

**FOUNDATION INVESTIGATION REPORT
HURDMAN BRIDGE REPLACEMENT
HIGHWAY 417 EXPANSION FROM NICHOLAS STREET TO VANIER PARKWAY
OTTAWA, ONTARIO**

G.W.P. 4091-07-00, SITE No. 3-073

Geocres Number: 31G5-245

Report to

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted for the proposed replacement of the existing Hurdman Bridge which carries Highway 417 over the Rideau River in Ottawa, Ontario. This structure replacement is part of the Highway 417 Expansion project, from Nicholas Street to Vanier Parkway.

The purpose of this investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, record of borehole sheets, stratigraphic profile and cross-sections, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions was developed from the data obtained in the course of the investigation.

Thurber carried out the investigation as a sub-consultant to McCormick Rankin Corporation, under the Ministry of Transportation Ontario (MTO) Agreement Number 4009-E-00007.

2 SITE DESCRIPTION

The Hurdman Bridge is located on Highway 417 approximately 4 km east of Ottawa city centre. The structure is a five span bridge with a total length of approximately 157 m, which crosses the Rideau River. The bridge deck is approximately 36.8 m wide and carries eight lanes of traffic for Highway 417. The bridge is supported on four piers and two abutments. The piers are numbered Pier 1 to Pier 4 from west to east. The piers and abutments are on shallow footings founded on bedrock. Approach embankments on either side of the bridge are approximately 5 m high.

A paved pathway for both pedestrians and cyclists runs under the existing bridge in front of each abutment. A gas main (300 mm diameter) runs parallel to the north side of the bridge and a watermain (1220mm diameter) runs in a east-southeast direction across the river on the south side

of the bridge. A 900 mm diameter storm sewer runs parallel to the south side of the west approach and outlets in the Rideau River. There is also a pedestrian bridge approximately 40m to the south of Hurdman Bridge.

In the mid to late 1980s, the Hurdman Bridge was widened from a six lane deck to an eight lane deck. Archive information suggests that during construction of the works in the mid-1980s, the gas main was relocated further north to its current location and its previous trench abandoned. The original gas main trench had an invert level approximately 1.2 to 1.8 m below the existing pier footing. A site instruction was issued to excavate the trench and backfill it with concrete whenever widening of footings at that time came within 2 m of the trench.

Topography across the site is generally flat. The Rideau River flows from south to north and is approximately 150 m wide at this site. The river is typically shallow at this location, being less than 1.5 m deep. A small island exists in the river just south of Pier 3.

Land use surrounding the site is commercial/industrial in the northeast and northwest quadrants. In the southwest quadrant are educational institutions, and the southeast quadrant consists of undeveloped parklands.

The site lies within the Ottawa Valley Clay Plains physiographic region, which comprises a clay plain interrupted by ridges of sand or rock. At the specific bridge site however, the general stratigraphy comprises glacial silt/sand till overlying bedrock at relatively shallow depth. The bedrock consists of the Carlsbad Formation, comprising dark grey shale interbedded with calcareous siltstone and limestone.

Photographs in Appendix C show the general nature of the site.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out during the period of July 19 to September 15, 2011 and consisted of drilling and sampling twenty-one boreholes at the existing structure (Boreholes HD-01 to 16, HD-04B to 06B, HD-11B and HD-15B). Nine of the boreholes at the approaches and abutments were drilled on land, eleven of the boreholes at the piers were drilled in the Rideau River and one borehole was drilled on the small island south of Pier 3.

At the west approach, boreholes HD-01 and HD-09 were drilled on the shoulders of Highway 417 and Boreholes HD-02 and HD-10 were drilled near the river bank in front of the west abutment. At the east approach, boreholes HD-08 and HD-16 were drilled just off the shoulder of Highway 417, and Boreholes HD-07, HD-15 and HD-15B were drilled in front of the east abutment by the river bank. The locations and termination depths and elevations of the twenty-one boreholes drilled at this site are listed in Table 3.1.

The approximate locations of the boreholes are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix D. A list of the borehole coordinates and elevations is included on this drawing.

Table 3.1 – Borehole Details

Location	Borehole	Water Elevation (m)	Depth of Water (m)	Ground Elevation (m)	Termination Depth (m)*	Termination Elevation (m)
West Approach	HD-01	-	-	61.5	10.4	51.1
	HD-09	-	-	60.6	9.5	51.0
West Abutment	HD-02	-	-	56.9	5.7	51.2
	HD-10	-	-	57.5	6.7	50.8
Pier 1	HD-03	55.1	0.4	54.7	3.5	51.2
	HD-11	55.3	0.3	55.0	5.7	49.3
	HD-11B	55.1	0.2	54.9	3.3	51.6
Pier 2	HD-04	55.1	0.4	54.7	3.4	51.3
	HD-04B	55.1	0.4	54.7	3.5	51.2
	HD-12	55.0	0.2	54.8	3.4	51.4
Pier 3	HD-05	55.1	0.4	54.7	3.5	51.2
	HD-05B	-	-	55.1	3.7	51.4
	HD-13	55.2	0.4	54.8	3.5	51.3
Pier 4	HD-06	55.2	0.6	54.6	3.4	51.2
	HD-06B	55.1	0.5	54.6	3.4	51.2
	HD-14	55.1	0.5	54.6	3.4	51.2
East Abutment	HD-07	-	-	57.3	6.6	50.7
	HD-15	-	-	57.4	6.1	51.3
	HD-15B	-	-	57.6	6.1	51.5
East Approach	HD-08	-	-	60.8	9.3	51.5
	HD-16	-	-	60.5	9.1	51.4

* Below ground elevation

The borehole locations were marked in the field, where possible and utility clearances were obtained prior to commencement of drilling operations. Consent was obtained from the National Capital Commission (NCC) for boreholes drilled near the east abutment and a permit was obtained from the City of Ottawa for boreholes drilled at the west abutment. A permit was also obtained from the Rideau Valley Conservation Authority (RVCA) for borehole drilling in the Rideau River and on the island south of Pier 3.

Three different drill rigs were used to complete the field investigation at this site. A truck-mounted CME 75 drill rig was used for boreholes located on the shoulder of Highway 417 and a track-mounted CME 45 drill rig was used for boreholes located adjacent to the highway. For these two rigs, a combination of hollow-stem auger drilling techniques and NQ coring methods were used to advance the boreholes. A portable Hilti drill was used for coring the boreholes located in and adjacent to the Rideau River. The portable drill was operated from a temporary scaffolding platform set up at each borehole location over water. For boreholes located on the east and west banks of the river, the portable Hilti drill was used in conjunction with a tripod and hammer set-up.

Overburden samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). A minimum 3.0 m length of bedrock core was recovered from each borehole. All rock cores were logged in the field, and the Total Core Recovery (TCR), Solid Core Recovery (SCR), Rock Quality Designation (RQD) and the Fracture Indices (FI) were determined.

The drilling and sampling operations were supervised on a full time basis by a member of Thurber's technical staff. The supervisor logged the boreholes and processed the recovered soil and bedrock samples for transport to Thurber's laboratory for further examination and testing.

Groundwater conditions were not recorded in the open boreholes during onshore drilling operations since water is introduced into the borehole during coring and is not representative of groundwater conditions on site. Standpipe piezometers consisting of 19 to 40 mm diameter PVC pipe with a slotted screen were installed in seven boreholes at this site. The completion details of the piezometers are summarized in Table 3.2. Following the final water level reading, the piezometers will be decommissioned in general accordance with MOE Regulation 903. Upon completion of drilling, boreholes without a piezometer installation were backfilled with bentonite chips or pellets and asphalt cold patch at the surface, where appropriate.

Table 3.2 – Piezometer Details

Borehole	Tip Position (m)		Completion Details
	Depth	Elev.	
HD-1	9.1	52.4	Sand filter from 10.4 to 5.8m, bentonite from 5.8 to 4.6m, cuttings and bentonite mixture from 4.6 to 0.1m, then asphalt cold patch to surface. Flush-mount casing protector at surface.
HD-7	6.6	50.7	Sand filter from 6.6 to 4.7m, bentonite from 4.7 to 0.1m, then sand and grass to surface. 0.6 m stick-up.
HD-8	7.8	53.0	Sand filter from 9.3 to 3.8m, bentonite from 3.8 to 3.1m, cuttings and bentonite mixture from 3.1 to surface. 0.6 m stick-up.
HD-9	6.7	53.9	Sand filter from 9.5 to 3.4m, bentonite from 3.4 to 1.8m, cuttings from 1.8 to 0.1m, then asphalt cold patch to surface. Flush-mount casing protector at surface.
HD-10	6.7	50.8	Sand filter from 6.7 to 4.9m, bentonite from 4.9 to 0.6m, then sand and gravel to surface. 0.6 m stick-up.
HD-15B	4.7	52.9	Bentonite from 6.1 to 4.7m, sand filter from 4.7 to 1.2m, bentonite from 1.2 to 0.05m, sand to surface. 0.7 m stick-up.
HD-16	7.6	52.9	Sand filter from 9.1 to 4.0m, cuttings and bentonite mixture from 4.0 to surface. 0.6 m stick-up.

4 LABORATORY TESTING

All recovered soil samples were subjected to Visual Identification and moisture content determinations. Selected samples were also subjected to grain size distribution analyses (sieve and hydrometer) and Atterberg Limits testing, where appropriate. The results of this testing program are summarized on the Record of Borehole sheets included in Appendix A and on the figures presented in Appendix B.

Point load tests were carried out on selected samples of intact bedrock core to assist in evaluation of the compressive strength of the bedrock. Results of the point load tests are included on the Record of Borehole sheets in Appendix A (as average per core run).

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendix A and to the Borehole Locations and Soil Strata Drawings in Appendix D. An overall description of the stratigraphy based on the conditions encountered in the boreholes is given in the following paragraphs. However, the factual data presented in the borehole logs takes precedence over this general description and interpretation of the site conditions.

In general terms, the stratigraphy encountered in the boreholes drilled on land consists of asphalt or a thin layer of organics overlying various fills, which are underlain by silty sand till. Shale bedrock was encountered below the till. The stratigraphy encountered in the boreholes drilled in the Rideau River generally consists of shale bedrock at the surface of the river bed.

More detailed descriptions of the individual strata encountered at the existing bridge site are presented below.

5.1 Asphalt

Asphalt was encountered in Boreholes HD-01 and HD-09 which were drilled on the shoulders of Highway 417. The asphalt was between 125 and 150 mm thick.

Borehole HD-02 which was drilled on the pedestrian pathway that passes under the Hurdman Bridge on the west bank of the Rideau River encountered 100 mm asphalt.

5.2 Topsoil

A thin layer of topsoil was encountered at surface in Boreholes HD-08 and HD-16, which were drilled at the edge of Highway 417 and in Boreholes HD-07, HD-15 and HD-15B, which were drilled on the east bank of the Rideau River. The topsoil was typically 25 mm thick.

A layer of brown silty topsoil was also encountered at surface in borehole HD-05B, which was drilled on the small island south of Pier 3. This layer of silty topsoil contains some sand, cobbles and boulders and was 0.5 m thick.

5.3 Sand/ Gravelly Sand/ Sand and Gravel Fill

A layer of fill was encountered beneath the asphalt and topsoil in all boreholes drilled at the abutments and approaches. The fill varies from sand, gravelly sand to sand and gravel.

