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REPORT ON

Geotechnical Investigation Des Allumettes Bridge Replacement Ottawa River Ontario-Québec

Submitted to:
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REPORT



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1.0 INTRODUCTION

This report presents the results of a geotechnical investigation carried out for the proposed replacement of the Des Allumettes Bridge, which crosses the Ottawa River connecting Ontario and Québec.

The purpose of this geotechnical investigation was to assess the general soil, bedrock, and groundwater conditions at the bridge location. Based on an interpretation of the factual information obtained, along with the existing subsurface information available for the site, a general description of the subsurface conditions in the area of the proposed structure is presented. These interpreted subsurface conditions and available project details were used to prepare engineering guidelines on the geotechnical design aspects of the project.

The reader is referred to the “Important Information and Limitations of This Report” which follows the text of the report but forms an integral part of this document.



2.0 DESCRIPTION OF PROJECT AND SITE

Plans are being prepared for the replacement of the Des Allumettes Bridge, which connects Ontario and Québec (see Key Plan, Figure 1).

The existing Des Allumettes Bridge crosses the main channel of the Ottawa River from just southeast of Pembroke, Ontario to the Allumettes Island in Québec. The bridge is an important interprovincial transportation link between Highway 17 in Ontario and Highway 148 in Québec. It carries about 7,000 vehicles per day with a commercial vehicle component of about 10 percent.

The existing Des Allumettes Bridge was designed in 1955 by the Department of Public Works of Canada and constructed between 1955 and 1957. The existing bridge is a seven-span modified Warren deck truss structure, with a total length of 308 metres and has spans ranging from 29.3 metres to 51.2 metres in length. All of the piers and abutments are understood to be supported on large spread footings which are founded on bedrock. Other information with regards to the existing bridge foundations, such as founding elevations, footing sizes, or design loading was not available.

Since its construction, the bridge has undergone numerous repairs and rehabilitation works. It is understood that, in light of the various major component deficiencies in the existing bridge, that the bridge is to be replaced. It is understood from Delcan that there have been no observed or reported substructure deficiencies with the existing bridge or its approaches attributable to foundation conditions.

Based on the drawings provided by Delcan Corporation (Delcan), the following is known about the proposed new bridge:

- The new bridge will be constructed immediately downstream (east) of the existing structure.
- The new bridge will be a three-span steel box girder structure, which will be supported on concrete piers and abutments. The proposed lengths of the spans are 85, 110, and 85 metres, respectively.
- The new piers will be located in close proximity to two of the existing pier locations (existing Piers 2 and 4).
- The new approach embankments will be widened towards the east to accommodate the realignment of the new bridge.
- The south (Ontario) approach embankment will extend up to a maximum elevation of about 122 metres at about Station 10+490 (i.e., a maximum height of about 10 metres above the existing ground surface from the base of the existing embankment).
- The north (Québec) approach embankment will extend up to a maximum elevation of about 125.5 metres at about Station 10+770 (i.e., a maximum height of about 14 metres above the existing ground surface from the base of the existing embankment).
- The embankment side slopes will be inclined at a minimum of 2 horizontal to 1 vertical (2H:1V) on both the Ontario and Québec approaches, with the exception of a section of the Ontario embankment along Beckett View Drive (between Stations 50+060 and 50+112) where the slope will be inclined as steep as 1.3H :1V.
- New approach roadways, approximately 470 metres in length, will be constructed on both sides of the bridge to connect the existing Regional Road/Route 148 to the new bridge.



The geotechnical investigation for the existing bridge was undertaken in 1953, and consisted of 14 boreholes advanced along the existing bridge alignment. All of the boreholes were extended to depths varying from about 5 to 11 metres below the original ground surface or river floor. Information on that investigation is summarized in the following drawing, which is provided in Appendix B.

- Drawing by Department of Public Works Canada, titled “Sheet 17, Steel Reinforcement Schedule and Boring Data” revised November 16, 1955 (Project No. SD 6 – 2C).

Based on a review of that previous geotechnical investigation and published geological mapping, the subsurface conditions in the area of the bridge are indicated to consist of very limited thicknesses of sand and gravel overburden, underlain by limestone, sandstone, and granite bedrock. In some locations, the bedrock was indicated to contain clay seams and weathered in the upper 2 to 3 metres. However, the available data only consists of basic bedrock types with little information on the characterization of the bedrock structure and rock quality.

Published bedrock geology mapping indicates that several formations of bedrock exist at the site, namely: Precambrian, Rockcliff, Gull River, and Oxford. Published mapping also indicates that two fault lines run transverse (perpendicular) to the existing bridge alignment. Information on the fault locations was obtained from “Paleozoic Geology of Southern Ontario, Ontario Geology Survey, Miscellaneous Release, Data 219”. The approximate locations of the fault lines based on the mapping are shown on Figure 1. No other information was available with regards to the faults.



3.0 INVESTIGATION PROCEDURES

The field work for this investigation was carried out from November 1 through 29, 2012. During that time, the following testholes were put down at the approximate locations shown on the Site Plans, Figures 2A and 2B:

- Four boreholes (numbered 12-101, 12-102, 12-107, and 12-108) were advanced near the proposed abutment locations, two near the proposed Québec abutment and two near the proposed Ontario abutment.
- Four boreholes (numbered 12-103 to 12-106, inclusive) were advanced near the proposed in-water piers, two at each pier location. Multiple attempts were required to advance boreholes 12-105 and 12-106.
- Thirty-five augerholes/boreholes (numbered 12-01 to 12-35, inclusive) were advanced along the proposed approach roadways, at about 25 metre spacing, on both the Québec and Ontario sides of the bridge.

The boreholes at the proposed abutments (numbered 12-101, 12-102, 12-107, and 12-108) were advanced using either an LC-60 tracked-mounted or a CME-55 truck-mounted hollow-stem auger drill rig. The augers on the drill rigs had an outside diameter of 200 millimetres and the augers were equipped with carbide teeth. The boreholes were advanced to the bedrock surface which was encountered within about 1 metre of the existing ground surface. Upon encountering the bedrock surface, these boreholes were further advanced about 15 metres into the bedrock using rotary diamond drilling techniques while retrieving NQ and NQ3 sized bedrock core.

The boreholes at the proposed in-water piers (numbered 12-103 to 12-106, inclusive) were advanced using a CME-55 hollow-stem auger drill rig, which was mounted onto a barge. The augers on the drill rigs had an outside diameter of 200 millimetres and the augers were equipped with carbide teeth. A crane was used for loading/unloading the drill rig onto and off of the barge. The boreholes were advanced to the bedrock surface which was encountered within about 1 metre of the river floor. Upon encountering the bedrock surface, the boreholes were further advanced about 9 to 15 metres into the bedrock using rotary diamond drilling techniques while retrieving NQ and NQ3 sized bedrock core.

The testholes for the proposed approach embankment roadway (numbered 12-01 to 12-35, inclusive) were advanced using an LC-60 tracked-mounted hollow-stem auger drill rig. The augers on the drill rigs had an outside diameter of 200 millimetres and the augers were equipped with carbide teeth. Four of the testholes (numbered 12-20, 12-22, 12-24, and 12-26), which were advanced deeper for the design of the proposed retaining wall (which is no longer being considered), were advanced to about 2.5 to 8.5 metres (practical refusal to augering) below the existing ground surface. The remaining testholes were advanced to about 1.5 metres below the existing ground surface or practical refusal on augering, whichever was encountered first. "End of Augerhole" is indicated on the records of augerholes at the termination depth. This termination indicates that the planned depth had been achieved. Where auger refusal was encountered at a depth shallower than the intended termination depth, the records of augerholes show "auger refusal" as the termination description.

The drill rigs, barge, and other drilling supply equipment were supplied and operated by Marathon Drilling Company of Ottawa, Ontario.

Standard Penetration Tests (SPTs) were carried out at regular intervals of depth within the boreholes and samples of the soils encountered were recovered using drive open sampling equipment.



GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT

A monitoring well was sealed into the bedrock in borehole 12-101 to allow for subsequent groundwater measurement and environmental sampling, which was required for the Phase II Environmental Site Assessment (ESA). The groundwater level in this borehole was measured on November 28, 2012.

The field work was supervised by a member of our technical staff who located the testholes, supervised the drilling and in situ testing operations, logged the testholes and samples, and took custody of the soil samples and bedrock core. The soil and bedrock samples were identified in the field, placed in appropriate containers, labelled, and transported to our Ottawa geotechnical laboratory where the samples underwent further detailed visual examination by the project engineer and laboratory testing. The laboratory testing included grain size distribution and unconfined compressive strength determinations.

One sample of groundwater obtained from the Ottawa River at the site was submitted to EXOVA laboratories for basic chemical analysis related to potential sulphate attack on buried concrete elements and corrosion of buried steel elements.

The testhole locations were selected by Golder Associates in consultation with Delcan. The testholes were subsequently located in the field by Golder Associates personnel. The testhole locations and ground surface elevations were surveyed by Golder Associates personnel using a Trimble R8 GPS survey unit. The elevations are referenced to Geodetic datum (MTM, NAD 83, coordinate system).



4.0 SUBSURFACE CONDITIONS

4.1 General

Information on the subsurface conditions is provided as follows:

- Stratigraphic profile, provided on Figure 2C.
- Typical cross-sections, provided on Figures 2D and 2E.
- Grain size distribution testing results, provided on Figures 3 to 5.
- Record of Augerhole, Borehole, and Drillhole Sheets for the current investigation, provided in Appendix A.
- Borehole data from the previous investigation, provided in Appendix B.
- Photographs of the bedrock core for the current investigation, provided in Appendix C.
- Unconfined compressive strength testing results for the current investigation, provided in Appendix D.

In general, the subsurface conditions across the site can be summarised as follows:

- North Abutment and North Pier – Limited thickness of fill or native overburden, with the bedrock surface within about 1 metre of the existing ground surface or river floor. The bedrock predominately consists of interbedded shale and sandstone at the proposed abutment location, and interbedded sandstone, siltstone, and dolostone at the proposed pier location.
- South Abutment and South Pier – Limited thickness of fill or native overburden, with the bedrock surface within about 1 metre of the existing ground surface or river floor. The bedrock predominately consists of an upper zone of dolostone, underlain by a thin layer of arkose, followed by gneiss/granite. At the south pier, an approximately 0.2 metre thick sand seam exists between the dolostone and arkose bedrock. A highly fractured zone (possible fault) was also encountered at the proposed south pier location. This fractured zone is about 9 metres depth below the river floor (i.e., at about elevation 101 metres) and extends to at least 13 metres depth below the river floor (i.e., to about elevation 94 metres).
- North Approach Embankment – Limited thickness of fill or native overburden. Practical refusal to augering or shallow bedrock was generally encountered within about 1.5 metres below the existing ground surface. Bedrock outcropping is visible along some sections of the approach.
- South Approach Embankment – Up to about 8 metres of sandy fill (existing approach embankment), generally thickening towards the south abutment. Practical refusal to augering was encountered at depths varying from about 1.3 to 8.5 metres below the existing ground surface.

The following sections present a more detailed overview of the subsurface conditions encountered in the boreholes put down for the current investigation.

4.2 Pavement Structure, Fill, and Topsoil

Fill exists at both abutments and along both approach embankments.



At the north and south abutments (boreholes 12-101, 12-102, 12-107 and 12-108), the fill thickness varies from about 0.5 to 1.2 metres. The fill at these locations generally consists of topsoil, underlain by silty sand, with variable amounts of gravel, cobbles, and organic matter. The topsoil fill is up to about 150 millimetres thick.

At the north approach embankment (boreholes 12-01 to 12-19, inclusive), the fill thickness is limited, ranging from nil to about 1.0 metres. At the south approach embankment (testholes 12-20 to 12-35, inclusive), the fill ranges from about 1.3 to 7.9 metres, generally thickening towards the existing bridge abutment. Within the area of the north approach embankment, the fill generally consists of sand, gravel, silt, cobbles, boulders, and organic matter.

Testholes 12-20, 12-28, and 12-29 were advanced through the existing pavement structure of Highway 148. The pavement structure at these locations consists of about 140 to 210 millimetres of asphaltic concrete overlying sandy and gravelly fill (base/subbase material).

SPTs carried out within the fill gave “N” values ranging widely from 4 to 74 blows per 0.3 metres of penetration, indicating a loose to very dense state of packing; however, the fill encountered within the approach embankments is generally in a dense to very dense state of packing.

The results of grain size distribution testing carried out on samples from the fill are provided on Figures 3 and 4. The results of that testing indicate that the fill in the Québec approach embankment generally meets the grading specifications for MG 112 per Bureau de Normalisation du Québec Norme (NQ) 2560-114 Part II Table 1 (see Figure 3). The fill in the Ontario approach embankment generally meets the grading specifications for Granular ‘B’ Type I, per Ontario Provincial Standard Specifications (OPSS) 1010, with the exception of the sample from augerhole 12-25 which is finer than the allowed specifications (see Figure 4).

Topsoil exists at the ground surface or beneath the fill at various locations along the north approach embankment. Where encountered, the topsoil varies from about 50 to 340 millimetres in thickness. No topsoil exists at the testhole locations along the south approach embankment.

4.3 Sand, Silty Sand, and Gravelly Sand

The fill and topsoil are generally underlain by variable deposits of sand. These deposits vary from sand, silty sand to gravelly sand. In the majority of the testholes, this layer was fully penetrated and varies from about 0.1 to 1.0 metres in thickness. Where not fully penetrated, the deposits were proven to be at least 0.8 to 1.3 metres thick.

SPTs carried out within the sandy deposits gave SPT “N” values of 3 to greater than 50 blows per 0.3 metres of penetration, indicating a very loose to very dense state of packing.

The results of grain size distribution testing carried out on two samples from the sandy deposits are provided on Figure 5.

4.4 Silty Clay to Clayey Silt

A discontinuous layer of silty clay to clayey silt exists at the surface of the river floor and beneath portions of the approach embankment fill. The clayey and silty soils generally contain some sand and a trace of gravel. Where encountered, these soils vary from about 0.1 to 1.0 metres in thickness.



4.5 Refusal and Bedrock

Practical refusal to augering was encountered at various locations along both of the approach embankments, varying from about nil (i.e., outcropping) to 1.4 metres below the existing ground surface at the north approach, and from about 1.3 (likely obstructions within the fill) to 8.5 metres (generally deepening towards the south abutment) below the existing ground surface at the south approach.

Auger refusal may indicate the bedrock surface; however, it could also represent cobbles or boulders within the overburden.

Bedrock was encountered at the existing ground surface/river floor or below the overburden materials in all of the boreholes advanced for the bridge and several of the augerholes advanced for the north approach embankment. Bedrock outcropping is also visible along some sections of the north approach.

Boreholes 12-101 to 12-108 were extended into the bedrock for depths ranging from about 9 to 15 metres, using rotary diamond drilling techniques while retrieving NQ and NQ3 sized core. The following table summarizes the ground surface/river floor, bedrock elevations, and depth to bedrock as encountered at the boreholes advanced at the proposed bridge foundations.

| Borehole Number | Location | Ground Surface/ River Floor Elevation (m) | Bedrock Surface Elevation (m) | Depth to Bedrock (m) |
|---------------------|-------------------|--|--|----------------------------|
| 12-101 | North Abutment | 114.7 | 114.2 | 0.5 |
| 12-102 | | 115.1 | 114.3 | 0.8 |
| 12-103 | North Pier | 109.0 | 108.3 | 0.7 |
| 12-104 | | 109.6 | 108.6 | 1.0 |
| 12-105 ¹ | South Pier | 107.4 | 106.5 | 0.9 |
| 12-106 ¹ | | 107.1 | 106.4 | 0.7 |
| 12-107 | South Abutment | 113.0 | 111.8 | 1.2 |
| 12-108 | | 112.8 | 111.8 | 1.0 |

Note: ¹ Multiple attempts were made to advance the borehole. Bedrock information shown above is based on selected boreholes.

At the north abutment and pier (boreholes 12-101 to 12-104), the bedrock predominately consists of interbedded shale and sandstone at the proposed abutment location, and interbedded sandstone, siltstone and dolostone at the proposed pier location. The Rock Quality Designation (RQD) values measured on the recovered bedrock core samples typically ranged between 50 and 100 percent, indicating a fair to excellent rock quality.

At the south abutment and pier (boreholes 12-105 to 12-108), the bedrock predominately consists of an upper zone (about 2.6 to 5.0 metres) of dolostone, generally thickening to the north, underlain by a thin layer of arkose (about 0.2 to 0.4 metres), followed by gneiss/granite.



At the south abutment, the RQD values measured on the recovered bedrock core samples typically ranged between 60 and 100 percent, generally increasing with depth, indicating a fair to excellent rock quality.

At the south pier, one of the boreholes (12-106) encountered an approximately 0.2 metre thick sand seam between the dolostone and arkose bedrock. A highly fractured zone (a possible fault) was also encountered at this pier location at about 9 metres depth below the river floor (i.e., at about elevation 101 metres), where the measured RQD values are generally nil. This fractured zone extends to at least 13 metres depth below the river floor (i.e., at least elevation 94 metres).

Photographs of the bedrock core retrieved for the current investigation are provided in Appendix C.

The results of laboratory testing carried out on specimens of the bedrock core are summarized in the table below and are provided in Appendix D. The testing was carried out in accordance to ASTM D 3148-72. The measured unconfined compressive strengths (UCS) ranged from about 13 to 67 megapascals, indicating a weak to strong bedrock.

| Borehole Number | Sample Depth (m) | Location | Bulk Density (g/cm ³) | Young's Modulus (GPa) | Poisson's Ratio | UCS (MPa) | Lithology |
|-----------------|------------------|----------------|-----------------------------------|-----------------------|-----------------|-----------|-----------|
| 12-101 | 2.7 – 3.0 | North Abutment | 2.52 | 16.5 | 0.10 | 51 | Sandstone |
| 12-101 | 8.4 – 8.6 | | 2.50 | 3.0 | 0.17 | 16 | Sandstone |
| 12-103 | 4.2 – 4.3 | North Pier | 2.50 | 3.9 | 0.11 | 26 | Dolostone |
| 12-103 | 12.1 – 12.2 | | 2.36 | 2.3 | - | 13 | Sandstone |
| 12-105C | 7.3 – 7.5 | South Pier | 2.50 | 14.4 | 0.10 | 67 | Dolostone |
| 12-105C | 12.9 – 13.0 | | 2.62 | 6.9 | 0.15 | 32 | Gneiss |
| 12-106B | 11.0 – 11.2 | | 2.64 | 8.6 | 0.13 | 35 | Arkose |
| 12-107 | 1.4 – 1.6 | South Abutment | 2.50 | 12.4 | 0.22 | 36 | Dolostone |
| 12-107 | 9.0 – 9.2 | | 2.85 | 7.5 | 0.10 | 29 | Gneiss |
| 12-108 | 1.7 – 1.9 | | 2.59 | 7.0 | 0.40 | 28 | Dolomite |
| 12-108 | 4.1 – 4.3 | | 2.63 | 3.3 | 0.12 | 24 | Gneiss |

4.6 Groundwater Conditions

A monitoring well was sealed into the bedrock in borehole 12-101. The monitoring well was installed as part of the Phase II ESA program. The groundwater level in this borehole was measured at about elevation 112.4 metres on November 28, 2012.

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



5.0 ENGINEERING RECOMMENDATIONS

5.1 General

This section of the report provides foundation engineering guidelines and recommendations pertaining to the proposed replacement of the Des Allumettes Bridge, which crosses the Ottawa River connecting Ontario and Québec. The guidelines presented in this section have been developed in a manner consistent with the procedures outlined in the following publications:

- Canadian Highway Bridge Design Code CAN/CSA-S6-06 (CHBDC);
- Canadian Foundation Engineering Manual (CFEM);
- American Association of State Highway and Transportation Officials (ASHTO);
- Ontario Provincial Standard Specifications (OPSS);
- Cahier des Charges et Devis Généraux, Construction et Réparation, 2013;
- Normes Ouvrages Routiers, Tome II, Construction Routière; and,
- Normes Ouvrages Routiers, Tome VII, Matériaux.

The recommendations provided in this report are based on an interpretation of the factual data obtained from the testholes. The interpretation and recommendations provided in this report are intended to provide the designers with sufficient information to assess the feasible foundation alternatives and to design the proposed structure foundations. Where comments are made on construction, they are provided only in order to highlight those aspects which could affect the design of the project, and for which special provisions or operational constraints may be required. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods, and scheduling.

The reader is referred to the “Important Information and Limitations of This Report” which follows the text but forms an integral part of this document.

Based on the drawings provided by Delcan, the following is known about the project:

- The new bridge will be constructed immediately downstream (east) of the existing structure.
- The new bridge will be a three-span steel box girder structure which will be supported on concrete piers and abutments. The proposed lengths of the spans are 85, 110, and 85 metres, respectively.
- The new piers will be located in close proximity to two of the existing pier locations (existing Piers 2 and 4).
- The new approach embankments will be widened towards the east to accommodate the realignment of the new bridge.
- The south (Ontario) approach embankment will extend up to a maximum elevation of about 122 metres at about Station 10+490 (i.e., a maximum height of about 10 metres above the existing ground surface from the base of the existing embankment).



- The north (Québec) approach embankment will extend up to a maximum elevation of about 125.5 metres at about Station 10+770 (i.e., a maximum height of about 14 metres above the existing ground surface from the base of the existing embankment).
- The embankment side slopes will be inclined at a minimum of 2H:1V on both the Ontario and Québec approaches, with the exception of a section of the Ontario embankment along Beckett View Drive (between Stations 50+060 and 50+112) where the slope will be inclined as steep as 1.3H:1V.
- New approach roadways, approximately 470 metres in length, will be constructed on both sides of the bridge to connect the existing Regional Road 148 to the new bridge.

5.2 Bridge Foundations

The subsurface conditions at the proposed bridge location generally consist of limited thicknesses of fill and native overburden, with the bedrock surface within about 1 metre of the existing ground surface or river floor.

Given the shallow depth to bedrock in this area of the bridge, it is considered that the new bridge abutments and piers can be supported on shallow spread footings which are placed on or within the bedrock. However, to reduce the amount of in-water works (and dewatering requirements), the piers could be supported on cast in place concrete caissons; this will eliminate the need for coffer-dams to isolate the piers from the river during construction.

Geotechnical recommendations for the design of the foundations for the bridge abutments and piers are presented in the following sections. The design recommendations are based on the abutments being supported on spread footings and the piers being supported on caissons, which is understood to be in agreement with the current design.

5.2.1 Shallow Footing Foundations – Abutments

5.2.1.1 Axial Geotechnical Resistance

Based on the results of the current and previous investigations, the bedrock surface at the proposed abutment locations exists within about 1 metre of the existing ground surface (i.e., about elevation 114 metres at the north abutment and about elevation 112 metres at the south abutment).

It is considered that the new bridge abutments can be supported on shallow spread footings which are placed on or within the bedrock (i.e., founding levels at about elevation 114 metres at north abutment and about elevation 112 metres at the south abutment).

Based on the information provided by Delcan, the following is understood with regards to the foundations for the abutments:

- The abutments will be supported by strip footings measuring up to about 3 metres in width.
- The footings will be required to support a maximum applied Serviceability Limit States (SLS) net bearing resistance of 450 kilopascals.
- The footings will be required to support a maximum applied Ultimate Limit States (ULS) factored bearing resistance of 625 kilopascals.



It is considered that the strip footing foundations founded on the bedrock surface at the abutments may be designed using an ULS factored bearing resistance of 1,000 kilopascals, which exceeds the above bearing resistance value.

Provided the bedrock surface is properly cleaned of soil and highly weathered bedrock at the time of construction, the settlement of spread footings using the above SLS bearing resistance value would be negligible.

The geotechnical resistances provided above are given under the assumption that the loads will be applied perpendicular to the surface of the footings. Where the loads are not applied perpendicular to the surface of the footing, inclination of the load should be taken into account in accordance with the CHBDC.

Based on the borehole data, arkose exists at about 3 to 4 metres depth below the existing ground surface at the south abutment. Arkose is susceptible to hydrolysis due to the natural geology of the rock type (i.e., coarse grained and poorly welded) in comparison with gneiss (i.e., crystalline and strong mineral welding due to metamorphism). At the borehole locations, the arkose is up to about 0.4 metres thick and is underlain by gneiss. Based on the depth of the arkose and the proposed founding elevation, arkose is not expected to be encountered at the founding levels. However, if arkose is encountered at founding level, the foundations should be lowered and supported on the underlying gneiss bedrock.

5.2.1.2 Resistance to Lateral Loads

Resistance to lateral forces / sliding resistance between the concrete footings and the bedrock subgrade should be calculated in accordance with Section 6.7.5 of the CHBDC. The coefficient of friction, $\tan \delta$, may be taken as 0.7 for cast-in-place concrete footings constructed on the bedrock. This represents an unfactored value; in accordance with the CHBDC, a resistance factor of 0.8 is to be applied in calculating the horizontal resistance.

The above value assumes that the bedrock surface is properly cleaned of soil and highly weathered material, and the subgrade is not disturbed by construction.

It is understood that dowels are being proposed at both abutments to resist some of the lateral loading. It is also understood that:

- 20M dowels are required to resist a factored load of 70 kilonewtons.
- 30M dowels are required to resist a factored load of 165 kilonewtons.
- 35M dowels are required to resist a factored load of 265 kilonewtons.
- The dowels will be spaced at about 500 millimetres.
- Each abutment footing will be embedded a minimum of 600 millimetres into the bedrock.

An assessment was carried out to determine the minimum embedment length of each bar to resist the above loadings, and the results are as follows:

- 20M dowels – 0.3 metres embedment for the south abutment and 0.8 metres embedment for the north abutment.
- 30M dowels – 0.3 metres embedment for the south abutment and 0.8 metres embedment for the north abutment.
- 35M dowels – 0.5 metres embedment for the south abutment and 1.0 metres embedment for the north abutment.



If the dowel diameters, loadings, or footing embedment change, the required depth of dowel embedment must be re-evaluated.

5.2.1.3 Frost Protection

The *unweathered* bedrock at this site is not considered to be frost susceptible and therefore, in general, earth cover for frost protection purposes is not required for footings placed on the bedrock.

However, the previous investigation indicated the presence of soil fill seams; these seams would be frost susceptible. As such, where there would be less than 1.8 metres of earth cover, the absence of soil-filled seams should be confirmed at the time of construction by drilling 50 millimetre diameter probeholes within the footing areas at a 3-metre spacing and to at least 2 metres below the finished grade level above the footings. A qualified geotechnical engineer licensed in the Province of Ontario or Québec should inspect the probeholes.

If soil-filled seams are encountered, the following two options could be considered:

- The footing and bearing surface could be insulated; or,
- The frost-susceptible bedrock could be sub-excavated and replaced with mass concrete.

5.2.2 Caisson Foundations – Piers

It is considered that the new bridge piers can be supported on cast-in-place concrete caissons.

The use of a liner or casing will be required in order to advance the caissons with minimal loss of ground, since the overburden materials at the river bottom would not stand un-supported. The use of a liner or casing would also eliminate the need of coffer-dams for construction of the caissons.

Additionally, it will be difficult to clean the bedrock socket/surface, even with the use of casings, unless the casings are (nominally) socketed into the bedrock; the overburden material could otherwise flow under the casings, at the interface with the bedrock.

The tops of the casings should be extended to above an elevation of approximately 114.5 metres (i.e., about 2 metres above the river level to account for any artesian pressure) until the concrete is cast. Otherwise, some groundwater flow up the casings could occur, which could interfere with the concrete placement/curing. If the (final) top-of-caisson level needs to be lower than elevation 114.5 metres, the tops of the casings could be temporarily installed at a higher level than required, extending above the groundwater level, and then only cut down to the design level once the concrete has set.

Depending on the actual piezometric level at the time of construction, the required top-of-casing level may need to be adjusted.

The axial resistance of caisson foundations is primarily based on side-wall (shaft) shear rather than end-bearing. Given the artesian condition in the bedrock and the expected permeable nature of the bedrock, it may not be feasible to dewater and properly clean the bottoms of the caissons and, as such, preparation/cleaning of the bedrock surface for end-bearing may not be feasible. The caissons should therefore be socketed into the bedrock and designed based on side-wall shear resistance.

To provide full fixity for the proposed 2.1 metre diameter caissons, the caissons should be provided with a minimum socket length of 4 metres.



Since it may not be feasible to dewater the sockets, particularly with the artesian conditions, it should be planned to construct the caissons 'in the wet', using tremie techniques. Inspection of the rock sockets by diver, prior to concreting, may be necessary.

The bedrock at this site varies in strength from weak to strong. The caisson rock sockets will therefore have to be advanced by rock coring, chisel/churn drilling, and/or a down-the-hole hammer techniques.

Given the challenging construction conditions, it is recommended that a cross-hole sonic logging (CSL) integrity testing program be carried out to identify possible flaws in the concrete. The testing should be carried out in accordance with ASTM D 6760-08. The caissons should be tested no sooner than three calendar days after placement of all concrete in any caisson, but within 45 days after placement. Each caisson will need to be provided with steel tubes to allow for this testing. A specification for this testing can be provided.

5.2.2.1 Axial Geotechnical Resistance and Settlement

Current plans indicate that the caissons will have a diameter of 2,100 millimetres and will be socketed a minimum of 4 metres into the bedrock.

The following information was provided by Delcan so that a settlement assessment could be carried out.

| | Soil Springs, Fixed-Fixed Piers, 2100 mm | Soil Springs, Pinned-Fixed Piers, 2100 mm |
|----------------------------------|---|--|
| I_{cr} / I_g | 1 | 1 |
| Long. Period (s) | 1.74 | 1.74 |
| Trans. Period (s) | 1.86 | 1.97 |
| Pier M_y (kNm) | 7,624 | 8,233 |
| Pier M_z (kNm) | 4,358 | 8,912 |
| Pier M_{res} (kNm) | 7,735 | 9,248 |
| R | 1 | 1 |
| Pier M_{res} (kNm) | 7,735 | 9,248 |
| Caisson M_y (kNm) | 7,624 | 8,233 |
| Caisson M_z (kNm) | 3,952 | 8,912 |
| Caisson M_{res} (kNm) | 7,716 | 9,248 |
| Caisson F_z (kN) | 2,450 | 2,646 |
| Caisson F_y (kN) | 1,274 | 2,864 |
| Caisson F_{res} (kN) | 2,480 | 2,972 |
| Caisson P (kN) | 15,638 | 14,023 |
| Δ_{long} (mm) | 60 | 60 |
| $\Delta_{trans\ piers}$ (mm) | 65 | 70 |
| $\Delta_{trans\ abutments}$ (mm) | 55 | 57 |



A settlement assessment was carried out using Phase 2 (©RocScience). The analysis was modeled based primarily on the subsurface conditions encountered at borehole 12-106, taking into account the presence of the sand seam and the fracturing in the bedrock (possible fault), which is considered to be the worst case scenario for the entire site.

The input parameters required for the analyses include unit weight, Poisson's ratio, and Young's Modulus. The unit weights and Poisson's Ratios were obtained from the results of the laboratory testing carried out on selected rock core samples. For each rock unit in the model, average values for unit weight and Poisson's ratio were calculated from all samples of the same rock type/formation.

The Young's Modulus used in the model was also obtained from the laboratory testing and was downgraded to a rock mass modulus to account for jointing/fracturing in the rock. The results of laboratory testing carried out on specimens of the bedrock core are summarized in Appendix D. The Rock Mass Rating (RMR), which is an indication of the overall rock quality was used to downgrade the intact modulus.

The RMR incorporates five parameters: strength, RQD, joint spacing, condition of joints, and groundwater conditions. Strength was obtained from the results of unconfined compressive strength testing. A weighted average value of RQD was calculated for each rock type in the model based on the measured RQD. Joint spacing was estimated from the borehole data. Joint condition was assumed based on past experience for the specific rock types used in the analysis. Groundwater conditions were assumed.

Our assessment indicates that, based on the above caisson diameters, socket length, and loading conditions, the settlement of the caissons would be less than 15 millimetres.

5.2.2.2 Resistance to Lateral Loads

Due to the limited thicknesses of the overburden, the resistance to lateral loading derived from the soil in front of the caissons should not be relied upon. The resistance to lateral loading will therefore have to be derived entirely from the rock.

At the south pier, where the socket will be entirely within the dolostone, a spring constant of 9,000 meganewtons per metre per metre length can be used for design. At the north pier, where the socket will be within dolostone, siltstone, and sandstone, a spring constant of 2,700 meganewtons per metre per metre length can be used for design.

5.2.2.3 Frost Protection

The Ottawa River at the pier locations is greater than about 3 to 5 metres deep and, as such, the water will not freeze to its river bed in the winter and therefore frost protection is not required for the in-water piers.

