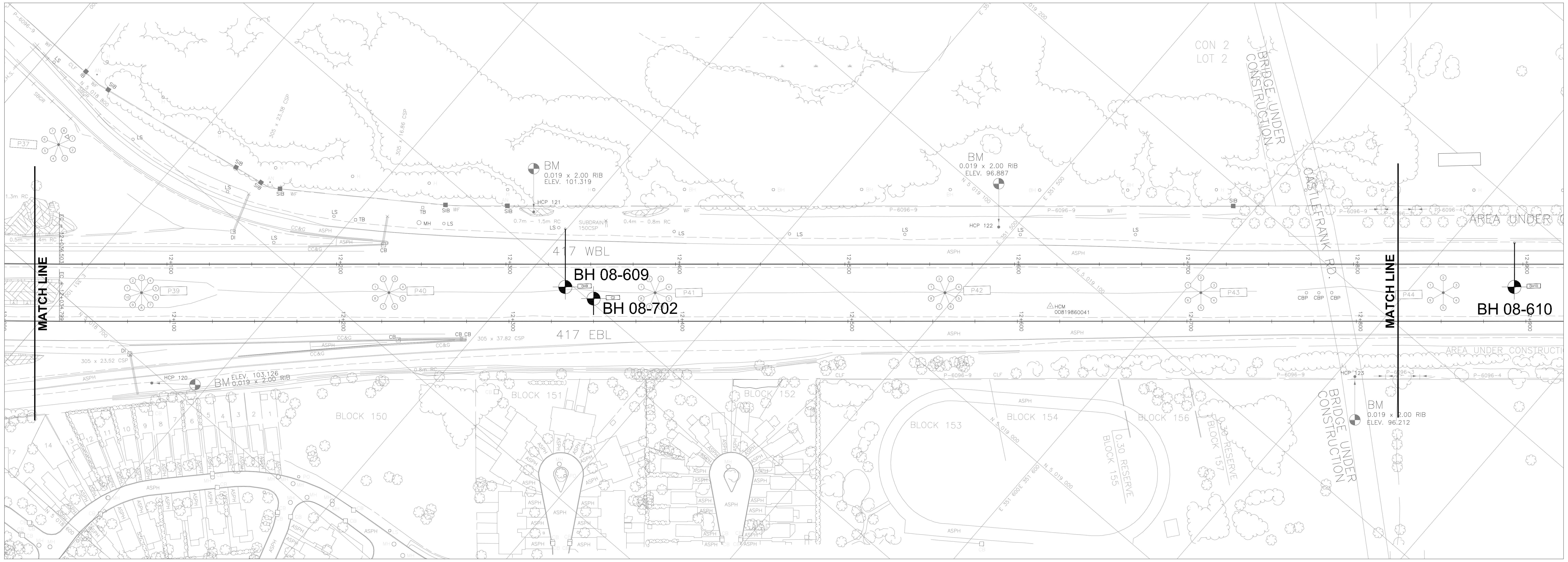
NO.	DATE	BY	REVISION

Geocres No. 31G5–226

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. F.J.H.	DWG. 3

PLOT DATE: September 02, 2009
FILENAME: N:\Active\2007\1121 - Geotechnical\07-1121-0151 MRC Hwy 417 Ottawa\ACAD\Phase 4000 (OHS)\0711210151-4000-01.dwg

MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

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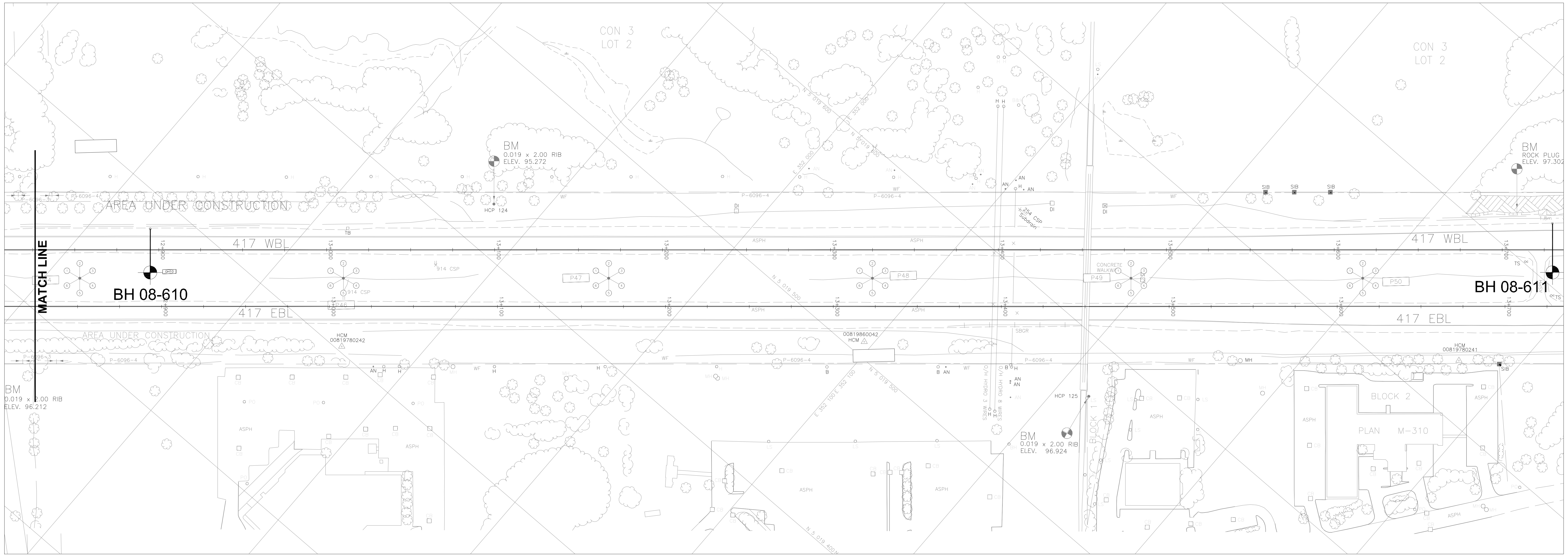
SCALE METRES



PLAN

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SCALE METRES

METRIC

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

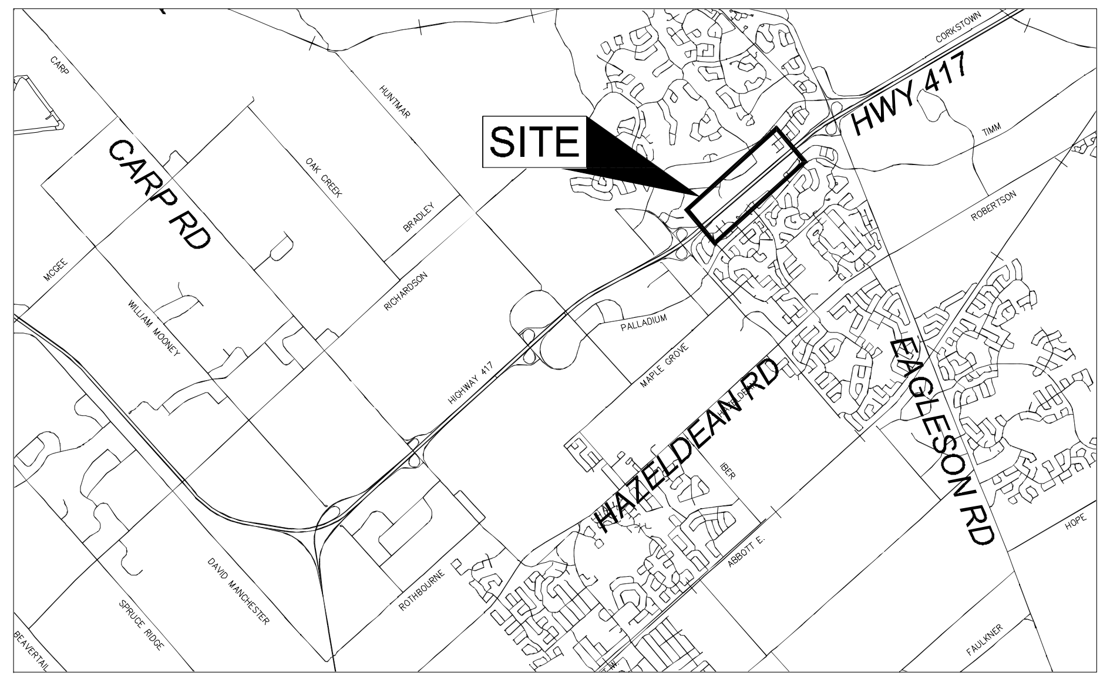
WP No. 255-98-00

SHEET
1

HWY 417 EXPANSION
TRICHORD OVERHEAD SIGNS, CANTILEVER SIGNS
AND ATMS OVERHEAD CHANGEABLE MESSAGE SIGN
BOREHOLE LOCATIONS

Golder Associates

Golder Associates Ltd.
OTTAWA, ONTARIO, CANADA



KEY PLAN

2 0 2 4
SCALE KM

LEGEND

◐	Borehole – Current Golder Associates Ltd. Investigation
●	Borehole – Previous MTO Investigation Geocres No. 31G5–205
⊕	Borehole – Previous MTO Investigation Geocres No. 31G5–198