Sand fill was encountered below the asphalt in Boreholes HD-01 and HD-09 at the west approach, and below the topsoil in Boreholes HD-08 and HD-16 at the east approach. The sand fill is brown and contains trace to some gravel, silt and clay. Hydrocarbon odour and dark grey to black staining of the fill were noted in Boreholes HD-09 and HD-16 at approximate depths of 3.2 and 3.4 m.

Brown to dark brown sand and gravel fill was encountered below the asphalt in Borehole HD-02 and at surface in Borehole HD-10 at the west abutment. In Borehole HD-10, a layer of concrete 150 mm thick was encountered at 0.6 m depth beneath the sand and gravel fill. Beneath the concrete layer, the fill consists of brownish grey silty sand with some gravel and trace of clay.

Gravelly sand fill was encountered below the topsoil in Boreholes HD-07, HD-15 and 15B at the east abutment. The gravelly sand fill is dark brown to brown and contains some silt, shale fragments and some rootlets.

In Borehole HD-11, drilled in the Rideau River near Pier 1, gravel fill containing concrete rubble and shale fragments was encountered below 0.9 m of concrete and concrete rubble. The gravel fill was 1.4 m thick with a lower boundary at a depth of 2.6 m (Elevation

52.7 m) below the river water level. This fill is believed to be backfill material in the abandoned gas main trench.

The thickness of the sand/gravel ranged from 3.0 to 4.5 m in the approaches and 0.6 to 2.1 m at the base of the abutments. The lower boundary was at Elev. 55.4 to 57.8 m. Details of the fill thickness and elevations are summarized in Table 5.1.

Table 5.1 – Fill thickness encountered in boreholes

Foundation Element	Borehole	Top Elevation of Fill (m)	Bottom Elevation of Fill (m)	Thickness of Fill (m)
West Approach	HD-01	61.4	56.9	4.5
	HD-09	60.4	56.6	3.8
West Abutment	HD-02	56.8	55.6	1.2
	HD-10	57.5	55.4	2.1
East Abutment	HD-07	57.3	56.7	0.6
	HD-15	57.4	56.8	0.6
	HD-15B	57.6	56.4	1.2
East Approach	HD-08	60.8	57.8	3.0
	HD-16	60.5	57.1	3.4
Pier 1	HD-11	55.0	52.7	2.3

SPT ‘N’ values recorded in the cohesionless fill typically ranged from 8 to 29 blows for 0.3 m penetration, indicating a loose to compact relative density. Locally, higher SPT ‘N’ values between 31 blows/ 0.3 m penetration and 60 blows for 0.025 m penetration were recorded in Boreholes HD-01, HD-08, HD-09 and HD-15B, indicating a dense to very dense condition or possible cobbles in the fill.

The moisture contents ranged from 2 to 16%.

Grain size distribution analyses were carried out on three samples of the sand fill. The results of these tests are plotted on Figure B1, Appendix B, and are summarized below.

Gravel %	6 to 18
Sand %	67 to 90
Silt and Clay%	4 to 15

5.4 Silt

A thin layer of silt containing some clay, to clayey silt with some sand was encountered below the sand fill in Boreholes HD-01 and HD-16. The silt to clayey silt layer is grey to greyish brown in colour and contains trace of organics in Borehole HD-01.

The thickness of the silt layer ranged from 0.7 to 1.0 m with a lower boundary at a depth of 4.1 to 5.6 m (Elevations 56.4 to 55.8 m).

An SPT 'N' value of 6 blows for 0.3 m penetration was recorded in this layer in Borehole HD-01, indicating a firm consistency. The moisture contents measured in two samples of the clayey silt were 27 and 30%.

5.5 Sand and Gravel

A thin layer of sand and gravel was encountered below the fill layer and overlying bedrock in borehole HD-10. The sand and gravel is brownish grey and contains trace of silt and shale fragments.

The sand and gravel layer was 0.6 m thick with a lower boundary at 2.7 m depth (Elevation 54.8).

An SPT 'N' value of 17 blows for 0.3 m penetration was recorded in this layer, indicating a compact condition. The moisture content measured in a single sample of the sand and gravel was 14%.

The results of a grain size distribution analysis on a sample of sand and gravel are plotted in Figure B2, Appendix B and summarized below:

Gravel %	50
Sand %	42
Silt and Clay%	8

5.6 Silty Sand Till

Dark brown to dark grey silty sand till containing trace to some clay and trace to some gravel was encountered overlying the bedrock in all of the boreholes which were drilled on land except for Borehole HD-10.

The thickness of the silty sand till varied from 0.9 to 2.9 m. The depth to the base of the silty sand till ranged from 2.2 m to 7.3 m (Elevations 54.9 to 54.2 m).

SPT 'N' values recorded in the silty sand till typically ranged from 10 blows for 0.3 m penetration to 50 blows/0.125 m penetration, indicating a compact to very dense condition. Lower 'N' values of 6 and 9 blows for 0.3 m penetration, indicating a loose condition, were recorded in Boreholes HD-02 and HD-15. Difficult augering was experienced in Boreholes HD-01, HD-08, and HD-16, and in some cases coring was required to advance these boreholes through the till to the bedrock surface, indicating the possible presence of cobbles, boulders and shale slabs.

The moisture content of the silty sand till typically ranged from 6 to 16%. Two samples of the silty sand till had higher moisture contents (26% and 52%, both in Borehole

HD-02). The moisture content of 52% can likely be attributed to the presence of some organics and wood fragments in the sample.

Grain size distribution analyses were carried out on eight samples of the silty sand till. The results of these tests are plotted on Figures B3 and B4, Appendix B, and are summarized below.

Gravel %	0 to 19
Sand %	41 to 64
Silt %	24 to 45
Clay %	4 to 14

Some samples of the silty sand till exhibited plasticity to enable Atterberg Limits testing. Three Atterberg Limits tests were carried out on the silty sand till. The results of these tests are plotted on Figure B5, Appendix B and are summarized below. The results suggest slight plasticity within the till.

Plastic Limit %	12 to 16
Liquid Limit %	19 to 26
Plasticity Index %	7 to 10

Glacial tills are known to contain cobbles, boulders and slabs of bedrock.

5.7 Shale Bedrock

Bedrock was encountered below the silty sand till in all the boreholes drilled at the bridge approaches and the abutments, except for Borehole HD-10 where bedrock was encountered below the sand and gravel layer. Bedrock was encountered at the surface of the river bed in all of the boreholes drilled at the pier locations in the river except for Boreholes HD-05B (where the bedrock was encountered below topsoil on a small island), HD-11 (which penetrated probable backfilled trench) and HD-11B where 200 mm of sand and gravel was encountered above bedrock.

Bedrock was proven by coring in all boreholes drilled at this site. The depths and elevations at which bedrock was encountered are summarized in Table 5.2.

The bedrock was described as dark grey shale. Locally in Boreholes HD-01 and HD-09, hard limestone interbeds were encountered. The bedrock was generally described as slightly weathered to fresh. At some locations the bedrock was highly weathered at surface. Highly fractured/ rubble zones, typically less than 250mm thick and locally up to 600mm thick, were noted, as was clay seams of up to 15mm in thickness.

Table 5.2 – Depths and Elevations of Bedrock Surface

Location	Borehole	Weathered Bedrock Surface		Unweathered Bedrock Surface	
		Depth (m)*	Elevation (m)	Depth below Weathered Bedrock Surface (m)	Elevation (m)
West Approach	HD-01	7.3	54.2	0.0	54.2
	HD-09	6.2	54.3	0.7	53.6
West Abutment	HD-02	2.2	54.7	0.3	54.4
	HD-10	2.7	54.8	0.3	54.5
Pier 1	HD-03	0.0	54.7	0.4	54.3
	HD-11	2.3**	52.7	0.2	52.5
	HD-11B	0.2	54.7	0.5	54.2
Pier 2	HD-04	0.0	54.7	0.5	54.2
	HD-04B	0.0	54.7	0.3	54.4
	HD-12	0.0	54.8	0.8	54.0
Pier 3	HD-05	0.0	54.7	0.4	54.3
	HD-05B	0.5	54.6	0.1	54.5
	HD-13	0.0	54.8	0.6	54.2
Pier 4	HD-06	0.0	54.6	0.6	54.0
	HD-06B	0.0	54.6	0.6	54.0
	HD-14	0.0	54.6	0.5	54.1
East Abutment	HD-07	3.0	54.3	0.7	53.7
	HD-15	3.0	54.4	0.4	54.2
	HD-15B	2.7	54.9	0.4	54.5
East Approach	HD-08	5.9	54.9	0.4	54.5
	HD-16	6.1	54.4	0.1	54.3

* Excluding depth of water in river

**Presumed abandoned gas main trench

Total Core Recovery (TCR) in the bedrock ranged from 70 to 100%, but with some outlier values as low as 33%. The RQD values typically ranged from 0 to 80% indicating a variable rock quality ranging from very poor to good. An RQD value of 0% was recorded in the initial 100 to 600mm run at the bedrock surface in the majority of boreholes. The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, ranged from 0 to greater than 15.

The estimated unconfined compressive strength (UCS) of the rock, interpreted from point load tests conducted on intact rock cores, generally ranged from 8 to 45 MPa, indicating a

weak to medium strong strength classification. One value of 99 MPa (strong) was obtained on a sample of probable limestone from Borehole HD-05B. The variability of the rock strength is likely related to the limestone content and hard interbeds.

5.8 Water Levels

Groundwater levels were not recorded in the boreholes during drilling. Water was added into the boreholes as part of the rock coring operations and therefore natural groundwater levels were not measured in the bedrock.

A standpipe piezometer was installed in seven boreholes at this site upon completion of drilling. The groundwater level at the approach embankments varied between 4.9 and 6.7 m depth (Elev. 53.8 and 56.6). The groundwater level measured at the river banks was between depths of 2.1 and 2.5 m (Elev. 55.0 and 55.3).

The groundwater depths and elevations measured in the piezometers are shown in Table 5.3.

Table 5.3 – Groundwater Depths and Elevations

Borehole	Date	Water Level (m)	
		Depth	Elevation
HD-1	12-Oct-2011	4.9	56.6
HD-07	2-Sept-2011	2.1	55.2
	20-Sept-2011	2.1	55.2
	12-Oct-2011	2.1	55.2
HD-08	20-Sept-2011	5.6	55.2
	12-Oct-2011	5.7	55.1
HD-09	18-Aug-2011	5.8	54.8
	12-Oct-2011	5.0	55.6
HD-10	2-Sept-2011	2.5	55.0
	20-Sept-2011	2.2	55.3
	12-Oct-2011	2.3	55.2
HD-15B	2-Sept-2011	2.3	55.3
	20-Sept-2011	2.4	55.2
	12-Oct-2011	2.5	55.1
HD-16	20-Sept-2011	5.9	54.6
	12-Oct-2011	6.7	53.8

Seasonal fluctuations of the groundwater level and the water level in the river 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.

The water level in the Rideau River at the time of investigation (July – September 2011) was approximate Elev. 55.1 m. The depth of water at the borehole locations ranged from 0.2 to 0.6 m.

