



THURBER ENGINEERING LTD.

**PRELIMINARY
FOUNDATION INVESTIGATION AND DESIGN REPORT
MCEWEN CREEK CULVERT (SITE 3-315/C)
HIGHWAY 417 / HUNT CLUB ROAD INTERCHANGE
OTTAWA, ONTARIO
G.W.P. 4074-11-00**

GEOCRES NO.: 31G5-262b

**SUBMITTED TO
MCINTOSH PERRY CONSULTING ENGINEERS LTD.**

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual data obtained from a foundation investigation conducted by Thurber Engineering Ltd. (Thurber) for Culvert 3-315/C carrying McEwen Creek flow below Highway 417 in Ottawa, Ontario. Thurber carried out the investigation as a sub-consultant to McIntosh Perry Consulting Engineers Ltd. on behalf of the Ministry of Transportation Ontario (MTO) under Agreement 4013-E-0014.

A foundation investigation has been carried out by Thurber to aid in the rehabilitation of the existing culvert structure. The purpose of the investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, record of boreholes, stratigraphic profile, laboratory test results and a written description of the subsurface conditions.

The following reference numbers apply to this site:

- Current W.P. 4074-11-00
- Site No. 3-315/C
- GEOCRES No. 31G5-237, 31G5-240, 31G5-262b
- Construction Contract 73-190
- Historic W.P. 10-69-16

2 SITE DESCRIPTION AND GEOLOGY

The site is located in eastern Ottawa, in the Township of Gloucester at the Highway 417 / Hunt Club Road Interchange. The location of the Culvert 3-315/C is shown on the Key Plan Insert on Drawing No. 1 in Appendix A. It is noted that for project orientation purposes Highway 417 within the project limits, will be assumed to run north-south while the culvert runs west-east. The terrain in the vicinity of the culvert is generally flat and is brush, and grass covered. The creek banks slope up at the outlet to form parts of the embankments for the Hunt Club Road Interchange. It is noted that Hunt Club Road crosses above Highway 417 and the west end of the culvert is directly below the Hunt Club Road structure. Site photographs showing the general site conditions are provided in Appendix D.

The site is situated within the physiographic region identified as the Ottawa Valley Clay Plains, as reported by Chapman and Putnam (1984). This physiographic region generally consists of clay plains interrupted by ridges of rock or sand.

Geological Survey of Canada, Map 1506A Surficial Geology of Ottawa, indicates that the overburden in the region consists predominantly of clay and silt with underlying erosional terraces.

The results of a review of borehole data from the existing GEOCRETS reports indicate that the overburden materials at the site consist predominantly of a silty clay overlying a silt till, underlain by a shale bedrock with limestone interbedding. The borehole data indicates that the overburden thickness in the vicinity of the Culvert 3-315/C is generally less than 6 m.

The Generalized Bedrock Geology of Ottawa-Hull, Map 1508A, indicates that the bedrock underlying the site belongs to the Carlsbad Formation of Ordovician age and consists of grey shale.

3 CULVERT DESCRIPTION

Based on the historic General Layout Drawing provided in Appendix A, the culvert was originally constructed in seven, concrete box sections plus two additional concrete headwall sections; one at each of the inlet and outlet. The total length of structure is reported to be 74.2 m. The internal dimensions of the individual culvert sections were noted as 6.1 m wide and 3.7 m in height. The culvert was extended to the east as part of the construction of the Highway 417 / Hunt Club Road Interchange, completed in 2014. It is noted that Hunt Club Road crosses above Highway 417 and the west end of the culvert is directly below the Hunt Club Road Structure.

The stream bed for Culvert 3-315/C had a design top elevation ranging from 63.4 m to 63.2 m and had a thickness of 300 mm. The concrete base for the culvert had a design top elevation ranging from 63.2 m to 62.8 m and had a thickness of 0.4 m. Bedding material is indicated on the drawing to be Select Subgrade Material with a thickness of 800 mm or the depth to sound bedrock whichever is less. Therefore, the culvert is founded at approximate elevations ranging from 62.8 m to 62.4 m; and the underside of bedding ranges from 62.0 m to 61.6 m elevation and is near the contact between the silty clay and the silt till strata. Flow through the culvert is from west to east.

A structure inspection was conducted by MTO in August 2012, for Culvert 3-315/C with the report issued September 2012. Condition data outlined in the report for the culvert structure ranged from poor to good but typically the culvert was rated in good condition. The report recommended minor concrete rehabilitation work to be completed for the culvert within 1 to 5 years of the inspection.

The site was inspected by Thurber Engineering staff during the week of July 14th, 2014. Several photographs of the site are provided in Appendix D for reference.

At the time of the inspection, the following observations were made:

West Inlet:

- Gabions were installed at the inlet for erosion protection
- Vegetation was noted on the side slopes, behind the wing walls and on top of the culvert
- The slope behind the wing walls was measured at approximately 22° and were noted as being in generally good condition
- No obvious settlement of the road surface was observed at the crossing

East Outlet:

- Construction of the culvert extension and surrounding creek banks was ongoing at the time of Thurber's inspection. As such no erosion protection measures were installed nor had vegetation cover been established, either behind the wing walls or over the culvert
- Erosion behind the wing walls and over the culvert was noted
- No obvious settlement of the road surface was observed at the crossing

4 BACKGROUND – PREVIOUS INVESTIGATION

4.1 Overview

The investigation for the initial construction of the culvert was carried out in 1972 by the MTO Foundations Office and included four boreholes, as documented in GEOCREs Report No. 31G5-90. Consolidation testing was carried out for samples of the silty clay encountered at the site. The results indicate that the preconsolidation pressures ranged from 165 kPa to 300 kPa and the compression index ranged from 0.36 to 1.25.

Several more recent foundation investigations have been carryout in the general vicinity of Culvert 3-315/C; the most recent of which were for the construction of the Highway 417 / Hunt Club Road Interchange by Thurber. The first investigation was for the underpass bridge structure; GEOCREs Report No. 31G5-237, dated February 2011 and the second was for the extension of the Culvert 3-315/C; GEOCREs Report No. 31G5-240, dated March 2011. A hydrogeological investigation was also conducted at the site the results of which are presented in the Thurber report for the City of Ottawa Report No. 19-5438-7 entitled: Hydrogeology Assessment Hunt Club Road Extension from Russell Road to Highway 417.

Copies of these investigation reports are provided in Appendix E.

4.2 GEOCREs 31G5-237 Investigation

The underpass bridge structure investigation consisted of 14 sampled boreholes (designated 10-01 to 10-16) which were advanced to depths ranging from 4.4 m to 9.0 m including bedrock coring and sampling.

For reference, the report indicates the stratigraphy in the area of the culvert structure is generally characterized as follows:

- 100 to 175 mm thick layer of top soil ground surface cover; overlying
- 2.9 m to 4.5 m thick stratum of firm to very stiff silty clay; overlying
- 0.3 m to 2.0 m thick stratum of soft to hard silt till; underlain by
- Shale bedrock with limestone interbedding
- Groundwater levels were measured at elevations ranging from 64.0 m to 65.0 m

4.3 GEOCREs 31G5-240 Investigation

The investigation for the extension of Culvert 3-315/C consisted of two sampled boreholes (designated 10-13 and 10-14) which were advanced to depths of 3.8 m to 5.5 m. No bedrock coring was carried out for this investigation.

For reference, the report indicates the stratigraphy in the area of the culvert structure is generally characterized as follows:

- 4.1 m of sand fill material (Borehole 10-13 only);
- 125 mm thick layer of top soil ground surface cover (Borehole 10-14 only); overlying
- 1.1 m to 2.9 m thick stratum of firm to stiff silty clay; overlying
- 0.3 m to 0.8 m thick stratum of soft to hard silt till
- Both boreholes terminated at auger refusal on probable bedrock

4.4 Hydrogeology Assessment Report

The hydrogeology assessment investigation consisted of two falling head and three raising head in-situ hydraulic conductivity tests conducted within silty sand/silt till deposits. The field tests were conducted in the monitoring wells installed in five boreholes, located in various locations across Hunt Club Road / Highway 417 interchange site. The vertical hydraulic conductivity values for the clay deposit were determined based on laboratory testing on undisturbed Shelby Tube samples obtained during the field investigation of particular relevance to the present assignment are the results for boreholes 09-18 and 10-12.

5 INVESTIGATION PROCEDURE

Prior to carrying out the investigation, Thurber personnel laid out the locations of the geotechnical investigation boreholes based on the site plans provided and measurements from existing site features. As a component of our standard procedures and due diligence, Thurber engaged Ontario One Call to provide utility locate clearances for the intended borehole locations.

The field investigation for this site included advancing one borehole which was drilled on August 28th, 2014. The location coordinates and elevation of the borehole are shown on the Borehole Location and Soil Strata Drawing No. 1 in Appendix A and are summarized in the Table 5-1.

Table 5-1: Borehole Summary

Borehole	Location	Ground Surface Elevation (m)	Depth (m)
14-4	Highway 417 Eastbound Lane 2	67.9	8.7

Borehole 14-4 was advanced with a CME55 truck mounted drill rig equipped with hollow stem augers. The subsurface stratigraphy encountered in the boreholes was recorded in the field by Thurber personnel. Split spoon samples were collected at regular depth intervals in the borehole via the completion of Standard Penetration Tests (SPTs), following the methods described in ASTM Standard D1586-11. In-situ shear strength measurements were also carried out using an MTO N-vane within the cohesive stratum. All soil samples recovered from the borehole were placed in moisture-proof containers and the samples were transported to Thurber's Ottawa geotechnical laboratory for further examination and testing.

Groundwater was measured in the open borehole on completion of drilling prior to backfilling.

Borehole 14-4 was backfilled with a low-permeability combination of auger cuttings and bentonite pellets in general accordance with the intent of Ontario MOE Regulation 903 and capped at the ground surface with a 300 mm layer of cold patch asphalt.

6 LABORATORY TESTING

Geotechnical laboratory testing was carried out in the Thurber geotechnical laboratory in Ottawa, Ontario, and consisted of natural moisture content determination and visual identification of all soil samples in accordance with the current MTO standards. Grain size distribution analysis including hydrometer analysis and Atterberg Limits testing was also carried out to MTO and ASTM standards.

The laboratory test results are presented on the Record of Borehole sheet provided in Appendix B and are illustrated on the Figures C1 to C4 provided in Appendix C.

7 DESCRIPTION OF SUBSURFACE CONDITIONS

7.1 Overview

Reference is made to the 2014 Record of Borehole sheet in Appendix B for details of the soil stratigraphy encountered in the borehole advanced for the current investigation. A stratigraphic profile for the existing culvert alignment is presented on the Drawing No. 1 in Appendix A for illustrative purposes. An overall description of the stratigraphy is given in the following paragraphs; however, the factual data presented in the Record of Borehole governs any interpretation of the site conditions.

For reference, the stratigraphy in the area of the culvert structure is generally characterized by an asphalt/topsoil ground surface cover, overlying a granular fill overlying a silty clay, overlying a silt till, underlain by inferred bedrock. The borehole for the 2014 investigation was terminated on the probable bedrock stratum.

7.2 Asphalt

A 150 mm thick asphalt layer was encountered at the ground surface.

7.3 Fill

A fill layer was encountered below the asphalt pavement consisting predominately of sand and gravel with varying amounts of silt and trace amounts of clay size particles. The top of this stratum was at elevation 67.7 m and the layer had a thickness of 2.0 m. The standard penetration test (SPT) 'N' values ranged from 18 to 46 blows per 0.3 m of penetration; indicating a dense to compact condition. The results of grain size analysis completed on a sample of this material indicated a gravel content of 35%, sand content of 47%, and a fines content (combined silt and clay size particles) of 18%. The results of the gradation analysis are illustrated on Figure C1 in Appendix C.

The moisture content of the samples tested ranged from 4% to 6%.

7.4 Silty Clay/Clay

The fill layer was underlain by a 3.9 m thick stratum of silty clay. The top of this stratum was at elevation 65.7 m. The SPT 'N' values recorded in the silty clay layer generally ranged from 2 to 12 blows per 0.3 m penetration. The measured undrained shear strength values ranged from 90

kPa to 30 kPa based on the results of in-situ shear vane testing carried out in Borehole 14-4. The shear strength values indicate the silty clay to have a stiff to firm consistency that decreased in strength with depth.

The results of grain size analysis tests completed on two samples of this material are summarized in Table 7-1 and are illustrated on Figure C2 in Appendix C.

The moisture content of the samples tested ranged from 25% to 50%.

Table 7-1: Gradation Results for Clay

Soil Particles	%
Gravel	0
Sand	1 and 7
Silt	40 and 56
Clay	43 and 53

Atterberg Limits test results of two samples of this material indicate a clay of high plasticity at the top of the stratum to clay of low plasticity at a depth of 5.1 m. The results of the Atterberg Limits tests are summarized in Table 7-2 and are illustrated on Figure C4 in Appendix C.

Table 7-2: Atterberg Limits Test Results

Soil Particles	%
Plastic Limit	16 and 18
Liquid Limit	30 and 52
Plasticity Index	14 and 34

7.5 Silt Till

A glacial till stratum consisting predominately of silt and clay with varying amounts of sand and gravel was encountered below the silty clay stratum in Borehole 14-4. The top of this stratum was at elevation 61.8 m and the layer had a thickness of 2.6 m. The SPT 'N' values were greater than 100 blows per 0.3 m of penetration; indicating a very dense state.

Cobbles were inferred to be present within this stratum, based on observed grinding of the augers. It should be noted that cobbles and boulders were also noted within the silt till stratum on the Records of Borehole from previous investigations.

The results of grain size analysis completed on a sample of this material indicated a gravel content of 18%, sand content of 19%, silt content 37% and a clay content of 26%. The results of the gradation analysis for the silt till are illustrated on Figure C3 in Appendix C.

The moisture content of the sample tested was 28%.

7.6 Bedrock

Bedrock was inferred beneath the glacial till by auger refusal in Borehole 14-4 at an elevation of 59.2 m.

Bedrock coring was carried out as part of the 2011 underpass bridge structure investigation; GEOCRE Report No. 31G5-237. The bedrock / soil interface was proven by coring in 12 of the

14 boreholes advanced as part of the 2011 investigation. The bedrock surface ranged in elevation from 60.7 m to 62.2 m. Bedrock total core recovery ranged from 93% to 100%; solid core recovery ranged from 40% to 100%; and the measured RQD values ranged from 40% to 100%. Based on the RQD values the rock mass quality is classified as ranging from poor to excellent. Based on the results of point load testing the bedrock ranges from weak shale to strong limestone.

Geological mapping suggests the bedrock at this site is shale of the Carlsbad Formation.

7.7 Groundwater Conditions

Groundwater was measured as part of the 2014 investigation in the open borehole prior to backfilling at an elevation 60.3 m or 7.6 m below the existing ground surface.

A 19 mm inside diameter PVC monitoring well was installed in each of Boreholes 10-03, 10-05, 10-07, and 10-12 as part of the 2011 investigation. Groundwater levels in the monitoring wells were recorded in July 2010, at depths of 0.94 m to 1.5 m corresponding to elevations ranging from 64.0 m to 65.0 m.

The water level in McEwen Creek was measured at the time of Thurber's site inspection on July 17, 2014, at a depth of 3.5 m below the top of the culvert; corresponding to an elevation of 63.6 m.

The groundwater level in the area of the culvert is expected to reflect the water level in the creek. The observations noted above are considered short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

7.8 Hydraulic Conductivity of Site Materials

The recommended design hydraulic conductivity values for the overburden materials encountered at the site are provided in Table 7-3. The value provided for silty clay and silt till were based on the results presented in Thurber's Hydrogeology Assessment Report No. 19-5437-7 dated April 2011 which was referenced previously in this report. The value for the sand and gravel fill is estimated from an empirical relationship with grain size distribution.

Table 7-3: Hydraulic Conductivity Values for Site Materials

Material	Hydraulic Conductivity (m/s)
Sand + Gravel Fill	1×10^{-6} to 1×10^{-5}
Silt Till	1×10^{-8} to 1×10^{-7}
Silty Clay	1×10^{-10} to 1×10^{-8}

8 MISCELLANEOUS

Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to drilling. Thurber personnel surveyed the borehole ground surface elevation, and used measurements taken in the field to determine the northing and easting coordinates from existing CAD drawings.

George Downing Estate Drilling Ltd. of Hawkesbury Ontario supplied and operated the truck mounted CME 55 drill rig to carry out the borehole drilling, sampling, and in-situ testing operations. Beacon Lite of Ottawa, Ontario, supplied the traffic control equipment and personnel required for drilling operations.

The drilling, and sampling operations in the field were supervised on a full time basis by Ms. Katrina Young of Thurber. Laboratory testing was carried out by Thurber in its MTO-approved laboratory in Ottawa, Ontario.

Overall project management and direction of the field program was provided by Dr. Fred Griffiths, P.Eng. Interpretation of the field data and preparation of this report was completed by Mr. Christopher Murray, E.I.T. The report was reviewed by Dr. Fred Griffiths, P.Eng. and Dr. P.K. Chatterji, P.Eng., the Designated Principal Contact for MTO Foundations Projects.

Christopher Murray, M.A.Sc., E.I.T.
Geotechnical Engineer in Training



Fred Griffiths, P.Eng.
Associate, Senior Geotechnical Engineer



P.K. Chatterji, P.Eng.
Review Principal, Designated MTO Contact

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GEOCRETS NO.: 31G5-267**

PART 2: ENGINEERING DISCUSSION AND PRELIMINARY RECOMMENDATIONS

9 GENERAL

This report presents interpretation of the geotechnical data in the factual report and presents preliminary geotechnical recommendations for construction, excavation and dewatering.

The site is located in eastern Ottawa, in the Township of Gloucester at the Highway 417 / Hunt Club Road Interchange. The location of the Culvert 3-315/C is shown on the Key Plan Insert on Drawing No. 1 in Appendix A.

Based on the historic General Layout Drawing provided in Appendix A, the culvert was originally constructed in seven, concrete box sections plus two additional concrete headwall sections; one at each of the inlet and outlet. The total length of structure is reported to be 74.2 m. The internal dimensions of the individual culvert sections were noted as 6.1 m wide and 3.7 m in height. The culvert was extended to the east as part of the construction of the Hunt Club Road Interchange, completed in 2014. It is noted that Hunt Club Road crosses above Highway 417 and the west end of the culvert is directly below the Hunt Club Road Structure.

The stream bed for Culvert 3-315/C had a design top elevation ranging from 63.4 m to 63.2 m and had a thickness of 300 mm. The concrete base for the culvert had a design top elevation ranging from 63.2 m to 62.8 m and had a thickness of 0.4 m. Bedding material is indicated on the drawing to be Select Subgrade Material with a thickness of 800 mm or the depth to sound bedrock whichever is less. Therefore, the culvert is founded at approximate elevations ranging from 62.8 m to 62.4 m; and the underside of bedding ranges from 62.0 m to 61.6 m elevation and is near the contact between the silty clay and the silt till strata. Flow through the culvert is from west to east.

It is understood that it is proposed to rehabilitate the culvert with 35 m² of concrete repairs. This work is to be completed in the dry.

10 EXCAVATION, DEWATERING AND TEMPORARY SUPPORT

10.1 Excavations

Where excavations are required in order to rehabilitate the culvert they must be conducted in accordance with the requirements of the Occupational Health and Safety Act and Regulations (OHSA) for Construction Projects. The native very stiff to soft silty clay and very dense silt till reported at this site should be classified Type 3. The embankment fill material should be classified as a Type 3 soil.

The Contract Documents should alert the Contractor to the risks associated with excavations near McEwen Creek and below the groundwater level and specify that an appropriate dewatering system must be provided to maintain a stable and dry work area.

10.2 Static Lateral Earth Pressure Coefficients

Lateral earth pressures acting on the structure should be computed in accordance with the CHBDC but generally are given by the expression:

$$P_h = K^*(\gamma h + q)$$

where:

P_h = horizontal pressure on the wall (kPa)

K = earth pressure coefficient

γ = unit weight of retained soil

h = depth below top of fill where pressure is computed (m)

q = value of any surcharge (kPa)

The recommended lateral earth pressure parameters for use in the design for both a horizontal and for 2H:1V (Horizontal:Vertical) back-slope are provided in Table 10-1.

For rigid structures such as Culvert 3-315/C, it is recommended that at-rest horizontal lateral earth pressures be used for design. Active pressures should be used in design for unrestrained walls.

A lateral pressure due to backfill compaction should be added to the calculated lateral earth pressure in accordance with the Section 6.9.3 of the CHBDC.

The parameters provided in Table 10-1 are based on the assumption that the backfill is fully drained so that there are no unbalanced hydrostatic pressures. If adequate drainage cannot be confirmed, the potential for hydrostatic pressures should be considered.

Table 10-1: Static Lateral Earth Pressure Coefficients

Parameter	OPSS Granular A & OPSS Granular B Type II	OPSS Granular B Type I & Existing Fill	Native	Native Silt Till
Soil Unit Weight, kN/m^3 , γ	21	20 / 19	17	19
Angle of Internal Friction, ϕ	35°	30°	27°	30°
Horizontal Back-Slope				
Coefficient of at Rest Earth Pressure, K_o (Restrained Wall)	0.43	0.50	0.55	0.50
Coefficient of Active Earth Pressure, K_a (Unrestrained Wall)	0.27	0.33	0.38	0.33
2H:1V Back-Slope				
Coefficient of Active Earth Pressure, K_a	0.39	0.54	0.7	0.54

10.3 Dewatering

The Contractor must be prepared to control the groundwater and surface water flow at the site to permit the proposed culvert rehabilitation works to be conducted in a dry and stable excavation. The groundwater level for the site at the time of the proposed rehabilitation works should be taken as the water level in McEwen Creek. It is recommended that the rehabilitation works be conducted during a drier season such as after the spring freshet or prior to the fall season.

Temporary water course diversion may be required to rehabilitate the culvert in the dry. Water from either surface flow and/or groundwater must be diverted away from the excavation at all times. Groundwater perched within the embankment fill, surface runoff and/or the water from the creek will tend to seep into, and accumulate in proposed excavations.

If excavations below the groundwater level are anticipated, a cofferdam may be required to control inflow of water into the excavation.

Dewatering and surface water diversion must remain operational and effective until the culvert is repaired and backfilled. Decisions regarding dewatering, must be carried out by the Contractor.

It is recommended that the Contract Documents identify a water level in McEwen Creek against which the cofferdam must provide protection and prevent flooding of the work area. The appropriate water level must consider hydrologic and hydraulic factors and should be carried out by specialists experienced in this field. At a minimum the expected spring freshet level or the level reached by a storm of an appropriate return period should be used as the design water level.

Further discussion with regards to dewatering at this site is provided in the Non-Standard Special Provision (NNSP) in Appendix E.

10.4 Cofferdam

Culvert rehabilitation works should be conducted in a dry and stable excavation.

Considering the depth to bedrock it is anticipated that where a cofferdam is required, one option is to construct it using a sheet pile wall system driven to bedrock. It should be noted that the bedrock surface at the site was encountered at depths of 5.5 m to 8.7 m corresponding to elevations of 59.2 m to 62.2 m. The work area could then be kept dry through the use of sump pits and pumps. The McEwen Creek flow should be temporarily diverted around the cofferdam and work area with a pumping bypass system.

11 CLOSURE

Overall project management and direction of the field program was provided by Dr. Fred Griffiths, P.Eng. Interpretation of the field data and preparation of this report was completed by Mr. Christopher Murray, E.I.T. The report was reviewed by Dr. Fred Griffiths, P.Eng. and Dr. P.K. Chatterji, P.Eng., the Designated Principal Contact for MTO Foundations Projects.

Christopher Murray, M.A.Sc., E.I.T.
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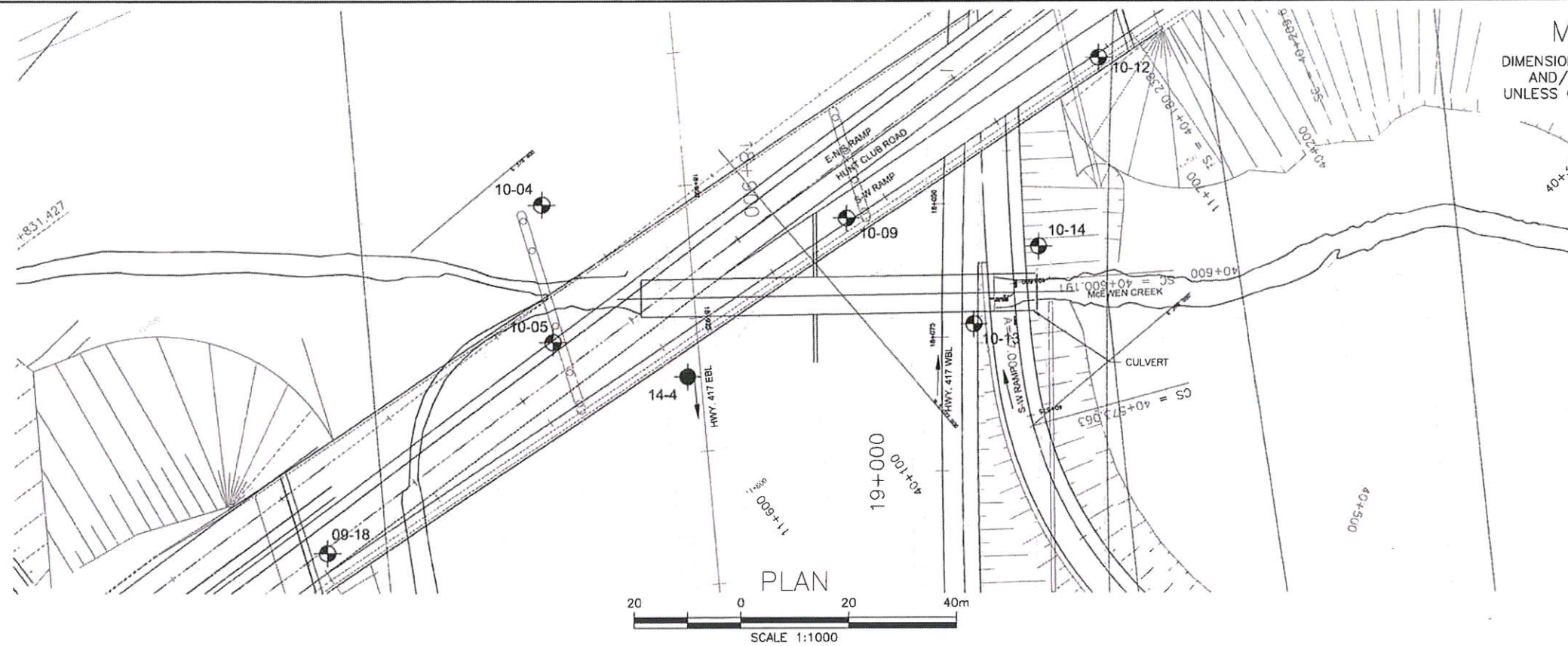


Fred Griffiths, P.Eng.
Associate, Senior Geotechnical Engineer



P.K. Chatterji, P.Eng.
Review Principal, Designated MTO Contact

APPENDIX A
BOREHOLE LOCATIONS AND SOIL STRATA DRAWINGS
HISTORICAL CONSTRUCTION DRAWINGS



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

CONT No
WP No 4074-11-00

McEWEN CREEK CULVERT
CULVERT 3-315/C

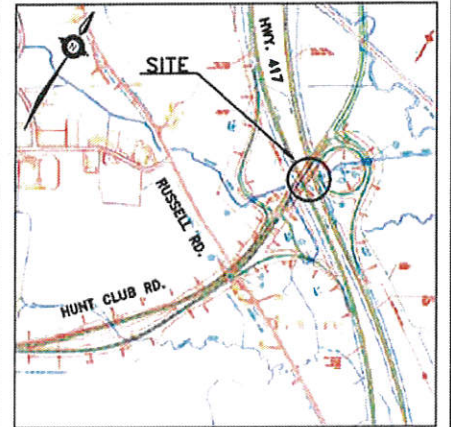
BOREHOLE LOCATIONS AND SOIL STRATA



SHEET



THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

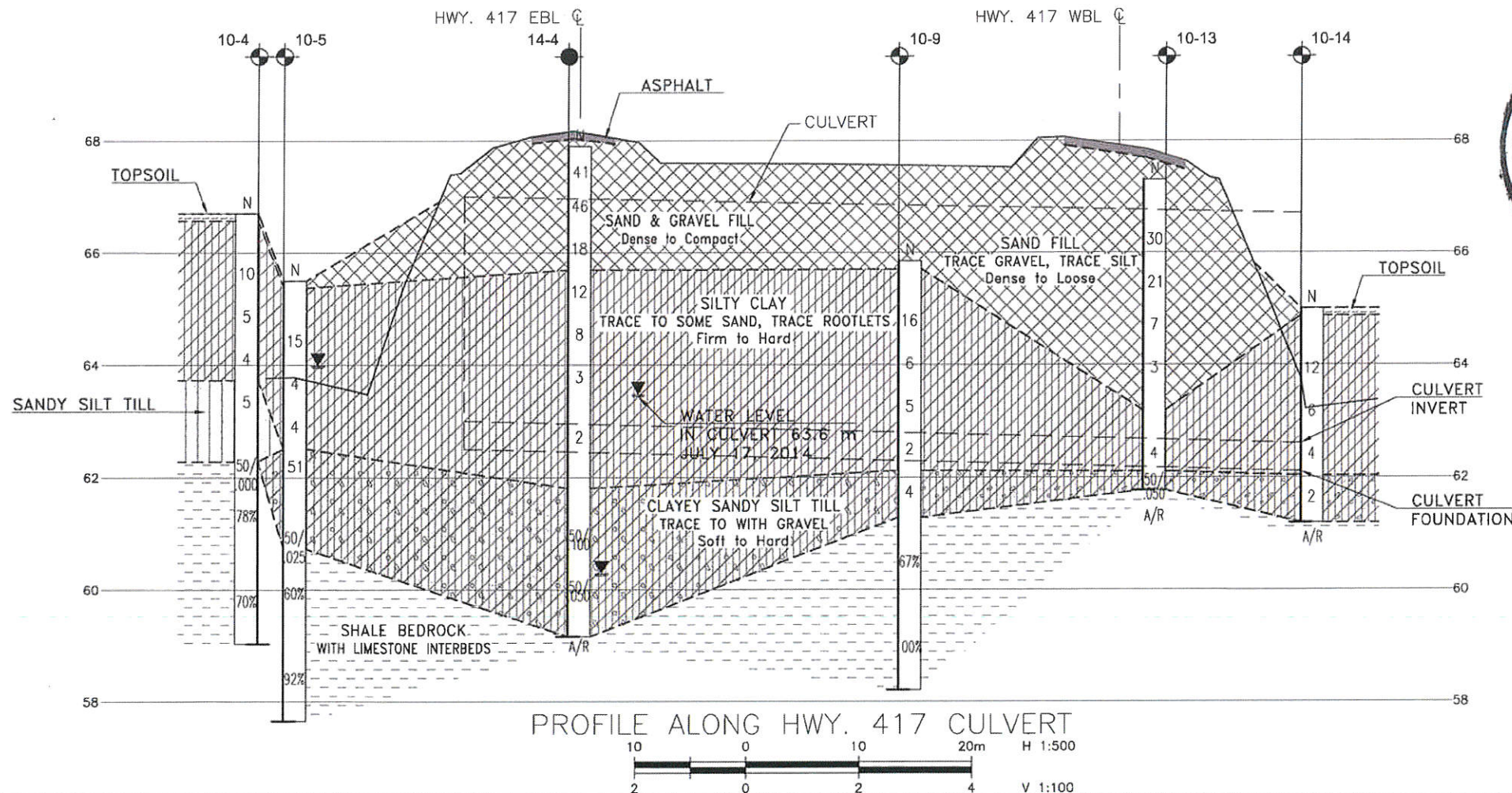
●	Borehole (Current Investigation)
○	Borehole (Previous Investigation)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60' Cone, 475J/blow)
PH	Pressure, Hydraulic
W	Water Level
HA	Head Artesian Water
P	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
14-4	67.9	5 027 568.3	376 451.3
10-4	66.7	5 027 568.3	376 409.0
10-5	65.5	5 027 553.3	376 430.1
10-9	65.9	5 027 609.9	376 447.7
10-12	65.6	5 027 665.0	376 455.1
10-13	67.3	5 027 615.1	376 478.3
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09-18	66.5	5 027 496.0	376 433.2

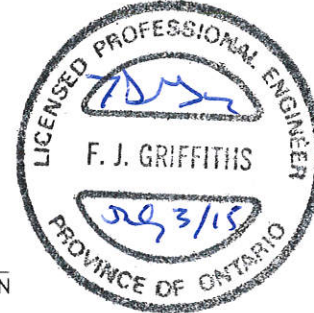
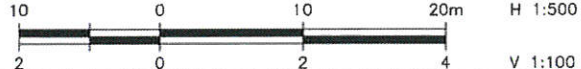
-NOTES-

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

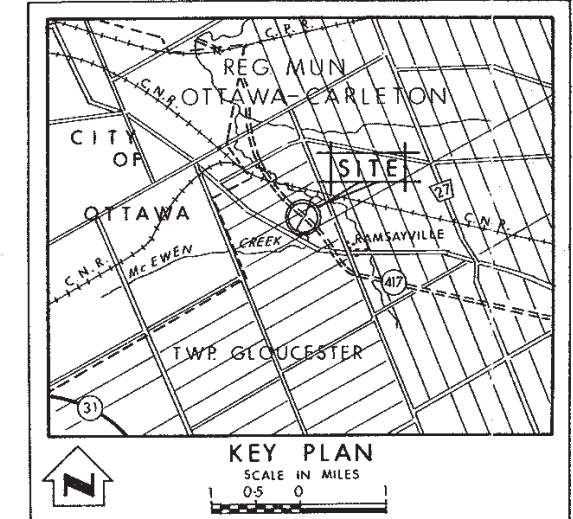
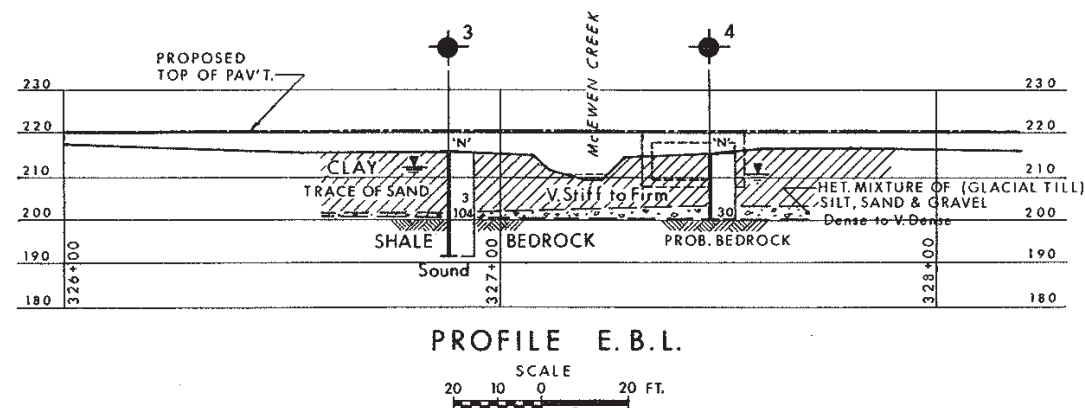
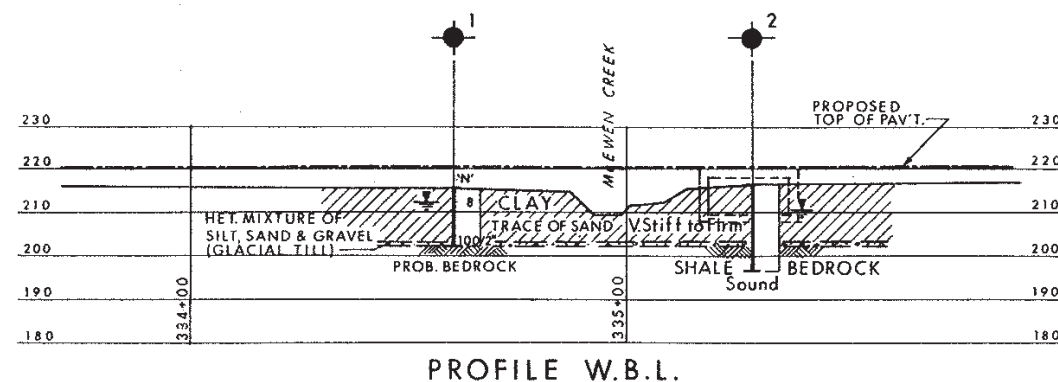
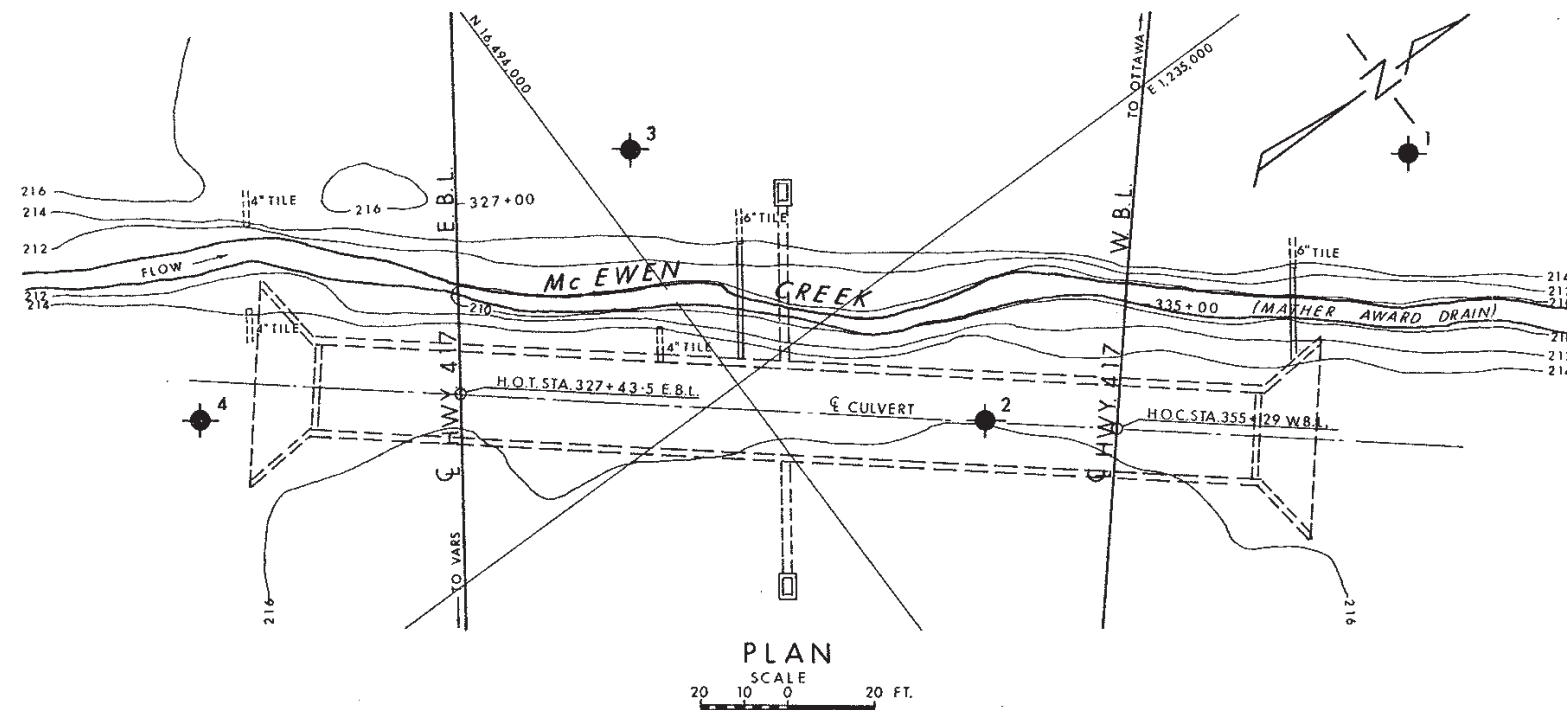
GEORES No. 31G5-262a



PROFILE ALONG HWY. 417 CULVERT



DATE	BY	DESCRIPTION
DESIGN	CM	CHK PC
LOAD	DATE	DEC. 2014
DRAWN	MFA	CHK CM
SITE	STRUCT	OWG 1



LEGEND

- Bore Hole
- ⊕ Cone Penetration Test
- ⊙ Bore Hole & Cone Test
- ≡ Water Levels established at time of field investigation, OCT. 1972

NO.	ELEVATION	STATION	OFFSET
1	214.9	334+60	62' LT. WBL.
2	216.0	335+29	30' RT. WBL.
3	215.6	326+88	40' LT. EBL.
4	215.1	327+48	60' RT. EBL.

— NOTE —

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS—ONTARIO
DESIGN SERVICES BRANCH—FOUNDATIONS OFFICE

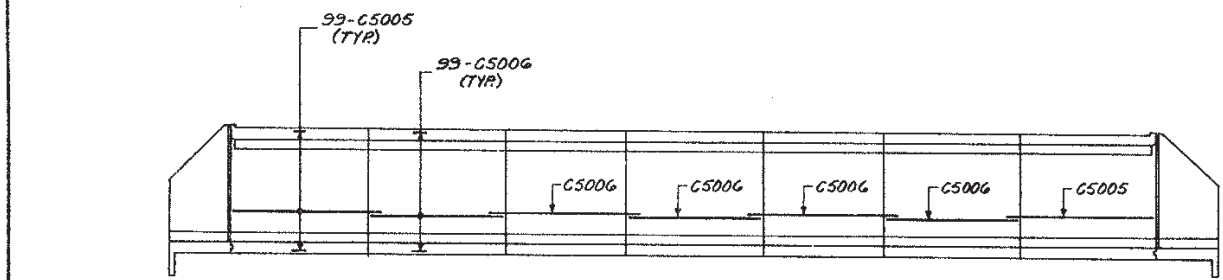
McEWEN CREEK (MATHER AWARD DRAIN)

HIGHWAY NO. 417 E.B.L. & W.B.L. DIST. NO. 9
CO. REGIONAL MUNICIPALITY OF OTTAWA-CARLETON
TWP. GLOUCESTER LOT 4 CON. 6

BORE HOLE LOCATIONS & SOIL STRATA

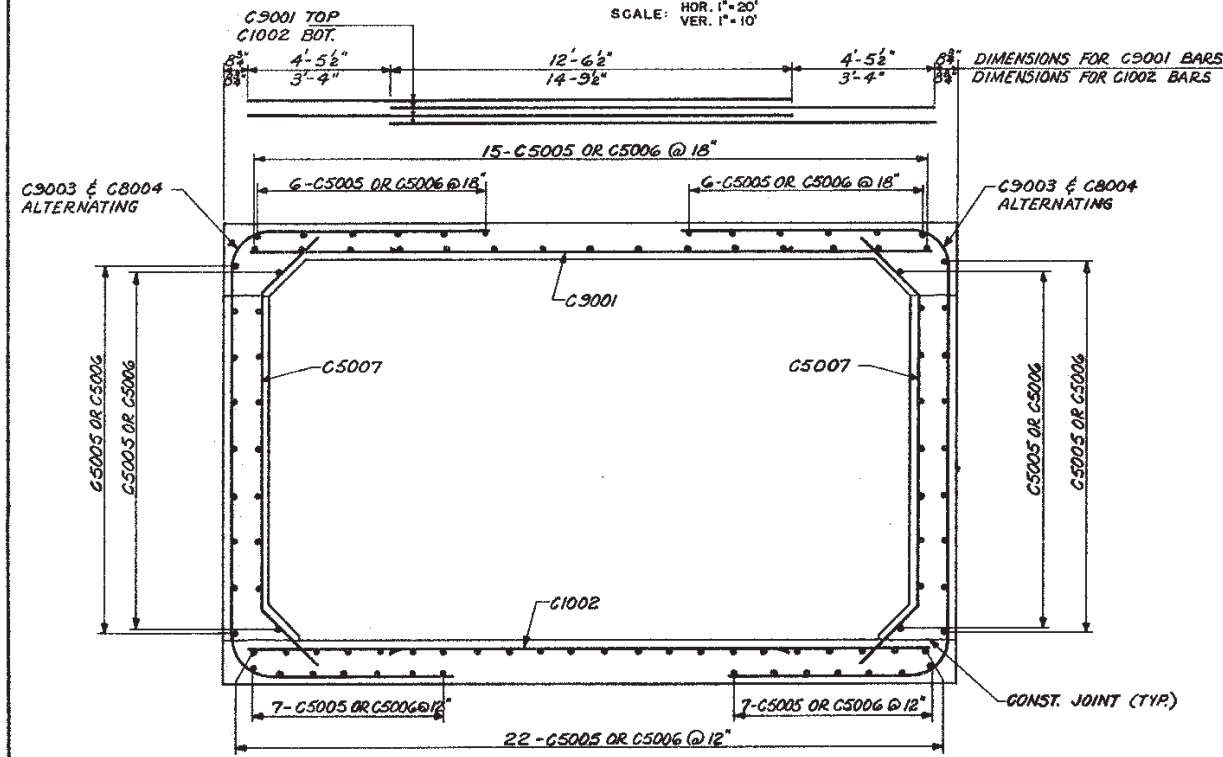
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DRAWN O. J. CHECKED <input checked="" type="checkbox"/>	W.O. NO. 72-11104	72-11104A
DATE 29 NOV. 1972	SITE NO. 3-315	BRIDGE DRAWING NO.
APPROVED <i>[Signature]</i>	CONT. NO. 73-190	3-315-2

NOTE: The complete soil investigation report for this structure may be examined at the Bridge Office and Foundation Office, Downsview, and at the Ottawa District Office.