No.	ELEVATION	CO–ORDINATES	
		NORTHING	EASTING
08–601	113.6	5016164.5	347747.6
08–602	108.3	5016474.4	348087.5
08–603	107.5	5016553.1	348200.4
08–604	105.6	5016867.1	348536.6
08–605	100.6	5017580.9	349303.4
08–606	97.8	5017866.4	349661.0
08–607	93.9	5018117.8	350133.1
08–608	96.1	5018333.0	350539.7
08–609	99.7	5018896.8	351321.7
08–610	92.4	5019262.0	351746.1
08–611	94.9	5019806.7	352379.0
08–701	105.1	5016934.5	348610.4
08–702	99.7	5018902.5	351338.8
08–703	86.2	5021719.0	355474.7
08–704	73.3	5021970.6	355906.9
06–33	67.8	5022231.9	356362.8
02–601	98.2	5021367.4	354881.0

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

REFERENCE

Base plan supplied by the McCormick Rankin Corporation

PLOT DATE: September 02, 2009
FILENAME: N:\Active\2007\1121 – Geotechnical\07–1121–0151 MRC Hwy 417 Ottawa\ACAD\Phase 4000 (OHS)\071121015 1–4000–01.dwg

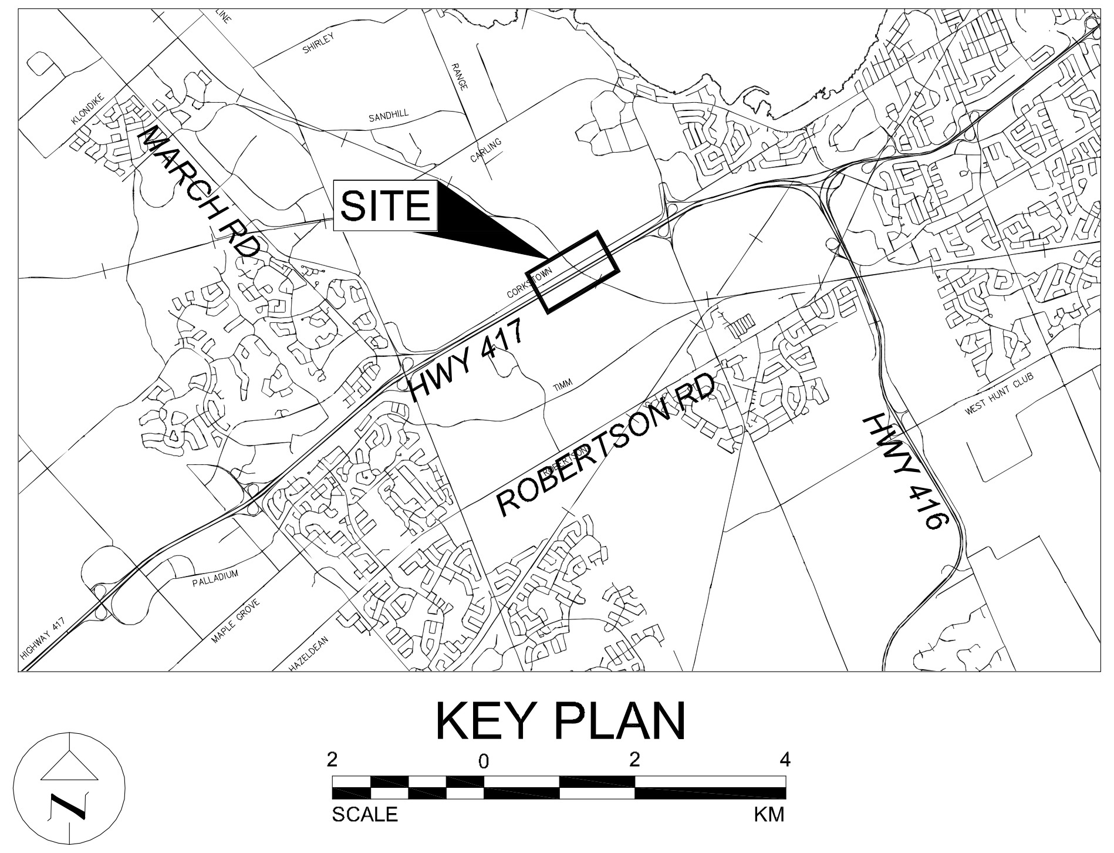
WP No. 255-98-00

HWY 417 EXPANSION

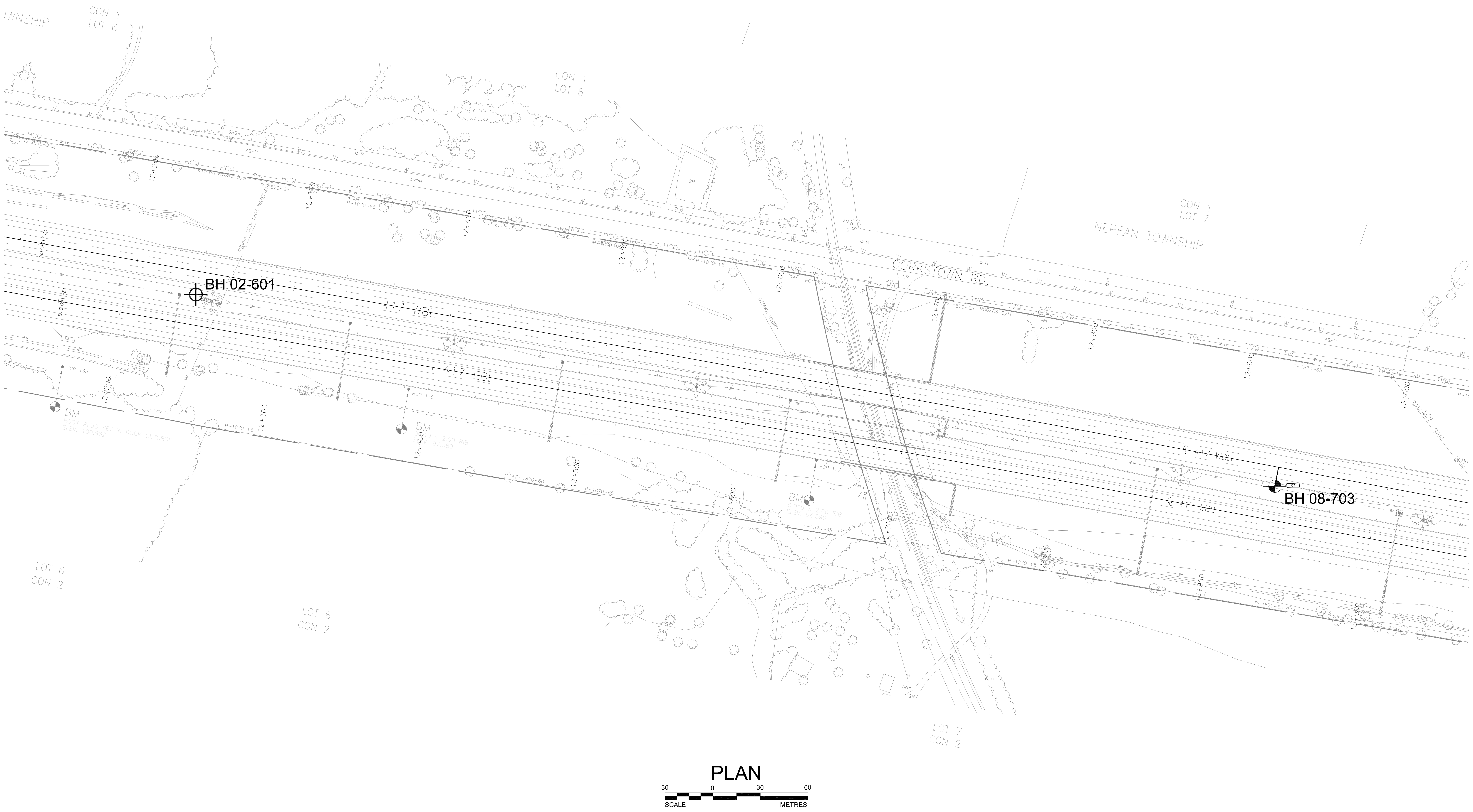
TRICHORD OVERHEAD SIGNS, CANTILEVER SIGNS
AND ATMS OVERHEAD CHANGEABLE MESSAGE SIGN
BOREHOLE LOCATIONS