6 MISCELLANEOUS

The borehole locations were selected and established in the field by Thurber Engineering Ltd. Surveyors from MMM Group determined the co-ordinates and ground surface elevations at the boreholes after completion of the site investigation.

Eastern Ontario Diamond Drilling Ltd. from Hawkesbury, Ontario supplied both a truck mounted CME 75 drill rig and track mounted CME 45 drill rig and conducted the drilling, sampling and in-situ testing operations. OGS Inc. from Almonte, Ontario supplied the portable drilling and coring equipment and conducted the drilling, sampling and in-situ testing operations at the piers.

The field investigation was supervised by Mr. Ryan Kromer and Mr. Luke Gilarski, E.I.T. of Thurber. Overall planning and supervision of the field program was conducted by Ms. Lindsey Blaine, E.I.T.

Interpretation of the field data and preparation of the report were carried out by Ms. Lindsey Blaine, E.I.T. and Mr. Murray Anderson, P.Eng.

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

Thurber Engineering Ltd.

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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		Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
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.				
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 HD-01

1 OF 2

METRIC

W.P. 4091-07-00 LOCATION N 5 031 092.3 E 370 198.0 ORIGINATED BY LPG
 HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring (CME 75) COMPILED BY AN
 DATUM Geodetic DATE 2011.09.15 - 2011.09.15 CHECKED BY LRB

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					WATER CONTENT (%)				
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL			× LAB VANE	W _P	W	W _L	
61.5						20	40	60	80	100	20	40	60	GR	SA	SI	CL
0.0	ASPHALT: (125mm)																
0.1	SAND, trace to some gravel, some silt Dense to Compact Brown Moist (FILL)		1	AS													
			2	SS	46									10	79	11	(SI+CL)
			3	SS	28												
			4	SS	11												
			5	SS	12												
56.9																	
4.6	SILT, some clay, trace organics Firm Grey Moist		6	SS	6												
55.8																	
5.6	Silty SAND, some clay, trace gravel Very Dense Dark Brown Moist (TILL) Difficult augering at 5.6m		7	SS	76/ 0.225									10	41	35	14
54.2																	
7.3	SHALE, fresh, laminated, grey, very thin limestone interbeds through out		1	RUN													
			2	RUN													

Continued Next Page

+ 3 . X 3 : Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HD-01

2 OF 2

METRIC

W.P. 4091-07-00 LOCATION N 5 031 092.3 E 370 198.0 ORIGINATED BY LPG
 HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring (CME 75) COMPILED BY AN
 DATUM Geodetic DATE 2011.09.15 - 2011.09.15 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								20	40	60	80	100					
Continued From Previous Page																	
51.1																	
10.4	END OF BOREHOLE AT 10.4m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Oct.12/11 4.9 56.6						51										

RECORD OF BOREHOLE No HD-02

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 095.1 E 370 247.8 ORIGINATED BY RK
 HWY 417 BOREHOLE TYPE Tripod with Hammer/Portable Hilti Drill COMPILED BY AN
 DATUM Geodetic DATE 2011.07.27 - 2011.07.27 CHECKED BY LRB

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE				WATER CONTENT (%) w _p w w _L				
56.9 0.0 0.1	ASPHALT: (100mm) SAND and GRAVEL, some silt Compact Dark Brown Moist (FILL)		1	SS	15											
55.6 1.3	Silty SAND, trace clay, trace gravel, some wood fragments Loose to Compact Brown to Dark Grey Moist to Wet (TILL)		2	SS	6										0 49 45 6	
54.7 2.2	SHALE, fresh, thinly laminated, occasional horizontal joints, dark grey		1	RUN	118/ 0.20									FI	TCR=70% SCR=70% RQD=0%	
			2	RUN										3	TCR=91% SCR=89% RQD=37% UCS=14MPa Average	
			3	RUN										1	TCR=100% SCR=61% RQD=39% UCS=32MPa Average	
			4	RUN										0	TCR=100% SCR=93% RQD=20% UCS=17MPa Average	
51.2 5.7	END OF BOREHOLE AT 5.7m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.6m, SAND AND GRAVEL TO 0.15m AND ASPHALT COLD PATCH TO SURFACE.													2		
														3		

RECORD OF BOREHOLE No HD-03

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 097.0 E 370 269.3 ORIGINATED BY RK
 HWY 417 BOREHOLE TYPE Portable Hilti Drill - Coring COMPILED BY AN
 DATUM Geodetic DATE 2011.07.26 - 2011.07.26 CHECKED BY LRB

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						WATER CONTENT (%)			
								○ UNCONFINED		+ FIELD VANE				w P w w L			
55.1							20	40	60	80	100						
0.0	WATER						55										
54.7																	
0.4	SHALE, slightly weathered to fresh, thinly laminated, horizontal joints, dark grey Highly fractured from 0.4m to 0.6m Clay seam at 1.9m		1	RUN													
			2	RUN			54										
			3	RUN			53										
			4	RUN			52										
51.2																	
3.9	END OF BOREHOLE AT 3.9m. BOREHOLE BACKFILLED WITH BENTONITE PELLETS.																

+³, ×³: Numbers refer to
Sensitivity

20
15
10



(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HD-04

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 101.0 E 370 303.6 ORIGINATED BY RK
 HWY 417 BOREHOLE TYPE Portable Hilti Drill - Coring COMPILED BY AN
 DATUM Geodetic DATE 2011.07.26 - 2011.07.26 CHECKED BY LRB

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				w _P w w _L				
55.1							20	40	60	80	100	20	40	60		
0.0	WATER															
54.7																
0.4	SHALE, slightly weathered to fresh, thinly laminated, occasional horizontal joints, dark grey Rubble zone (150mm) at 0.4m Highly fractured zone (250mm) at 0.6m		1	RUN												
			2	RUN												
			3	RUN												
51.3																
3.8	END OF BOREHOLE AT 3.8m. BOREHOLE BACKFILLED WITH BENTONITE PELLETS.															

+³, X³: Numbers refer to
Sensitivity






20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HD-04B

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 097.0 E 370 304.8 ORIGINATED BY RK
 HWY 417 BOREHOLE TYPE Portable Hilti Drill - Coring COMPILED BY AN
 DATUM Geodetic DATE 2011.08.31 - 2011.08.31 CHECKED BY LRB

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							WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w _p w w _L		
55.1							20	40	60	80	100	20	40	60			
0.0	WATER																
54.7																	
0.4	SHALE, slightly weathered to fresh, thinly laminated, occasional horizontal joints, dark grey Rubble zone (150mm) at surface Clay seam (5mm)		1	RUN													
			2	RUN													
	Clay seam in joint																
			3	RUN													
			4	RUN													
51.2	Vertical joint (250mm long) at 3.1m Rubble zone (50mm) at 3.4m																
3.9	END OF BOREHOLE AT 3.9m. BOREHOLE BACKFILLED WITH BENTONITE CHIPS TO SURFACE.																

+³, X³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HD-05

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 106.0 E 670 338.5 ORIGINATED BY RK
HWY 417 BOREHOLE TYPE Portable Hilti Drill - Coring COMPILED BY AN
DATUM Geodetic DATE 2011.07.25 - 2011.07.25 CHECKED BY LRB

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					
								20 40 60 80 100					
55.1													
0.0	WATER						55					FI	
54.7												3	
0.4	SHALE, slightly weathered to fresh, thinly laminated, dark grey, occasional horizontal fractures, some rubble zones Rubble zone (50mm) at 0.7m		1	RUN			54					4	TCR=83% SCR=69% RQD=16% UCS=40MPa Average
			2	RUN								4	
	Rubble zone (75mm) at 2.0m Rubble zone (100mm) at 2.2m Rubble zone (150mm) at 2.5m						53					1	TCR=96% SCR=67% RQD=31% UCS=39MPa Average
			3	RUN								0	
							52					1	
			4	RUN								2	TCR=97% SCR=81% RQD=25% UCS=19MPa Average
51.2												5	
3.9	END OF BOREHOLE AT 3.9m. BOREHOLE BACKFILLED WITH BENTONITE PELLETS.											3	TCR=100% SCR=96% RQD=24%
												4	UCS=26MPa Average

+ 3, X 3: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HD-05B

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 099.0 E 370 339.7 ORIGINATED BY RK
HWY 417 BOREHOLE TYPE Portable Hilti Drill - Coring COMPILED BY AN
DATUM Geodetic DATE 2011.08.31 - 2011.08.31 CHECKED BY LRB

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						WATER CONTENT (%)					
								○ UNCONFINED + FIELD VANE						w _p w w _L					
								● QUICK TRIAXIAL x LAB VANE											
55.1							20	40	60	80	100								
0.0	TOPSOIL, silty, some sand, some cobbles and boulders																		

+³, X³: Numbers refer to
Sensitivity




20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HD-06

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 111.0 E 370 373.1 ORIGINATED BY RK
HWY 417 BOREHOLE TYPE Portable Hilti Drill - Coring COMPILED BY AN
DATUM Geodetic DATE 2011.07.22 - 2011.07.22 CHECKED BY LRB

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 (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			WATER CONTENT (%)					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE								
55.2								20	40	60	80	100				
0.0	WATER						55									
54.6	Scattered cobbles															
0.6	SHALE, slightly weathered to fresh, thinly laminated, occasional vertical joints, dark grey		1	RUN			54							FI	TCR=84% SCR=23% RQD=0% UCS=35MPa Average	
			2	RUN										3	TCR=96% SCR=69% RQD=19% UCS=27MPa Average	
			3	RUN			53							5	TCR=98% SCR=98% RQD=50% UCS=35MPa Average	
			4	RUN			52							4	TCR=100% SCR=100%	
51.2	END OF BOREHOLE AT 4.0m. BOREHOLE BACKFILLED WITH BENTONITE PELLETS.													3	RQD=66% UCS=17MPa Average	
4.0														6		

+³, ×³: Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HD-06B

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 105.0 E 370 374.0 ORIGINATED BY RK
HWY 417 BOREHOLE TYPE Portable Hilti Drill - Coring COMPILED BY AN
DATUM Geodetic DATE 2011.08.30 - 2011.08.31 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)		
								○ UNCONFINED	+	FIELD VANE	● QUICK TRIAXIAL						×	LAB VANE	
55.1							20	40	60	80	100	20	40	60					
0.0	WATER																		
54.6																			
0.5	SHALE, fresh, thinly laminated, dark grey, occasional horizontal joints, occasional clay seams		1	RUN															
	Clay seam (5mm)		2	RUN															
			3	RUN															
	Clay seam (5mm) at 3.7m Clay seam (5mm) at 3.8m		4	RUN															
51.2																			
3.9	END OF BOREHOLE AT 3.9m. BOREHOLE BACKFILLED WITH BENTONITE CHIPS.																		