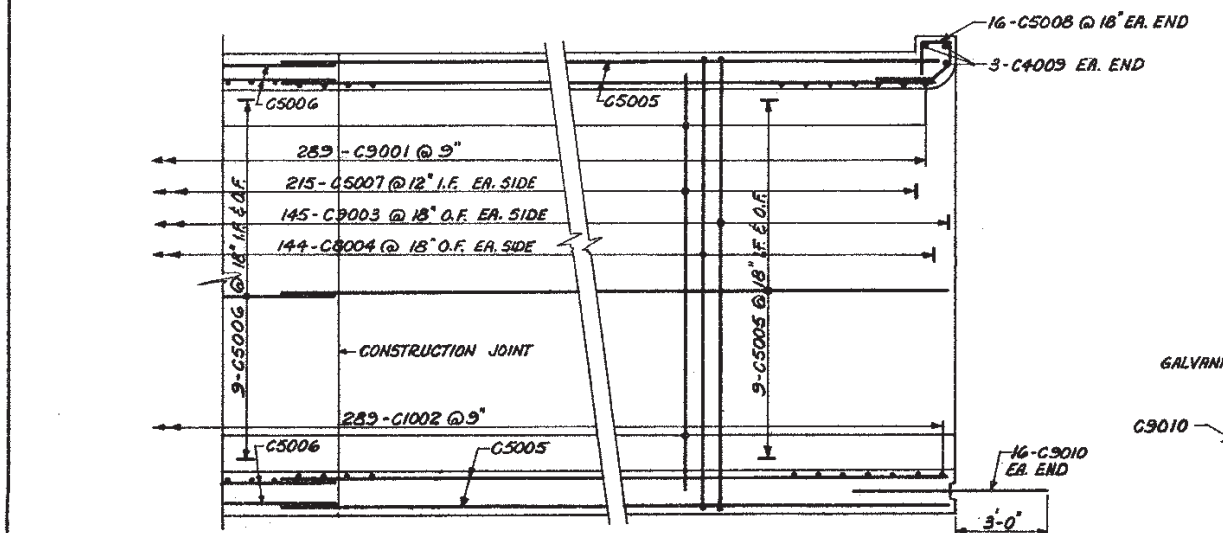
SECTIONAL ELEVATION

SCALE: HOR. 1"=20'
VER. 1"=10'



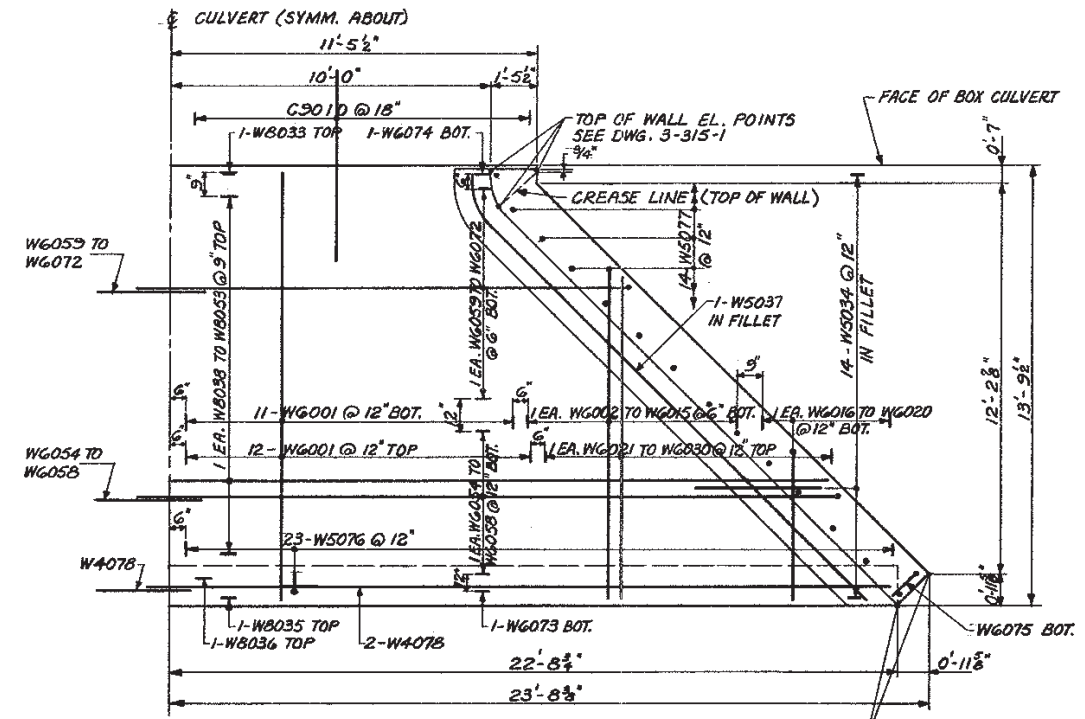
TRANSVERSE SECTION

SCALE: 3/8"=1'-0"



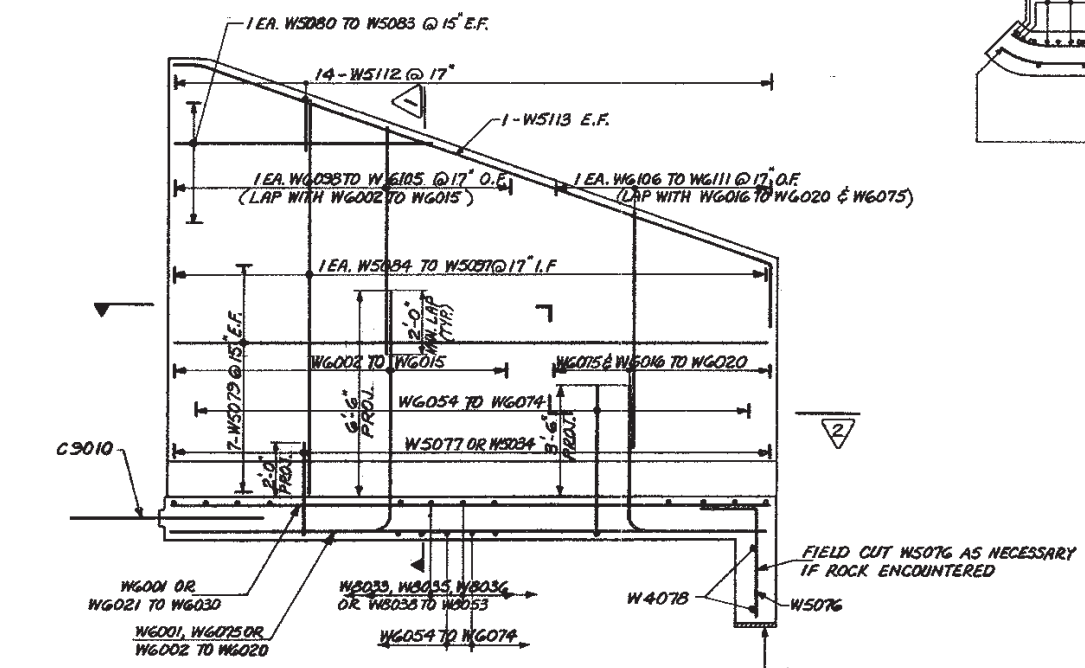
LONGITUDINAL SECTION

SCALE: 3/8"=1'-0"



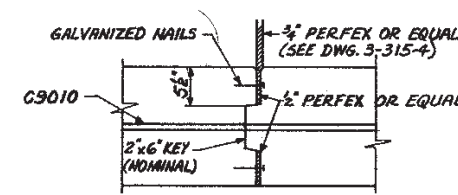
HALF PLAN OF INLET/OUTLET SLAB

SCALE: 3/8"=1'-0"



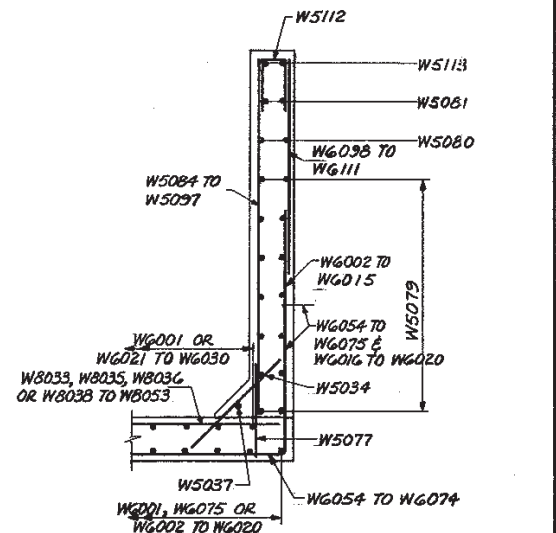
ELEVATION

SCALE: 3/8"=1'-0"



HINGE DETAIL

SCALE: 1"=1'-0"



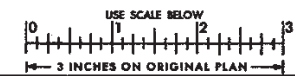
NOTES:
E.F. DENOTES EACH FACE
I.F. DENOTES INSIDE FACE
O.F. DENOTES OUTSIDE FACE

REVISIONS	DATE	BY	DESCRIPTION

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS ONTARIO			
Consulting Engineers & Planners			
McEWEN CREEK (MATHER DRAIN) 1.2 MILES EAST OF WALKLEY RD.			
KING'S HIGHWAY No. 417		DIST. No. 9	
CO. REG. MUN. OTTAWA-CARLETON		TWP. GLOUCESTER LOT 2 CON. VI	
DETAILS			
APPROVED [Signature]		SITE No. 3-315 W.P. No. 10-89-18	
DESIGN [Signature]		CONTRACT No. 73-196	
DRAWING A.G.Y. CHECK C.N.B.		DRAWING No. 3-315-3	
DATE MAR. 73		LOADING 1520-44	



FOR REDUCED PLAN



APPENDIX B
RECORD OF BOREHOLE SHEETS

RECORD OF BOREHOLE No 14-4

1 OF 1

METRIC

W.P. 4074-11-00 LOCATION McEwen Creek Culvert N 5 027 568.3 E 376 451.3 ORIGINATED BY KMY
HWY 417 BOREHOLE TYPE Hollow Stem Auger COMPILED BY KMY
DATUM Geodetic DATE 2014.08.28 - 2014.08.28 CHECKED BY FJG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				
								20	40	60	80	100	W _P	W		
67.9																
0.0	Asphalt (150 mm)															
0.2	Silty Sand and Gravel Dense Grey FILL		1	SS	41											
			2	SS	46										35 47 18 (SI+CL)	
66.5																
1.4	Compact		3	SS	18											
65.7																
2.2	Clay (CH), silty Stiff Grey to Brown		4	SS	12											
			5	SS	8										0 7 40 53	
			6	SS	3											
63.0										11.0 +						
4.9	Silty Clay (CL) Firm Grey		7	SS	2										0 1 56 43	
61.8										+						
6.1	Clayey Silt some Sand and Gravel Hard Grey TILL inferred cobbles and boulders based on auger grinding		8	SS	50/ 100mm										18 19 37 26	
			9	SS	50/ 50mm											
59.2																
8.7	Auger Refusal at 8.7 m on probable bedrock Borehole remained open with water at 7.6 m after drilling															

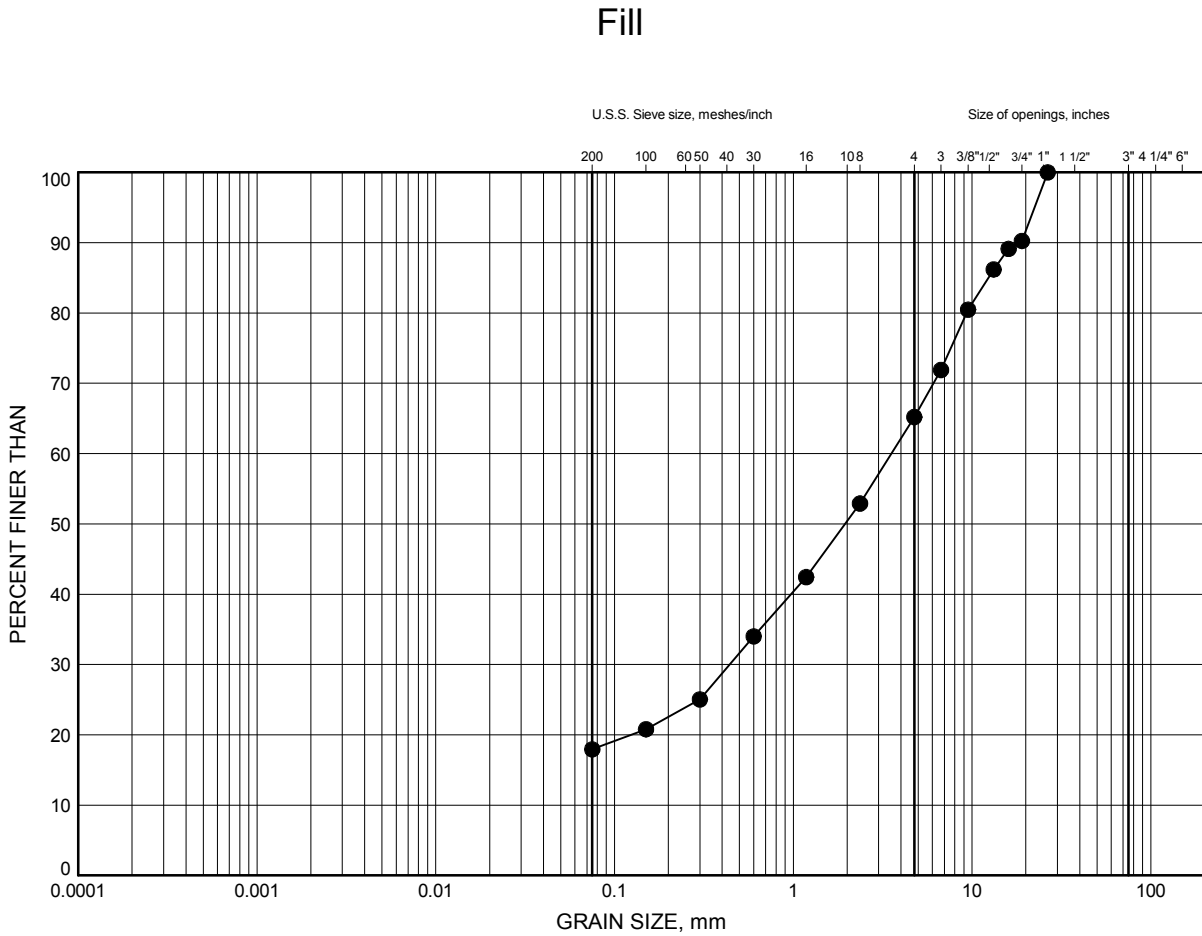
ONTMT4S 19-3405-3-CULVERT 13.GPJ 2012TEMPLATE(MTO).GDT 2/7/15

APPENDIX C
LABORATORY TEST RESULTS

19-3405-3

McEwen Creek Culvert GRAIN SIZE DISTRIBUTION

FIGURE C1



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-4	1.07	66.83

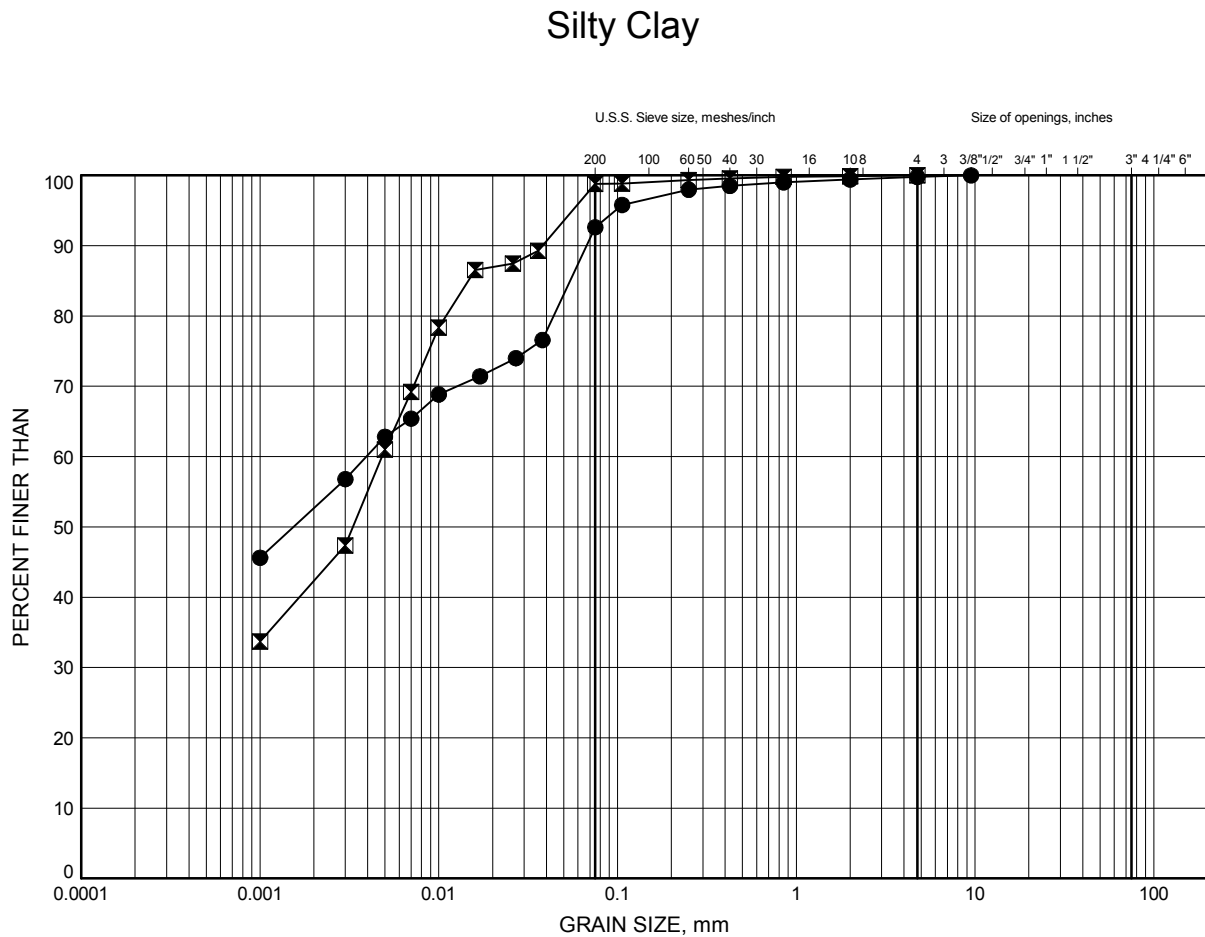
Date November 2014
W.P. 4074-11-00



Prep'd CM
Chkd. FJG

McEwen Creek Culvert GRAIN SIZE DISTRIBUTION

FIGURE C2



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-4	3.35	64.55
⊠	14-4	5.18	62.72

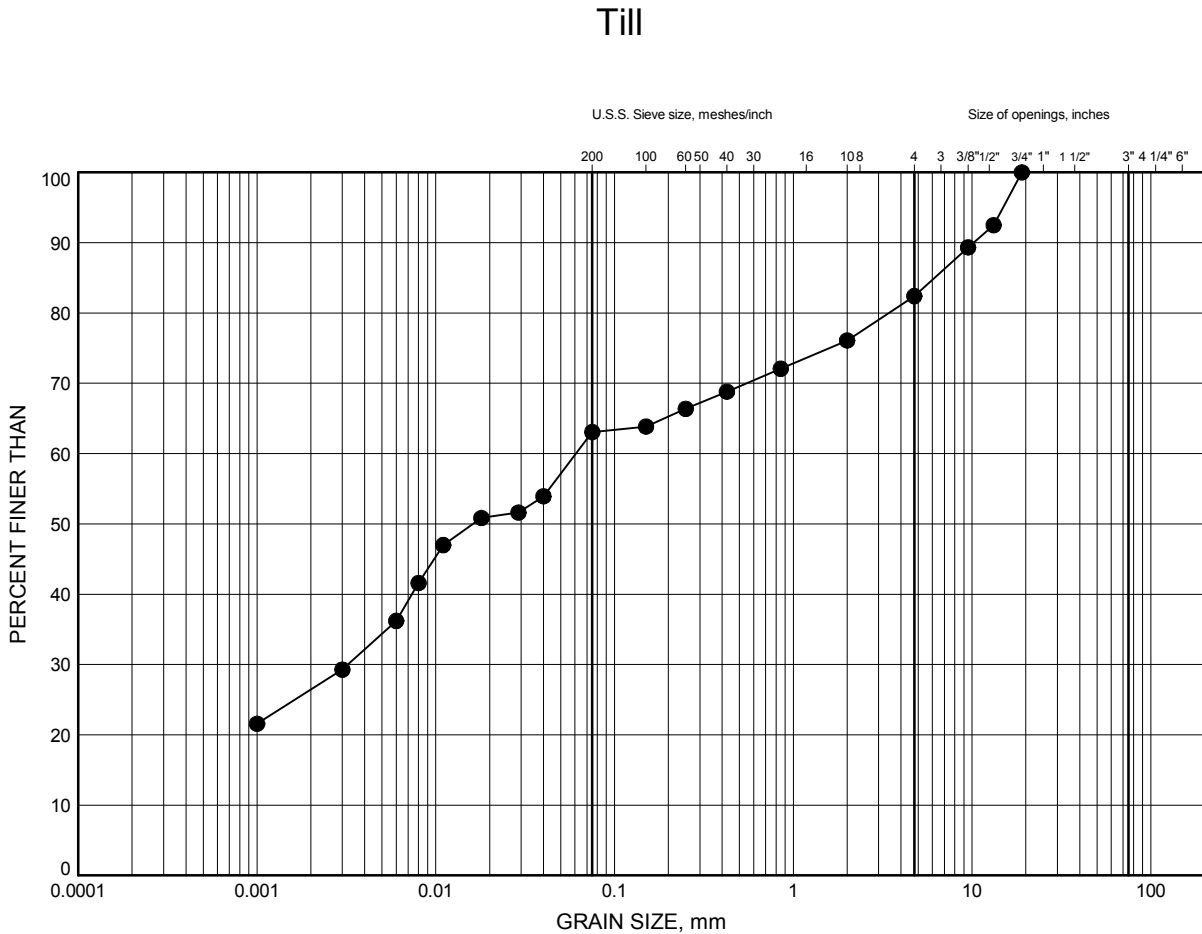
Date November 2014
W.P. 4074-11-00



Prep'd CM
Chkd. FJG

McEwen Creek Culvert GRAIN SIZE DISTRIBUTION

FIGURE C3



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-4	7.01	60.89

Date November 2014
W.P. 4074-11-00

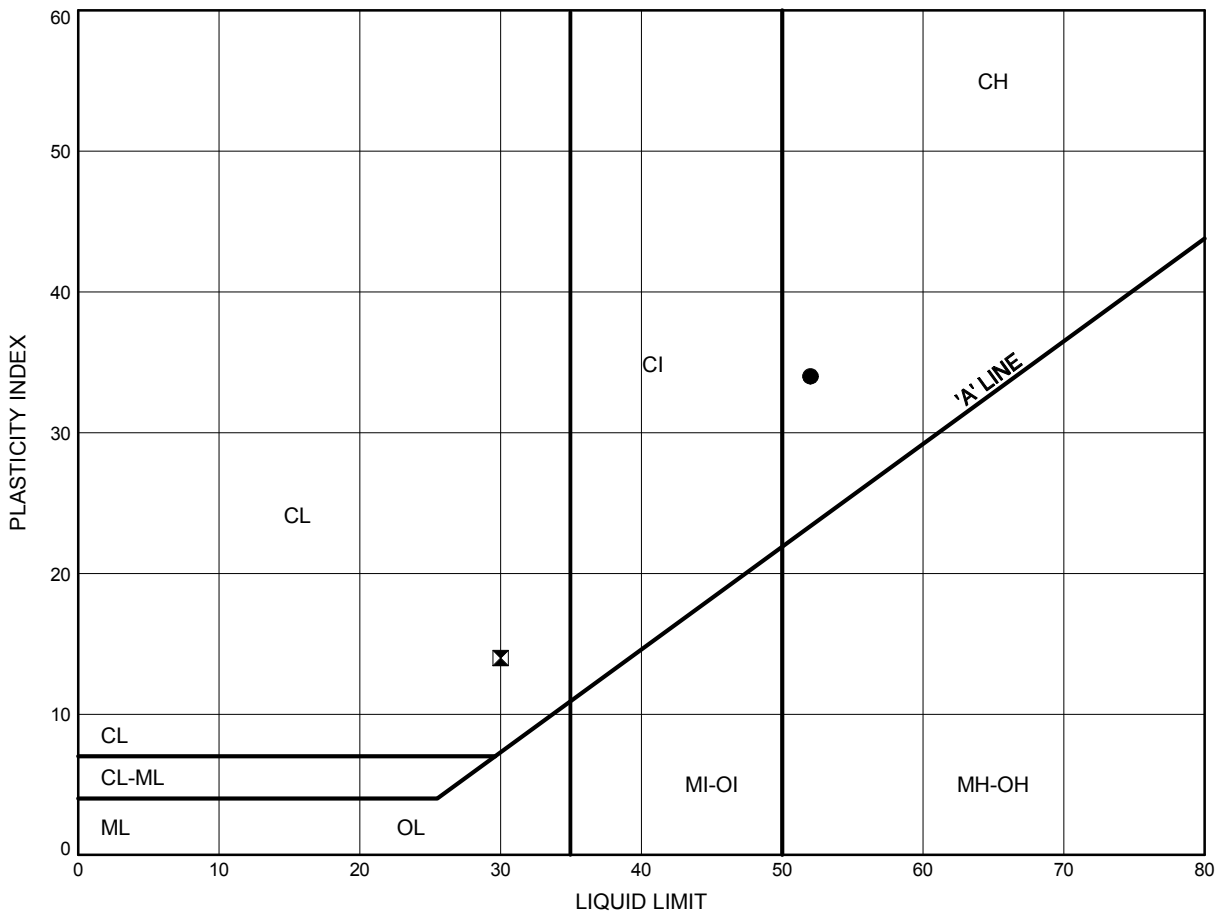


Prep'd CM
Chkd. FJG

McEwen Creek Culvert
ATTERBERG LIMITS TEST RESULTS

FIGURE C4

Silty Clay



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-4	3.35	64.55
⊠	14-4	5.18	62.72

Date November 2014
 W.P. 4074-11-00



Prep'd CM
 Chkd. FJG

APPENDIX D
SELECTED PHOTOGRAPHS

19-3405-3

**GWP 4074-11-00
Site Photographs**

**PRELIMINARY FOUNDATION DESIGN
MCEWEN CREEK CULVERT STRUCTURE (SITE 3-315/C)**

West inlet



Northwest inlet wing wall



**GWP 4074-11-00
Site Photographs**

**PRELIMINARY FOUNDATION DESIGN
MCEWEN CREEK CULVERT STRUCTURE (SITE 3-315/C)**

West inlet looking upstream



East outlet



**GWP 4074-11-00
Site Photographs**

**PRELIMINARY FOUNDATION DESIGN
MCEWEN CREEK CULVERT STRUCTURE (SITE 3-315/C)**

East outlet note erosion of material
behind wingwall



APPENDIX E

**Highway 417 Underpass Bridge Structure; GEOCRETS Report No. 31G5-237
Extension of the Culvert 3-315/C; GEOCRETS Report No. 31G5-240
Hydrogeology Assessment Hunt Club Road Extension from Russell Road to Highway 417
Thurber Engineering Ltd Report No. 19-5438-7**

**FOUNDATION INVESTIGATION REPORT
HUNT CLUB ROAD EXTENSION
HWY 417 UNDERPASS
SITES 6 & 15
CITY OF OTTAWA, ONTARIO**

Geocres Number: 31G5-237

Report to

AECOM

Thurber Engineering Ltd.
2010 Winston Park Drive, Suite 103
Oakville, Ontario
L6H 5R7
Phone: (905) 829 8666
Fax: (905) 829 1166

February 25, 2011

File: 19-5438-7

H:\19\5438\7 Hwy417 Hunt Club IC\Reports & Memos\13-Hwy 417 Structure No.
6 & 15\Final Report\FIR\HWY 417 Underpass Sites 6&15 FIR (Feb25-11).doc



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PART 1 FACTUAL INFORMATION

1	INTRODUCTION	1
2	SITE DESCRIPTION	1
3	SITE INVESTIGATION AND FIELD TESTING	1
4	LABORATORY TESTING	2
5	DESCRIPTION OF SUBSURFACE CONDITIONS	3
5.1	General.....	3
5.2	Topsoil/Organics.....	3
5.3	Silty Clay	3
5.4	Silt Till	4
5.5	Bedrock.....	5
5.6	Water Levels.....	6
6	CLOSURE	7

Appendices

Appendix A	Record of Borehole Sheets
Appendix B	Laboratory Test Results
Appendix C	Borehole Location and Soil Strata Drawing
Appendix D	Factual Data from Previous Investigations

FOUNDATION INVESTIGATION REPORT
HUNT CLUB ROAD EXTENSION
HWY 417 UNDERPASS
SITES 6 & 15
CITY OF OTTAWA, ONTARIO

Geocres Number: 31G5-237

PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the site of the proposed structure to carry Hunt Club Road over Highway 417 in the City of Ottawa, Ontario.

The purpose of the investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, borehole logs, stratigraphic profile and cross-sections and a written description of the subsurface conditions. A model of the subsurface conditions was developed from data obtained in the course of the investigation. This model describes the geotechnical conditions influencing design and construction of the foundations and approach embankments for the proposed bridge.

Thurber carried out the investigation as a sub-consultant to AECOM.

2 SITE DESCRIPTION

The site is situated at the proposed interchange of Highway 417 and Hunt Club Road extension, southeast of City of Ottawa. The lands to the southwest have been developed as industrial. The lands to the south and east of the site are presently mostly agricultural.

The bridge structures lie where the proposed Hunt Club Road Extension crosses Highway 417. Highway 417 carries four-lane traffic running in the west-east direction. South of Highway 417, McEwan Creek merges with Ramsay Creek which carries the surface flow to the north. Ramsay Creek passes underneath the Highway 417 embankment through a rectangular box culvert. The bridge site is located 1.5 km north east of the Hunt Club / Hawthorne intersection and 400 m northeast of Russell Road.

The general stratigraphy of the area is characterized by a clay plain (Leda clay) underlain by glacial till and then by interbedded shale and limestone bedrock.

3 SITE INVESTIGATION AND FIELD TESTING

The soil stratigraphy presented in this report is based on the results of a field investigation carried

out between July 19 and July 29, 2010. The site investigation consisted of drilling and sampling a total of 14 boreholes at the bridge site. These boreholes were advanced to depths of 4.4 to 9.0 m. The approximate locations of the boreholes are shown on the attached Borehole Locations and Soil Strata Drawings in Appendix C.

Field layout for the site investigation was carried out by Thurber using GPS equipment.

Hollow stem auger drilling techniques were used to advance the boreholes in the overburden and diamond coring was used to penetrate and core the bedrock. Overburden samples were obtained using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) and Shelby tube samples were obtained where soft clay was encountered. In-situ vane shear strength tests were conducted in the clay where applicable. It is important to note that the MTO N-Vane was not suitable for the soil conditions (i.e. firm to very stiff clay) encountered at this site. A smaller vane (50.8mm in diameter and 127mm in height with 45 degree tapered ends) was used to determine the in-situ undrained shear strength of the clayey deposit.

The positions of the principal boreholes considered in the preparation of this report, relative to the structure site are as shown in Table 3.1.

Table 3.1 – Borehole Locations Relative to Structures

Location of Structure	Boreholes Considered in Design	
	<i>Current Investigation</i>	<i>Previous Investigation</i>
South Approach	10-16	09-03, 09-17, 09-18, CPTU-02
South Abutment	10-01, 10-02, 10-03	-
South Pier	10-04, 10-05, 10-06	-
North Pier	10-07, 10-08, 10-09	-
North Abutment	10-10, 10-11, 10-12	-
North Approach	10-15	09-27, 09-28

The coordinates and elevations of the boreholes are given on the Borehole Locations and Soil Strata Drawings and on the individual Record of Borehole Sheets in Appendix A.

A standpipe piezometer, consisting of 19 mm PVC pipe with slotted tips, was installed in four of the boreholes to monitor the groundwater level.

A member of Thurber's engineering staff supervised the drilling and sampling operations on a full time basis. The inspector logged the boreholes and the recovered samples and processed them for transport to Thurber's laboratory.

4 LABORATORY TESTING

All recovered soil samples were subjected to visual identification and to natural moisture content determination. The results of this testing are shown on the Record of Borehole sheets in Appendix A.

Selected samples were subjected to gradation analysis (sieve and hydrometer) and Atterberg Limit tests and the results are shown on the Record of Borehole sheets in Appendix A and on the charts

in Appendix B.

Rock cores were logged and Total Core Recovery (TCR), Solid Core Recovery (SCR) and Rock Quality Designation (RQD) were determined on each rock core. Point load tests were conducted on the rock cores to assess the Unconfined Compressive Strength (UCS) of the rock. This information is provided on the borehole logs in Appendix A.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

5.1 General

Reference is made to the Record of Borehole sheets in Appendix A. Details of the encountered soil stratigraphy are presented in that appendix and on the attached Borehole Locations and Soil Strata Drawings in Appendix C. Relevant factual data obtained from previous investigations are also included in Appendix D. An overall description of the stratigraphy is given in the following paragraphs however the factual data presented in the borehole logs governs any interpretation of the site conditions.

In general terms, the site was found to be underlain by a thin veneer of topsoil overlying a deposit of silty clay which in turn is underlain by sandy clayey silt till over interbedded shale and limestone bedrock. Ramsay Creek has eroded its valley into the silty clay layer.

More detailed descriptions of the individual strata are presented below.

5.2 Topsoil/Organics

Topsoil was encountered at the ground surface in all boreholes. The thickness ranged from 100 to 175 mm. Further variations in thickness may occur between or beyond the boreholes and in other areas of the site.

5.3 Silty Clay

A deposit of silty clay was encountered below the topsoil in all boreholes. The thickness of the clay layer ranges from 2.9 m to 4.5 m. The base of the clay layer ranges from Elevation 64.0 to 61.2 m.

The recorded SPT 'N' values in the clay layer ranged from 1 to 27 blows for 0.3 m of penetration. Higher 'N' values were observed in the crust closer to the surface. The vane shear strengths measured in the deposit range from 80 to 133 kPa. The SPT, shear vane and available CPT data (shown in Appendix D) indicate that the silty clay has firm to very stiff consistency, typically with shear strength decreasing with depth. Variations in the assessed strength are due in part to variations in the silt content and the presence of thin seams of silt. The sensitivity of the silty clay, as measured in remoulded vane shear tests, ranged from 2.1 to 7.5 indicating the deposit has low to medium sensitivity.

The recorded natural moisture contents in the clay ranged from 13 to 62%, typically

between 23 and 45%.

The grain size distributions of selected samples of this soil are plotted on the Record of Borehole sheets and shown in Figures B2 to B5 in Appendix B. The gradation test results are summarized below.

Soil Particles	(%)
Gravel	0
Sand	0 to 8
Silt	32 to 58
Clay	38 to 68

Atterberg Limit tests (Figures B7 through B10) indicate that the silty clay deposit has low to high plasticity, with varying percentage of silt content. The plasticity of the deposit generally lies in the high plasticity range (CH) near the surface, and low plasticity range (CL) near its base.

The results of an oedometer (one-dimensional consolidation) tests carried out on an undisturbed silty clay sample are summarized on the borehole log (09-18, located near south abutment) in Appendix D and in the following table:

BH	09-18
Sample ID	TW1
Unit Weight (γ) kN/m³	17.1
Specific Gravity (G_s)	2.76
Initial Void Ratio (e_o)	1.371
Pre-consolidation Pressure (P'_c)	180
Over-consolidation Ratio (OCR)	4.1
$P'_c - P'_o$ (OCD) kPa	136
Compression Index (C_c)	0.635
Recompression Index (C_r)	0.080

The results of the oedometer test, insitu vane and piezocone testing indicate that the clayey deposit is heavily over-consolidated (OCR = 20 to 6) in the crust and becomes over-consolidated (OCR = 6 to 2) with depth.

5.4 Silt Till

A silt till layer was encountered below the silty clay in all boreholes. This soil is described as trace clay to clayey, trace sand to sandy, trace gravel. The thickness of this till layer varied from 0.3 to 2.0 m. The underside of the silt till ranges from elevation 62.2 to 60.7.

This soil is classified as soft to hard having SPT 'N' values of 2 to 51 blows for 0.3 m of

penetration. High SPT blow counts of over 50 blows / 0.15 m penetration were noted at the base of the till layer, which may indicate the presence of cobbles and boulders or rock pieces.

The measured natural moisture ranged between 8 to 18 %.

The grain size distributions of selected samples of this soil are plotted on the Record of Borehole sheets and shown in Figure B1 in Appendix B. The gradation test results are summarized below.

Soil Particles	(%)
Gravel	0 to 1
Sand	18 to 37
Silt	47 to 53
Clay	16 to 28

Atterberg Limit tests (Figure B6) indicate that the silt till deposit is low in plasticity.

5.5 Bedrock

Below the silt till, the boreholes encountered bedrock consisting of shale with frequent strong limestone interbeds. The bedrock is grey in colour and is moderately to highly weathered at the surface, becoming slightly weathered to fresh with depth. The shale is laminated to thinly bedded with vertical joints and occasional highly broken zones noted within the core samples. Occasional clay seams, up to 150 mm in thickness, were noted in the boreholes. Bedrock was encountered at the following depths and elevations.

Table 5.1 – Bedrock Depths and Elevations (in metres)

South Abutment		South Pier		North Pier		North Abutment	
Depth (m)	Elev.	Depth (m)	Elev.	Depth (m)	Elev.	Depth (m)	Elev.
<i>BH 10-01</i>		<i>BH 10-04</i>		<i>BH 10-07</i>		<i>BH 10-10</i>	
4.4	61.1	4.4	62.2	5.0	60.9	4.6	60.9
<i>BH 10-02</i>		<i>BH 10-05</i>		<i>BH 10-08</i>		<i>BH 10-11</i>	
4.6	61.2	4.8	60.7	4.6	60.9	4.6	61.4
<i>BH 10-03</i>		<i>BH 10-06</i>		<i>BH 10-09</i>		<i>BH 10-12</i>	
4.9	61.3	5.0	60.9	4.6	61.3	4.6	61.0

The following properties were measured from the rock cores recovered at the abutment and pier boreholes:

Total core recovery (TCR)	93 - 100%
Solid core recovery (SCR)	40 – 100%
Rock Quality Designation (RQD)	40 – 100%
Unconfined Compressive Strength assessed from Point load Test	8.5 to 91 MPa

The RQD values are indicative of poor to excellent quality rock.

The UCS values are indicative of weak (Shale) to strong (Limestone) rock.

5.6 Water Levels

The initial and final groundwater depths and elevations are shown in Table 5.2. The values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level will be influenced by Ramsay Creek and may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

Table 5.2 – Groundwater Depths (meters) and Elevations

July 26, 2010 to July 30, 2010

South Abutment (BH 10-03)		South Pier (BH 10-05)		North Pier (BH 10-07)		North Abutment (BH 10-12)	
Depth (m)	Elev.	Depth (m)	Elev.	Depth (m)	Elev.	Depth (m)	Elev.
1.5	64.7	1.5	64.1	1.0	64.9	1.6	64.0
1.5	64.7	-	-	0.9	65.0	1.6	64.0

6 CLOSURE

Surveying of the locations of the boreholes was carried out by staff from Thurber using GPS equipment.

Full time supervision of field activities was carried out by Mr. Stephane Loranger, C.E.T. of Thurber.

Overall supervision of the field program and preparation of the factual report were carried out by Mr. Lukasz Gilarski, E.I.T. and Mr. Jason Lee, P.Eng.

The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.

Lukasz Gilarski, E.I.T.

Jason Lee, P.Eng., M.Sc.
Geotechnical Engineer



P.K. Chatterji, P.Eng., Ph.D.
Review Principal



Appendix A
Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

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

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



Water Level

C_{pen}






Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

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

EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION		SYMBOLS	
Fresh (FR)	No visible signs of weathering.		
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.		CLAYSTONE
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.		COAL
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.		Bedrock (general)

DISCONTINUITY SPACING		STRENGTH CLASSIFICATION			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.

TERMS					
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen				
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.				

RECORD OF BOREHOLE No BH10-01

1 OF 1

METRIC

W.P. 19-5438-7 LOCATION N 5 027 512.7 E 376 399.1 ORIGINATED BY SLL
 HWY 417/Hunt Club Road BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2010.07.19 - 2010.07.19 CHECKED BY LPG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N VALUES			SHEAR STRENGTH kPa									
65.5								20	40	60	80	100					
0.0	TOPSOIL: (100mm)							20	40	60	80	100					
0.1	Silty CLAY , trace sand, trace rootlets Firm to Stiff Dark Brown Moist		1	SS	12		65										
			2	SS	6		64										
	Becoming Grey		3	SS	3		63										0 4 58 38
62.5																	
3.0	Sandy, Clayey, SILT , trace gravel Stiff Grey Moist (TILL)		4	SS	7		62										
61.1	Auger refusal at 4.4m		5	SS	50/ 0.025		61										No Recovery
4.4	SHALE , slightly weathered to fresh, thinly bedded, frequent limestone interbeds, grey, medium strong to strong Occasional mechanical breaks 75mm vertical joints at 4.4m 50mm rubble zone at 4.8m		1	RUN			60										RUN 1# TCR=100%, SCR=98%, RQD=67% UCS=74.2MPa
			2	RUN			59										RUN 2# TCR=100%, SCR=100%, RQD=97% UCS=47.3MPa
58.0							58										
7.5	END OF BOREHOLE AT 7.5m. BOREHOLE BACKFILLED WITH HOLEPLUG BENTONITE TO 1.6m, THEN CUTTINGS TO SURFACE.																