SHEET
1

Golder Associates Ltd.
OTTAWA, ONTARIO, CANADA



KEY PLAN



PLAN

LEGEND

⊕	Borehole – Current Golder Associates Ltd. Investigation
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08-605	100.6	5017580.9	349303.4
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08-607	93.9	5018117.8	350133.1
08-608	96.1	5018333.0	350539.7
08-609	99.7	5018896.8	351321.7
08-610	92.4	5019262.0	351746.1
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STATIONS IN KILOMETRES + METRES

REFERENCE

Base plan supplied by the McCormick Rankin Corporation

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DRAWN: J.M.	CHKD. L.C.C.	APPD. F.J.H.	DWG. 5

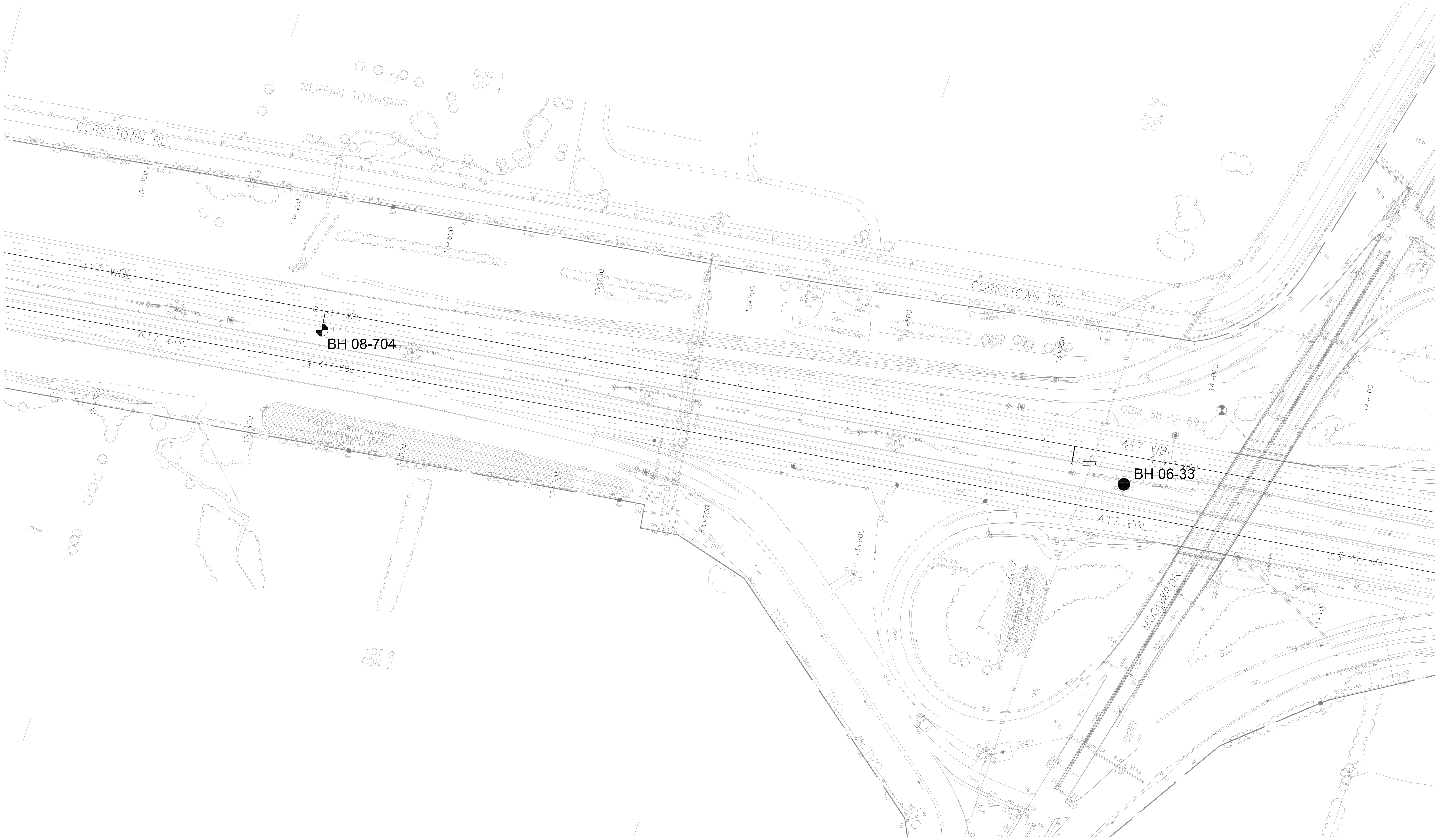
MINISTRY OF TRANSPORTATION, ONTARIO

WP No. 255-98-00

HWY 417 EXPANSION
TRICHORD OVERHEAD SIGNS, CANTILEVER SIGNS
AND ATMS OVERHEAD CHANGEABLE MESSAGE SIGN
BOREHOLE LOCATIONS

SHEET
1

Golder Associates Ltd.
OTTAWA, ONTARIO, CANADA



PLAN

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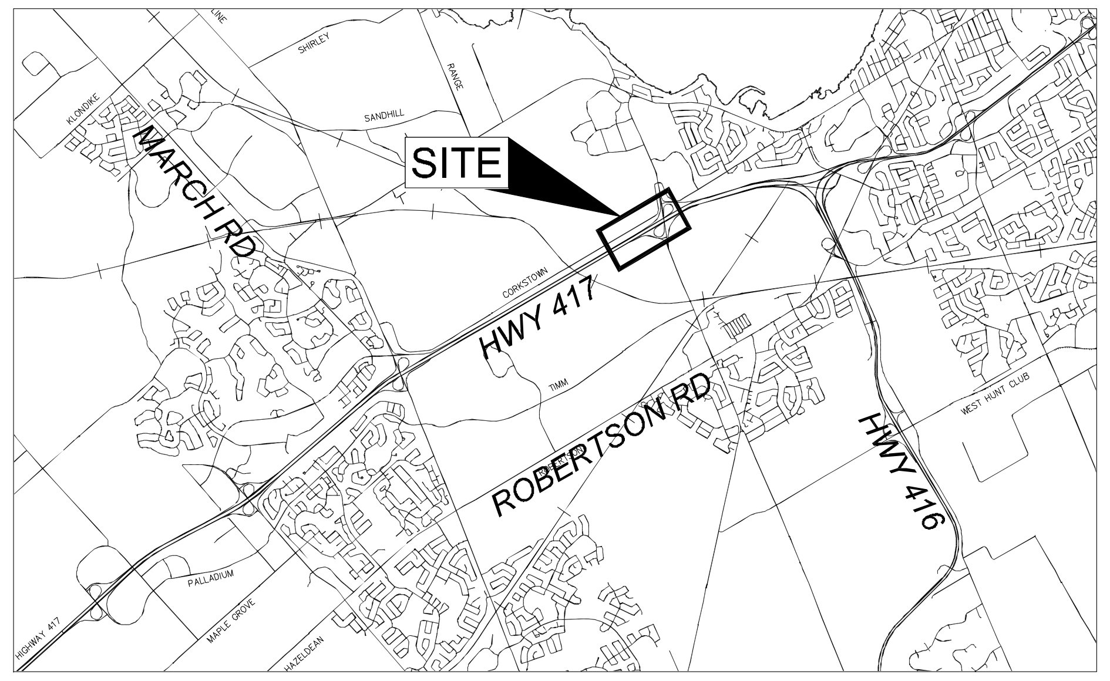
SCALE METRES