RECORD OF BOREHOLE No HD-07

1 OF 1



METRIC

W.P. 4091-07-00 LOCATION N 5 031 113.6 E 370 398.9 ORIGINATED BY RK
HWY 417 BOREHOLE TYPE Tripod with Cathead/Portable Hilti Drill COMPILED BY AN
DATUM Geodetic DATE 2011.07.20 - 2011.07.20 CHECKED BY LRB

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							x LAB VANE	
57.3							20	40	60	80	100	20	40	60	GR	SA	SI	CL
8.8	TOPSOIL: (25mm)		1	SS	8													
56.7	Gravelly SAND, some silt, trace of clay, shale fragments		2	SS	31													
0.6	Loose Dark Brown Moist (FILL)		3	SS	29													
	Silty SAND, trace to some clay, trace to some gravel, some shale fragments		4	SS	10													
	Loose to Dense Dark Brown Moist (TILL)		5	SS	12													
	180mm cobble (coring)																	
54.3	Becomes wet																	
3.0	SHALE, slightly weathered to fresh, thinly laminated, dark grey, some clay in fractures		1	RUN														
			2	RUN														
			3	RUN														
			4	RUN														
50.7	END OF BOREHOLE AT 6.6m. Piezometer installation consists of 30mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.																	
6.6																		
	WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Sep.02/11 2.1 55.2 Sep.20/11 2.1 55.2 Oct.12/11 2.1 55.2																	

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

METRIC

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	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		
60.8											

8.8	TOPSOIL: (25mm) SAND, trace to some gravel Dense to Compact Brown (some orange staining) Damp (FILL)	1	SS	42																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
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+³, ×³: Numbers refer to Sensitivity

METRIC

ONTMT4S 1201A.GPJ 11/22/11

RECORD OF BOREHOLE No HD-09

1 OF 2

METRIC

W.P. 4091-07-00 LOCATION N 5 031 125.7 E 370 199.7 ORIGINATED BY LPG
 HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring (CME 75) COMPILED BY AN
 DATUM Geodetic DATE 2011.08.15 - 2011.08.15 CHECKED BY LRB

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 (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							w _p	w	w _L
							20	40	60	80	100	20	40	60			
60.6																	
0.0	ASPHALT: (150mm)																
0.2	SAND, trace to some gravel, trace silt Compact Brown Moist (FILL)		1	AS			60										
			2	SS	23												
			3	SS	29		59										
			4	SS	10		58							6 90 4 (SI+CL)			
	Becomes very dense, possible hydrocarbon Dark Grey Probable boulder at 3.2m		5	SS	60/0.025		57										
56.6																	
4.0	Silty SAND, some clay, trace gravel Dense to Very Dense Dark Brown to Dark Grey Moist (TILL)		6	SS	36		56							3 51 36 10			
							55										
			7	SS	90												
54.3																	
6.2	SHALE, slightly weathered to fresh, laminated, very fine, grey, very thin limestone interbeds through out		1	RUN			54						FI				
							53						>10	TCR=100% SCR=67% RQD=19% UCS=11MPa Average			
	Highly fractured with clay infilling		2	RUN									>10				
							52						4	TCR=100% SCR=93% RQD=50% UCS=16MPa Average			
			3	RUN									3				
													0				
51.0													2	TCR=100% SCR=100% RQD=100%			
9.5	END OF BOREHOLE AT 9.5m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe												0	UCS=15MPa Average			

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HD-09

2 OF 2

METRIC

W.P. 4091-07-00 LOCATION N 5 031 125.7 E 370 199.7 ORIGINATED BY LPG
HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring (CME 75) COMPILED BY AN
DATUM Geodetic DATE 2011.08.15 - 2011.08.15 CHECKED BY LRB

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa	WATER CONTENT (%)	W _p	W		
	Continued From Previous Page						20 40 60 80 100	20 40 60					
	with a 3.0m slotted screen.												
	WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Aug.18/11 5.8 54.8 Oct.12/11 5.0 55.6												

RECORD OF BOREHOLE No HD-10

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 133.9 E 370 237.4 ORIGINATED BY RK
 HWY 417 BOREHOLE TYPE Tripod with Hammer/Portable Hilti Drill COMPILED BY AN
 DATUM Geodetic DATE 2011.07.27 - 2011.07.27 CHECKED BY LRB

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						WATER CONTENT (%)				
57.5								20	40	60	80	100		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L		
0.0	SAND and GRAVEL Brown Damp (FILL)																	
56.9	CONCRETE: (150mm)																	
56.9																		
0.8	Silty SAND , some gravel, trace clay Compact Brownish Grey Wet (FILL)		1	SS	14										○			
			2	SS	11										○			
55.4																		
2.1	SAND and GRAVEL , trace silt, shale fragments Compact Brownish Grey Wet		3	SS	17										○			
54.8			1	RUN												○		50 42 8 (SI+CL)
2.7	SHALE , slightly weathered to fresh, thinly laminated, dark grey, occasional horizontal joints		2	RUN														TCR=50% SCR=0% RQD=0%
			3	RUN														TCR=77% SCR=44% RQD=12% UCS=29MPa Average
	Highly fractured from 4.0m to 4.6m		3	RUN														TCR=77% SCR=13% RQD=0% UCS=24MPa Average
			4	RUN														TCR=93% SCR=33% RQD=17% UCS=15MPa Average
			5	RUN														TCR=100% SCR=100% RQD=72% UCS=17MPa Average
50.8																		
6.7	END OF BOREHOLE AT 6.7m. Piezometer installation consists of 30mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen.																	
	WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Sep.02/11 2.5 55.0 Sep.20/11 2.2 55.3 Oct.12/11 2.3 55.2																	

+³. X³: Numbers refer to
Sensitivity

20
15 10 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HD-11

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 136.0 E 370 263.6 ORIGINATED BY RK
 HWY 417 BOREHOLE TYPE Portable Hilti Drill - Coring COMPILED BY AN
 DATUM Geodetic DATE 2011.07.26 - 2011.07.26 CHECKED BY LRB

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						WATER CONTENT (%) w _p w w _L					
55.3								20	40	60	80	100							
0.0	WATER																		
55.0	Scattered cobbles, with sand		1	RUN			55												
0.3	CONCRETE RUBBLE		2	RUN															
54.5																			
0.8	CONCRETE																		
54.1																			
1.2	GRAVEL, with rubble and shale fragments (FILL)		3	RUN			54												
52.7							53												
2.6	SHALE, fresh, thinly laminated, occasional horizontal and vertical joints, dark grey Highly fractured from 2.6m to 2.8m		4	RUN			52												
	Rubble zone (50mm) at 3.3m																		
			5	RUN			51												
	Rubble zone (125mm) at 4.3m																		
	Rubble zone (50mm) at 4.8m		6	RUN			50												
49.3																			
6.0	END OF BOREHOLE AT 6.0m. BOREHOLE BACKFILLED WITH BENTONITE PELLETS.																		

ONTMT4S 1201A.GPJ 11/22/11

RECORD OF BOREHOLE No HD-11B

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 144.0 E 370 262.9 ORIGINATED BY RK
 HWY 417 BOREHOLE TYPE Portable Hilti Drill - Coring COMPILED BY AN
 DATUM Geodetic DATE 2011.08.29 - 2011.08.29 CHECKED BY LRB

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				
55.1														
0.0	WATER													
0.2	SAND and GRAVEL, some cobbles													
54.7	SHALE, fresh, thinly laminated, occasional horizontal joints, dark grey, occasional clay infilling of joints		1	RUN										
0.4														
	Vertical joint (100mm) at 2.6m		3	RUN										
51.6			4	RUN										
3.5	END OF BOREHOLE AT 3.5m. BOREHOLE BACKFILLED WITH BENTONTIE CHIPS.													

+³ ×³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HD-12

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 149.0 E 370 297.6 ORIGINATED BY RK
 HWY 417 BOREHOLE TYPE Portable Hilti Drill - Coring COMPILED BY AN
 DATUM Geodetic DATE 2011.07.28 - 2011.07.28 CHECKED BY LRB











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 (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			WATER CONTENT (%)						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE									
55.0							20 40 60 80 100				20 40 60						
0.0	WATER																
0.2	SHALE, slightly weathered to fresh, thinly laminated, dark grey Highly fractured from 0.2m to 0.8m		1	RUN										FI	TCR=33% SCR=0% RQD=0%		
			2	RUN												>10	
			3	RUN												>10	TCR=92% SCR=63% RQD=27% UCS=21MPa Average
51.4	Rubble zone (50mm) at 3.5m		4	RUN										9	TCR=100% SCR=98% RQD=0% UCS=15MPa Average		
			4	RUN												5	TCR=96% SCR=92% RQD=43% UCS=13MPa Average
3.6	END OF BOREHOLE AT 3.6m. BOREHOLE BACKFILLED WITH BENTONITE PELLETS.																

RECORD OF BOREHOLE No HD-13

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 154.0 E 370 332.5 ORIGINATED BY RK
HWY 417 BOREHOLE TYPE Portable Hilti Drill - Coring COMPILED BY AN
DATUM Geodetic DATE 2011.08.29 - 2011.08.29 CHECKED BY LRB

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE				WATER CONTENT (%) w _p w w _L				
55.2							20	40	60	80	100					
0.0	WATER															
54.8																
0.4	SHALE, slightly weathered to fresh, thinly laminated, occasional horizontal joints, occasional clay infilling of joints, dark grey		1	RUN												
																
	Clay seam (10mm)		2	RUN												
																
	Sub-vertical joint (50mm) at 2.5m		3	RUN												
																
																
			4	RUN												
																
51.3																
3.9	END OF BOREHOLE AT 3.9m. BOREHOLE BACKFILLED WITH BENTONITE CHIPS.															

+³ . X³ : Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HD-14

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 159.0 E 370 366.2 ORIGINATED BY RK
 HWY 417 BOREHOLE TYPE Portable Hilti Drill - Coring COMPILED BY AN
 DATUM Geodetic DATE 2011.08.30 - 2011.08.30 CHECKED BY LRB

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						WATER CONTENT (%)		
								○ UNCONFINED		+ FIELD VANE				w p w w L		
55.1						20	40	60	80	100	20	40	60			
0.0	WATER															
54.6																
0.5	SHALE, slightly weathered to fresh, thinly laminated, occasional horizontal joints, dark grey Rubble zone (50mm) at 0.9m		1	RUN										FI		
														>15		
			2	RUN										5		
	Clay seam (5mm) at 1.9m													4		
														4		
			3	RUN										5		
														4		
														2		
														2		
	Clay seam (15mm) at 3.8m		4	RUN										5		
														5		
51.2														>10		
3.9	END OF BOREHOLE AT 3.9m. BOREHOLE BACKFILLED WITH BENTONITE CHIPS.													UCS=30MPa Average		

RECORD OF BOREHOLE No HD-15

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 156.0 E 370 394.7 ORIGINATED BY RK
HWY 417 BOREHOLE TYPE Tripod with Cathead/Portable Hilti Drill COMPILED BY AN
DATUM Geodetic DATE 2011.07.19 - 2011.07.19 CHECKED BY LRB

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								
57.4							20	40	60	80	100					GR SA SI CL
56.8	TOPSOIL: (25mm)		1	SS	19											
56.6	Gravelly SAND, some silt Compact Brown Dry (FILL)		2	SS	22											
56.4	Silty SAND, trace to some gravel, trace to some clay Compact to Loose Dark Brown Moist to Wet (TILL) Cobble (150mm)		3	SS	50/ 0.125											
56.2			1	RUN												8 64 24 4
56.0			4	SS	10											
55.8	Shale fragments		5	SS	9											
54.4			2	RUN												TCR=50% SCR=43% RQD=0%
54.2	SHALE, highly weathered to fresh, thinly laminated, occasional horizontal fractures, dark grey, some clay infilling in fractures		3	RUN												TCR=92% SCR=75% RQD=55% UCS=14MPa Average
54.0			4	RUN												TCR=96% SCR=79% RQD=53% UCS=16MPa Average
53.8			5	RUN												TCR=100% SCR=91% RQD=80% UCS=10MPa Average
51.3																
6.1	END OF BOREHOLE AT 6.1m. BOREHOLE BACKFILLED WITH BENTONITE PELLETS TO 0.1m, THEN GRASS AND ORGANICS TO SURFACE.															