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BH10-02

1 OF 1

METRIC

W.P. 19-5438-7 LOCATION N 5 027 503.2 E 376 416.0 ORIGINATED BY SLL
 HWY 417/Hunt Club Road BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2010.07.20 - 2010.07.20 CHECKED BY LPG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N VALUES			20 40 60 80 100	W _P W W _L	20 40 60	GR SA SI CL		
65.8													
0.0	TOPSOIL, with rootlets (125mm)												
0.1	Silty CLAY, trace sand Stiff to Firm Brown Moist		1	SS	12		65						0 1 39 60
			2	SS	5		64						
			3	SS	3		63						
62.5	Becoming grey		4	SS	4		62						
3.4	Sandy, ClayeySILT, trace gravel Firm to Stiff Dark Grey Moist to Wet (TILL)						61						
61.2	Auger refusal at 4.6m		5	SS	50/		60						
4.6	SHALE slightly weathered to fresh, thinly bedded, frequent limestone interbeds, grey, medium strong to strong Occasional mechanical breaks 100mm rubble zone at 4.7m Vertical joints at: 75mm at 5.6m 175mm at 5.9m 75mm at 6.5m 50mm at 6.9m		1	RUN	0.050		59						No Recovery
			2	RUN			58						
			3	RUN									
57.5													
8.3	END OF BOREHOLE AT 8.3m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.9m, THEN CUTTINGS TO SURFACE.												

ONTMT4S 4387.GPJ 10/4/10

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BH10-03

1 OF 1

METRIC

W.P. 19-5438-7 LOCATION N 5 027 490.8 E 376 436.1 ORIGINATED BY SLL
 HWY 417/Hunt Club Road BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2010.07.19 - 2010.07.19 CHECKED BY LPG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
								20 40 60 80 100	WATER CONTENT (%)			
66.2												
0.0												
0.1	TOPSOIL, with rootlets (100mm)											
	Silty CLAY, trace rootlets Very Stiff to Firm Brown Moist		1	SS	16							
			2	SS	4							
	With silt seams		3	SS	3							
			4	SS	1							
61.6												
4.6	Sandy ClayeySILT, trace gravel		5	SS	59/							
61.3	Hard				0.150							
4.9	Grey Moist (TILL) Shale fragments Auger refusal at 4.9m		1	RUN								
	SHALE, slightly weathered to fresh, thinly bedded, frequent limestone interbeds, grey, weak to strong Occasional mechanical breaks Rubble zone at: 75mm at 5.0m 50mm at 5.3m											
			2	RUN								
58.2			3	RUN								
8.0	END OF BOREHOLE AT 8.0m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.											
	WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2010.07.26 1.50 64.67 2010.07.30 1.48 64.69											

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BH10-04

1 OF 1

METRIC

W.P. 19-5438-7 LOCATION N 5 027 568.3 E 376 409.0 ORIGINATED BY SLL
 HWY 417/Hunt Club Road BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2010.07.20 - 2010.07.20 CHECKED BY LPG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
66.7								20	40	60	80	100		
0.0	TOPSOIL , with rootlets (125mm)													
0.1	Silty CLAY , trace sand, trace rootlets Firm to Stiff Brown Moist		1	SS	10		66							
			2	SS	5		65							
	Becoming grey		3	SS	4		64							
63.7														
3.0	Sandy SILT , some clay to clayey Stiff Dark Grey Moist (TILL)		4	SS	5		63							0 37 47 16
62.2	Auger refusal at 4.4m													
4.4	SHALE slightly weathered to fresh, thinly bedded, frequent limestone interbeds, grey, medium strong to strong Vertical joints at: 150mm at 4.6m 75mm at 7.5m		5	SS	50/ 0.00		62						FI 6 4 1 2 1 2 3	No Recovery RUN 1# TCR=100%, SCR=98%, RQD=78% UCS=50.1MPa RUN 1# TCR=95%, SCR=95%, RQD=70% UCS=38.3MPa
			1	RUN			61							
			1	RUN			60							
59.0														
7.7	END OF BOREHOLE AT 7.7m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.4m, THEN CUTTINGS TO SURFACE.													

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BH10-05

1 OF 1

METRIC

W.P. 19-5438-7 LOCATION N 5 027 553.3 E 376 430.1 ORIGINATED BY SLL
 HWY 417/Hunt Club Road BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2010.07.29 - 2010.07.29 CHECKED BY LPG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
65.5								20 40 60 80 100					
0.0								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					
0.1	TOPSOIL with rootlets (125mm)							20 40 60 80 100					
	Silty CLAY, trace sand Firm to Very Stiff Brown Moist		1	SS	15		65	20 40 60 80 100					
	Becoming grey		2	SS	4		64	20 40 60 80 100					0 0 37 63
			3	SS	4		63	20 40 60 80 100					
62.5								20 40 60 80 100					
3.0	Clayey SILT, some sand, trace gravel, trace shale fragments Hard Dark Grey Moist to Wet (TILL)		4	SS	51		62	20 40 60 80 100					1 18 53 28
							61	20 40 60 80 100					
60.7	Auger refusal at 4.8m		5	SS	50/			20 40 60 80 100					
4.8	SHALE moderately to slightly weathered, thinly bedded, frequent limestone interbeds, grey, weak to strong Occasional mechanical breaks Rubble zone between 25mm to 50mm at 4.8m, 5.0m, 5.8m		1	RUN	0.025		60	20 40 60 80 100					RUN 1# TCR=93%, SCR=80%, RQD=60% UCS=8.5MPa
			2	RUN			59	20 40 60 80 100					RUN 2# TCR=98%, SCR=98%, RQD=92% UCS=32.6MPa
							58	20 40 60 80 100					
57.7								20 40 60 80 100					
7.8	END OF BOREHOLE AT 7.8m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.							20 40 60 80 100					
	WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2010.07.30 1.45 64.07							20 40 60 80 100					

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BH10-06

1 OF 1

METRIC

W.P. 19-5438-7 LOCATION N 5 027 547.1 E 376 441.1 ORIGINATED BY SLL
 HWY 417/Hunt Club Road BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2010.07.28 - 2010.07.28 CHECKED BY LPG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
65.9								20 40 60 80 100					
0.0	TOPSOIL, with rootlets (150mm)							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					
0.2	Silty CLAY, trace sand Firm to Stiff Brown Moist		1	SS	13		65	20 40 60 80 100					
			2	SS	7		64	20 40 60 80 100					
	Becoming grey		3	SS	5		63	20 40 60 80 100					
	Moist to Wet		4	SS	3			20 40 60 80 100					
62.5	Clayey SILT, some sand, trace gravel, trace shale fragments Stiff to Hard Dark Grey Moist (TILL)		5	SS	5		62	20 40 60 80 100					0 8 49 43
3.4			6	SS	58/ 0.225		61	20 40 60 80 100					
60.9	Auger refusal at 5.0m							20 40 60 80 100					
5.0	SHALE, moderately weathered to fresh, thinly bedded, frequent limestone interbeds, grey, weak to strong Occasional mechanical breaks Rubble zone at: 75mm at 5.0m 25mm at 5.4m 25mm at 7.0m Vertical joints at: 75mm at 5.6m 150mm at 7.1m		1	RUN			60	20 40 60 80 100				FI 8 6 4 2 1	RUN 1# TCR=100%, SCR=90%, RQD=54% UCS=23.4MPa
			2	RUN			59	20 40 60 80 100				1 4 4	RUN 2# TCR=100%, SCR=86%, RQD=86% UCS=27.4MPa
			3	RUN			58	20 40 60 80 100				1 0	RUN 3# TCR=94%, SCR=94%, RQD=82% UCS=36.9MPa
57.8	END OF BOREHOLE AT 8.1m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.5m, THEN CUTTINGS TO SURFACE.							20 40 60 80 100					
8.1								20 40 60 80 100					

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BH10-07

1 OF 2

METRIC

W.P. 19-5438-7 LOCATION N 5 027 630.1 E 376 418.8 ORIGINATED BY SLL
 HWY 417/Hunt Club Road BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2010.07.23 - 2010.07.23 CHECKED BY LPG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
66.0								20	40	60	80	100		
0.0	TOPSOIL , with rootlets (125mm)							20	40	60	80	100		
0.1	Silty CLAY , trace sand Firm to Stiff Brown Moist		1	SS	13		65							0 3 47 50
			2	SS	16		64							
	Becoming grey		3	SS	4		63							
	silt seams		4	SS	3		62							
61.7			5	SS	2		61							
4.3	Sandy Clayey SILT , trace gravel, trace shale fragments Firm to Hard Grey		6	SS	51/ 0.275		61							
60.9	Wet (TILL)													
5.0	Auger refusal at 5.0m		1	RUN			60							RUN 1# TCR=98%, SCR=92%, RQD=79% UCS=42.5MPa
	SHALE slightly weathered to fresh, thinly bedded, frequent limestone interbeds, grey, medium strong to strong 150mm clay seams at 5.4m		2	RUN			59							RUN 2# TCR=100%, SCR=100%, RQD=80% UCS=59.8MPa
			3	RUN			58							RUN 3# TCR=100%, SCR=100%, RQD=96%
57.0							57							UCS=80.1MPa
9.0	END OF BOREHOLE AT 9.0m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.													

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

METRIC

[illegible]

RECORD OF BOREHOLE No BH10-08

1 OF 1

METRIC

W.P. 19-5438-7 LOCATION N 5 027 618.9 E 376 432.5 ORIGINATED BY SLL
 HWY 417/Hunt Club Road BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2010.07.23 - 2010.07.23 CHECKED BY LPG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
65.4								20 40 60 80 100					
0.0	TOPSOIL, with rootlets (125mm)							20 40 60 80 100					
0.1	Silty CLAY , trace sand, trace rootlets Firm to Stiff Dark Brown Moist		1	SS	10		65						
	Becoming grey		2	SS	7		64						
			3	SS	4		63						0 1 44 55
	with silt seams		4	SS	4		62						
61.2			5	SS	1		61						0 2 56 42
4.3	Sandy, Clayey, SILT , trace gravel, trace shale fragments						61					FI	
60.9	Firm to Hard Dark Grey Wet (TILL)						60					3	
4.6	Auger refusal at 4.6m		1	RUN			59					7	
	SHALE , moderately weathered to slightly weathered, thinly bedded, frequent limestone interbeds, grey, medium strong to strong Occasional mechanical breaks 25mm rubble zone at 5.6m, 5.8m and 6.2m		2	RUN			58					3	RUN 1# TCR=97%, SCR=90%, RQD=43% UCS=85.9MPa
57.8												8	
7.6	END OF BOREHOLE AT 7.6m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.4m, THEN CUTTINGS TO SURFACE.											4	
												3	
												1	RUN 2# TCR=98%, SCR=97%, RQD=68% UCS=36.5MPa
												2	
												2	

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BH10-09

1 OF 1

METRIC

W.P. 19-5438-7 LOCATION N 5 027 609.9 E 376 447.7 ORIGINATED BY SLL
HWY 417/Hunt Club Road BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2010.07.22 - 2010.07.22 CHECKED BY LPG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
65.9								20 40 60 80 100					
0.0	TOPSOIL, with rootlets (150mm)												
0.2	Silty CLAY , trace rootlets Firm to Very Stiff Dark Brown Moist		1	SS	16		65						
			2	SS	6		64						No Recovery
	Becoming grey		3	SS	5		63						
	With silt seams		4	SS	2								0 0 55 45
62.1													
3.7	Clayey SILT , some sand, trace gravel, trace shale fragments Firm Dark Grey Wet (TILL)		5	SS	4		62						
61.3	Auger refusal at 4.6m												
4.6	SHALE , slightly weathered to fresh, thinly bedded, frequent limestone interbeds, grey, medium strong to strong Occasional mechanical breaks		1	RUN			61						RUN 1# TCR=97%, SCR=92%, RQD=67% UCS=51.5MPa
	50mm rubble zone at 5.9m						60						
			2	RUN			59						RUN 2# TCR=100%, SCR=100%, RQD=100% UCS=91.0MPa
58.2													
7.6	END OF BOREHOLE AT 7.6m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 2.0m, THEN CUTTINGS TO SURFACE.												

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

RECORD OF BOREHOLE No BH10-10

1 OF 1

METRIC

W.P. 19-5438-7 LOCATION N 5 027 685.1 E 376 422.7 ORIGINATED BY SLL
 HWY 417/Hunt Club Road BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2010.07.22 - 2010.07.22 CHECKED BY LPG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						PLASTIC LIMIT w _P NATURAL MOISTURE CONTENT w LIQUID LIMIT w _L WATER CONTENT (%)						
65.6								20	40	60	80	100								
0.0	TOPSOIL, with rootlets (125mm)																			
0.1	Silty CLAY, trace sand, trace rootlets Firm to Very Stiff Brown Moist																			
			1	SS	14														0 1 39 60	
			2	SS	7															
	with silt seams Becoming grey		3	SS	3															
62.1																				
3.4	SILT, some clay, trace to some sand Firm to Hard Dark Grey Moist (TILL)																			
			4	SS	4															
60.9	Auger refusal at 4.6m		5	SS	50/															
4.6	SHALE, slightly weathered to fresh, thinly bedded, frequent limestone interbeds, grey, medium strong to strong Rubble Zones at: 225mm at 5.8m 25mm at 6.6m 50mm at 7.0m 50mm at 7.7m Vertical joints at: 575m at 5.7m 600mm at 6.3m 125mm at 7.2m 75mm at 7.7m				0.075															
			1	RUN															RUN 1# TCR=100%, SCR=64%, RQD=55% UCS=38.5MPa	
			2	RUN															RUN 2# TCR=100%, SCR=40%, RQD=40% UCS=26.8MPa	
57.8																				
7.8	END OF BOREHOLE AT 7.8m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.9m, THEN CUTTINGS TO SURFACE.																			

ONTMT4S 4387.GPJ 10/4/10

RECORD OF BOREHOLE No BH10-11

1 OF 1

METRIC

W.P. 19-5438-7 LOCATION N 5 027 675.2 E 376 440.7 ORIGINATED BY SLL
 HWY 417/Hunt Club Road BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2010.07.21 - 2010.07.21 CHECKED BY LPG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*"N" VALUES			SHEAR STRENGTH kPa		W P W W L			
66.0								20 40 60 80 100					
0.0	TOPSOIL , with rootlets (150mm)							○ UNCONFINED + FIELD VANE					
0.2	Silty CLAY , trace sand, trace rootlets Firm to Very Stiff Dark Brown Moist		1	SS	27		65	● QUICK TRIAXIAL × LAB VANE					
	Becoming grey		2	SS	6		64		>>--				
	with silt seams		3	SS	5		63		>>--				
62.2													
3.8	SILT , some sand, some clay Firm to Hard Dark Grey Moist (TILL)		4	SS	7		62						
61.4	Auger refusal at 4.6m		5	SS	50/								
4.6	SHALE slightly weathered to fresh, thinly bedded, frequent limestone interbeds, grey, medium strong to strong Rubble zone at: 50mm at 5.1m 75mm at 5.9m 50mm at 7.0m 113mm at 7.2m Vertical joints at: 125mm at 5.4m 225mm at 5.8m 138mm at 7.3m		1	RUN	0.050		61						
			2	RUN			59						
58.3													
7.7	END OF BOREHOLE AT 7.7m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.6m, THEN CUTTINGS TO SURFACE.												

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

METRIC



+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No BH10-13

1 OF 1

METRIC

W.P. 19-5438-7 LOCATION N 5 027 615.1 E 376 478.3 ORIGINATED BY SLL
 HWY 417/Hunt Club Road BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2010.07.27 - 2010.07.27 CHECKED BY LPG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w _P w w _L WATER CONTENT (%)				
67.3								20	40	60	80	100							
0.0	SAND , trace to some gravel, trace silt Dense to Loose Brown Moist (FILL)						67												
			1	SS	30										○				
							66									○			
			2	SS	21											○			
							65									○			
			3	SS	7											○			
							64									○			
			4	SS	3														
63.2																			
4.1	Silty CLAY , some sand Firm to Hard Grey Moist						63												
			5	SS	4											┌─○			
							62												
61.7			6	SS	50/											○			
5.5	END OF BOREHOLE AT 5.5m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE OPEN AND DRY ON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 2.3m, THEN CUTTINGS TO SURFACE.				0.050														

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BH10-14

1 OF 1

METRIC

W.P. 19-5438-7 LOCATION N 5 027 633.7 E 376 475.0 ORIGINATED BY SLL
 HWY 417/Hunt Club Road BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2010.07.21 - 2010.07.21 CHECKED BY LPG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							PLASTIC LIMIT W _P NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L			
65.0								20	40	60	80	100						
0.0	TOPSOIL, with rootlets (125mm)																	
0.1	Silty CLAY , trace sand, trace rootlets Stiff to Firm Brown Moist		1	SS	12		64											
			2	SS	6		63											
	Becoming grey		3	SS	4													0 1 61 38
62.0							62											
3.0	Clayey Sandy SILT , trace gravel Soft Dark Grey Moist to Wet (TILL)		4	SS	2													1 32 45 22
61.2																		
3.8	END OF BOREHOLE AT 3.8m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.1m, THEN CUTTINGS TO SURFACE.																	

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

RECORD OF BOREHOLE No BH10-15

1 OF 1

METRIC

W.P. 19-5438-7 LOCATION N 5 027 683.5 E 376 454.3 ORIGINATED BY SLL
 HWY 417/Hunt Club Road BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2010.07.22 - 2010.07.22 CHECKED BY LPG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N VALUES			SHEAR STRENGTH kPa								
66.6								20	40	60	80	100				
0.0	TOPSOIL, with rootlets (125mm)															
0.1	Silty CLAY, trace rootlets Firm to Very Stiff Brown Moist		1	SS	20											
	Becoming grey		2	SS	8											0 0 35 65
	with silt seams		3	SS	6											
	Some sand, trace shale fragments		4	SS	3											0 0 55 45
63.1	Sandy, Clayey,SILT, trace gravel, trace shale fragments Firm Dark Grey Moist (TILL)		5	SS	3											
62.1																
4.4	END OF BOREHOLE AT 4.4m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE OPEN AND WATER LEVEL AT 3.1m ON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.1m, THEN CUTTINGS TO SURFACE. CONTINUOUS SHEAR VANE TESTS CARRIED OUT AT 1.5m WEST OF BH10-15.															

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BH10-16

1 OF 1

METRIC

W.P. 19-5438-7 LOCATION N 5 027 487.2 E 376 413.6 ORIGINATED BY SLL
 HWY 417/Hunt Club Road BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2010.07.20 - 2010.07.20 CHECKED BY LPG

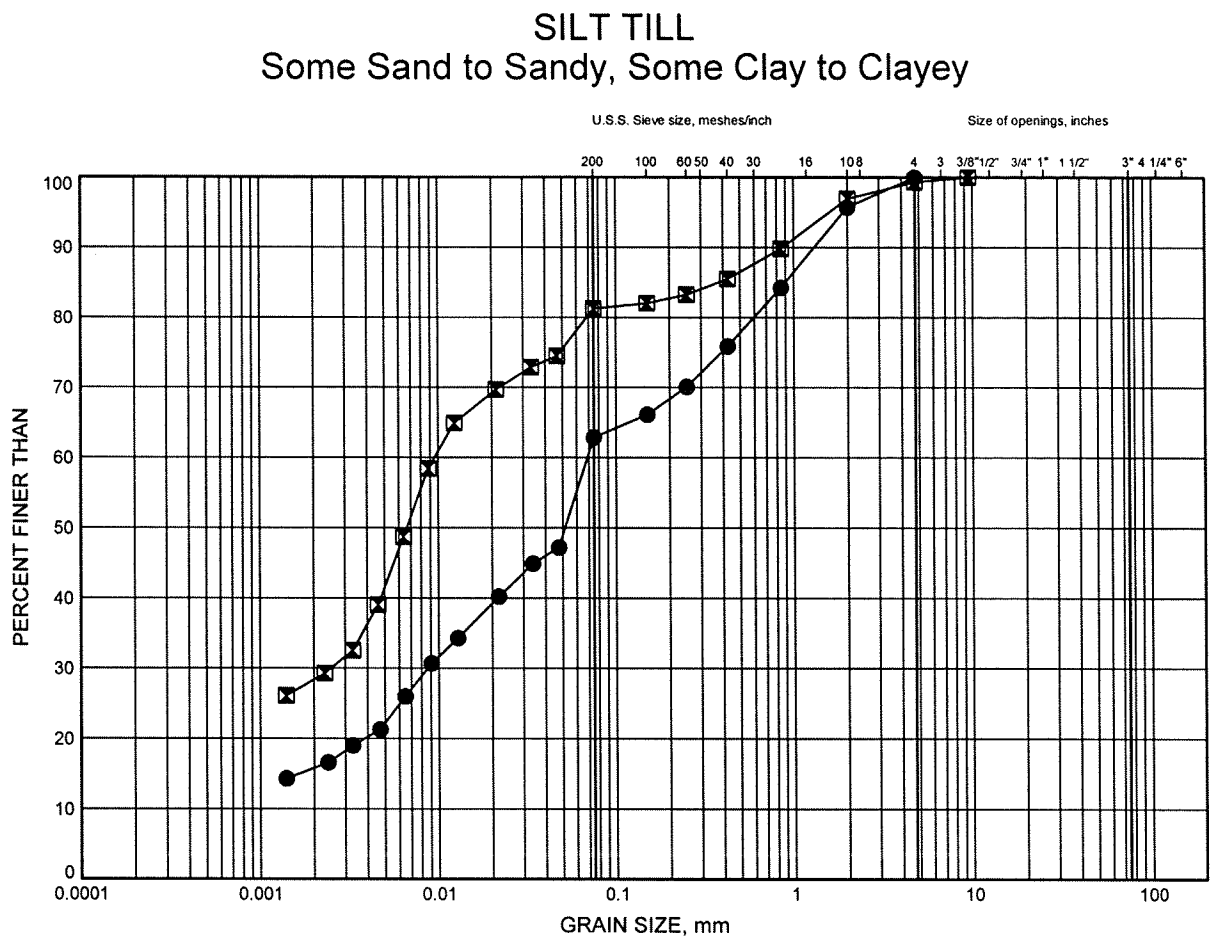
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ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
67.0														
0.0														
0.1	<div>TOPSOIL, with rootlets (100mm)</div> <div>Silty CLAY, trace sand Firm to Very Stiff Brown Moist</div>	<div></div>												
			1	SS	13									
			2	SS	4									
	Becoming grey													
	With silt seams		3	SS	3									
64.0														
3.0	<div>Sandy, ClayeySILT, trace gravel, trace shale fragments Soft to Hard Grey Moist (TILL)</div>	<div></div>	4	SS	2									
62.1			5	SS	63/ 0.175									
5.0	END OF BOREHOLE AT 5.0m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE OPEN AND WATER LEVEL AT 4.0m ON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.5m, THEN CUTTINGS TO SURFACE.													

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

Appendix B
Laboratory Test Results

GRAIN SIZE DISTRIBUTION

FIGURE B1



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH10-04	3.35	63.30
⊠	BH10-05	3.31	62.21

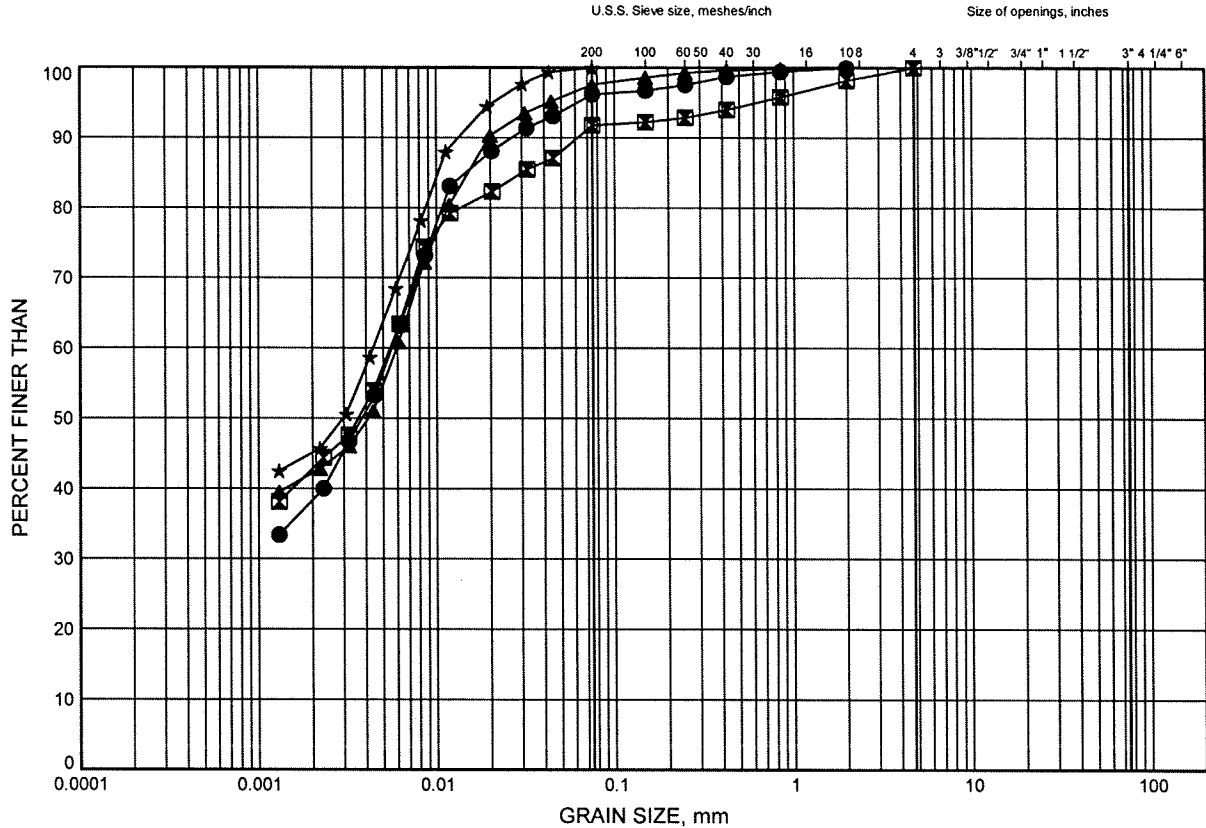


W.P.# 19-5438-7
Prepared By AN
Checked By JPL

GRAIN SIZE DISTRIBUTION

FIGURE B2

SILTY CLAY (CL)



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH10-01	2.59	62.93
⊠	BH10-06	3.35	62.53
▲	BH10-08	4.04	61.40
★	BH10-15	3.35	63.21

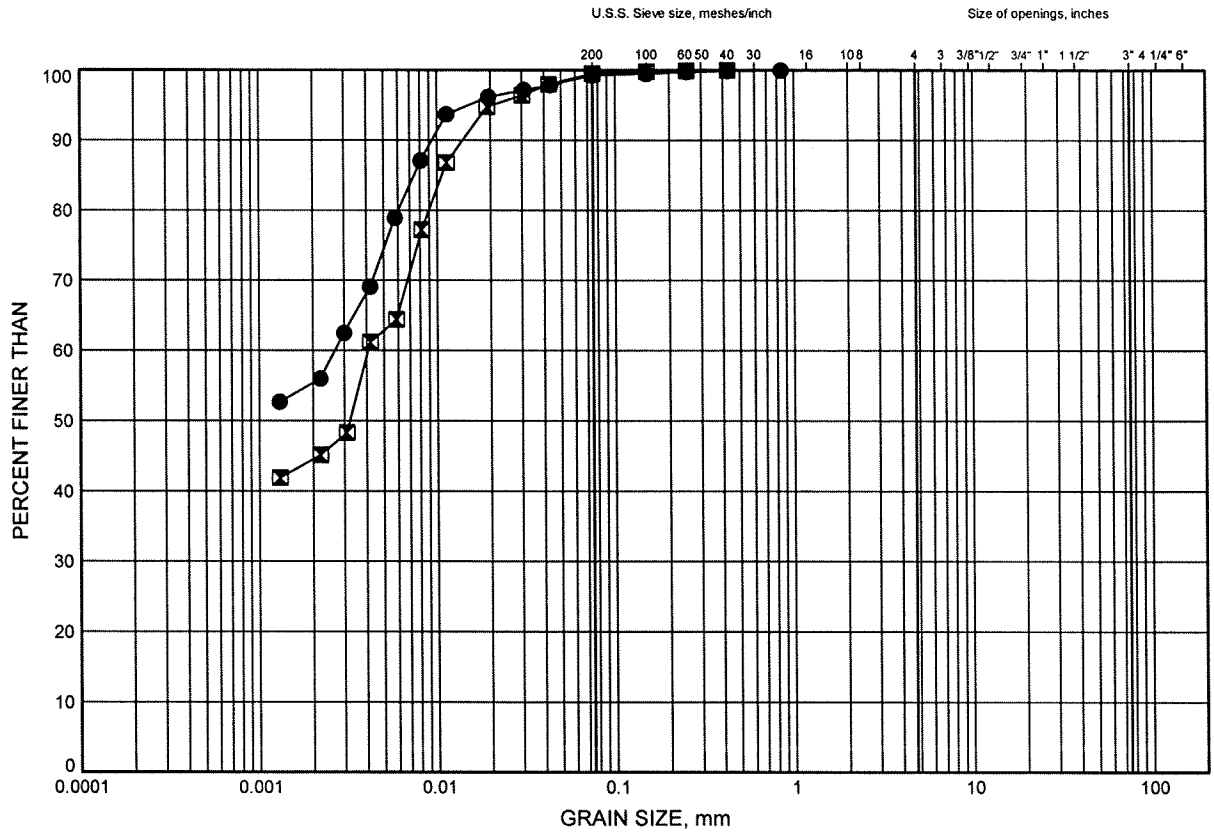


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 Checked By JPL

GRAIN SIZE DISTRIBUTION

FIGURE B3

SILTY CLAY (CI)



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH10-08	2.59	62.85
⊠	BH10-09	3.35	62.53

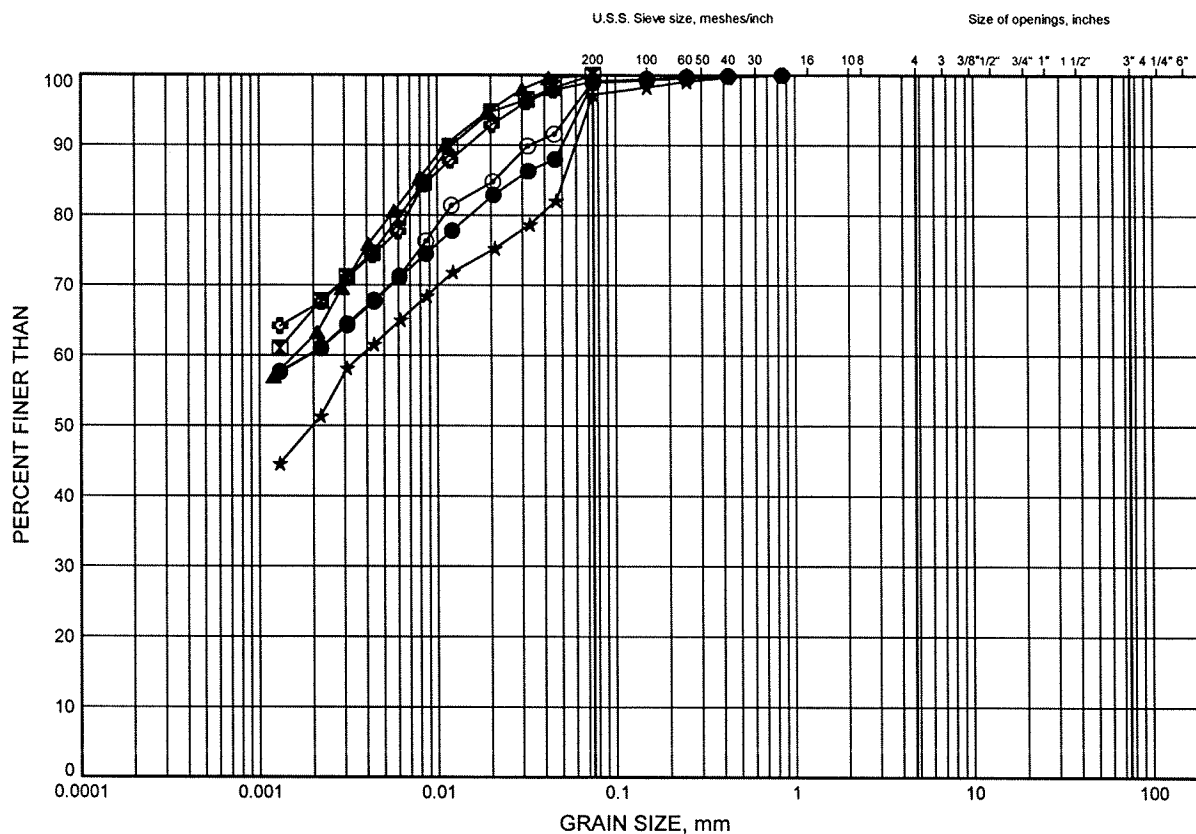


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GRAIN SIZE DISTRIBUTION

FIGURE B4

SILTY CLAY (CH)



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH10-02	1.07	64.76
⊠	BH10-03	1.83	64.34
▲	BH10-05	1.83	63.70
★	BH10-07	1.07	64.90
⊙	BH10-10	1.83	63.75
⊕	BH10-11	2.59	63.39

GRAIN SIZE DISTRIBUTION - THURBER 4387.GPJ 9/15/10

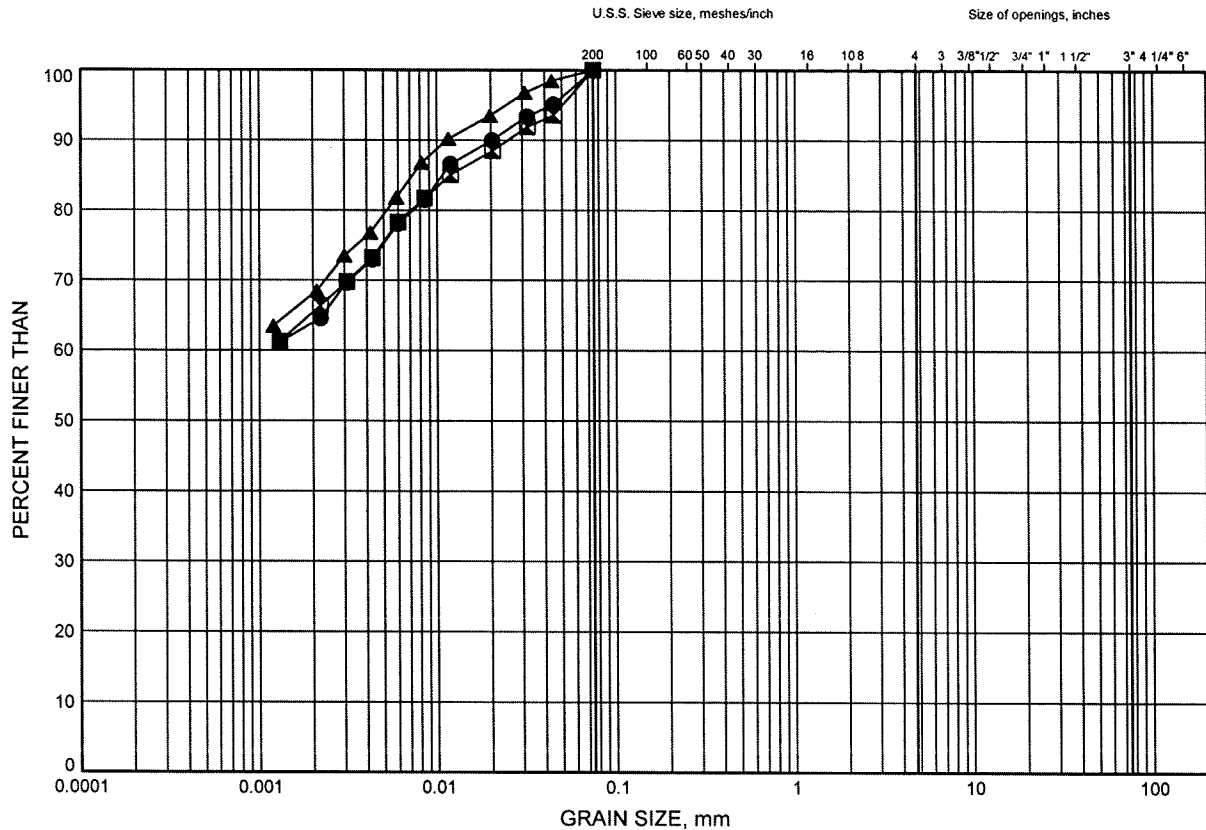
W.P.# 19-5438-7
 Prepared By AN
 Checked By JPL



GRAIN SIZE DISTRIBUTION

FIGURE B5

SILTY CLAY (CH)



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

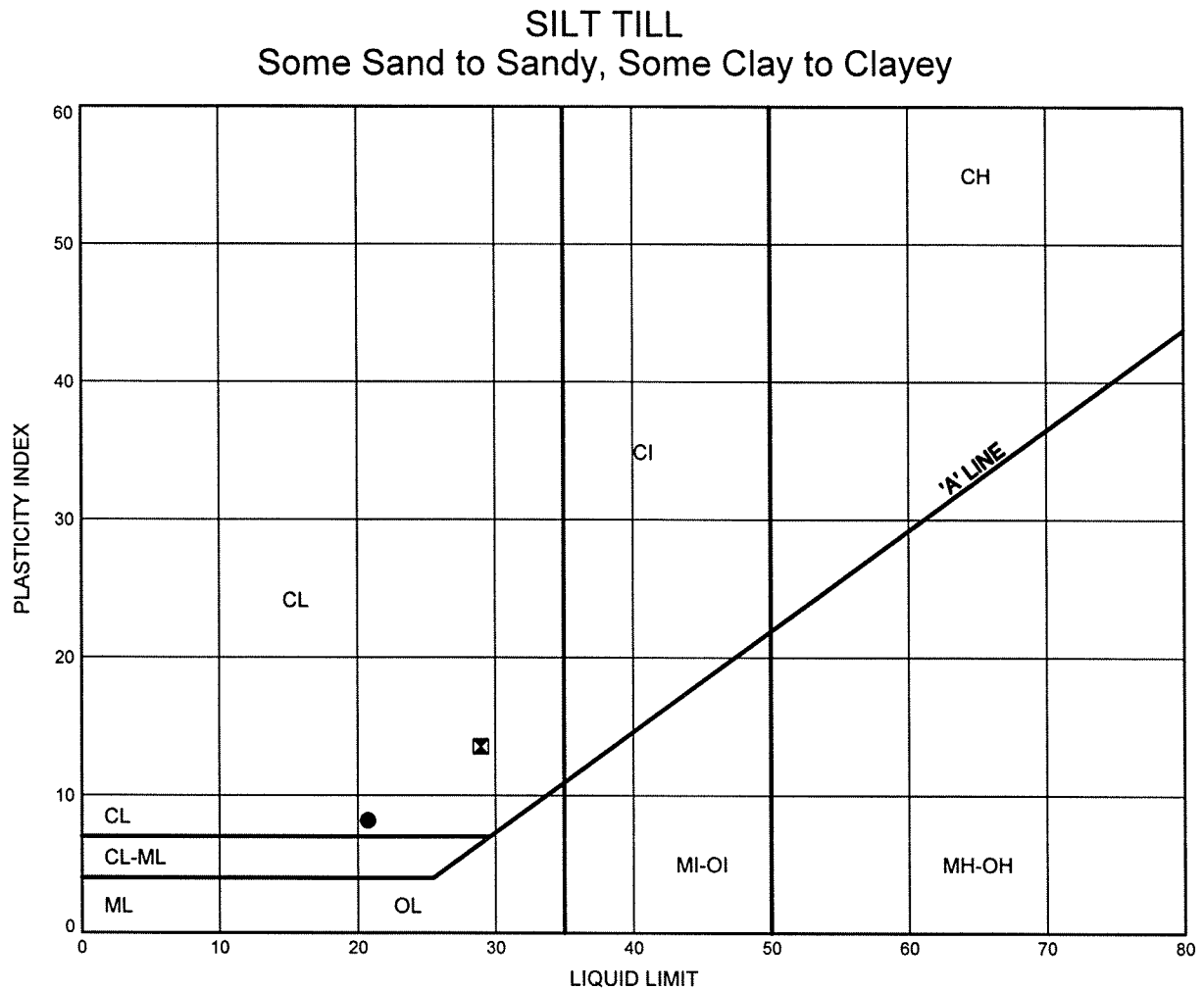
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH10-12	1.83	63.75
■	BH10-15	1.83	64.73
▲	BH10-16	1.83	65.19



W.P.# 19-5438-7
 Prepared By AN
 Checked By JPL

ATTERBERG LIMITS TEST RESULTS

FIGURE B6



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BH10-04	3.35	63.30
⊠	BH10-05	3.31	62.21

Date September 2010
Project 19-5438-7

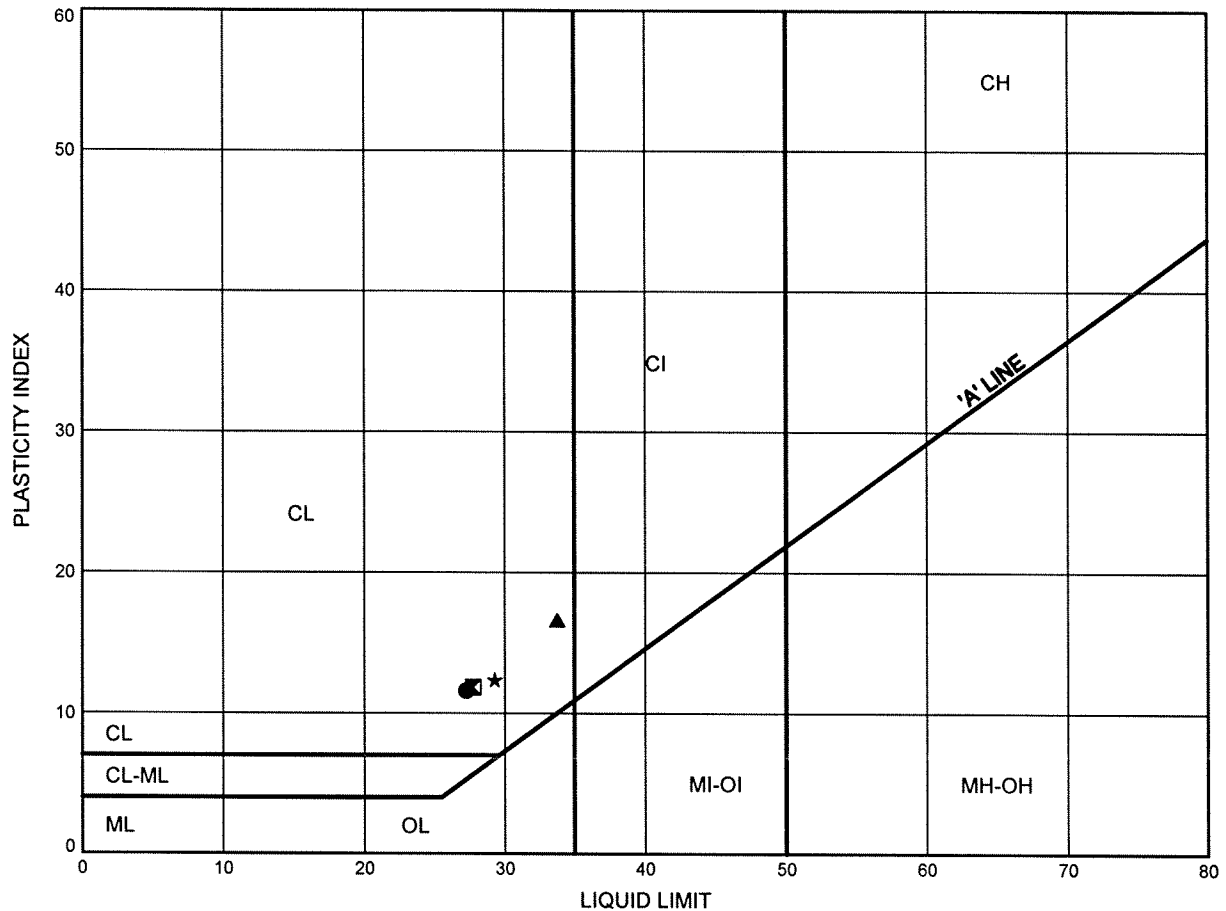


Prep'd AN
Chkd. JPL

ATTERBERG LIMITS TEST RESULTS

FIGURE B7

SILTY CLAY (CL)