KEY PLAN

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LEGEND

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REFERENCE
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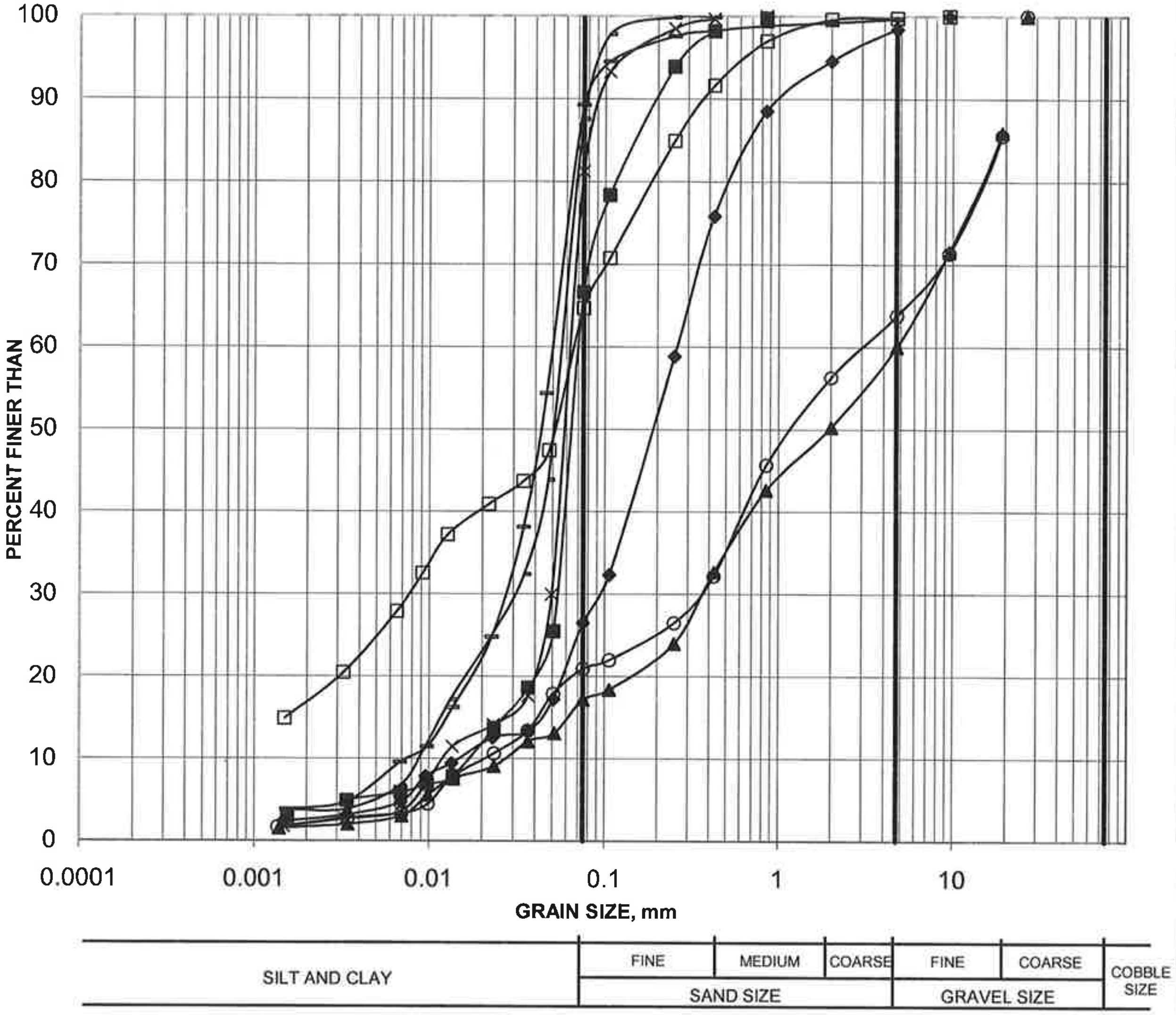
FILENAME: N:\Active\2007\1121 – Geotechnical\07–1121–0151 MRC Hwy 417 Ottawa\ACAD\Phase 4000 (OHS)\0711210151–4000–01.dwg

GRAIN SIZE DISTRIBUTION

FIGURE 1

Sands and Silts



	Borehole	Sample	Depth (m)
■	08-602	2	1.52-2.13
×	08-603	4	3.05-3.66
–	08-604	2	1.52-2.13
–	08-604	4	3.05-3.66
◆	08-607	2	1.52-2.13
□	08-611	2	1.37-1.98
▲	08-611	4	2.90-3.51
○	08-611	5	3.66-4.27