+ 3, X 3: Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HD-15B

1 OF 1

METRIC

W.P. 4091-07-00 LOCATION N 5 031 160.9 E 370 393.2 ORIGINATED BY RK
HWY 417 BOREHOLE TYPE Tripod/Portable Hilti Drill COMPILED BY AN
DATUM Geodetic DATE 2011.09.01 - 2011.09.01 CHECKED BY LRB

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										
57.6								20	40	60	80	100						
56.4	TOPSOIL: (25mm) Gravelly SAND, some rootlets Very Dense to Dense Dark Brown Damp (FILL)		1	SS	75													
			2	SS	33													
54.9	Silty SAND, trace gravel, trace to some clay, some shale fragments Compact to Very Dense Dark Brown Damp (TILL)		3	SS	18													
			4	SS	53													
	Shale fragments		5	SS	106/													
51.5	SHALE, slightly weathered to fresh, thinly laminated, occasional clay seams, dark grey		1	RUN	0.250													
			2	RUN														
			3	RUN														
	Sub-vertical joint from 4.8m to 5.0m		4	RUN														
6.1	END OF BOREHOLE AT 6.1m. Piezometer installation consists of 40mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Sep.2/11 2.3 55.3 Sep.20/11 2.4 55.2 Oct.12/11 2.5 55.1																	

+ 3, X 3: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HD-16

1 OF 2

METRIC

W.P. 4091-07-00 LOCATION N 5 031 160.4 E 370 419.3 ORIGINATED BY RK
 HWY 417 BOREHOLE TYPE Hollow Stem Augers/NQ Coring - CME 45 COMPILED BY AN
 DATUM Geodetic DATE 2011.09.06 - 2011.09.06 CHECKED BY LRB

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						
60.5							20	40	60	80	100	20	40	60		
59.8	TOPSOIL: (25mm)		1	SS	17											
	SAND, some gravel, some silt Compact to Loose Brown Damp Moist (FILL)		2	SS	12											
			3	SS	8											
			4	SS	11											
57.1	Black staining, hydrocarbon odour		5	SS	18											18 67 15 (SI+CL)
56.4	Clayey SILT, some sand Greyish Brown															
54.1	Silty SAND, trace gravel, trace clay Very Dense Dark Brown Damp (TILL)		6	SS	77/ 0.280											9 54 28 9
	Difficult augering at 5.2m															
54.4																
6.1	SHALE, fresh, thinly laminated, occasional horizontal and sub-horizontal joints, dark grey		1	RUN												
	Rubble zone (100mm thick) at 6.1m															
			2	RUN												
51.4																
9.1	END OF BOREHOLE AT 9.1m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen.															

Continued Next Page

+ 3, × 3: Numbers refer to
Sensitivity

20
15 10 5
10 (%) STRAIN AT FAILURE

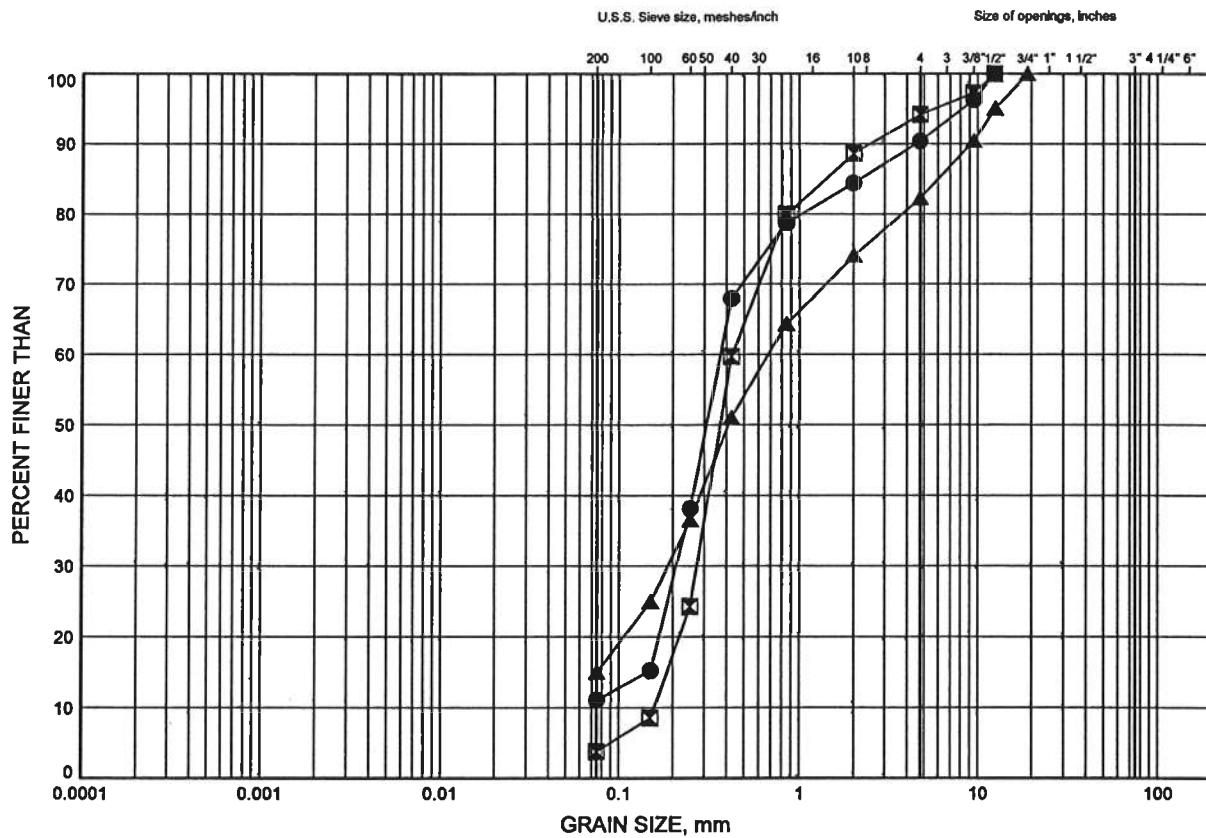
Appendix B

Laboratory Test Results

Highway 417 Ottawa: Nicholas to Vanier 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)
●	HD-01	1.07	60.40
⊠	HD-09	2.59	57.97
▲	HD-16	2.59	57.91



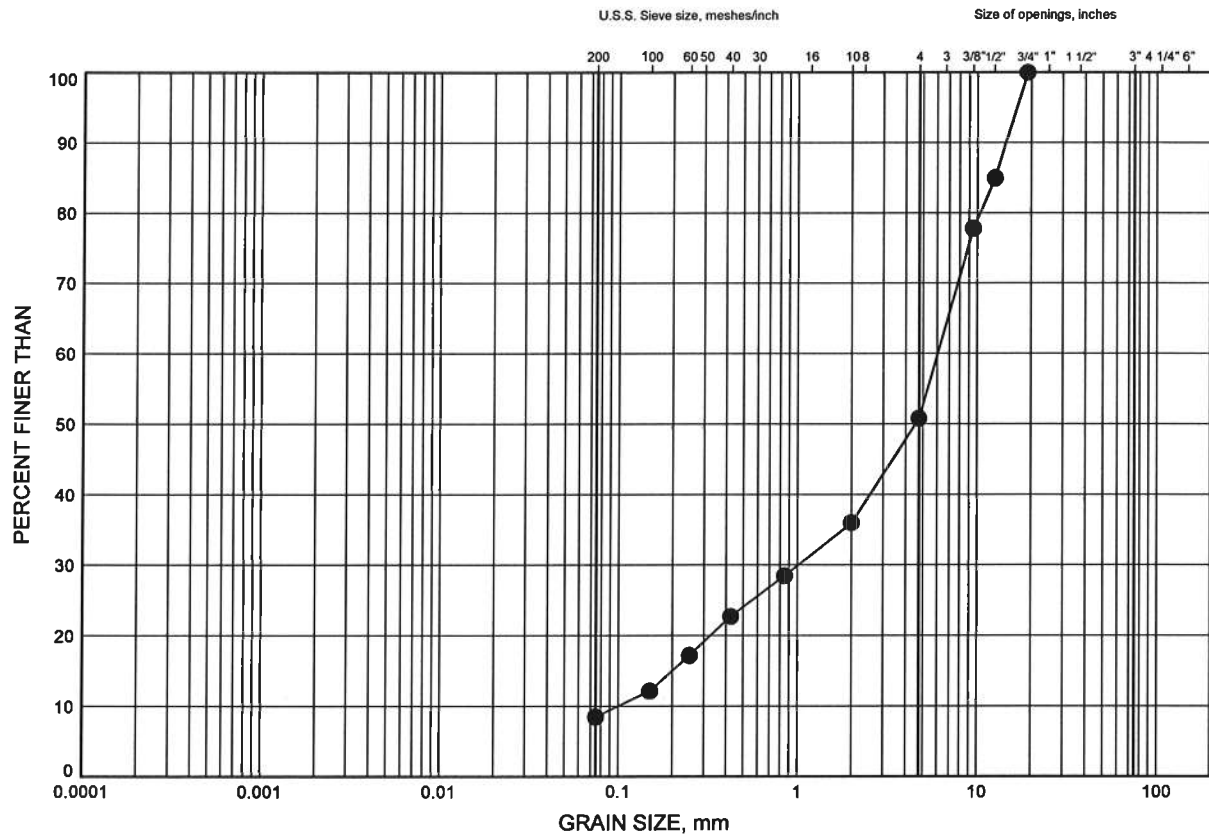
W.P.# 4091-07-00
Prepared By LRB
Checked By MC

Highway 417 Ottawa: Nicholas to Vanier

GRAIN SIZE DISTRIBUTION

FIGURE B2

SAND & GRAVEL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HD-10	2.44	55.04