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BH10-01	2.59	62.93
⊠	BH10-06	3.35	62.53
▲	BH10-08	4.04	61.40
★	BH10-15	3.35	63.21

Date September 2010

Project 19-5438-7



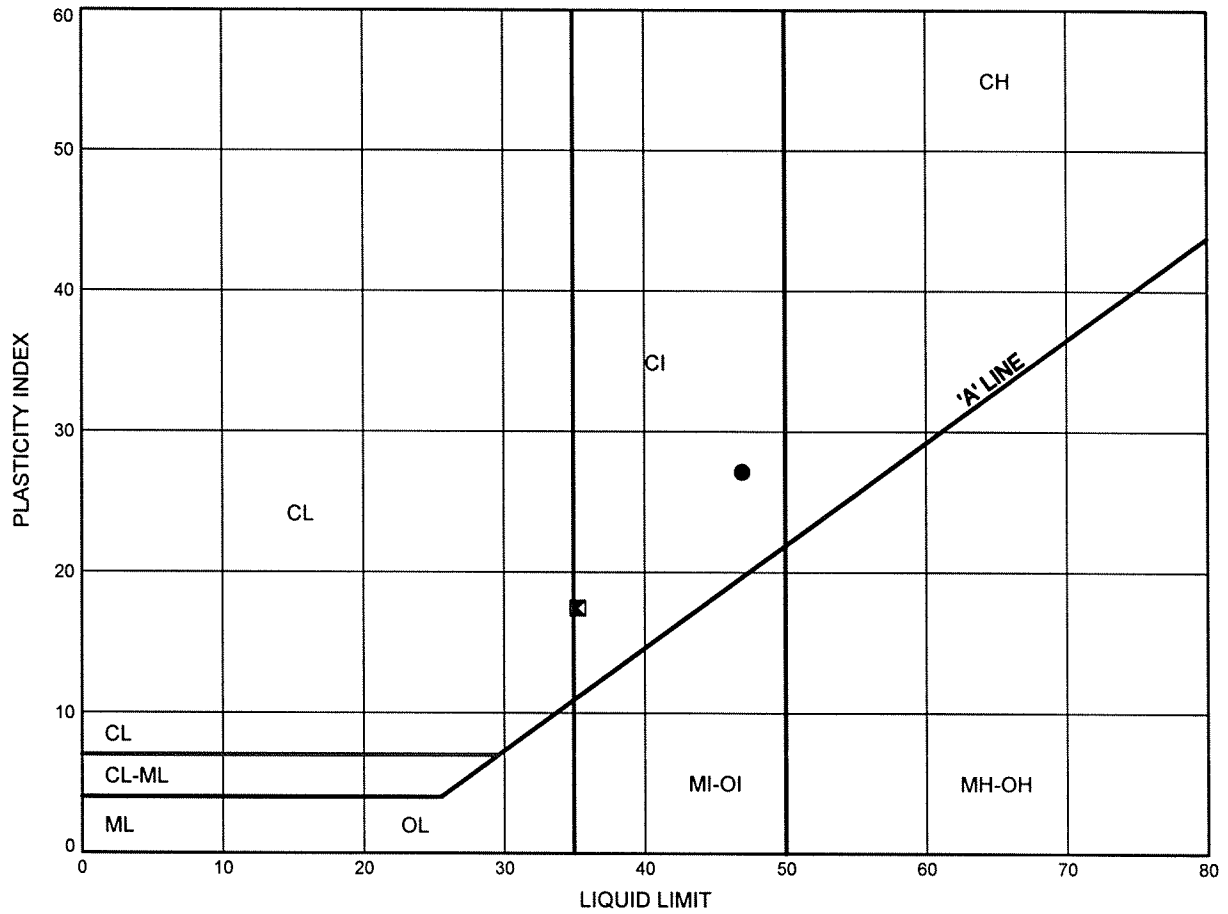
Prep'd AN

Chkd. JPL

ATTERBERG LIMITS TEST RESULTS

FIGURE B8

SILTY CLAY (CI)



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BH10-08	2.59	62.85
⊠	BH10-09	3.35	62.53

Date September 2010

Project 19-5438-7



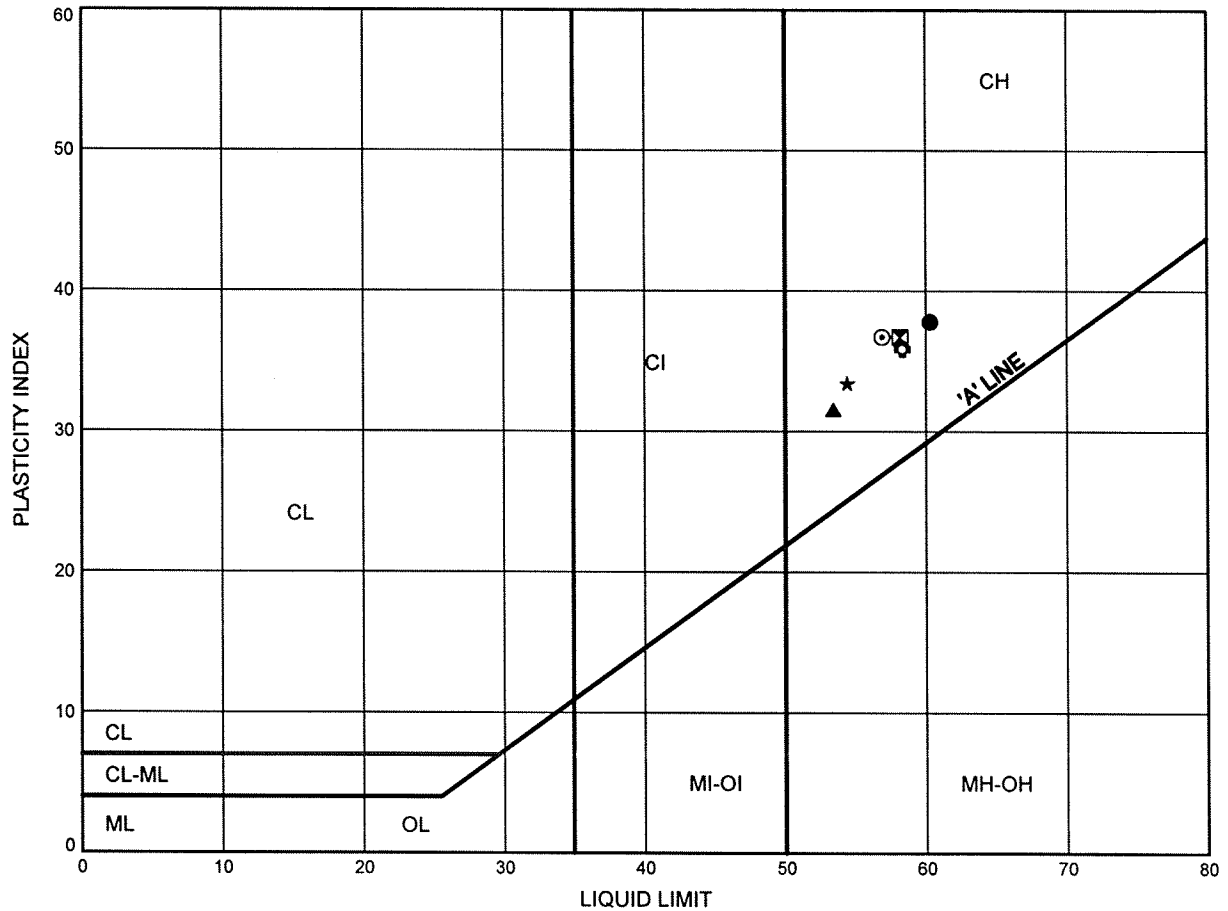
Prep'd AN

Chkd. JPL

ATTERBERG LIMITS TEST RESULTS

FIGURE B9

SILTY CLAY (CH)



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BH10-02	1.07	64.76
⊠	BH10-03	1.83	64.34
▲	BH10-05	1.83	63.70
★	BH10-07	1.07	64.90
⊙	BH10-10	1.83	63.75
⊕	BH10-11	2.59	63.39

Date September 2010

Project 19-5438-7



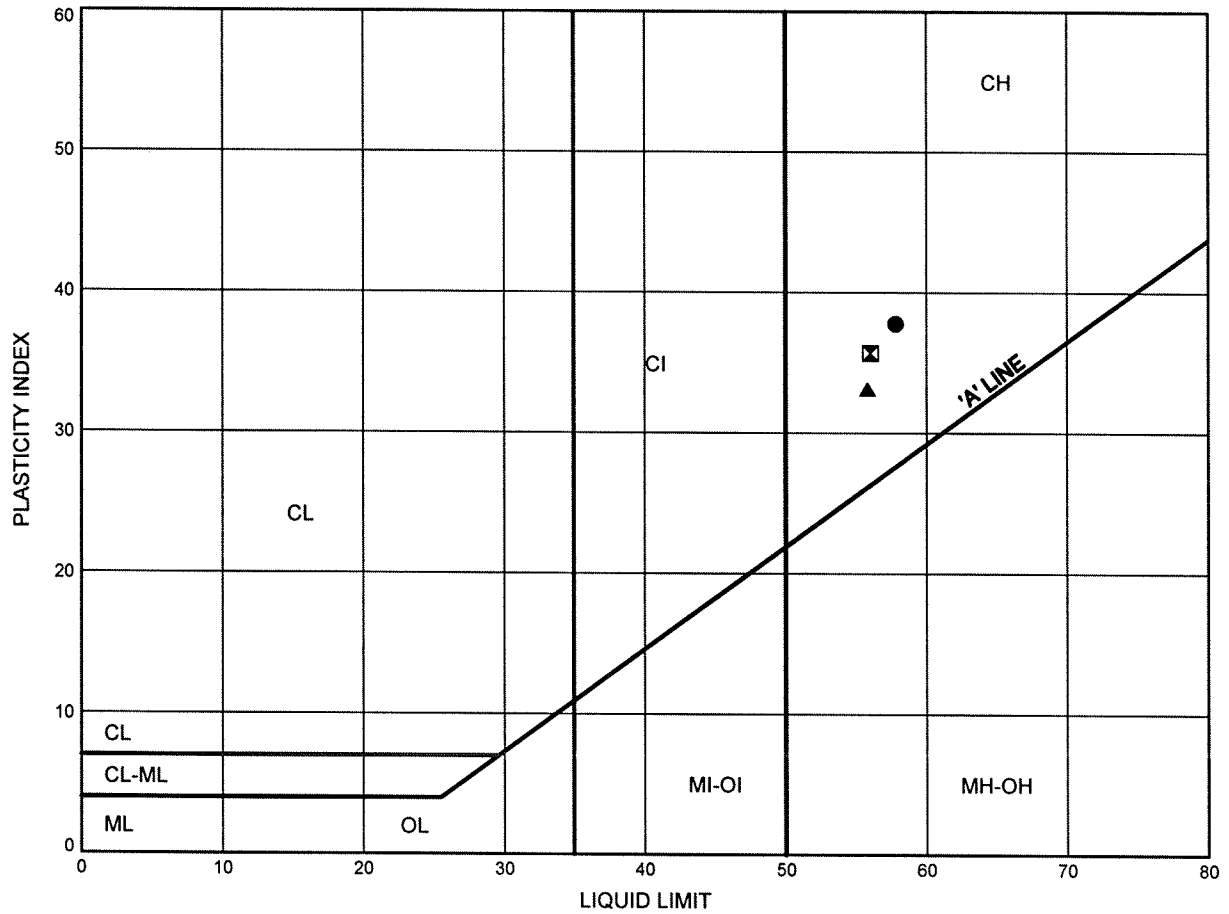
Prep'd AN

Chkd. JPL

ATTERBERG LIMITS TEST RESULTS

FIGURE B10

SILTY CLAY (CH)



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BH10-12	1.83	63.75
⊠	BH10-15	1.83	64.73
▲	BH10-16	1.83	65.19

Date September 2010

Project 19-5438-7



Prep'd AN

Chkd. JPL

Appendix C

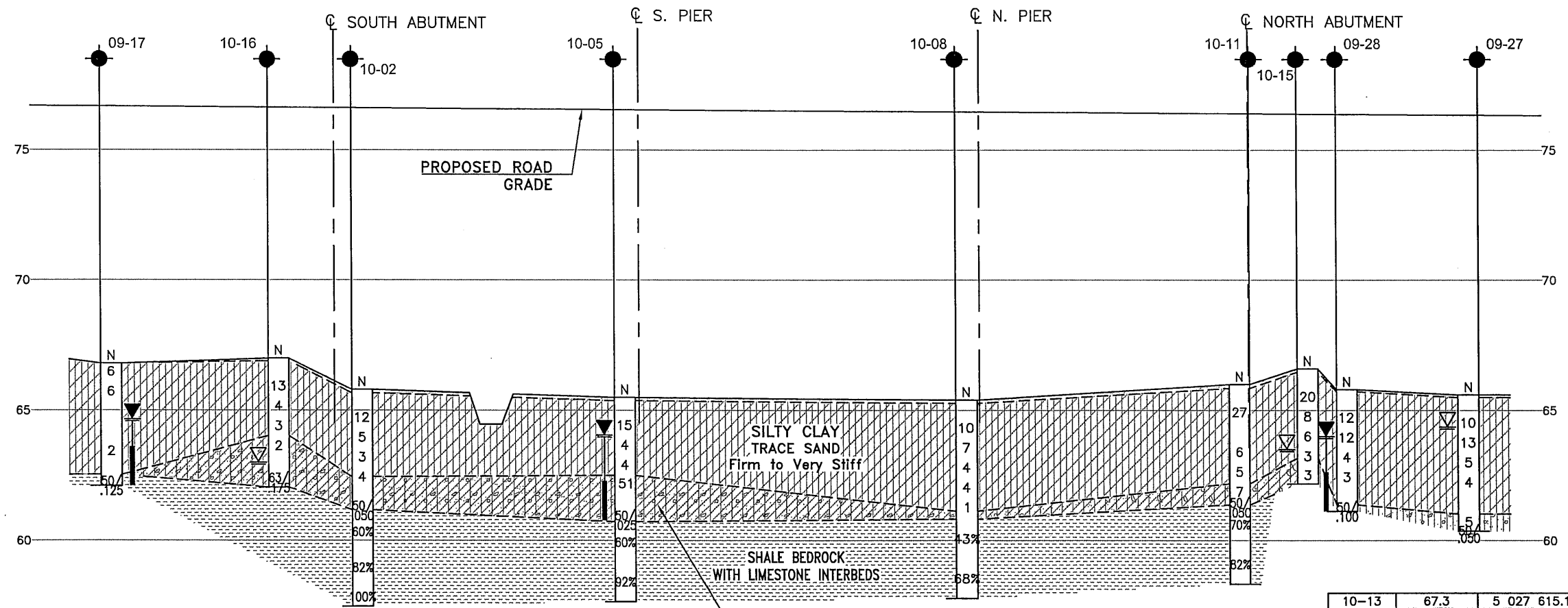
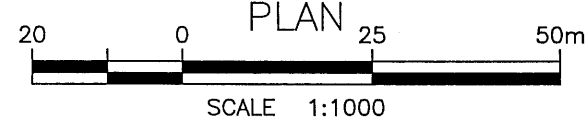
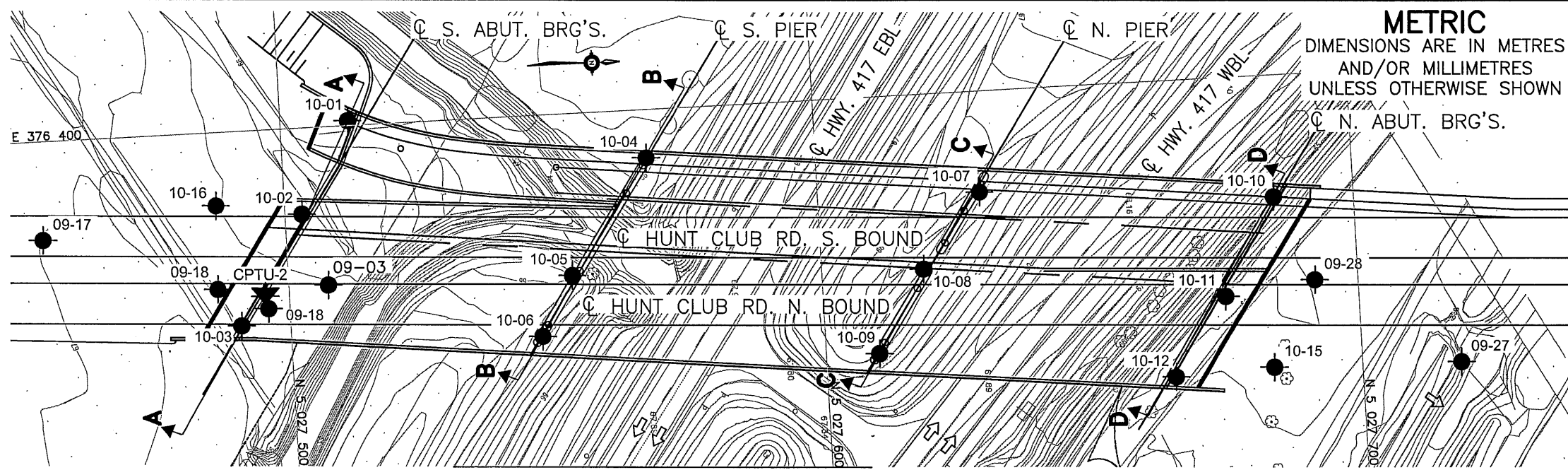
Drawing - Borehole Location and Soil Strata

Drawing Frame: 79mm x 54mm City of Ottawa 2006 (Rev.0)

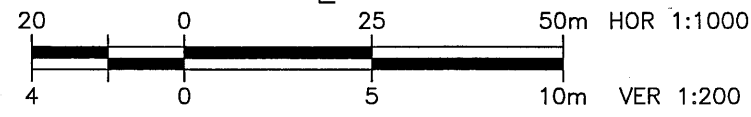
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Last Saved: Friday, February 25, 2011 5:26:43 PM

Consultant's Information: K:\Drawing\15543031\Hwy417\BoreholePlan\Borehole2010.dwg



PROFILE ALONG SBL OF HUNT CLUB ROAD



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

HUNT CLUB ROAD
EXTENSION 417
SN 227680

HIGHWAY 417 UNDERPASS STRUCTURE
BOREHOLE LOCATIONS
& SOIL STRATA

W. Newell, P.Eng.
Director Infrastructure Services

Ziad A. Ghadban, P.Eng.
Manager, Construction Services - East

NOTE:
The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.



Contract No. ISB09-5133 Drawing No. 002

Sheet No. of

Asset No.

Asset Group

Des: DGW Chkd: SZ

Dwn: SAE Chkd: SB

Utility Circulation No.:

Construction Inspector:

Code: CAN/CSA-S6-06

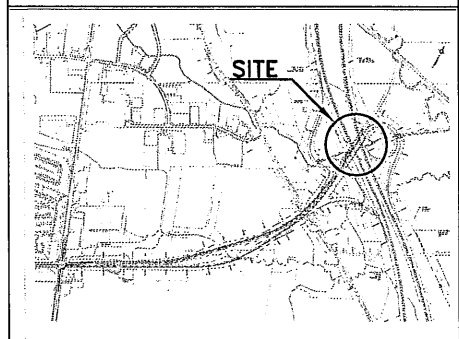
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No.	Description	By	Date (dd/mm/yyyy)

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KEYPLAN

LEGEND

	Borehole
	Piezocone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level observed during drilling
	Water level in Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
10-01	65.5	5 027 512.7	376 399.1
10-02	65.8	5 027 503.2	376 416.0
10-03	66.2	5 027 490.8	376 436.1
10-04	66.7	5 027 568.3	376 409.0
10-05	65.5	5 027 553.3	376 430.1
10-06	65.9	5 027 547.1	376 441.1
10-07	66.0	5 027 630.1	376 418.8
10-08	65.4	5 027 618.9	376 432.5
10-09	65.9	5 027 609.9	376 447.7
10-10	65.6	5 027 685.1	376 422.7
10-11	66.0	5 027 675.2	376 440.7
10-12	65.6	5 027 665.0	376 455.1
10-13	67.3	5 027 615.1	376 478.3
10-14	65.0	5 027 633.7	376 475.0
10-15	66.6	5 027 683.7	376 475.0
10-16	67.0	5 027 487.2	376 413.6
09-17	66.8	5 027 454.6	376 418.3
09-18	66.5	5 027 496.0	376 433.2
09-27	65.6	5 027 718.5	376 455.2
09-28	65.8	5 027 691.9	376 438.5
CPTU-2	66.5	5 027 495.5	376 430.8

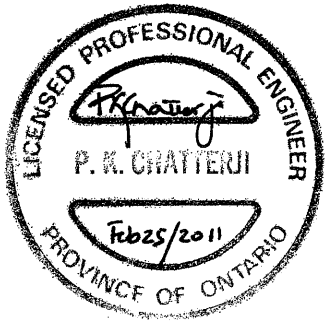
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-NOTES-

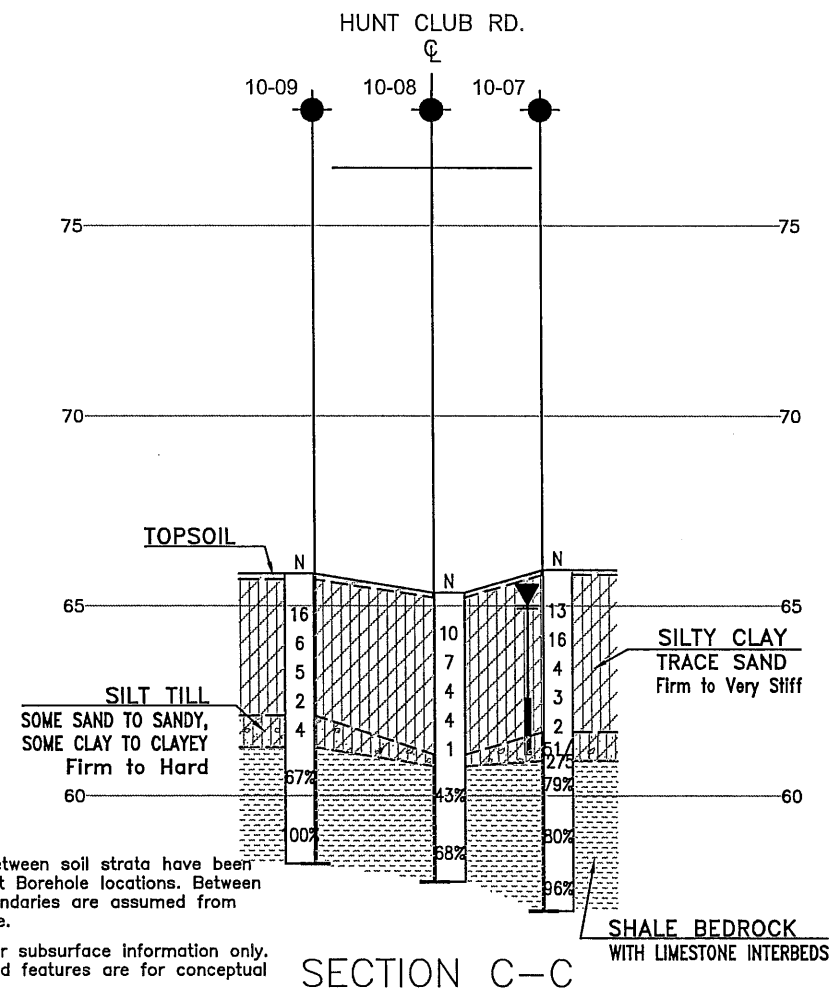
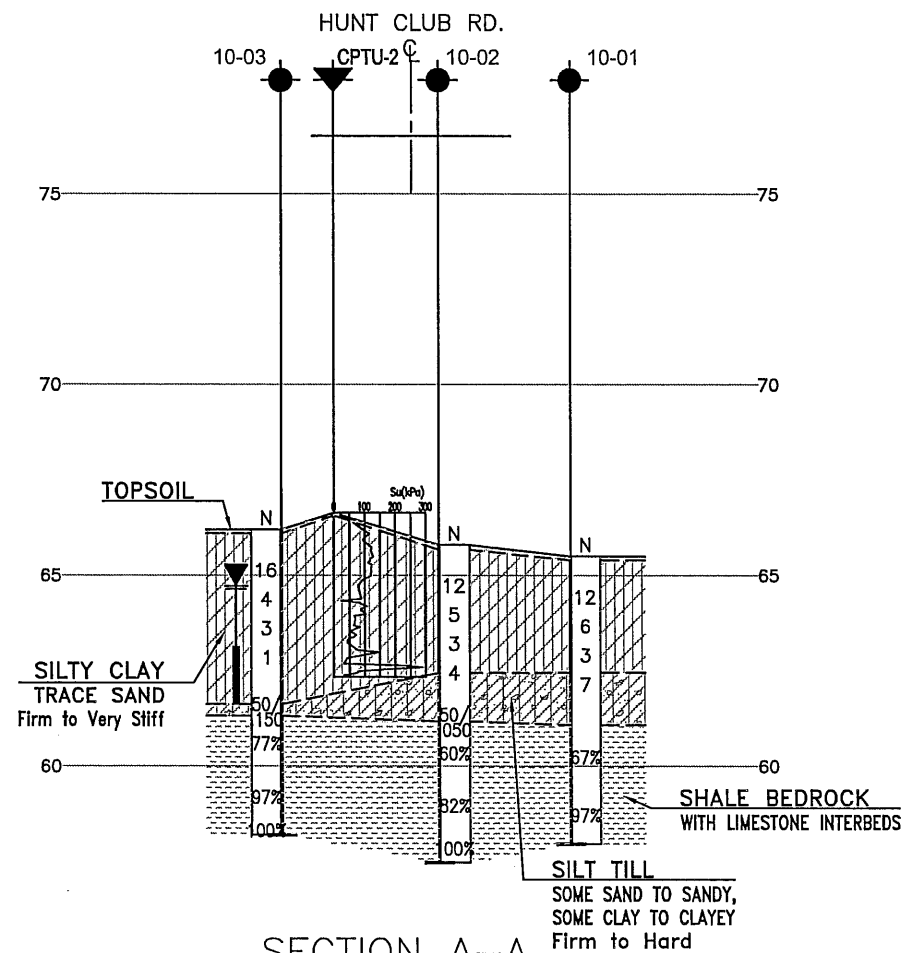
- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

REVISIONS	DATE	BY	DESCRIPTION

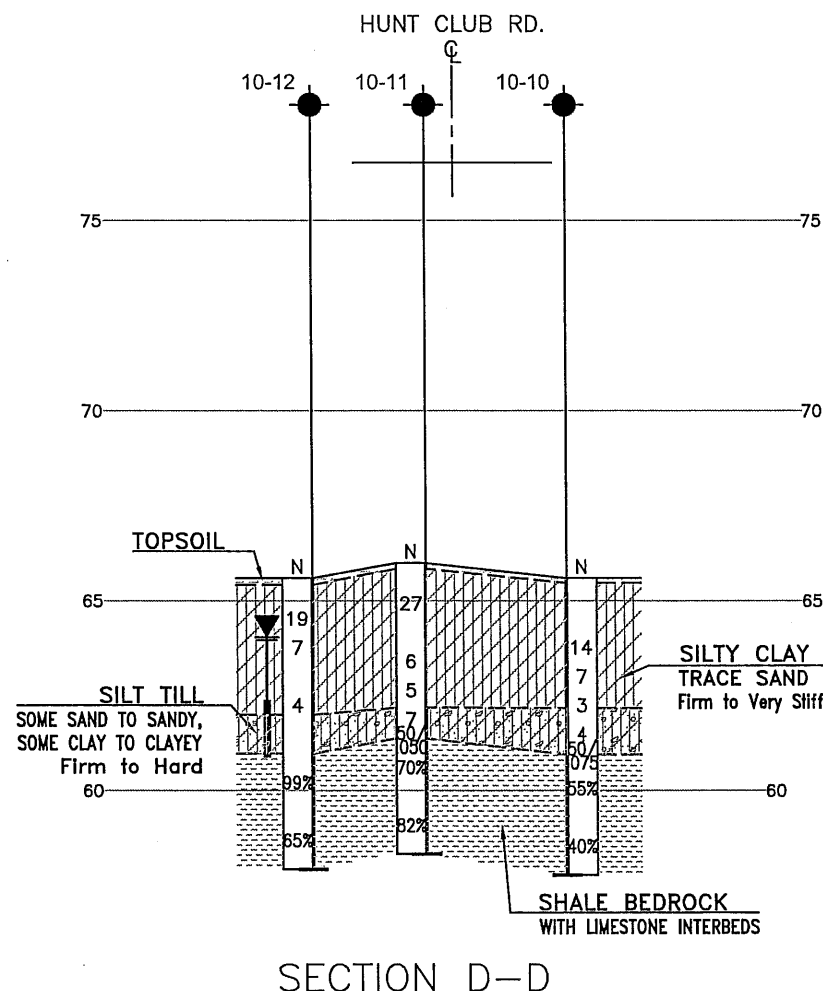
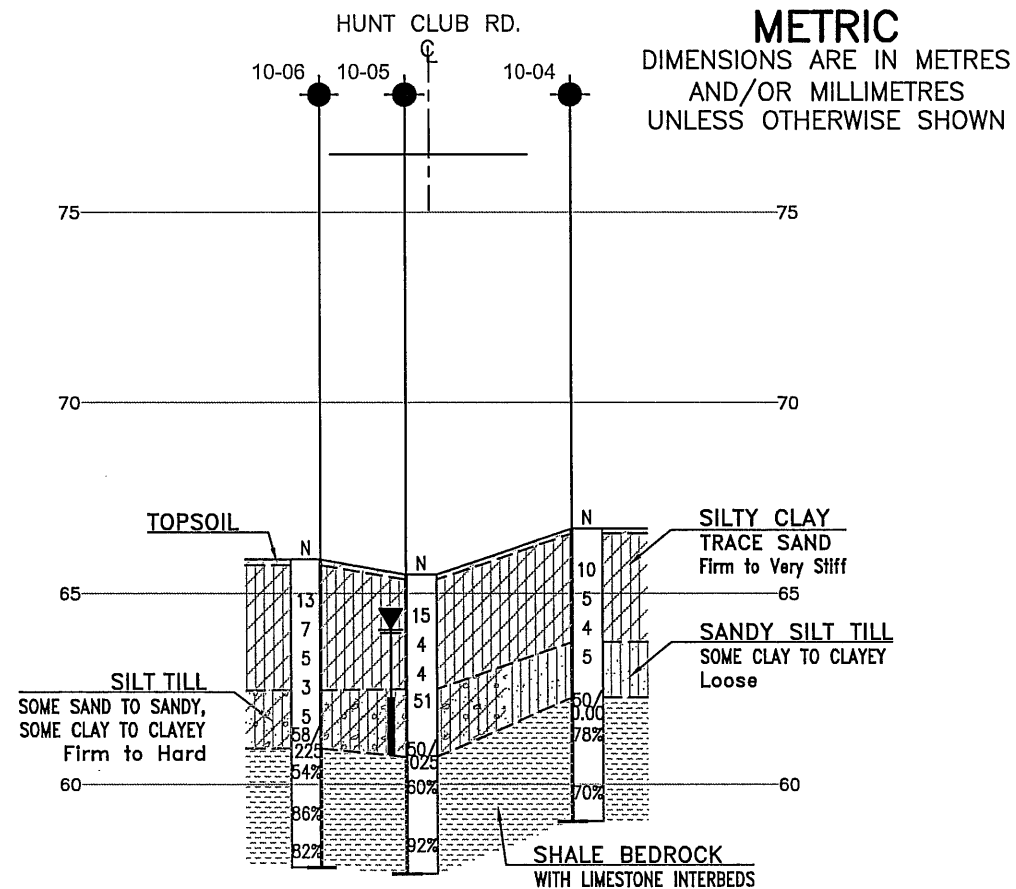
DESIGN	CHK JPL	CODE	LOAD	DATE OCT. 2010
DRAWN	AN	SITE	STRUCT	DWG 1



FILENAME: PLOT.DWG

**-NOTES-**

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.



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

HUNT CLUB ROAD
EXTENSION 417
SN 227680

HIGHWAY 417 UNDERPASS STRUCTURE
BOREHOLE LOCATIONS
& SOIL STRATA

W. Newell, P.Eng.
Director Infrastructure Services

Ziad A. Ghadban, P.Eng.
Manager, Construction Services - East

Contract No.
ISB09-5133

Drawing No.
002

Sheet No.
 of

Asset No.

Asset Group

Des: DGW Chk'd: SZ

Dwn: SAE Chk'd: SB

Utility Circulation No.:

Construction Inspector:

Code:
 CAN/CSA-S8-06

Load:
 CL-625-ONT

NOTE:
The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

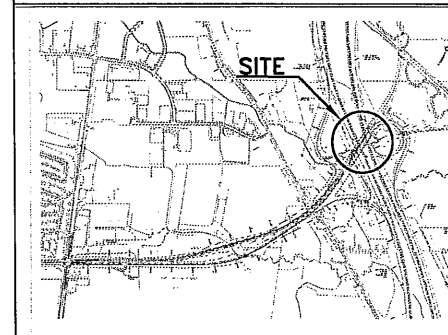
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No.	Description	By	Date (dd/mm/yyyy)

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GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

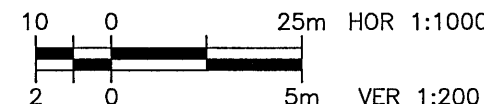
**KEYPLAN****LEGEND**

◆	Borehole
▼	Piezocene
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level observed during drilling
▽	Water level in Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal



NO	ELEVATION	NORTHING	EASTING
10-01	65.5	5 027 512.7	376 399.1
10-02	65.8	5 027 503.2	376 416.0
10-03	66.2	5 027 490.8	376 436.1
10-04	66.7	5 027 568.3	376 409.0
10-05	65.5	5 027 553.3	376 430.1
10-06	65.9	5 027 547.1	376 441.1
10-07	66.0	5 027 630.1	376 418.8
10-08	65.4	5 027 618.9	376 432.5
10-09	65.9	5 027 609.9	376 447.7
10-10	65.6	5 027 685.1	376 422.7
10-11	66.0	5 027 675.2	376 440.7
10-12	65.6	5 027 665.0	376 455.1
CPTU-2	66.5	5 027 495.5	376 430.8

GEOCREs No. 31G5-237



REVISIONS	DATE	BY	DESCRIPTION

DESIGN	CHK	JPL	CODE	LOAD	DATE	OCT. 2010
DRAWN	AN	SITE	STRUCT	DWG 2		

Appendix D
Factual Data from Previous Investigations

RECORD OF BOREHOLE No 09-03

1 OF 1

METRIC

G.W.P. 19-5438-7 LOCATION N 5 027 507.4 E 376 429.4 ORIGINATED BY GA
HWY 417 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2009-06-16 - 2009-06-16 CHECKED BY DEE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	120 140 160 180 200	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L		
66.6	Geodetic													
0.0	TOPSOIL: (75mm)													
0.1	Silty CLAY, trace fine sand, occasional rootlets Stiff to Very Stiff Brown to Grey Moist		1	SS	11									
			2	SS	23									
			3	SS	21									
			4	SS	22									
	Stiff		5	SS	13									
	Very Stiff													
62.1														
4.6	Silty SAND, some clay to clayey, trace gravel Compact Grey Moist (TILL)		6	SS	21									
61.3														
5.3	END OF BOREHOLE AT 5.6m UPON AUGER REFUSAL. BOREHOLE OPEN TO 5.3m AND WATER LEVEL AT 5.3m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 09.06.17 2.05 64.59 09.09.11 1.66 64.98													

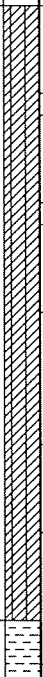


+ 3 . X 3 : Numbers refer to
Sensitivity 20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 09-17

1 OF 1

METRIC

G.W.P. 19-5438-7 LOCATION N 5 027 454.6 E 376 418.3 ORIGINATED BY ES
 HWY 417/Hunt Club Road BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2009-12-13 - 2009-12-13 CHECKED BY TJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL LIMIT MOISTURE CONTENT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)					
66.8								20 40 60 80 100			W _P W W _L				
0.0	Silty CLAY , trace sand Stiff to Very Stiff Brown Moist		1	SS	6										
	Grey		2	SS	6										
			1	TW											
	Becoming firm		3	SS	2										
62.6															
4.3	SHALE , highly weathered														
62.1	Hard Grey		4	SS	50/										
4.7	Moist				.125										
END OF BOREHOLE AT 4.7m UPON AUGER REFUSAL. Piezometer installation consists of 50mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2009.12.22 2.0 64.8 2010.01.12 2.1 64.7															

+³ ×³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE



▽ Water level in open borehole
▽ Water level in piezometer

RECORD OF BOREHOLE No 09-17

1 OF 1

METRIC

G.W.P. 19-5438-7 LOCATION N 5 027 454.6 E 376 418.3 ORIGINATED BY ES
 HWY 417/Hunt Club Road BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2009-12-13 - 2009-12-13 CHECKED BY TJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
66.8							20 40 60 80 100								
0.0	Silty CLAY , trace sand Stiff to Very Stiff Brown Moist		1	SS	6										
	Grey		2	SS	6										
			1	TW											
	Becoming firm		3	SS	2										
62.6															
4.3	SHALE , highly weathered Hard Grey		4	SS	50/										
62.1	Moist														
4.7	END OF BOREHOLE AT 4.7m UPON AUGER REFUSAL. Piezometer installation consists of 50mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2009.12.22 2.0 64.8 2010.01.12 2.1 64.7														

+³ ×³ Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

Water level in open borehole
Water level in piezometer

RECORD OF BOREHOLE No 09-18

1 OF 1

METRIC

G.W.P. 19-5438-7 LOCATION N 5 027 496.0 E 376 433.2 ORIGINATED BY ES
 HWY 417/Hunt Club Road BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2009-12-13 - 2009-12-13 CHECKED BY TJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
66.5								20 40 60 80 100						
0.0	Silty CLAY , trace sand Stiff to Very Stiff Brown Moist		1	SS	9			○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						GR SA SI CL
	Grey		2	SS	9									
			3	SS	6									
			1	TW										0 0 47 53
	Becoming firm													OED: e ₀ =1.371 P _r =180 kPa C _c =0.635 C _u =0.080 G _s =2.76 OCR=4.1
62.4														
4.1	Silty SAND , some clay, trace gravel, occasional shale fragments Compact Grey Moist (TILL)		4	SS	25									8 45 32 15
61.4														
60.4	SHALE highly weathered													
5.2	END OF BOREHOLE AT 5.2m UPON AUGER REFUSAL. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2009.12.22 1.8 64.7 2010.01.12 2.1 64.4													

+³, X³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

Water level in open borehole
Water level in piezometer

RECORD OF BOREHOLE No 09-27

1 OF 1

METRIC

G.W.P. 19-5438-7 LOCATION N 5 027 718.5 E 376 455.2 ORIGINATED BY ES
HWY 417/Hunt Club Road BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA
DATUM Geodetic DATE 2010.01.08 - 2010.01.08 CHECKED BY TJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
65.6								20	40	60	80	100		
0.0	TOPSOIL:(100mm)							○ UNCONFINED	+ FIELD VANE					
0.1	Silty CLAY, trace sand Stiff to Very Stiff Brown Moist		1	AS				● QUICK TRIAXIAL	x LAB VANE					
			1	SS	10									
	Becoming firm to stiff		2	SS	13									
			3	SS	5									
	Grey		4	SS	4									
61.0														
4.6	Silty SAND, some clay to clayey, trace gravel Loose to Very Dense		5	SS	5									
	Grey													
60.3	Wet		6	SS	50/									
5.2	(TILL)				.050									
	END OF BOREHOLE AT 5.2m UPON AUGER REFUSAL. BOREHOLE OPEN AND WATER LEVEL AT 1.2m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO 2.9m, THEN CUTTINGS TO SURFACE.													