Project: 0711210151

Golder Associates

25-Aug-09

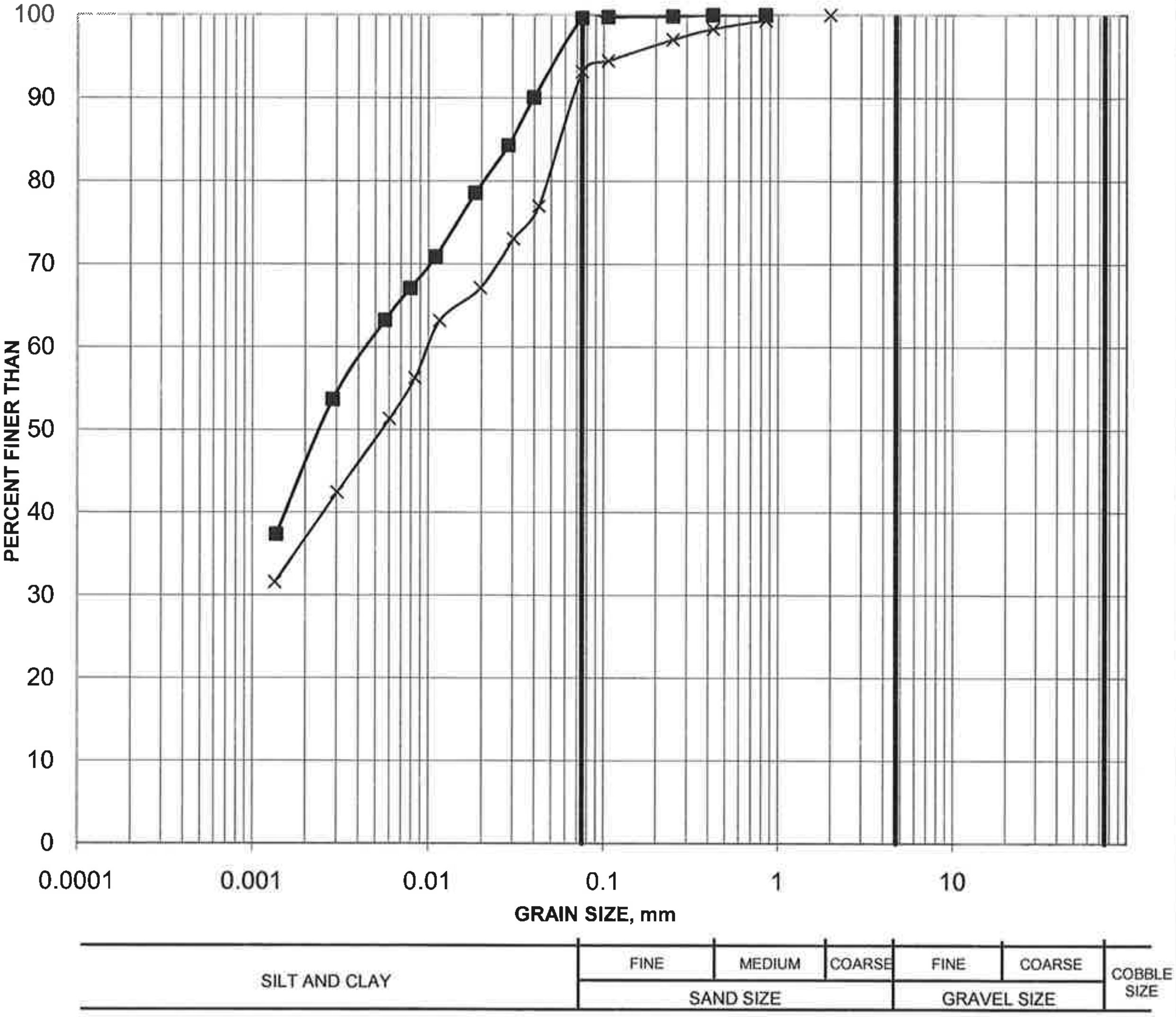
Created by: MI

Checked by: CMM

GRAIN SIZE DISTRIBUTION

FIGURE 2

Weathered Silty Clay to Clay



Borehole	Sample	Depth (m)
—■— 08-605	4	4.57-5.18
—×— 08-608	1	0.76-1.37

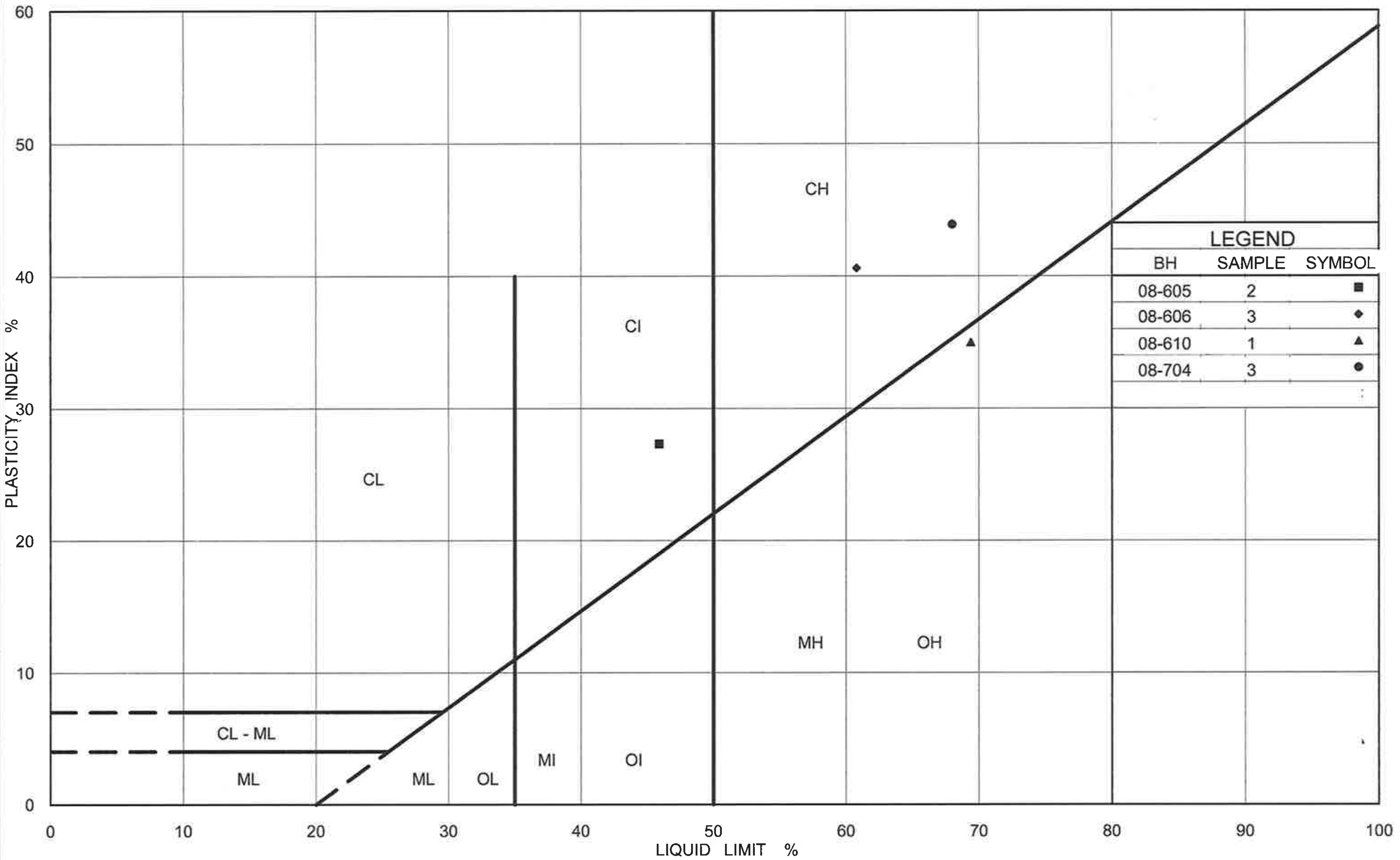
Project: 0711210151

Golder Associates

25-Aug-09

Created by: MI
Checked by: CMM

Oct 75, FF-S-21



BH	SAMPLE	SYMBOL
08-605	2	■
08-606	3	◆
08-610	1	▲
08-704	3	●

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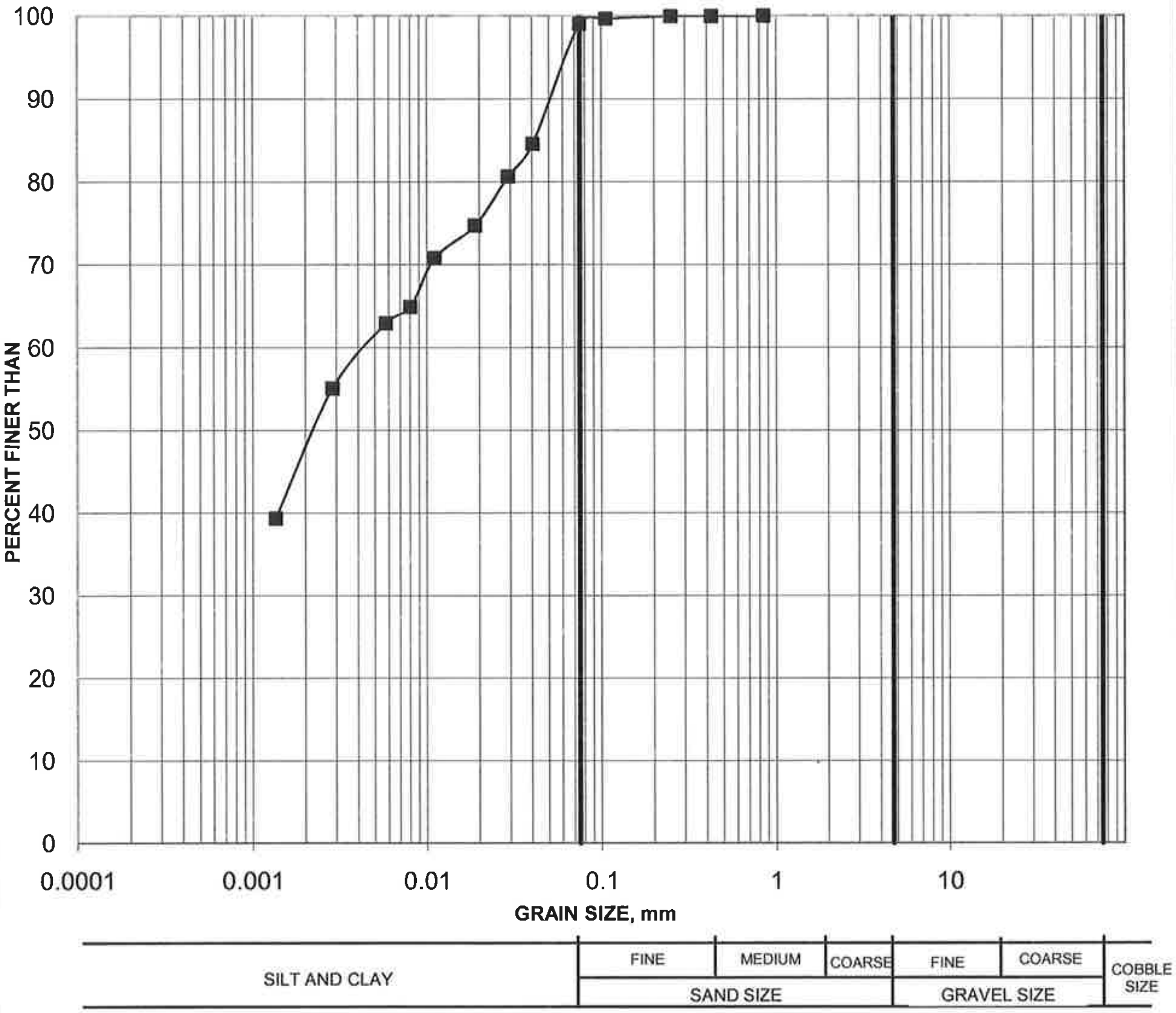
PLASTICITY CHART
Weathered Silty Clay to Clay