5.3 Rock Anchors

It is understood that rock anchors may be required at the proposed abutments and will be required for a new sign near the Québec abutment.



In designing grouted rock anchors, consideration should be given to four possible anchor failure modes.

- i) Failure of the steel tendon or top anchorage;
- ii) Failure of the grout/tendon bond;
- iii) Failure of the rock/grout bond; and,
- iv) Failure within the rock mass, or rock cone pull-out.

Potential failure modes i) and ii) are structural and are best addressed by the structural engineer. Adequate corrosion protection of the steel components should be provided to prevent potential premature failure due to steel corrosion.

For potential failure mode iii), the factored bond stress at the concrete/rock interface may be taken as 750 kilopascals for ULS design purposes. The upper one metre of rock should be ignored due to potentially weathering of the rock. If the response of the anchor under SLS conditions needs to be evaluated, for a preliminary assessment it may conservatively be taken as the elastic elongation of the unbonded portion of the anchor under the design loading.

For potential failure mode iv), the resistance should be calculated based on the buoyant weight of the potential mass of rock which could be mobilized by the anchor. This is typically considered as the mass of rock included within a cone (or wedge for a line of closely spaced anchors) having an apex at the tip of the anchor and having an apex angle of 60 degrees. For each individual anchor, the ULS factored geotechnical resistance can be calculated based on the following equation:

$$Q_r = \phi \frac{\pi}{3} \gamma' D^3 \tan^2(\theta)$$

Where:

- Q_r = Factored uplift resistance of the anchor, kilonewtons;
- ϕ = Resistance factor, use 0.4;
- γ' = Effective unit weight of rock, use 17 kilonewtons per cubic metre;
- D = Anchor length in metres; and,
- θ = $\frac{1}{2}$ of the apex angle of the rock failure cone, use 30 degrees.

Where the anchor load is applied at an angle to the vertical, the anchor capacity should be reduced as follows:

$$Q_r' = Q_r \cos(\alpha)$$

Where:

- Q_r' = Factored uplift resistance of the anchor subject to inclined load in kilonewtons;
- Q_r = Factored uplift resistance of the anchor, kilonewtons; and,
- α = Angle between the load direction and the vertical.



For a group of anchors or for a line of closely spaced anchors, the resistance must consider the potential overlap between the rock masses mobilized by individual anchors. In the case of group effects for a series of rock anchors in a rectangle with width “a” and length “b” installed to a depth “D”, the equation for the volume of the truncated trapezoid failure zone would be as follows:

$$V = \frac{4}{3} D^3 \sin^2 \varphi + aD^2 \sin \varphi + bD^2 \sin \varphi + abD$$

Where:

- V = Volume of the truncated trapezoid failure zone in cubic metres;
- D = Depth of anchor group in metres;
- a = width of anchor group in metres;
- b = length of the anchor group in metres; and,
- φ = $\frac{1}{2}$ of the apex angle of the rock failure cone, use 30 degrees.

The ULS factored geotechnical resistance for the truncated trapezoid failure formed by the group of anchors can then be calculated based on the following equation:

$$Q_r = \phi \gamma' V$$

Where:

- Q_r = Factored uplift resistance of the anchor, kilonewtons;
- ϕ = Resistance factor, use 0.4;
- γ' = Effective unit weight of rock, use 17 kilonewtons per cubic metre below groundwater level; and,
- V = Volume of truncated trapezoid in cubic metres.

It is suggested that proof-load tests be carried out on the anchors. The proof-load tests should be carried out to 1.3 times the anchor service loads, and at least 10 percent of the anchors should be tested in this manner.

The installation and testing of the anchors should be supervised by the geotechnical engineer. Care must be taken during grouting to ensure that the grouting pressure is sufficient to bond the entire length of the grout area with a minimum of voids. It is also suggested that the anchor holes be thoroughly flushed with water to remove all debris and rock flour. It is essential that rock flour be completely removed from the anchor holes to be grouted to ensure an adequate bond between the grout and the rock.

Prestressing of the anchors prior to loading will minimize anchor movement due to service loads.

5.4 Seismic Coefficient

For this site, the Peak Horizontal Acceleration (PHA) is 0.2, zonal acceleration ratio is 0.2, and seismic performance zone is 3.

For seismic design purposes, the Site Coefficient, S, for this site in accordance with Section 4.4.6 of the CHBDC may be taken as 1.0, consistent with Soil Profile Type I.



5.5 Foundation Backfill

The soils at this site are frost susceptible and should not be used as backfill against foundation elements, within about 1.8 metres below the finished grade. To avoid problems with frost adhesion and heaving, the foundations within the zone of frost influence (i.e., about 1.8 metres below finished grade) should be backfilled with non-frost susceptible sand or sand and gravel conforming to the requirements for OPSS Granular B Type I.

If the passive resistance to the foundation offered by the backfill soils will be relied upon to resist lateral loading, then the foundation backfill materials should be compacted to at least 95 percent of their standard Proctor maximum dry density. It is considered that the backfill requirements provided in OPSD 3101.50 should be sufficient, with the exception that the fill material should extend to at least 1.2 metres beyond the back (and to the bottom) of the footing before extending up at 1.5H:1V.

5.6 Lateral Earth Pressures

The lateral earth pressures acting on the bridge abutments and wing walls will depend on the type and method of placement of the backfill materials, the nature of the soils behind the backfill, the magnitude of surcharge including construction loadings, the freedom of lateral movement of the structure, and the drainage conditions behind the walls. Seismic (earthquake) loading must also be taken into account in the design.

The following recommendations are made concerning the design of the abutment stems and wing walls in accordance with the CHBDC:

- Select free-draining granular fill meeting the specifications of OPSS Granular 'A' or Granular 'B' Type II but with less than 5 percent passing the 200 sieve should be used as backfill behind the walls. This fill should be compacted in accordance with OPSS 501.
- Longitudinal drains and weep holes should be installed to provide positive drainage of the granular backfill. Other aspects of the granular backfill requirements with respect to sub-drains and frost tapers should be in accordance with OPSD 3101.150, 3190.100, and 3121.150.
- A minimum compaction surcharge of 12 kilopascals should be included in the lateral earth pressures for the structural design of the walls, in accordance with CHBDC Section 6.9.3 and Figure 6.6. Care must be taken during the compaction operation not to overstress the wall. Heavy construction equipment should be maintained at a distance of at least 1 metre away from the walls while the backfill soils are being placed. Hand-operated compaction equipment should be used to compact the backfill soils within a 1-metre wide zone adjacent to the walls. Other surcharge loadings should be accounted for in the design, as required.
- The granular fill may be placed either in a zone with a width equal to at least 1.8 metres behind the back of the abutment stem (Case (a) on Figure C6.20 of the Commentary to the CHBDC) or within the wedge-shaped zone defined by a line drawn at 1.5H:1V extending up and back from the rear face of the footing (Case (b) on Figure C6.20 of the Commentary to the CHBDC).



5.6.1 Static Lateral Earth Pressures

The following guidelines and recommendations are provided regarding the lateral earth pressures for static (i.e., not earthquake) loading conditions:

- For Case (a), the pressures are based on the embankment fill materials and the following parameters (unfactored) may be used assuming the use of Select Subgrade Material (SSM) in Ontario or MG112 in Québec:

| Material | SSM | MG112 |
|--|----------------------|----------------------|
| Soil Unit Weight | 20 kN/m ³ | 19 kN/m ³ |
| Coefficients of static lateral earth pressure: | | |
| Active, K_a | 0.35 | 0.35 |
| At rest, K_o | 0.50 | 0.50 |
| Passive, K_p | 3.0 | 3.0 |

- For Case (b), the pressures are based on using engineered granular fill and the following parameters (unfactored) may be used:

| Material | Granular 'A' / MG20 | Granular 'B' / Type II / MG 56 |
|--|------------------------|-----------------------------------|
| Soil Unit Weight | 22 kN/m ³ | 21 kN/m ³ |
| Coefficients of static lateral earth pressure: | | |
| Active, K_a | 0.27 | 0.27 |
| At rest, K_o | 0.43 | 0.43 |
| Passive, K_p | 3.7 | 3.7 |

- The above pressure coefficients assume that the back of the wall is near vertical and the ground surface behind the wall is flat. Where sloping backfill is present above the top of the wall, the lateral earth pressures under static conditions will need to be recalculated.
- If the wall support and superstructure allow lateral yielding or where the abutments are expected to move away from the retained soils as the superstructure contracts due to decreases in ambient temperature, active earth pressures may be used in the geotechnical design of the structure. The movement to allow active pressures to develop within the backfill, and thereby assume an unrestrained structure, may be taken as:
 - Rotation of approximately 0.002 about the base of a vertical wall:
 - Horizontal translation of 0.001 times the height of the wall; or,
 - A combination of both.



- If the abutment support does not allow lateral yielding (i.e., restrained structure where the rotational or horizontal movement is not sufficient to mobilize an active earth pressure condition), at-rest earth pressures (plus any compaction surcharge) should be assumed for geotechnical design.
- Where the abutments are expected to move into the retained soils, such as at semi-integral abutments where the superstructure expands due to increases in ambient temperature, passive earth pressures should be considered. The movements required to fully mobilize passive pressure or resistance are much larger than those required to mobilize active pressure. In practice, movements may not be sufficient to mobilize the full passive resistance. The movement to allow passive pressures to develop within the backfill may be taken as:
 - Rotation of approximately 0.100 about the base of the vertical wall;
 - Rotation of approximately 0.020 about the top of a vertical wall;
 - Horizontal translation of 0.05 times the height of the wall; or,
 - A combination of the above.
- Where movements are not sufficient to mobilize full passive resistance, K_p may be determined in accordance with Figure C6.16 of the *CHBDC Commentary* based on the amount of displacement.

5.6.2 Seismic Lateral Earth Pressures

Seismic (earthquake) loading must be taken into account in the assessment in accordance with Section 4.6 of the *CHBDC*. In this regard, the following should be included in the assessment of lateral earth pressures:

- Seismic loading will result in increased lateral earth pressures acting on the wall. The walls should be designed to withstand the combined lateral loading for the appropriate static pressure conditions given above, plus the earthquake-induced dynamic earth pressure. The site-specific zonal acceleration ratio (A) for this site is 0.2. The seismic lateral earth pressure coefficients given below have been derived based on a design zonal acceleration ratio of $A = 0.2$.
- In accordance with Sections 4.6.4 and C.4.6.4 of the *CHBDC* and its *Commentary*, for structures which do not allow lateral yielding, the horizontal seismic coefficient (k_h) used in the calculation of the seismic active pressure coefficient is taken as 1.5 times the zonal acceleration ratio (i.e., $k_h = 0.3$). For structures which allow lateral yielding (k_h), is taken as 0.5 times the zonal acceleration ratio (i.e., $k_h = 0.1$).
- The following seismic active pressure coefficients (K_{AE}) for the two backfill cases (Case (a) and Case (b)) may be used in the assessment. It should be noted that these seismic earth pressure coefficients assume that the back of the wall is near vertical and the ground surface behind the wall is flat. Where sloping backfill is present above the top of the wall, the lateral earth pressures under seismic loading conditions should be calculated by treating the weight of the backfill located above the top of the wall as a surcharge.



Seismic Active Pressure Coefficients, K_{AE}

| Material | Case (a) | Case (b) | |
|-------------------|-------------|-------------------------|---------------------------------|
| | SSM / MG112 | Granular 'A' / MG 20 | Granular 'B' Type II / MG 56 |
| Yielding wall | 0.39 | 0.30 | 0.30 |
| Non-yielding wall | 0.62 | 0.50 | 0.50 |

- The above K_{AE} values for yielding walls are applicable provided that the wall can move up to 250A (millimetres), where A is the design zonal acceleration ratio of 0.2. This corresponds to displacements of up to approximately 50 millimetres at this site.
- The earthquake-induced dynamic pressure distribution, which is to be added to the static earth pressure distribution, is a linear distribution with maximum pressure at the top of the wall and minimum pressure at its toe (i.e., an inverted triangular pressure distribution). The total pressure distribution (static plus seismic) may be determined as follows:

$$\sigma_h(d) = K \gamma d + (K_{AE} - K) \gamma (H-d)$$

Where: $\sigma_h(d)$ is the (static plus seismic) lateral earth pressure at depth, d, (kPa);

K is the static active earth pressure coefficient, K_a (**to be used for yielding walls**);

K is the static at-rest earth pressure coefficient, K_o (**to be used for non-yielding walls**);

K_{AE} is the seismic active earth pressure coefficient;

γ is the unit weight of the backfill soil (kN/m^3), as given previously;

d is the depth below the top of the wall (m); and,

H is the total height of the wall (m).

5.7 Approach Embankments

The new approach embankments will be up to about 10 metres in height at the south approach and up to about 14 metres in height at the north approach. The embankments will be widened by up to about 35 metres towards the east (from the crest of the old embankment slope to the toe of new embankment slope) to accommodate the realignment of the new bridge. Some typical cross-sections are shown on Figures 2D and 2E.

Testholes 12-01 to 12-35, inclusive, were advanced along the proposed approach embankments, at about 25 metre spacing, on both the Québec and Ontario sides. The subsurface conditions along the proposed north approach generally consist of limited thickness of fill or native overburden, with the bedrock surface within about 1.5 metres below the existing ground surface. Along the south approach, the fill is up to about 8 metres high and generally thickening towards the abutment. Practical refusal to augering was encountered at depths varying from about 1.3 to 8.5 metres below the existing ground surface.



5.7.1 Subgrade Preparation and Embankment Construction

In order to improve the embankment performance, any topsoil, organic matter and softened/loosened soils should be stripped from within the limits of the approach embankments. All subgrade soils should be proof rolled prior to fill placement.

Based on the results of the current investigation, topsoil and/or organic matter (which should be removed) were encountered at the existing ground surface or beneath the fill at various locations along the north approach embankment. Where encountered, the topsoil varies from about 50 to 340 millimetres in thickness. Topsoil was not encountered within the testholes along the south approach embankment.

Numerous hand dug test pits were also put down just south of the existing roadways along both approaches. At these locations, approximately 50 to 490 millimetres of topsoil/organic matter exists between the ditch and the fence line along the north approach, and approximately 120 to 300 millimetres of topsoil/organic matter exist behind the guiderail along the south approach.

The expected depths of stripping of topsoil and/or organic matter are summarized in the following table. The values presented in the table are based on the subsurface conditions encountered in the hand dug test pits and, as such, the thicknesses may vary locally.

| Depth of Topsoil and/or Organic Matter (mm) | North Approach | South Approach |
|---|-------------------|-------------------|
| Minimum | 50 | 120 |
| Maximum | 490 | 300 |
| Average | 220 | 185 |

The embankment fill should be placed in regular lifts with a loose thickness not exceeding 300 millimetres, and should be compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable vibratory compaction equipment. The final lift prior to placement of the granular subbase and base courses should be compacted to at least 100 percent of the material's standard Proctor maximum dry density. Inspection and field density testing should be carried out by qualified personnel during placement operations to ensure that appropriate materials are used and that adequate levels of compaction have been achieved.

To reduce surface water erosion on the embankment side slopes, placement of topsoil and seeding or pegged sod is recommended.

5.7.2 Embankment Settlement

Provided that the new embankment fill consists of sandy Select Subgrade Material (SSM) and compacted in accordance with Section 5.7.1 above, the post-construction settlement due to compression of the embankment fill itself is expected to be between 25 and 50 millimetres. The use of granular fills (OPSS Granular A or B Type II) would reduce the magnitude of *post-construction* settlement, due to the compression of the embankment fill itself, to about 25 millimetres.



The new approach embankments will be partially underlain by the existing embankment fill materials that form the side slopes of the existing Highway 148 embankment. The embankment fill encountered in the testholes consists of sand, gravel, silt, cobbles and boulders, and is generally in a dense to very dense state of packing. It is considered acceptable that these fill materials be left in place beneath the new embankment footprint. Provided that the subgrade surface is heavily proof rolled and compacted to at least 95 percent of the materials' standard Proctor maximum dry density, using large vibratory compaction equipment, the post-construction settlement of the existing fill should be less than about 15 millimetres, and it is expected that much of this settlement will occur during construction of the embankment.

Native sandy soils exist beneath the fill at some portions of the site. Pseudo-elastic settlement of these soils should be less than about 25 millimetres and would occur likely entirely during construction of the embankment. Significant post-construction settlement of the sandy soils is therefore not expected.

5.7.3 Embankment Stability

Approach embankments up to about 10 to 14 metres high with 2H:1V side slopes, constructed on properly prepared subgrade surface and compacted in accordance with Sections 5.7.1 and 5.7.2 above, are considered acceptable from a global slope stability perspective.

As previously noted, a section of the embankment (between Stations 50+060 and 50+112) along Beckett View Drive is proposed with side slopes of 1.3H:1V and is proposed to be constructed using blast rock fill. This section of the embankment is also considered to be stable under both static and seismic loading conditions. The rock fill embankment should be constructed in accordance to OPSS 206. In areas where the rock fill will be underlain by existing sandy embankment materials, a non-woven geotextile should be placed at the interface of the earth fill and rock fill to prevent fine particles from migrating into the voids of the rock fill.

5.8 Pavement Design

5.8.1 Pavement Materials

Present pavement design technology emphasizes the importance of providing proper drainage directly under the asphaltic concrete layers. The drainage layer significantly improves the freeze-thaw resistance of the asphaltic concrete and decreases the frequency of transverse cracking, therefore extending the life of the pavement.

In Ontario, granular base and subbase for new construction should therefore consist of OPSS Granular O and Granular B Type II, respectively. Granular O provides superior drainage of pavement and will decrease the amount of pavement transverse cracking, which will in turn decrease maintenance requirements and extend the life of the pavement.

5.8.2 AASHTO Pavement Design Parameters

The traffic data for Highway 148 (Ontario) and Route 148 (Québec) was provided by Delcan for the pavement structure assessment. In March 2012, the average annual daily traffic (AADT) data on Highway 148, approximately 1.5 kilometres west of the Ontario and Québec border, was determined to be 5,189 vehicles. The AADT on Route 148 was estimated to be 5,200. Therefore, for this project, we have used an AADT of 5,200. We have also assumed a design period of 30 years, 10 percent truck traffic, and a projected traffic volume growth rate of 2 percent.



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The input parameters and the resulting estimated equivalent single axle loads (ESAL) over the design period using the AASHTO design method are as follows:

| Traffic Data | Highway/Route 148 |
|---|-------------------|
| Average Annual Daily Traffic (AADT) 2012 ¹ | 5,200 |
| Design Period (years) | 30 |
| Commercial Vehicles (%) | 10 |
| Growth Rate (%) | 2 |
| Estimated ESALs by 2042 | 7,350,000 |

Note: ¹ Provided by Delcan.

As shown in the above table, the projected estimated total ESALs over the design period are about 7.4 million. Therefore, a Traffic Category C would be appropriate for this roadway.

The following design parameters were used in the pavement design analysis.

- Initial Serviceability = 4.5
- Terminal Serviceability = 2.6
- Reliability Level = 95 percent
- Overall Standard Deviation = 0.45
- Subgrade Resilient Modulus = 30,000 kilopascals (based on SSM and/or compacted fill, e.g. bridge approach embankments)

Based on these design parameters, the minimum required structural number (SN) for a new pavement structure is 146 millimetres.

Structural coefficients are assigned to each pavement layer to determine the thickness required/contributed by each layer and, ultimately, the overall pavement thickness and strength.

The following structural and drainage coefficients were used in the analysis.

| Component Layer | Structural Coefficient | Drainage Coefficient |
|-----------------------------|------------------------|----------------------|
| Hot Laid Asphaltic Concrete | 0.42 | 1.0 |
| Granular O Base | 0.14 | 1.0 |
| Granular B Type II Subbase | 0.14 | 1.0 |



5.8.3 Recommended Pavement Structure

Based on the above parameters, the following pavement structure is considered appropriate for the approaches to the bridge:

| Component Layer | | Design Thickness (mm) | Recommended Material | |
|----------------------------|-------------------|-----------------------|-----------------------|---------------------|
| | | | Ontario Designation | Québec Designation |
| Hot Mix Asphaltic Concrete | Surface Course | 40 | Superpave SP 12.5 FC2 | ESG-10 |
| | Upper Base Course | 60 | Superpave SP 19.0 | ESG-14 ² |
| | Lower Base Course | 65 | Superpave SP 19.0 | ESG-14 ² |
| Granular Material | Base | 200 | Granular O | MG 20 |
| | Subbase | 400 ¹ | Granular B Type II | MG 112 (non SP) |

Notes: ¹ Assumes that the embankment fills will consist of adequately placed and compacted SSM or granular engineered fill.

² The standard asphaltic concrete base course typically consists of GB-20. However, ESG-14 is required to satisfy the recommended minimum paving thicknesses.

The pavement structure was designed following AASHTO procedures as well as Chaussée 2 design software (obtained from the MTQ web site), including the requirements of Table 2.4-1 in Tome II “Conception Routière, and based on the materials specifications for Ontario and Québec respectively.

It is noted that the subbase material on the Québec side (MG-112) is specified as “non SP”. This restriction is needed to avoid poorly graded materials which would not be appropriate even though they meet the gradation requirements of MG-112.

The calculated SN for this pavement design is 149 millimetres, which exceeds the minimum required value of 146 millimetres (see Section 5.8.2). From a design and overall pavement performance point of view, the Ontario and Québec pavement design would be considered to be equivalent. Therefore, an option should be provided in the contract to supply one or the other for the entire project.

In addition, it is understood that the bridge deck wearing surface will consist of asphaltic concrete overlying 10 millimetre thick waterproofing membrane. The asphaltic concrete for the bridge deck should consist of the following:

| Component Layer | | Design Thickness (mm) | Recommended Material | |
|----------------------------|----------------|-----------------------|--------------------------------|--------------------|
| | | | Ontario Designation | Québec Designation |
| Hot Mix Asphaltic Concrete | Surface Course | 40 | Superpave SP 12.5 FC2 | ESG-10 |
| | Base Course | 40 | Superpave SP 12.5 ¹ | ESG-10 |

Note: ¹ To avoid introducing another asphaltic concrete mix to the project, this layer could also consist of Superpave SP 12.5 FC2.



The Superpave traffic level and the asphalt cement grade for the roadway and bridge deck should consist of the following:

| Asphaltic Concrete Layer | Design Values |
|--------------------------|--------------------|
| Superpave Traffic Level | C |
| PG Asphalt Cement | 64–34 ¹ |

Note: ¹ The standard PG asphalt cement for this area is PG 58-34. However, given the “Emergency Route” designation of this bridge, it is recommended that the asphalt cement grade be raised by at least one grade to PG 64-34.

The above pavement design is based on the assumption that the pavement subgrade has been acceptably prepared (i.e., where grade raise fill has been adequately compacted to the required density and the subgrade surface not disturbed by construction operations or precipitation). Depending on the actual conditions of the pavement subgrade at the time of construction, it could be necessary to increase the thickness of the subbase.

The granular material used for the pavements on the Ontario side of the bridge should meet the requirements of OPSS 1010 and should be placed and compacted in accordance with OPSS 501 Method B. The granular material should be uniformly compacted to at least 98 percent of the material’s standard Proctor maximum dry density using suitable vibratory compaction equipment. The granular material used for the pavements on the Québec side of the bridge should meet the requirements of the Ministère des Transports du Québec specification 2101 and the Bureau de Normalisation du Québec specification NQ 2560-114, Partie II. Placement and compaction should be in accordance with the Cahier des Charges et Devis Généraux, Construction et Réparation, Chapitre 12.

The asphalt cement and asphaltic concrete on the Ontario side of the bridge should meet the requirements of OPSS.PROV 1101 and OPSS.PROV 1151, respectively, and should be placed and compacted in accordance with OPSS 310. The asphalt cement and asphaltic concrete on the Québec side of the bridge should meet the requirements of the Ministère des Transports du Québec specifications 4101 and 4202, respectively, and should be placed and compacted in accordance with the Cahier des Charges et Devis Généraux, Construction et Réparation, Chapitre 13.

5.8.4 Transition Details and Pavement Tie-Ins

The current profile indicates that the Québec approach will require a transition for an earth/rock cut both longitudinally and in section in some areas. Since this section of the highway is in Québec, the Transports Québec Normes Ouvrages Routiers, Tome II Chapitre 1 should be used for the transition details.

The transverse detail (section) is provided on Numéro 017 and the longitudinal detail is provided on Numéro 019. The frost penetration depth “P” should be 2.25 metres as per Tome II Chapitre 1 Page 5 for a highway.

The geotextile should be Type III. The properties for a Type III are provided in Tome VII Chapitre 13 Norme 13101 Page 4 of 4.



Where the new pavements will connect to the existing pavements, the new pavement structures should be continued at least to the limits of construction with any longitudinal transitions and/or tapers occurring thereafter.

At such locations, the longitudinal transitions should be constructed by cutting the existing pavement structure vertically to the bottom of the existing subbase. The new granular layers should be tapered up or down, as required, at a slope of 10H:1V to match the existing pavement structure. The asphaltic concrete does not need to be tapered between the new construction and the existing pavement. However, the asphaltic concrete of the existing pavement should be milled back an additional 300 millimetres to a depth matching the proposed surface course of the new asphaltic concrete.

A schematic diagram depicting the longitudinal transition is provided on Figure 6.

5.8.5 Tack Coat

A tack coat should be provided on all vertical and horizontal milled surfaces. On the Ontario side of the bridge, the tack coat application should be as per OPSS 313 and OPSS.PROV 308 and the material should consist of SS-1 emulsified asphalt diluted with an equal volume of water. On the Québec side of the bridge, the tack coat materials and application should be in accordance with the Cahier des Charges et Devis Généraux, Construction et Réparation, Chapitre 13.

5.8.6 Pavement Treatments

The surface of the subgrade or fill should be crowned or sloped to promote drainage of the roadway granular structure. Wherever possible, the granulars should daylight at the edges of the pavement structure.

Where additional drainage of the pavement structure is required, subdrains should be provided along the roadway length. The subdrains should be installed in accordance with OPSD 206.050. The subdrains should be connected to catchbasins or outlet to adjacent ditches such that the pavement structure will be positively drained and will intercept flows within the subbase.

5.8.7 Subgrade Preparation and Protection

In preparation for new pavement construction, all topsoil, organic matter and/or other unsuitable material (e.g., fill containing organic matter and/or debris) should be excavated from the proposed pavement footprint.

The expected depths of stripping of topsoil and/or organic matter are provided in Section 5.7.1.

Based on the borehole data, the general pavement subgrade will likely consist of existing fill, silty sand and/or gravelly sand. The existing granular fills can generally remain in-place, provided some modest settlement of the subgrade can be tolerated, except where they contain or are underlain by topsoil or organic matter (such as at augerholes 12-01, 12-02, and 12-04 etc. on the Québec approach). However, the asphaltic concrete surface should be removed or in-place processed.

Where the subgrade is not too wet to be trafficable, the surface should be proof rolled with a heavy smooth drum roller under the supervision of qualified geotechnical personnel to identify soft and disturbed areas. Soft/disturbed soils would require subexcavation and replacement with more suitable fill.

Sections requiring grade raising to the proposed subgrade level should then be filled per the recommendation provided in Section 5.7.1.



5.9 Construction Considerations

5.9.1 Excavations

Excavations for construction of the abutment foundations are expected to extend through limited thicknesses of fill or native overburden and potentially into the bedrock. No unusual problems are anticipated in excavating the overburden soils using conventional hydraulic excavating equipment. Significant amounts of groundwater should be expected for excavations below the river level. Additional guidelines on groundwater control are provided in Section 5.9.3.

Excavations should be carried out in accordance with the guidelines outlined in the latest edition of the Occupational Health and Safety Act (OHSA) for Construction Activities. For “short-term” excavations, the overburden soils above the water table are classified as a Type 3 soil per the OHSA and therefore temporary excavations could be made with unsupported side slopes no steeper than 1H:1V. For “longer-term” excavations, or if the excavations will be left open during the winter months, shallower side slopes of 2H:1V may be required. Excavations in saturated sands will however be classified as a Type 4 soil and excavation side slopes of no steeper than at 3H:1V will be required.

For shallow depths of excavation, it may be possible to remove the upper portion of the weathered bedrock using large hydraulic excavating equipment. Further shallow bedrock removal could be accomplished using mechanical methods (such as hoe ramming). Excavations deep into the rock, if required, will likely require hoe ramming in conjunction with line drilling or drill and blast procedures.

5.9.2 Temporary Excavation Shoring

The temporary excavation shoring, if required, should be designed and installed in accordance with OPSS 539, and it is considered that a design Performance Level 2 would be appropriate for this site. The design of any required shoring will be entirely the responsibility of the contractor.

The shoring method(s) chosen to support the excavation sides must take into account: soil stratigraphy, groundwater conditions, methods adopted to manage the groundwater, permissible ground movements associated with the excavation and construction of the shoring system, and potential impacts on adjacent structures.

For any of the shoring systems, some form of lateral support to the shoring is required for excavation depths greater than about 3 metres. Lateral restraint can be provided by means of tie-backs consisting of grouted bedrock anchors, tie-rods to deadman anchorages, and the socketed ‘toe’ portion of the soldier piles.

Conceptually, it is expected that the shoring at this site, if required, might consist of steel soldier piles and timber lagging, supported by pre-stressed tie-backs.

To the expected depths of excavation, it is not expected that basal heaving or basal instability will be a concern.



5.9.3 Groundwater Control

At the proposed abutment locations, excavations are expected to extend through the sandy overburden and possibly into the bedrock. Groundwater inflow into the excavations should be expected. However, it should generally be possible to handle the groundwater inflow by pumping from well filtered sumps in the excavations provided suitably sized pumps are used. Higher rates of groundwater inflow should be expected where the excavation extends through the bedrock *near or below the groundwater level*. If excavations are expected to extend below the river level, some form of active groundwater level lowering may be required to lower the groundwater level below the depth of excavation prior to excavation. The groundwater level should be lowered to at least 0.5 metres below the planned bottom of excavation level, in advance of or during excavation.

At the in-water pier locations, the proposed caisson foundations will eliminate the need of coffer-dams to isolate the pier locations from the river. Depending on the level of the river at the time of construction, fractures within the bedrock, including the possible fault encountered at one of the boreholes, could allow significant amounts of water to infiltrate into the base of the caisson foundations. The presumption should be that caissons will be constructed “in the wet” (as discussed in Section 5.2.2).

The actual rate of groundwater inflow to the excavations will depend on many factors including the contractor’s schedule and rate of excavation, the size of the excavation, and the time of year at which the excavation is made. There also may be instances where significant volumes of precipitation and/or groundwater collects in an open excavation, and must be pumped out.

The design of the groundwater control system should be entirely the responsibility of the contractor.

A Permit-To-Take-Water (PTTW) from the Ministry of the Environment of Ontario (MOE) will be required for rates of groundwater inflow in excess of 50,000 litres per day, which will likely be the case for excavations below the river level. A hydrogeological assessment will be required in support of a PTTW application.

5.9.4 Corrosion and Cement Type

One sample of groundwater obtained from the Ottawa River at the site was submitted to EXOVA laboratories for chemical analysis related to potential corrosion of exposed buried ferrous elements and potential sulphate attack on buried concrete elements. The results of the analysis are provided in Appendix E.

The results indicate that concrete made with Type GU Portland cement should be acceptable for substructures. The results also indicate a moderate potential for corrosion of exposed ferrous metal, which should be considered in the design of the substructures.



6.0 ADDITIONAL CONSIDERATIONS

All footing and/or subgrade areas should be inspected by experienced geotechnical personnel prior to filling or concreting to ensure that subgrade having adequate bearing capacity has been reached and that the bearing surfaces have been properly prepared. The placing and compaction of any engineered fill should be inspected to ensure that the materials used conform to the specifications from both a grading and compaction view point.

The caisson sockets will also need to be inspected (possibly by divers) to document that they have been adequately cleaned, have been drilled to the required depth, and that the rock quality is consistent with the design.


It is recommended that the groundwater level monitoring device installed at the site be ultimately decommissioned in accordance with Ontario Regulation 128/03. It is considered that this abandonment can be more economically abandoned as part of the construction contract. A special provision for that work can be provided, if required. If that is not the case or is not considered feasible, abandonment of the monitoring wells can be carried out separately.

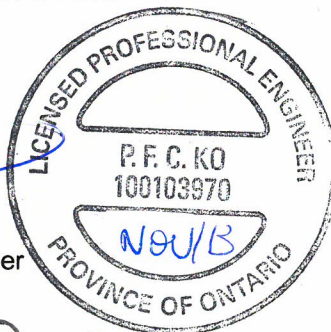
The samples obtained for this investigation will be retained in storage for a period of 3 months following issuance of this report. They will then be disposed of, unless direction for extended storage is provided.