+³, X³: Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 09-28

1 OF 1

METRIC

G.W.P. 19-5438-7 LOCATION N 5 027 691.9 E 376 438.5 ORIGINATED BY ES
 HWY 417/Hunt Club Road BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2010-01-08 - 2010-01-08 CHECKED BY TJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
65.8								20	40	60	80	100					GR	SA	SI	CL
0.0	TOPSOIL: (75mm)																			
0.1	Silty CLAY, trace sand Stiff to Very Stiff Brown Moist		1	AS																
			1	SS	12															
			2	SS	12															
	Becoming firm to stiff Grey		3	SS	4															
			4	SS	3															
61.3																				
4.4	Silty SAND, some clay, occasional shale fragments		5	SS	50/															
61.1	(TILL)				.100															
4.7	END OF BOREHOLE AT 4.7m UPON AUGER REFUSAL. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2010.01.12 1.8 64.0																			

+ 3, X 3: Numbers refer to
Sensitivity

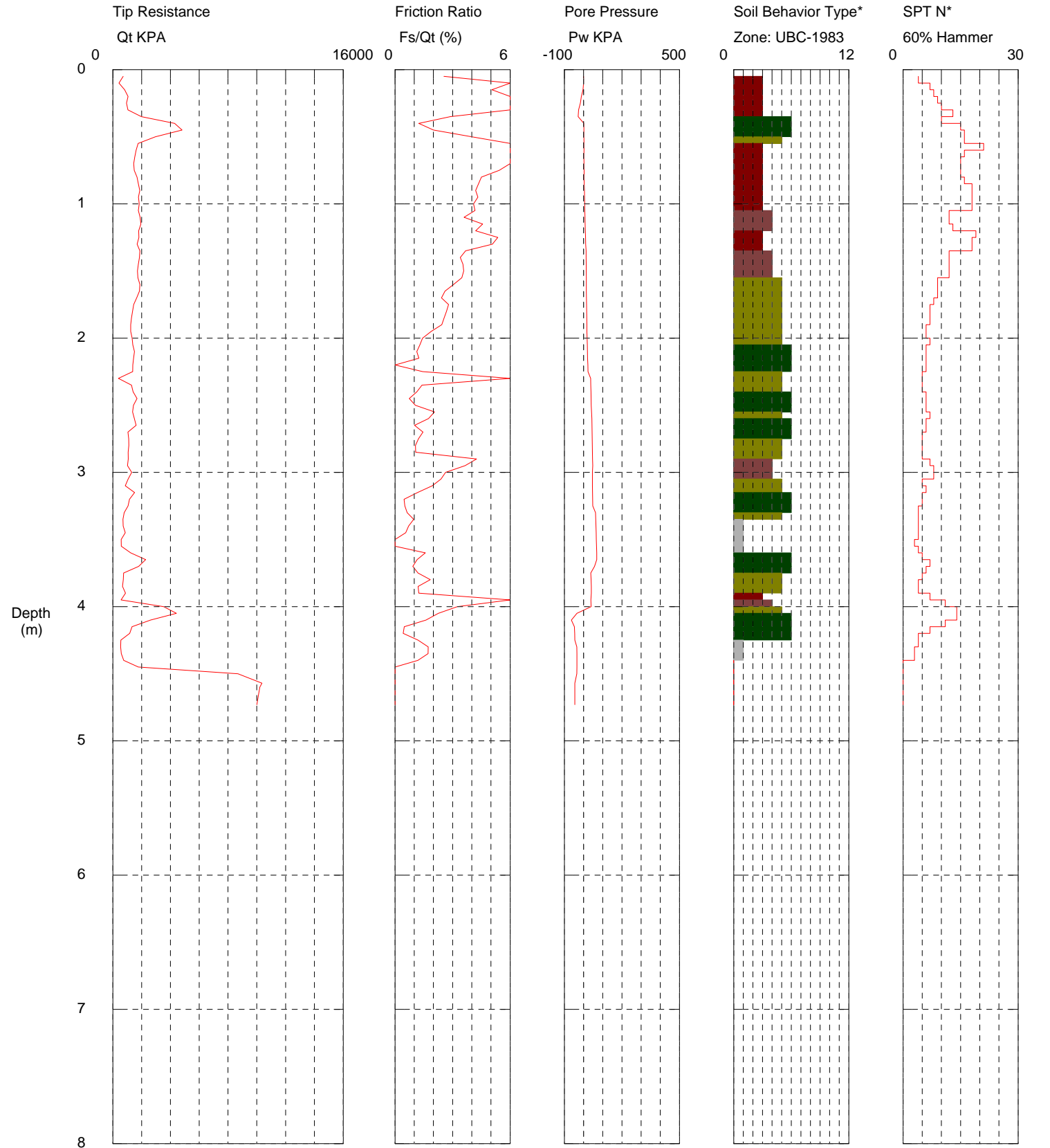
20
15 10 5
(%) STRAIN AT FAILURE

▽ Water level in open borehole
▽ Water level in piezometer

Thurber Engineering

Operator: Brown
Sounding: CPT-02
Cone Used: DSG1029

CPT Date/Time: 12/16/2009 10:04:31 AM
Location: Hunt Club Road
Job Number: 19-5438-7



1 sensitive fine grained
2 organic material
3 clay

4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt

7 silty sand to sandy silt
8 sand to silty sand
9 sand

10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

In Situ Engineering

*Soil behavior type and SPT based on data from UBC-1983

Consolidation Test Report

CLIENT: **AECON**

FILE NUMBER: **19-5438-7**

PROJECT: **Hwy 417 Hunt Club Road**

REPORT DATE: **24-Feb-10**

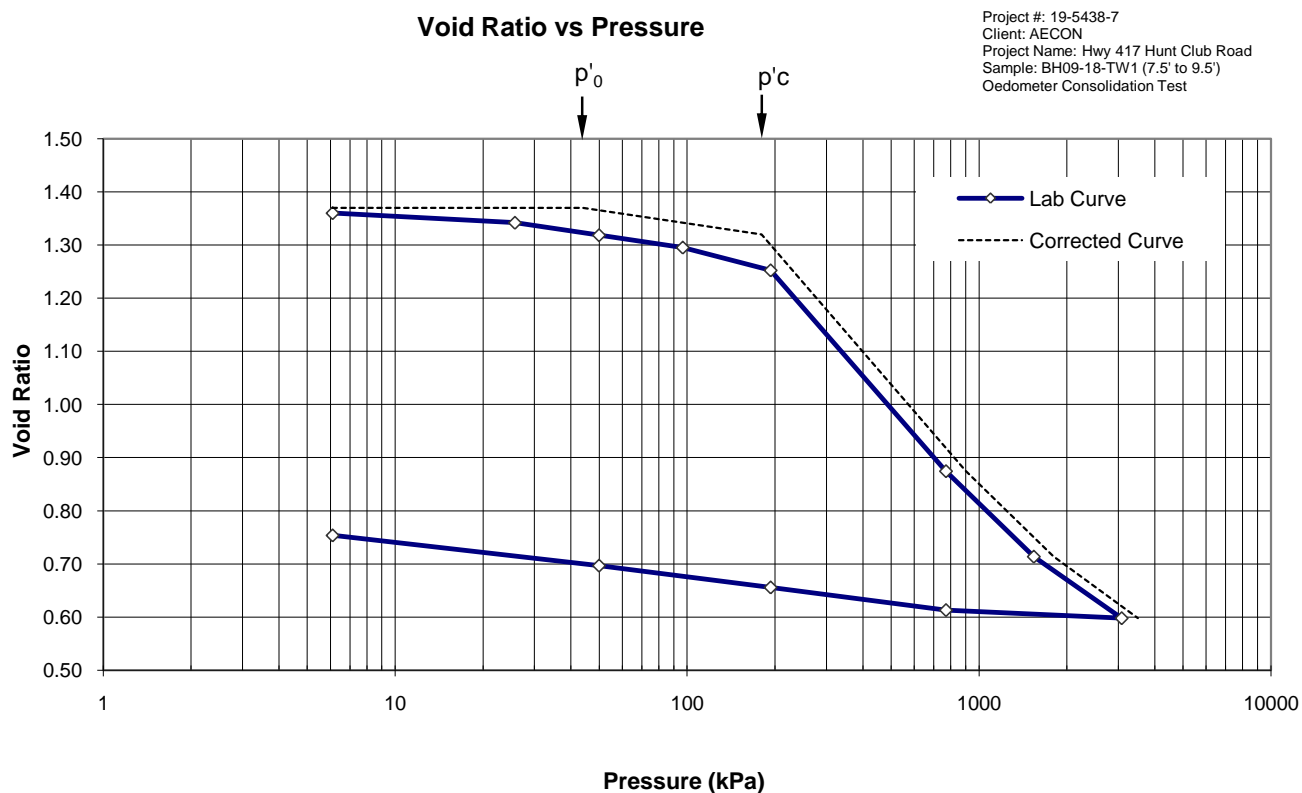
TEST DATES: **February 11, 2010 - February 23, 2010**

SAMPLE: **BH09-18-TW1 (7.5' to 9.5')**
Clay, Silty, grey, (CL), Grain Size: 53% Clay, 47% Silt

PROCEDURE: Test carried out in accordance with Standard Test Method for One-Dimensional Consolidation Properties of Soils, ASTM D 2435-04, method B

	<u>Start of Test</u>	<u>End of Test</u>
Wet Dens. (kg/m ³)	1742.0	2072.8
Dry Dens. (kg/m ³)	1164.5	1573.7
Moisture Cont. (%)	49.6	31.7
Void Ratio	1.370	0.754
Saturation (%)	99.9	

Note: A Specific Gravity of 2.76 was measured for the void ratio and saturation calculations.



TEST DONE BY: EA
REVIEWED BY: JPL

Consolidation Test Report

Hwy 417 Hunt Club Road
19-5438-7

BH09-18-TW1 (7.5' to 9.5')

TRIMMING: The Specimen was manually trimmed to the size of consolidation ring, then mounted in a fixed ring consolidometer

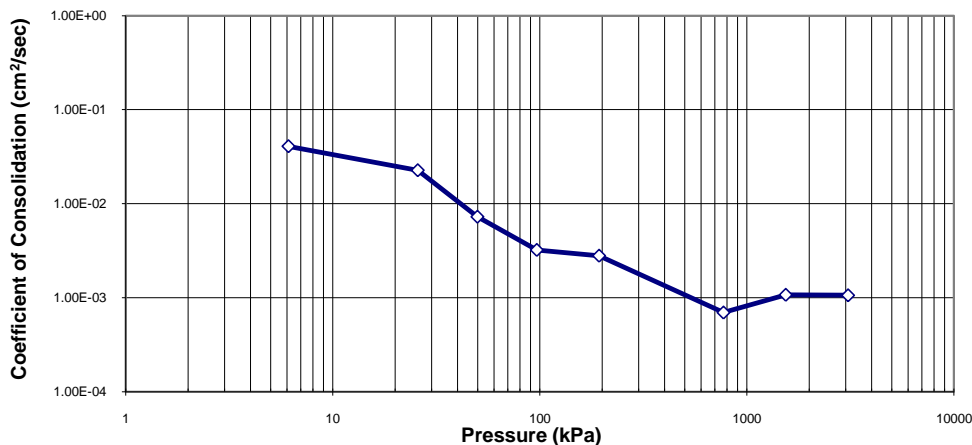
LOADING: A seating load of 6.1 kPa was applied and the consolidometer was flooded with distilled water. Sample was monitored to ensure no swelling effect occurred before the start of the test. Subsequent loads were applied after 100% primary consolidation was reached.

CALCULATIONS: Coefficients of Consolidation were calculated by the square root time method.

Pressure (kPa)	Corr. H. (mm)	Avg. H. (mm)	t_{90} (min)	C_v (cm ² /s)	Void Ratio	m_v (m ² /kN)	k (cm/s)
0.0	25.500				1.370		
6.1	25.393	25.447	0.56	4.07E-02	1.360	6.88E-04	2.74E-06
25.7	25.198	25.296	1.00	2.26E-02	1.342	3.92E-04	8.68E-07
49.9	24.946	25.072	3.06	7.25E-03	1.319	4.13E-04	2.94E-07
96.6	24.696	24.821	6.76	3.22E-03	1.295	2.15E-04	6.77E-08
193.2	24.234	24.465	7.56	2.80E-03	1.253	1.94E-04	5.31E-08
770.7	20.167	22.201	25.00	6.97E-04	0.875	2.91E-04	1.98E-08
1540.7	18.437	19.302	12.25	1.07E-03	0.714	1.11E-04	1.17E-08
3081.4	17.190	17.814	10.56	1.06E-03	0.598	4.39E-05	4.57E-09
770.7	17.354	17.272			0.613		
193.2	17.813	17.584			0.656		
49.9	18.255	18.034			0.697		
6.1	18.867	18.561			0.754		

Coefficient of Consolidation vs. Pressure

Project #: 19-5438-7
Client: AECON
Project Name: Hwy 417 Hunt Club Road
Sample: BH09-18-TW1 (7.5' to 9.5')
Oedometer Consolidation Test



Notes: C_v and k calculated using t_{90} values

TEST DONE BY: EA
REVIEWED BY: JPL



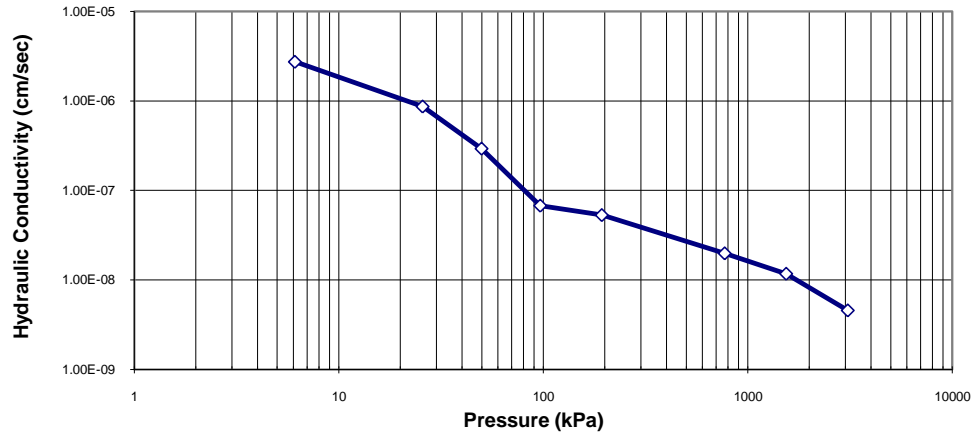
Consolidation Test Report

Hwy 417 Hunt Club Road
19-5438-7

BH09-18-TW1 (7.5' to 9.5')

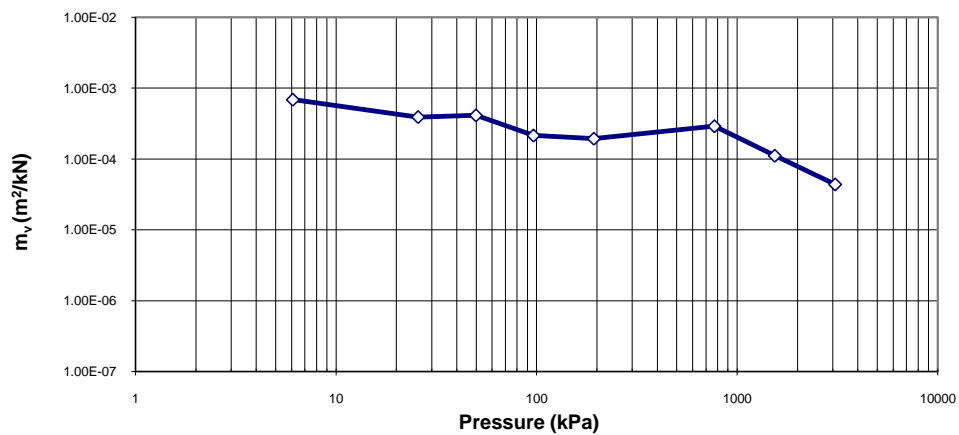
Hydraulic Conductivity vs. Pressure

Project #: 19-5438-7
Client: AECON
Project Name: Hwy 417 Hunt Club Road
Sample: BH09-18-TW1 (7.5' to 9.5')
Oedometer Consolidation Test



m_v vs. Pressure

Project #: 19-5438-7
Client: AECON
Project Name: Hwy 417 Hunt Club Road
Sample: BH09-18-TW1 (7.5' to 9.5')
Oedometer Consolidation Test



TEST DONE BY: EA
REVIEWED BY: JPL

**FOUNDATION INVESTIGATION REPORT
HWY 417 CULVERT EXTENSION
HUNT CLUB ROAD AND HIGHWAY 417 INTERCHANGE
CITY OF OTTAWA, ONTARIO**

Geocres Number: 31G5- 240

Report to

AECOM

Thurber Engineering Ltd.
2010 Winston Park Drive, Suite 103
Oakville, Ontario
L6H 5R7
Phone: (905) 829 8666
Fax: (905) 829 1166

March 11, 2011

File: 19-5438-7

H:\19\5438\7 Hwy417 Hunt Club IC\Reports & Memos\15-Hwy 417 Culvert
Extension\Final Report\FIR\HWY 417 Culvert Extension FIR (Mar11-11).doc



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2 SITE DESCRIPTION 1

3 SITE INVESTIGATION AND FIELD TESTING 2

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 5.3 Sand Fill..... 3

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Appendices

Appendix A	Record of Borehole Sheets
Appendix B	Laboratory Test Results
Appendix C	Borehole Location and Soil Strata Drawing

FOUNDATION INVESTIGATION REPORT
HWY 417 CULVERT EXTENSION
HUNT CLUB ROAD AND HIGHWAY 417 INTERCHANGE
CITY OF OTTAWA, ONTARIO

Geocres Number: 31G5- 240

PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the site of the proposed extension of the culvert that carries Ramsay Creek under Highway 417 at the Hunt Club Road and Highway 417 Interchange in the City of Ottawa, Ontario.

The purpose of the investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, borehole logs, stratigraphic profile and a written description of the subsurface conditions. A model of the subsurface conditions was developed from data obtained in the course of the investigation. This model describes the geotechnical conditions influencing design and construction of the foundations for the proposed culvert extension.

Thurber Engineering Ltd. (Thurber) carried out the investigation as a sub-consultant to AECOM.

2 SITE DESCRIPTION

The site of the proposed culvert extension is located near Highway 417 WBL and the existing culvert that carries Ramsay Creek under Highway 417 EBL and WBL. The culvert extension will carry Ramsay Creek under the new S-W Ramp that runs parallel to Highway 417 WBL at this location. The site is located approximately 1.6 km north east of the intersection of Hunt Club Road and Hawthorne Road and 400 m northeast of Russell Road.

The site is located in the southeast portion of City of Ottawa. The lands to the west have been developed for industrial use. The lands to the south and east of the site are primarily agricultural.

The existing embankment fill in the proximity of the culvert is about 2 to 2.5 m high. The embankment showed no signs of distress. The flow direction is to the north carrying Ramsay Creek passing through a culvert beneath the embankment.

The general stratigraphy of the area is characterized by a clay plain (Leda clay) underlain by glacial till, which is underlain by shale bedrock with interbedded limestone.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation consisted of drilling and sampling two boreholes at the site of the proposed culvert extension. Boreholes 10-13 and 10-14 were drilled on July 27, 2010 and July 21, 2010, respectively and were advanced to depths of 5.5 and 3.8 m. The approximate locations of these boreholes are shown on the Borehole Locations and Soil Strata Drawing included in Appendix C. The coordinates and elevations of the boreholes are listed on the Borehole Locations and Soil Strata Drawing and are included on the individual Record of Borehole Sheets in Appendix A.

Field layout of the borehole locations for this site investigation was carried out by Thurber personnel using GPS equipment.

Hollow stem augers were used to advance the boreholes through the overburden and the boreholes were terminated upon refusal on probable bedrock. Overburden samples were obtained using a split spoon sampler in conjunction with Standard Penetration Testing (SPT).

A member of Thurber's technical staff supervised the drilling and sampling operations on a full time basis. The inspector logged the boreholes and the recovered samples and processed them for transport to Thurber's office.

4 LABORATORY TESTING

All recovered soil samples were subjected to visual identification and to natural moisture content determination. The results of this testing are shown on the Record of Borehole sheets included in Appendix A.

Selected samples were also subjected to gradation analysis (sieve and hydrometer) and Atterberg Limits testing and the results are shown on the Record of Borehole sheets in Appendix A and on the figures in Appendix B.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

5.1 General

Reference is made to the Record of Borehole sheets in Appendix A. Details of the encountered soil stratigraphy are presented in these records and on the attached Borehole Locations and Soil Strata Drawing. An overall description of the stratigraphy is given in the following paragraphs however the factual data presented in the borehole logs governs any interpretation of the site conditions.

In general terms, the site was found to be underlain by a thin veneer of topsoil, a layer of silty clay underlain by a layer of glacial till. Near the existing culvert, sand embankment fill was encountered at the ground surface. Ramsay Creek has eroded its channel into the silty clay deposit. Both boreholes were terminated upon auger refusal or probable bedrock.

More detailed descriptions of the individual strata are presented below.

5.2 Topsoil

Topsoil was encountered at the ground surface in Borehole 10-14. The thickness of the topsoil at this location was found to be 125 mm. It should be noted that variations in topsoil thickness may occur beyond the borehole.

5.3 Sand Fill

Sand fill was encountered surficially in Borehole 10-13 and was found to extend to 4.1 m depth (underside Elevation 63.2 m). The sand fill contains trace to some gravel and trace silt and has a moisture content of approximately 5 to 10%. This sand fill was likely placed during construction of the Highway 417 embankment and the existing culvert.

SPT N-values recorded in the sand fill ranged from 3 to 30 blows per 0.3 m penetration, indicating a very loose to dense relative density. In general, the N-values decreased with depth within the sand fill.

A gradation analysis was performed on a selected sample of the sand fill, the results of which are summarized below.

Soil Particles	Percentage (%)
Gravel	9
Sand	83
Silt and Clay	8

These results are also shown on the Record of Borehole sheets included in Appendix A. As well, the grain size distribution curve for this sample is presented in Figure B1, Appendix B.

5.4 Silty Clay

A deposit of silty clay was encountered below the sand fill in Borehole 10-13 and below the topsoil in Borehole 10-14. The silty clay layer encountered in Borehole 10-13 and 10-14 was 1.1 m (underside Elevation 62.1 m) and 2.9 m thick (underside Elevation 62.0 m) respectively. The silty clay contains trace to some sand and trace rootlets and has moisture contents ranging from 17 to 34%.

SPT N-values recorded in the silty clay layer generally ranged from 4 to 12 blows per 0.3 m penetration, indicating a firm to stiff consistency. In Borehole 10-14, where the silty clay deposit was thicker, N-values decreased with depth.

Selected samples of the silty clay underwent Atterberg Limits testing and gradation testing, the results of which are included on the Record of Borehole sheets in Appendix A and are summarized below.

Index Property	Moisture Content (%)
Liquid Limit	29 to 32

Plastic Limit	17 to 18
Plasticity Index	12 to 14

The results of the Atterberg Limits tests indicate that the silty clay encountered in these two boreholes is of low plasticity, which corresponds to group symbol CL.

Soil Particles	Percentage (%)
Gravel	0
Sand	1 to 14
Silt	51 to 61
Clay	35 to 38

The grain size distribution curves for these selected samples are shown on Figure B2 in Appendix B.

5.5 Till

A clayey sandy silt glacial till layer was encountered below the silty clay in Boreholes 10-13 and 10-14. The clayey sandy silt till contains trace gravel and has a natural moisture content of approximately 18%. This layer encountered in Borehole 10-13 and 10-14 was 0.3 m (underside Elevation 61.7 m) and 0.8 m (underside Elevation 61.2 m) thick respectively, with auger refusal on probable bedrock identifying the base of this layer.

SPT N-value was recorded in Borehole 10-14 as being 2 blows per 0.3 m penetration, indicating a soft consistency. In Borehole 10-13, an SPT N-value of 50 blows for 0.05 m penetration was recorded on probable bedrock.

A gradation analysis was performed on a selected sample of the clayey sandy silt till, the results of which are summarized below.

Soil Particles	Percentage (%)
Gravel	1
Sand	32
Silt	45
Clay	22

These results are also shown on the Record of Borehole sheets included in Appendix A and the grain size distribution curve for this sample is presented in Figure B3, Appendix B.

5.6 Water Levels

Groundwater levels were observed in the open boreholes upon completion of drilling. Borehole 10-13 was dry upon completion. The groundwater level in Borehole 10-14 is expected to reflect the water level in Ramsay Creek. These observations are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level will be influenced by the creek level and may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

6 MISCELLANEOUS

Surveying of the borehole locations was carried out by Thurber personnel using GPS equipment.

Full time supervision of field activities was carried out by Mr. Stephane Loranger, C.E.T. of Thurber.

Overall supervision of the field program was carried out by Mr. Lukasz Gilarski, E.I.T. Interpretation of the data and preparation of the report were carried out by Mrs. Lindsey Blaine, E.I.T. and Mr. Jason Lee, P.Eng.

The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.

Lindsey Blaine, E.I.T.

Jason P Lee, P.Eng., M.Sc.
Geotechnical Engineer



P.K. Chatterji, P.Eng., Ph.D.
Review Principal



Appendix A
Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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



4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

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

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






 Water Level
 Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

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

EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION		SYMBOLS	
Fresh (FR)	No visible signs of weathering.		
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.		CLAYSTONE
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.		COAL
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.		Bedrock (general)

DISCONTINUITY SPACING		STRENGTH CLASSIFICATION			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.

TERMS					
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen				
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.				

RECORD OF BOREHOLE No BH10-13

1 OF 1

METRIC

W.P. 19-5438-7 LOCATION N 5 027 615.1 E 376 478.3 ORIGINATED BY SLL
 HWY 417/Hunt Club Road BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2010.07.27 - 2010.07.27 CHECKED BY LPG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
67.3 0.0	SAND, trace to some gravel, trace silt Dense to Loose Brown Moist (FILL)														9 83 8 (SI+CL)	
			1	SS	30											
			2	SS	21											
			3	SS	7											
			4	SS	3											
63.2 4.1	Silty CLAY, some sand Firm to Hard Grey Moist														0 14 51 35	
			5	SS	4											
62.1 5.2	Clayey Sandy SILT, trace gravel Hard Grey Moist to Wet (TILL)															
61.7 5.5			6	SS	50/											
	END OF BOREHOLE AT 5.5m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE OPEN AND DRY ON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 2.3m, THEN CUTTINGS TO SURFACE.															

ONTMT4S 4387.GPJ 11/10/10

RECORD OF BOREHOLE No BH10-14

1 OF 1

METRIC

W.P. 19-5438-7 LOCATION N 5 027 633.7 E 376 475.0 ORIGINATED BY SLL
 HWY 417/Hunt Club Road BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2010.07.21 - 2010.07.21 CHECKED BY LPG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
65.0								20 40 60 80 100					
0.0	TOPSOIL, with rootlets (125mm)							20 40 60 80 100					
0.1	Silty CLAY , trace sand, trace rootlets Stiff to Firm Brown Moist		1	SS	12		64						
			2	SS	6		63						
	Becoming grey		3	SS	4								0 1 61 38
62.0							62						1 32 45 22
3.0	Clayey Sandy SILT , trace gravel Soft to Firm Dark Grey Moist to Wet (TILL)		4	SS	2								
61.2													
3.8	END OF BOREHOLE AT 3.8m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.1m, THEN CUTTINGS TO SURFACE.												

+³ . X³ : Numbers refer to
Sensitivity

20
15
10

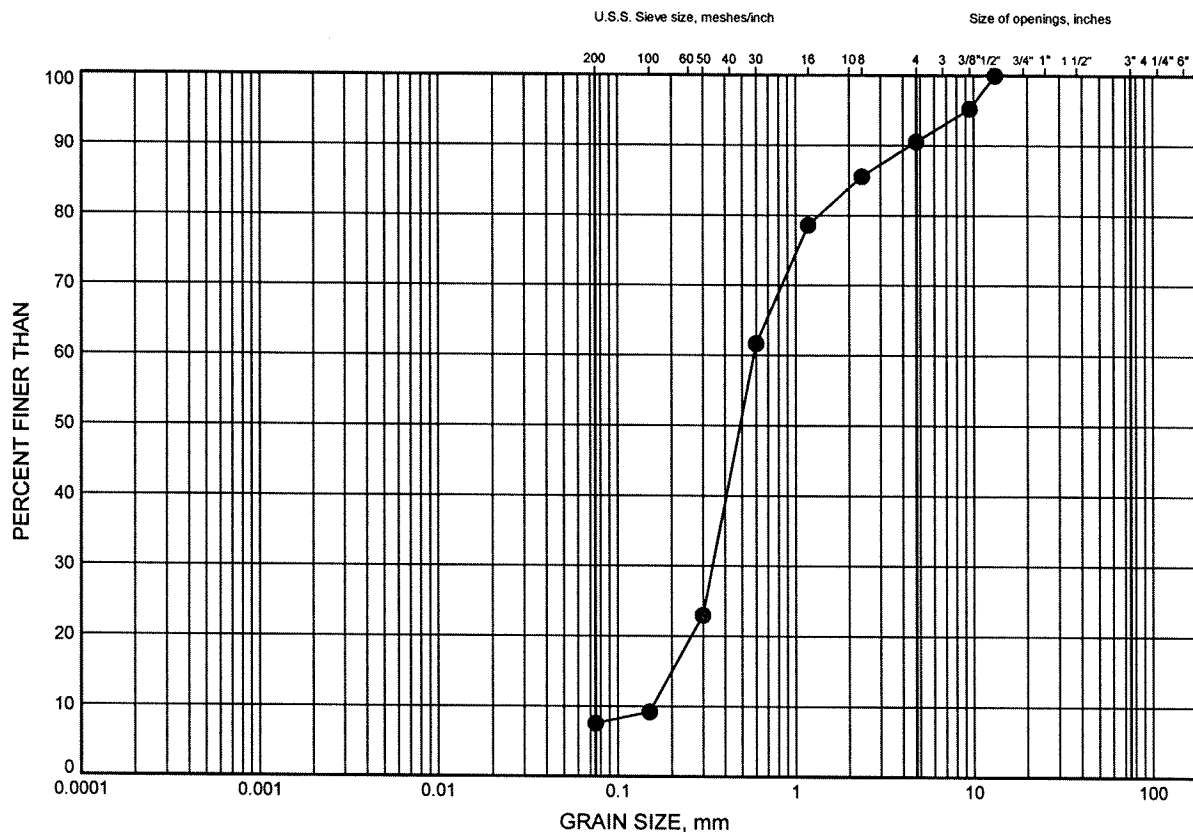
(%) STRAIN AT FAILURE

Appendix B
Laboratory Test Results

GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND FILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH10-13	2.59	64.69

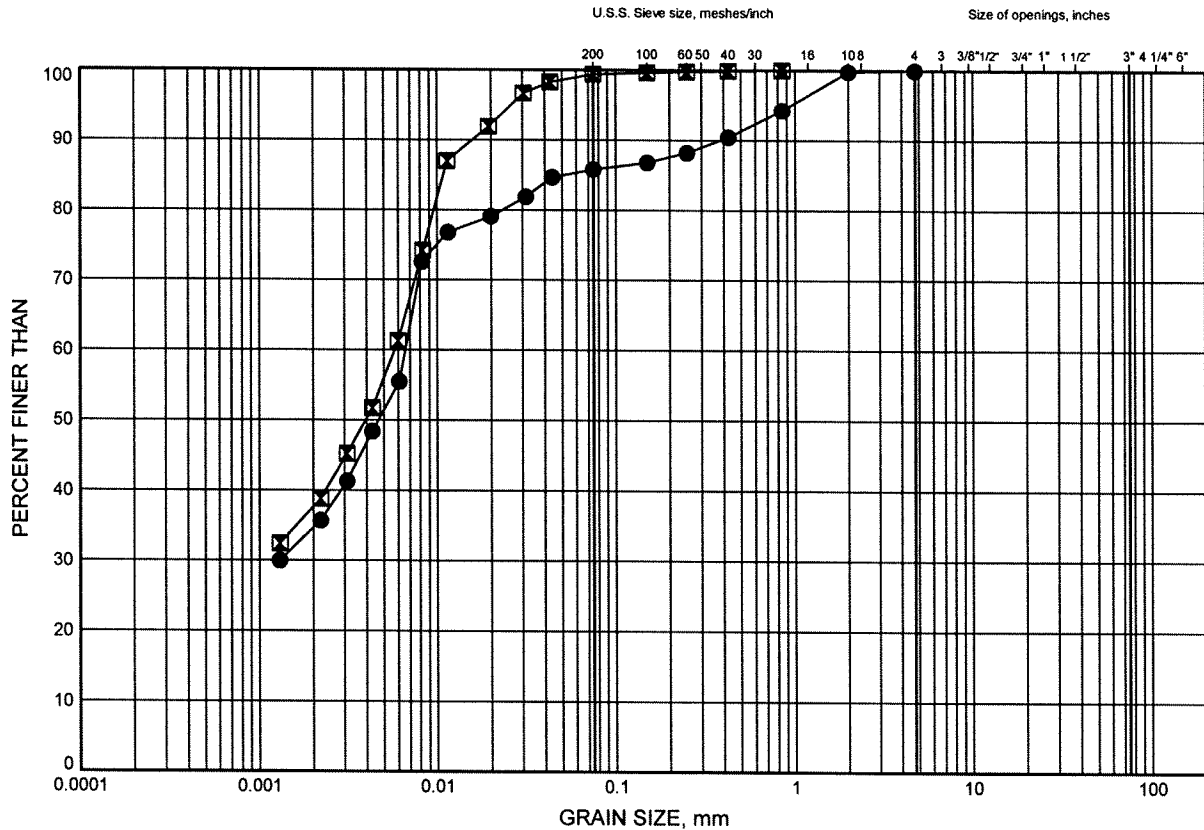


W.P.# 19-5438-7
 Prepared By LRB
 Checked By JPL

GRAIN SIZE DISTRIBUTION

FIGURE B2

SILTY CLAY



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH10-13	4.88	62.41
□	BH10-14	2.59	62.37

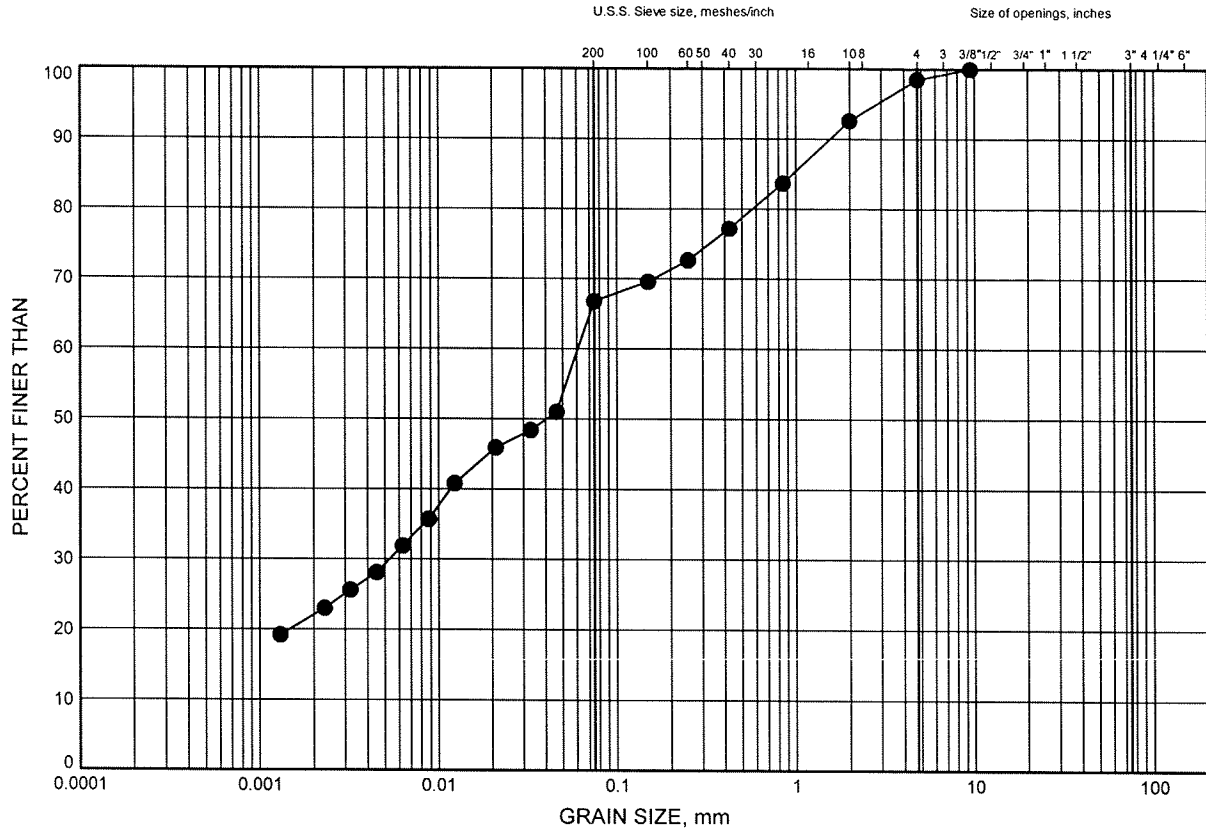


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GRAIN SIZE DISTRIBUTION

FIGURE B3

TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH10-14	3.35	61.61

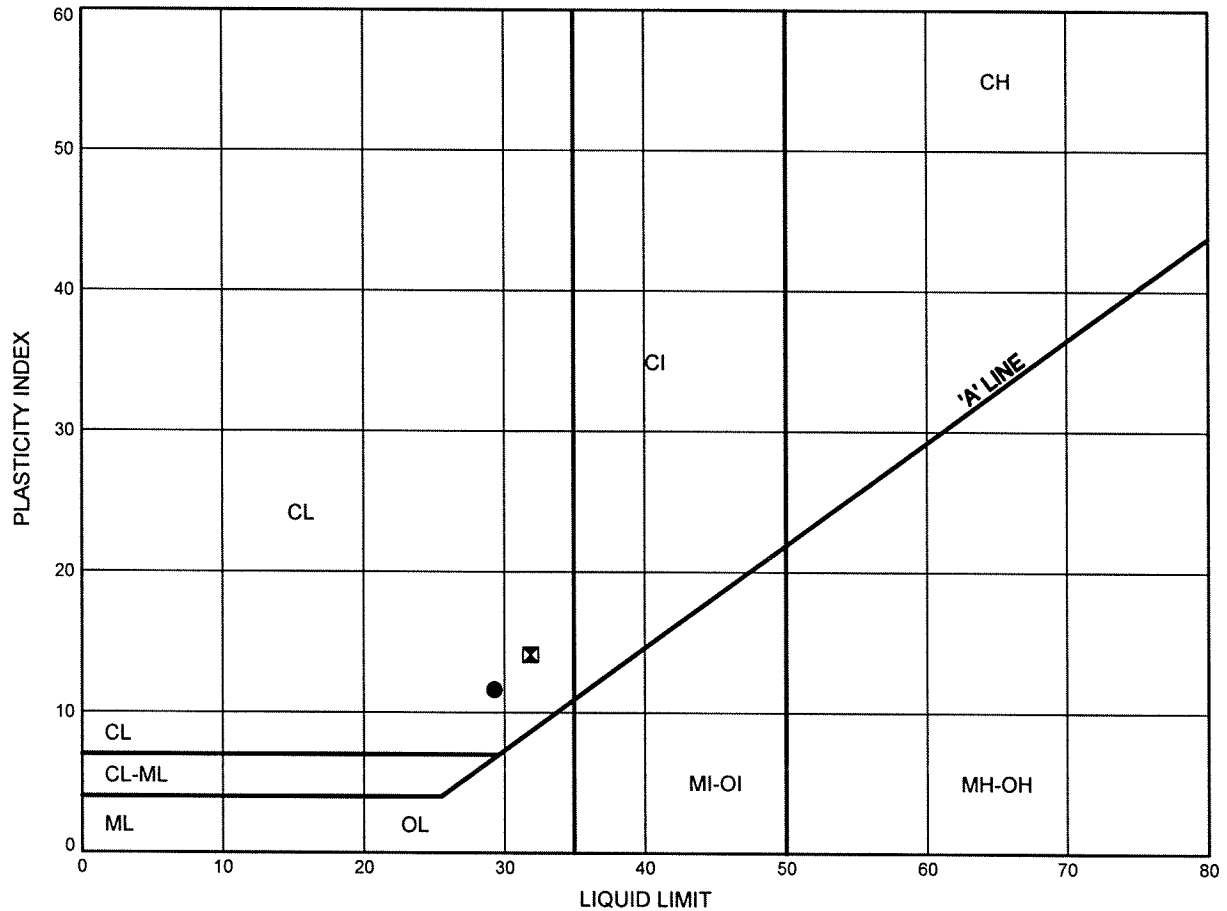


W.P.# 19-5438-7
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 Checked By JPL

ATTERBERG LIMITS TEST RESULTS

FIGURE B4

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BH10-13	4.88	62.41
☒	BH10-14	2.59	62.37

Date August 2010

Project 19-5438-7



Prep'd LRB

Chkd. JPL



THURBER ENGINEERING LTD.
GEOTECHNICAL ■ ENVIRONMENTAL ■ MATERIALS

**HYDROGEOLOGY ASSESSMENT
HUNT CLUB ROAD EXTENSION
FROM RUSSELL ROAD TO HIGHWAY 417
CITY OF OTTAWA, ONTARIO**

Report to

AECOM



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April 26, 2011

File: 19-5438-7

Steven Sather, P.Eng.
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Apr. 26/11

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Technical Analysis



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Statement of General Conditions



LIST OF APPENDICES

Appendix A: Drawings and Figures

Figure 1	Site Location Plan (OBM map)
Figure 2	Excavation Locations (from OBM map)
Dwg. No. 302	Russell Road Structure Borehole Data
Dwg. No. 702	S-E Ramp Borehole Data
Dwg. No. 802	W-N/S Ramp Borehole Data
Dwg. No. 002 (x 2)	Highway 417 Underpass Structure Borehole Locations and Soil Strata
Dwg. No. 902	S-W Ramp Borehole Data
Dwg. No. 1002	E-N/S Ramp Borehole Data
Dwg. No. 1102	Highway 417 Culvert Extension Borehole Location and Soil Strata

Appendix B: Groundwater Samples - Analytical Data

Appendix C: Search Results: Well Records



1. INTRODUCTION

This report summarizes a hydrogeologic assessment of the conditions at this site as it relates to the proposed groundwater control measures which will be required during construction of Part B of this project (further discussed below). This report is intended to provide data in support of the application for a Permit to Take Water as excavations required for construction of culvert footings, abutment pile caps and abutment footings will require dewatering during construction.

This report is subject to the attached Statement of General Conditions which is included at the end of the text of this report. The reader's attention is specifically drawn to these conditions as it is essential that they be followed for proper use and interpretation of this report. It is understood that copies of the report will be provided to the Ontario Ministry of Environment for the purpose of obtaining a Permit to Take Water (PTTW) for temporary dewatering.

2. BACKGROUND

2.1 Description of Project

The project involves the construction of an extension of Hunt Club Road eastwards to connect with Highway 417, in the City of Ottawa, Ontario. The project is to be constructed in two parts, Part A being the extension of Hunt Club Road from Hawthorne Road eastwards to short of Russell Road. Part B of the project continues from Russell Road, northeast to a new interchange with Highway 417. This report pertains to Part B, which consists of 6 bridge structures and 1 culvert extension as follows:

Table 1: Foundation Details

Site	Foundation Elements	Foundation Type
Russell Road Structure	North and South Abutments	Piles driven to bedrock
S-E Ramp over McEwan Creek	East and West Abutments	Piles driven bedrock
W-N/S Ramp Structure over Ramsay Creek	East and West Abutments	Footings on bedrock
E-N/S and S-W Ramps over Ramsay Creek	East and West Abutments	Footings on bedrock
	East and West Abutments	Footings on bedrock
Highway 417 Underpass Structure	North and South Abutments	Piles driven to bedrock
	North and South Piers	Footings on bedrock
Highway 417 Culvert Extension	North and South Legs	Footings on bedrock



As identified above, some of these structures will be supported on steel H piles driven to refusal on bedrock. For these structures, excavations up to 3 m deep will be made in the area of abutments to permit construction of the pile caps on which the structures will be supported. Those structures not supported on piles will be supported on footings founded on bedrock, which will require excavations through overburden materials that are locally 3 m to 6 m thick.

2.2 Description of Taking

The proposed groundwater taking will involve temporary groundwater extraction from dewatering measures required during construction. No permanent dewatering systems will be installed as part of this project. Excavations for the abutment pile caps and footings will extend up to 5 meters below the water table. The relative pumping rates and area of influence (where depression of the water-table is expected) are presented separately below.

Temporary dewatering measures required during construction will be designed and operated by the Contractor who will provide water treatment to meet discharge requirements (Provincial Water Quality Objectives). It is expected that individual dewatering systems, comprising pumping from sumps, will be required at each excavation location until the excavations are backfilled.

3. CHARACTERIZATION OF THE HYDROGEOLOGIC SETTING

3.1 Geological Setting

The geology of the area is characterized by medium to high plastic glaciomarine clays overlying relatively thin and often discontinuous silty sand to silt glacial till. The overburden deposits overlie sedimentary bedrock of the Georgian Bay Formation consisting of shale with limestone interbeds.

3.2 Surface Conditions

In general, the site is located on rolling terrain incorporating open farm fields and undeveloped bush areas. The ground surface within the limits of the project area varies between Elevations 65 m and 70 m, gradually dipping downwards towards the north.



The regional groundwater gradient is northwards to the Ottawa River. McEwan Creek and Ramsay Creek run through the project area. McEwan Creek flows northeast to Ramsay Creek which in turn eventually flows into the Ottawa River, located approximately 9kms to the north.

3.3 Subsurface Conditions

Borehole logs, laboratory test results, and other investigation data are summarized in the following data reports:

- Foundation Investigation Report – Hunt Club Road Over Russell Road, dated Feb. 25, 2011 by Thurber Engineering Ltd.
- Foundation Investigation Report – S-E Ramp over McEwan Creek, dated Feb. 25, 2011 by Thurber Engineering Ltd.
- Foundation Investigation Report – W-N/S Ramp over Ramsay Creek, dated Feb. 25, 2011 by Thurber Engineering Ltd.
- Foundation Investigation Report – S-W & E-N/S Ramps over Ramsay Creek, dated Feb. 25, 2011 by Thurber Engineering Ltd.
- Foundation Investigation Report – Highway 417 Culvert Extension, dated Mar. 11, 2011 by Thurber Engineering Ltd.
- Foundation Investigation Report– Highway 417 Underpass, dated Feb. 25, 2011 by Thurber Engineering Ltd.
- Foundation Investigation and Design Report – Hunt Club Road Extension Embankment Design From Hawthorne Road to Russell Road, dated Dec. 1, 2009 by Thurber Engineering Ltd.