FIG No. 3

Project No. 07-1121-0151-06

GRAIN SIZE DISTRIBUTION	FIGURE 4

Unweathered Silty Clay to Clay

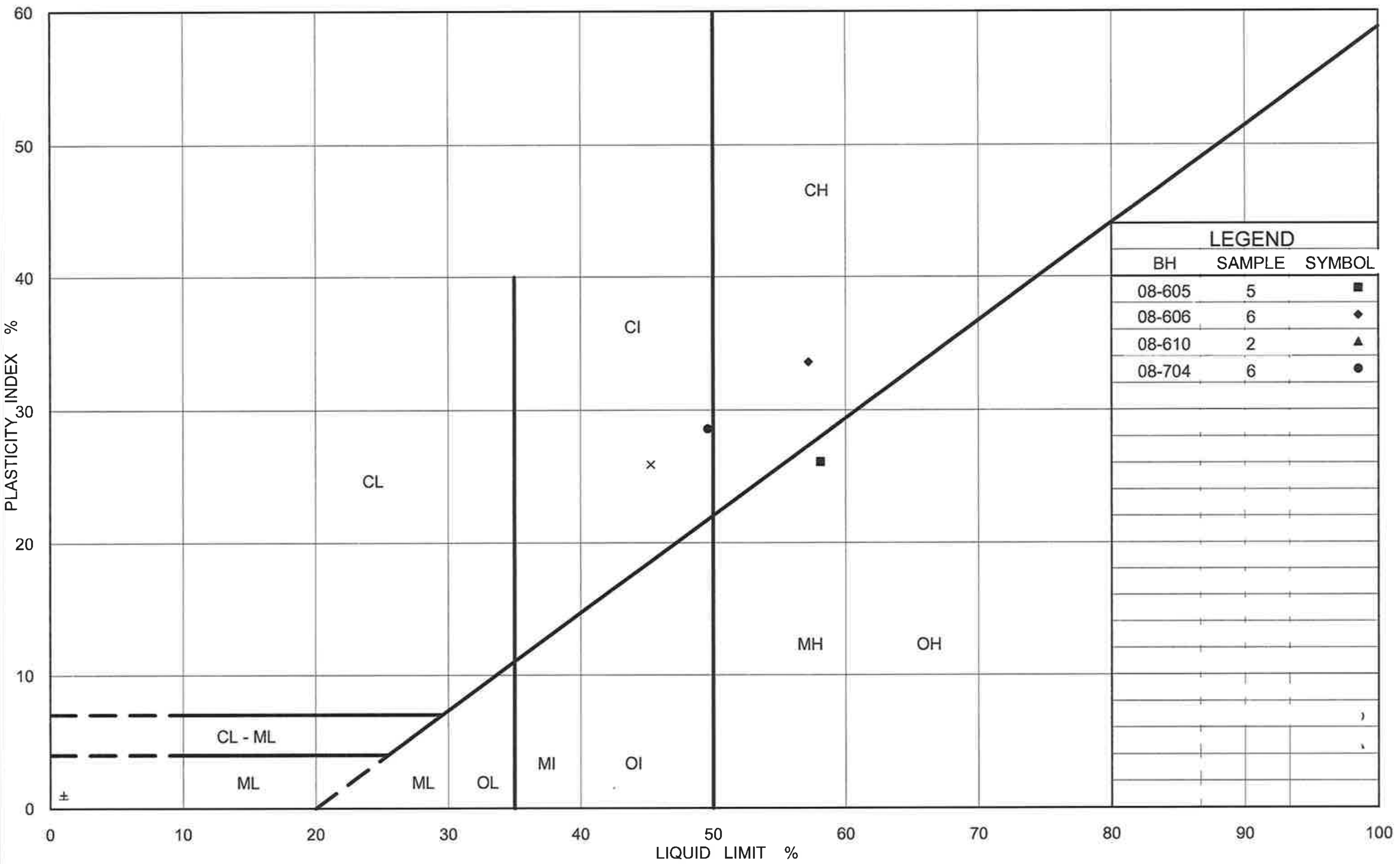


	Borehole	Sample	Depth (m)
■	08-606	5	4.57-5.18

Project: 07-1121-0151 **Golder Associates** 25-Aug-09

Created by:	MI
Checked by:	CMM

Oct 75, FF-S-21



LEGEND		
BH	SAMPLE	SYMBOL
08-605	5	■
08-606	6	◆
08-610	2	▲
08-704	6	●

Ministry of Transportation

Ontario

PLASTICITY CHART
Unweathered Silty Clay to Clay

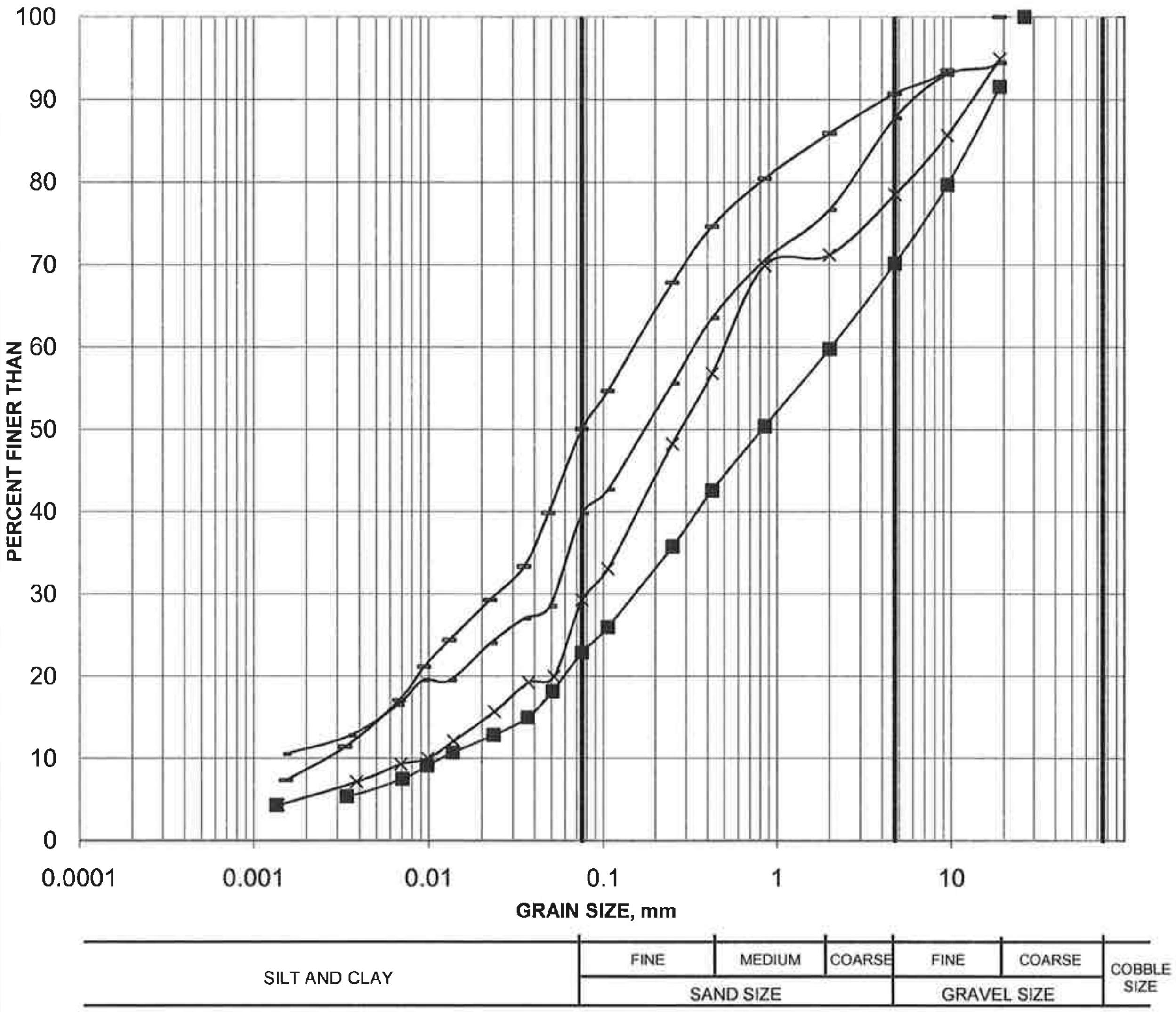
FIG No. 5

Project No. 07-1121-0151-06

GRAIN SIZE DISTRIBUTION

FIGURE 6

Sand to Silty Sand Till



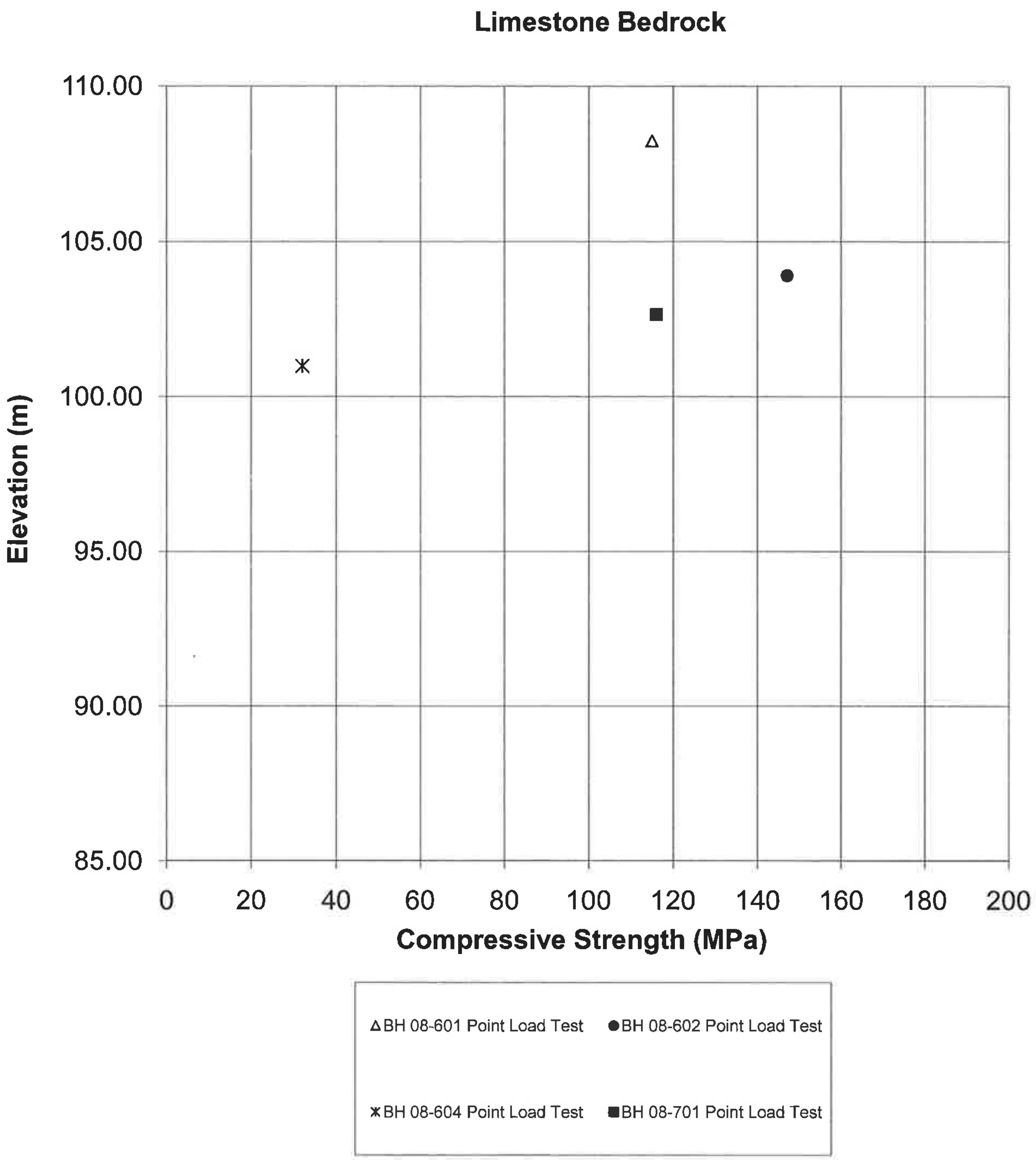
Borehole	Sample	Depth (m)
—■— 08-601	6	4.57-5.18
—×— 08-603	5	3.81-4.42
—-— 08-603	8	5.95-6.40
—▬— 08-610	4	3.81-4.42