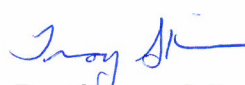
No chemical analysis of the soil quality (or groundwater quality) in relation to the disposal options was carried out as part of this geotechnical investigation.

Golder Associates should be retained to review the final drawings and specifications for this project prior to tendering to ensure that the guidelines in this report have been adequately interpreted.

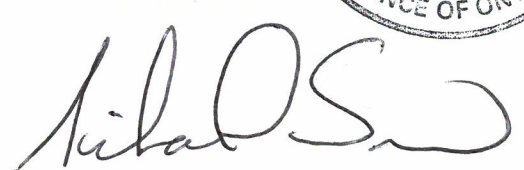
GOLDER ASSOCIATES LTD.


Christine Ko, P.Eng.
Geotechnical Engineer




Troy Skinner, P.Eng.
Associate




Michael Snow, P.Eng., ing.
Principal



CK/TMS/MGG/bg

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IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client, Delcan Corporation / Public Works and Government Services Canada (PWGSC). The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder cannot be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then the client may authorize the use of this report for such purpose by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process, provided this report is not noted to be a draft or preliminary report, and is specifically relevant to the project for which the application is being made. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but 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 available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client cannot rely upon the electronic media versions of Golder's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder cannot be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Groundwater Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT (cont'd)

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. **The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report.** The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

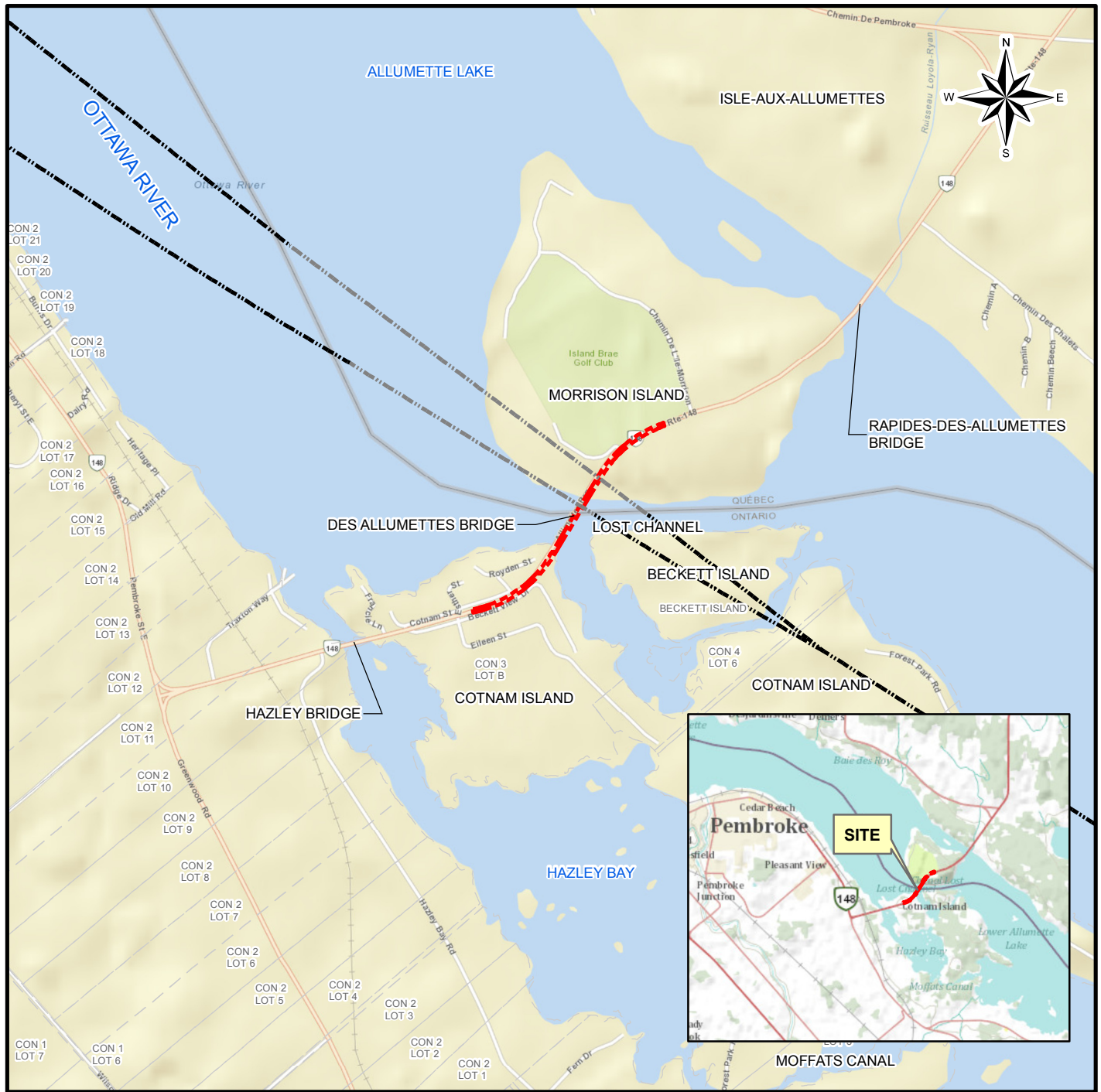
Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder's report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder's report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.

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500 0 500
SCALE 1:25,000 METRES

LEGEND

- APPROXIMATE FAULT LOCATION
(BASED ON PUBLISHED MAPPING)
- SITE

NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH
THE ACCOMPANYING GOLDER ASSOCIATES LTD.
REPORT No. 11-1121-0290-2000

REFERENCE

BASE DATA PROVIDED BY ESRI CANADA
ARCGIS ONLINE 2011
DATUM: NAD 83, COORDINATE SYSTEM: MTM ZONE 9
FAULT DATA OBTAINED FROM " PALEOZOIC GEOLOGY
OF SOUTHERN ONTARIO, ONTARIO GEOLOGICAL SURVEY,
MISCELLANEOUS RELEASE - DATA 219



| | |
|--------|-----------|
| DATE | Nov. 2013 |
| DESIGN | CK |
| GIS | BR |

TITLE

KEY PLAN

| | |
|---------|---|
| PROJECT | GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT OTTAWA RIVER, ONTARIO - QUEBEC |
|---------|---|

FIGURE 1

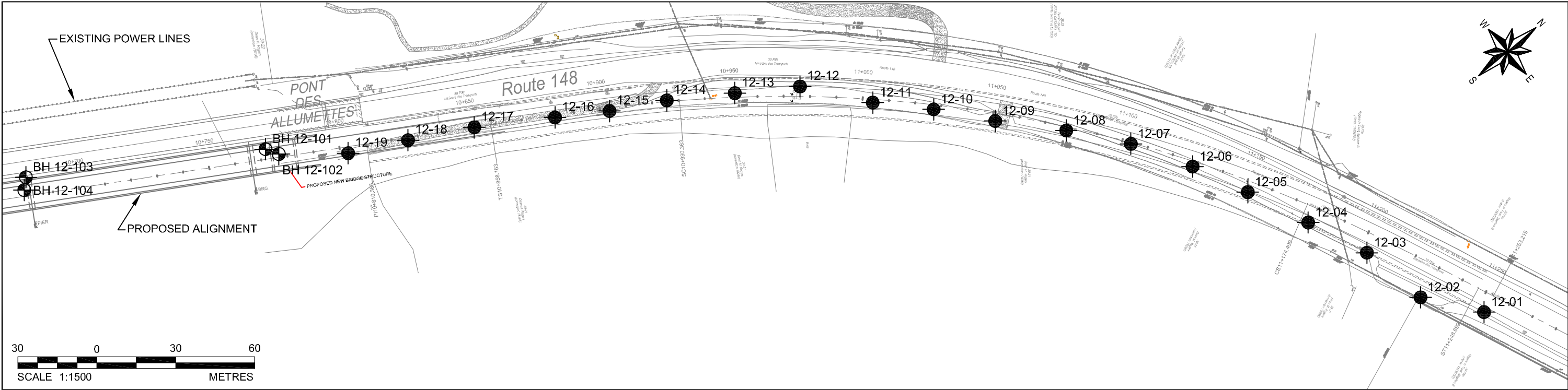
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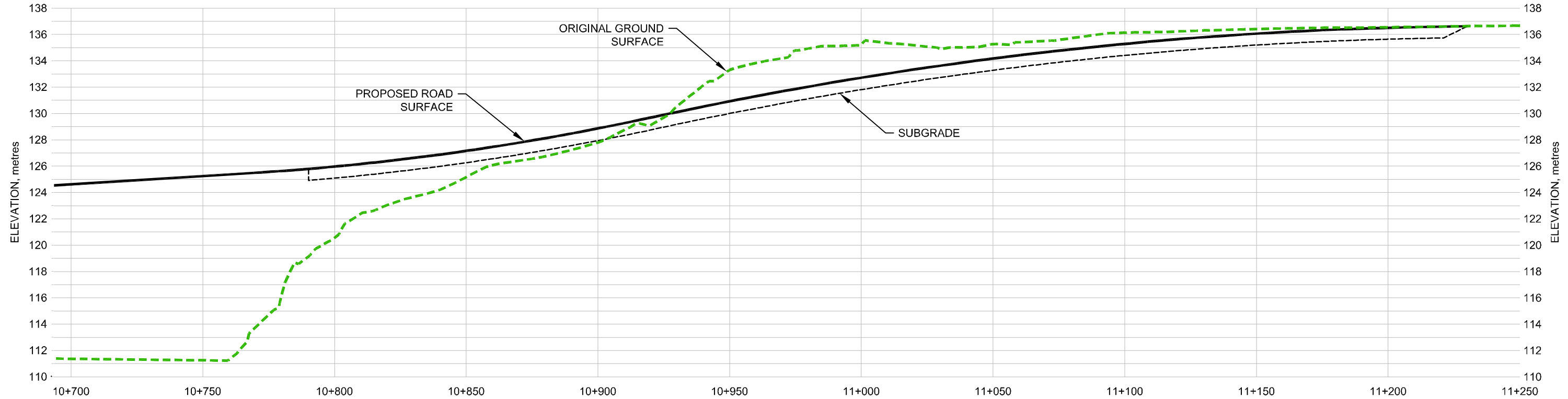
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NORTH APPROACH - QUEBEC



PROFILE

LEGEND

- APPROXIMATE AUGERHOLE LOCATION IN PLAN, CURRENT INVESTIGATION
- APPROXIMATE BOREHOLE LOCATION IN PLAN, CURRENT INVESTIGATION

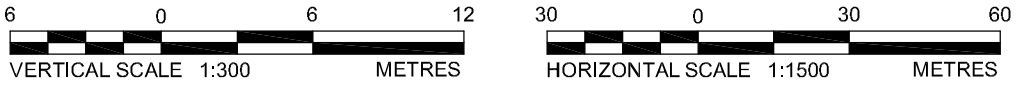
REFERENCE


BASE PLAN PROVIDED IN ELECTRONIC FORMAT BY DELCAN CORPORATION, AUGUST 24, 2012

PROFILE PROVIDED IN ELECTRONIC FORMAT BY DELCAN CORPORATION, JULY 16, 2013

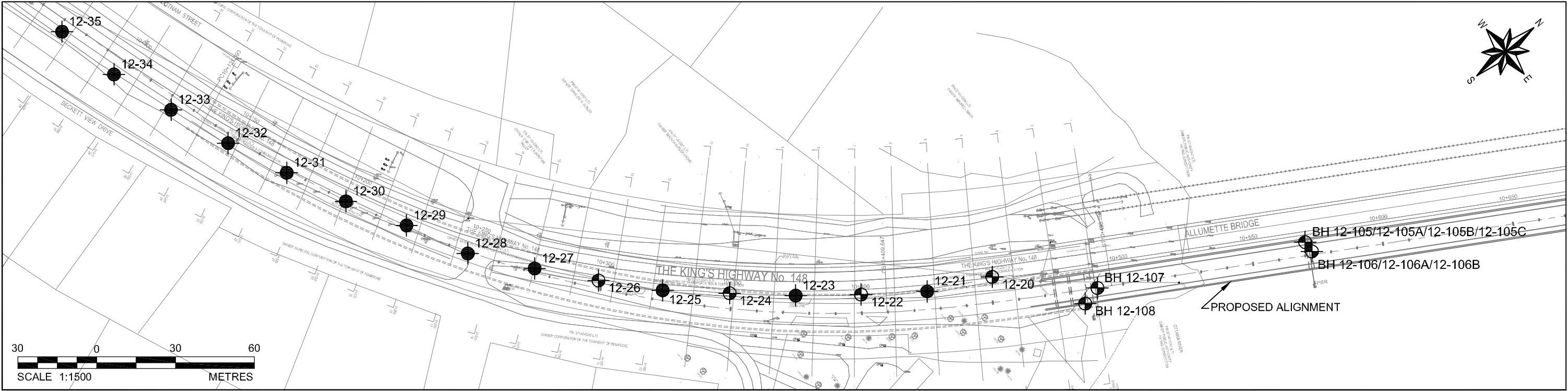
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THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES LTD. REPORT No. 11-1121-0290-2000

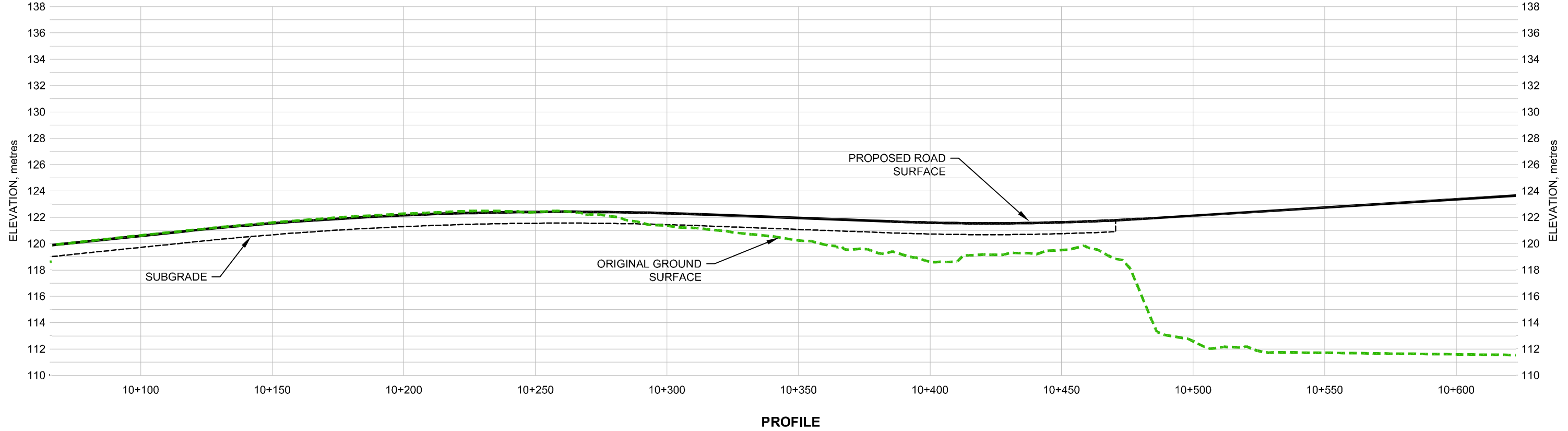


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| | | DATE | Nov. 2013 | | |
| | | DESIGN | C.K. | | |
| | | CADD | J.E.M./P.L.G. | | |
| FILE No. 111210290-2000-02r2.dwg | | CHECK | C.K. | GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT OTTAWA RIVER, ONTARIO-QUEBEC | |
| PROJECT No. 11-1121-0290 | REV. | REVIEW | T.M.S. | | |
| | | | | FIGURE | 2A |

FILENAME: \\golder\gds\ga\Ottawa\Active\2011\11-1121-0290 PWGSC Des Allumettes Bridge EA\Spatial\IM\CAD\Phase 2000\111210290-2000-02r2.dwg



SOUTH APPROACH - ONTARIO



PROFILE

LEGEND

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- APPROXIMATE BOREHOLE LOCATION IN PLAN, CURRENT INVESTIGATION

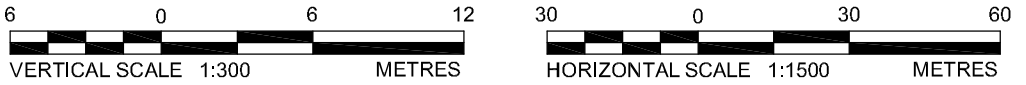
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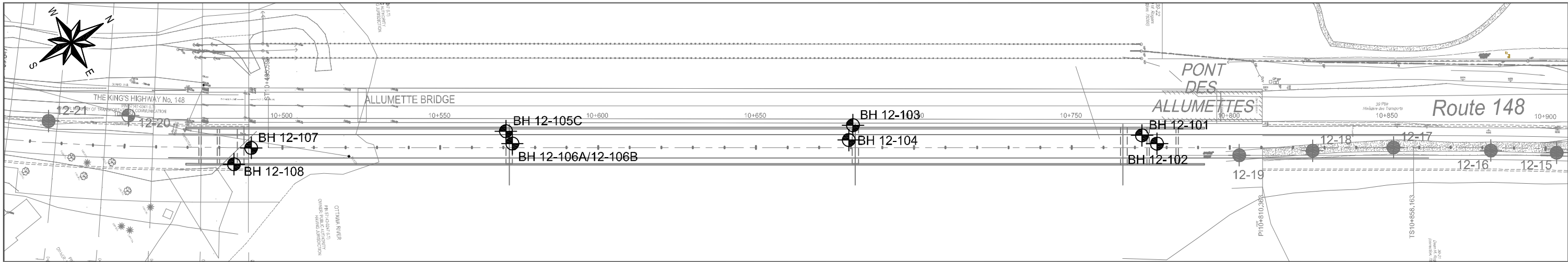
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THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES LTD. REPORT No. 11-1121-0290-2000

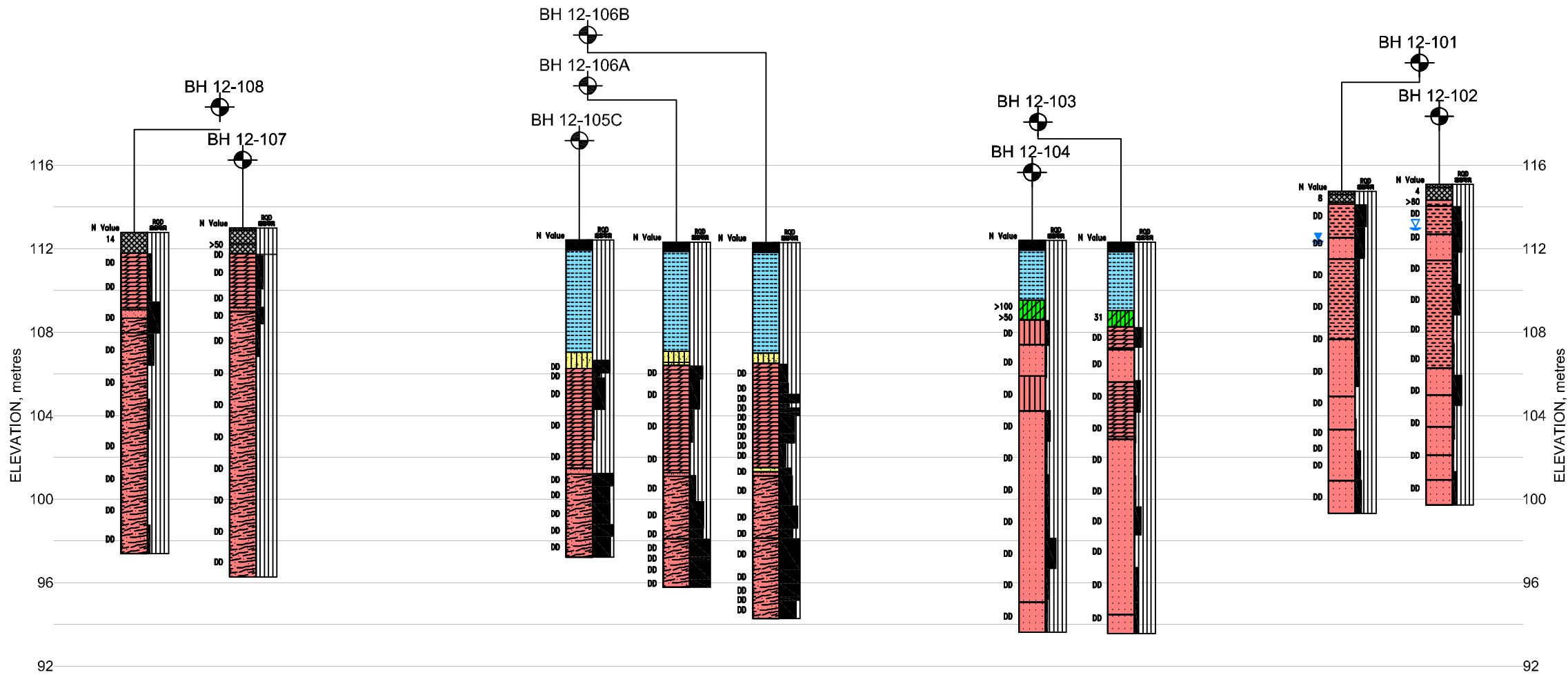


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| | | DATE | Nov. 2013 | | |
| | | DESIGN | C.K. | | |
| | | CADD | J.E.M./P.L.G. | | |
| FILE No. 111210290-2000-02r2.dwg | | CHECK | C.K. | GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT OTTAWA RIVER, ONTARIO-QUEBEC | |
| PROJECT No. 11-1121-0290 | | REV. | REVIEW T.M.S. | | |
| | | | | FIGURE | 2B |

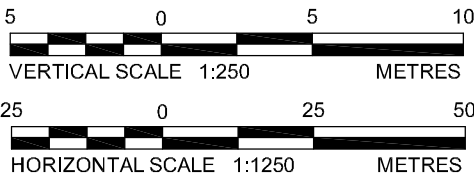
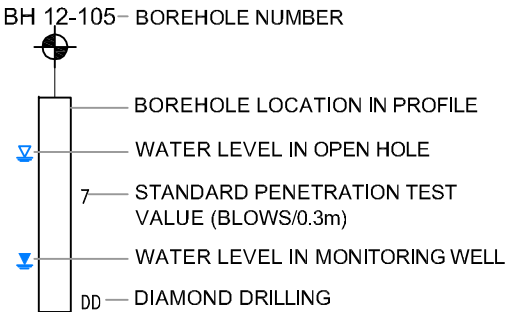
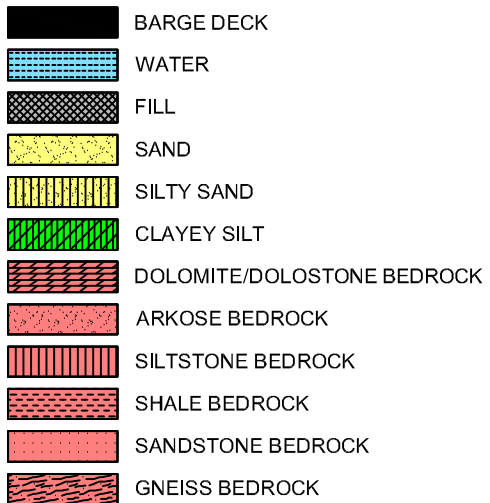
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PLAN VIEW



SUBSURFACE STRATIGRAPHY



LEGEND

- APPROXIMATE AUGERHOLE LOCATION IN PLAN, CURRENT INVESTIGATION
- APPROXIMATE BOREHOLE LOCATION IN PLAN, CURRENT INVESTIGATION


REFERENCE

BASE PLAN PROVIDED IN ELECTRONIC FORMAT BY DELCAN CORPORATION, AUGUST 24, 2012

NOTE

- THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES LTD. REPORT No. 11-1121-0290-2000
- MULTIPLE ATTEMPTS MADE TO ADVANCE BH 12-105 AND BH 12-106. ONLY SELECTED BOREHOLE INFORMATION IS SHOWN
- SOME BOREHOLES AND AUGERHOLES ARE 'GREYED OUT' FOR CLARITY



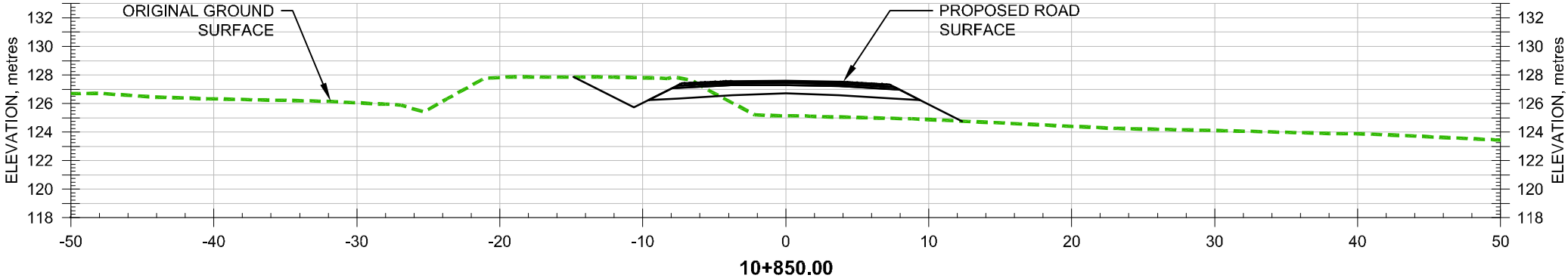
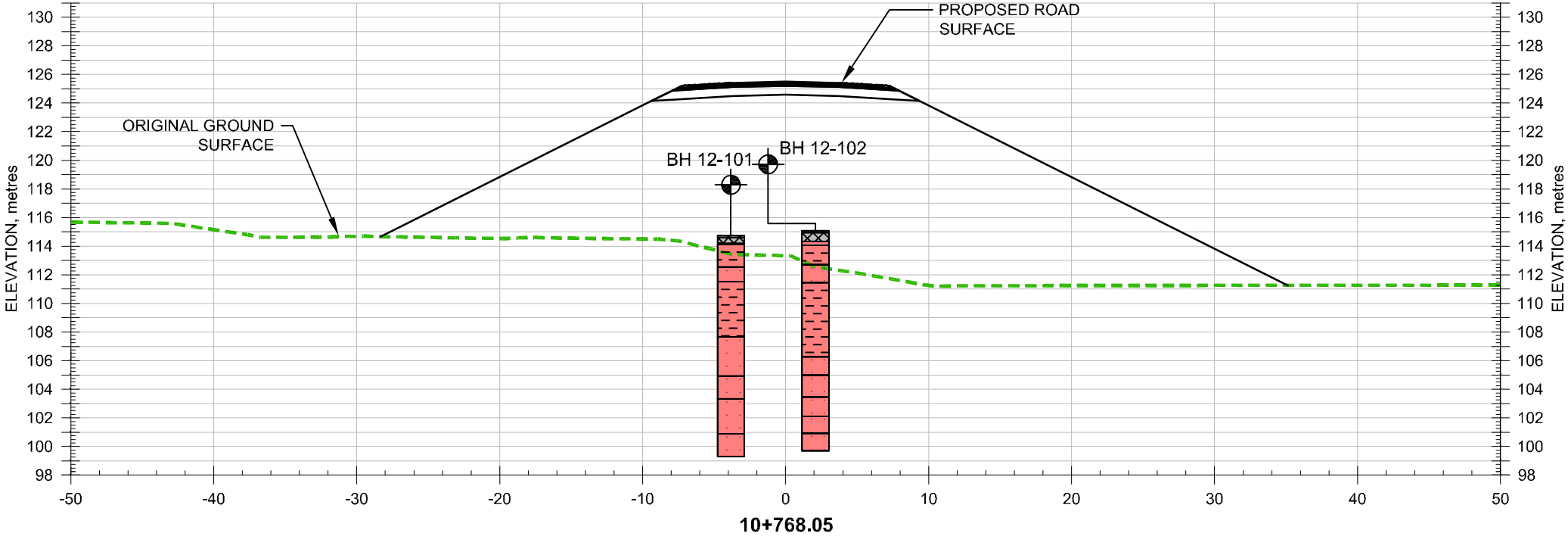
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|---|-------------------------|--------|-----------|--------|
|  Golder Associates Ottawa, Ontario | | SCALE | AS SHOWN | |
| | | DATE | Nov. 2013 | |
| | | DESIGN | C.K. | |
| | | CADD | P.L.G. | |
| | | CHECK | C.K. | |
| FILE No. | 111210290-2000-02r2.dwg | | REVIEW | T.M.S. |
| PROJECT No. | 11-1121-0290 | REV. | | |

SITE PLAN AND STRATIGRAPHIC PROFILE

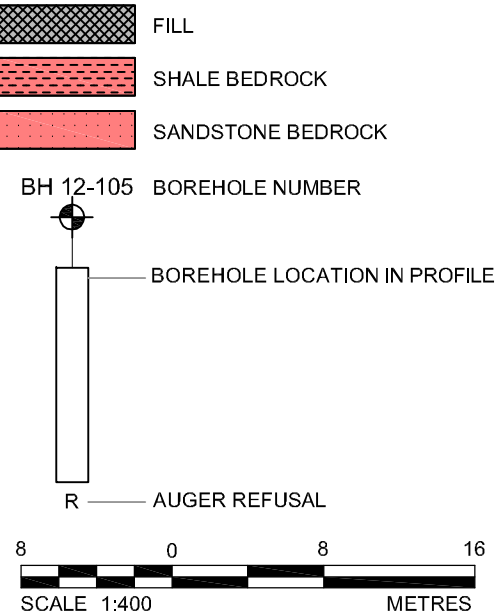
GEOTECHNICAL INVESTIGATION
DES ALLUMETTES BRIDGE REPLACEMENT
OTTAWA RIVER, ONTARIO-QUEBEC

FIGURE 2C

FILENAME: \\golder.gds\ga\Ottawa\Active\2011\1121 - Geotechnical\11-1121-0290 PWGSC Des Allumettes Bridge EA\Spatial_IM\CAD\Phase 2000\111210290-2000-02r2.dwg