A summary of the subsurface conditions encountered at each site is presented in the following table. In general, the subsurface conditions consist of a thin layer of topsoil overlying 1.1 m to 5.0 m of silty clay, which in turn overlies 0.3 m to 4.1 m of silty sand/silt till. The above sequence is underlain by shale bedrock with limestone interbeds. At 2 sites, a discontinuous layer of sand was encountered above the silty clay at some boreholes. As well, the silty sand/silt till was not encountered above the bedrock in some of the boreholes at 2 sites.

The depth to groundwater was relatively shallow, 0.6 m to 1.1 m below ground surface.



Table 2: Summary of Subsurface Conditions

Site	Groundwater Level (mbgs*)	Thicknesses (m)		
		Upper Sand (m)	Silty Clay (m)	Sandy Silt/Silt Till (m)
Russell Road Structure	1.1 to 3.4	1.0 to 2.0	3.2 to 5.0	2.1 to 4.1
S-E Ramp over McEwan Creek	1.1 to 3.5	-	2.8 to 4.5	2.0 to 3.1
W-N/S Ramp over Ramsay Creek	1.1 to 2.1	0 to 1.4	2.0 to 3.2	0 to 0.5
Highway 417 Underpass Structure	0.9 to 1.5	-	2.9 to 4.5	0.3 to 2.0
E-N/S and S-W Ramps over Ramsay Creek	0.6 to 2.8	-	2.5 to 4.5	0 to 2.1
Highway 417 Culvert Extension	N/A	-	1.1 to 2.9	0.3 to 0.8

*mbgs meters below ground surface

The subsurface conditions encountered at the location of each structure are summarized in the profile drawings included in Appendix A.

3.4 Conductivity Testing

In-situ testing was carried out at selected locations during the investigation to assess the variation of hydraulic conductivity of the silty sand/silt till deposits. Rising-head and falling head tests were carried out in 51 mm diameter piezometers (19 mm diameter in BH10-12) installed in the silt/silty sand till. The recovery data was analyzed based on the method of Hvorslev, 1951. The results of these tests are presented in the table below.

Laboratory consolidation testing was carried out on selected samples of the silty clay deposit to assess compressibility and vertical hydraulic conductivity from undisturbed Shelby Tube samples of the silty clay. The results of the lab and field tests are presented in the table below.



Table 3: Hydraulic Conductivity

Test Location	Method	Material	Hydraulic Conductivity (m/s)
S-08	Rising Head Piezometer Test	Silty Sand Till	1.1×10^{-8}
S-13	Falling Head Piezometer Test	Silty Sand Till	3.1×10^{-5}
S-30	Falling Head Piezometer Test	Silty Sand Till	1.0×10^{-5}
S-30	Rising Head Piezometer Test	Silty Sand Till	1.7×10^{-5}
BH10-12	Rising Head Piezometer Test	Silt Till	9.8×10^{-8}
BH09-11	Consolidation Test	Silty Clay	5×10^{-9}
BH09-13	Consolidation Test	Silty Clay	1×10^{-9}
BH09-18	Consolidation Test	Silty Clay	6×10^{-10}

3.5 Groundwater Chemistry

Both filtered and unfiltered groundwater samples were collected from selected monitoring wells installed in the silt/silty sand till and were submitted to AGAT Laboratories for chemical analysis. A water sample was also collected from the creek for analysis. The analytical results were compared to the Provincial Water Quality Objectives (PWQOs) for discharge of groundwater to surface waters.

Based on the PWQOs, the unfiltered groundwater samples contained several parameters with concentrations exceeding the guideline values (Boron, Copper, Iron, Lead, Nickel, Total Phosphorus, Uranium, and Vanadium). In the filtered groundwater samples, only Boron, Iron, and Total Phosphorus were found in concentrations exceeding the PWQOs.

The results of the analytical laboratory tests are presented in the Certificate of Analysis included in Appendix B. Those parameters with concentrations exceeding the PWQOs are listed on page 3 of the Certificate of Analysis, indicating that treatment of groundwater will be required prior to discharge.

Based on data obtained from Leveloggers installed in 3 different monitoring wells, the temperature of the groundwater was between 7°C and 10°C.



4. STUDY METHODOLOGY

4.1 Precipitation

It is anticipated that surface water from precipitation will also need to be pumped out of the excavations. To estimate potential precipitation volumes during construction the average daily rainfall intensity for a 25 year return period was utilized over a catchment area 5 times larger than the surface area of each excavation.

4.2 Hydrogeologic Analysis

A hydrogeologic analysis was carried out to model the influence of the proposed excavations on the existing groundwater flow system in terms of withdrawal rate and radius of influence. A separate analysis was carried out for each individual foundation element excavation (18 in total).

Groundwater flow was modeled based on a combination of methods to approximate field conditions:

- i. steady-state conditions in a leaky-confined aquifer, and
- ii. steady-state conditions in an unconfined aquifer.

The leaky-confined method is considered representative of the relatively low permeability clay overlying silty sand till and the unconfined method is representative of excavations extending into the silty sand/silt till which would lead to dewatering of the water-bearing silty sand/silt till. Depending on the dimensions of the excavation the model either considered one-dimensional flow to a slot or radial flow to a well or to a group of wells

As mentioned above, where dewatering would be expected to drawdown the water table within the silty sand unit, unconfined conditions were modeled to provide a better estimate of flow rates. Two separate scenarios were considered for the unconfined aquifer; the first scenario assumed connectivity with the adjacent creek (where present) to model maximum potential inflow rate and the second scenario assumed limited connectivity with the adjacent creek, which is considered a more likely situation.



Vertical recharge at ground surface was set as 5% of the average annual precipitation rate for Ottawa, which is comparable to the estimated vertical seepage rate within the clay. Discharge rates under transient conditions were calculated based on the method of Hantush-Jacob, 1955.

4.3 Dewatering Rates

Steady state conditions are expected to take several months to occur and accordingly allowance should be made for higher transient discharge rates that will be encountered during construction, as provided in Table 4 below. These rates are based on the assumption that higher permeability sand layers with connectivity to the adjacent creek are encountered in the excavation. It should be noted that these rates represent the total seepage rate per site (not total rate per excavation), including precipitation. Some bridge sites are expected to have multiple excavations (abutments and piers), as identified in the following table.

Table 4: Construction Dewatering Rates

Site	Total No. of Excavations	Surface Precipitation (L/day)	Typical Daily Seepage Rate (L/day)	Maximum Daily Seepage Rate (L/day)
Russell Road Structure	2	365,000	16,000	410,000
S-E Ramp over McEwan Creek	2	65,000	52,000	200,000
W-N/S Ramp over Ramsay Creek	2	246,000	1,184,000	3,200,000
Highway 417 Underpass Piers	4	32,000	2,200,000	5,500,000
Highway 417 Underpass Abutments	2	154,000	480,000	1,400,000
E-N/S and S-W Ramps over Ramsay Creek	4	182,000	2,760,000	7,100,000
Highway 417 Culvert Extension	2	8,000	416,000	1,100,000



4.4 Radius of Influence

The maximum radius of influence (water-table drawdown) which will occur under steady-state conditions was calculated. The resulting radii measured from the centre of each individual excavation are provided in Table 5.

Table 5: Radii of Influence Per Individual Excavation

Site	Radii (m)
Russell Road Structure	275
S-E Ramp over McEwan Creek	300
W-N/S Ramp over Ramsay Creek	250
Highway 417 Underpass Piers	250
Highway 417 Underpass Abutments	225
E-N/S and S-W Ramps over Ramsay Creek	250
Highway 417 Culvert Extension	375

5. IMPACT ASSESSMENT

5.1 Geotechnical Impacts

The associated stress changes in the silty clay are expected to be relatively small because of the limited depth of excavation. Settlement of the silty clay associated groundwater withdrawal is expected to be less than 20 mm. Existing infrastructure in the area is limited to the embankments for Highway 417.

5.2 Surface Water Impacts

Many of the proposed excavations are located within 25 m of either McEwan Creek or Ramsay Creek. Should any of the excavations penetrate water bearing layers that are connected to a creek, large volumes of water will need to be pumped out of the excavations, which would proportionately reduce flow rates in the creek(s). In order to reduce the influence of pumping on the nearby creeks, coffer dams or sheet pile walls will be required. Where excavation is located within 15 m of a stream, sheet piles or coffer dams should be provided to control flow into the excavations.



It is anticipated that water will be removed by pumping from the open excavation to remove surface water. This water typically has a high concentration of Total Suspended Solids (TSS). To minimize the impacts of high TSS concentrations, provisions shall be made to filter the surface water through a sedimentation tank or filter bag before discharging to the creek, as per OPSS 518 - Construction Specification For Control of Water From Dewatering Operations.

In filtered groundwater samples, several other water quality assessment parameters (Boron, Iron, and Total Phosphorus) were found to exceed the PWQO guidelines for discharge of groundwater to surface water. These parameters are known to affect aquatic life, therefore water pumped out of the excavations will require additional treatment methods prior to discharge. The water temperature will also need to be monitored and controlled to ensure cold water is not discharge into warm surface water.

5.3 Existing Groundwater Users

There are records for over 200 wells within a 3 kilometer radius of the site, including at least 15 wells that are within 500 meter of the site. Most of these wells have been used for domestic water use while some have been used for livestock, irrigation, municipal and industrial use in the area. These wells produce between 1 and 190 litres per minute with the higher yields being encountered in wells screened in a sand/gravel deposit. Domestic wells which take their water from the bedrock have typically been tested at a rate of 20 L/min.

Based on the radii of influence presented above, the possibility exists that some nearby wells will be impacted. A monitoring program is therefore recommended to assess the potential for impacts.

6. CONCLUSIONS AND RECOMMENDATIONS

Before dewatering begins at any of the sites related to this phase of the project, a manual reading of the water levels in wells within 500 m of any excavation should be taken. It is prudent to advise home owners within the zone of influence of the proposed water taking so that interference issues can be anticipated. Provisions should be made to provide alternate water supply on a temporary basis if indicated by the monitoring data.



Samples of the discharged water should be tested to ensure it is of suitable quality to be discharged to the environment.

The recommended monitoring plan may require the installation of monitoring wells if none are currently available and should consist of the following: sampling of well water for Water Quality Assessment analysis a minimum of 3 times (prior to construction, during construction, and post construction), and monthly monitoring of water levels in the wells during construction.

Recommendations

- Provide suitable water treatment measures for discharge of water from excavation.
- Install coffer dams or sheet piles where excavation is within 15 m of stream to control seepage rates.
- Carry out inventory of existing water wells within 500 m of any proposed excavation. Where existing wells are encountered, a monitoring plan should be implemented. Monitoring to be carried out from subject wells or from additional monitoring well installed between excavation and subject wells.
- Provide suitable measures to prevent surface water from entering excavations.

STATEMENT OF GENERAL CONDITIONS

1. STANDARD OF CARE

This study and Report have been prepared in accordance with generally accepted engineering or environmental consulting practices in this area. No other warranty, expressed or implied, is made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report which is of a summary nature and is not intended to stand alone without reference to the instructions given to us by the Client, communications between us and the Client, and to any other reports, writings, proposals or documents prepared by us for the Client relative to the specific site described herein, all of which constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. WE CANNOT BE RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purpose that were described to us by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the document are only valid to the extent that there has been no material alteration to or variation from any of the said descriptions provided to us unless we are specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT OUR WRITTEN CONSENT. WE WILL CONSENT TO ANY REASONABLE REQUEST BY THE CLIENT TO APPROVE THE USE OF THIS REPORT BY OTHER PARTIES AS "APPROVED USERS". The contents of the Report remain our copyright property and we authorize only the Client and Approved Users to make copies of the Report only in such quantities as are reasonably necessary for the use of the Report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make the Report, or any portion thereof, available to any party without our written permission. Any use which a third party makes of the Report, or any portion of the Report, are the sole responsibility of such third parties. We accept no responsibility for damages suffered by any third party resulting from unauthorized use of the Report.

5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgemental in nature and even comprehensive sampling and testing programs, implemented with the appropriate equipment by experienced personnel, may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and all persons making use of such documents or records should be aware of, and accept, this risk. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

(see over...)

INTERPRETATION OF THE REPORT *(continued)*

- b) **Reliance on Provided Information:** The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to us. We have relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, we cannot accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of persons providing information.

6. RISK LIMITATION

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause an accidental release of those substances. In consideration of the provision of the services by us, which are for the Client's benefit, the Client agrees to hold harmless and to indemnify and defend us and our directors, officers, servants, agents, employees, workmen and contractors (hereinafter referred to as the "Company") from and against any and all claims, losses, damages, demands, disputes, liability and legal investigative costs of defence, whether for personal injury including death, or any other loss whatsoever, regardless of any action or omission on the part of the Company, that result from an accidental release of pollutants or hazardous substances occurring as a result of carrying out this Project. This indemnification shall extend to all Claims brought or threatened against the Company under any federal or provincial statute as a result of conducting work on this Project. In addition to the above indemnification, the Client further agrees not to bring any claims against the Company in connection with any of the aforementioned causes.

7. SERVICES OF SUBCONSULTANTS AND CONTRACTORS

The conduct of engineering and environmental studies frequently requires hiring the services of individuals and companies with special expertise and/or services which we do not provide. We may arrange the hiring of these services as a convenience to our Clients. As these services are for the Clients' benefit, the Client agrees to hold the Company harmless and to indemnify and defend us from and against all claims arising through such hirings to the extent that the Client would incur had he hired those services directly. This includes responsibility for payment for services rendered and pursuit of damages for errors, omissions or negligence by those parties in carrying out their work. In particular, these conditions apply to the use of drilling, excavation and laboratory testing services.

8. CONTROL OF WORK AND JOBSITE SAFETY

We are responsible only for the activities of our employees on the jobsite. The presence of our personnel on the site shall not be construed in any way to relieve the Client or any contractors on site from their responsibilities for site safety. The Client acknowledges that he, his representatives, contractors or others retain control of the site and that we never occupy a position of control of the site. The Client undertakes to inform us of all hazardous conditions, or other relevant conditions of which the Client is aware. The Client also recognizes that our activities may uncover previously unknown hazardous conditions or materials and that such a discovery may result in the necessity to undertake emergency procedures to protect our employees as well as the public at large and the environment in general. These procedures may well involve additional costs outside of any budgets previously agreed to. The Client agrees to pay us for any expenses incurred as the result of such discoveries and to compensate us through payment of additional fees and expenses for time spent by us to deal with the consequences of such discoveries. The Client also acknowledges that in some cases the discovery of hazardous conditions and materials will require that certain regulatory bodies be informed and the Client agrees that notification to such bodies by us will not be a cause of action or dispute.

9. INDEPENDENT JUDGEMENTS OF CLIENT

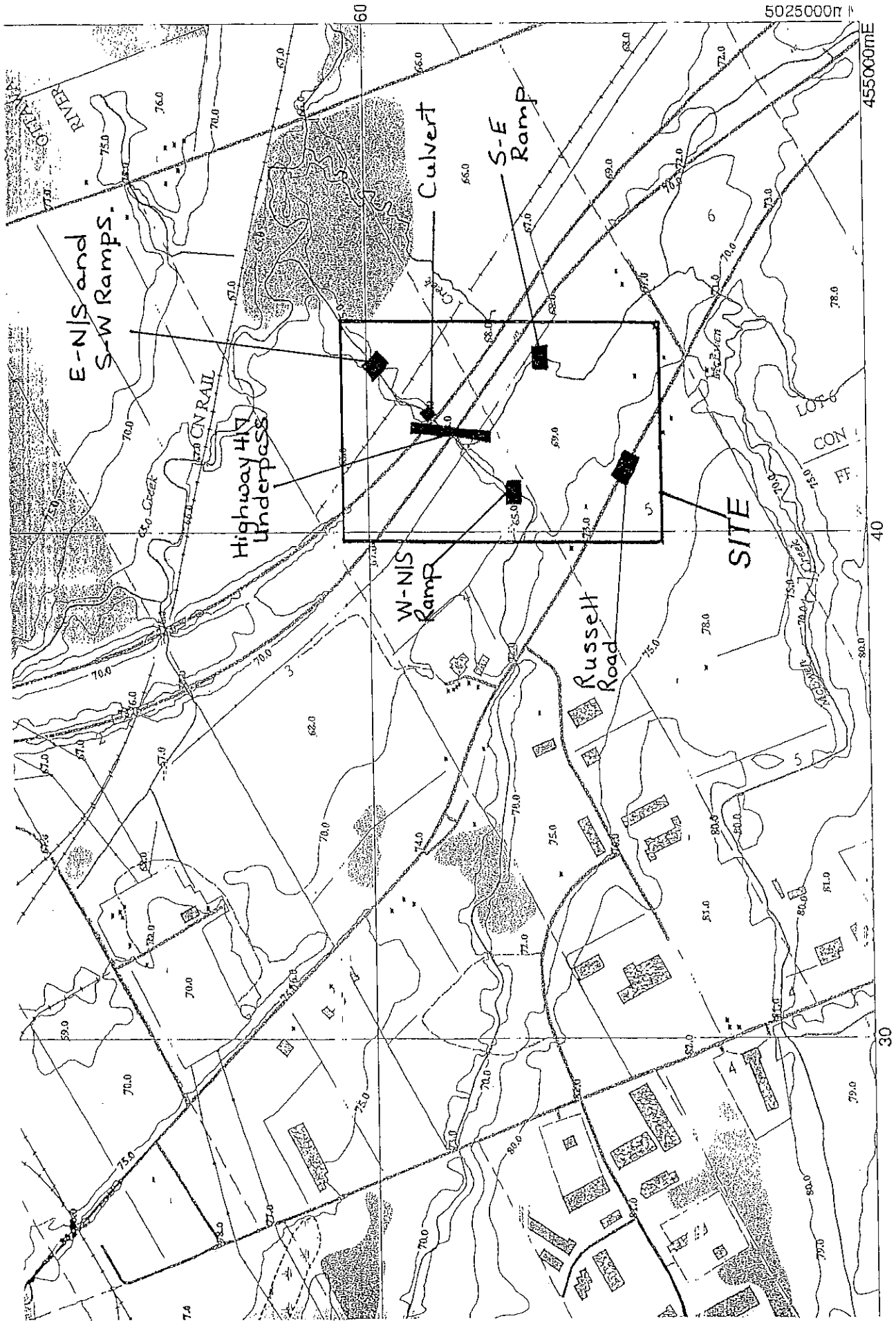
The information, interpretations and conclusions in the Report are based on our interpretation of conditions revealed through limited investigation conducted within a defined scope of services. We cannot accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes decisions made to either purchase or sell land.



APPENDIX A

DRAWINGS AND FIGURES

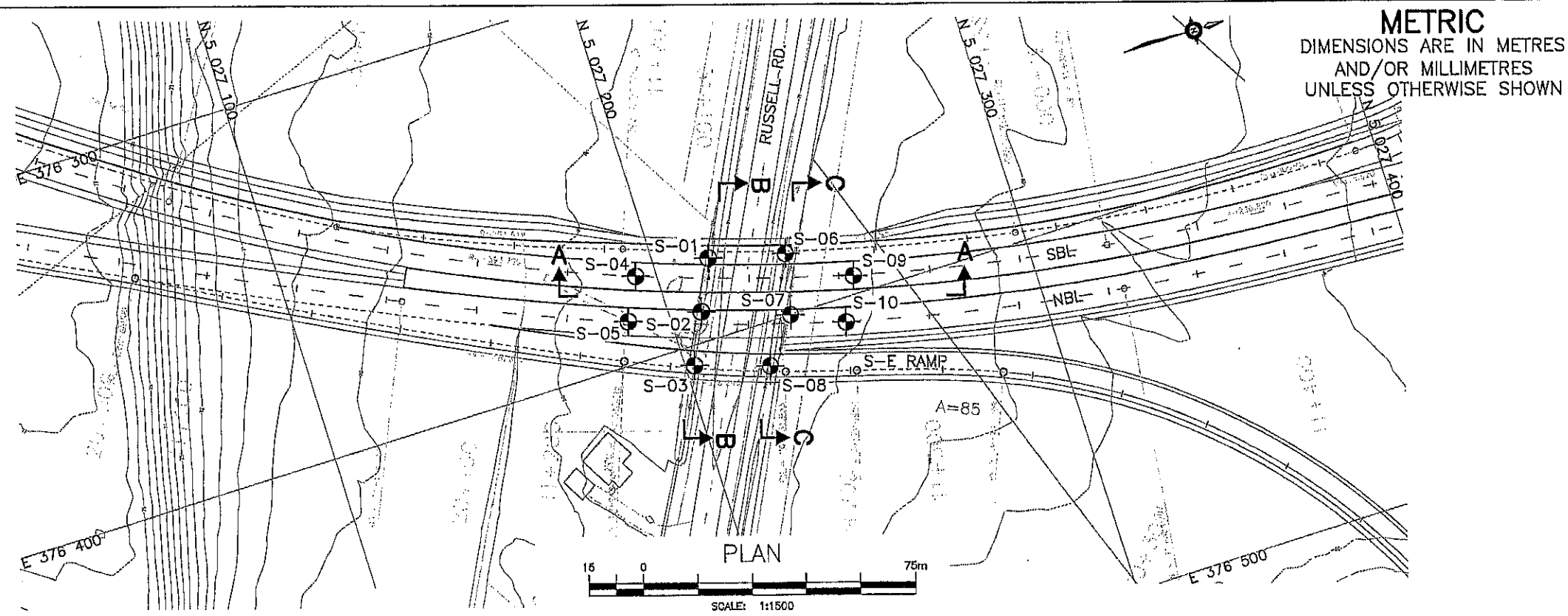
Figure 1	Site Location Plan (OBM map)
Figure 2	Excavation Locations (from OBM map)
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Dwg. No. 702	S-E Ramp Borehole Data
Dwg. No. 802	W-N/S Ramp Borehole Data
Dwg. No. 002 (x 2)	Highway 417 Underpass Structure Borehole Locations and Soil Strata
Dwg. No. 902	S-W Ramp Borehole Data
Dwg. No. 1002	E-N/S Ramp Borehole Data
Dwg. No. 1102	Highway 417 Culvert Extension Borehole Location and Soil Strata



SITE LOCATION FIGURE 2

From Ontario Base Map 10 18 4500 50250

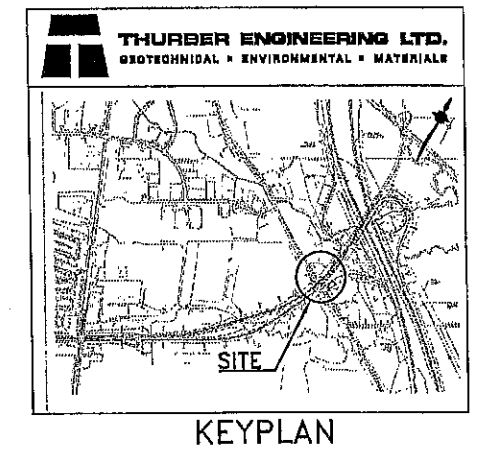
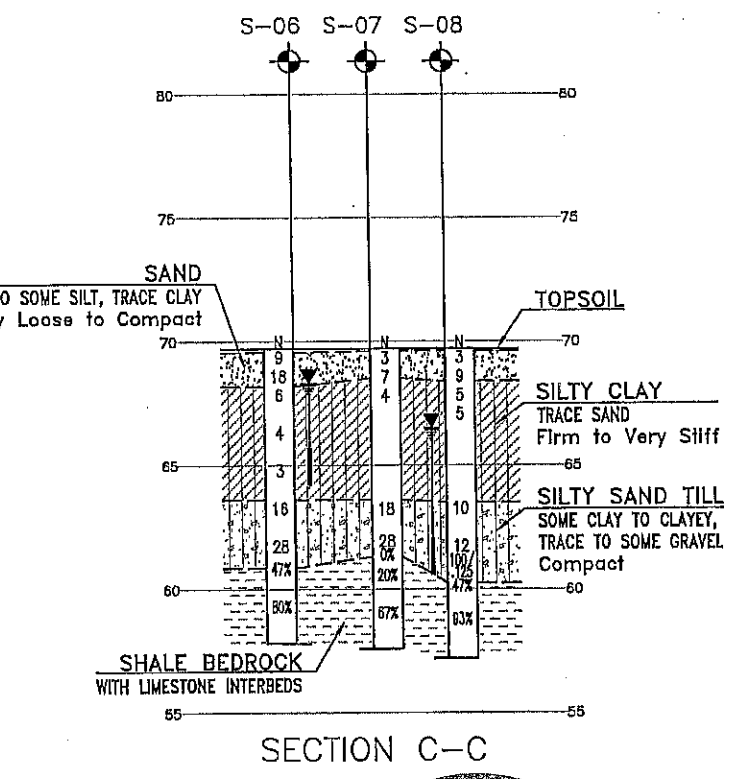
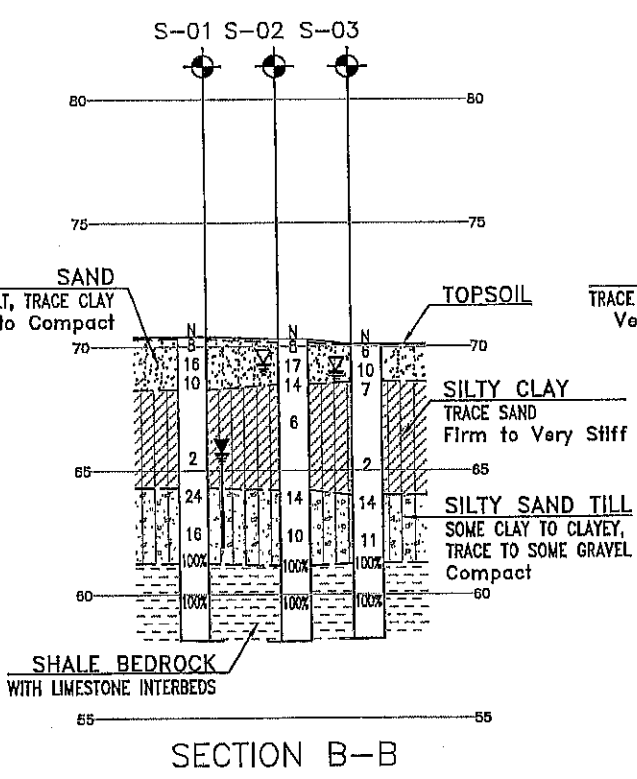
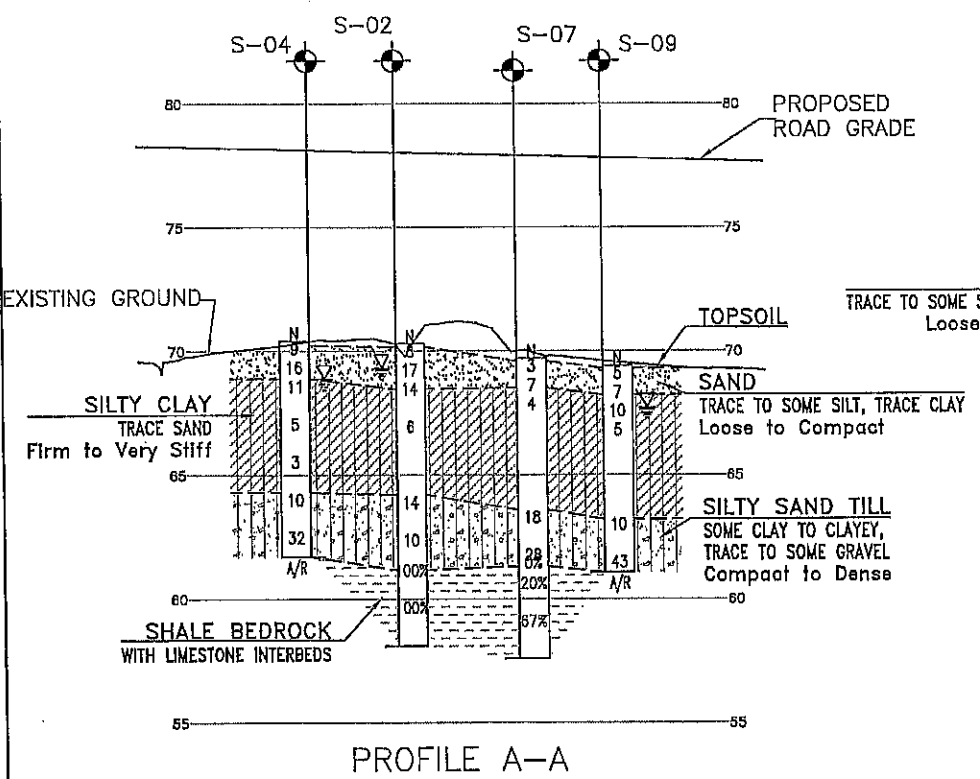
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Checked: J. P. K. Lee, P. Eng. 10/01/2011 10:00 AM
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Project: RUSSELL ROAD STRUCTURE NORTH & SOUTH BOUND LANES WITH S-E RAMP BOREHOLE DATA
Scale: 1:1500
Date: 10/01/2011
Drawing No: 302
Sheet No: 1 of 1
Asset No: 100086735
Asset Group: 100086735
Disc: JPL
Chk'd: AEG
Dwg: AN
Chk'd: AEG
Utility Circulation No: 100086735
Construction Inspector: 100086735
Code: CAN/CSA-S8-08
Load: CL-625-CHT



HUNT CLUB ROAD EXTENSION 417 SN 228700			
RUSSELL ROAD STRUCTURE NORTH & SOUTH BOUND LANES WITH S-E RAMP BOREHOLE DATA		Contract No. ISB09-5133B	Drawing No. 302
Z. Ghadban, P.Eng. Manager, Design & Construction - East		J. MacDonald, P. Eng. Project Manager	
		Sheet No.	1 of 1
		Asset No.	100086735
		Asset Group	100086735
		Disc	JPL
		Chk'd	AEG
		Dwg	AN
		Chk'd	AEG
		Utility Circulation No.	100086735
		Construction Inspector	100086735
		Code	CAN/CSA-S8-08
		Load	CL-625-CHT
NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.			
REVISIONS			
No.	Description	By	Date (month/year)
1	60% SUBMISSION	BZ	10/10
2	90% SUBMISSION	BZ	02/11

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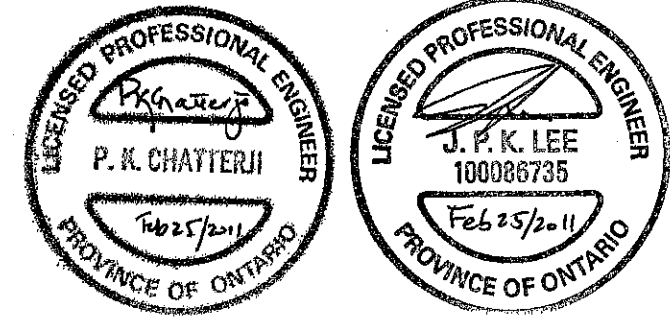
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	Borehole and Cone		
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CONE	Blows /0.3m (60° Cone, 475J/blow)		
PH	Pressure, Hydraulic		
	Water Level observed during drilling		
	Water level in Piezometer		
90%	Rock Quality Designation (RQD)		
A/R	Auger Refusal		
NO	ELEVATION	NORTHING	EASTING
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S-02	70.3	5 027 205.3	376 390.3
S-03	70.1	5 027 199.2	376 404.6
S-04	70.4	5 027 184.1	376 378.9
S-05	70.1	5 027 186.7	376 389.1
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GEOCREs No. 31G5-235

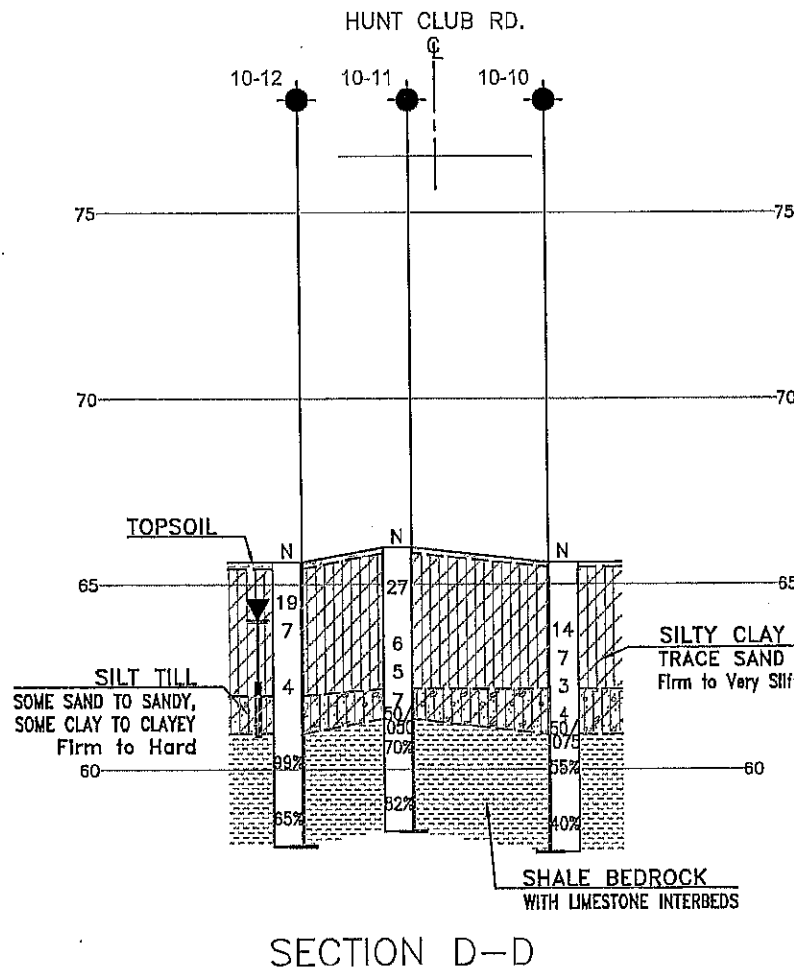
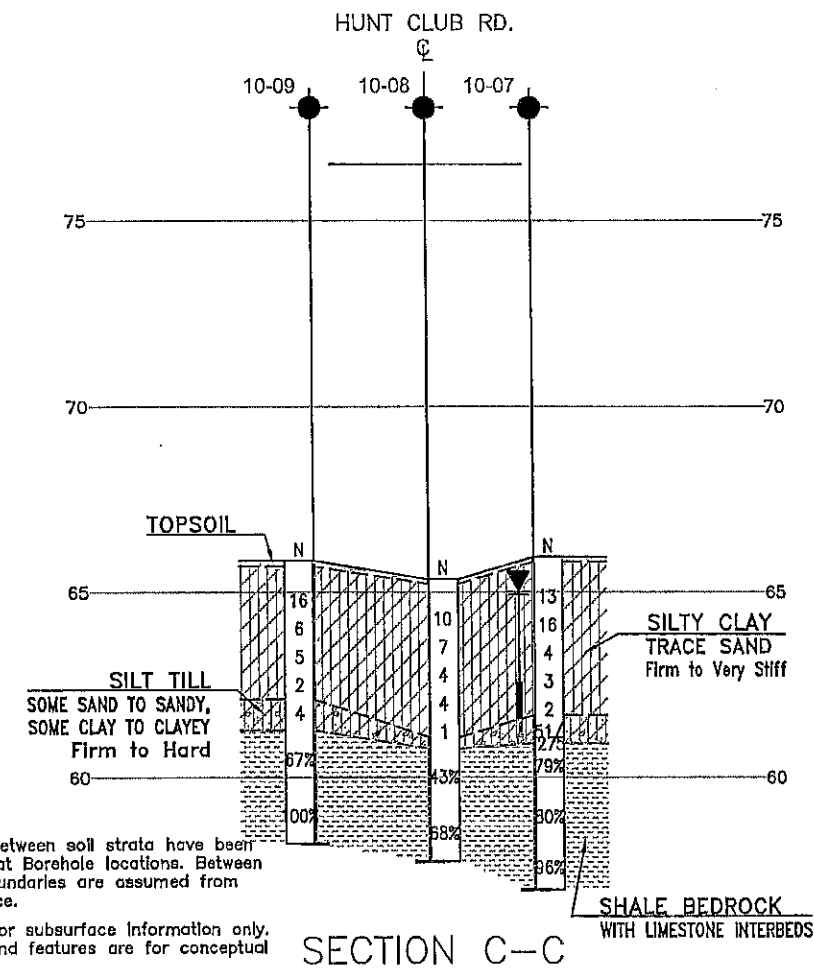
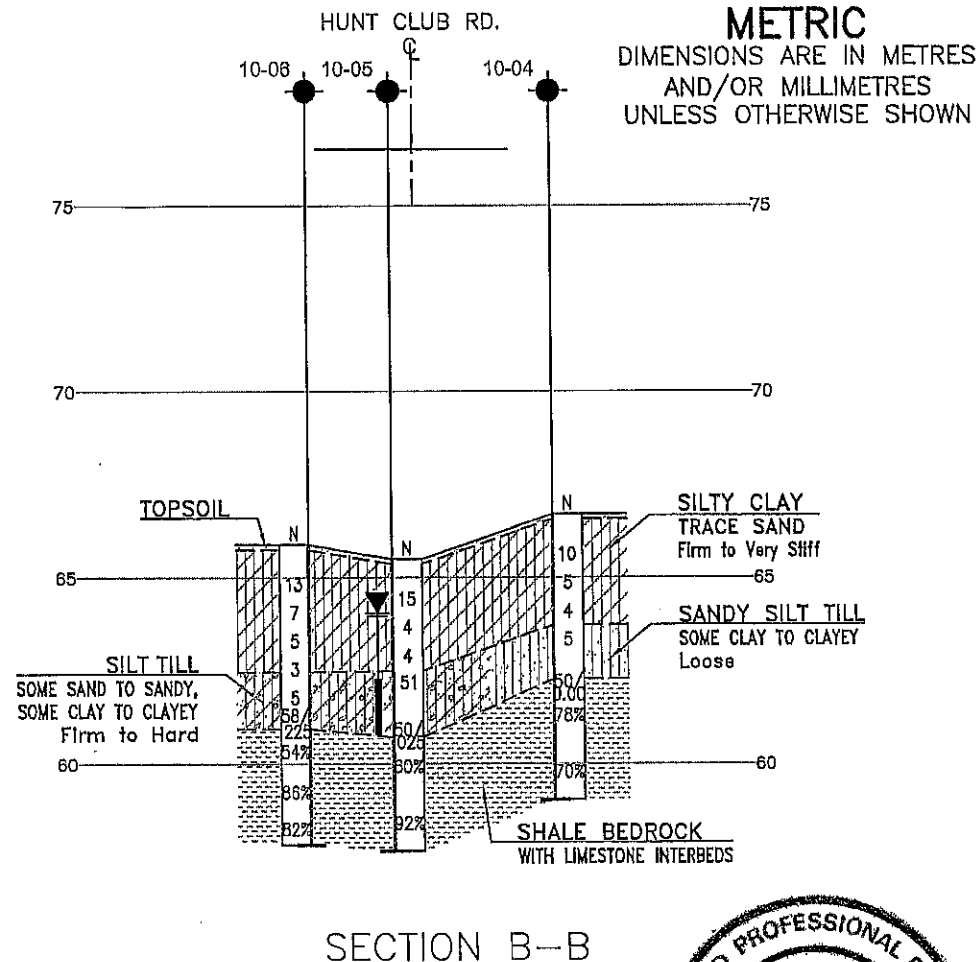
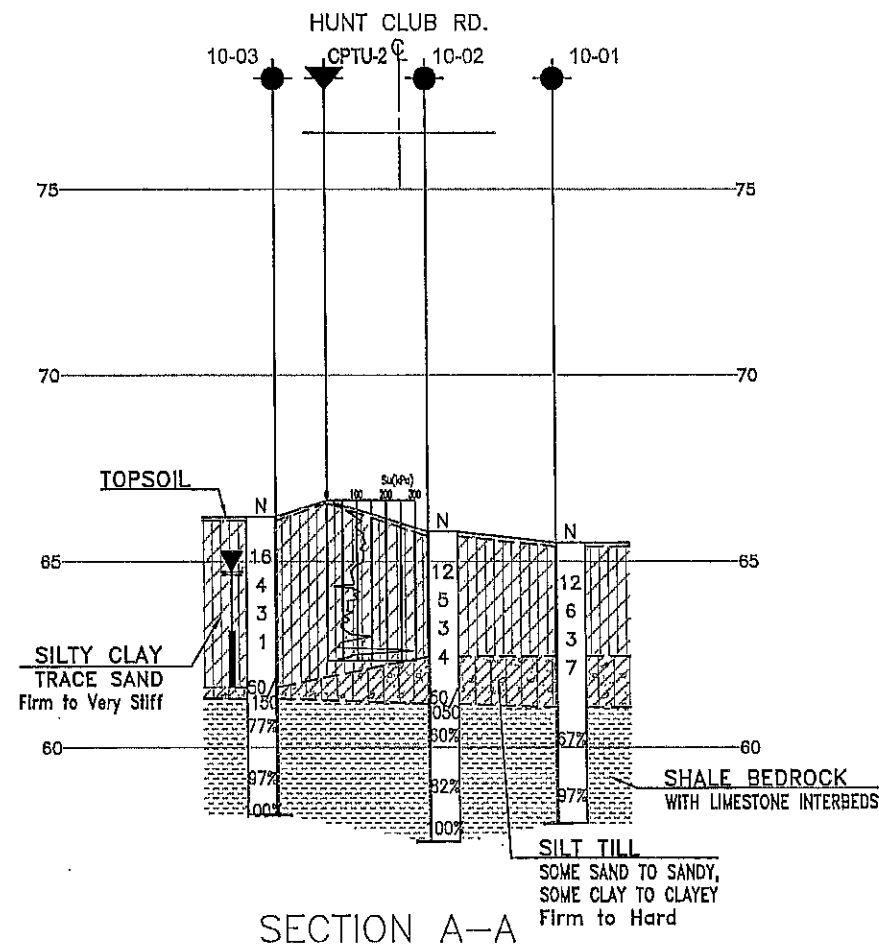
NOTES:

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

2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.



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HUNT CLUB ROAD
EXTENSION 417
SN 227680

HIGHWAY 417 UNDERPASS STRUCTURE
BOREHOLE LOCATIONS
& SOIL STRATA

W. Newell, P.Eng.
Director Infrastructure Services

Ziad A. Ghadban, P.Eng.
Manager, Construction Services - East

Ottawa

Contract No.
ISB09-5133

Sheet No.
002

Asset No.