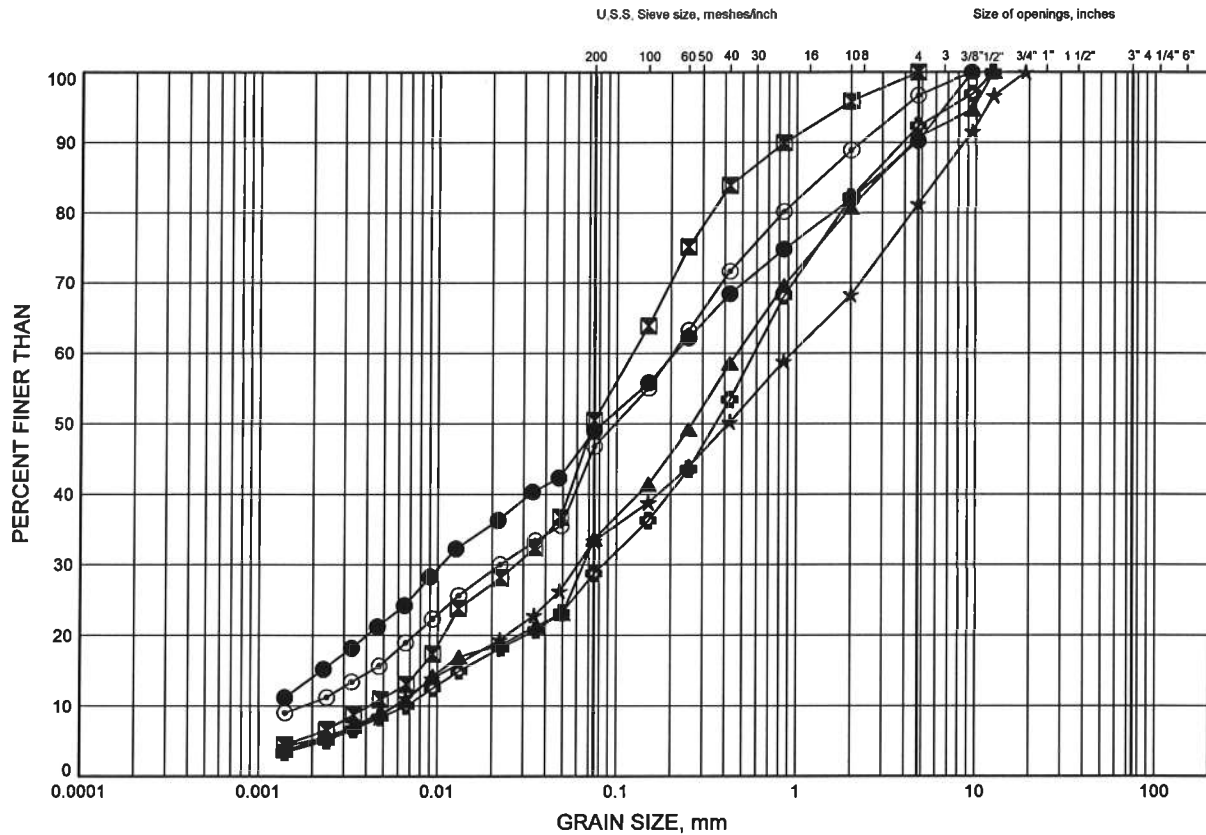


W.P.# 4091-07-00
 Prepared By AN
 Checked By LRB

Highway 417 Ottawa: Nicholas to Vanier GRAIN SIZE DISTRIBUTION

FIGURE B3

SILTY SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HD-01	6.29	55.18
⊠	HD-02	1.60	55.32
▲	HD-07	2.74	54.52
★	HD-08	3.35	57.42
⊙	HD-09	4.57	55.99
⊕	HD-15	2.27	55.13

GRAIN SIZE DISTRIBUTION - THURBER 1201A GPJ 11/21/11

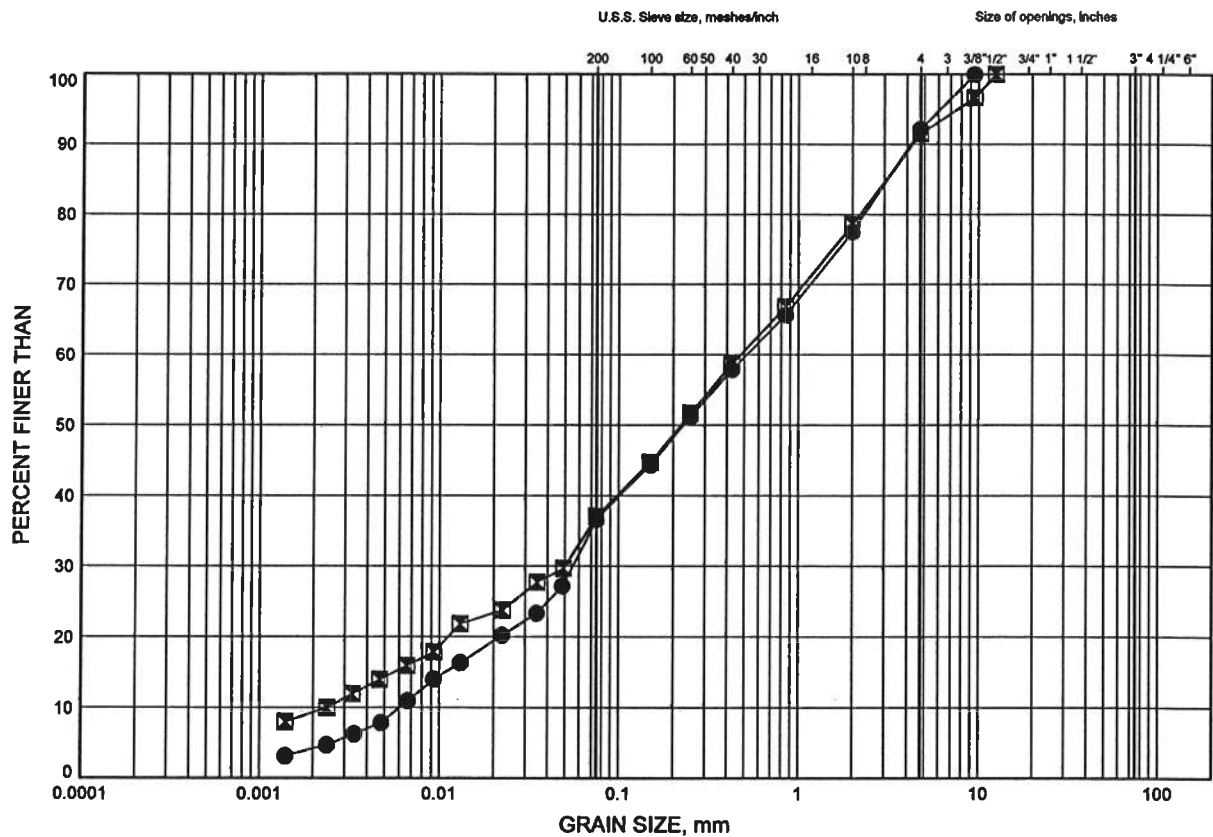
W.P.# .4091-07-00.....
Prepared By .AN.....
Checked By .LRB.....



Highway 417 Ottawa: Nicholas to Vanier GRAIN SIZE DISTRIBUTION

FIGURE B4

SILTY SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HD-15B	2.13	55.49
■	HD-16	4.88	55.62

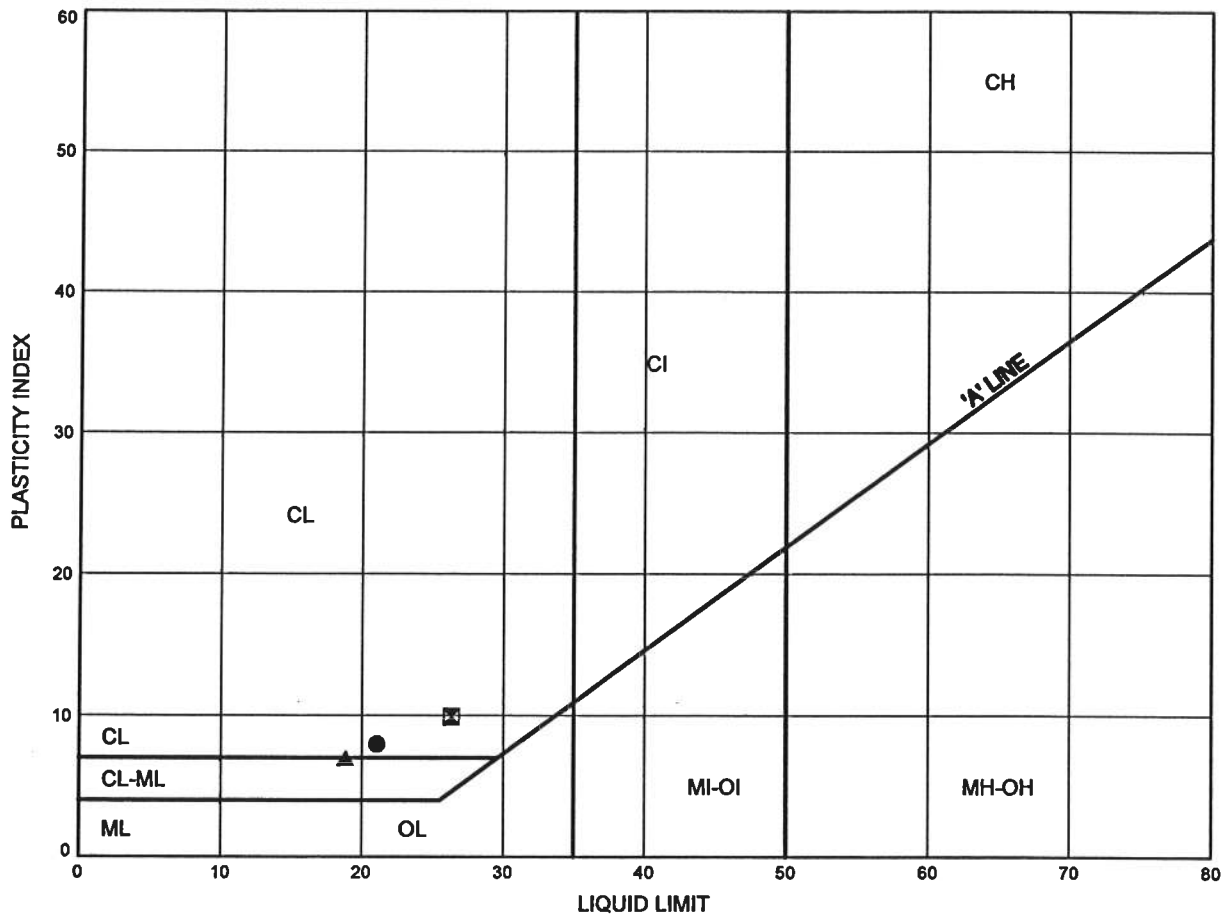


W.P.# 4091-07-00
Prepared By AN
Checked By LRB

Highway 417 Ottawa: Nicholas to Vanier
ATTERBERG LIMITS TEST RESULTS

FIGURE B5

SILTY SAND TILL - Trace to Some Clay



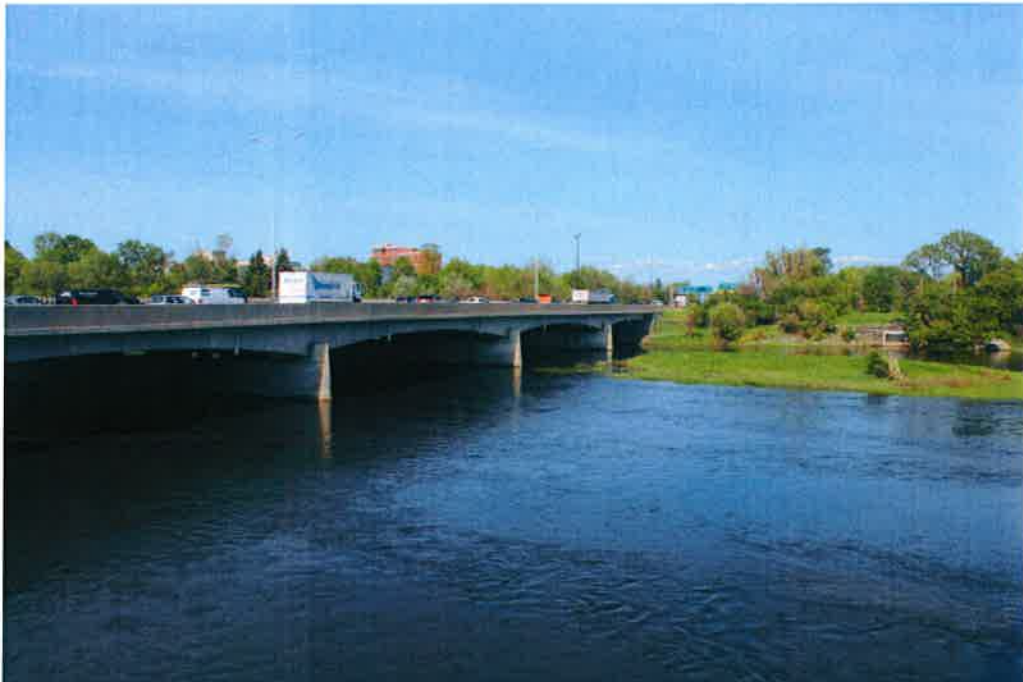
SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	HD-01	6.29	55.18
■	HD-07	2.74	54.52
▲	HD-09	4.57	55.99