SUBSURFACE STRATIGRAPHY




REFERENCE

BASE PLAN PROVIDED IN ELECTRONIC FORMAT
BY DELCAN CORPORATION, AUGUST 24, 2012

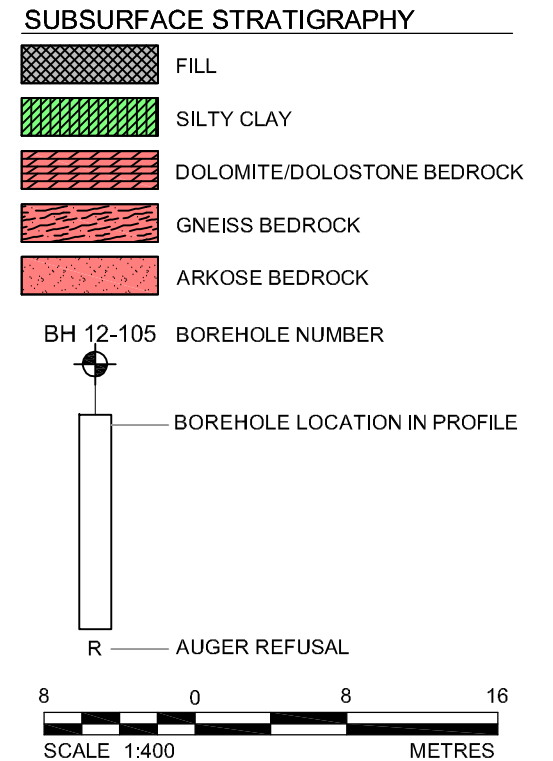
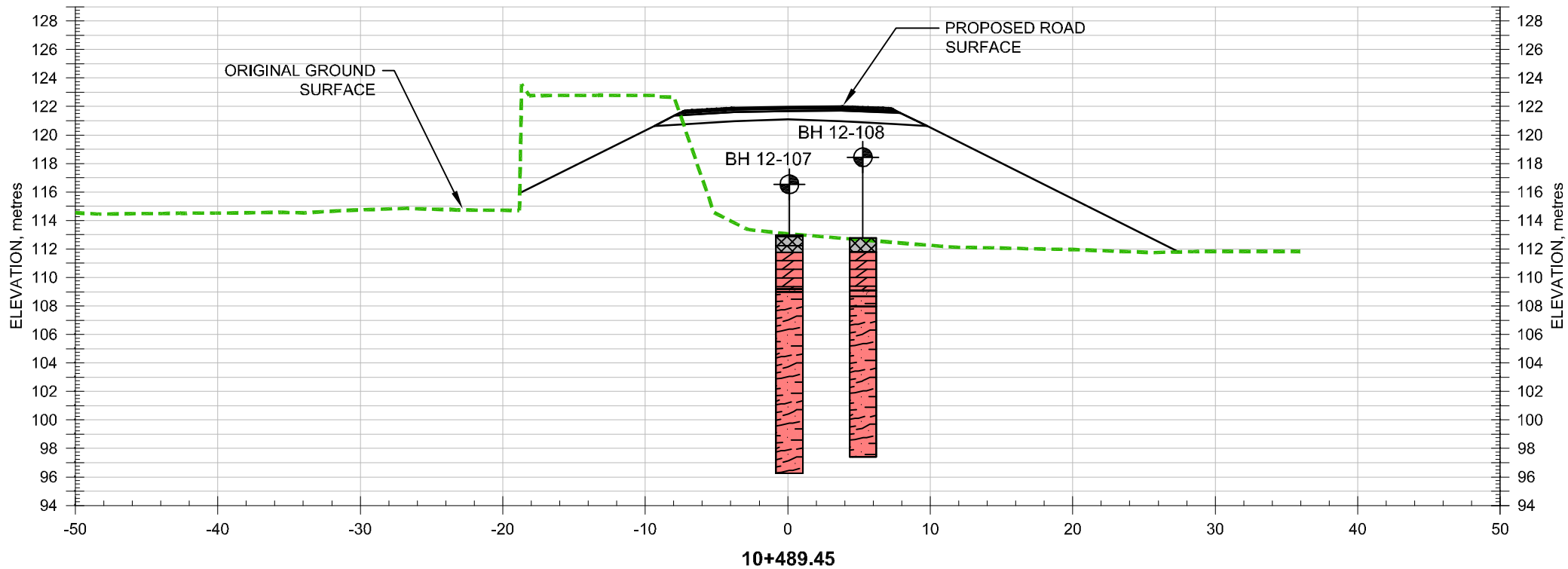
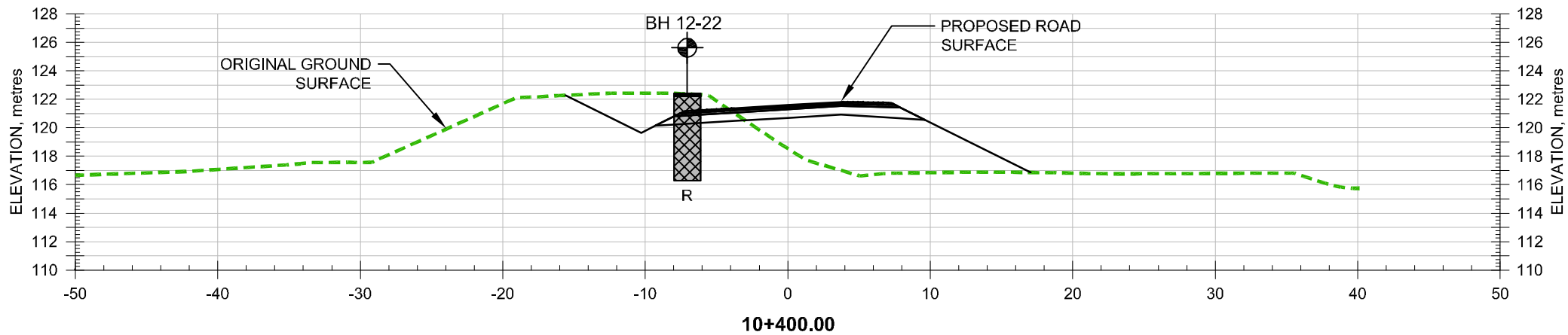
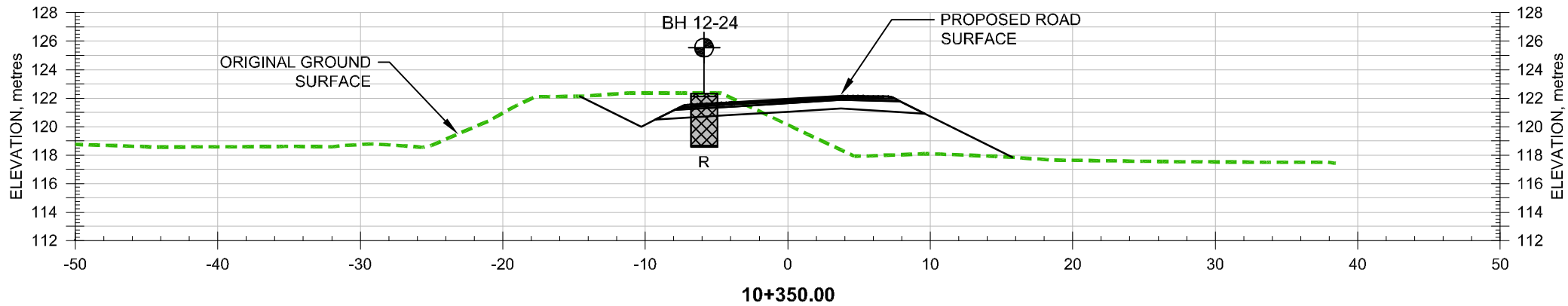
PROFILE PROVIDED IN ELECTRONIC FORMAT
BY DELCAN CORPORATION, JULY 16, 2013

NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE
ACCOMPANYING GOLDER ASSOCIATES LTD.
REPORT No. 11-1121-0290-2000

| | | | |
|--|--------|---------------|---|
|  Golder Associates Ottawa, Ontario | SCALE | AS SHOWN | CROSS-SECTIONS 10+768.05 AND 10+850 |
| | DATE | Nov. 2013 | |
| | DESIGN | C.K. | |
| | CADD | J.E.M./P.L.G. | |
| FILE No. 111210290-2000-02r2.dwg | CHECK | C.K. | GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT OTTAWA RIVER, ONTARIO-QUEBEC |
| PROJECT No. 11-1121-0290 | REV. | REVIEW T.M.S. | |
| | | | FIGURE 2D |

FILENAME: \\golder.gds\gal\Ottawa\Active\2011\1121 - Geotechnical\11-1121-0290 PWGSC Des Allumettes Bridge EA\Spatial_IM\CAD\Phase 2000\111210290-2000-02r2.dwg




REFERENCE

BASE PLAN PROVIDED IN ELECTRONIC FORMAT
BY DELCAN CORPORATION, AUGUST 24, 2012

PROFILE PROVIDED IN ELECTRONIC FORMAT
BY DELCAN CORPORATION, JULY 16, 2013

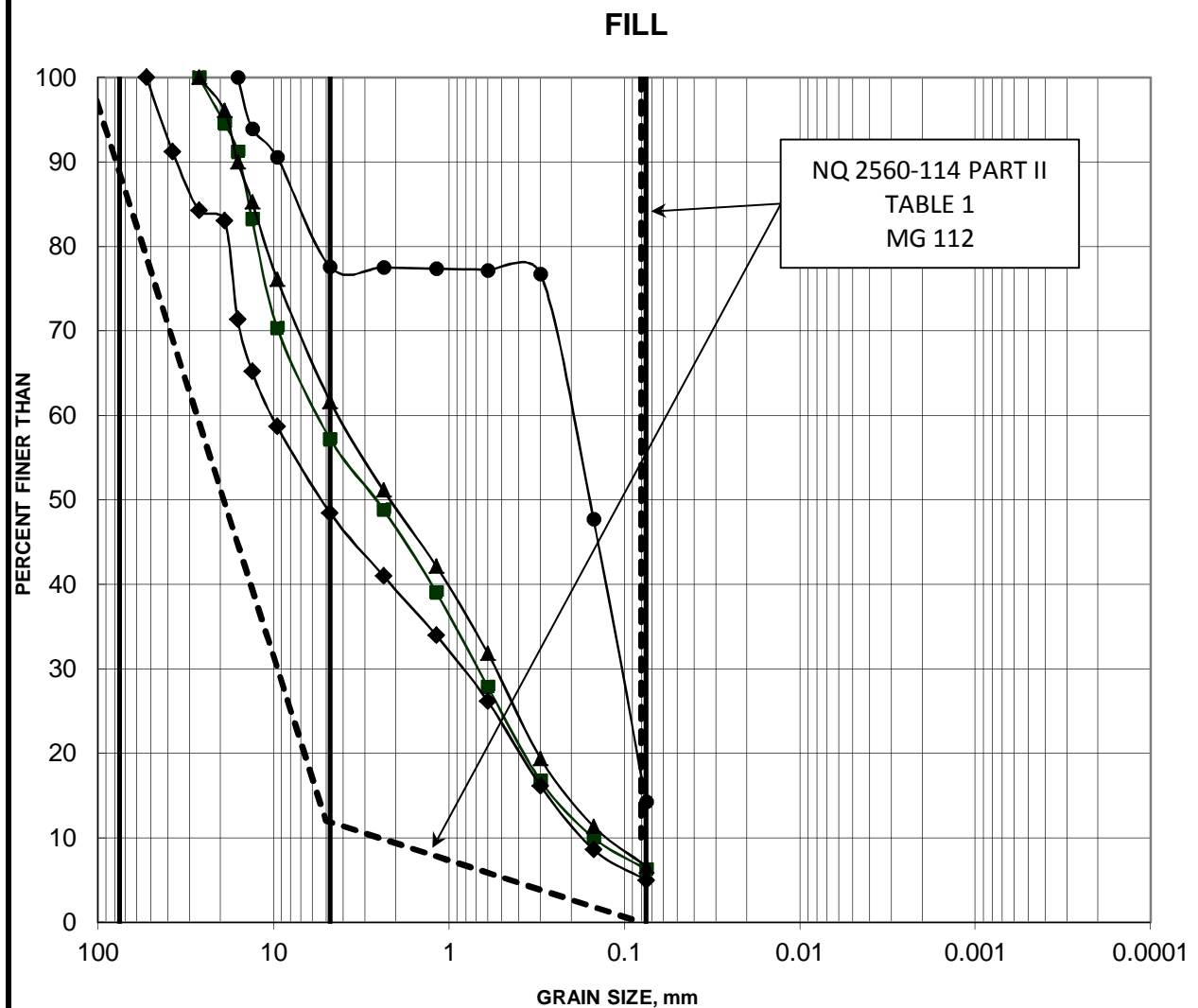
NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE
ACCOMPANYING GOLDER ASSOCIATES LTD.
REPORT No. 11-1121-0290-2000

| | | | |
|---|--------|---------------|---|
|  Golder Associates Ottawa, Ontario | SCALE | AS SHOWN | CROSS-SECTIONS 10+350, 10+400, AND 10+489.45 |
| | DATE | Nov. 2013 | |
| | DESIGN | C.K. | |
| | CADD | J.E.M./P.L.G. | |
| FILE No. 111210290-2000-02r2.dwg | CHECK | C.K. | GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT OTTAWA RIVER, ONTARIO-QUEBEC |
| PROJECT No. 11-1121-0290 | REVIEW | T.M.S. | |
| FIGURE | | | 2E |

GRAIN SIZE DISTRIBUTION

FIGURE 3



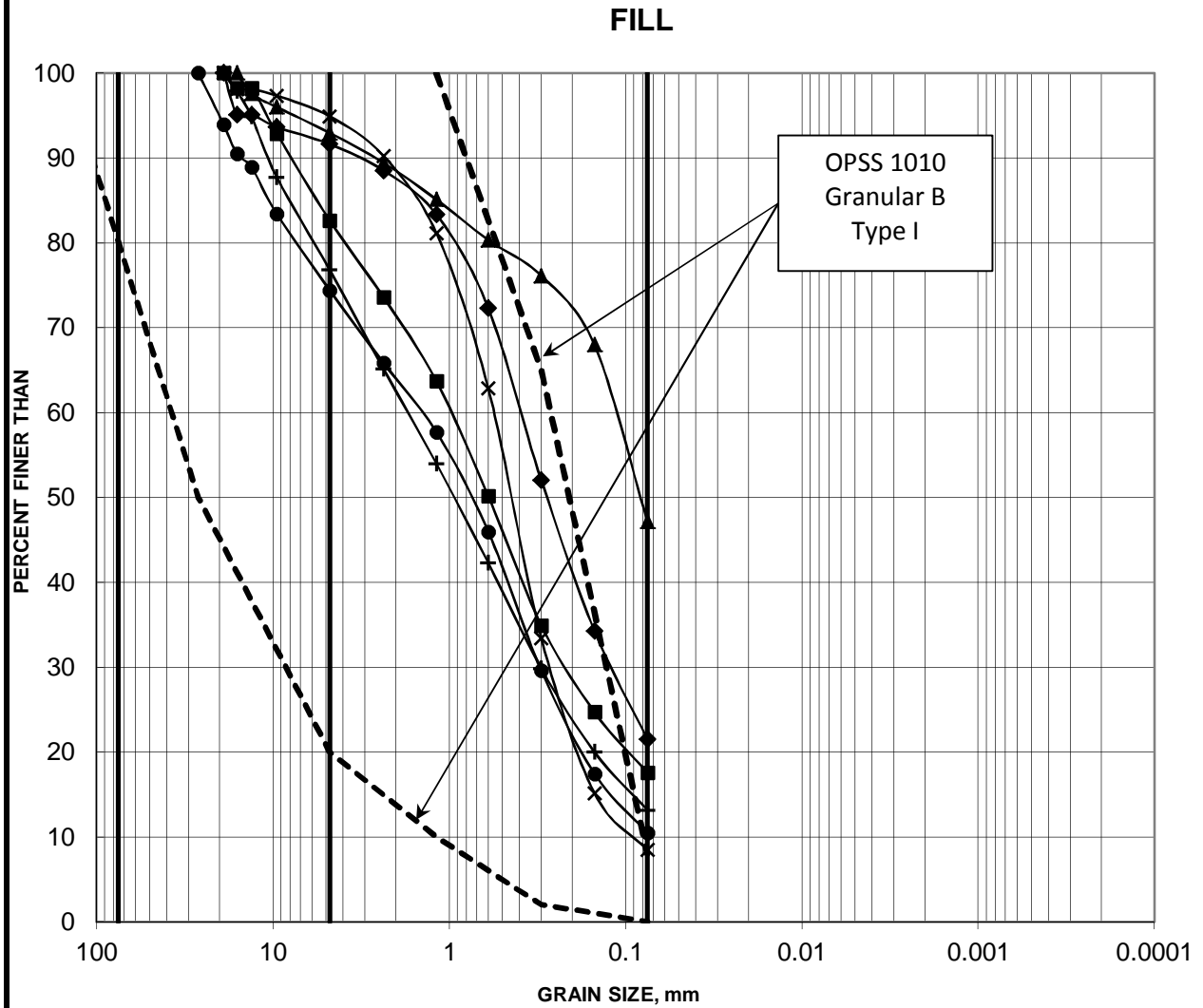
| | | | | | | |
|--------|-------------|------|-----------|--------|------|---------------|
| Cobble | coarse | fine | coarse | medium | fine | SILT AND CLAY |
| Size | GRAVEL SIZE | | SAND SIZE | | | |

| Augerhole | Sample | Depth (m) |
|-----------|--------|-----------|
| 12-07 | 1 | 0.10-0.25 |
| 12-15 | 1 | 0.20-0.30 |
| 12-18 | 1 | 0.00-0.10 |
| 12-18 | 2 | 0.30-0.45 |

Notes : - Sand and gravel particles :
 - Rounded to angular
 - Hard and durable

GRAIN SIZE DISTRIBUTION

FIGURE 4



| Cobble Size | coarse | fine | coarse | medium | fine | SILT AND CLAY |
|----------------|-------------|------|-----------|--------|------|---------------|
| | GRAVEL SIZE | | SAND SIZE | | | |

| Augerhole | Sample | Depth (m) |
|-----------|--------|-----------|
| ■ | 12-21 | 1 |
| ◆ | 12-21 | 2 |
| ▲ | 12-25 | 2 |
| ● | 12-32 | 1 |
| + | 12-34 | 1 |
| × | 12-35 | 1 |

Notes : - Sand and gravel particles :
 - Rounded to angular
 - Hard and durable

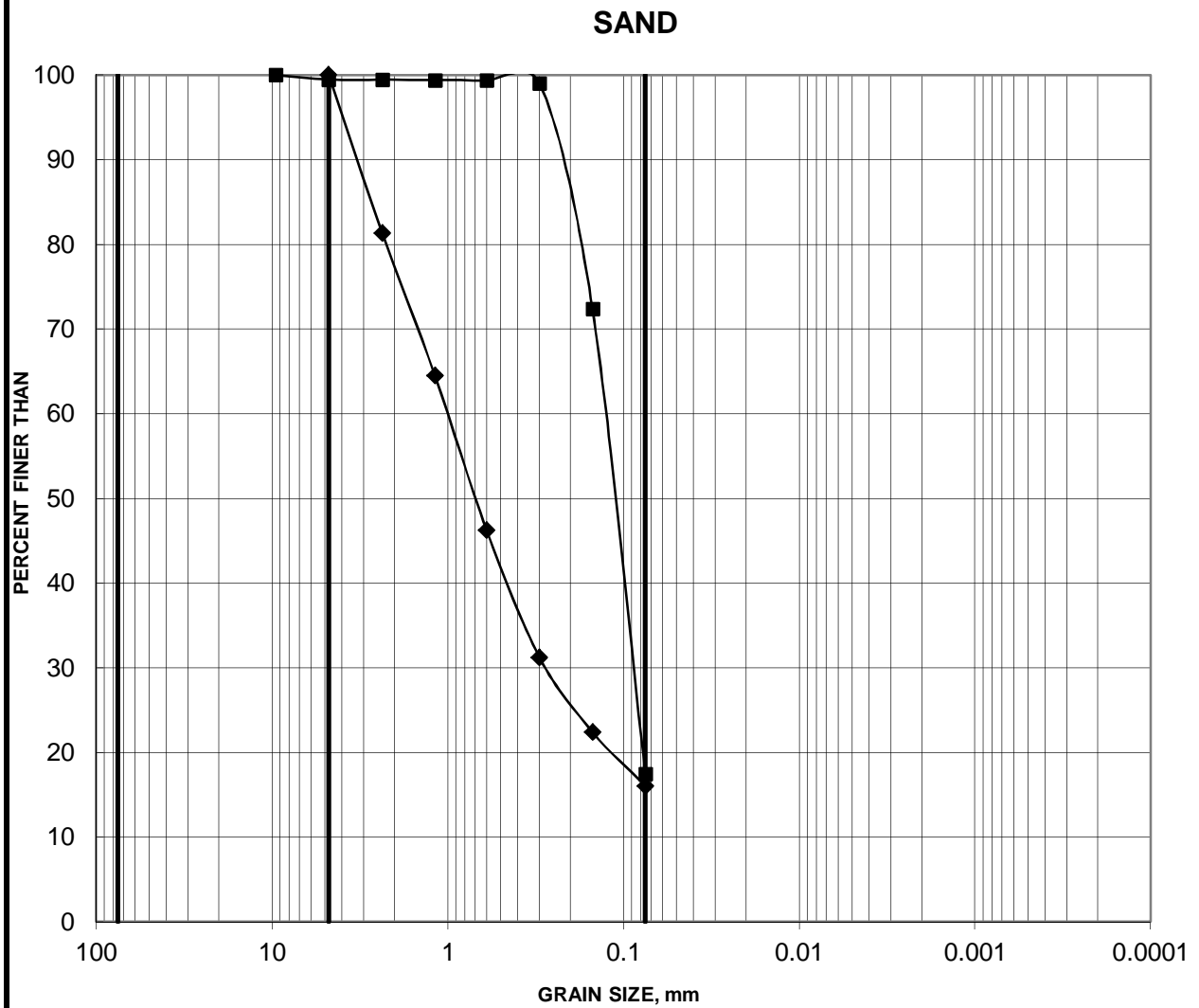
Project: 11-1121-0290

Golder Associates

Created by: CW
 Checked by: CNM

GRAIN SIZE DISTRIBUTION

FIGURE 5

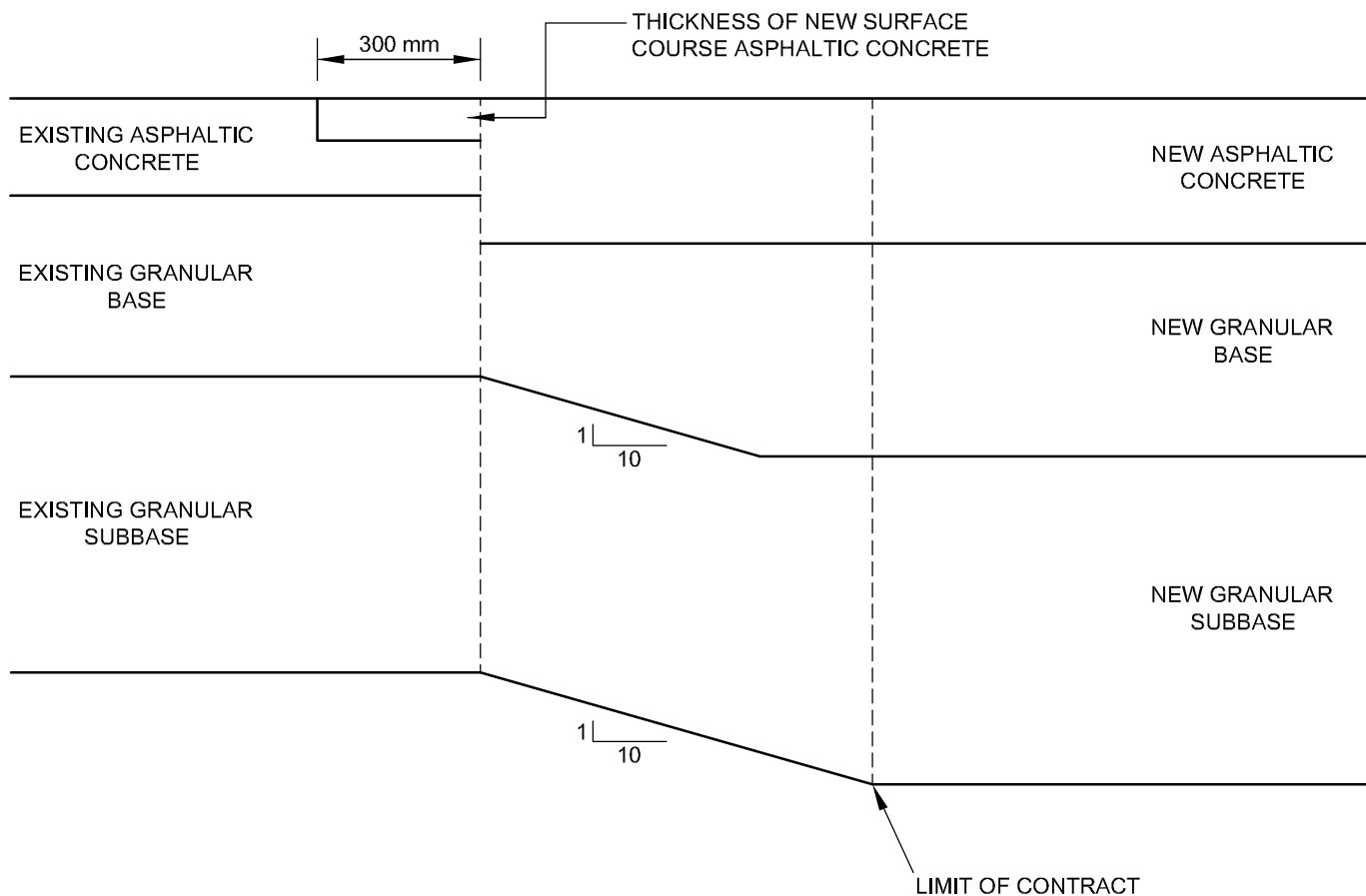


| | | | | | | |
|--------|-------------|------|-----------|--------|------|---------------|
| Cobble | coarse | fine | coarse | medium | fine | SILT AND CLAY |
| Size | GRAVEL SIZE | | SAND SIZE | | | |

| Augerhole | Sample | Depth (m) |
|-----------|--------|-----------|
| 12-03 | 2 | 0.65-0.75 |
| 12-06 | 2 | 1.00-1.07 |

Notes : - Sand and gravel particles :
 - Rounded to angular
 - Hard and durable

PLOT DATE: November 29, 2013
FILENAME: N:\Active\2011\1121 - Geotechnical\11-1121-0290 PWGSC Des Allumettes Bridge EA\Spatial\IM\CAD\Phase 2000\111210290-2000-06.dwg



NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING
GOLDER ASSOCIATES LTD. REPORT No. 11-1121-0290-2000



| | |
|--------|------------|
| SCALE | NTS |
| DATE | March 2013 |
| DESIGN | |
| CAD | P.L.G. |
| CHECK | C.K. |
| REVIEW | M.G.G. |

LONGITUDINAL TRANSITION

GEOTECHNICAL INVESTIGATION
DES ALLUMETTES BRIDGE REPLACEMENT
OTTAWA RIVER, ONTARIO - QUEBEC

FIGURE

6



APPENDIX A

List of Abbreviations and Symbols

Lithological and Geotechnical Rock Description Terminology

Record of Augerhole, Borehole and Drillhole Sheets

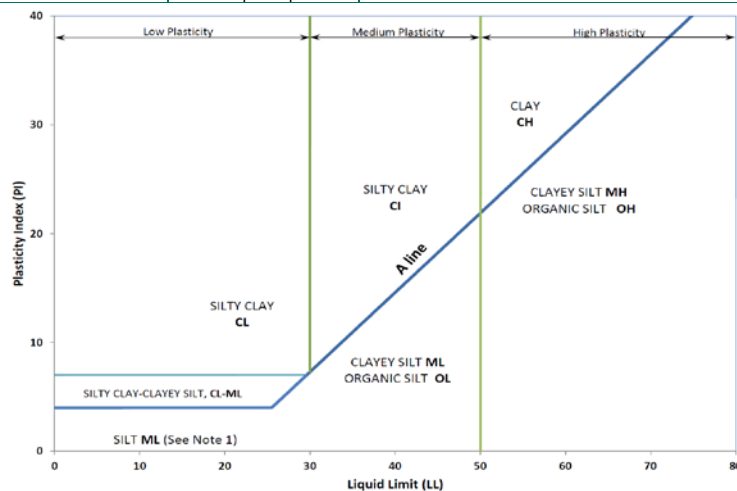
Current Investigation by Golder Associates



METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

| Organic or Inorganic | Soil Group | Type of Soil | | Gradation or Plasticity | $Cu = \frac{D_{60}}{D_{10}}$ | | $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ | | | Organic Content | USCS Group Symbol | Group Name | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--|---|---|--|--|------------------------------|----------------------------|--|---|---|-----------------|-------------------------------|------------------------------|-------------------|------------------------|-------|------|------|---------|------------------------------|--------|----|------|------|-------------|------|-------------|-------------|--------|----|-------------|------------------------|-------------------|---------------|----------------|-------------|-----|-----------|----|--------------|-------------------|---------------|--------|-------------|---------------|--------|----|-------------|------|----------------|----------------|--------------|----------------|-----------|----|--------------|--|--------------------|------|---------------|-----------------|-------------|---------------|-------------------------------|----|------------|-----------------------|------|----------------|-----------------|--------------|--------|----|------------|------------------------|------|------|-------|---------|------|----|------|---|--|--------------------------------|--|--|--|--|--|--|--|------------|----|------------------------|--|--|--|--|
| INORGANIC (Organic Content $\leq 30\%$ by mass) | COARSE-GRAINED SOILS ($>50\%$ by mass is larger than 0.075 mm) | GRAVELS ($>50\%$ by mass of coarse fraction is larger than 4.75 mm) | Gravels with $\leq 12\%$ fines (by mass) | Poorly Graded | <4 | | ≤ 1 or ≥ 3 | | | $\leq 30\%$ | GP | GRAVEL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | Well Graded | ≥ 4 | | 1 to 3 | | | | GW | GRAVEL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | Gravels with $> 12\%$ fines (by mass) | Below A Line | n/a | | | | | | | GM | SILTY GRAVEL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | Above A Line | n/a | | | | | | | GC | CLAYEY GRAVEL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | SANDS ($\geq 50\%$ by mass of coarse fraction is smaller than 4.75 mm) | Sands with $\leq 12\%$ fines (by mass) | Poorly Graded | <6 | | ≤ 1 or ≥ 3 | | | | SP | SAND | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | Well Graded | ≥ 6 | | 1 to 3 | | | | SW | SAND | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | Sands with $> 12\%$ fines (by mass) | Below A Line | n/a | | | | | | | SM | SILTY SAND | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | Above A Line | n/a | | | | | | | SC | CLAYEY SAND | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Organic or Inorganic | Soil Group | Type of Soil | | Laboratory Tests | Field Indicators | | | | | Organic Content | USCS Group Symbol | Primary Name | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Dilatancy | Dry Strength | Shine Test | Thread Diameter | Toughness (of 3 mm thread) | INORGANIC (Organic Content $\leq 30\%$ by mass) | FINE-GRAINED SOILS ($\geq 50\%$ by mass is smaller than 0.075 mm) | SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below) | | Liquid Limit <50 | | | | Rapid | None | None | >6 mm | N/A (can't roll 3 mm thread) | $<5\%$ | ML | SILT | Slow | None to Low | Dull | 3mm to 6 mm | None to low | $<5\%$ | ML | CLAYEY SILT | Liquid Limit ≥ 50 | Slow to very slow | Low to medium | Dull to slight | 3mm to 6 mm | Low | 5% to 30% | OL | ORGANIC SILT | Slow to very slow | Low to medium | Slight | 3mm to 6 mm | Low to medium | $<5\%$ | MH | CLAYEY SILT | None | Medium to high | Dull to slight | 1 mm to 3 mm | Medium to high | 5% to 30% | OH | ORGANIC SILT | CLAYS (PI and LL plot above A-Line on Plasticity Chart below) | Liquid Limit <30 | None | Low to medium | Slight to shiny | ~ 3 mm | Low to medium | 0% to 30% (see Note 2) | CL | SILTY CLAY | Liquid Limit 30 to 50 | None | Medium to high | Slight to shiny | 1 mm to 3 mm | Medium | CI | SILTY CLAY | Liquid Limit ≥ 50 | None | High | Shiny | <1 mm | High | CH | CLAY | HIGHLY ORGANIC SOILS (Organic Content $>30\%$ by mass) | | Peat and mineral soil mixtures | | | | | | | | 30% to 75% | PT | SILTY PEAT, SANDY PEAT | Predominantly peat, may contain some mineral soil, fibrous or amorphous peat | | | |
| INORGANIC (Organic Content $\leq 30\%$ by mass) | FINE-GRAINED SOILS ($\geq 50\%$ by mass is smaller than 0.075 mm) | SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below) | Liquid Limit <50 | Rapid | None | None | | | | >6 mm | | N/A (can't roll 3 mm thread) | $<5\%$ | ML | SILT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | Slow | None to Low | Dull | | | | 3mm to 6 mm | None to low | $<5\%$ | ML | CLAYEY SILT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | Liquid Limit ≥ 50 | Slow to very slow | Low to medium | Dull to slight | | | | 3mm to 6 mm | Low | 5% to 30% | OL | ORGANIC SILT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | Slow to very slow | Low to medium | Slight | | | | 3mm to 6 mm | Low to medium | $<5\%$ | MH | CLAYEY SILT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | None | Medium to high | Dull to slight | | | 1 mm to 3 mm | Medium to high | 5% to 30% | OH | ORGANIC SILT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | CLAYS (PI and LL plot above A-Line on Plasticity Chart below) | Liquid Limit <30 | None | Low to medium | Slight to shiny | | | ~ 3 mm | Low to medium | 0% to 30% (see Note 2) | CL | SILTY CLAY | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | Liquid Limit 30 to 50 | None | Medium to high | Slight to shiny | | | 1 mm to 3 mm | Medium | | CI | SILTY CLAY | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | Liquid Limit ≥ 50 | None | High | Shiny | | | <1 mm | High | | CH | CLAY | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | HIGHLY ORGANIC SOILS (Organic Content $>30\%$ by mass) | | Peat and mineral soil mixtures | | | | | | | | 30% to 75% | PT | SILTY PEAT, SANDY PEAT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | Predominantly peat, may contain some mineral soil, fibrous or amorphous peat | | | | | | | | 75% to 100% | | PEAT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.

Note 2 – For soils with $<5\%$ organic content, include the descriptor “trace organics” for soils with between 5% and 30% organic content include the prefix “organic” before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.

For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between “clean” and “dirty” sand or gravel.

For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.

A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to indicate a range of similar soil types within a stratum.



ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

| Soil Constituent | Particle Size Description | Millimetres | Inches (US Std. Sieve Size) |
|------------------|---------------------------|---|--|
| BOULDERS | Not Applicable | >300 | >12 |
| COBBLES | Not Applicable | 75 to 300 | 3 to 12 |
| GRAVEL | Coarse Fine | 19 to 75 4.75 to 19 | 0.75 to 3 (4) to 0.75 |
| SAND | Coarse Medium Fine | 2.00 to 4.75 0.425 to 2.00 0.075 to 0.425 | (10) to (4) (40) to (10) (200) to (40) |
| SILT/CLAY | Classified by plasticity | <0.075 | < (200) |

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

| Percentage by Mass | Modifier |
|--------------------|--|
| >35 | Use 'and' to combine major constituents (i.e., SAND and GRAVEL, SAND and CLAY) |
| > 12 to 35 | Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable |
| > 5 to 12 | some |
| ≤ 5 | trace |

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.).

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d :

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

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

SAMPLES

| | |
|----------|--|
| AS | Auger sample |
| BS | Block sample |
| CS | Chunk sample |
| DO or DP | Seamless open ended, driven or pushed tube sampler – note size |
| DS | Denison type sample |
| FS | Foil sample |
| RC | Rock core |
| SC | Soil core |
| SS | Split spoon sampler – note size |
| ST | Slotted tube |
| TO | Thin-walled, open – note size |
| TP | Thin-walled, piston – note size |
| WS | Wash sample |

SOIL TESTS

| | |
|-----------------|---|
| w | water content |
| PL, w_p | plastic limit |
| LL, w_L | liquid limit |
| C | consolidation (oedometer) test |
| CHEM | chemical analysis (refer to text) |
| CID | consolidated isotropically drained triaxial test ¹ |
| CIU | consolidated isotropically undrained triaxial test with porewater pressure measurement ¹ |
| D_R | relative density (specific gravity, G_s) |
| DS | direct shear test |
| GS | specific gravity |
| M | sieve analysis for particle size |
| MH | combined sieve and hydrometer (H) analysis |
| MPC | Modified Proctor compaction test |
| SPC | Standard Proctor compaction test |
| OC | organic content test |
| SO ₄ | concentration of water-soluble sulphates |
| UC | unconfined compression test |
| UU | unconsolidated undrained triaxial test |
| V (FV) | field vane (LV-laboratory vane test) |
| Y | unit weight |

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

NON-COHESIVE (COHESIONLESS) SOILS

Compactness²

| Term | SPT 'N' (blows/0.3m) ¹ |
|------------|-----------------------------------|
| Very Loose | 0 - 4 |
| Loose | 4 to 10 |
| Compact | 10 to 30 |
| Dense | 30 to 50 |
| Very Dense | >50 |

- SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects.
- Definition of compactness descriptions based on SPT 'N' ranges from Terzaghi and Peck (1967) and correspond to typical average N_{60} values.

Field Moisture Condition

| Term | Description |
|-------|---|
| Dry | Soil flows freely through fingers. |
| Moist | Soils are darker than in the dry condition and may feel cool. |
| Wet | As moist, but with free water forming on hands when handled. |

COHESIVE SOILS

Consistency

| Term | Undrained Shear Strength (kPa) | SPT 'N' ¹ (blows/0.3m) |
|------------|--------------------------------|-----------------------------------|
| Very Soft | <12 | 0 to 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 | >200 | >30 |

- SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.

Water Content

| Term | Description |
|-------------|--|
| $w < PL$ | Material is estimated to be drier than the Plastic Limit. |
| $w \sim PL$ | Material is estimated to be close to the Plastic Limit. |
| $w > PL$ | Material is estimated to be wetter than the Plastic Limit. |



LIST OF SYMBOLS

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

I. GENERAL

| | |
|-------------|---------------------------------------|
| π | 3.1416 |
| $\ln x$ | natural logarithm of x |
| \log_{10} | x or log x, logarithm of x to base 10 |
| g | acceleration due to gravity |
| t | time |

II. STRESS AND STRAIN

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

III. SOIL PROPERTIES

(a) Index Properties

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

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

| | |
|-------------|---|
| C_c | compression index (normally consolidated range) |
| C_r | recompression index (over-consolidated range) |
| C_s | swelling index |
| C_α | secondary compression index |
| m_v | coefficient of volume change |
| C_v | coefficient of consolidation (vertical direction) |
| C_h | coefficient of consolidation (horizontal direction) |
| T_v | time factor (vertical direction) |
| U | degree of consolidation |
| σ'_p | pre-consolidation stress |
| OCR | over-consolidation ratio = σ'_p / σ'_{vo} |

(d) Shear Strength

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

* Density symbol is ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

Notes: 1
2

$$\tau = c' + \sigma' \tan \phi'$$

$$\text{shear strength} = (\text{compressive strength})/2$$



LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERINGS STATE

Fresh: no visible sign of weathering

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

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

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

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

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

BEDDING THICKNESS

| <u>Description</u> | <u>Bedding Plane Spacing</u> |
|---------------------|------------------------------|
| Very thickly bedded | Greater than 2 m |
| Thickly bedded | 0.6 m to 2 m |
| Medium bedded | 0.2 m to 0.6 m |
| Thinly bedded | 60 mm to 0.2 m |
| Very thinly bedded | 20 mm to 60 mm |
| Laminated | 6 mm to 20 mm |
| Thinly laminated | Less than 6 mm |

JOINT OR FOLIATION SPACING

| <u>Description</u> | <u>Spacing</u> |
|--------------------|------------------|
| Very wide | Greater than 3 m |
| Wide | 1 m to 3 m |
| Moderately close | 0.3 m to 1 m |
| Close | 50 mm to 300 mm |
| Very close | Less than 50 mm |

GRAIN SIZE

| <u>Term</u> | <u>Size*</u> |
|---------------------|-------------------------|
| Very Coarse Grained | Greater than 60 mm |
| Coarse Grained | 2 mm to 60 mm |
| Medium Grained | 60 microns to 2 mm |
| Fine Grained | 2 microns to 60 microns |
| Very Fine Grained | Less than 2 microns |

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

CORE CONDITION

Total Core Recovery (TCR)

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

Solid Core Recovery (SCR)

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

Rock Quality Designation (RQD)

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

DISCONTINUITY DATA

Fracture Index

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

Dip with Respect to Core Axis

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

Description and Notes

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

Abbreviations

| | |
|---------------------|-------------------|
| JN Joint | PL Planar |
| FLT Fault | CU Curved |
| SH Shear | UN Undulating |
| VN Vein | IR Irregular |
| FR Fracture | K Slickensided |
| SY Stylolite | PO Polished |
| BD Bedding | SM Smooth |
| FO Foliation | SR Slightly Rough |
| CO Contact | RO Rough |
| AXJ Axial Joint | VR Very Rough |
| KV Karstic Void | |
| MB Mechanical Break | |

TABLE 1
RECORD OF AUGERHOLES

| AUGERHOLE NUMBER (ELEVATION) | DEPTH (METRES) | DESCRIPTION |
|------------------------------------|-------------------|--|
| 12-01 (136.42 m) | 0.00 – 0.30 | (SP) gravelly SAND, fine to coarse, trace silt; brown; non-cohesive, moist (FILL) |
| | 0.30 – 0.35 | TOPSOIL |
| | 0.35 – 0.50 | (SM) SILTY SAND, fine to medium, with rootlets and organic matter; dark brown; non-cohesive, moist |
| | 0.50 – 0.91 | (SP) SAND, fine to medium, trace to some silt; brown; non-cohesive, moist |
| | 0.91 | Auger Refusal |
| | | <div><div>Sample</div><div>Depth (m)</div><div>10.10 – 0.20</div><div>20.50 – 0.60</div></div> |
| | | |
| 12-02 (136.27 m) | 0.00 – 1.00 | (SP) gravelly SAND, fine to coarse, with cobbles and boulders; brown to dark brown; non-cohesive, moist (FILL) |
| | 1.00 – 1.12 | TOPSOIL |
| | 1.12 | Auger Refusal |
| | | <div><div>Sample</div><div>Depth (m)</div><div>10.15 – 0.35</div><div>21.00 – 1.12</div></div> |
| | | |
| 12-03 (136.23 m) | 0.00 – 0.62 | (SP) gravelly SAND, fine to coarse; dark brown; non-cohesive, moist (FILL) |
| | 0.62 – 1.02 | (SP) SAND, fine, trace to some silt; brown; non-cohesive, moist |
| | 1.02 | Auger Refusal |
| | | <div><div>Sample</div><div>Depth (m)</div><div>Lab Testing</div><div>10.25 – 0.40</div><div>20.65 – 0.75</div><div>M</div></div> |
| | | |

TABLE 1
RECORD OF AUGERHOLES

| AUGERHOLE NUMBER (ELEVATION) | DEPTH (METRES) | DESCRIPTION |
|------------------------------------|-------------------|--|
| 12-04 (136.20 m) | 0.00 – 0.62 | (SP) gravelly SAND, fine to coarse, trace to some silt; dark brown; non-cohesive, moist (FILL) |
| | 0.62 – 1.00 | (SM) SILTY SAND, fine to medium, with organic matter; brown; non-cohesive, moist (FILL) |
| | 1.00 – 1.12 | TOPSOIL |
| | 1.12 | Auger Refusal |
| | | <div> <div>Sample</div> <div>1</div> </div> <div> <div>Depth (m)</div> <div>1.00 – 1.12</div> </div> |
| 12-05 (136.15 m) | 0.00 – 0.55 | (SP) gravelly SAND, fine to coarse, trace silt; dark brown; non-cohesive, moist (FILL) |
| | 0.55 – 0.67 | (SP) SAND, fine to medium, trace to some silt; brown; non-cohesive, moist (FILL) |
| | 0.67 – 0.77 | TOPSOIL |
| | 0.77 – 1.04 | (SP) SAND, fine to medium, trace silt; brown; non-cohesive, moist |
| | 1.04 | Auger Refusal |
| | | <div> <div>Sample</div> <div>1</div> </div> <div> <div>Depth (m)</div> <div>0.20 – 0.30</div> </div> <div> <div>2</div> <div>0.55 – 0.67</div> </div> <div> <div>3</div> <div>0.67 – 0.77</div> </div> |
| 12-06 (136.27 m) | 0.00 – 0.47 | (SP) gravelly SAND, fine to coarse, trace silt; dark brown; non-cohesive, moist (FILL) |
| | 0.47 – 0.62 | TOPSOIL |
| | 0.62 – 1.07 | (SP) SAND, fine to coarse, trace to some silt; brown; non-cohesive, moist |
| | 1.07 | Auger Refusal |
| | | <div> <div>Sample</div> <div>1</div> </div> <div> <div>Depth (m)</div> <div>0.47 – 0.62</div> </div> <div> <div>2</div> <div>1.00 – 1.07</div> </div> <div> <div>Lab Testing</div> <div>M</div> </div> |

TABLE 1
RECORD OF AUGERHOLES

| AUGERHOLE NUMBER (ELEVATION) | DEPTH (METRES) | DESCRIPTION |
|------------------------------------|-------------------|---|
| 12-07 (136.14 m) | 0.00 – 0.40 | (SP-GP) SAND and GRAVEL, fine to coarse, trace silt; dark brown; non-cohesive, moist (FILL) |
| | 0.40 – 0.55 | TOPSOIL |
| | 0.55 – 0.86 | (SP) SAND, fine to medium, trace to some silt; brown; non-cohesive, moist |
| | 0.86 | Auger Refusal |
| | | <div> <div>Sample</div> <div>1</div> </div> <div> <div>Depth (m)</div> <div>0.10 – 0.25</div> </div> <div> <div>Lab Testing</div> <div>M</div> </div> |
| 12-08 (135.53 m) | 0.00 – 0.07 | (SM) SILTY SAND, fine, with organic matter; dark brown; moist (Topsoil FILL) |
| | 0.07 – 0.13 | (SM) SILTY SAND, fine; brown; non-cohesive, moist (FILL) |
| | 0.13 | Shovel Refusal on Bedrock |
| 12-09 (135.71 m) | 0.00 – 0.22 | TOPSOIL |
| | 0.22 – 0.81 | (SP) SAND, fine to medium, trace to some silt; brown; non-cohesive, moist |
| | 0.81 | Auger Refusal |
| | | <div> <div>Sample</div> <div>1</div> </div> <div> <div>Depth (m)</div> <div>0.60 – 0.70</div> </div> |

TABLE 1
RECORD OF AUGERHOLES

| AUGERHOLE NUMBER (ELEVATION) | DEPTH (METRES) | DESCRIPTION |
|------------------------------------|---|---|
| 12-10 (135.06 m) | 0.00 – 0.20 | (SP) SAND, fine to medium, trace to some silt, with rootlets and organic matter; dark brown; non-cohesive, moist (Topsoil FILL) |
| | 0.20 – 0.55 | (SP) SAND, fine to medium, trace silt; brown; non-cohesive, moist (FILL) |
| | 0.55 – 0.70 | TOPSOIL |
| | 0.70 – 1.50 | (SM) SILTY SAND, fine, trace to some gravel, with cobbles; dark brown to brown; non-cohesive, moist |
| | 1.50 | End of Augerhole |
| | | <div><div>Sample</div><div>Depth (m)</div></div> |
| | | <div><div>1</div><div>0.35 – 0.45</div></div> |
| 12-11 (135.61 m) | 0.00 – 0.34 | TOPSOIL |
| | 0.34 – 0.45 | (SP) SAND, fine to medium, trace silt; brown; non-cohesive, moist |
| | 0.45 | Shovel Refusal on Bedrock |
| 12-12 (134.69 m) | 0.00 | Shovel Refusal on Exposed Bedrock |
| 12-13 (133.49 m) | 0.00 – 0.25 | TOPSOIL |
| | 0.25 – 0.91 | (SM) SILTY SAND, fine, trace gravel, with cobbles; brown; non-cohesive, moist |
| | 0.91 – 1.40 | Highly weathered SANDSTONE BEDROCK |
| | 1.40 | Auger Refusal |
| | | <div><div>Sample</div><div>Depth (m)</div></div> |
| | <div><div>1</div><div>0.50 – 0.70</div></div> | |
| | <div><div>2</div><div>1.30 – 1.40</div></div> | |

TABLE 1
RECORD OF AUGERHOLES

| AUGERHOLE NUMBER (ELEVATION) | DEPTH (METRES) | DESCRIPTION |
|------------------------------------|---|---|
| 12-14 (130.12 m) | 0.00 – 0.32 | TOPSOIL |
| | 0.32 – 0.58 | (SM) SILTY SAND, fine, trace to some gravel, with cobbles, boulders and organic matter; brown to light brown; non-cohesive, moist |
| | 0.58 – 1.12 | Highly weathered SANDSTONE BEDROCK |
| | 1.12 | Auger Refusal |
| 12-15 (127.99 m) | 0.00 – 0.02 | Weathered ASPHALTIC CONCRETE |
| | 0.02 – 0.10 | Highly weathered concrete (FILL) |
| | 0.10 – 0.60 | (SP-GP) SAND and GRAVEL, fine to coarse, trace silt, with glass; dark brown; non-cohesive, moist (FILL) |
| | 0.60 – 0.75 | TOPSOIL |
| | 0.75 – 1.08 | (ML) CLAYEY SILT, some sand, with organic matter; dark brown to brown; cohesive, moist |
| | 1.08 – 1.50 | Highly weathered SANDSTONE BEDROCK |
| | 1.50 | End of Augerhole |
| | | <div> <div>Sample</div> <div>Depth (m)</div> <div>Lab Testing</div> </div> |
| | | <div>1</div> <div>0.20 – 0.30</div> <div>M</div> |
| | | <div>2</div> <div>0.75 – 0.85</div> <div></div> |
| | <div>3</div> <div>1.40 – 1.50</div> <div></div> | |
| 12-16 (126.82 m) | 0.00 – 0.25 | (SP) gravelly SAND, fine to coarse, trace silt; dark brown to brown; non-cohesive, moist (FILL) |
| | 0.25 – 0.60 | (SM) SILTY SAND, fine to medium; dark brown to brown; non-cohesive, moist (FILL) |
| | 0.60 – 0.85 | (SM) SILTY SAND, fine, trace gravel; brown; non-cohesive, moist |
| | 0.85 – 1.50 | Highly weathered SANDSTONE BEDROCK |
| | 1.50 | End of Augerhole |
| | | <div> <div>Sample</div> <div>Depth (m)</div> </div> |
| | <div>1</div> <div>0.50 – 0.60</div> | |
| | <div>2</div> <div>0.60 – 0.85</div> | |
| | <div>3</div> <div>0.95</div> | |

TABLE 1
RECORD OF AUGERHOLES

| AUGERHOLE NUMBER (ELEVATION) | DEPTH (METRES) | DESCRIPTION |
|------------------------------------|-------------------|--|
| 12-17 (125.45 m) | 0.00 – 0.15 | (SP) gravelly SAND, fine to coarse, trace silt; dark brown; non-cohesive, moist (FILL) |
| | 0.15 – 0.30 | TOPSOIL |
| | 0.30 – 0.76 | (SM) SILTY SAND, fine, trace gravel; light brown; non-cohesive, moist |
| | 0.76 | Auger Refusal |
| | | <div> <div>Sample</div> <div>Depth (m)</div> <div>10.15 – 0.30</div> </div> |
| 12-18 (123.43 m) | 0.00 – 0.20 | (SP-GP) SAND and GRAVEL, fine to coarse, trace silt; dark brown; non-cohesive, moist (FILL) |
| | 0.20 – 0.65 | (SP) gravelly SAND, fine, trace to some silt; brown; non-cohesive, moist (FILL) |
| | 0.65 – 1.20 | (SM) SILTY SAND, fine, trace gravel; light brown; non-cohesive, moist |
| | 1.20 | Auger Refusal |
| | | <div> <div>Sample</div> <div>Depth (m)</div> <div>Lab Testing</div> <div>10.00 – 0.10M</div> <div>20.30 – 0.45M</div> <div>31.10 – 1.20</div> </div> |
| 12-19 (121.05 m) | 0.00 – 0.33 | (SP) gravelly SAND, medium to coarse, trace to some silt; dark brown to brown; non-cohesive, moist, compact (FILL) |
| | 0.33 – 0.61 | (SM) SILTY SAND, fine to medium, trace gravel and clay, with organic matter; dark brown; non-cohesive, moist, compact |
| | 0.61 – 1.50 | (SM) SILTY SAND, fine, some gravel; light brown; non-cohesive, moist, dense |
| | 1.50 | End of Augerhole |
| | | <div> <div>Sample</div> <div>Depth (m)</div> <div>SPT “N”</div> <div>10.00 – 0.6126</div> <div>20.61 – 1.2236</div> </div> |

TABLE 1
RECORD OF AUGERHOLES

| AUGERHOLE NUMBER (ELEVATION) | DEPTH (METRES) | DESCRIPTION | | | | | | | | | | | | |
|------------------------------------|-------------------|---|---------------|------------------|--------------------|---|-------------|---|---|-------------|---|---|-------------|--|
| 12-21 (122.52 m) | 0.00 – 0.21 | (SW) gravelly SAND, fine to coarse, trace to some silt; dark brown; non-cohesive, moist (FILL) | | | | | | | | | | | | |
| | 0.21 – 0.40 | (SM) SILTY SAND, fine to coarse, trace to some gravel, brown; non-cohesive, moist (FILL) | | | | | | | | | | | | |
| | 0.40 – 1.50 | (SP) SAND, fine to medium, trace gravel, with cobbles and boulders; brown; non-cohesive, moist (FILL) | | | | | | | | | | | | |
| | 1.50 | End of Augerhole | | | | | | | | | | | | |
| | | <table> <tr> <th><u>Sample</u></th><th><u>Depth (m)</u></th><th><u>Lab Testing</u></th></tr> <tr> <td>1</td><td>0.00 – 0.15</td><td>M</td></tr> <tr> <td>2</td><td>0.21 – 0.40</td><td>M</td></tr> <tr> <td>3</td><td>0.50 – 0.60</td><td></td></tr> </table> | <u>Sample</u> | <u>Depth (m)</u> | <u>Lab Testing</u> | 1 | 0.00 – 0.15 | M | 2 | 0.21 – 0.40 | M | 3 | 0.50 – 0.60 | |
| <u>Sample</u> | <u>Depth (m)</u> | <u>Lab Testing</u> | | | | | | | | | | | | |
| 1 | 0.00 – 0.15 | M | | | | | | | | | | | | |
| 2 | 0.21 – 0.40 | M | | | | | | | | | | | | |
| 3 | 0.50 – 0.60 | | | | | | | | | | | | | |
| 12-23 (122.40 m) | 0.00 – 0.32 | (SP) gravelly SAND, medium to coarse, trace silt; dark brown; non-cohesive, moist (FILL) | | | | | | | | | | | | |
| | 0.32 – 1.50 | (SP) SAND, medium, trace gravel, with cobbles; brown; non-cohesive, moist (FILL) | | | | | | | | | | | | |
| | 1.50 | End of Augerhole | | | | | | | | | | | | |
| 12-25 (122.424m) | 0.00 – 0.10 | (SP) gravelly SAND, fine to coarse, trace silt; grey brown; non-cohesive, moist (FILL) | | | | | | | | | | | | |
| | 0.10 – 0.18 | (SM) SAND and SILT, fine to coarse, trace to some gravel, trace to some clay; grey brown; non-cohesive, moist (FILL) | | | | | | | | | | | | |
| | 0.18 – 0.23 | (SP) gravelly SAND, fine to coarse, trace silt; dark brown; non-cohesive, moist (FILL) | | | | | | | | | | | | |
| | 0.23 – 1.50 | (SP) SAND, medium, trace gravel, with grey silty clay layers and cobbles; brown; non-cohesive, moist (FILL) | | | | | | | | | | | | |
| | 1.50 | End of Augerhole | | | | | | | | | | | | |
| | | <table> <tr> <th><u>Sample</u></th><th><u>Depth (m)</u></th><th><u>Lab Testing</u></th></tr> <tr> <td>1</td><td>0.00 – 0.10</td><td></td></tr> <tr> <td>2</td><td>0.10 – 0.18</td><td>M</td></tr> <tr> <td>3</td><td>0.18 – 0.23</td><td></td></tr> </table> | <u>Sample</u> | <u>Depth (m)</u> | <u>Lab Testing</u> | 1 | 0.00 – 0.10 | | 2 | 0.10 – 0.18 | M | 3 | 0.18 – 0.23 | |
| <u>Sample</u> | <u>Depth (m)</u> | <u>Lab Testing</u> | | | | | | | | | | | | |
| 1 | 0.00 – 0.10 | | | | | | | | | | | | | |
| 2 | 0.10 – 0.18 | M | | | | | | | | | | | | |
| 3 | 0.18 – 0.23 | | | | | | | | | | | | | |

TABLE 1
RECORD OF AUGERHOLES

| AUGERHOLE NUMBER (ELEVATION) | DEPTH (METRES) | DESCRIPTION |
|------------------------------------|--|---|
| 12-27 (122.34 m) | 0.00 – 0.10 | (SP) gravelly SAND, fine to coarse; dark brown; non-cohesive, moist (FILL) |
| | 0.10 – 0.20 | (SM) SILTY SAND, fine; brown; non-cohesive, moist (FILL) |
| | 0.20 – 0.33 | (SP) gravelly SAND, fine to coarse, brown; non-cohesive, moist (FILL) |
| | 0.33 – 1.50 | (SP) SAND, fine to medium, trace to some gravel; brown; non-cohesive, moist (FILL) |
| | 1.50 | End of Augerhole |
| | | <div><div>Sample</div><div>Depth (m)</div></div> |
| | | <div><div>1</div><div>0.00 – 0.10</div></div> <div><div>2</div><div>0.10 – 0.20</div></div> <div><div>3</div><div>0.20 – 0.30</div></div> <div><div>4</div><div>0.40 – 0.50</div></div> |
| 12-28 (122.46 m) | 0.00 – 0.16 | ASPHALTIC CONCRETE |
| | 0.16 – 0.40 | (SP) gravelly SAND, fine to coarse, trace silt; brown; non-cohesive, moist (FILL) |
| | 0.40 – 0.50 | (SM) SILTY SAND, fine to medium, trace gravel; dark brown; non-cohesive, moist (FILL) |
| | 0.50 – 1.20 | (SP) SAND, fine to medium, trace silt; brown; non-cohesive, moist (FILL) |
| | 1.20 – 1.30 | (SM) SILTY SAND, fine to medium, trace gravel; dark brown; non-cohesive, moist (FILL) |
| | 1.30 | Auger Refusal |
| | | <div><div>Sample</div><div>Depth (m)</div></div> |
| | <div><div>1</div><div>0.16 – 0.30</div></div> <div><div>2</div><div>0.40 – 0.50</div></div> <div><div>3</div><div>1.30</div></div> | |

TABLE 1
RECORD OF AUGERHOLES

| AUGERHOLE NUMBER (ELEVATION) | DEPTH (METRES) | DESCRIPTION |
|------------------------------------|-------------------|---|
| 12-29 (122.47 m) | 0.00 – 0.14 | ASPHALTIC CONCRETE |
| | 0.14 – 0.28 | (SP) gravelly SAND, fine to coarse; brown; non-cohesive, moist (FILL) |
| | 0.28 – 1.45 | (SP) SAND, medium, trace gravel and silt, with cobbles; brown; non-cohesive, moist (FILL) |
| | 1.45 – 1.50 | (SP) gravelly SAND, fine to medium, with cobbles and boulders; brown to dark brown; non-cohesive, moist (FILL) |
| | 1.50 | End of Augerhole <div style="display: flex; justify-content: center;"> <div style="text-align: center;"><u>Sample</u></div> <div style="text-align: center;"><u>Depth (m)</u></div> </div> <div style="display: flex; justify-content: center; margin-top: 5px;"> <div style="text-align: center;">1</div> <div style="text-align: center;">0.14 – 0.28</div> </div> <div style="display: flex; justify-content: center; margin-top: 5px;"> <div style="text-align: center;">2</div> <div style="text-align: center;">1.45 – 1.50</div> </div> |
| 12-30 (122.23 m) | 0.00 – 0.13 | (SP) gravelly SAND, fine to coarse, trace silt; brown; non-cohesive, moist (FILL) |
| | 0.13 – 0.25 | (SM) SILTY SAND, fine, trace gravel; brown; non-cohesive, moist (FILL) |
| | 0.25 – 1.50 | (SP) SAND, fine to medium, trace gravel and silt; brown; non-cohesive, moist (FILL) |
| | 1.50 | End of Augerhole <div style="display: flex; justify-content: center;"> <div style="text-align: center;"><u>Sample</u></div> <div style="text-align: center;"><u>Depth (m)</u></div> </div> <div style="display: flex; justify-content: center; margin-top: 5px;"> <div style="text-align: center;">1</div> <div style="text-align: center;">0.00 – 0.13</div> </div> <div style="display: flex; justify-content: center; margin-top: 5px;"> <div style="text-align: center;">2</div> <div style="text-align: center;">0.13 – 0.25</div> </div> <div style="display: flex; justify-content: center; margin-top: 5px;"> <div style="text-align: center;">3</div> <div style="text-align: center;">0.75 – 0.90</div> </div> |
| 12-31 (121.95 m) | 0.00 – 0.26 | (SP) gravelly SAND, fine to coarse; dark brown; non-cohesive, moist (FILL) |
| | 0.26 – 1.50 | (SP) SAND, fine to medium, trace gravel and silt, with cobbles; brown; non-cohesive, moist (FILL) |
| | 1.50 | End of Augerhole |

TABLE 1
RECORD OF AUGERHOLES

| AUGERHOLE NUMBER (ELEVATION) | DEPTH (METRES) | DESCRIPTION | | | | | | | | | |
|------------------------------------|-------------------|---|--------------------|------------------|--------------------|-------------|-------------|---|---|-------------|--|
| 12-32 (121.47 m) | 0.00 – 0.16 | (SP) gravelly SAND, fine to coarse, trace to some silt; dark brown; non-cohesive, moist (FILL) | | | | | | | | | |
| | 0.16 – 1.50 | (SP) SAND, fine to medium, trace gravel and silt; brown; non-cohesive, moist (FILL) | | | | | | | | | |
| | 1.50 | Auger Refusal | | | | | | | | | |
| | | <table><tr><td><u>Sample</u></td><td><u>Depth (m)</u></td><td><u>Lab Testing</u></td></tr><tr><td>1</td><td>0.00 – 0.10</td><td>M</td></tr><tr><td>2</td><td>0.85 – 1.05</td><td></td></tr></table> | <u>Sample</u> | <u>Depth (m)</u> | <u>Lab Testing</u> | 1 | 0.00 – 0.10 | M | 2 | 0.85 – 1.05 | |
| | <u>Sample</u> | <u>Depth (m)</u> | <u>Lab Testing</u> | | | | | | | | |
| 1 | 0.00 – 0.10 | M | | | | | | | | | |
| 2 | 0.85 – 1.05 | | | | | | | | | | |
| | | | | | | | | | | | |
| 12-33 (121.03 m) | 0.00 – 0.35 | (SP) gravelly SAND, fine to coarse, trace silt; dark brown; non-cohesive, moist (FILL) | | | | | | | | | |
| | 0.35 – 1.40 | (SP) SAND, fine to medium, trace gravel and silt, with cobbles; brown; non-cohesive, moist (FILL) | | | | | | | | | |
| | 1.40 – 1.50 | (SP) gravelly SAND, fine to coarse, trace silt, with cobbles and boulders; red brown; non-cohesive, moist (FILL) | | | | | | | | | |
| | 1.50 | End of Augerhole | | | | | | | | | |
| | | <table><tr><td><u>Sample</u></td><td><u>Depth (m)</u></td></tr><tr><td>1</td><td>1.40 – 1.50</td></tr></table> | <u>Sample</u> | <u>Depth (m)</u> | 1 | 1.40 – 1.50 | | | | | |
| <u>Sample</u> | <u>Depth (m)</u> | | | | | | | | | | |
| 1 | 1.40 – 1.50 | | | | | | | | | | |
| | | | | | | | | | | | |
| 12-34 (120.25 m) | 0.00 – 0.35 | (SP) gravelly SAND, fine to coarse, trace to some silt; dark brown; non-cohesive, moist (FILL) | | | | | | | | | |
| | 0.35 – 0.65 | (SP) SAND, fine to medium, trace gravel, with cobbles; brown; non-cohesive, moist (FILL) | | | | | | | | | |
| | 0.65 – 1.50 | (SP) gravelly SAND, fine to coarse, trace silt, with cobbles and boulders; red brown; non-cohesive, moist (FILL) | | | | | | | | | |
| | 1.50 | End of Augerhole | | | | | | | | | |
| | | <table><tr><td><u>Sample</u></td><td><u>Depth (m)</u></td><td><u>Lab Testing</u></td></tr><tr><td>1</td><td>0.05 – 0.30</td><td>M</td></tr><tr><td>2</td><td>0.30 – 1.00</td><td></td></tr></table> | <u>Sample</u> | <u>Depth (m)</u> | <u>Lab Testing</u> | 1 | 0.05 – 0.30 | M | 2 | 0.30 – 1.00 | |
| <u>Sample</u> | <u>Depth (m)</u> | <u>Lab Testing</u> | | | | | | | | | |
| 1 | 0.05 – 0.30 | M | | | | | | | | | |
| 2 | 0.30 – 1.00 | | | | | | | | | | |
| | | | | | | | | | | | |

TABLE 1
RECORD OF AUGERHOLES

| AUGERHOLE NUMBER (ELEVATION) | DEPTH (METRES) | DESCRIPTION | | | | | | | | |
|------------------------------------|-------------------|--|---------------|------------------|--------------------|---|-------------|---|---|-------------|
| 12-35 (119.86 m) | 0.00 – 0.10 | (SW) gravelly SAND, fine to coarse, trace to some silt; dark brown; non-cohesive, moist (FILL) | | | | | | | | |
| | 0.10 – 0.75 | (SP) SAND, fine to medium, trace gravel, with cobbles; brown; non-cohesive, moist (FILL) | | | | | | | | |
| | 0.75 – 1.50 | (SP) gravelly SAND, fine to coarse, trace silt, with cobbles; red brown; non-cohesive, moist (FILL) | | | | | | | | |
| | 1.50 | End of Augerhole | | | | | | | | |
| | | <table> <tr> <th><u>Sample</u></th><th><u>Depth (m)</u></th><th><u>Lab Testing</u></th></tr> <tr> <td>1</td><td>0.30 – 0.40</td><td>M</td></tr> <tr> <td>2</td><td>0.80 – 1.00</td><td></td></tr> </table> | <u>Sample</u> | <u>Depth (m)</u> | <u>Lab Testing</u> | 1 | 0.30 – 0.40 | M | 2 | 0.80 – 1.00 |
| <u>Sample</u> | <u>Depth (m)</u> | <u>Lab Testing</u> | | | | | | | | |
| 1 | 0.30 – 0.40 | M | | | | | | | | |
| 2 | 0.80 – 1.00 | | | | | | | | | |

n:\active\2011\1121 - geotechnical\11-1121-0290 pwgsc des allumettes bridge ea\phase 2000 geotech\03-memos\techmem-002\appendix a - current logs\11-1121-0290 record of augerholes.docx