Asset Group

Des: DOW CHX 82

Dw: BAE CHX 85

Utility Circulation No:

Construction Inspector:

Code: CAN/CSA-S6-06

Load: CL-625-OHT

NOTE:
The location of utilities is approximate only. The exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

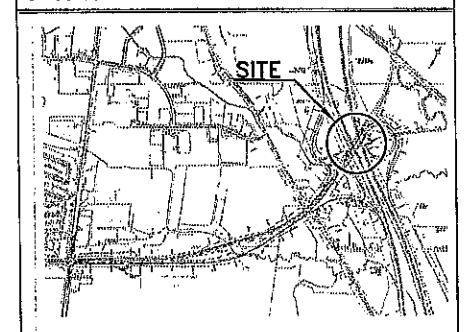
AECOM

No.	Description	By	Date (dd/mm/yyyy)

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THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



KEYPLAN

LEGEND

•	Borehole
•	Piezometer
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
W	Water Level observed during drilling
W	Water level in Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
10-01	65.5	5 027 512.7	376 399.1
10-02	65.8	5 027 503.2	376 416.0
10-03	66.2	5 027 490.8	376 436.1
10-04	66.7	5 027 568.3	376 409.0
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10-07	66.0	5 027 630.1	376 418.8
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10-11	66.0	5 027 675.2	376 440.7
10-12	65.6	5 027 665.0	376 455.1

GEOCRETS No. 31G5-237

NOTES:

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

10-13	67.3	5 027 615.1	376 478.3
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CPTU-2	66.5	5 027 495.5	376 430.8



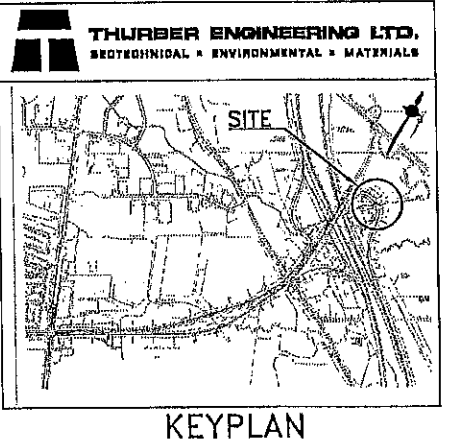
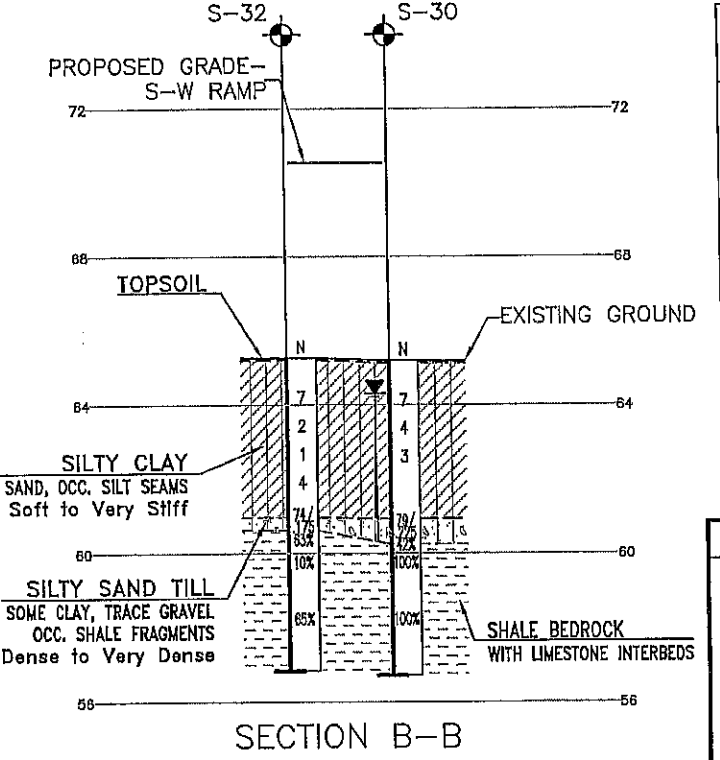
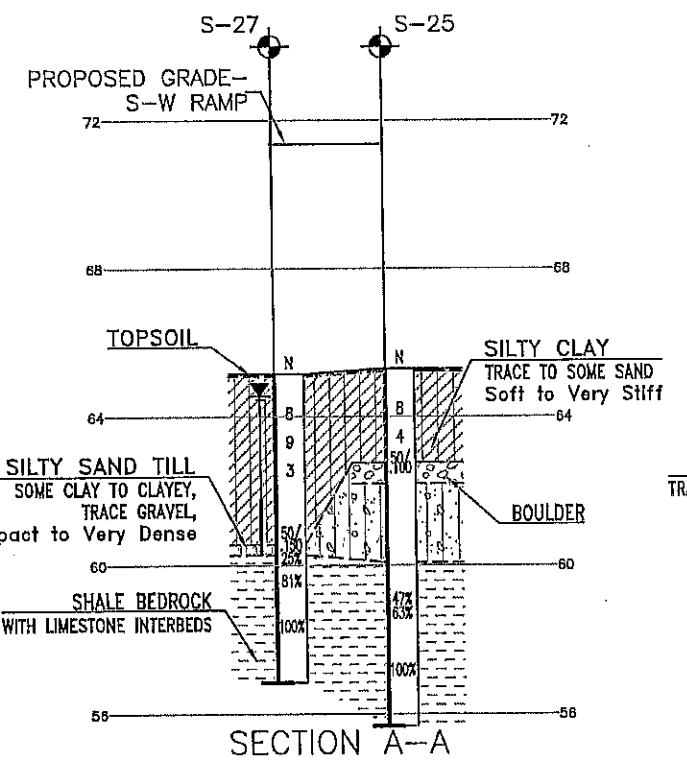
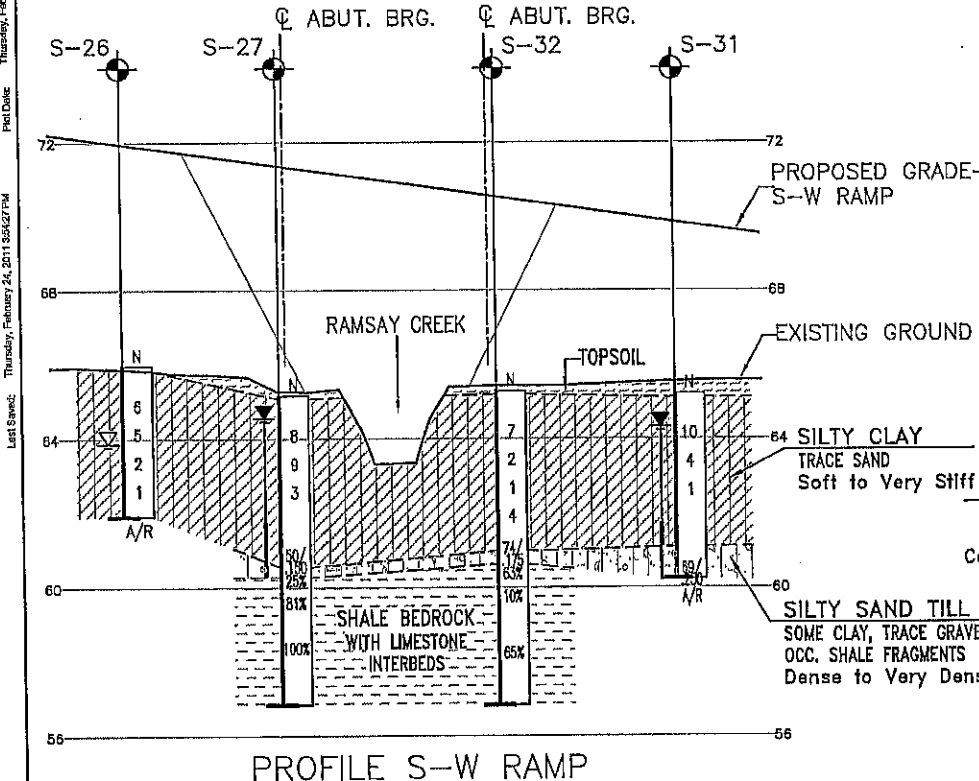
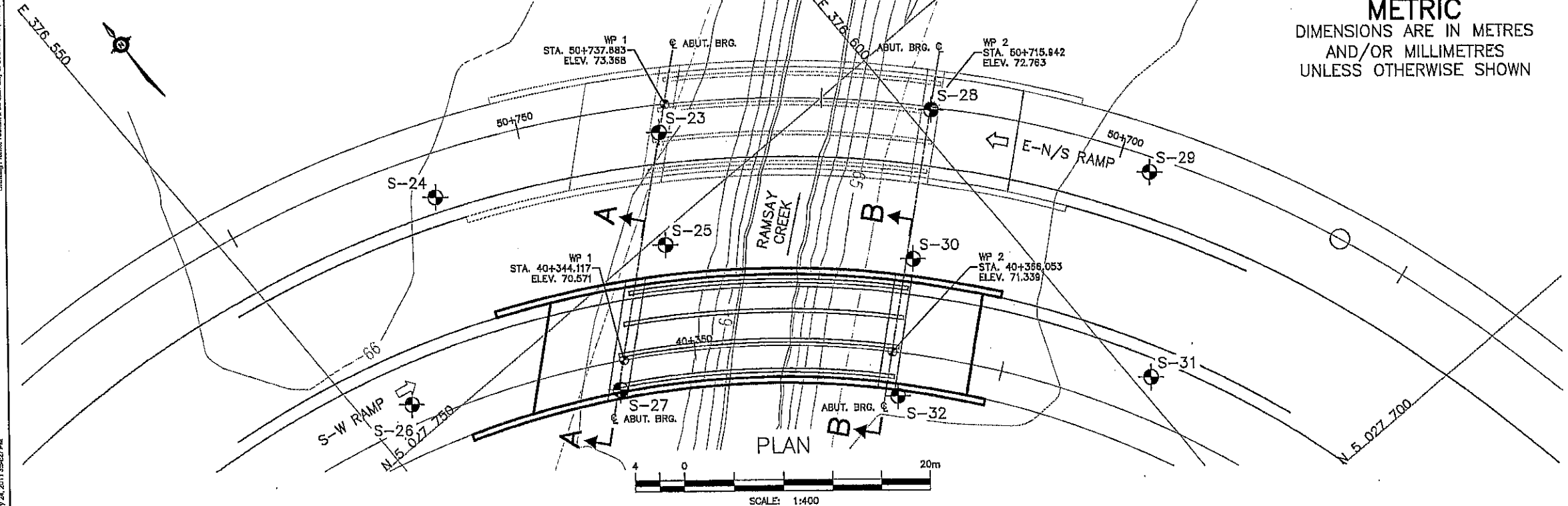
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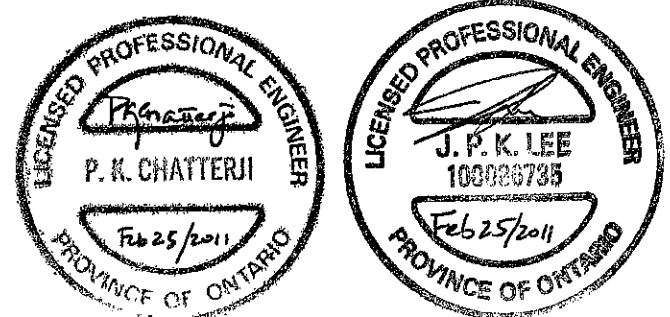
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Plot Date: Thursday, February 24, 2011 3:56:27 PM

Consultant: AECOM



- NOTES-**
- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
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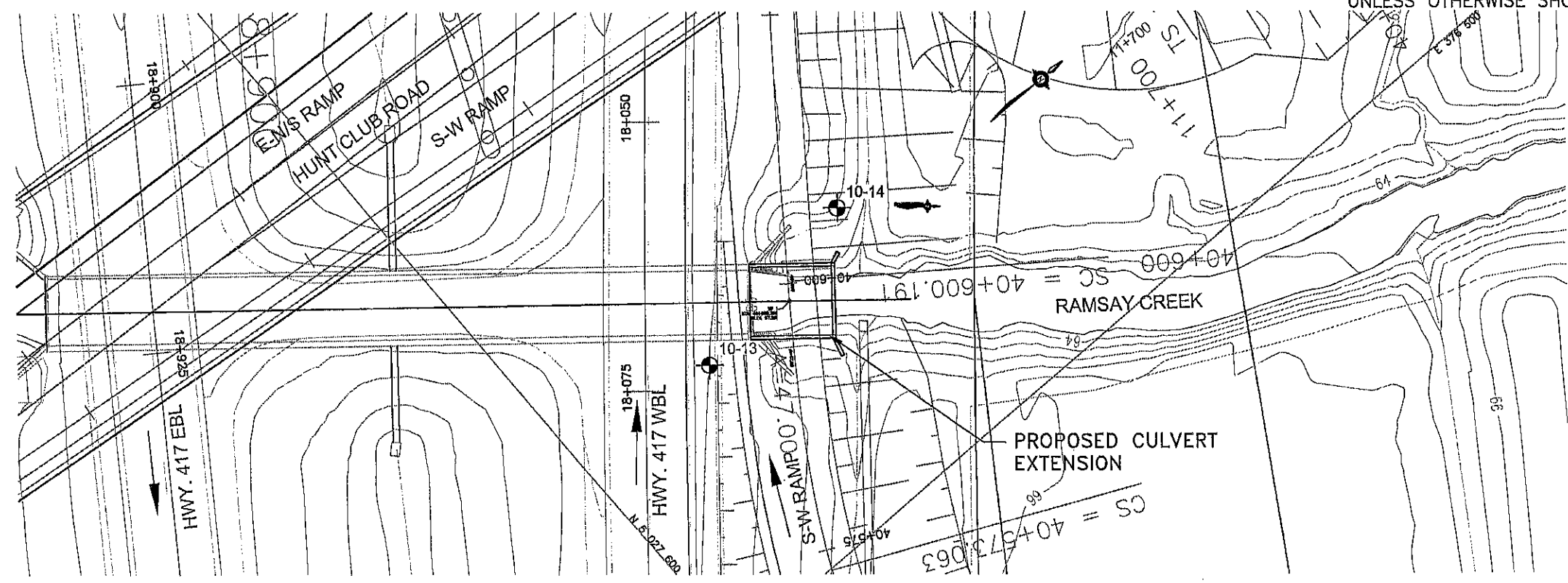
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SITE 9 S-W RAMP BOREHOLE DATA													
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Contract No. ISB09-5133 Drawing No. 902													
Sheet No. - of -													
Asset No. -													
Asset Group -													
Date: 1/11	Client: AEG												
Drawn: MFA	Checked: AEG												
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Construction Inspector -													
Code: CAN/CSA-S8-08													
Location: CL-025-ONT													
AECOM													
<small>NOTE: The location of utilities is approximate only. The actual location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.</small>													
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No.	Description	By	Date (mm/dd/yy)										
1	50% SUBMISSION	SZ	10/10										
2	90% SUBMISSION	SZ	02/11										

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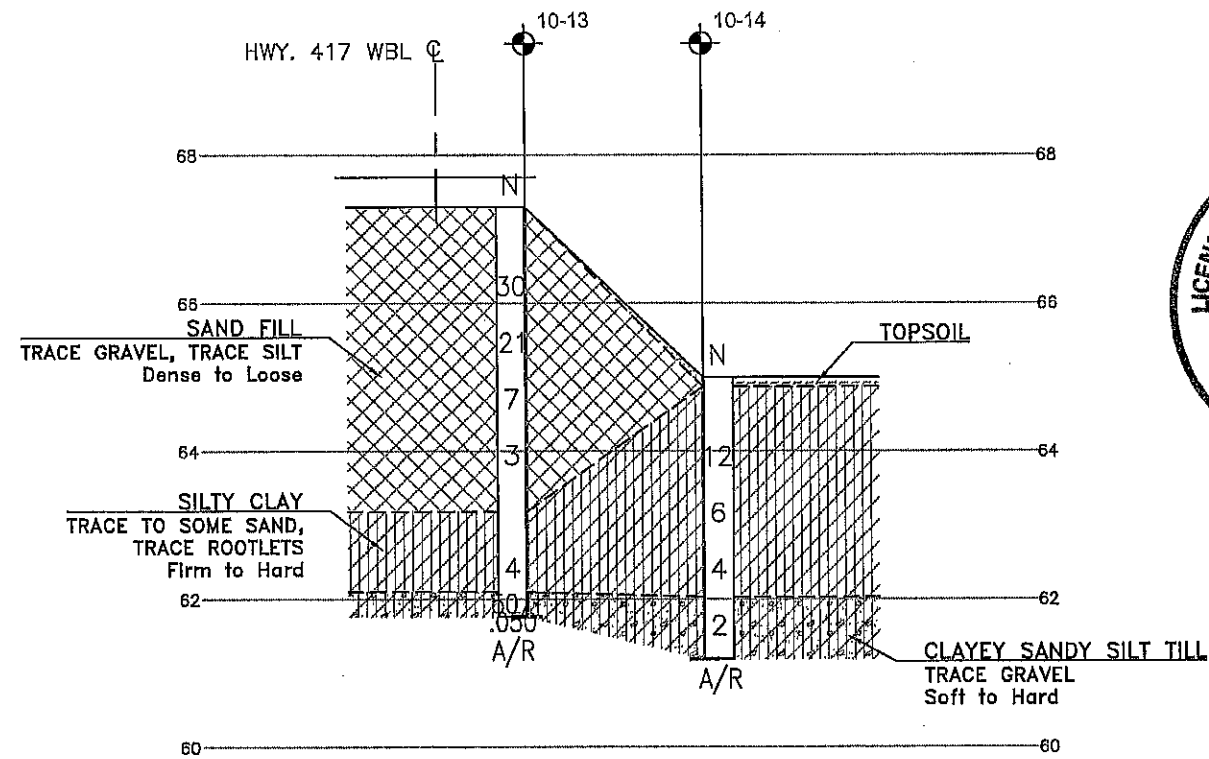
Do not scale this document. All measurements must be obtained from stated dimensions.

LEGEND			
	Borehole		
	Borehole and Cone		
N	Blows /0.3m (Std Pen Test, 475J/blow)		
CONE	Blows /0.3m (60° Cone, 475J/blow)		
PH	Pressure, Hydraulic		
	Water Level observed during drilling		
	Water level in Piezometer		
90%	Rock Quality Designation (RQD)		
A/R	Auger Refusal		
NO	ELEVATION	NORTHING	EASTING
S-23	65.6	5 027 756.3	378 583.5
S-24	66.0	5 027 764.1	378 566.1
S-25	65.3	5 027 749.1	376 578.0
S-26	66.0	5 027 762.7	376 583.8
S-27	65.2	5 027 742.6	376 587.6
S-28	65.2	5 027 743.4	376 601.6
S-29	65.2	5 027 728.1	378 611.9
S-30	65.2	5 027 735.2	378 592.7
S-31	65.2	5 027 715.5	376 601.3
S-32	65.3	5 027 727.6	378 584.6
GEOCRES No. 31G5-234			

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

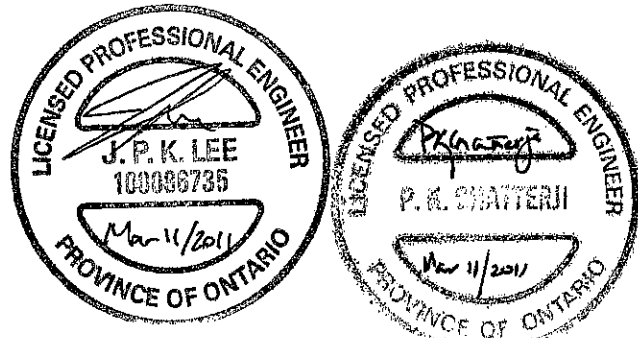


SCALE: 1:500
PLAN



PROFILE ALONG HWY. 417 CULVERT

SCALE: 1:500
VER 1:100



**HUNT CLUB ROAD
EXTENSION 417**
SN 227680

**HWY. 417 CULVERT EXTENSION
BOREHOLE LOCATION
& SOIL STRATA**

W. Newell, P.Eng.
Director Infrastructure Services

Ziad A. Ghadban, P.Eng.
Manager, Construction Services - Est.

Asset No.
CL-623-ONT

Ottawa

Contract No. ISB09-5133
Drawing No. 1102

Sheet No. 1 of 1

Asset Group

Desk: COW
Drawn: BAE
Checked: SB

Utility Circulation No.

Construction Inspection

Code: CANOSA-86-08

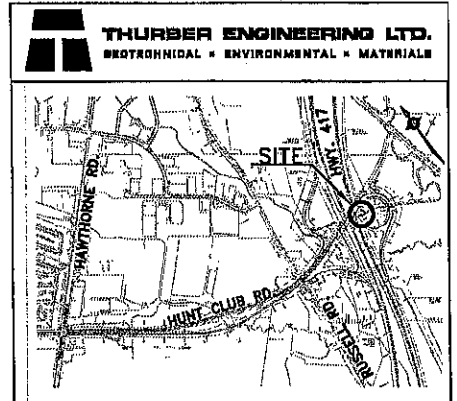
Load: CL-623-ONT

NOTE:
The location of utilities is approximate only. The exact location should be determined by consulting the municipal utilities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

No.	Description	By	Date (dd/mm/yy)
1	ISSUED FOR TENDER	JL	03/11

This drawing has been prepared for the use of AECOM's client and may not be used, reproduced or relied upon by third parties, except as agreed by AECOM and its client, as required by law or for use by governmental reviewing agencies. AECOM accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without AECOM's express written consent.

Do not scale this document. All measurements must be obtained from stated dimensions.



KEYPLAN

LEGEND

+	Borehole
•	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
W	Water Level observed during drilling
W	Water level in Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
10-13	67.3	5 027 615.1	376 478.3
10-14	65.0	5 027 633.7	376 475.0

-NOTES-

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 31G5-240

DATE	BY	DESCRIPTION
DESIGN	LPG	CHK JPL
DRAWN	AN	SITE
LOAD	STRUCT	DWG



THURBER ENGINEERING LTD.

APPENDIX B
GROUNDWATER SAMPLES – ANALYTICAL RESULTS

Certificate of Analysis

AGAT WORK ORDER: 11T477543

PROJECT NO: 19-5438-7

ATTENTION TO: Luke Gilarski

CLIENT NAME: THURBER ENGINEERING LTD

Water Quality Assessment

DATE SAMPLED: Mar 09, 2011	DATE RECEIVED: Mar 10, 2011				DATE REPORTED: Mar 21, 2011				SAMPLE TYPE: Water
Parameter	Unit	G / S	RDL	S-13		10-12		CREEK	
				UNFILTERED	S-13 FILTERED	UNFILTERED	10-12 FILTERED		
Electrical Conductivity	uS/cm		2	1800	1840	711	730	2290	
pH	pH Units	6.5-8.5	NA	8.30	8.18	8.48	8.37	8.20	
Saturation pH				6.86	6.85	7.66	7.55	7.23	
Langlier Index				1.44	1.33	0.82	0.82	0.97	
Total Dissolved Solids	mg/L		20	1120	1100	756	640	1310	
Total Hardness (as CaCO3)	mg/L		10	297	302	74	93	295	
% Difference/ Ion Balance			0.1	1.8	3.5	3.3	2.2	0.6	
Alkalinity (as CaCO3)	mg/L		5	366	374	228	235	158	
Bicarbonate (as CaCO3)	mg/L		5	362	374	218	230	158	
Carbonate (as CaCO3)	mg/L		5	<5	<5	10	<5	<5	
Hydroxide (as CaCO3)	mg/L		5	<5	<5	<5	<5	<5	
Fluoride	mg/L		0.05	0.96	0.99	0.31	0.41	<0.05	
Chloride	mg/L		0.10	353	353	65.5	64.3	683	
Bromide	mg/L		0.05	0.68	0.67	<0.05	<0.05	<0.05	
Nitrate as N	mg/L		0.05	<0.05	<0.05	<0.05	0.12	0.71	
Nitrite as N	mg/L		0.05	<0.05	<0.05	<0.05	<0.05	<0.05	
Sulphate	mg/L		0.10	125	125	58.3	70.7	105	
Ortho phosphate as P	mg/L		0.10	<0.10	<0.10	<0.10	<0.10	<0.10	
Total Phosphorus	mg/L	0.03	0.05	5.59	4.14	15.6	15.9	0.11	
Ammonia as N	mg/L		0.02	0.16	0.14	0.21	0.24	0.07	
Total Organic Carbon	mg/L		0.5	11.0	10.3	4.3	2.7	5.5	
Reactive Silica	mg/L		0.05	11.2	11.5	14.2	13.4	8.02	
Colour	TCU		5	11	14	14	16	26	
Turbidity	NTU		0.5	28.5	23.5	143	126	18.2	
Calcium	mg/L		0.05	80.7	82.5	13.9	18.2	86.2	
Magnesium	mg/L		0.05	23.2	23.4	9.51	11.5	19.3	
Sodium	mg/L		0.05	334	352	151	147	436	
Potassium	mg/L		0.05	6.82	6.84	3.93	4.59	4.62	
Aluminum	mg/L		0.004	3.77	0.595	6.85	0.077	0.643	
Arsenic	mg/L	0.1	0.003	0.004	<0.003	0.006	0.008	<0.003	
Barium	mg/L		0.002	0.689	0.929	1.84	0.103	0.065	
Boron	mg/L	0.20	0.010	0.466	0.652	0.112	0.156	0.063	

Mike M. M. M.
Certified By:

Parameter	Unit	G / S	RDL	S-13			10-12			CREEK
				UNFILTERED	S-13 FILTERED	UNFILTERED	10-12 FILTERED			
				2297001	2297008	2297015	2297021			
Cadmium	mg/L	0.0002	0.002	<0.002	<0.002	<0.002	<0.002	<0.002		
Chromium	mg/L		0.003	<0.003	0.006	0.004	<0.003	<0.003		
Copper	mg/L	0.005	0.003	<0.003	<0.003	<0.003	0.004	0.004		
Iron	mg/L	0.3	0.010	0.015	0.980	27.6	0.023	0.650		
Lead	mg/L	0.005	0.002	<0.002	<0.002	0.019	<0.002	<0.002		
Manganese	mg/L		0.002	0.113	4.76	0.063	0.114	0.114		
Mercury	mg/L	0.0002	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001		
Molybdenum	mg/L	0.04	0.002	0.004	0.006	0.009	0.025	0.002		
Nickel	mg/L	0.025	0.003	0.025	0.008	0.059	<0.003	0.009		
Selenium	mg/L	0.1	0.004	0.006	<0.004	<0.004	<0.004	<0.004		
Silver	mg/L	0.0001	0.002	<0.002	<0.002	<0.002	<0.002	<0.002		
Strontium	mg/L		0.005	1.19	0.912	2.60	0.378	0.669		
Thallium	mg/L	0.0003	0.006	<0.006	<0.006	<0.006	<0.006	<0.006		
Titanium	mg/L		0.002	0.091	0.031	0.034	0.004	0.045		
Uranium	mg/L	0.005	0.002	0.003	<0.002	0.007	0.002	<0.002		
Vanadium	mg/L	0.005	0.002	0.017	0.005	0.030	0.003	0.007		
Zinc	mg/L	0.03	0.005	0.050	0.012	0.049	0.013	0.020		

Comments:	RDL - Reported Detection Limit; G / S - Guideline / Standard; Refers to PWQO (mg/L)

Certified By:



AGAT Laboratories

Guideline Violation

AGAT WORK ORDER: 11T477543

PROJECT NO: 19-5438-7

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: THURBER ENGINEERING LTD

ATTENTION TO: Luke Gilarski

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	GUIDEVALUE	RESULT
2297001	S-13 UNFILTERED	PWQO (mg/L)	Water Quality Assessment	Boron	0.20	0.466
2297001	S-13 UNFILTERED	PWQO (mg/L)	Water Quality Assessment	Copper	0.005	0.015
2297001	S-13 UNFILTERED	PWQO (mg/L)	Water Quality Assessment	Iron	0.3	10.2
2297001	S-13 UNFILTERED	PWQO (mg/L)	Water Quality Assessment	Lead	0.005	0.008
2297001	S-13 UNFILTERED	PWQO (mg/L)	Water Quality Assessment	Total Phosphorus	0.03	5.59
2297001	S-13 UNFILTERED	PWQO (mg/L)	Water Quality Assessment	Vanadium	0.005	0.017
2297001	S-13 UNFILTERED	PWQO (mg/L)	Water Quality Assessment	Zinc	0.03	0.050
2297008	S-13 FILTERED	PWQO (mg/L)	Water Quality Assessment	Boron	0.20	0.652
2297008	S-13 FILTERED	PWQO (mg/L)	Water Quality Assessment	Iron	0.3	0.980
2297008	S-13 FILTERED	PWQO (mg/L)	Water Quality Assessment	Total Phosphorus	0.03	4.14
2297015	10-12 UNFILTERED	PWQO (mg/L)	Water Quality Assessment	Iron	0.3	27.6
2297015	10-12 UNFILTERED	PWQO (mg/L)	Water Quality Assessment	Lead	0.005	0.019
2297015	10-12 UNFILTERED	PWQO (mg/L)	Water Quality Assessment	Nickel	0.025	0.059
2297015	10-12 UNFILTERED	PWQO (mg/L)	Water Quality Assessment	Total Phosphorus	0.03	15.6
2297015	10-12 UNFILTERED	PWQO (mg/L)	Water Quality Assessment	Uranium	0.005	0.007
2297015	10-12 UNFILTERED	PWQO (mg/L)	Water Quality Assessment	Vanadium	0.005	0.030
2297015	10-12 UNFILTERED	PWQO (mg/L)	Water Quality Assessment	Zinc	0.03	0.049
2297021	10-12 FILTERED	PWQO (mg/L)	Water Quality Assessment	Total Phosphorus	0.03	15.9
2297027	CREEK	PWQO (mg/L)	Water Quality Assessment	Iron	0.3	0.650
2297027	CREEK	PWQO (mg/L)	Water Quality Assessment	Total Phosphorus	0.03	0.11
2297027	CREEK	PWQO (mg/L)	Water Quality Assessment	Vanadium	0.005	0.007



THURBER ENGINEERING LTD.

APPENDIX C
SEARCH RESULTS: WELL RECORDS

TOWNSHIP CONCESSION (LOT)	UTM ¹	DATE ² CNTR	CASING DIA	WATER ^{5,6} DETAIL	STAT LVL/PUMP LVL ⁷ RATE ⁸ /TIME HR:MIN	WATER USE ⁹	SCREEN INFO ¹⁰	WELL # (AUDIT#) WELL TAG #	DEPTHS TO WHICH FORMATIONS EXTEND ^{5,11}
GLoucester Township RF 06(003)	18 453451 5025762*	1954/08 3113	04 04	FR 0031	042 / 058 001 / 0:30	DO	1502304 () RED MSND 0008 BLUE CLAY 0027 GRVL 0031 BLACK SHLE 0090		
GLoucester Township RF 06(005)	18 454171 5025392*	1949/01 1114	04 04	FR 0058	015 / / :0	DO	1502306 () QRTZ 0030 ROCK 0058		
GLoucester Township RF 06(005)	18 454131 5025412*	1949/11 1114	04 04	UK 0080	012 / 020 / 0:30	IN	1502307 () BLUE CLAY 0035 LMSN 0080		
GLoucester Township RF 06(005)	18 454091 5025442*	1949/01 1114	04 04	FR 0036	010 / 003 / 0:30	DO	1502305 () BLUE CLAY 0030 LMSN 0036		
GLoucester Township RF 06(005)	18 453301 5024822*	1952/11 1107	04 04	FR 0053	006 / 053 006 / 1:0	DO	1502309 () BRWN LOAM 0002 BLACK SHLE 0012 GREY SHLE 0053		
GLoucester Township RF 06(005)	18 454011 5025409*	2001/04 4006				DO	1531854 (227491)		
GLoucester Township RF 06(005)	18 453261 5024882*	1953/04 1107	06 06	FR 0065 FR 0120 FR 0200	006 / 200 005 / 4:0	IN	1502310 () CLAY LOAM 0004 BLACK SHLE 0006 GREY SHLE 0396		
OTTAWA CITY ()	18 453264 5024850*	2008/07 1844			002 / / :0 005 / / :0 004 / / :0 017 / / :0	0003 03 0005 02 0002 00 0002 01 0002 01 0001 00 0002 00 0003 04	7115788 (M02888) A068579 BRWN CGVL MSND SILT 0027 GREY FILL CLAY SAND 0037		
OTTAWA CITY ()	18 453380 5024804*	2009/09 7241						7132698 (M05246) A081867	

Notes:

1. UTM in Zone, Easting, Northing and Datum is NAD83; L: UTM estimated from Centroid of Lot; W: UTM not from Lot Centroid
2. Date Work Completed
3. Well Contractor Licence Number
4. Casing diameter in inches
5. Unit of Depth in Feet
6. See Table 4 for Meaning of Code
7. STAT LVL: Static Water Level in Feet ; PUMP LVL: Water Level After Pumping in Feet
8. Pump Test Rate in GPM, Pump Test Duration in Hour : Minutes
9. See Table 3 for Meaning of Code
10. Screen Depth and Length in feet
11. See Table 1 and 2 for Meaning of Code

1. Core Material and Descriptive terms									
Code	Description	Code	Description	Code	Description	Code	Description	Code	Description
BLDR	BOULDERS	FORD	FRACTURED	IRFM	IRON FORMATION	PORS	POROUS	SOFT	SOFT
BSLT	BASALT	FGRD	FINE-GRAINED	LIMY	LIMY	PRDG	PREVIOUSLY DUG	SPST	SOAPSTONE
CGRD	COARSE-GRAINED	FGVL	FINE GRAVEL	LMEN	LIMESTONE	PRDR	PREV. DRILLED	STKY	STICKY
CGVL	COARSE GRAVEL	FILL	FILL	LOAM	TOPSOIL	QRTZ	QUARTZITE	STNS	STONES
CHRT	CHERT	FLDS	FELDSPAR	LOOS	LOOSE	QSDN	QUICKSAND	STNY	STONEY
CLAY	CLAY	FLNT	FLINT	LTCL	LIGHT-COLOURED	QRTZ	QUARTZ	THIK	THICK
CLN	CLEAN	FOSS	FOSILIFEROUS	LYRD	LAYERED	ROCK	ROCK	THIN	THIN
CLYY	CLAYEY	FSND	FINE SAND	MARL	MARL	SAND	SAND	TILL	TILL
CMTD	CEMENTED	GNIS	GNEISS	MGRD	MEDIUM-GRAINED	SHLE	SHALE	UNKN	UNKNOWN TYPE
CONG	CONGLOMERATE	GRNT	GRANITE	MGVL	MEDIUM GRAVEL	SHLY	SHALY	VERY	VERY
CRYS	CRYSTALLINE	GRSN	GREENSTONE	MRBL	MARBLE	SHRP	SHARP	WBRG	WATER-BEARING
CSND	COARSE SAND	GRVL	GRAVEL	MSND	MEDIUM SAND	SHST	SCHIST	WDFR	WOOD FRAGMENTS
DKCL	DARK-COLOURED	GRWK	GREYWACKE	MUCK	MUCK	SILT	SILT	WTHD	WEATHERED
DLMT	DOLOMITE	GVLY	GRAVELLY	OSDN	OVERBURDEN	SLTE	SLATE		
DNSE	DENSE	GYPG	GYPGUM	PKCD	PACKED	SLTY	SILTY		
DRTY	DIRTY	HARD	HARD	PEAT	PEAT	SNDG	SANDSTONE		
DRY	DRY	HPAN	HARDFAN	PGVL	PEA GRAVEL	SNDY	SANDY		

2. Core Color	
Code	Description
WHIT	WHITE
GRY	GREY
BLU	BLUE
GRN	GREEN
YLLW	YELLOW
BRWN	BROWN
RED	RED
BLK	BLACK
BLGY	BLUE-GREY

3. Water Use		
Code	Description	Description
DO	Domestic	OT
ST	Livestock	TH
IR	Irrigation	DE
IN	Industrial	MO
CO	Commercial	
MN	Municipal	
PS	Public	
AC	Cooling And A/C	
NU	Not Used	

4. Water Detail		
Code	Description	Description
FR	Fresh	GS
SA	Salty	IR
SU	Sulphur	
MN	Mineral	
UK	Unknown	

TOWNSHIP CONCESSION (LOT)	UTM ¹	DATE ² CNTR ³	CASING DIA ⁴	WATER ^{5,6} DETAIL	STAT LVL/PUMP LVL ⁷ RATE ⁸ /TIME HR:MIN	WATER USE ⁹	SCREEN INFO ¹⁰	WELL # (AUDIT#) WELL TAG #	DEPTHS TO WHICH FORMATIONS EXTEND ^{5,11}
GLoucester TOWNSHIP BF (029)	18 455753 5024105	2003/03 1119	08 06 06	UK 0111 UK 0116	016 / 110 011 / 1:0	0.1	1533565 (248242) SAND BLDL 0045 GREY LMSN 0081 GREY SANDS 0122		
GLoucester TOWNSHIP BF (029)	18 455785 5024095	2003/03 1119	08 06 06	UK 0088 UK 0094	018 / 090 010 / 1:0	0.17	1533564 (248243) SAND GRVL 0040 GREY LMSN 0102		
GLoucester TOWNSHIP CCN 05 (020)	18 455492 5024963	1987/11 4875	06 06 01	SA 0163	023 / 140 010 / 4:0	0.03	1522020 (21030) BLUE CLAY HARD 0010 BLUE CLAY SOFT 0125 GREY GRVL SAND BLDL 0161 BLGY SHLE GRVL FCRD 0163 BLACK SHLE 0175		
GLoucester TOWNSHIP JG (016)	18 451160 5027399	2004/09 7282	02 02	FR 0008			0015 10 GREY CLAY SILTY STNS 0025		
GLoucester TOWNSHIP JG (016)	18 451231 5027285	2004/10 7282	01				0038 -10 0012 -07 1535242 (Z20075) A019880 BRWN SAND LOAM LOOS 0016 GREY CLAY SILT LOOS 0043		
GLoucester TOWNSHIP JG (016)	18 451214 5027443	2004/08 1844	02				1535296 (Z11975) A011957		
GLoucester TOWNSHIP OF 03 (027)	18 451277 5027347	2004/10 7147	02				1535263 (Z17532) A017364 GREY 0001 BRWN SAND GRVL 0005 GREY SAND SILT CLAY 0015 GREY CLAY SILT WBRG 0019		
GLoucester TOWNSHIP OF 04 (014)	18 456897 5028104	2003/09 1844					1534444 (171876)		
GLoucester TOWNSHIP OF 04 (014)	18 456897 5028104	2003/09 1844					1534443 (171878)		
GLoucester TOWNSHIP OF 04 (014)	18 456897 5028104	2003/09 1844					1532200 (223424) LNKN 0090		
GLoucester TOWNSHIP OF 04 (017)	18 455836 5027498	2001/07 6006					1535109 (Z11999)		
GLoucester TOWNSHIP OF 04 (019)	18 455225 5027013	2004/09 1844					1536372 (Z28055)		
GLoucester TOWNSHIP OF 04 (019)	18 454909 5027026	2005/09 7260					1501539 () BLACK LOAM 0002 BLUE CLAY 0038 GRVL 0060 BLACK SHLE 0100		
GLoucester TOWNSHIP OF 04 (020)	18 454751 5026402	1954/05 3113	04 04 01	FR 0040	040 / 040 002 / 0:30	0.12	1501538 () RED MSND 0010 BLUE CLAY 0097 GREY LMSN 0212		
GLoucester TOWNSHIP OF 04 (020)	18 454896 5027022	1950/10 1114	06 06 01	MN 0168 MN 0122 MN 0145	045 / 060 003 / :0	0.2			

002
010
110
200
07
04
05
04

Well Computer Print Out Data as of December 23 2009

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TOWNSHIP CONCESSION (LOT)	UTM ¹	DATE ² CNTR ³	CASING DIA ⁴	WATER ^{5,6} DETAIL	STAT LVL/PUMP LVL ⁷ RATE ⁸ /TIME HR:MIN	WATER USE ⁹	SCREEN INFO ¹⁰	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND ^{5,11}
GLoucester Township OF 05(015)	18 456871 5026682	1970/07 1802	06	SA 0184	036 / 120 014 / 1:0	DO		1510694 () YELLOW MSND 0005 GREY CLAY 0182 BLACK MSND GRVL 0187
GLoucester Township OF 05(019)	18 456031 5024972	1956/01 3113	04	MN 0196	028 / 032 004 / 1:0	ST		1501542 () RED CLAY 0154 MSND GRVL 0196
GLoucester Township OF 05(019)	18 455891 5025007	1957/07 3113	04 04	MN 0225	018 / 225 002 / 1:0	DO		1501543 () RED CLAY 0005 BLUE CLAY 0155 MSND GRVL 0170 BLACK SHLE LMSN 0225
GLoucester Township OF 05(020)	18 455652 5024467	2004/08 1944						1535103 (212006)
GLoucester Township OF 05(020)	18 455492 5024964	1987/10 4875	06 06					1522019 (21028) BLUE CLAY HARD 0010 BLUE CLAY SOFT 0120 GREY GRVL SAND BLDR 0166 BLACK SHLE LMSN 0405
GLoucester Township OF 05(020)	18 455336 5024992	1958/09 1107	04 04	SA 0284	025 / 200 008 / 1:0	ST		1501547 () BLACK LOAM 0002 BLUE CLAY 0176 SHLE 0284
GLoucester Township OF 05(020)	18 455261 5025052	1956/11 3113	04 04	MN 0040 MN 0153	010 / 067 004 / :0	DO		1501546 () RED CLAY 0090 GRVL MSND 0153 BLACK SHLE 0210
GLoucester Township OF 05(020)	18 455491 5024482	1950/06 1803	02 02	FR 0070	001 / 030 004 / 3:0	DO		1501548 () CLAY 0031 LMSN 0078
GLoucester Township OF 05(020)	18 455631 5024222	1952/01 1802	03 03	MN 0180	010 / 028 008 / 1:0	PS		1501544 () CLAY 0120 MSND GRVL 0160 LMSN 0184
GLoucester Township OF 05(020)	18 455951 5024102	1956/03 1107	04 04	SA 0210	010 / 020 008 / 1:0	DO		1501545 () BLUE CLAY 0160 GREY FSND 0167 GREY SHLE 0210
GLoucester Township OF 05 ()	18 455917 5023199	2004/11 1844						1534519 (205666)
GLoucester Township OF 06(020)	18 456381 5022252	1960/06 3113	04 04	FR 0175	003 / 005 040 / 18:0	DO		1501557 () BLUE CLAY 0131 MSND GRVL 0164 LMSN 0176
GLoucester Township OF 06(020)	18 455891 5023462	1965/09 3504	06	SA 0130	006 / 010 008 / 8:0	DO		1501559 () CLAY 0130 FSND 0162
GLoucester Township OF 06(020)	18 456391 5022247	1960/10 4216	07	SA 0152	010 / 030 030 / 1:0	DO		1501558 () CLAY 0151 GRVL 0152
GLoucester Township OF 06(020)	18 455751 5023862	1957/09 1107	04 04	SA 0174	006 / 010 008 / 1:0	DO		1501540 () BLACK LOAM 0002 BLUE CLAY 0166 GREY SHLE 0174
GLoucester Township RF 04(006)	18 451621 5023546	2005/08 7260	30					1536367 (228059)
GLoucester Township RF 04(006)	18 451396 5023517	1950/09 5448	05	FR 0085	030 / 050 005 / 0:30	DO		1501844 () MSND 0005 CLAY 0050 MSND 0080 GRVL 0085