Project: 0711210151 **Golder Associates** 25-Aug-09

Created by:	MI
Checked by:	CMM

SUMMARY OF LABORATORY COMPRESSIVE STRENGTH MEASUREMENTS

FIGURE 7



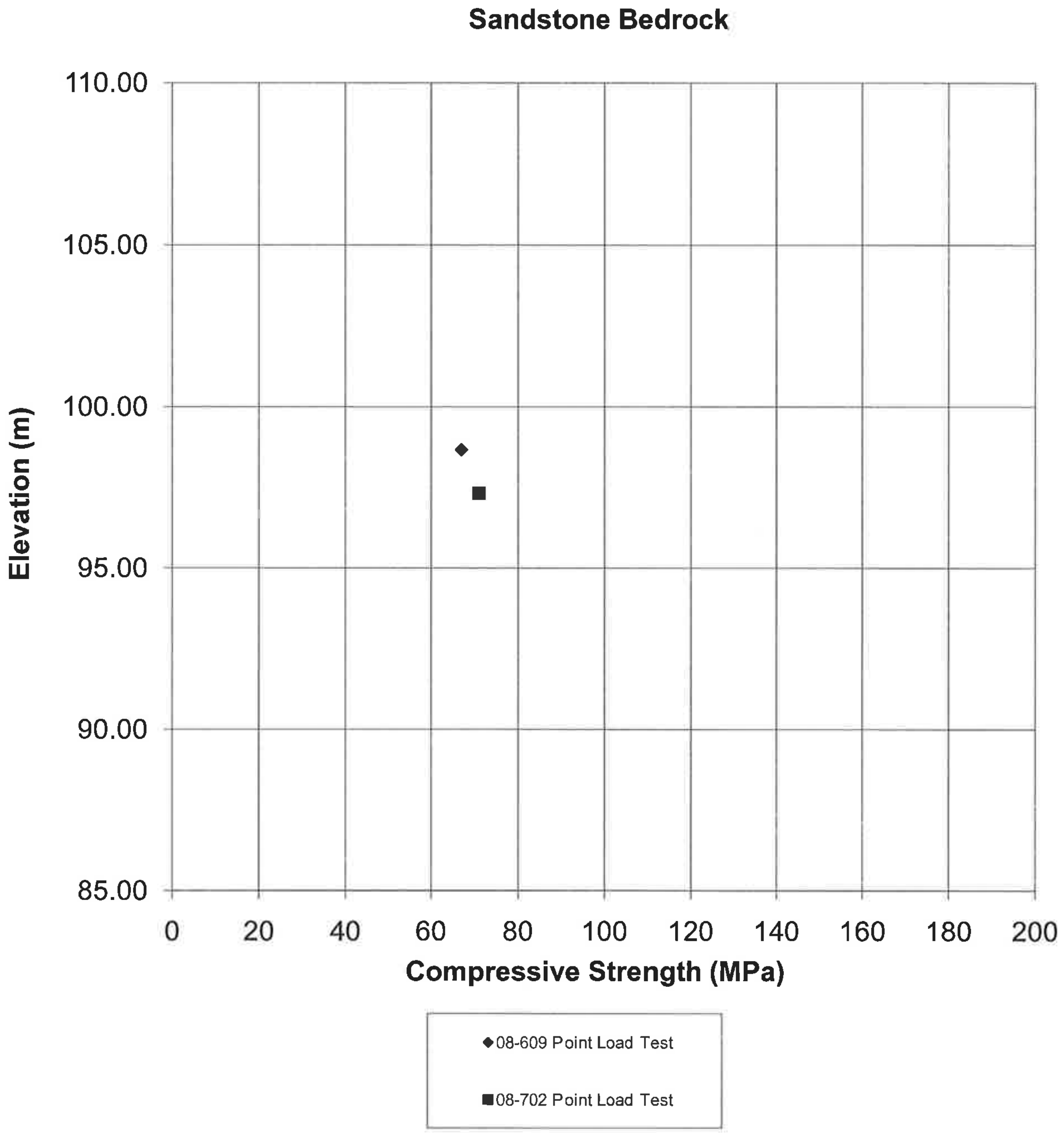
Created by:	SAT
Checked by:	FJH

Project: 07-1121-015-05

Golder Associates

SUMMARY OF LABORATORY COMPRESSIVE STRENGTH MEASUREMENTS

FIGURE 8

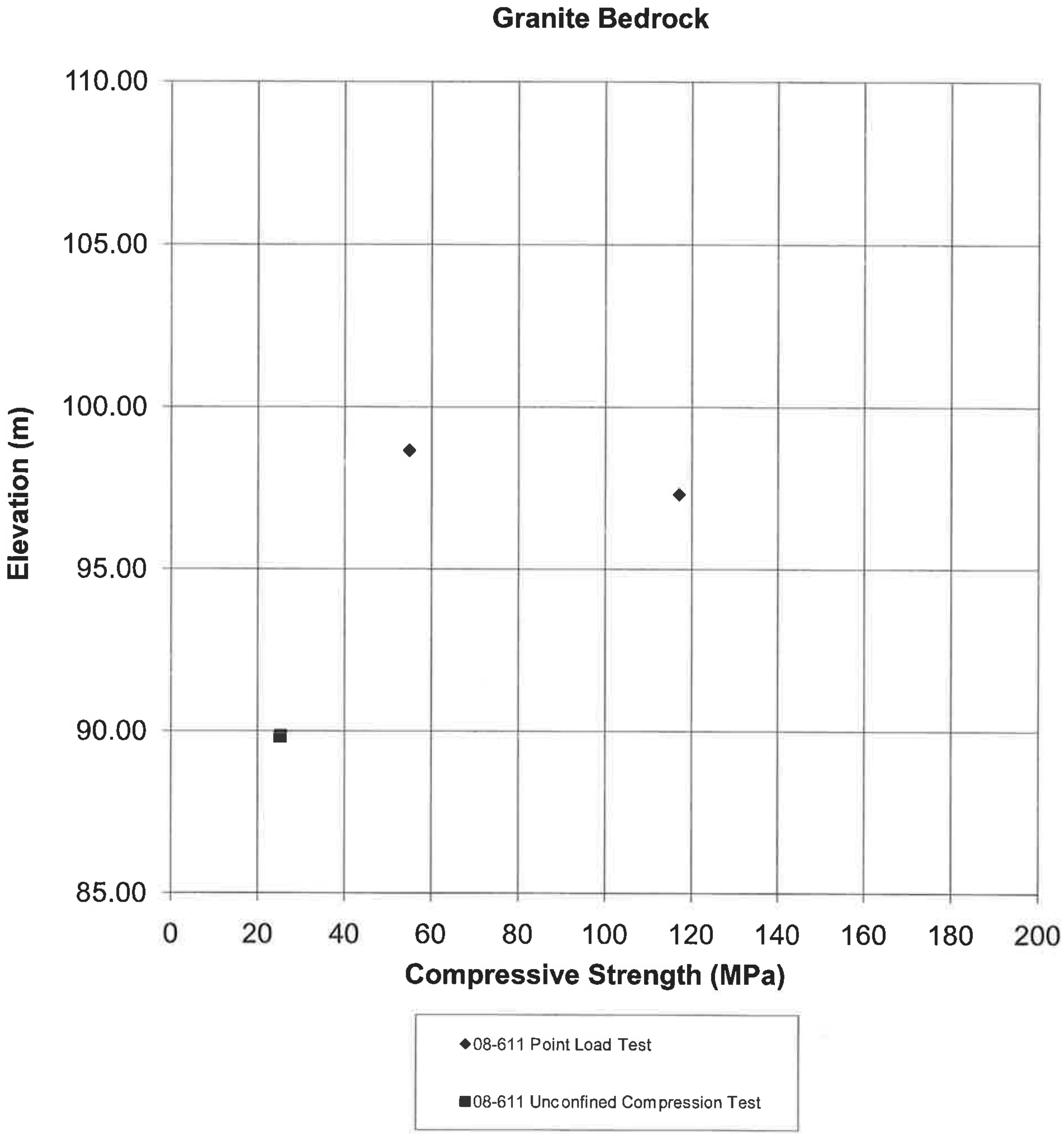


Project: 07-1121-015-05 **Golder Associates**

Created by:	SAT
Checked by:	FJH

SUMMARY OF LABORATORY COMPRESSIVE STRENGTH MEASUREMENTS

FIGURE 9



Project: 07-1121-015-05

Golder Associates

Created by:	SAT
Checked by:	FJH

APPENDIX A

Sample Non-Standard Special Provisions

CONTROL OF ARTESIAN GROUNDWATER CONDITIONS FOR CAISSON INSTALLATION - Item No.

Special Provision

Excavations for the sign foundation at OH10 may encounter slight artesian groundwater conditions in the bedrock, based on the results from a nearby borehole advanced for a HML pole. Appropriate construction procedures and equipment shall be used to control the groundwater during drilling and concrete placement for the foundation at this sign location.

Following construction of the foundation for OH10, a granular filter layer shall be constructed at ground surface surrounding the sign footing. The granular filter layer shall consist of a minimum 0.3 m thickness of OPSS 1010 Granular A, extending from the edge of the foundation for a minimum distance of 1 m in all directions.

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

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

Special Provision

Caisson foundation excavations will be advanced through cohesionless soils that may be water-bearing; these soils are subject to conditions of unbalanced hydrostatic pressure and will consequently slough/flow, cave-in and boil into unsupported caisson holes. 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 IN TILL AND ROCK FILL DURING CAISSON INSTALLATION FOR OVERHEAD SIGNS - Item No.

Special Provision

Rock fill was encountered at some of the sign support locations, and cobbles and boulders were observed within the glacial till deposits overlying bedrock at some of the sign support locations, as noted on the borehole records. Appropriate equipment and procedures will be required to penetrate the rock fill and cobbles/boulders in the glacial till as part of caisson installation for the sign supports.

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, sandstone and granite bedrock, where present at the proposed sign 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

1.0 GENERAL

1.1 Scope

The work for the above noted tender item shall be in accordance with OPSS 904, including all special provisions, except as extended herein. This document specifies additional requirements for the supply, installation and testing of Dowels into Rock for the structure footings.

1.2 Instructions to Contractor

1.2.1 These instructions are to be read in conjunction with the Contract Drawings.

1.2.2 A total of 1 test Dowels into Rock are required for the Dowels into Rock at each structure footing.

1.2.3 Dowels shall extend through tremie concrete and into sound bedrock to the specified embedment depth.

1.3 Qualifications

1.3.1 **Qualifications of Staff from Contractor or Sub-Contractor Completing Work for the Dowels into Rock:** All work shall be performed under the direction of personnel experienced with all aspects associated with the installation of Dowels into Rock. Such experience shall have been obtained within the preceding five (5) years on projects of similar nature and scope to the work required for this project.

1.3.2 **Qualifications of the 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.

1.3.3 **Qualifications of the 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.

1.4 Responsibilities of the Contractor

1.4.1 The **Contractor** shall prove the allowable bond stress by tests of the Dowels into Rock on non-production Dowels into Rock.

1.4.2 The **Contractor** shall supply equipment, materials and skilled personnel to install production Dowels into Rock and conduct the specified acceptance tests. It shall be the responsibility of the Contractor to constantly monitor the acceptance tests, maintain specified test loads and record test measurements as specified by the Contract Administrator.

1.4.3 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.

1.4.4 The **Contractor** shall submit 4 copies of all Working Drawings to the Contract Administrator as outlined in Section 1.6.

1.5 Definitions

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

1.5.2 Design **Engineer**: An Engineer who has a minimum of five (5) 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.

1.5.3 Quality Verification Engineer: An Engineer who has a minimum of five (5) 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.