PROJECT: 11-1121-0290

RECORD OF BOREHOLE: 12-101

SHEET 1 OF 4

LOCATION: See Site Plan

BORING DATE: November 26, 2012

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | | | SAMPLES | | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m | | | | HYDRAULIC CONDUCTIVITY, k, cm/s | | | | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION | | | | | | | | | |
|-----------------------|---------------------------|---|-------------|-----------------------|---------|---------------|---|----------------|----|---------------|------------------------------------|-----------------------|--|-------|----------------------------|---|------------------|--|------------------|--|------------------|--|------------------|--|--|
| | | DESCRIPTION | STRATA PLOT | ELEV. DEPTH (m) | NUMBER | TYPE (% REC.) | BLOWS/0.15m | SHEAR STRENGTH | | | | WATER CONTENT PERCENT | | | | | | | | | | | | | |
| | | | | | | | | 20 | | 40 | | 60 | | 80 | | | 10 ⁻⁶ | | 10 ⁻⁵ | | 10 ⁻⁴ | | 10 ⁻³ | | |
| | | | | | | | | Cu, kPa | | nat V. rem V. | | + ⊕ | | Q - U | | | ● - ○ | | Wp | | W | | Wi | | |
| | | | | | | | | 20 | 40 | 60 | 80 | | | 20 | 40 | 60 | 80 | | | | | | | | |
| 0 | Rotary Drill NW Casing | GROUND SURFACE | | 114.74 | | | | | | | | | | | | | | | | | | | | | |
| | | Topsoil (FILL) | | 0.00 | | | 1 | | | | | | | | | | | | | | | | | | |
| | | (SM) SILTY SAND, fine to coarse, trace to some gravel, with rootlets and organic matter; dark brown; non-cohesive, moist, loose (FILL) | | 0.13 | 1 | SS (50) | | | | | | | | | | | | | | | | | | | |
| | | Slightly weathered green SHALE | | 114.21 | | | 5 | | | | | | | | | | | | | | | | | | |
| | | BEDROCK | | 0.53 | | | 15 | | | | | | | | | | | | | | | | | | |
| 1 | Rotary Drill NQ Core | Slightly to moderately weathered thinly bedded red brown to green very fine grained weak SHALE BEDROCK, with thin beds of grey coarse grained sandstone | | 0.61 | | C1 | | | | | | | | | | | | | | | | | | | |
| | | | | | | | NQ RC | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Fresh to slightly weathered medium bedded light grey fine to coarse grained medium strong to strong SANDSTONE BEDROCK, with thin beds of black, green, and grey shale | | 112.53 | | C2 | | | | | | | | | | | | | | | | | | | |
| | | | | 2.21 | | | | NQ RC | | | | | | | | | | | | | | | | | |
| 3 | Rotary Drill NQ Core | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Fresh laminated green to red brown very fine grained weak SHALE BEDROCK, with laminations of grey fine to coarse grained sandstone | | 111.51 | | C3 | | | | | | | | | | | | | | | | | | | |
| | | | | 3.23 | | | | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | C3 | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | NQ RC | | | | | | | | | | | | | | | | | |
| 5 | Rotary Drill NQ Core | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | C4 | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | C4 | | | | | | | | | | | | | | | | | | |
| 7 | Rotary Drill NQ Core | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Fresh thinly bedded grey brown to light grey fine to medium grained weak SANDSTONE BEDROCK, with laminations of black, grey, and green shale | | 107.65 | | C5 | | | | | | | | | | | | | | | | | | | |
| | | | | 7.09 | | | | | | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | C6 | | | | | | | | | | | | | | | | | | |
| 9 | Rotary Drill NQ Core | | | | | | | | | | | | | | | | | | | | | | | | |
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| | | | | | | | C7 | | | | | | | | | | | | | | | | | | |
| 10 | Rotary Drill NQ Core | | | | | | | | | | | | | | | | | | | | | | | | |
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| | | CONTINUED NEXT PAGE | | | | | | | | | | | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

ASTM - SOIL (WITH % RECOVERY) 1111210290.GPJ GAL-MIS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF BOREHOLE: 12-101

SHEET 2 OF 4

LOCATION: See Site Plan

BORING DATE: November 26, 2012

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | | | SAMPLES | | | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m | | | | HYDRAULIC CONDUCTIVITY, k, cm/s | | | | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION |
|-----------------------|-------------------------|---|-------------|-----------------------|---------|---------------|-------------|---|----|----|----|------------------------------------|------------------|------------------|------------------|----------------------------|---|
| | | DESCRIPTION | STRATA PLOT | ELEV. DEPTH (m) | NUMBER | TYPE (% REC.) | BLOWS/0.15m | | | | | | | | | | |
| | | | | | | | | SHEAR STRENGTH | | | | WATER CONTENT PERCENT | | | | | |
| | | | | | | | | Cu, kPa | | | | nat V. + Q - ● rem V. ⊕ U - ○ | | | | | |
| | | | | | | | | 20 | 40 | 60 | 80 | 10 ⁻⁶ | 10 ⁻⁵ | 10 ⁻⁴ | 10 ⁻³ | | |
| | | | | | | | | 20 | 40 | 60 | 80 | Wp | W | WI | | | |
| | | | | | | | | | | | | | | | | | |
| 10 | Rotary Drill NQ Core | --- CONTINUED FROM PREVIOUS PAGE --- | | | | | | | | | | | | | | | |
| | | Fresh medium bedded light grey to green fine to very coarse grained weak bioclastic SANDSTONE BEDROCK, with thin beds of green to black shale | | | C7 | NQ RC | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | | |
| | | Fresh thinly bedded light grey to grey brown fine to medium grained weak to medium strong SANDSTONE BEDROCK, with very thin beds of black to grey shale | | 103.33 11.41 | C8 | NQ RC | | | | | | | | | | | |
| 12 | | | | | C9 | NQ RC | | | | | | | | | | | |
| 13 | | | | | C10 | NQ RC | | | | | | | | | | | |
| | | Fresh medium bedded green changing to red brown fine to coarse grained weak to medium strong SANDSTONE BEDROCK, with thin laminations of black shale | | 100.89 13.85 | C11 | NQ RC | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | | |
| | | End of Borehole | | 99.31 15.43 | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | | | | |

Bentonite Seal

W.L. in Screen at
Elev. 112.35 on
November 28,
2012

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

ASTM - SOIL (WITH % RECOVERY) 1111210290.GPJ GAL-MIS.GDT 11/29/13 JM

SHEET 3 OF 4

DATUM: Geodetic

DRILLING CONTRACTOR: Marathon

[illegible]

CHECKED: CK

MIS-RCK 004 111210290.GPJ GAL-MISS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF DRILLHOLE: 12-101

SHEET 4 OF 4

LOCATION: See Site Plan

DRILLING DATE: November 26, 2012

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG:

DRILLING CONTRACTOR: Marathon

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. | | RUN No. | COLOUR % RETURN | FLUSH | JN - Joint FLT - Fault SHR - Shear VN - Vein CJ - Conjugate | BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage | PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular | PO - Polished K - Slickensided SM - Smooth Ro - Rough MB - Mechanical Break | BR - Broken Rock | NOTE: For additional abbreviations refer to list of abbreviations & symbols. | WATER LEVELS INSTRUMENTATION | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| | | | | DEPTH (m) | RECOVERY | | | | | | | | | | R.Q.D. % | FRACT. INDEX PER 0.3 m | DISCONTINUITY DATA | | | | HYDRAULIC CONDUCTIVITY | | | Diametral Point Load Index (MPa) | RMC -Q AVG. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | TOTAL CORE % | SOLID CORE % | TYPE AND SURFACE DESCRIPTION | Ucon | Jr | Ja | K ₁ cm/sec | | | K ₂ cm/sec | K ₃ cm/sec | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| 11 | Rotary Drill NQ Core | --- CONTINUED FROM PREVIOUS PAGE --- | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50



LOGGED: RI








CHECKED: CK

MIS-RCK 004 1111210290.GPJ GAL-MISS.GDT 11/29/13 JM

SHEET 1 OF 4

DATUM: Geodetic

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | | | SAMPLES | | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m | | | | HYDRAULIC CONDUCTIVITY, k, cm/s | | | | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION | |
|-----------------------|---------------------------|--|---|-----------------------|-------------------------|-------------|---|---------------|--------|------------|------------------------------------|------------------|------------------|------------------|----------------------------|---|--|
| | | DESCRIPTION | STRATA PLOT | ELEV. DEPTH (m) | NUMBER TYPE (% REC.) | BLOWS/0.15m | | | | | | | | | | | |
| | | | | | | | SHEAR STRENGTH | | | | WATER CONTENT PERCENT | | | | | | |
| | | | | | | | Cu, kPa | nat V. rem V. | + ⊕ | Q - U - | ● ○ | Wp | W | WI | | | |
| | | | | | | | 20 | 40 | 60 | 80 | | 10 ⁻⁶ | 10 ⁻⁵ | 10 ⁻⁴ | 10 ⁻³ | | |
| | | | | | | | 20 | 40 | 60 | 80 | | 20 | 40 | 60 | 80 | | |
| 0 | Rotary Drill NW Casing | GROUND SURFACE | | 115.08 | | | | | | | | | | | | | |
| | | Topsoil (FILL) |  | 0.00 | | WH | | | | | | | | | | | |
| | | (SM) SILTY SAND, fine to medium, trace clay and gravel, with rootlets and organic matter; dark brown; non-cohesive, moist, very loose to loose (FILL) |  | 0.15 | 1 | SS (67) | | | | | | | | | | | |
| 1 | | Slightly weathered green SHALE BEDROCK |  | 114.32 | | | | | | | | | | | | | |
| | | | | 0.76 | 2 | SS (100) | | | | | | | | | | | |
| | | | | 114.06 | | | | | | | | | | | | | |
| | | Slightly to moderately weathered thinly bedded red brown to green very fine grained weak SHALE BEDROCK, with thin beds of grey fine grained siltstone |  | 1.02 | | | | | | | | | | | | | |
| | | | | | C1 | NQ RC | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | |
| | | | | 112.69 | | | | | | | | | | | | | |
| | | Fresh medium bedded light grey fine to coarse grained medium strong to weak SANDSTONE BEDROCK, with thin beds of black to green shale with some fossils |  | 2.39 | | | | | | | | | | | | | |
| | | | | | C2 | NQ RC | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | |
| | | | | 111.45 | | | | | | | | | | | | | |
| | | Fresh laminated grey green and red brown very fine to medium grained weak SHALE BEDROCK, with laminations of grey fine to coarse grained sandstone and siltstone |  | 3.63 | | | | | | | | | | | | | |
| | | | | | C3 | NQ RC | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| 5 | Rotary Drill NQ Core | | | | | | | | | | | | | | | | |
| | | | | | | C4 | NQ RC | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | |
| | | Fresh laminated to thinly interbedded grey medium to fine grained weak SANDSTONE and SHALE BEDROCK |  | 106.29 | | | | | | | | | | | | | |
| | | | | 8.79 | | | | | | | | | | | | | |
| | | | | | C7 | NQ RC | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | |
| | | CONTINUED NEXT PAGE | | | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

PROJECT: 11-1121-0290

RECORD OF BOREHOLE: 12-102

SHEET 2 OF 4

LOCATION: See Site Plan

BORING DATE: November 27, 2012

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | | | SAMPLES | | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m | | | | | HYDRAULIC CONDUCTIVITY, k, cm/s | | | | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION |
|-----------------------|---|--|-----------------|-----------------------|----------|---------------|---|----------------------------|----|----|----|---|----|----|----|----------------------------|---|
| | | DESCRIPTION | STRATA PLOT | ELEV. DEPTH (m) | NUMBER | TYPE (% REC.) | BLOWS/0.15m | | | | | | | | | | |
| | | | | | | | | 20 40 60 80 | | | | 10 ⁻⁶ 10 ⁻⁵ 10 ⁻⁴ 10 ⁻³ | | | | | |
| | | | | | | | | SHEAR STRENGTH Cu, kPa | | | | nat V. + Q - rem V. ⊕ U - | | | | | |
| | | | | | | | | 20 | 40 | 60 | 80 | 20 | 40 | 60 | 80 | | |
| 10 | Rotary Drill NQ Core | --- CONTINUED FROM PREVIOUS PAGE --- | | | | | | | | | | | | | | | |
| | | Fresh medium bedded light grey to green fine to very coarse grained weak SANDSTONE BEDROCK, with thin beds of green to black shale | | 104.98 10.10 | C7 | NQ RC | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | | |
| | | Fresh thinly to massively bedded light grey to grey fine to coarse grained weak to medium strong bioclastic SANDSTONE BEDROCK, with very thin interbeds of black to grey shale | | 103.47 11.61 | C8 | NQ RC | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | | |
| | Fresh to slightly weathered medium bedded grey medium to coarse grained weak to medium strong SANDSTONE BEDROCK, with laminations of green to black shale | | 102.12 12.96 | C9 | NQ RC | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | | |
| | Fresh medium bedded green to red brown fine to coarse grained weak to medium strong SANDSTONE BEDROCK, with laminations of black shale | | 100.92 14.16 | C10 | NQ RC | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | |
| 15 | | End of Borehole | | 99.72 15.36 | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | | | | |

W.L. in open hole
at 2.08 m depth
below ground
surface on
November 28,
2012

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

ASTM - SOIL (WITH % RECOVERY) 1111210290.GPJ GAL-MIS.GDT 11/29/13 JM

SHEET 3 OF 4

DATUM: Geodetic

DRILLING CONTRACTOR: Marathon

[illegible]

CHECKED: CK

MIS-RCK 004 111210290.GPJ GAL-MISS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF DRILLHOLE: 12-102

SHEET 4 OF 4

LOCATION: See Site Plan

DRILLING DATE: November 27, 2012

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG:

DRILLING CONTRACTOR: Marathon

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | FLUSH | COLOUR % RETURN | JN - Joint FLT - Fault SHR - Shear VN - Vein CJ - Conjugate | BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage | PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular | PO - Polished K - Slickensided SM - Smooth Ro - Rough MB - Mechanical Break | BR - Broken Rock | RECOVERY TOTAL CORE % SOLID CORE % | R.Q.D. % | FRACT. INDEX PER 0.3 m | B Angle | DIP w.r.t. CORE AXIS | DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION | Joon Jr Ja | HYDRAULIC CONDUCTIVITY K, cm/sec | Diametral Point Load Index (MPa) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION |
|-----------------------|-----------------|--|--------------|-----------------------|---------|-------|--------------------|---|--|---|---|------------------|--|-------------|---------------------------------|---------|----------------------------|---|------------|--|---|--------------------|--|
| | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| | | --- CONTINUED FROM PREVIOUS PAGE --- | | | | | | | | | | | | | | | | | | | | | |
| | | Fresh medium bedded light grey to green fine to very coarse grained weak SANDSTONE BEDROCK, with thin beds of green to black shale | | 103.47 | | | | | | | | | | | | | | | | | | | |
| 12 | | Fresh thinly to massively bedded light grey to grey fine to coarse grained weak to medium strong bioclastic SANDSTONE BEDROCK, with very thin interbeds of black to grey shale | | 11.61 | 8 | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | | Fresh to slightly weathered medium bedded grey medium to coarse grained weak to medium strong SANDSTONE BEDROCK, with laminations of green to black shale | | 102.12 | | | | | | | | | | | | | | | | | | | |
| | | | | 12.96 | 9 | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | | Fresh medium bedded green to red brown fine to coarse grained weak to medium strong SANDSTONE BEDROCK, with laminations of black shale | | 100.92 | | | | | | | | | | | | | | | | | | | |
| | | | | 14.16 | 10 | | | | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | | | | | | | | |
| | | End of Drillhole | | 99.72 | | | | | | | | | | | | | | | | | | | |
| | | | | 15.36 | | | | | | | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | | | | | | | | | | |
| 21 | | | | | | | | | | | | | | | | | | | | | | | |

W.L. in open hole
at 2.08 m depth
below ground
surface on
November 28,
2012

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

MIS-RCK 004 1111210290.GPJ GAL-MISS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF BOREHOLE: 12-103

SHEET 1 OF 4







LOCATION: See Site Plan

BORING DATE: November 27, 2012

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | | | SAMPLES | | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m | | | | HYDRAULIC CONDUCTIVITY, k, cm/s | | | | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION | |
|-----------------------|---------------------------|--|---|-----------------------|---------|---------------|---|---------------------------|----|--------------------------------|------------------------------------|-----------------------|------------------|------------------|----------------------------|---|------------------|
| | | DESCRIPTION | STRATA PLOT | ELEV. DEPTH (m) | NUMBER | TYPE (% REC.) | BLOWS/0.15m | RESISTANCE, BLOWS/0.3m | | | | k, cm/s | | | | | |
| | | | | | | | | SHEAR STRENGTH Cu, kPa | | nat V. + Q - rem V. ⊕ U - ● | | WATER CONTENT PERCENT | | | | | |
| | | | | | | | | 20 | 40 | 60 | 80 | 10 ⁻⁶ | 10 ⁻⁵ | 10 ⁻⁴ | | | 10 ⁻³ |
| | | | | | | | | 20 | 40 | 60 | 80 | 20 | 40 | 60 | 80 | | |
| 0 | | BARGE DECK | | 112.31 | | | | | | | | | | | | | |
| | Rotary Drill NW Casing | BARGE |  | 0.00 | | | | | | | | | | | | | |
| | | | | 111.85 | | | | | | | | | | | | | |
| | | WATER |  | 0.46 | | | | | | | | | | | | | |
| 1 | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | |
| 4 | | (ML) CLAYEY SILT, some sand, trace gravel, occasional thin lamination of silty fine sand; red brown to grey brown; non-cohesive, wet |  | 109.03 3.28 | 1 | SS (58) | 16 17 14 22 | | | | | | | | | | |
| | Rotary Drill NQ Core | Slightly weathered to fresh thinly bedded grey fine grained weak to medium strong DOLOSTONE BEDROCK, with thin beds of black to green shale |  | 108.25 4.06 | | C1 | NQ RC | | | | | | | | | | |
| 5 | | Fresh thinly to medium bedded brown to light grey fine to coarse grained weak to medium strong SANDSTONE BEDROCK, with thin beds of black to green shale |  | 107.16 5.15 | | C2 | NQ RC | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | |
| 7 | | Fresh thinly bedded light grey fine to medium grained weak to medium strong DOLOSTONE BEDROCK, with thin beds of black shale and grey sandstone |  | 105.60 6.71 | | C3 | NQ RC | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | |
| 9 | | | | | | C4 | NQ RC | | | | | | | | | | |
| | | | | 102.88 9.43 | | C5 | NQ RC | | | | | | | | | | |
| 10 | | CONTINUED NEXT PAGE | | | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

ASTM - SOIL (WITH % RECOVERY) 1111210290.GPJ GAL-MIS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF BOREHOLE: 12-103

SHEET 2 OF 4

LOCATION: See Site Plan

BORING DATE: November 27, 2012

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | | | SAMPLES | | | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m | | | | HYDRAULIC CONDUCTIVITY, k, cm/s | | | | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION | | | | | | | | |
|-----------------------|-------------------------|--|-------------|-----------------------|---------|---------------|-------------|---|----|---------------|----|------------------------------------|--|-------|--|----------------------------|---|------------------|--|------------------|--|------------------|--|------------------|--|
| | | DESCRIPTION | STRATA PLOT | ELEV. DEPTH (m) | NUMBER | TYPE (% REC.) | BLOWS/0.15m | SHEAR STRENGTH | | | | WATER CONTENT PERCENT | | | | | | | | | | | | | |
| | | | | | | | | 20 | | 40 | | 60 | | 80 | | | | 10 ⁻⁶ | | 10 ⁻⁵ | | 10 ⁻⁴ | | 10 ⁻³ | |
| | | | | | | | | Cu, kPa | | nat V. rem V. | | + ⊕ | | Q - U | | | | ● - ○ | | Wp | | W | | Wi | |
| | | | | | | | | 20 | 40 | 60 | 80 | | | | | | | | | | | | | | |
| 10 | | --- CONTINUED FROM PREVIOUS PAGE --- | | | | | | | | | | | | | | | | | | | | | | | |
| | Rotary Drill NQ Core | Fresh thinly to medium bedded red brown fine to coarse grained medium strong to weak SANDSTONE BEDROCK, with laminations to thin interbeds of grey to red brown shale and grey dolostone | | | C5 | NQ RC | | | | | | | | | | | | | | | | | | | |
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| | | | | | C6 | NQ RC | | | | | | | | | | | | | | | | | | | |
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DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

ASTM - SOIL (WITH % RECOVERY) 1111210290.GPJ GAL-MIS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF DRILLHOLE: 12-103

SHEET 3 OF 4

LOCATION: See Site Plan

DRILLING DATE: November 27, 2012

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG:

DRILLING CONTRACTOR: Marathon

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. | | RUN No. | COLOUR % RETURN | FLUSH | JN - Joint FLT - Fault SHR - Shear VN - Vein CJ - Conjugate | BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage | PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular | PO - Polished K - Slickensided SM - Smooth Ro - Rough MB - Mechanical Break | BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols. | DISCONTINUITY DATA | | | | | | | | | | HYDRAULIC | | Diameter Point Load Index (MPa) | RMC -Q AVG. | NOTES WATER LEVELS INSTRUMENTATION | | | | | |
|-----------------------|-----------------|--|--------------|--------------|----------|---------|--------------------|-------|---|--|---|---|---|--------------------|---------------------------------|--------------------------------------|---------------------------------|------|----|----|-----------|--------------|-----------------|-----------------|---------------------------------|--|-------------------|--|------|----|----|-----------|--------------|
| | | | | DEPTH (m) | RECOVERY | | | | | | | | | R.Q.D. % | FRACT. INDEX PER 0.3 m | B Angle DIP w.r.t CORE AXIS | TYPE AND SURFACE DESCRIPTION | Ucon | Jr | Ja | K, cm/sec | CONDUCTIVITY | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | TOTAL CORE % | SOLID CORE % | TYPE AND SURFACE DESCRIPTION | | | | Ucon | Jr | Ja | K, cm/sec | CONDUCTIVITY |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | BEDROCK SURFACE | | 108.25 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | | Slightly weathered to fresh thinly bedded grey fine grained weak to medium strong DOLOSTONE BEDROCK, with thin beds of black to green shale | | 4.06 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | | Fresh thinly to medium bedded brown to light grey fine to coarse grained weak to medium strong SANDSTONE BEDROCK, with thin beds of black to green shale | | 107.16 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | | Fresh thinly bedded light grey fine to medium grained weak to medium strong DOLOSTONE BEDROCK, with thin beds of black shale and grey sandstone | | 105.60 | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | | | | 6.71 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | | | | | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | | Fresh thinly to medium bedded red brown fine to coarse grained medium strong to weak SANDSTONE BEDROCK, with laminations to thin interbeds of grey to red brown shale and grey dolostone | | 102.88 | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | | | | 9.43 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | | | | | 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| 14 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | CONTINUED NEXT PAGE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

MIS-RCK 004 11-11210290.GPJ GAL-MISS.GDT 11/29/13 JM

SHEET 4 OF 4

DATUM: Geodetic

DRILLING CONTRACTOR: Marathon

MIS-RCK 004 111210290.GPJ GAL-MISS.GDT 11/29/13 JM

CHECKED: CK

PROJECT: 11-1121-0290

RECORD OF BOREHOLE: 12-104

SHEET 2 OF 4

LOCATION: See Site Plan

BORING DATE: November 14, 2012

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | | | SAMPLES | | | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m | | | | HYDRAULIC CONDUCTIVITY, k, cm/s | | | | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION | | | | |
|-----------------------|------------------------------------|--|-------------|-----------------------|---------|---------------|-------------|---|----|----|----|------------------------------------|------------------|------------------|------------------|----------------------------|---|-----------------------|--|--|--|
| | | DESCRIPTION | STRATA PLOT | ELEV. DEPTH (m) | NUMBER | TYPE (% REC.) | BLOWS/0.15m | 20 | 40 | 60 | 80 | 10 ⁻⁶ | 10 ⁻⁵ | 10 ⁻⁴ | 10 ⁻³ | | | | | | |
| | | | | | | | | SHEAR STRENGTH Cu, kPa | | | | nat V. + Q - ● rem V. ⊕ U - ○ | | | | | | WATER CONTENT PERCENT | | | |
| | | | | | | | | | | | | | | | | | | Wp ———— W ———— Wl | | | |
| | | | | | | | | 20 | 40 | 60 | 80 | 20 | 40 | 60 | 80 | | | | | | |
| 10 | | --- CONTINUED FROM PREVIOUS PAGE --- | | | | | | | | | | | | | | | | | | | |
| | Rotary Drill NQ Core | Fresh thinly to medium bedded red brown fine to coarse grained weak to medium strong SANDSTONE BEDROCK, with laminations to thin interbeds of grey to red brown shale and grey siltstone | | | | | | | | | | | | | | | | | | | |
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| 15 | | | | | | | | | | | | | | | | | | | | | |
| | - Mud seam from 12.89 m to 12.91 m | | | | | | | | | | | | | | | | | | | | |
| | - Mud seam from 13.16 m to 13.18 m | | | | | | | | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | | | | | | | | | |
| | - Mud seam from 15.56 m to 15.57 m | | | | | | | | | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | | | | | | | | | | |
| | | Fresh medium bedded grey to light grey medium to coarse grained weak to medium strong SANDSTONE BEDROCK, with laminations of black to green shale | | 95.06 17.33 | | | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| 19 | | End of Borehole | | 93.62 18.77 | | | | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

ASTM - SOIL (WITH % RECOVERY) 1111210290.GPJ GAL-MIS.GDT 11/29/13 JM

SHEET 3 OF 4

DATUM: Geodetic

DRILLING CONTRACTOR: Marathon

CHECKED: CK

MIS-RCK 004 111210290.GPJ GAL-MISS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF DRILLHOLE: 12-104

SHEET 4 OF 4

LOCATION: See Site Plan

DRILLING DATE: November 14, 2012

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG:

DRILLING CONTRACTOR: Marathon

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. | | RUN No. | COLOUR % RETURN | FLUSH | RECOVERY | | | | R.Q.D. % | FRACT. INDEX PER 0.3 m | DISCONTINUITY DATA | | | | HYDRAULIC CONDUCTIVITY | | | | Diametral Index (MPa) | RMC -Q AVG. | NOTES WATER LEVELS INSTRUMENTATION | | | | | | | | | | | | | | | | | | | | | | | | |
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| | | | | DEPTH (m) | | | | | TOTAL CORE % | SOLID CORE % | B Angle | DIP w.r.t CORE AXIS | | | TYPE AND SURFACE DESCRIPTION | Ucon | Jr | Ja | K _v cm/sec | T ₁₀ | T ₅ | T ₂ | | | | T ₁ | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | JN - Joint FLT - Fault SHR - Shear VN - Vein CJ - Conjugate | BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage | PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular | PO - Polished K - Slickensided SM - Smooth Ro - Rough MB - Mechanical Break | BR - Broken Rock | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | NOTE: For additional abbreviations refer to list of abbreviations & symbols. | | | | | | | | | | | | | | | | | |
| --- CONTINUED FROM PREVIOUS PAGE --- | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | Rotary Drill NG Core | Fresh thinly to medium bedded red brown fine to coarse grained weak to medium strong SANDSTONE BEDROCK, with laminations to thin interbeds of grey to red brown shale and grey siltstone - Mud seam from 15.56 m to 15.57 m | | | 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| 17 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 18 | | Fresh medium bedded grey to light grey medium to coarse grained weak to medium strong SANDSTONE BEDROCK, with laminations of black to green shale | | | 95.06 17.33 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 19 | | End of Drillhole | | | 93.62 18.77 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 21 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 22 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 23 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

MIS-RCK 004 1111210290.GPJ GAL-MISS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF BOREHOLE: 12-105

SHEET 1 OF 2











LOCATION: See Site Plan

BORING DATE: November 6, 2012

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | | | SAMPLES | | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m | | | | HYDRAULIC CONDUCTIVITY, k, cm/s | | | | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION | |
|-----------------------|---------------------------|--|---|------------------------|---------|---------------|---|---------------------------|----|--------------------------------|------------------------------------|-----------------------|------------------|------------------|----------------------------|---|------------------|
| | | DESCRIPTION | STRATA PLOT | ELEV. DEPTH (m) | NUMBER | TYPE (% REC.) | BLOWS/0.15m | RESISTANCE, BLOWS/0.3m | | | | k, cm/s | | | | | |
| | | | | | | | | SHEAR STRENGTH Cu, kPa | | nat V. + Q - rem V. ⊕ U - ● | | WATER CONTENT PERCENT | | | | | |
| | | | | | | | | 20 | 40 | 60 | 80 | 10 ⁻⁶ | 10 ⁻⁵ | 10 ⁻⁴ | | | 10 ⁻³ |
| | | | | | | | | | | | | | | | | | |
| 0 | | BARGE DECK | | 112.57 | | | | | | | | | | | | | |
| | Rotary Drill NW Casing | BARGE |  | 0.00 | | | | | | | | | | | | | |
| | | | | 112.09 | | | | | | | | | | | | | |
| | | WATER |  | 0.48 | | | | | | | | | | | | | |
| 1 | | |  | | | | | | | | | | | | | | |
| 2 | | |  | | | | | | | | | | | | | | |
| 3 | | |  | | | | | | | | | | | | | | |
| 4 | | |  | | | | | | | | | | | | | | |
| 5 | | |  | | | | | | | | | | | | | | |
| | Rotary Drill NQ Core | (SM) SILTY SAND, fine to coarse, trace gravel, trace clay; dark brown; non-cohesive, wet, very loose |  | 107.44 5.13 | 1 | SS (6) | WH WH 3 | | | | | | | | | | |
| 6 | | (SM) SILTY SAND, fine, some clay, trace to some gravel; grey brown; non-cohesive, wet, very loose |  | 106.57 6.00 6.09 | 2 | SS (86) | | | | | | | | | | | |
| | | Slightly weathered to fresh thinly bedded yellow brown fine grained DOLOSTONE BEDROCK, with thin calcite veins and vugs |  | 106.02 6.55 | C1 | NQ RC | | | | | | | | | | | |
| 7 | | End of Borehole | | | | | | | | | | | | | | | |
| | | Note: Broke core barrel | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

ASTM - SOIL (WITH % RECOVERY) 1111210290.GPJ GAL-MIS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF DRILLHOLE: 12-105

SHEET 2 OF 2

LOCATION: See Site Plan

DRILLING DATE: November 6, 2012

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG:

DRILLING CONTRACTOR: Marathon

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | FLUSH | COLOUR % RETURN | JN - Joint FLT - Fault SHR - Shear VN - Vein CJ - Conjugate | BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage | PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular | PO - Polished K - Slickensided SM - Smooth Ro - Rough MB - Mechanical Break | BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols. | NOTES WATER LEVELS INSTRUMENTATION |
|-----------------------|-------------------------|--|--------------|-----------------------|---------|-------|--------------------|---|--|---|---|---|--|
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | BEDROCK SURFACE | | 106.48 | | | | | | | | | |
| | Rotary Drill NG Core | Slightly weathered to fresh thinly bedded yellow brown fine grained DOLOSTONE BEDROCK, with thin calcite veins and vugs | | 6.09 | 1 | | | | | | | | |
| | | End of Drillhole | | 106.02 | | | | | | | | | |
| | | Note: Broke core barrel | | 6.55 | | | | | | | | | |
| 7 | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

MIS-RCK 004 1111210290.GPJ GAL-MISS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF BOREHOLE: 12-105A