TOWNSHIP CONCESSION (LOT)	UTM ¹	DATE ² CNTR	CASING DIA ⁴	WATER ^{5,6} DETAIL	STAT LVL/PUMP LVL ⁷ RATE ⁸ /TIME HR:MIN	WATER USE ⁹	SCREEN INFO ¹⁰	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND ^{5,11}
GLoucester Township RF 04 (007)	18 450931 5022502*	1968/04 1301	05 05	FR 0125	025 / 135 003 / 2:0	DO	1509623 () MSND 0070 BLACK SHLE 0135	
GLoucester Township RF 04 (007)	18 451001 5022442*	1969/02 1301	05 05	FR 0125	027 / 040 010 / 1:0	DO	1509959 () MSND 0030/FSND 0067 BLACK SHLE 0127	
GLoucester Township RF 04 (007)	18 451681 5023127*	1955/11 1802	02				1501859 () MSND 0028 BLACK LMSN 0190	
GLoucester Township RF 04 (007)	18 451666 5023107*	1955/11 1802	02				1501860 () MSND 0027 BLACK LMSN 0070	
GLoucester Township RF 04 (007)	18 451116 5022532*	1959/11 1603	03 03	FR 0090	023 / 030 003 / 3:0	DO	1501868 () CLAY 0070 MSND 0083 LMSN 0090	
GLoucester Township RF 04 (007)	18 451201 5022592*	1959/11 1603	03 03	FR 0101	023 / 030 004 / 3:0	DO	1501869 () CLAY 0070 MSND 0085 LMSN 0101	
GLoucester Township RF 04 (007)	18 451041 5022487*	1960/03 4216	04 04	FR 0140	045 / 060 003 / 1:0	DO	1501873 () MSND 0080 LMSN 0145	
GLoucester Township RF 04 (007)	18 451046 5022477*	1960/10 4216	04 04	SA	030 / 265 010 / 1:0	DO	1501874 () PRDG 0145 UNKN UNKN UNKN 0265	
GLoucester Township RF 04 (007)	18 451071 5022502*	1960/02 1802	06	FR 0074	020 / 070 010 / 2:0	DO	1501875 () CLAY MSND 0030 MSND 0070 UNKN UNKN	
GLoucester Township RF 04 (007)	18 451026 5022487*	1961/03 1603	03 02	FR 0069	017 / 030 004 / 2:0	DO	1501881 () MSND 0060 SHLE 0069	
GLoucester Township RF 04 (007)	18 450976 5022507*	1960/12 4216	04 04	FR 0113	025 / 050 010 / 1:0	DO	1501894 () CSND 0070 GREY LMSN 0113	
GLoucester Township RF 04 (007)	18 450931 5022547*	1960/08 1802	03 03	FR 0118	015 / 065 003 / 2:0	DO	1501885 () FSND 0067 BLACK SHLE 0130	
GLoucester Township RF 04 (007)	18 450981 5022577*	1961/04 1802	06 06	FR 0075	020 / 075 010 / 1:0	DO	1501886 () MSND GRVL BLDR 0030 MSND 0073 GREY LMSN 0075	
GLoucester Township RF 04 (007)	18 451011 5022597*	1959/08 1603	03 03	FR 0069	016 / 030 006 / 3:0	DO	1501887 () MSND 0064 LMSN 0069	
GLoucester Township RF 04 (007)	18 451011 5022522*	1959/12 4216	04 04	FR 0100	020 / 022 006 / 1:0	DO	1501888 () MSND 0072 LMSN SHLE 0107	
GLoucester Township RF 04 (007)	18 450926 5022597*	1960/05 1603	03 03	FR 0079	022 / 030 004 / 2:0	DO	1501889 () CLAY 0020 MSND 0072 LMSN 0079	
GLoucester Township RF 04 (007)	18 450996 5022637*	1962/11 1628	02 02 03	FR 0080	028 / 028 004 / 2:0	DO	1501897 () MSND 0055 HPAN MSND BLDR 0073 LMSN 0083	

TOWNSHIP	CONCESSION (LOT)	UTM ¹	DATE ² CNTR ³	CASING DIA ⁴	WATER ^{5,6} DETAIL	STAT LVL/PUMP LVL ⁷ RATE ⁸ /TIME HR:MIN	WATER USE ⁹	SCREEN INFO ¹⁰	WELL # (AUDIT#) WELL TAG #	DEPTHS TO WHICH FORMATIONS EXTEND ^{5,11}
GLoucester Township	RF 04(007)	18 451176 5022107*	1962/11 1802	08 08	FR 0066	030 / 200 003 / 10:0	PS		1501898 () MSND 0040 HPAN 0063 BLACK SHLE 0200	
GLoucester Township	RF 04(007)	18 451201 5022592*	1964/10 1603	03 03	FR 0111	025 / 060 005 / 2:0	DO		1501907 () MSND 0060 BLDR MSND 0086 LMSN 0111	
GLoucester Township	RF 04(008)	18 451166 5022212*	1963/03 4216	07 07	FR 0135	020 / 060 010 / 4:0	DO		1501902 () MSND 0066 BLACK SHLE 0135	
GLoucester Township	RF 04(008)	18 451046 5022542*	1962/11 1802	06 06	FR 0030	018 / 029 003 / 2:0	DO		1501899 () BRWN MSND 0020 GRVL MSND 0030	
GLoucester Township	RF 04(008)	18 451221 5022147*	1961/04 1802	06 04	FR 0050	010 / 055 050 / 1:0	DO		1501942 () CSND 0060 BLACK SHLE 0061	
GLoucester Township	RF 04(008)	18 451196 5022467*	1957/08 1603	03 03	UK 0100	014 / 022 003 / 3:0	DO		1501932 () MSND 0066 GREY LMSN 0100	
GLoucester Township	RF 04(008)	18 451151 5022157*	1956/01 3701	06 06	FR 0525 FR 0555	010 / 045 012 / 3:0	PS		1502024 () MSND 0063 BRWN SHLE 0525 SHLE 0555	
GLoucester Township	RF 04(009)	18 451506 5022187*	1955/07 4833	05 05	FR 0045	007 / 010 005 / 0:15	DO		1501969 () MSND 0039 LMSN 0046	
GLoucester Township	RF 04(009)	18 451586 5022237*	1955/07 4833	05 05	FR 0085	006 / 008 005 / 0:15	DO		1501970 () MSND 0035 LMSN 0087	
GLoucester Township	RF 04(009)	18 451586 5022277*	1955/08 3701	05 05	SU 0045 SU 0051	020 / 040 003 / 1:0	DO		1501973 () MSND 0038 BRWN SHLE 0051	
GLoucester Township	RF 04(009)	18 451996 5022382*	1955/08 4825	05 03	FR 0197	006 / 197 / :0	DO		1501975 () MSND 0032 SHLE 0197	
GLoucester Township	RF 04(009)	18 451946 5022402*	1955/08 4833	04 04	FR 0045	006 / 010 005 / 0:15	DO		1501976 () MSND 0043 LMSN 0049	
GLoucester Township	RF 04(009)	18 451926 5022427*	1955/08 4833	04 04	FR 0065	006 / 010 005 / 0:15	DO		1501977 () MSND 0047 LMSN 0067	
GLoucester Township	RF 04(009)	18 451611 5022247*	1955/08 4833	05 05	FR 0045	015 / 025 005 / 0:15	DO		1501978 () MSND 0035 LMSN 0050	
GLoucester Township	RF 04(009)	18 451451 5022122*	1964/11 1802	06 06	FR 0033	014 / 025 033 / 1:0	DO		1502090 () MSND 0028 GRVL 0033	
GLoucester Township	RF 04(009)	18 451666 5022332*	1955/08 4833	05 05	FR 0090	015 / 020 005 / 0:15	DO		1501980 () MSND 0038 LMSN 0092	
GLoucester Township	RF 04(009)	18 451776 5022262*	1955/09 1802	03 03	FR 0301	006 / 055 004 / 2:0	DO		1501981 () MSND 0030 LMSN 0130 SHLE 0304	

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GLoucester TOWNSHIP RF 04 (009)	18 451816 5022417"	1955/09 1802	03 03	FR 0163	011 / 055 002 / 2:0	DO		1501982 () MSND 0045 LMSN 0130 SHLE 0164
GLoucester TOWNSHIP RF 04 (009)	18 451821 5022122"	1955/09 4833	04 04	FR 0200	015 / 100 005 / 0:20	DO		1501984 () MSND 0085 LMSN 0208
GLoucester TOWNSHIP RF 04 (009)	18 451506 5022252"	1955/10 4833	04 04	FR 0064	015 / 030 005 / 0:15	DO		1501986 () MSND 0046 LMSN 0066
GLoucester TOWNSHIP RF 04 (009)	18 451626 5022222"	1956/10 4825	04 04	FR 0038	005 / 012 005 / 0:30	DO		1502054 () MSND 0031 LMSN 0042
GLoucester TOWNSHIP RF 04 (009)	18 451621 5022317"	1958/08 3002	05 05	SU 0122	006 / 028 003 / 1:0	DO		1502056 () BRWN CLAY MSND 0018 BLUE CLAY 0030 BLACK SHLE 0128
GLoucester TOWNSHIP RF 04 (009)	18 451726 5022377"	1958/11 1603	02 02	SA 0096	005 / 030 002 / 6:0	DO		1502057 () CLAY 0030 MSND 0035 LMSN 0096
GLoucester TOWNSHIP RF 04 (009)	18 451931 5022347"	1959/10 1632	03 02	FR 0075	010 / 016 005 / 0:30	DO		1502061 () MSND 0030 BLDR MSND 0038 GREY LMSN 0075
GLoucester TOWNSHIP RF 04 (009)	18 451291 5022127"	1960/08 4216	04 04	FR 0115	015 / 020 005 / 1:0	DO		1502064 () CLAY MSND 0065 GREY LMSN 0115
GLoucester TOWNSHIP RF 04 (009)	18 451931 5022502"	1960/09 1802	06 06	FR 0050	015 / 050 033 / 2:0	DO		1502065 () LOAM MSND 0005 FSND 0049 MSND GRVL 0050 BLACK SHLE 0051
GLoucester TOWNSHIP RF 04 (009)	18 451436 5022122"	1961/02 1802	06 06	FR 0047	025 / 048 004 / 1:0	DO		1502069 () YELW MSND 0030 HEAN 0047 BLACK SHLE 0050
GLoucester TOWNSHIP RF 04 (009)	18 451796 5022267"	1963/08 1629	02 02	FR 0062	008 / 035 004 / 1:0	DO		1502083 () MSND GRVL 0028 QSNB BLDR 0035 GRVL BLDR 0039 LMSN 0062
GLoucester TOWNSHIP RF 04 (009)	18 451706 5022187"	1964/07 1603	03 03	FR 0200	023 / 060 003 / 6:0	DO		1502086 () MSND 0034 GREY LMSN 0200
GLoucester TOWNSHIP RF 04 (009)	18 451876 5022272"	1955/07 4833	05 05	FR 0060	010 / 020 005 / 0:15	DO		1501968 () MSND 0042 LMSN 0061
GLoucester TOWNSHIP RF 04 (009)	18 451716 5022307"	1955/07 4833	05 05	FR 0200	003 / 060 005 / 0:15	DO		1501967 () MSND 0036 LMSN 0205
GLoucester TOWNSHIP RF 04 (009)	18 451746 5022327"	1955/07 3701	05 05	SU 0060 SU 0077	014 / 040 003 / 1:0	DO		1501964 () MSND 0046 BRWN SHLE 0077
GLoucester TOWNSHIP RF 04 (009)	18 451531 5022202"	1955/07 3701	05 05	SU 0100 SU 0127	020 / 100 003 / 2:0	DO		1501962 () MSND 0069 BRWN SHLE 0127
GLoucester TOWNSHIP RF 04 (009)	18 451876 5022372"	1955/07 4833	04 04	FR 0065	006 / 015 005 / 0:15	DO		1501958 () MSND 0042 LMSN 0068

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GLoucester TOWNSHIP RF 04(009)	18 451731 5022287*	1955/08 3701	05 05	FR 0170 FR 0150	040 / 075 005 / 1:0	DO		1501979 () MSND 0048 BRWN SHLE 0170
GLoucester TOWNSHIP RF 05(002)	18 451447 5025182*	2004/11 1844	02	FR 0010			0007 10	1535222 (219252) A019090 BRWN CLAY SAND FILL 0002 GREY CLAY SOFT 0016
GLoucester TOWNSHIP RF 05(006)	18 452425 5023988*	2000/10 1119	09 06 06	FR 0206 FR 0214	030 / 120 010 / 1:0	DO		1531693 (222862) GRVL 0003 GREY SNDS 0220
GLoucester TOWNSHIP RF 05(006)	18 451731 5023462*	1964/08 1539	05 05	FR 0070	014 / 070 004 / 1:0	ST DO		1501850 () MSND 0008 HPAN 0035 SILTE ROCK 0080
GLoucester TOWNSHIP RF 05(006)	18 453118 5024222*	2005/11 1844	35	0002	/ 014 / :20	END		1536191 (231621)
GLoucester TOWNSHIP RF 05(006)	18 453281 5024492*	1953/01 1107	05 05	FR 0113	006 / 013 008 / 1:0	ST DO		1502214 () BLCK LOAM 0002 BLCK SHLE 0007 GREY SHLE 0113
GLoucester TOWNSHIP RF 05(009)	18 453441 5023012*	1958/08 3113	04 04	FR 0060	005 / 011 027 / 1:0	DO		1502215 () GREY MSND 0012 BLUR CLAY 0015 MSND GRVL 0020 SHLE ROCK 0080
GLoucester TOWNSHIP RF 05(009)	18 453491 5023052*	1960/09 1802	06 06	FR 0085	014 / 080 002 / 1:0	DO		1502218 () LOAM MSND 0007 FSND 0035 BLCK SHLE 0100
GLoucester TOWNSHIP RF 05(009)	18 453511 5022942*	1959/03 3113	04 04	SU 0082	005 / 009 014 / 0:30	DO		1502216 () GREY MSND 0016 BLCK GRVL 0020 BLCK SHLE 0082
GLoucester TOWNSHIP RF 05(009)	18 453441 5022962*	1960/06 1802	06 06	FR 0100	010 / 080 002 / 2:0	DO		1502217 () LOAM MSND 0020 LMSN 0120
GLoucester TOWNSHIP RF 05(010)	18 453841 5022942*	1956/12 1107	04 04	FR 0097	002 / 012 008 / 1:0	DO		1502219 () GREY MSND 0008 BLUE CLAY 0040 GREY MSND 0048 GREY SHLE 0097
GLoucester TOWNSHIP RF 05(010)	18 453831 5022972*	1957/10 1107	04 04	FR 0111	003 / 010 008 / 1:0	DO		1502220 () BLCK LOAM 0002 GREY MSND 0006 BLUE CLAY 0032 CLAY GRVL 0036 SHLE ROCK 0111
GLoucester TOWNSHIP RF 06(002)	18 453241 5026232*	1967/03 3504	06 06	FR 0100	018 / 120 004 / 3:0	ST DO		1502302 () LOAM 0007 BLCK LMSN 0150
GLoucester TOWNSHIP RF 06(003)	18 453733 5026160*	1994/06 6844	02	UK 0015		END	0010 10	1528053 (149092) BRWN CLAY GRVL LOOS 0005 GREY CLAY DNSE 0012 GREY CLAY GRVL 0015 GREY CLAY 0020
GLoucester TOWNSHIP RF 06(003)	18 453733 5026160*	1994/06 6844	02	UK 0014		END	0010 10	1528052 (149095) BRWN CLAY GRVL STNS 0005 GREY CLAY GRVL DNSE 0016 GREY CLAY 0020
GLoucester TOWNSHIP RF 06(003)	18 453729 5026160*	2002/05 6006	06 05	FR 0034	030 / 070 010 / 1:30	DO		1532828 (237328) RED CLAY SOFT 0025 BLUR CLAY SOFT 0034 GREY LMSN HARD 0070

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GLoucester Township	RF 06(003)	18 453733 5026160 ⁴	1994/06 6844	02	UK 0016	042 / 058 001 / 0:30	DO	0010 10	1528054 (149093)	BRWN CLAY GRVL STNS 0005 GREY CLAY SOFT 0015 GREY CLAY GRVL DNSE 0020 BLDR HARD 0020
GLoucester Township	RF 06(003)	18 453733 5026160 ⁴	1994/06 6844	02	UK 0015		DO	0010 10	1528055 (149097)	BRWN CLAY SAND GRVL 0005 BRWN GRVL CLAY PKCD 0010 GREY CLAY STNS DNSE 0020
GLoucester Township	RF 06(003)	18 453451 5025762 ⁴	1954/08 3113	04 04	FR 0031	042 / 058 001 / 0:30	DO		1502304 ()	RED MSND 0008 BLUE CLAY 0027 GRVL 0031 BLACK SHLE 0090
GLoucester Township	RF 06(003)	18 453251 5025872 ⁴	1953/08 1107	04 04	FR 0090	015 / 030 001 / 1:0	DO		1502303 ()	CLAY BLDR GRVL 0030 MSND 0040 LMSN 0090
GLoucester Township	RF 06(003)	18 453733 5026160 ⁴	1994/06 6844	02	UK 0015		DO	0010 10	1528051 (149096)	BRWN CLAY STNS LOOS 0005 GREY CLAY GRVL 0016 GREY CLAY DNSE 0020
GLoucester Township	RF 06(005)	18 454381 5025392 ⁴	1958/05 1802	02 02	FR 0098	004 / 020 006 / 2:0	DO		1502313 ()	BLUE CLAY 0036 GREY LMSN 0102
GLoucester Township	RF 06(005)	18 454271 5025452 ⁴	1967/05 1802	06 06					1502315 ()	SHLE 0200
GLoucester Township	RF 06(005)	18 454251 5025512 ⁴	1967/06 3504	10 10	FR 0020	004 / 012 003 / 7:0	CO		1502316 ()	BLACK MUCK 0005 BLACK SHLE 0060
GLoucester Township	RF 06(005)	18 454011 5025405 ⁴	2001/04 4006				DO		1531854 (227491)	
GLoucester Township	RF 06(005)	18 454351 5025402 ⁴	1958/06 3113	04 04	FR 0076	025 / 032 008 / 1:0	DO		1502314 ()	BLUE CLAY 0021 MSND GRVL 0030 BLACK SHLE ROCK 0076
GLoucester Township	RF 06(005)	18 454246 5025402 ⁴	1958/03 1107	04 04	FR 0078	011 / 013 008 / 1:0	DO		1501549 ()	BLACK LOAM 0003 BLUE CLAY 0037 GREY SHLE 0078
GLoucester Township	RF 06(005)	18 454031 5025442 ⁴	1949/01 1114	04 04	FR 0036	010 / 003 / 0:30	DO		1502305 ()	BLUE CLAY 0030 LMSN 0036
GLoucester Township	RF 06(005)	18 454171 5025392 ⁴	1949/01 1114	04 04	FR 0058	015 / / :0	DO		1502306 ()	QRTZ 0030 ROCK 0058
GLoucester Township	RF 06(005)	18 454131 5025412 ⁴	1949/11 1114	04 04	UK 0080	012 / 020 / 0:30	IN		1502307 ()	BLUE CLAY 0035 LMSN 0080
GLoucester Township	RF 06(005)	18 454211 5025352 ⁴	1949/12 1114	04 04	MN 0080	012 / 020 / 0:30	DO		1502308 ()	BLUE CLAY 0035 LMSN 0080
GLoucester Township	RF 06(005)	18 453301 5024822 ⁴	1952/11 1107	04 04	FR 0053	006 / 053 008 / 1:0	DO		1502309 ()	BRWN LOAM 0002 BLACK SHLE 0012 GREY SHLE 0053

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GLOUCESTER TOWNSHIP RF 06(005)	18 453261 5024882*	1953/04 1107	06 06	FR 0065 FR 0120 FR 0200	006 / 200 005 / 4:0	IN		1502310 () CLAY LOAM 0004 BLACK SHLE 0006 GREY SHLE 0396
GLOUCESTER TOWNSHIP RF 06(005)	18 453211 5024992*	1953/10 1107	06 06	FR 0645	010 / 500 010 / 5:0	IN		1502311 () CLAY LOAM 0002 GREY SHLE 0550 LMSN 0645
GLOUCESTER TOWNSHIP RF 06(005)	18 454321 5025392*	1958/01 1801	02 02	FR 0124	007 / 022 005 / 1:0	DO		1502312 () BLACK CLAY 0035 BLACK SHLE 0124
GLOUCESTER TOWNSHIP RF 06(007)	18 453481 5024372*	1953/04 1107	04 04	FR 0163	006 / 040 002 / 1:0	DO		1502317 () SHLE ROCK 0163
GLOUCESTER TOWNSHIP RF 06(008)	18 455211 5025052*	1947/09 1107	05 05	SA 0108	026 / 026 008 / 0:30	DO		1502367 () BLUE CLAY 0106 GRVL 0108
GLOUCESTER TOWNSHIP RF 06(008)	18 455191 5025008*	1974/04 2557	06 06	FR 0125	020 / / :0	IN		1513987 () BRWN SAND 0013 GREY CLAY 0098 GREY LMSN 0175
GLOUCESTER TOWNSHIP RF 06(008)	18 455171 5025102*	1952/03 1107	04 04	FR 0136	018 / 008 / 1:0	DO		1502318 () LOAM 0003 BLUE CLAY 0100 BLACK MSND 0105 GREY SHLE 0136
GLOUCESTER TOWNSHIP RF 06(009)	18 453791 5023307*	1970/02 1802	06 06	FR 0040	008 / 080 008 / 4:0	DO		1510567 () YLLW MSND 0015 BRWN CLAY 0027 BRWN GRVL MSND 0036 GREY SHLE 0080
GLOUCESTER TOWNSHIP RF 06(009)	18 453726 5023476*	2004/08 1844						1535100 (Z20802)
GLOUCESTER TOWNSHIP RF 06(009)	18 453716 5023457*	2004/08 1844		0004				1535105 (Z12004)
GLOUCESTER TOWNSHIP RF 06(010)	18 453916 5022980*	1970/08 1802	06 06	FR 0078	005 / 024 007 / 1:0	DO		1510769 () YLLW MSND 0009 CLAY 0028 BLACK GRVL MSND 0040 SHLE 0120
GLOUCESTER TOWNSHIP RF 06(010)	18 455521 5024152*	1950/11 1107	04 04	MN 0166	003 / 025 008 / 2:0	DO		1502319 () BLACK LOAM 0004 BLUE CLAY 0162 GREY SHLE 0166
GLOUCESTER TOWNSHIP RF 06(010)	18 455581 5024062*	1952/05 3725	04 04	MN 0130	009 / 009 013 / 1:30	DO		1502320 () RED CLAY 0013 BLUE CLAY 0111 GRVL 0144 BLACK ROCK SHLE 0195
GLOUCESTER TOWNSHIP RF 06(010)	18 455341 5023672*	1959/07 3113	04 04	FR 0175	011 / 020 006 / 1:0	DO		1502321 () BLACK CLAY 0125 GRVL MSND 0140 BLACK GRVL 0145 BLACK SHLE ROCK 0175
GLOUCESTER TOWNSHIP RF 06(010)	18 454431 5023172*	1960/10 1107	04 04	FR 0088	010 / 010 008 / 1:0	DO		1502322 () GREY MSND 0006 BLUE CLAY 0060 BLACK MSND 0064 GREY SHLE 0088
GLOUCESTER TOWNSHIP RF 06(010)	18 453901 5023002*	1970/02 1802	06 06	FR 0031	004 / 035 007 / 3:0	DO	0031 04	1510566 () LOAM 0001 YLLW MSND 0009 BRWN CLAY 0027 GRVL MSND 0035
GLOUCESTER TOWNSHIP RF 06(012)	18 455830 5023321*	1983/01 1558	06 06	SA 0178	020 / 033 020 / 1:30	ST DO		1518137 () GREY CLAY 0096 GREY CLAY SAND BLDR 0153 GREY LMSN SHLE SOFT 0180

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1210 GLOUCESTER TOWNSHIP RF 06 (012)	18 455930 5023121"	1984/01 1517	06 06	SA 0100	030 / 045 010 / 1:20	DO		1518998 ()		BRWN LOAM 0006 BRWN SAND 0020 GREY CLAY 0085 GRVL 0097 GREY LMSN 0105
1217 GLOUCESTER TOWNSHIP RF 06 (012)	18 454586 5022332"	1974/07 1558	06 06	FR 0103	012 / 035 030 / 1:0	DO		1514335 ()		BRWN GRVL FILL 0002 GREY CLAY SAND 0050 GREY SAND BLDR 0070 GREY HPAN BLDR 0082 GREY LMSN 0105
1218 GLOUCESTER TOWNSHIP (019)	18 454211 5027900"	2006/08 1414	06					1536596 (Z51934) A038764		GREY TILL 0010 BLUE CLAY 0060 GREY GRVL 0065 GREY LMSN 0090
1219 GLOUCESTER TOWNSHIP ()	18 454549 5027976"	2006/07 1414	06					1536601 (Z51938) A036197		GREY TILL 0009 BLUE CLAY 0073 GREY GRVL 0078 GREY LMSN 0100
1220 GLOUCESTER TOWNSHIP ()	18 456487 5025021"	2006/06 1844	12	FR	003 / 008 044 / 1:0	DO		1536590 (Z36630) A033419		PRDG 0023
1221 GLOUCESTER TOWNSHIP ()	18 453253 5023936"	2006/02 1844				IR		1536541 (Z50450) A029955		
1222 GLOUCESTER TOWNSHIP ()	18 453225 5023982"	2006/07 1844				IR		1536542 (Z50449) A029554		
1223 GLOUCESTER TOWNSHIP ()	18 453239 5023957"	2006/07 1844				DO		1536540 (Z50448) A029555		
1224 GLOUCESTER TOWNSHIP ()	18 456850 5025076"	2006/05 1844			/ 021 / :15			1536589 (Z31663)		
1225 GLOUCESTER TOWNSHIP ()	18 456050 5025012"	2006/05 1844			/ 003 021 / 1:0			1536588 (Z31640)		
1226 GLOUCESTER TOWNSHIP ()	18 454594 5026493"	2006/05 1844			/ 004 020 / :15			1536587 (Z31666)		
1227 GLOUCESTER TOWNSHIP ()	18 456703 5025016"	2006/05 1844						1536586 (Z31664)		
1228 GLOUCESTER TOWNSHIP ()	18 453055 5023958"	2006/07 1844				IR		1536543 (Z50451) A029520		
1229 GLOUCESTER TOWNSHIP 02 (019)	18 454418 5027841"	2006/07 1414	06					1536599 (Z51936) A038763		GREY TILL 0010 BLUE CLAY 0077 GREY GRVL 0083 GREY LMSN 0110
1230 GLOUCESTER TOWNSHIP 04 (007)	18 451622 5023099"	2007/10 1414	06	FR 0148	019 / 031 005 / 1:0	DO		7052063 (Z57241) A057407		BRWN SAND PKD 0008 BLUE CLAY SOFT 0005 GREY GRVL PKD 0041 GREY LMSN LYRD 0158
1231 GLOUCESTER TOWNSHIP 04 (007)	18 451623 5023129"	2007/10 7260						7052624 (Z56819)		0013

TOWNSHIP CONCESSION (LOT)	UTM ¹	DATE ² CNTR ³	CASING DIA ⁴	WATER ^{5,6} DETAIL	STAT LVL/PUMP LVL ⁷ RATE ⁸ /TIME HR:MIN	WATER USE ⁹	SCREEN INFO ¹⁰	WELL # (AUDIT#) WELL TAG #	DEPTHS TO WHICH FORMATIONS EXTEND ^{5,11}
GLoucester TOWNSHIP 04(020)	18 454912 5027023"	2005/09 1414	06	FR 0115	048 / 051 008 / 1:0	DO		1535829 (227973) A033791	BRWN SAND PKCD 0009 GREY CLAY SOFT 0065 GREY GRVL PKCD 0098 GREY LMSN LYRD 0120
GLoucester TOWNSHIP 05(020)	18 455492 5024963"	1993/11 6629	06	FR 0070	021 / 060 010 / 1:0	DO		1527879 (135007)	BRWN SAND STNS DNSE 0033 GREY LMSN LYRD 0080
GLoucester TOWNSHIP 06(003)	18 452894 5025795"	2005/04 1844	01	FR 0006		NU	0003 17	1535450 (219260) A019083	GREY CLAY 0010 BLUE CLAY HARD 0012 GREY LMSN SHLE 0020
GLoucester TOWNSHIP ()	18 454837 5026320"	2005/03 1844				NU		1535718 (231575)	0003
GLoucester TOWNSHIP ()	18 453235 5024443"	2005/03 1844				NU		1535582 (227111)	
GLoucester TOWNSHIP ()	18 454430 5022513"	2005/03 1844	06		015 / 016 011 / 1:0	DO		1535581 (227110) A020589	
GLoucester TOWNSHIP ()	18 456858 5024993"	2005/03 1844		0003	003 / 011 / 1:0	NU		1535579 (227112)	
GLoucester TOWNSHIP ()	18 456093 5027140"	2004/12 1844	02	SA		NU		1535387 (220829)	
GLoucester TOWNSHIP ()	18 456309 5027019"	2004/12 1844						1535386 (220820)	
GLoucester TOWNSHIP ()	18 456092 5027141"	2004/12 1844				NU		1535385 (220824)	
GLoucester TOWNSHIP ()	18 456306 5027021"	2004/12 1844				NU		1535384 (220821)	
GLoucester TOWNSHIP ()	18 456371 5026810"	2006/08 7260				NU		1536772 (252501)	
GLoucester TOWNSHIP ()	18 456661 5025109"	2006/06 7260				NU		1536774 (252496)	
GLoucester TOWNSHIP ()	18 451137 5027644"	2006/11 6964	02				0004 10	7041587 (234824) A032128	0000 SAND GRVL FILL 0002 BRWN SAND FILL LOOS 0002 GREY CLAY 0015
GLoucester TOWNSHIP ()	18 456690 5026330"	2005/03 1844		FR 0011	013 / 015 / 1:5	DO		1535862 (231583) A028499	

TOWNSHIP	CONCESSION (LOT)	UTM ¹	DATE ²	CASING	WATER ^{5,6}	STAT LVL/PUMP LVL ⁷	WATER USE ⁹	SCREEN	WELL # (AUDIT#)	WELL TAG #	DEPTHS TO WHICH FORMATIONS EXTEND ^{5,11}
			CNTR ³	DIA ⁴	DETAIL	RATE ⁸ /TIME HR:MIN		INFO ¹⁰			
GLoucester Township	()	18 450331 5025057*	2008/02 6964	02				0302	7103721 (M00807) A032174		
								03	BRWN SAND GRVL 0002 BRWN CLAY SOFT		
								0002	0015		
								03			
								0002			
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								10			
GLoucester Township	()	18 455217 5025154*	2005/07 1844						1535737 (Z31604)		
								0020			
HUNtley Township	09(016)	18 455497 5027991*	2008/11 1119	06 06	0118	005 / 103 012 / 1:0	DO		7116904 (Z90212) A079337		
									SAND 0004 BLACK GRNT 0400		
OTTAWA CITY	()	18 451109 5027365*	2006/06 1844						1536548 (Z50463) A029536		
OTTAWA CITY	()	18 451109 5027365*	2006/03 1844	02				0052	1536433 (Z36620) A029536		
								08	GREY SAND GRVL FGRL 0003 GREY SILT		
									CLAY SAND 0016 GREY SILT CLAY SOFT		
									0028 GREY BLDR BSLT 0032 GREY TILL		
									SAND GRVL 0043 ROCK LMSN 0060		
OTTAWA CITY	03(016)	18 455495 5027951*	2007/06 1119	06	0142	037 / 054 010 / 1:0	DO		7047626 (Z65181) A023086		
									RED SAND 0020 GREY CLAY 0125 SAND		
									GRVL 0132 BLACK SHLE 0152		
OTTAWA CITY	()	18 451711 5026742*	1956/06 4825	04 04	FR 0075	006 / 015 005 / 1:0	DO		1507812 ()		
									MSND CLAY 0016 LMSN 0100		
OTTAWA CITY	()	18 453380 5024804*	2009/09 7241						7132698 (M05246) A081867		
OTTAWA CITY	()	18 451751 5026642*	1956/07 4825	04 04	FR 0120	016 / 080 003 / 1:0	DO		1507814 ()		
									BLUE CLAY 0014 LMSN 0130		
OTTAWA CITY	()	18 451671 5026682*	1956/07 4825	04 04	FR 0062	003 / 010 005 / 1:0	DO		1507815 ()		
									CLAY 0010 LMSN 0082		
OTTAWA CITY	()	18 451771 5026602*	1956/07 4825	04 04	FR 0080	002 / 070 003 / 1:0	DO		1507816 ()		
									CLAY 0010 LMSN 0103		
OTTAWA CITY	()	18 451796 5026562*	1959/05 1107	05 05	SU 0108	007 / 010 008 / 1:0	DO		1507817 ()		
									BLUE CLAY 0022 PSND 0028 BLACK SHLE		
									0045 GREY SHLE 0108		

TOWNSHIP CONCESSION (LOT)	UTM ¹	DATE ² CNTR	CASING DIA ⁴	WATER ^{5,6} DETAIL	STAT LVL/PUMP LVL ⁷ RATE ⁸ /TIME HR:MIN	WATER USE ⁹	SCREEN INFO ¹⁰	WELL # (AUDIT#) WELL TAG #	DEPTHS TO WHICH FORMATIONS EXTEND ^{5,11}
OTTAWA CITY ()	18 451711 5026782*	1956/06 4825	04 04	FR 0095	010 / 098 004 / :0	DO		1508351 () CLAY 0021 LMSN 0098	
OTTAWA CITY ()	18 451711 5026782*	1956/06 4825	04 04	FR 0082	008 / 015 006 / 0:30	DO		1508352 () CLAY 0019 LMSN 0082	
OTTAWA CITY ()	18 451626 5026952*	1955/08 1107	04 04	FR 0129	016 / 025 008 / 1:0	DO		1508582 () LOAM MSND 0004 BLUE CLAY 0032 GRVL CLAY 0038 BLACK SHLE 0080 GREY SHLE 0129	
OTTAWA CITY ()	18 451491 5026992*	1960/09 1802	06 06	FR 0050	018 / 050 003 / 2:0	DO		1508680 () BLUE CLAY 0030 CLAY GRVL MSND 0032 BLACK SHLE 0055	
OTTAWA CITY ()	18 453241 5026502*	1959/09 3504	10	FR 0040	028 / 040 003 / :0	CO		1508785 () MSND 0006 CLAY 0040 SILT BLDR 0045	
OTTAWA CITY ()	18 453011 5026312*	1954/12 1107	04 04	FR 0115	011 / 025 008 / 1:0	DO		1508865 () BLACK LOAM 0004 BLUE CLAY 0025 GREY MSND CLAY 0032 BLACK SHLE 0065 GREY LMSN 0115	
OTTAWA CITY ()	18 452061 5026992*	1955/08 1107	04 04	FR 0089	015 / 040 001 / 1:0	PS		1508867 () BLUE CLAY 0036 SLTS 0089	
OTTAWA CITY ()	18 452711 5026482*	1957/10 1107	04 04	FR 0140	019 / 065 008 / 1:0	DO		1508869 () BLUE CLAY 0029 GRVL CLAY 0059 GREY SHLE 0140	
OTTAWA CITY ()	18 451301 5027522*	1958/07 3718	04 04	FR 0075	017 / 120 002 / 3:0	DO		1508870 () GREY LMSN 0045 GREY CLAY 0160	
OTTAWA CITY ()	18 451211 5027632*	1958/09 3718	04 04	FR 0185	017 / 050 006 / 15:0	DO		1508871 () PRDR 0160 LMSN 0200	
OTTAWA CITY ()	18 451241 5027542*	1958/10 1107	04 04	FR 0137	022 / 137 008 / 1:0	DO		1508878 () BLACK MSND LOAM 0003 BLUE CLAY 0050 MSND 0052 GREY SHLE 0137	
OTTAWA CITY ()	18 451346 5027302*	1951/10 3725	04 04	MN 0098	010 / 018 / :0	DO		1508881 () CLAY 0030 ROCK 0122	
OTTAWA CITY ()	18 451346 5027302*	1954/01 1107	04 04	FR 0115	015 / 032 008 / 1:0	DO		1508883 () MSND LOAM 0003 BLUE CLAY 0020 CLAY GRVL 0028 BLACK MSND 0032 GREY SHLE 0115	
OTTAWA CITY ()	18 451831 5026762*	1955/07 1802	03 03	FR 0060	016 / 018 003 / 2:0	DO		1508884 () CLAY 0026 LMSN 0062	
OTTAWA CITY ()	18 451631 5026762*	1955/07 1802	03 03	FR 0055	013 / 015 004 / 1:0	DO		1508885 () CLAY 0020 MSND 0028 LMSN 0060	
OTTAWA CITY ()	18 451246 5027527*	1955/09 1107	04 04	FR 0129	014 / 125 008 / 1:0	DO		1508886 () BLUE CLAY 0050 BLACK FSND 0053 BLACK SHLE 0075 GREY SHLE 0129	

Well Computer Print Out Data as of December 23 2009

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TOWNSHIP CONCESSION (LOT)	UTM ¹	DATE ² CNTR ³	CASING DIA ⁴	WATER ^{5,6} DETAIL	STAT LVL/PUMP LVL ⁷ RATE ⁸ /TIME HR-MIN	WATER USE ⁹	SCREEN INFO ¹⁰	WELL # (AUDITH) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND ^{5,11}
OTTAWA CITY ()	18 451571 5026682*	1956/07 4825	04 04	FR 0062	006 / 014 004 / 0:30	DO		1508887 () CLAY 0010 LMSN 0072
OTTAWA CITY ()	18 451591 5026622*	1956/07 4825	04 04	SA 0061	002 / 006 005 / 0:30	DO		1508888 () CLAY 0010 LMSN 0071
OTTAWA CITY ()	18 451601 5026592*	1956/08 4825	04 04	FR 0059	001 / 005 005 / 0:30	DO		1508889 () CLAY 0010 LMSN 0069
OTTAWA CITY ()	18 451271 5027462*	1959/05 1802	06 06	FR 0110	012 / 040 003 / 2:0	DO		1508890 () CLAY 0020 GRVL HPAN 0030 SHLE LMSN 0130
OTTAWA CITY ()	18 451236 5027522*	1960/10 1802	06 06	FR 0064	034 / 070 005 / 2:0	DO		1508957 () BLUE CLAY 0038 GRVL CLAY MSND 0048 GREY LMSN 0070
OTTAWA CITY ()	18 451991 5026772*	1968/06 1517	04 04	FR 0062	007 / 030 010 / 0:30	DO		1509584 () MSND LOAM 0003 QSNL 0026 BLUE CLAY FSND 0055 MSND GRVL 0062 GREY ROCK 0063
OTTAWA CITY ()	18 452531 5026662*	1975/03 1517	06 06	FR 0094	022 / 030 015 / 1:10	PS		1514732 () RED CLAY 0019 BLUE CLAY 0050 BLACK GRVL 0051 BLACK SHLE 0100
OTTAWA CITY ()	18 451034 5027736*	2006/09 1844	20				0002 18	1536783 (250503) A029560 BRWN SAND GRVL FILL 0002 GREY SILT 0014 GREY CLAY SLTY 0020
OTTAWA CITY ()	18 452733 5027066*	2007/10 1844	20				0003 03 0003 02	7100726 (M00537) A058358 0000 BRWN GRVL FILL 0002 BRWN GRVL SLTY DRY 0005 BRWN CLAY SLTY SAND 0020
OTTAWA CITY ()	18 453264 5024850*	2008/07 1844			002 / / :0 005 / / :0 004 / / :0 017 / / :0		0003 03 0005 02 0002 00 0002 01 01 0001 00 0002 00 0003 04	7115788 (M02888) A068579 BRWN CVL MSND SILT 0027 GREY FILL CLAY SAND 0037

TOWNSHIP CONCESSION (LOT)	UTM ¹	DATE ² CNTR ³	CASING DIA ⁴	WATER ^{5,6} DETAIL	STAT LVL/PUMP LVL ⁷ RATE ⁸ /TIME HR:MIN	WATER USE ⁹	SCREEN INFO ¹⁰	WELL # (ADDIT#) WELL TAG #	DEPTHS TO WHICH FORMATIONS EXTEND ^{5,11}
OTTAWA CITY ()	18 452652 5027794"	2008/10 7241	02				0002 05 0002 05 0005 15	7116052 (M02552) A078049 BRWN GRVL SAND SOFT 0003 GREY CLAY SILT SOFT 0005 GREY CLAY SILT SOFT 0020	
OTTAWA CITY ()	18 455688 5026691"	2008/12 6838						7116968 (Z70119)	
OTTAWA CITY ()	18 456854 5026692"	6838						7116969 (Z08983)	
OTTAWA CITY ()	18 455372 5022729"	2008/10 6838						7116970 (Z67222)	
OTTAWA CITY ()	18 455869 5023117"	2008/10 6838						7116971 (Z67221)	
OTTAWA CITY ()	18 455924 5023116"	6838	09					7117252 (Z87578) A008894	
OTTAWA CITY ()	18 451394 5025363"	2009/02 7241	02				0004 03 0004 03	7119472 (M04395) A075470 BRWN FILL SAND LOOS 0002 BRWN CLAY SILT SOFT 0010 GREY CLAY SILT WBRG 0024	
OTTAWA CITY ()	18 455688 5026960"	2008/12 6838	09 09					7119774 (Z87581) A054895	
OTTAWA CITY ()	18 452378 5025379"	2009/04 7241	01				0002 03 0002 03 0002 03	7122841 (M03875) A080420 BLACK LOAM SOFT 0001 BRWN CLAY SILT SOFT 0009 GREY CLAY SILT SOFT 0012 GREY CLAY SILT SOFT 0015	

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TOWNSHIP CONCESSION (LOT)	UTM ¹	DATE ² CNTR ³	CASING DIA ⁴	WATER ^{5,6} DETAIL	STAT LVL/PUMP LVL ⁷ RATE ⁸ /TIME HR:MIN	WATER USE ⁹	SCREEN INFO ¹⁰	WELL # (AUDIT#) WELL TAG #	DEPTHS TO WHICH FORMATIONS EXTEND ¹¹
OTTAWA CITY ()	18 453176 5025521*	2008/10 1844			001 / / :0		0002 02 0002 02 0002 03 0002 03 0003 03	7122988 (M02907) A074557 GREY FILL SILT 0002 BRWN SAND FILL 0003 GREY CLAY SLTY 0008 GREY CLAY SLTY GRVL 0022	
OTTAWA CITY ()	18 452580 5026587*	2009/07 7323	02				0010 05	7126061 (Z84661) A071887 BRWN LOAM SAND LOOS 0002 GREY CLAY SLTY WBRG 0015	
OTTAWA CITY ()	18 455643 5027040*	2009/06 6838	00	FR 0006		DO		7126541 (Z08982) A008891	
OTTAWA CITY ()	18 451904 5028043*	2009/08 7241	02				0004 10	7129961 (Z53882) A089131 BRWN SAND CLAY SOFT 0005 GREY SHLE WTHD 0010 GREY SHLE WTHD 0014	
OTTAWA CITY ()	18 451691 5026632*	1956/07 4825	04 04	FR 0066	003 / 016 005 / 1:0	DO		1507813 () CLAY 0010 LMSN 0076	
OTTAWA CITY (GLOUCES JG (013)	18 452621 5026502*	1948/08 2311	05 05	FR 0128	/ 040 / 1:0	NU		1500416 () LOAM MSND 0020 SHLE 0140	
OTTAWA CITY (GLOUCES OF 03(025)	18 451911 5027102*	1949/12 1107	06 06	FR 0172	012 / 172 006 / 2:0	DO		1501496 () CLAY LOAM 0002 BLUE CLAY 0037 GREY SLTE 0172	
OTTAWA CITY (GLOUCES OF 03(027)	18 451511 5027012*	1955/08 1801	02 02	FR 0106	008 / 020 004 / 2:0	DO		1507823 () CLAY 0022 LMSN 0106	
OTTAWA CITY (GLOUCES RF 06(002)	18 452751 5025972*	1975/12 1558	06 06					1515194 () BLACK LOAM PKD 0003 BRWN SAND PKD 0009 GREY LMSN HARD 0120 BLACK LMSN 0420 GREY LMSN 0500	
OTTAWA CITY (GLOUCES RF 06(002)	18 452731 5026022*	1975/03 1558	06 05		013 / 250 / 3:0	DO		1515287 () BRWN SAND 0003 GREY HPAN STNS PKD 0008 GREY LMSN SOFT 0173 BLACK SHLE SOFT 0300	

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APPENDIX F
NON-STANDARD SPECIAL PROVISION

19-3405-3

DEWATERING NNSP

The contractor shall implement groundwater control and ground support systems as are required to carry out the construction in a safe, stable, and dry excavation.

The contractor shall note that bedrock was encountered at elevations of 59.2 m to 62.2 m at the Culvert 3-315/C site.

The dewatering system shall be designed by a dewatering specialist engaged by the Contractor.

Where a cofferdam is required, the Contractor shall engage an experienced geotechnical engineer licensed to practice in Ontario to carry out the cofferdam design.