Appendix C

Site Photographs



Photograph 1: North side of Hurdman Bridge, looking east



Photograph 2: South side of Hurdman Bridge, looking east

Appendix D

Drawing

Borehole Locations and Soil Strata

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

CONT No
WP No 4157-11-01

HIGHWAY 417 EXPANSION
NICHOLAS STREET TO OR 174
RIDEAU RIVER (HURDMAN) BRIDGE
BOREHOLE LOCATIONS AND SOIL STRATA I

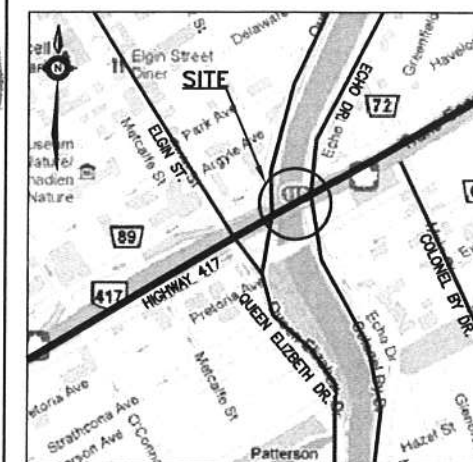


SHEET
41

MRC MCCORMICK RANKIN
A member of MCM GROUP



THURBER ENGINEERING LTD.



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
- HA Head Artesian Water
- P Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

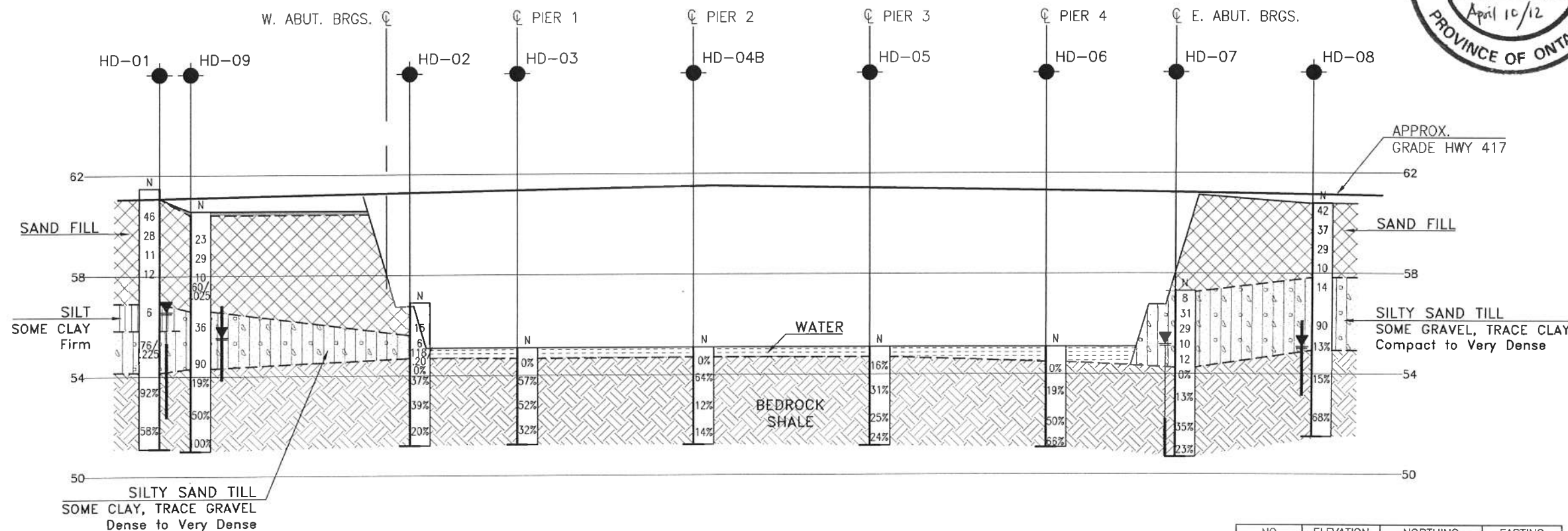
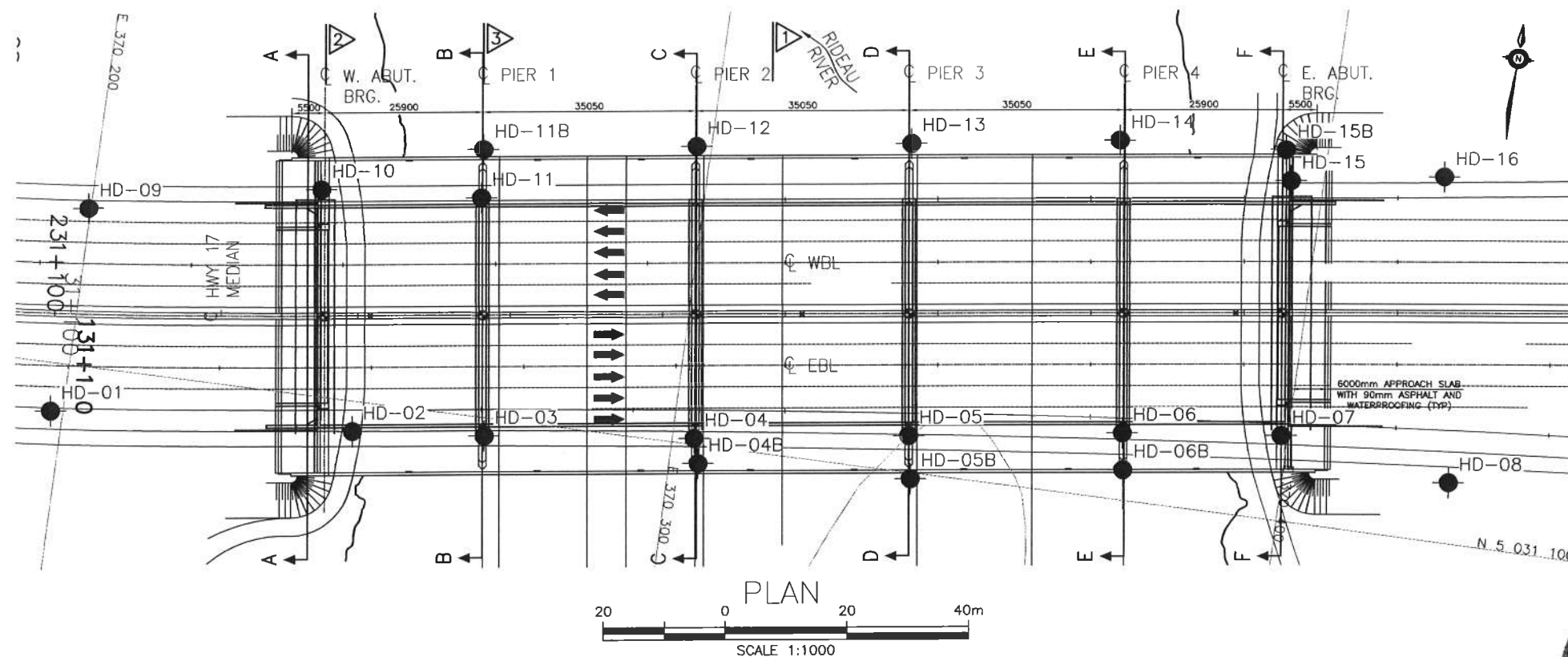
NO	ELEVATION	NORTHING	EASTING
HD-01	61.5	5 031 092.3	370 198.0
HD-02	56.9	5 031 095.1	370 247.8
HD-03	54.7	5 031 097.0	370 269.3
HD-04	54.7	5 031 101.0	370 303.6
HD-04B	55.1	5 031 097.0	370 304.8
HD-05	55.1	5 031 106.0	370 338.5
HD-05B	55.1	5 031 099.0	370 339.7
HD-06	55.2	5 031 111.0	370 373.1
HD-06B	55.1	5 031 105.0	370 374.0
HD-07	57.3	5 031 113.6	370 398.9
HD-08	60.8	5 031 110.4	370 427.0
HD-09	60.6	5 031 125.7	370 199.7
HD-10	57.5	5 031 133.9	370 237.4

-NOTES-

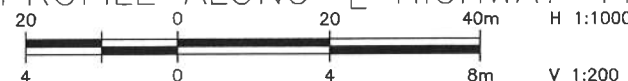
- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 31G5-245

DATE	BY	DESCRIPTION
DESIGN	LRB	CHK LRB
DRAWN	AN	CHK
		SITE
		STRUCT
		LDWG 2
		DATE APR. 2012



PROFILE ALONG CL HIGHWAY 417



NO	ELEVATION	NORTHING	EASTING
HD-11	55.3	5 031 136.0	370 263.6
HD-11B	55.1	5 031 144.0	370 262.9
HD-12	55.0	5 031 149.0	370 297.6
HD-13	55.2	5 031 154.0	370 332.5
HD-14	55.1	5 031 159.0	370 366.2
HD-15	57.4	5 031 156.0	370 394.7
HD-15B	57.6	5 031 160.9	370 393.2
HD-16	60.5	5 031 160.4	370 419.3

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

CONT No
WP No 4157-11-01

HIGHWAY 417 EXPANSION
NICHOLAS STREET TO OR 174
RIDEAU RIVER (HURDMAN) BRIDGE
BOREHOLE LOCATIONS AND SOIL STRATA II



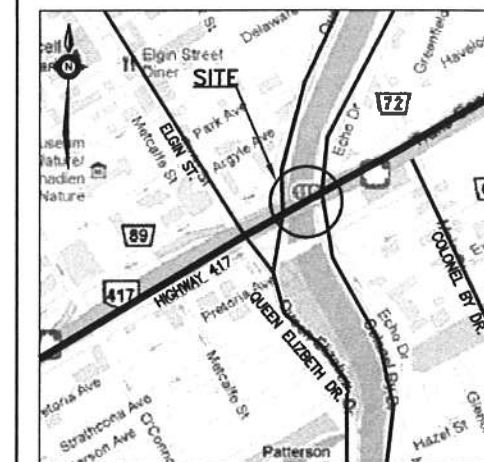
SHEET
42



McCORMICK RANKIN
A member of MRM GROUP



THURBER ENGINEERING LTD.