SHEET 1 OF 2





LOCATION: See Site Plan

BORING DATE: November 7, 2012

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | | | SAMPLES | | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m | | | | HYDRAULIC CONDUCTIVITY, k, cm/s | | | | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION | | | |
|-----------------------|---------------------------|--|---|-----------------------|---------|---------------|---|---------------------------|----|----------------------|------------------------------------|------------------|------------------|-----------------------|----------------------------|---|------------------|--|--|
| | | DESCRIPTION | STRATA PLOT | ELEV. DEPTH (m) | NUMBER | TYPE (% REC.) | BLOWS/0.15m | RESISTANCE, BLOWS/0.3m | | | | k, cm/s | | | | | | | |
| | | | | | | | | SHEAR STRENGTH Cu, kPa | | nat V. + rem V. ⊕ | | Q - ● U - ○ | | WATER CONTENT PERCENT | | | | | |
| | | | | | | | | 20 | 40 | 60 | 80 | 10 ⁻⁶ | 10 ⁻⁵ | 10 ⁻⁴ | | | 10 ⁻³ | | |
| | | | | | | | | | | | | | | | | | | | |
| 0 | | BARGE DECK | | 112.53 | | | | | | | | | | | | | | | |
| | Rotary Drill NW Casing | BARGE |  | 0.00 | | | | | | | | | | | | | | | |
| | | | | 112.06 | | | | | | | | | | | | | | | |
| | | WATER |  | 0.47 | | | | | | | | | | | | | | | |
| 1 | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | | |
| 6 | Rotary Drill NQ Core | (SP) SAND, fine to coarse, trace to some silt, trace gravel, with thin beds of brown silty fine sand; dark brown; non-cohesive, wet |  | 107.02 5.51 | | | | | | | | | | | | | | | |
| | | Slightly weathered to fresh thinly bedded yellow brown to grey fine grained medium strong DOLOSTONE BEDROCK, with laminations of dark grey siltstone and thin (~ 1 mm) calcite veins and vugs |  | 106.38 6.15 | C1 | NQ RC | | | | | | | | | | | | | |
| 7 | | | | | | C2 | NQ RC | | | | | | | | | | | | |
| | | End of Borehole | | 105.17 7.36 | | | | | | | | | | | | | | | |
| 8 | | Note: Barge shifted and had to abandon hole. | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

ASTM - SOIL (WITH % RECOVERY) 1111210290.GPJ GAL-MIS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF DRILLHOLE: 12-105A

SHEET 2 OF 2

LOCATION: See Site Plan

DRILLING DATE: November 7, 2012

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG:

DRILLING CONTRACTOR: Marathon

| DEPTH SCALE METRES | DRILLING RECORD | | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | FLUSH | COLOUR % RETURN | JN - Joint FLT - Fault SHR - Shear VN - Vein CJ - Conjugate | | | | BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage | | | | PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular | | | | PO - Polished K - Slickensided SM - Smooth Ro - Rough MB - Mechanical Break | | | | BR - Broken Rock | | | | NOTES WATER LEVELS INSTRUMENTATION | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------------------|-----------------|----------|-------------|--------------|-----------------------|---------|-------|--------------------|---|-----------------|-------------|--------------------------------|--|---------------------------|---------------------------------|------|---|----|-----------|------------------|---|-------------------|------------------|------------------|------------------|----------|----------|----------|--|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| | | | | | | | | | RECOVERY | | R.Q.D. % | FRACT INDEX PER 0.3 m | DISCONTINUITY DATA | | | | HYDRAULIC CONDUCTIVITY | | | | Diametral Point Load Index (MPa) | RMC -Q AVG. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | TOTAL CORE % | SOLID CORE % | | | B Angle | DIP w.r.t CORE AXIS | TYPE AND SURFACE DESCRIPTION | Ucon | Jr | Ja | K, cm/sec | 10 ⁻⁶ | | | 10 ⁻⁵ | 10 ⁻⁴ | 10 ⁻³ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 0.000000 | 0.000000 | | | | | | | 0.000000 | 0.000000 | | | | | | | | | | | | | | | | 0.000000 | 0.000000 | 0.000000 | | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 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0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

MIS-RCK 004 1111210290.GPJ GAL-MISS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF BOREHOLE: 12-105B

SHEET 1 OF 2




LOCATION: See Site Plan

BORING DATE: November 8, 2012

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | | SAMPLES | | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m | | | | HYDRAULIC CONDUCTIVITY, k, cm/s | | | | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION | | |
|-----------------------|---------------------------|--------------|--|-----------------------|--------|---|-------------|---------------------------|----|------------------------------------|----|--|----|----------------------------|---|--|--|
| | | DESCRIPTION | STRATA PLOT | ELEV. DEPTH (m) | NUMBER | TYPE (% REC.) | BLOWS/0.15m | | | | | | | | | | |
| | | | | | | | | SHEAR STRENGTH Cu, kPa | | nat V. + Q - ● rem V. ⊕ U - ○ | | WATER CONTENT PERCENT Wp — W — Wi | | | | | |
| | | | | | | | | 20 | 40 | 60 | 80 | 20 | 40 | 60 | 80 | | |
| 0 | | BARGE DECK | | 112.51 | | | | | | | | | | | | | |
| | Rotary Drill NW Casing | BARGE |  | 0.00 | | | | | | | | | | | | | |
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| | | WATER |  | 112.05 0.46 | | | | | | | | | | | | | |
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DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

ASTM - SOIL (WITH % RECOVERY) 1111210290.GPJ GAL-MIS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF DRILLHOLE: 12-105B

SHEET 2 OF 2

LOCATION: See Site Plan

DRILLING DATE: November 8, 2012

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG:

DRILLING CONTRACTOR: Marathon

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | FLUSH | COLOUR % RETURN | JN - Joint FLT - Fault SHR - Shear VN - Vein CJ - Conjugate | BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage | PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular | PO - Polished K - Slickensided SM - Smooth Ro - Rough MB - Mechanical Break | BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols. | RECOVERY TOTAL CORE % SOLID CORE % R.Q.D. % | FRACT. INDEX PER 0.3 m | DISCONTINUITY DATA B Angle DIP w.r.t. CORE AXIS | TYPE AND SURFACE DESCRIPTION | Joon Jr Ja | HYDRAULIC CONDUCTIVITY K, cm/sec | Diametral Point Load Index (MPa) | RMC -Q AVG. | NOTES WATER LEVELS INSTRUMENTATION |
|-----------------------|---------------------------|---|--------------|-----------------------|---------|-------|--------------------|---|--|---|---|---|---|---------------------------------|---|---------------------------------|------------|--|---|-------------------|--|
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| 6 | Rotary Drill NW Casing | BEDROCK SURFACE | | 106.54 | | | | | | | | | | | | | | | | | |
| 6 | | Slightly weathered to fresh thinly bedded yellow brown to grey fine grained medium strong DOLOSTONE BEDROCK, with thin laminations to laminated green to black shale, thin beds of grey siltstone with hematite staining and veins, and minor calcite veins | | 5.97 | 1 | | | | | | | | | | | | | | | | |
| 7 | Rotary Drill NQ Core | | | | 2 | | | | | | | | | | | | | | | | |
| 8 | | | | | 3 | | | | | | | | | | | | | | | | |
| 8 | | End of Drillhole | | 104.43 | | | | | | | | | | | | | | | | | |
| 9 | | Notes: 1. Barge shifted which resulted in drill rods being broken. Hole had to be abandoned. 2. Soil stratigraphy between 5.36 m and 5.97 m inferred from Borehole 12-105 | | 8.08 | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | | | | | | |
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| 15 | | | | | | | | | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

MIS-RCK 004 1111210290.GPJ GAL-MISS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF BOREHOLE: 12-105C

SHEET 1 OF 3




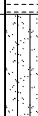

LOCATION: See Site Plan

BORING DATE: November 10, 2012

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | | | SAMPLES | | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m | | | | HYDRAULIC CONDUCTIVITY, k, cm/s | | | | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION | | | | | | | | | |
|-----------------------|---------------------------|--|---|-----------------------|---------|---------------|---|---------------------------|----|----------------------|------------------------------------|-----------------------|----|----|----------------------------|---|------------------|--|------------------|--|------------------|--|------------------|--|--|
| | | DESCRIPTION | STRATA PLOT | ELEV. DEPTH (m) | NUMBER | TYPE (% REC.) | BLOWS/0.15m | SHEAR STRENGTH | | | | WATER CONTENT PERCENT | | | | | | | | | | | | | |
| | | | | | | | | 20 | | 40 | | 60 | | 80 | | | 10 ⁻⁶ | | 10 ⁻⁵ | | 10 ⁻⁴ | | 10 ⁻³ | | |
| | | | | | | | | SHEAR STRENGTH Cu, kPa | | nat V. + rem V. ⊕ | | Q - ● U - ○ | | Wp | | | W | | Wi | | | | | | |
| | | | | | | | | 20 | 40 | 60 | 80 | 20 | 40 | 60 | 80 | | | | | | | | | | |
| 0 | | BARGE DECK | | 112.41 | | | | | | | | | | | | | | | | | | | | | |
| | Rotary Drill NW Casing | BARGE |  | 0.00 | | | | | | | | | | | | | | | | | | | | | |
| | | | | 111.94 | | | | | | | | | | | | | | | | | | | | | |
| | | WATER |  | 0.47 | | | | | | | | | | | | | | | | | | | | | |
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| 5 | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Rotary Drill NQ Core | (SM) SILTY SAND, fine to coarse, trace gravel, trace clay; dark brown; non-cohesive, wet, very loose |  | 107.05 5.36 | | | | | | | | | | | | | | | | | | | | | |
| 6 | | | | 106.25 6.16 | C1 | NQ RC | | | | | | | | | | | | | | | | | | | |
| | | Slightly weathered to fresh thinly bedded light grey fine grained medium strong to strong DOLOSTONE BEDROCK, with laminations of green to black shale and siltstone, some hematite staining and thin calcite veins throughout |  | | | C2 | NQ RC | | | | | | | | | | | | | | | | | | |
| 7 | | | | | | C3 | NQ RC | | | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | | | | | | C4 | NQ RC | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | C5 | NQ RC | | | | | | | | | | | | | | | | | | |
| | | CONTINUED NEXT PAGE | | | | | | | | | | | | | | | | | | | | | | | |

ASTM - SOIL (WITH % RECOVERY) 1111210290.GPJ GAL-MIS.GDT 11/29/13 JM

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

PROJECT: 11-1121-0290

RECORD OF BOREHOLE: 12-105C

SHEET 2 OF 3

LOCATION: See Site Plan

BORING DATE: November 10, 2012

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | | | SAMPLES | | | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m | | | | HYDRAULIC CONDUCTIVITY, k, cm/s | | | | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION | | | | |
|-----------------------|-------------------------|---|-------------|-----------------------|---------|---------------|-------------|---|----|----|----|------------------------------------|------------------|------------------|------------------|----------------------------|---|-----------------------|--|--|--|
| | | DESCRIPTION | STRATA PLOT | ELEV. DEPTH (m) | NUMBER | TYPE (% REC.) | BLOWS/0.15m | 20 | 40 | 60 | 80 | 10 ⁻⁶ | 10 ⁻⁵ | 10 ⁻⁴ | 10 ⁻³ | | | | | | |
| | | | | | | | | SHEAR STRENGTH Cu, kPa | | | | nat V. + Q - rem V. ⊕ U - ● | | | | | | WATER CONTENT PERCENT | | | |
| | | | | | | | | | | | | | | | | | | Wp — W — Wl | | | |
| | | | | | | | | 20 | 40 | 60 | 80 | 20 | 40 | 60 | 80 | | | | | | |
| 10 | | --- CONTINUED FROM PREVIOUS PAGE --- | | | | | | | | | | | | | | | | | | | |
| | Rotary Drill NQ Core | Slightly weathered to fresh thinly bedded light grey fine grained medium strong to strong DOLOSTONE BEDROCK, with laminations of green to black shale and siltstone, some hematite staining and thin calcite veins throughout | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| 11 | | Slightly weathered to fresh massive black to red fine to coarse grained weak to medium strong ARKOSE BEDROCK | | | | | | | | | | | | | | | | | | | |
| | | Slightly weathered massive black to pink fine to coarse grained strong to medium strong GNEISS BEDROCK, with some thin calcite veins throughout | | | | | | | | | | | | | | | | | | | |
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| 12 | | | | | | | | | | | | | | | | | | | | | |
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| 15 | | | | | | | | | | | | | | | | | | | | | |
| | | End of Borehole | | | | | | | | | | | | | | | | | | | |
| | | Note: Soil stratigraphy between 5.36 m and 6.16 m inferred from Borehole 12-105 | | | | | | | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | | | | | | | | | | |
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| 20 | | | | | | | | | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

ASTM - SOIL (WITH % RECOVERY) 1111210290.GPJ GAL-MIS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF DRILLHOLE: 12-105C

SHEET 3 OF 3

LOCATION: See Site Plan

DRILLING DATE: November 10, 2012

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG:

DRILLING CONTRACTOR: Marathon

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. | | | | | | | | | | | | | NOTES | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| | | | | DEPTH (m) | | | | | | | | | | | | | WATER LEVELS INSTRUMENTATION | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | RUN No. | FLUSH | RECOVERY | | R.Q.D. % | FRACT. INDEX PER 0.3 m | DISCONTINUITY DATA | | | | | HYDRAULIC CONDUCTIVITY | | | | | Diametral Point Load Index (MPa) | RMC -Q' AVG. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | TOTAL CORE % | SOLID CORE % | | | B Angle | DIP w.r.t. CORE AXIS | TYPE AND SURFACE DESCRIPTION | Joon | Jr | Ja | K, cm/sec | 10 | 10 | 10 | | | 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COLOUR % RETURN | | JN - Joint FLT - Fault SHR- Shear VN - Vein CJ - Conjugate | | BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage | | PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular | | PO - Polished K - Slickensided SM - Smooth Ro - Rough MB - Mechanical Break | | BR - Broken Rock | | NOTE: For additional abbreviations refer to list of abbreviations & symbols. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | BEDROCK SURFACE | | 106.25 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

MIS-RCK 004 1111210290.GPJ GAL-MISS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF BOREHOLE: 12-106

SHEET 1 OF 2






LOCATION: See Site Plan

BORING DATE: November 15, 2012

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | | | SAMPLES | | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m | | | | HYDRAULIC CONDUCTIVITY, k, cm/s | | | | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION | |
|-----------------------|---------------------------|---|---|-----------------------|---------|---------------|---|----------------|----|----------------------------------|------------------------------------|-----------------------|------------------|------------------|----------------------------|---|------------------|
| | | DESCRIPTION | STRATA PLOT | ELEV. DEPTH (m) | NUMBER | TYPE (% REC.) | BLOWS/0.15m | SHEAR STRENGTH | | | | WATER CONTENT PERCENT | | | | | |
| | | | | | | | | Cu, kPa | | nat V. + Q - ● rem V. ⊕ U - ○ | | Wp — W — Wl | | | | | |
| | | | | | | | | 20 | 40 | 60 | 80 | 10 ⁻⁶ | 10 ⁻⁵ | 10 ⁻⁴ | | | 10 ⁻³ |
| 0 | | BARGE DECK | | 112.35 | | | | | | | | | | | | | |
| | Rotary Drill NW Casing | BARGE |  | 0.00 | | | | | | | | | | | | | |
| | | | | 111.88 | | | | | | | | | | | | | |
| | | WATER |  | 0.47 | | | | | | | | | | | | | |
| 1 | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | |
| 6 | Rotary Drill NQ Core | (SM) SILTY SAND, fine to coarse, some gravel; dark brown to black; non-cohesive, wet, very dense |  | 106.94 | | | | | | | | | | | | | |
| | | | | 5.41 | 1 | SS (38) | WH 15 50 | | | | | | | | | | |
| | | (SM) SILTY SAND, fine, some gravel, trace clay; grey; non-cohesive, wet, very dense |  | 106.58 | | | | | | | | | | | | | |
| | | Slightly weathered thinly bedded yellow brown fine grained weak to medium strong DOLOSTONE BEDROCK, with laminations of green to black shale, occasional thin beds of sandstone |  | 5.82 | 2 | NQ RC | | | | | | | | | | | |
| | | | | 105.64 | | | | | | | | | | | | | |
| | | End of Borehole | | 6.71 | | | | | | | | | | | | | |
| 7 | | Note: Barge shifted and hole had to be abandoned | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

ASTM - SOIL (WITH % RECOVERY) 1111210290.GPJ GAL-MIS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF DRILLHOLE: 12-106

SHEET 2 OF 2

LOCATION: See Site Plan

DRILLING DATE: November 15, 2012

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG:

DRILLING CONTRACTOR: Marathon

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | FLUSH | COLOUR % RETURN | JN - Joint FLT - Fault SHR - Shear VN - Vein CJ - Conjugate | BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage | PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular | PO - Polished K - Slickensided SM - Smooth Ro - Rough MB - Mechanical Break | BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols. | NOTES WATER LEVELS INSTRUMENTATION | | | | | |
|-----------------------|-------------------------|--|--------------|-----------------------|---------|-------|--------------------|---|--|---|---|---|--|----|--|--|-------------------|----|
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | RECOVERY | R.Q.D. % | FRACT. INDEX PER 0.3 m | DISCONTINUITY DATA | | | | HYDRAULIC CONDUCTIVITY K, cm/sec | Dipmtr Point Load Index (MPa) | RMC -Q AVG. | |
| | | | | | | | | TOTAL CORE % | SOLID CORE % | B Angle | DIP w.r.t. CORE AXIS | TYPE AND SURFACE DESCRIPTION | Joon | Jr | Ja | 10 | 20 | 30 |
| | | BEDROCK SURFACE | | 106.53 | | | | | | | | | | | | | | |
| 6 | Rotary Drill NQ Core | Slightly weathered thickly bedded yellow brown fine grained weak to medium strong DOLOSTONE BEDROCK, with laminations of green to black shale, occasional thin beds of sandstone | | 5.82 | 1 | | | | | | | | | | | | | |
| | | End of Drillhole | | 105.64 | | | | | | | | | | | | | | |
| 7 | | Note: Barge shifted and hole had to be abandoned | | 6.71 | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

MIS-RCK 004 1111210290.GPJ GAL-MISS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF BOREHOLE: 12-106A

SHEET 1 OF 4






LOCATION: See Site Plan

BORING DATE: November 16, 2012

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | | SAMPLES | | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m | | | | HYDRAULIC CONDUCTIVITY, k, cm/s | | | | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION | | | |
|-----------------------|---------------------------|---|---|-----------------------|--------|---|-------------|---------------------------|----|------------------------------------|----|-----------------------|-----|----------------------------|---|-----|-----|------------------|
| | | DESCRIPTION | STRATA PLOT | ELEV. DEPTH (m) | NUMBER | TYPE (% REC.) | BLOWS/0.15m | | | | | | | | | | | |
| | | | | | | | | SHEAR STRENGTH Cu, kPa | | | | WATER CONTENT PERCENT | | | | | | |
| | | | | | | | | 20 | 40 | 60 | 80 | nat V. rem V. | + ⊕ | | | - ⊖ | ● ○ | 10 ⁻⁶ |
| | | | | | | | | 20 | 40 | 60 | 80 | | 20 | 40 | 60 | 80 | | |
| 0 | | BARGE DECK | | 112.32 | | | | | | | | | | | | | | |
| | Rotary Drill NW Casing | BARGE |  | 0.00 | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | WATER |  | 111.86 0.46 | | | | | | | | | | | | | | |
| 1 | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | |
| | | (SM) SILTY SAND, fine to coarse, some gravel; dark brown to black; non-cohesive, wet, very dense |  | 107.09 5.23 | | | | | | | | | | | | | | |
| | | (SM) SILTY SAND, fine, some gravel, trace clay; grey; non-cohesive, wet, very dense |  | 106.55 5.77 | | | | | | | | | | | | | | |
| 6 | | Slightly weathered to fresh thinly to medium bedded yellow brown to grey fine grained medium strong DOLOSTONE BEDROCK, with laminations of green to black shale, occasional thin beds of grey sandstone, and 1-10 mm thick calcite veins throughout |  | 5.92 | C1 | NQ RC | | | | | | | | | | | | |
| 7 | | | | | C2 | NQ RC | | | | | | | | | | | | |
| 8 | Rotary Drill NQ Core | | | | | | | | | | | | | | | | | |
| 9 | | | | | C3 | NQ RC | | | | | | | | | | | | |
| 10 | | | | | C4 | NQ RC | | | | | | | | | | | | |
| | | CONTINUED NEXT PAGE | | | | | | | | | | | | | | | | |

ASTM - SOIL (WITH % RECOVERY) 1111210290.GPJ GAL-MIS.GDT 11/29/13 JM

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

PROJECT: 11-1121-0290

RECORD OF BOREHOLE: 12-106A

SHEET 2 OF 4

LOCATION: See Site Plan

BORING DATE: November 16, 2012

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | | SAMPLES | | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m | | | | HYDRAULIC CONDUCTIVITY, k, cm/s | | | | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION | | |
|-----------------------|-------------------------|---|-------------|-----------------------|--------|---|-------------|---------------------------|----|------------------------------------|----|-----------------------|-----|----------------------------|---|-----|-------|
| | | DESCRIPTION | STRATA PLOT | ELEV. DEPTH (m) | NUMBER | TYPE (% REC.) | BLOWS/0.15m | | | | | | | | | | |
| | | | | | | | | SHEAR STRENGTH Cu, kPa | | | | WATER CONTENT PERCENT | | | | | |
| | | | | | | | | 20 | 40 | 60 | 80 | nat V. rem V. | + ⊕ | | | - ⊖ | Q - U |
| | | | | | | | | 20 | 40 | 60 | 80 | Wp — W — Wl | | | | | |
| | | | | | | | | 20 | 40 | 60 | 80 | | | | | | |
| 10 | Rotary Drill NQ Core | --- CONTINUED FROM PREVIOUS PAGE --- | | | | | | | | | | | | | | | |
| | | <div>Slightly weathered to fresh thinly to medium bedded yellow brown to grey fine grained medium strong DOLOSTONE BEDROCK, with laminations of green to black shale, occasional thin beds of grey sandstone, and 1-10 mm think calcite veins throughout</div> <div>Fresh to slightly weathered massive black to red fine to coarse grained weak to medium strong ARKOSE BEDROCK</div> <div>Slightly to moderately weathered massive black to pink fine to coarse grained medium strong to strong GNEISS BEDROCK</div> <div>Slightly to completely weathered massive black to pink fine to coarse grained weak to strong GNEISS BEDROCK</div> <div>- Possible fault from 14.22 m to 16.54 m</div> | | | C4 | NQ RC | | | | | | | | | | | |
| 11 | | | 101.26 | 11.06 | | | | | | | | | | | | | |
| | | | 11.23 | | C5 | NQ RC | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | | |
| 13 | | | | | C6 | NQ RC | | | | | | | | | | | |
| 14 | | | | | C7 | NQ RC | | | | | | | | | | | |
| | | | 98.10 | 14.22 | | | | | | | | | | | | | |
| | | | | | C8 | NQ RC | | | | | | | | | | | |
| 15 | | | | | C9 | NQ RC | | | | | | | | | | | |
| | | | | | C10 | NQ RC | | | | | | | | | | | |
| 16 | | | | C11 | NQ RC | | | | | | | | | | | | |
| | | End of Borehole | | 95.78 | 16.54 | | | | | | | | | | | | |
| 17 | | Note: Soil stratigraphy between 5.23 m and 5.92 m inferred from Borehole 12-106 | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

ASTM - SOIL (WITH % RECOVERY) 1111210290.GPJ GAL-MIS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF DRILLHOLE: 12-106A

SHEET 3 OF 4

LOCATION: See Site Plan

DRILLING DATE: November 16, 2012

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG:

DRILLING CONTRACTOR: Marathon

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. | RUN No. | COLOUR % RETURN | JN - Joint FLT - Fault SHR - Shear VN - Vein CJ - Conjugate | BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage | PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular | PO - Polished K - Slickensided SM - Smooth Ro - Rough MB - Mechanical Break | BR - Broken Rock | NOTES WATER LEVELS INSTRUMENTATION | | | | | | | | | | | | | | | |
|-----------------------|-----------------|-------------|--------------|-------|---------|--------------------|---|--|---|---|------------------|--|-------|--|-----------------|--------|-----------------------|---------|----------------------------|---------------------------------|-----------|----------|-----|---------------------------|------------------------------|-----|------|
| | | | | DEPTH | | | | | | | | | FLUSH | RECOVERY | R.Q.D. | FRACT. | DISCONTINUITY DATA | | | | HYDRAULIC | Diameter | RMC | | | | |
| | | | | (m) | | | | | | | | | | TOTAL CORE % | SOLID CORE % | % | INDEX PER 0.3 m | B Angle | DIP w.r.t. CORE AXIS | TYPE AND SURFACE DESCRIPTION | Icon | Jr | Ja | CONDUCTIVITY K, cm/sec | Point Load Index (MPa) | -Q' | AVG. |
| | | | | | | | | | | | | | | 80 | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

MIS-RCK 004 1111210290.GPJ GAL-MISS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF DRILLHOLE: 12-106A

SHEET 4 OF 4

LOCATION: See Site Plan

DRILLING DATE: November 16, 2012

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DRILL RIG:

DRILLING CONTRACTOR: Marathon

| DEPTH SCALE METRES | DRILLING RECORD | | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | COLOUR % RETURN | FLUSH | RECOVERY | | FRACT. INDEX PER 0.3 m | DISCONTINUITY DATA | | | | HYDRAULIC CONDUCTIVITY K, cm/sec | | Diametral Point Load Index (MPa) | RMC -Q AVG. | NOTES WATER LEVELS INSTRUMENTATION | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| | | | | | | | | | TOTAL CORE % | SOLID CORE % | | R.Q.D. % | B Angle | DIP w.r.t. CORE AXIS | TYPE AND SURFACE DESCRIPTION | Jcom | Jr | | | | Ja | Jc | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | Jd | Jf | Jg | Jh | Ji | Jj | Jk | Jl | Jm | Jn | Jo | Jp | Jq | Jr | Js | Jt | Ju | Jv | Jw | Jx | Jy | Jz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| | | Rotary Drill | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

MIS-RCK 004 1111210290.GPJ GAL-MISS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF BOREHOLE: 12-106B

SHEET 1 OF 4


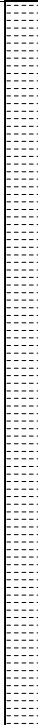


LOCATION: See Site Plan

BORING DATE: November 19, 2012

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | | | SAMPLES | | | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m | | | | HYDRAULIC CONDUCTIVITY, k, cm/s | | | | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION | | | | | | | | |
|-----------------------|---------------------------|---|---|-----------------------|----------|---------------|-------------|---|----|----------------------|----|------------------------------------|----|-----------------------|----|----------------------------|---|------------------|--|------------------|--|------------------|--|------------------|--|
| | | DESCRIPTION | STRATA PLOT | ELEV. DEPTH (m) | NUMBER | TYPE (% REC.) | BLOWS/0.15m | RESISTANCE, BLOWS/0.3m | | | | k, cm/s | | | | | | | | | | | | | |
| | | | | | | | | 20 | | 40 | | 60 | | 80 | | | | 10 ⁻⁶ | | 10 ⁻⁵ | | 10 ⁻⁴ | | 10 ⁻³ | |
| | | | | | | | | SHEAR STRENGTH Cu, kPa | | nat V. + rem V. ⊕ | | Q - ● U - ○ | | WATER CONTENT PERCENT | | | | Wp — W — Wi | | | | | | | |
| | | | | | | | | 20 | 40 | 60 | 80 | 20 | 40 | 60 | 80 | | | | | | | | | | |
| 0 | | BARGE DECK | | 112.29 | | | | | | | | | | | | | | | | | | | | | |
| | Rotary Drill NW Casing | BARGE |  | 0.00 | | | | | | | | | | | | | | | | | | | | | |
| | | | | 111.83 | | | | | | | | | | | | | | | | | | | | | |
| | | WATER |  | 0.46 | | | | | | | | | | | | | | | | | | | | | |
| 1 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | (SM) SILTY SAND, fine to coarse, some gravel; dark brown to black; non-cohesive, wet, very dense |  | 107.01 5.28 | | | | | | | | | | | | | | | | | | | | | |
| | | | | 106.52 | | | | | | | | | | | | | | | | | | | | | |
| 6 | | (SM) SILTY SAND, fine, some gravel, trace clay; grey; non-cohesive, wet, very dense |  | 5.79 | | | | | | | | | | | | | | | | | | | | | |
| | | Slightly weathered to fresh thinly bedded yellow brown to grey fine grained medium strong DOLOSTONE BEDROCK, with laminations of green to black shale, occasional thin beds of sandstone and 1-2 mm thick calcite veins | | C1 | NQ RC | | | | | | | | | | | | | | | | | | | | |
| 7 | | | | C2 | NQ RC | | | | | | | | | | | | | | | | | | | | |
| | | | | C3 | NQ RC | | | | | | | | | | | | | | | | | | | | |
| | | | | C4 | NQ RC | | | | | | | | | | | | | | | | | | | | |
| | | | | C5 | NQ RC | | | | | | | | | | | | | | | | | | | | |
| | | | | C6 | NQ RC | | | | | | | | | | | | | | | | | | | | |
| 8 | Rotary Drill NQ Core | | | C7 | NQ RC | | | | | | | | | | | | | | | | | | | | |
| | | | | C8 | NQ RC | | | | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | C9 | NQ RC | | | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | CONTINUED NEXT PAGE | | | | | | | | | | | | | | | | | | | | | | | |

ASTM - SOIL (WITH % RECOVERY) 1111210290.GPJ GAL-MIS.GDT 11/29/13 JM

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

PROJECT: 11-1121-0290

RECORD OF BOREHOLE: 12-106B

SHEET 2 OF 4

LOCATION: See Site Plan

BORING DATE: November 19, 2012

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | | SAMPLES | | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m | | | | HYDRAULIC CONDUCTIVITY, k, cm/s | | | | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION | | |
|---------------------------|-------------------------|---|-------------|-----------------------|--------|---|-------------|-----------------------|--|------------------------------------|--|------------------|--|----------------------------|---|--|--|
| | | DESCRIPTION | STRATA PLOT | ELEV. DEPTH (m) | NUMBER | TYPE (% REC.) | BLOWS/0.15m | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| 20 | | 40 | | 60 | | 80 | | 10 ⁻⁶ | | 10 ⁻⁵ | | 10 ⁻⁴ | | 10 ⁻³ | | | |
| SHEAR STRENGTH Cu, kPa | | nat V. + rem V. ⊕ | | Q - ● U - ○ | | | | WATER CONTENT PERCENT | | Wp | | W | | Wi | | | |
| 20 | | 40 | | 60 | | 80 | | 20 | | 40 | | 60 | | 80 | | | |
| 10 | | --- CONTINUED FROM PREVIOUS PAGE --- | | | | | | | | | | | | | | | |
| | Rotary Drill NQ Core | Slightly weathered to fresh thinly bedded yellow brown to grey fine grained medium strong DOLOSTONE BEDROCK, with laminations of green to black shale, occasional thin beds of sandstone and 1-2 mm thick calcite veins SAND SEAM Fresh to slightly weathered massive black to red fine to coarse grained medium strong ARKOSE BEDROCK Slightly to moderately weathered massive black to pink fine to coarse grained strong to very strong GNEISS BEDROCK < | | | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

ASTM - SOIL (WITH % RECOVERY) 1111210290.GPJ GAL-MIS.GDT 11/29/13 JM

SHEET 3 OF 4

DATUM: Geodetic

DRILLING CONTRACTOR: Marathon

[illegible]

CHECKED: CK

MIS-RCK 004 111210290.GPJ GAL-MISS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF DRILLHOLE: 12-106B

SHEET 4 OF 4

LOCATION: See Site Plan

DRILLING DATE: November 19, 2012

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG:

DRILLING CONTRACTOR: Marathon

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | COLOUR % RETURN | JN - Joint FLT - Fault SHR - Shear VN - Vein CJ - Conjugate | | | | | | | | | | | | BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage | | | | | | | | | | | | PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular | | | | | | | | | | | | PO - Polished K - Slickensided SM - Smooth Ro - Rough MB - Mechanical Break | | | | | | | | | | | | BR - Broken Rock | | | | | | | | | | | | NOTES WATER LEVELS INSTRUMENTATION | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| | | | | | | | RECOVERY | | | | FRACT. INDEX | | | | DISCONTINUITY DATA | | | | | | | | HYDRAULIC CONDUCTIVITY | | | | Diametral Point Load Index (MPa) | | | | RMC - Q' AVG. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | TOTAL CORE % | | SOLID CORE % | | R.Q.D. % | | INDEX PER 0.3 m | | B Angle | | DIP w.r.t. CORE AXIS | | TYPE AND SURFACE DESCRIPTION | | | | Joon | | Jr | | Ja | | K, cm/sec | | Point Load Index (MPa) | | RMC - Q' AVG. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | FLUSH | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 | 800000 |

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

MIS-RCK 004 1111210290.GPJ GAL-MISS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF BOREHOLE: 12-107