1.6 Submissions and Working Drawings

1.6.1 Working **Drawings** shall consist of drawings, testing and installation records, procedures and reports, and work plans.

1.6.2 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.

1.6.3 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.

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

1.6.5 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.

1.7 Subsurface Conditions

1.7.1 Soils, rock and groundwater conditions are described in the Foundation Investigation Report for this Contract.

2.0 MATERIALS

The non-shrink grout shall be an approved DSM 9.10.35 non-shrink grout.

The Contractor shall provide the following information from the manufacturer for non-shrink grout:

- Data sheets for the non-shrink grout,
- installation procedures

3.0 EQUIPMENT

3.1 General

3.1.1 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.

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

4.0 INSTALLATION

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

4.1 Construction of Holes

4.1.1 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.

4.1.2 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.

4.1.3 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.

4.2 Installation of Reinforcing Steel Bar

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

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

4.2.3 Dowels shall extend through the tremie concrete for the footing and into sound bedrock.

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

4.3 Grout

4.3.1 The non-shrink grout shall entirely fill the annular space between the reinforcing steel bar and side for the dowel hole.

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

4.3.3 Non-shrink grout shall be placed into the dowel hole using tremie placement methods.

5.0 TESTING REQUIREMENTS

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

5.1 General Testing Requirements

5.1.1 Refer to the attached Instructions to Contractor and the Contract Drawings for specific test details.

5.1.2 The Contractor shall install the number of Dowels into Rock specified in the contract documents for testing purposes. The purpose of the 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.

5.1.3 The equipment, labour and materials for test dowels shall be identical to Dowels into Rock at the each structure location.

5.1.4 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.

5.1.5 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.

5.1.6 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.

5.1.7 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 sound bedrock.

5.2 Testing Location

5.2.1 The Contractor shall remove all loose rock down to sound bedrock at the test location.

5.2.2 The test Dowels into Rock shall be constructed at locations specified by the Contract Administrator.

5.2.3 If site conditions dictate, changes to the test locations will be considered. The Contractor shall provide the Contract Administrator at least 2 days notice in writing of this operation.

5.3 Testing Equipment

5.3.1 The dowels into rock will be carried out generally in accordance with the prevailing requirements of A.S.T.M. (Designation D1143-81) superseded where applicable by the procedures specified in this document.

5.3.2 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.

5.3.3 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.

5.3.4 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.

5.4 Testing for Dowels Into Rock, and Report

5.4.1 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.

5.4.2 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 (0.0001 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.

5.4.3 Jacks used for reinforcing steel bars shall have a minimum ram dimension of 153 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.

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

5.5 Testing Loading

5.5.1 The testing procedures shall safely load test the Dowels into Rock in tension at a rate of approximately 100kN per minute to the specified test load. The load shall be increased by an additional 50 kN beyond this level as directed by the Quality Verification Engineer.

5.5.2 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.

5.6 Acceptance Criteria

5.6.1 The following acceptance criteria apply:

5.6.2 The testing of dowels shall be carried out in advance of the instalment of Dowels into Rock at each structure location.

5.6.3 Tests for Dowels into Rock shall have a capacity of at least **[insert value]** kN. The Quality Verification Engineer shall report on the acceptance of the tests for Dowels into Rock. The Quality Verification Engineer shall report on the testing of the Dowels into Rock including recommendations for increasing embedment depth, if necessary.

6.0 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.