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
HA	Head Artesian Water
P	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

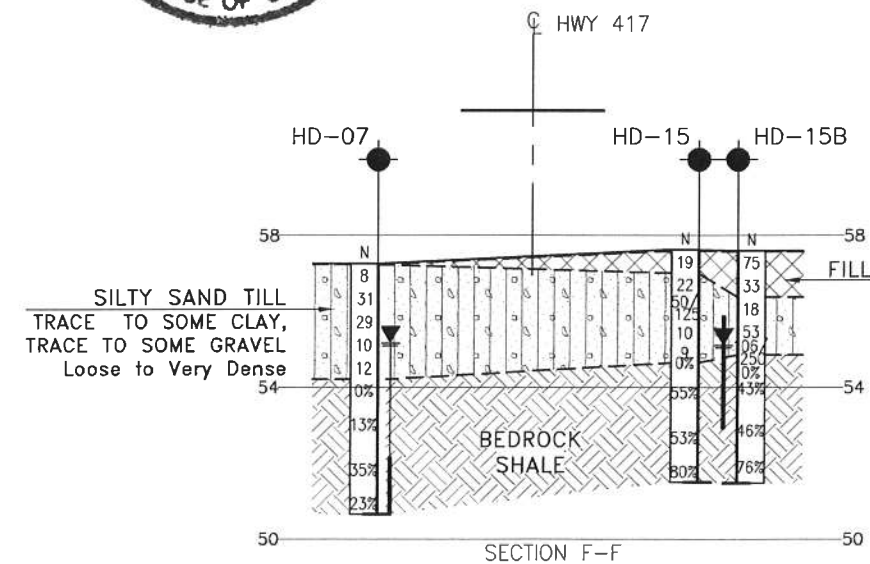
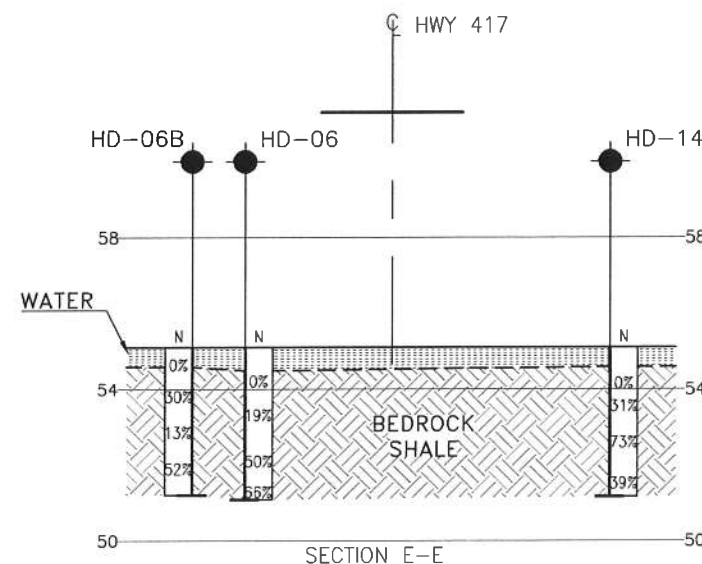
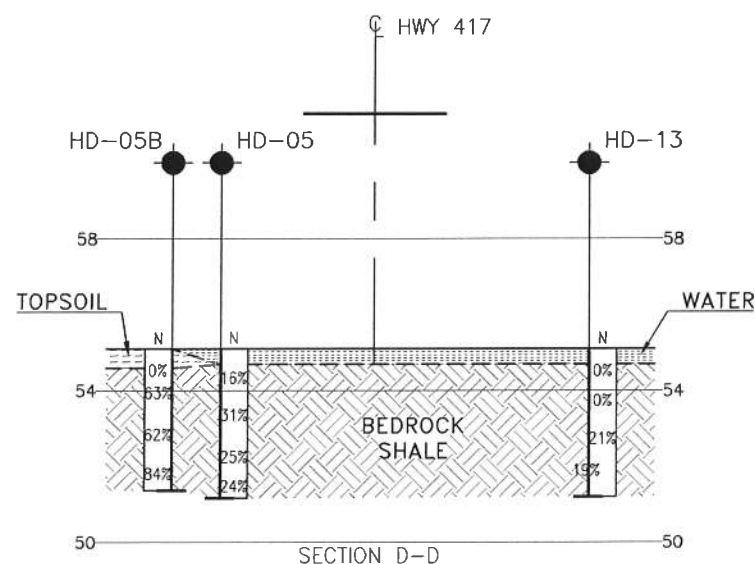
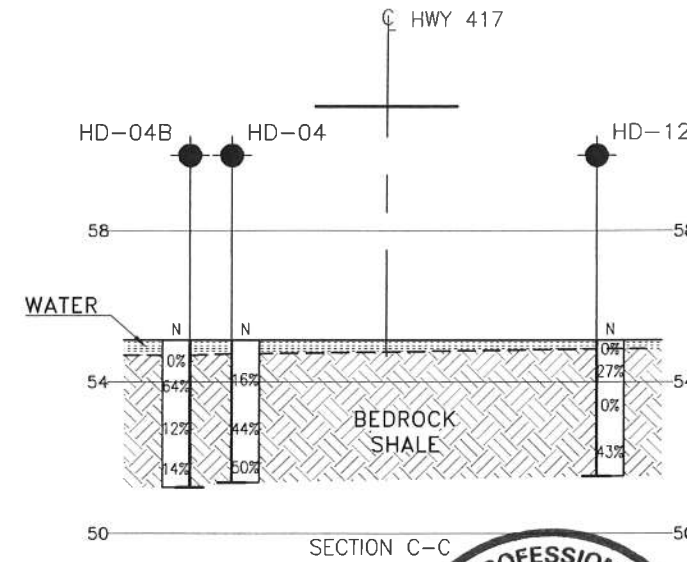
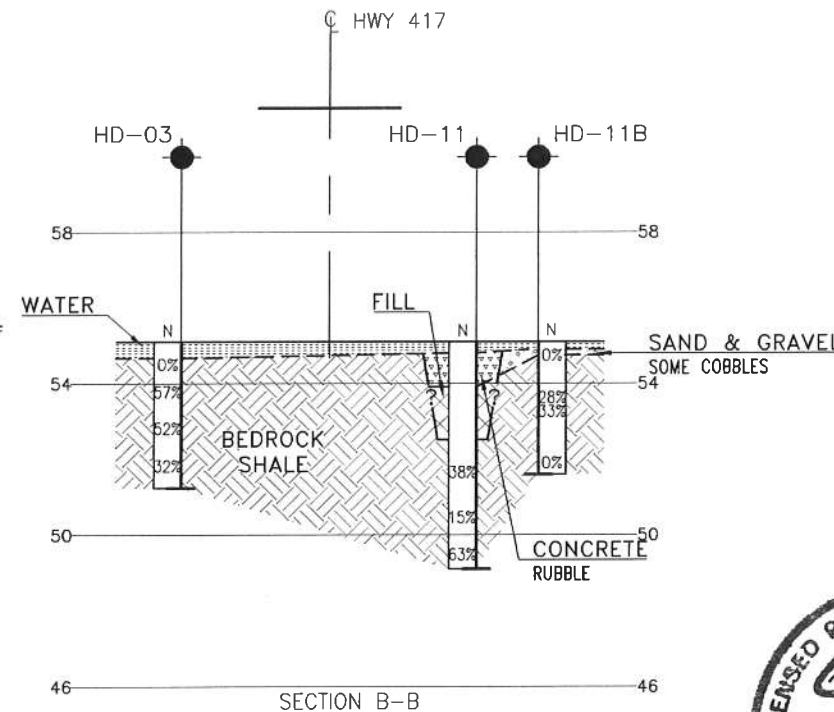
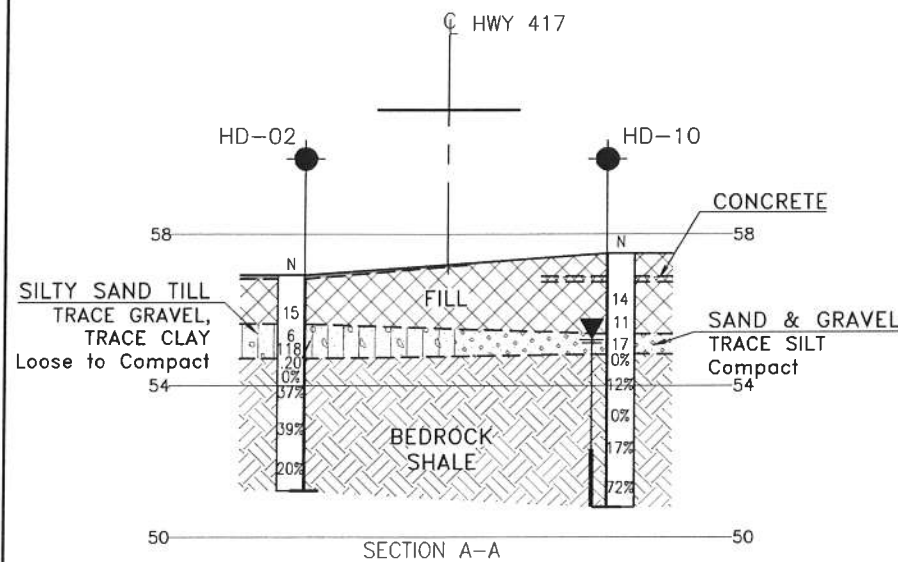
NO	ELEVATION	NORTHING	EASTING
HD-01	61.5	5 031 092.3	370 198.0
HD-02	56.9	5 031 095.1	370 247.8
HD-03	54.7	5 031 097.0	370 269.3
HD-04	54.7	5 031 101.0	370 303.6
HD-04B	55.1	5 031 097.0	370 304.8
HD-05	55.1	5 031 106.0	370 338.5
HD-05B	55.1	5 031 099.0	370 339.7
HD-06	55.2	5 031 111.0	370 373.1
HD-06B	55.1	5 031 105.0	370 374.0
HD-07	57.3	5 031 113.6	370 398.9
HD-08	60.8	5 031 110.4	370 427.0
HD-09	60.6	5 031 125.7	370 199.7
HD-10	57.5	5 031 133.9	370 237.4

-NOTES-

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

GEOCRES No. 31G5-245

DATE	BY	DESCRIPTION
DESIGN	LRB	CHK LRB
DRAWN	AN	CHK
LOAD		
SITE		
STRUCT		
DWG	3	



H 1:1000

V 1:200

NO	ELEVATION	NORTHING	EASTING
HD-11	55.3	5 031 136.0	370 263.6
HD-11B	55.1	5 031 144.0	370 262.9
HD-12	55.0	5 031 149.0	370 297.6
HD-13	55.2	5 031 154.0	370 332.5
HD-14	55.1	5 031 159.0	370 366.2
HD-15	57.4	5 031 156.0	370 394.7
HD-15B	57.6	5 031 160.9	370 393.2
HD-16	60.5	5 031 160.4	370 419.3