SHEET 2 OF 4

LOCATION: See Site Plan

BORING DATE: November 1, 2012

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | | SAMPLES | | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m | | | | HYDRAULIC CONDUCTIVITY, k, cm/s | | | | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION | | |
|-----------------------|-------------------------|--|-------------|-----------------------|--------|---|-------------|---------------------------|----|------------------------------------|----|--|------------------|----------------------------|---|------------------|------------------|
| | | DESCRIPTION | STRATA PLOT | ELEV. DEPTH (m) | NUMBER | TYPE (% REC.) | BLOWS/0.15m | SHEAR STRENGTH Cu, kPa | | nat V. + Q - ● rem V. ⊕ U - ○ | | WATER CONTENT PERCENT Wp I — W — WI | | | | | |
| | | | | | | | | 20 | 40 | 60 | 80 | 10 ⁻⁶ | 10 ⁻⁵ | | | 10 ⁻⁴ | 10 ⁻³ |
| 10 | Rotary Drill NQ Core | --- CONTINUED FROM PREVIOUS PAGE --- Fresh massive black to pink fine to medium grained medium strong to very strong GNEISS BEDROCK | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | | | | | |
| 17 | | End of Borehole | | 96.27 16.72 | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

ASTM - SOIL (WITH % RECOVERY) 1111210290.GPJ GAL-MIS.GDT 11/29/13 JM

SHEET 3 OF 4

DATUM: Geodetic

DRILLING CONTRACTOR: Marathon

[illegible]

CHECKED: CK

MIS-RCK 004 111210290.GPJ GAL-MISS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF DRILLHOLE: 12-107

SHEET 4 OF 4

LOCATION: See Site Plan

DRILLING DATE: November 1, 2012

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG:

DRILLING CONTRACTOR: Marathon

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | COLOUR % RETURN | FLUSH | JN - Joint FLT - Fault SHR - Shear VN - Vein CJ - Conjugate | | | | BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage | | | | PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular | | | | PO - Polished K - Slickensided SM - Smooth Ro - Rough MB - Mechanical Break | | | | BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols. | | | | NOTES WATER LEVELS INSTRUMENTATION | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| | | | | | | | | TOTAL CORE % | SOLID CORE % | | | TYPE AND SURFACE DESCRIPTION | Ucon | Jr | Ja | 10 10 10 10 | 10 10 10 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| | | --- CONTINUED FROM PREVIOUS PAGE --- | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

MIS-RCK 004 1111210290.GPJ GAL-MISS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF BOREHOLE: 12-108

SHEET 2 OF 4


LOCATION: See Site Plan

BORING DATE: November 24, 2012

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | | | SAMPLES | | | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m | | | | HYDRAULIC CONDUCTIVITY, k, cm/s | | | | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION | |
|-----------------------|-------------------------|---|--|-----------------------|----------|---------------|-------------|---|----|----------------------------------|----|------------------------------------|------------------|------------------|------------------|----------------------------|---|----|
| | | DESCRIPTION | STRATA PLOT | ELEV. DEPTH (m) | NUMBER | TYPE (% REC.) | BLOWS/0.15m | | | | | | | | | | | |
| | | | | | | | | SHEAR STRENGTH Cu, kPa | | nat V. + Q - ● rem V. ⊕ U - ○ | | WATER CONTENT PERCENT | | | | | | |
| | | | | | | | | 20 | 40 | 60 | 80 | 10 ⁻⁶ | 10 ⁻⁵ | 10 ⁻⁴ | 10 ⁻³ | | | Wp |
| | | | | | | | | 20 | 40 | 60 | 80 | 20 | 40 | 60 | 80 | | | |
| 10 | Rotary Drill NQ Core | --- CONTINUED FROM PREVIOUS PAGE --- Fresh black and pink fine to coarse grained strong to very strong granitic GNEISS BEDROCK |  | | | | | | | | | | | | | | | |
| | | | | C7 | NQ RC | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | | | |
| 12 | | | | | C8 | NQ RC | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | | | |
| 14 | | | | | C9 | NQ RC | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | | | |
| | | | | | C10 | NQ RC | | | | | | | | | | | | |
| | | End of Borehole | | 97.40 15.38 | | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50



LOGGED: DG

CHECKED: CK

ASTM - SOIL (WITH % RECOVERY) 1111210290.GPJ GAL-MIS.GDT 11/29/13 JM

SHEET 3 OF 4

DATUM: Geodetic

DRILLING CONTRACTOR: Marathon

[illegible]

CHECKED: CK

MIS-RCK 004 111210290.GPJ GAL-MISS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF DRILLHOLE: 12-108

SHEET 4 OF 4

LOCATION: See Site Plan

DRILLING DATE: November 24, 2012

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG:

DRILLING CONTRACTOR: Marathon

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. | | RUN No. | COLOUR % RETURN | JN - Joint FLT - Fault SHR - Shear VN - Vein CJ - Conjugate | BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage | PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular | PO - Polished K - Slickensided SM - Smooth Ro - Rough MB - Mechanical Break | BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols. | NOTES WATER LEVELS INSTRUMENTATION | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| | | | | DEPTH (m) | FLUSH | | | | | | | | RECOVERY | | R.Q.D. % | FRACT INDEX PER 0.3 m | DISCONTINUITY DATA | | | | HYDRAULIC CONDUCTIVITY | | | | Diametral Point Load Index (MPa) | RMC -Q AVG. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | TOTAL CORE % | SOLID CORE % | | | B Angle | DIP w.r.t. CORE AXIS | TYPE AND SURFACE DESCRIPTION | Ucon | Jr | Ja | K, cm/sec | 10 ⁻⁶ | | | 10 ⁻⁵ | 10 ⁻⁴ | 10 ⁻³ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| 11 | Rotary Drill NQ Core | --- CONTINUED FROM PREVIOUS PAGE --- Fresh black and pink fine to coarse grained strong to very strong granitic GNEISS BEDROCK | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50



LOGGED: DG

CHECKED: CK

MIS-RCK 004 1111210290.GPJ GAL-MISS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF BOREHOLE: 12-20

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: November 30, 2012

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | | | SAMPLES | | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m | | | | HYDRAULIC CONDUCTIVITY, k, cm/s | | | | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION | | | |
|-----------------------|---|--|-------------|-----------------------|---------|---------------|---|----------------|----|--------------------------------|------------------------------------|-----------------------|--|---|----------------------------|---|----|--|--|
| | | DESCRIPTION | STRATA PLOT | ELEV. DEPTH (m) | NUMBER | TYPE (% REC.) | BLOWS/0.15m | | | | | | | | | | | | |
| | | | | | | | | SHEAR STRENGTH | | | | WATER CONTENT PERCENT | | | | | | | |
| | | | | | | | | Cu, kPa | | nat V. + Q - rem V. ⊕ U - ○ | | Wp | | W | | | Wi | | |
| | | | | | | | | 20 | 40 | 60 | 80 | | | | | | | | |
| 0 | | GROUND SURFACE | | 122.57 | | | | | | | | | | | | | | | |
| | | ASPHALTIC CONCRETE | | 0.00 | | | | | | | | | | | | | | | |
| | | | | 122.36 | | | | | | | | | | | | | | | |
| | | (SP) gravelly SAND, medium to coarse; dark brown; non-cohesive, moist (FILL) | | 0.28 | | | | | | | | | | | | | | | |
| | | (SP) SAND, fine to medium, trace to some silt, trace gravel; brown to dark brown; non-cohesive, moist, dense to very dense (FILL) | | | | | | | | | | | | | | | | | |
| 1 | | | | | 1 | SS (100) | 7 | | | | | | | | | | | | |
| | | | | | | | 15 | | | | | | | | | | | | |
| | | | | | | | 18 | | | | | | | | | | | | |
| | | | | | | | 18 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| | | | | | | | 9 | | | | | | | | | | | | |
| | | | | | 2 | SS (100) | 18 | | | | | | | | | | | | |
| | | | | | | | 22 | | | | | | | | | | | | |
| 2 | | | | | | | 23 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| | | | | | | | 10 | | | | | | | | | | | | |
| | | | | | 3 | SS (67) | 18 | | | | | | | | | | | | |
| | | | | | | | 19 | | | | | | | | | | | | |
| | | | | | | | 26 | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | |
| | | | | | | | 10 | | | | | | | | | | | | |
| | | | | | 4 | SS (75) | 17 | | | | | | | | | | | | |
| | | | | | | | 20 | | | | | | | | | | | | |
| | | | | | | | 24 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| 4 | Power Auger 200 mm Diam. (Hollow Stem) | | | | | | 9 | | | | | | | | | | | | |
| | | | | | 5 | SS (75) | 13 | | | | | | | | | | | | |
| | | | | | | | 23 | | | | | | | | | | | | |
| | | | | | | | 33 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| | | | | | 6 | SS (75) | 9 | | | | | | | | | | | | |
| | | | | | | | 14 | | | | | | | | | | | | |
| 5 | | | | | | | 21 | | | | | | | | | | | | |
| | | | | | | | 23 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| | | | | | 7 | SS (100) | 14 | | | | | | | | | | | | |
| | | | | | | | 20 | | | | | | | | | | | | |
| | | | | | | | 26 | | | | | | | | | | | | |
| | | | | | | | 27 | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | | | |
| | | | | | | | 22 | | | | | | | | | | | | |
| | | | | | 8 | SS (100) | 25 | | | | | | | | | | | | |
| | | | | | | | 30 | | | | | | | | | | | | |
| | | | | | | | 41 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | 14 | | | | | | | | | | | | |
| | | | | | 9 | SS (100) | 22 | | | | | | | | | | | | |
| | | | | | | | 10 | | | | | | | | | | | | |
| | | | | | | | 12 | | | | | | | | | | | | |
| | | (SM) gravelly SILTY SAND, fine, trace clay, with organic matter; light grey brown; non-cohesive, moist, dense (FILL) | | 115.25 | | | | | | | | | | | | | | | |
| | | | | 7.32 | | | | | | | | | | | | | | | |
| | | | | | | | 6 | | | | | | | | | | | | |
| | | | | | | | 34 | | | | | | | | | | | | |
| 8 | | (CI-CL) SILTY CLAY, with rootlets and organic matter; grey brown; cohesive, moist, very stiff | | 114.65 | | 10 | SS (67) | 9 | | | | | | | | | | | |
| | | | | 7.92 | | | | 10 | | | | | | | | | | | |
| | | (SM) gravelly SILTY SAND, fine to medium, trace clay; grey brown; non-cohesive, moist to wet, dense | | 114.34 | | | | | | | | | | | | | | | |
| | | | | 8.23 | | | | | | | | | | | | | | | |
| | | End of Borehole Auger Refusal | | 114.03 | 11 | SS (100) | 50 | | | | | | | | | | | | |
| | | | | 8.54 | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

ASTM - SOIL (WITH % RECOVERY) 1111210290.GPJ GAL-MIS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF BOREHOLE: 12-22

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: November 25, 2012

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | | | SAMPLES | | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m | | | | HYDRAULIC CONDUCTIVITY, k, cm/s | | | | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION | |
|-----------------------|---|--|-------------|-----------------------|---------------------|----------------------|---|---------------------------|----|--------------------------------|------------------------------------|-----------------------|------------------|------------------|----------------------------|---|------------------|
| | | DESCRIPTION | STRATA PLOT | ELEV. DEPTH (m) | NUMBER | TYPE (% REC.) | BLOWS/0.15m | RESISTANCE, BLOWS/0.3m | | | | k, cm/s | | | | | |
| | | | | | | | | SHEAR STRENGTH Cu, kPa | | nat V. + Q - rem V. ⊕ U - ● | | WATER CONTENT PERCENT | | | | | |
| | | | | | | | | 20 | 40 | 60 | 80 | 10 ⁻⁶ | 10 ⁻⁵ | 10 ⁻⁴ | | | 10 ⁻³ |
| | | | | | | | | | | | | | | | | | |
| 0 | | GROUND SURFACE | | 122.42 | | | | | | | | | | | | | |
| | Power Auger 200 mm Diam. (Hollow Stem) | (SP) gravelly SAND, medium to coarse; dark brown; non-cohesive, moist (FILL) | | 0.00 | | | | | | | | | | | | | |
| | | (SM) SILTY SAND, fine; brown; non-cohesive, moist (FILL) | | 0.20 | | | | | | | | | | | | | |
| | | (SP) gravelly SAND, medium to coarse; dark brown; non-cohesive, moist (FILL) | | | | | | | | | | | | | | | |
| 1 | | (SP) SAND, fine to medium, trace gravel, trace silt; brown to dark brown; non-cohesive, moist, dense to very dense (FILL) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| 2 | | | | 1 | SS (67) | 11 20 26 43 | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| 3 | | | | 2 | SS (67) | 14 27 33 56 | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| 5 | | | 3 | SS (67) | 21 24 22 6 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| 6 | | End of Borehole Auger Refusal | | 116.30 6.12 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

ASTM - SOIL (WITH % RECOVERY) 1111210290.GPJ GAL-MIS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF BOREHOLE: 12-24

SHEET 1 OF 1


LOCATION: See Site Plan

BORING DATE: November 23, 2012

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | | | SAMPLES | | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m | | | | HYDRAULIC CONDUCTIVITY, k, cm/s | | | | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION | | | | | | | | | |
|-----------------------|---|---|---|--|---------|---------------|---|---------------------------|----------------------|----------------------------------|------------------------------------|-----------------------|----|----|----------------------------|---|------------------|--|------------------|--|------------------|--|------------------|--|--|
| | | DESCRIPTION | STRATA PLOT | ELEV. DEPTH (m) | NUMBER | TYPE (% REC.) | BLOWS/0.15m | SHEAR STRENGTH | | | | WATER CONTENT PERCENT | | | | | | | | | | | | | |
| | | | | | | | | 20 | | 40 | | 60 | | 80 | | | 10 ⁻⁶ | | 10 ⁻⁵ | | 10 ⁻⁴ | | 10 ⁻³ | | |
| | | | | | | | | SHEAR STRENGTH Cu, kPa | | nat V. + Q - ● rem V. ⊕ U - ○ | | | | | | | Wp | | W | | Wi | | | | |
| | | | | | | | | 20 | 40 | 60 | 80 | 20 | 40 | 60 | 80 | | | | | | | | | | |
| 0 | | GROUND SURFACE | | 122.34 | | | | | | | | | | | | | | | | | | | | | |
| | Power Auger 200 mm Diam. (Hollow Stem) | (SP) gravelly SAND, medium to coarse; dark brown to brown; non-cohesive, moist (FILL) |  | 0.00 | | | | | | | | | | | | | | | | | | | | | |
| | | (SP) SAND, fine to medium, trace to some gravel, with thin laminations of grey silty clay; non-cohesive, moist, very dense to compact (FILL) | | 122.12 | | | | | | | | | | | | | | | | | | | | | |
| | | | | 0.22 | | | | | | | | | | | | | | | | | | | | | |
| 1 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | 1 | SS (67) | 17 30 44 52 | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | 2 | SS (67) | 12 10 5 6 | | | | | | | | | | | | | | | | |
| | | | | (CI-CL) SILTY CLAY; dark brown; cohesive, moist | 118.68 | | | | | | | | | | | | | | | | | | | | |
| | | | | | 3.66 | | | | | | | | | | | | | | | | | | | | |
| | | | | | 3.76 | | | | | | | | | | | | | | | | | | | | |
| 4 | | End of Borehole Auger Refusal | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50



LOGGED: RI

CHECKED: CK

ASTM - SOIL (WITH % RECOVERY) 1111210290.GPJ GAL-MIS.GDT 11/29/13 JM

PROJECT: 11-1121-0290

RECORD OF BOREHOLE: 12-26

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: November 23, 2012

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | | | SAMPLES | | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m | | | | HYDRAULIC CONDUCTIVITY, k, cm/s | | | | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION | |
|-----------------------|---|---|--|-----------------------|--------------|---------------|---|----------------|----|----|------------------------------------|----------------------------------|------------------|------------------|----------------------------|---|--|
| | | DESCRIPTION | STRATA PLOT | ELEV. DEPTH (m) | NUMBER | TYPE (% REC.) | BLOWS/0.15m | | | | | | | | | | |
| | | | | | | | | SHEAR STRENGTH | | | | WATER CONTENT PERCENT | | | | | |
| | | | | | | | | Cu, kPa | | | | nat V. + Q - ● rem V. ⊕ U - ○ | | | | | |
| | | | | | | | 20 | 40 | 60 | 80 | 10 ⁻⁶ | 10 ⁻⁵ | 10 ⁻⁴ | 10 ⁻³ | | | |
| | | | | | | | 20 | 40 | 60 | 80 | 20 | 40 | 60 | 80 | | | |
| 0 | Power Auger 200 mm Diam. (Hollow Stem) | GROUND SURFACE | | 122.42 | | | | | | | | | | | | | |
| | | (SP) gravelly SAND, medium to coarse; dark brown; non-cohesive, moist (FILL) | | 0.00 | | | | | | | | | | | | | |
| | | (SM) SILTY SAND, fine; brown; non-cohesive, moist (FILL) | | 0.22 | | | | | | | | | | | | | |
| | | (SP) gravelly SAND, medium to coarse; dark brown; non-cohesive, moist (FILL) | | 0.32 | | | | | | | | | | | | | |
| | | (SP) SAND, fine to medium, trace gravel; brown; non-cohesive, moist, dense to very dense (FILL) | | 0.42 | | | | | | | | | | | | | |
| 1 | | | | | | | | | | | | | | | | | |
| 2 | | | | | 1 | SS (67) | 8 21 29 40 | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | (CI-ML) SILTY CLAY to CLAYEY SILT, some sand; dark brown; cohesive, moist | | 119.98 | | | | | | | | | | | | |
| | | | End of Borehole Auger Refusal | | 2.44 2.54 | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50



LOGGED: RI

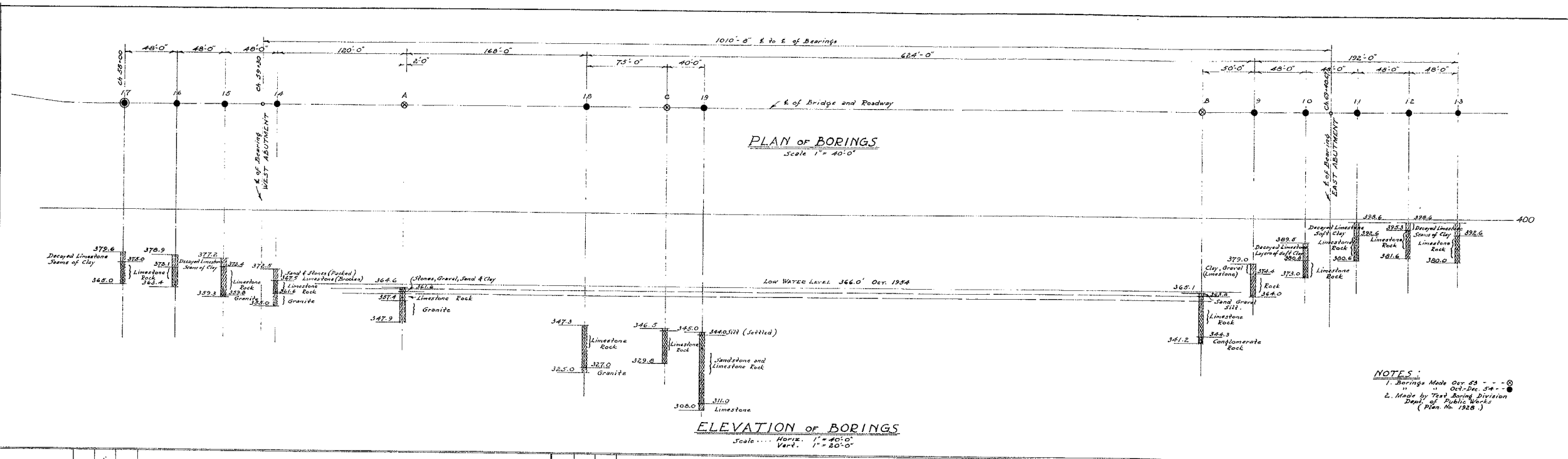
CHECKED: CK

ASTM - SOIL (WITH % RECOVERY) 1111210290.GPJ GAL-MIS.GDT 11/29/13 JM



APPENDIX B

Steel Reinforcement Schedule and Boring Data Previous Investigation by Others



| BILL OF MATERIALS | | | | | | | | | |
|--------------------------------|------|--------|-----|------|-----------|------|------------------|--|--|
| STRAIGHT BARS | | | | | BENT BARS | | | | |
| No. | Size | Length | No. | Size | Length | Mark | BENDING DIAGRAMS | | |
| ALL DIMENSIONS ARE OUT TO OUT. | | | | | | | | | |
| 24 | "11 | 35'-0" | 39 | "6 | 11'-0" | W1 | | | |
| 2 | "11 | 26'-0" | 134 | "5 | 6'-0" | W2 | | | |
| 12 | "11 | 25'-0" | 50 | "8 | 10'-0" | W3 | | | |
| 2 | "11 | 24'-0" | 17 | "6 | 7'-6" | W4 | | | |
| 2 | "11 | 22'-6" | 50 | "5 | 6'-0" | W5 | | | |
| 2 | "11 | 20'-6" | 50 | "5 | 9'-4" | W6 | | | |
| 2 | "11 | 19'-0" | 9 | "5 | 9'-0" | W7 | | | |
| 2 | "11 | 17'-0" | 4 | "5 | 23'-6" | W8 | | | |
| 12 | "11 | 16'-0" | 4 | "5 | 26'-6" | W9 | | | |
| 2 | "11 | 15'-0" | 4 | "5 | 21'-6" | W10 | | | |
| 17 | "9 | 35'-0" | 4 | "5 | 20'-6" | W11 | | | |
| 13 | "9 | 12'-0" | 4 | "5 | 19'-6" | W12 | | | |
| 30 | "8 | 6'-0" | 4 | "5 | 10'-6" | W13 | | | |
| 22 | "7 | 29'-6" | 4 | "5 | 17'-6" | W14 | | | |
| 232 | "6 | 26'-0" | 4 | "5 | 16'-6" | W15 | | | |
| 10 | "6 | 38'-0" | 4 | "5 | 15'-6" | W16 | | | |
| 70 | "6 | 35'-0" | 4 | "5 | 14'-6" | W17 | | | |
| 120 | "6 | 29'-6" | 4 | "5 | 13'-6" | W18 | | | |
| 6 | "6 | 28'-0" | 4 | "5 | 12'-6" | W19 | | | |
| 6 | "6 | 26'-0" | 4 | "5 | 11'-6" | W20 | | | |
| 22 | "6 | 18'-6" | 4 | "5 | 10'-6" | W21 | | | |
| 4 | "6 | 15'-0" | 4 | "5 | 9'-6" | W22 | | | |
| 4 | "6 | 14'-3" | 4 | "5 | 8'-6" | W23 | | | |
| 4 | "6 | 13'-6" | 4 | "5 | 7'-6" | W24 | | | |
| 4 | "6 | 12'-6" | 18 | "5 | 9'-5" | PY1 | | | |
| 4 | "6 | 12'-0" | | | | | | | |
| 4 | "6 | 11'-9" | | | | | | | |
| 4 | "6 | 10'-9" | | | | | | | |
| 84 | "6 | 10'-0" | | | | | | | |
| 4 | "6 | 9'-3" | | | | | | | |
| 4 | "6 | 9'-0" | | | | | | | |
| 4 | "6 | 8'-6" | | | | | | | |
| 4 | "6 | 8'-3" | | | | | | | |
| 4 | "6 | 7'-3" | | | | | | | |
| 176 | "6 | 4'-6" | | | | | | | |
| 20 | "5 | 28'-0" | | | | | | | |
| 10 | "5 | 33'-0" | | | | | | | |
| 2 | "5 | 8'-0" | | | | | | | |
| 24 | "5 | 30'-0" | | | | | | | |
| 14 | "5 | 28'-0" | | | | | | | |
| 14 | "11 | 28'-0" | | | | | | | |
| | | | | | | | | | |
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| | |
|--|----------------------------|
| Deck Concrete: 28.5 cu. yds. added in Curb | Nov. 16/55 |
| C.S. and longitudinal #3 bars added | Nov. 16/55 |
| Steel Reinforcement | Aug. 12/55 |
| REVISIONS | DATE |
| DEPARTMENT OF PUBLIC WORKS | |
| CANADA | |
| DEVELOPMENT ENGINEERING BRANCH | |
| INTERPROVINCIAL BRIDGE | |
| PEMBROKE TO ALLUMETTE ISLAND PROJECT | |
| STEEL REINF. SCHEDULE AND BORING DATA | |
| DESIGN | OFFICE FILE NO. SD 6-2C-17 |
| JOB SUPERVISOR | CHECKED D.A.S. |
| APPROVED | DATE MAY 18/57 |
| APPROVED | DATE MAY 10/57 |
| APPROVED | DATE MAY 10/57 |
| SHEET 17 OF 17 | |
| PROJECT NO. SD 6-2C | |




APPENDIX C

Photographs of Bedrock Core



Photo 1: Borehole 12-101 – Core Boxes 1 to 2 of 7 – 0.6 to 5.52 m Depth (dry)

| | | | | | |
|---|--|--------|-----------|---|----------|
|  | | | TITLE | | |
| | | | | | |
| | | | | | |
| | | DATE | June 2013 | GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | DESIGN | KE | | |
| PROJECT NO. 11-1121-0290 REV. 1 | | CHECK | CK | OTTAWA RIVER ONTARIO-QUEBEC | PLATE 1a |
| | | REVIEW | TMS | | |

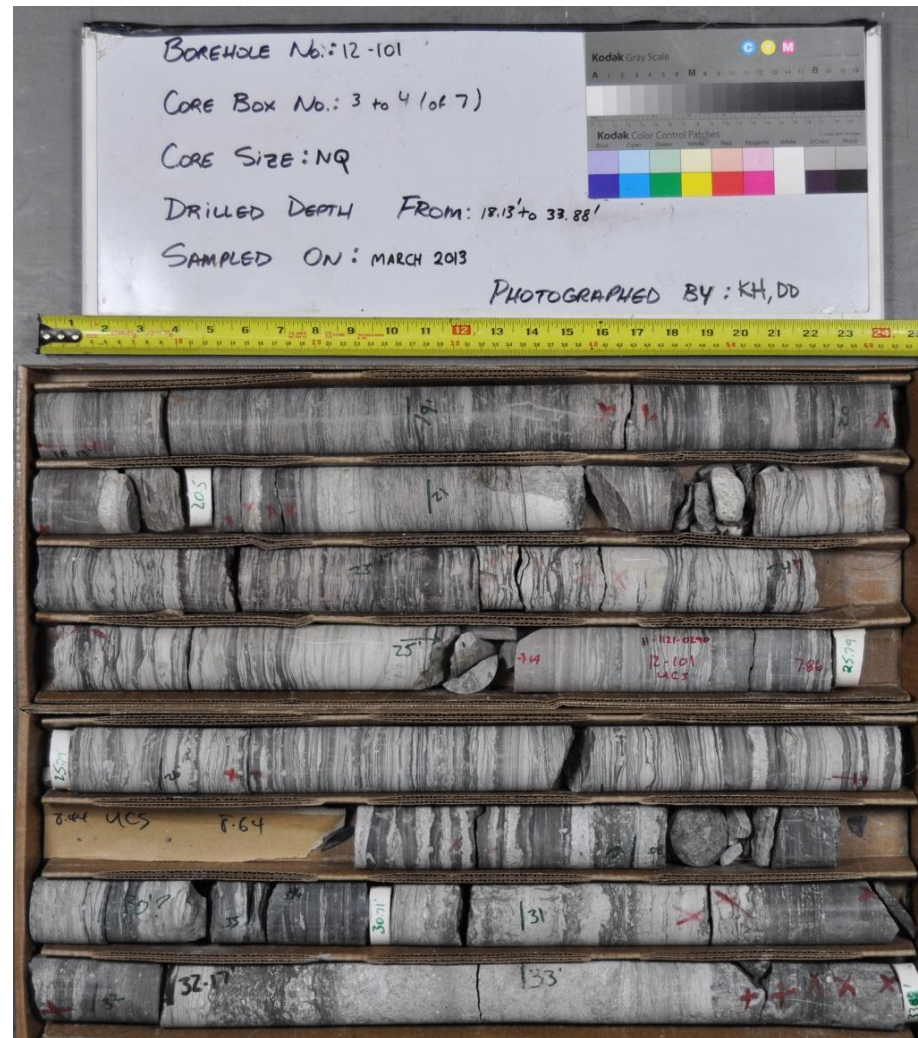



Photo 3: Borehole 12-101 – Core Boxes 3 to 4 of 7 – 5.52 to 10.33 m Depth (dry)

| | | | | |
|---|--------|----------------|---|-----------------|
|  | | | TITLE | |
| | | | | |
| | | DATE June 2013 | GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | DESIGN KE | | |
| PROJECT NO. 11-1121-0290 | REV. 1 | CHECK CK | OTTAWA RIVER ONTARIO-QUEBEC | PLATE 2a |
| | | REVIEW TMS | | |

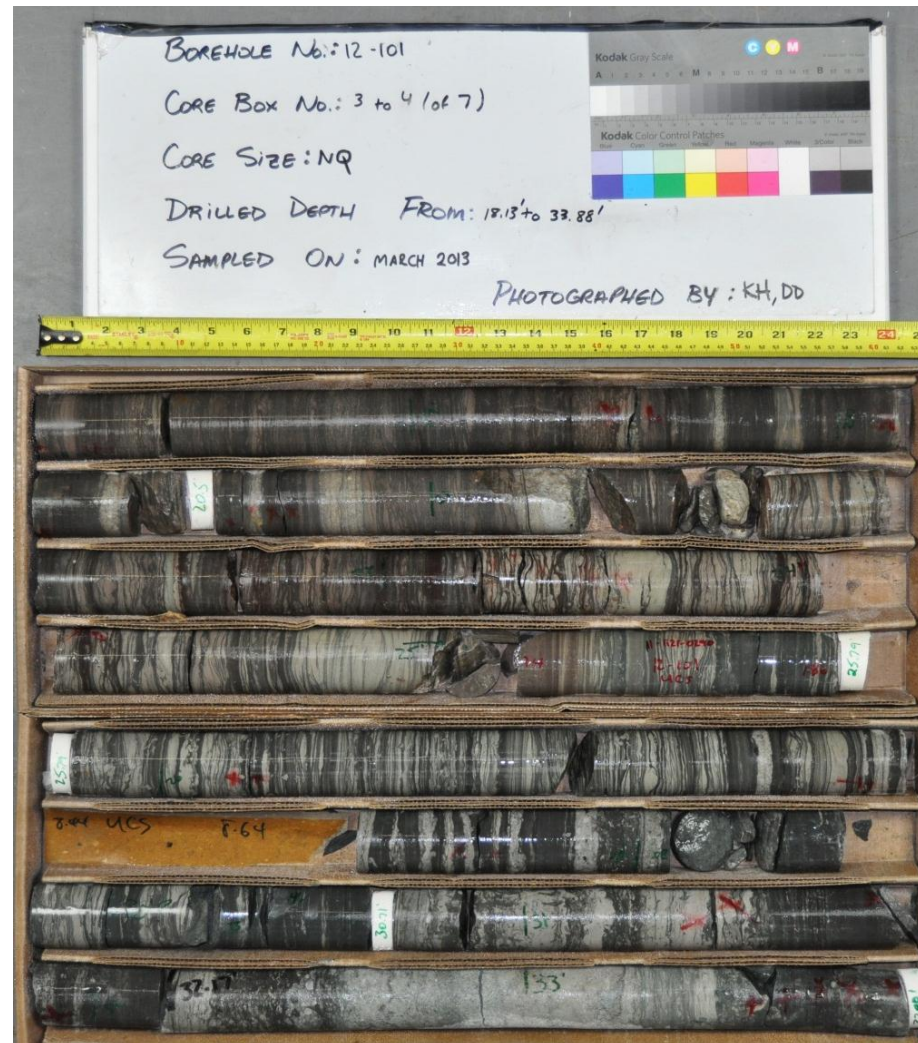


Photo 4: Borehole 12-101 – Core Boxes 3 to 4 of 7 – 5.52 to 10.33 m Depth (wet)



| | | | |
|---|--------------|---|--------|
|  | | TITLE GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | OTTAWA RIVER ONTARIO-QUEBEC | |
| | | PLATE 2b | |
| | | | |
| PROJECT NO. | 11-1121-0290 | REV. 1 | REVIEW |
| | | | TMS |



Photo 5: Borehole 12-101 – Core Boxes 5 to 6 of 7 – 10.33 to 14.79 m Depth (dry)

| | | | | | |
|---|--------|-------------------|--|--------------|--------------------------------|
|  | | | TITLE GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | | |
| | | | | | |
| | | | | | |
| | | DATE June 2013 | | | |
| | | | | DESIGN KE | OTTAWA RIVER ONTARIO-QUEBEC |
| | | CHECK CK | | | |
| PROJECT NO. 11-1121-0290 | REV. 1 | REVIEW TMS | | | |

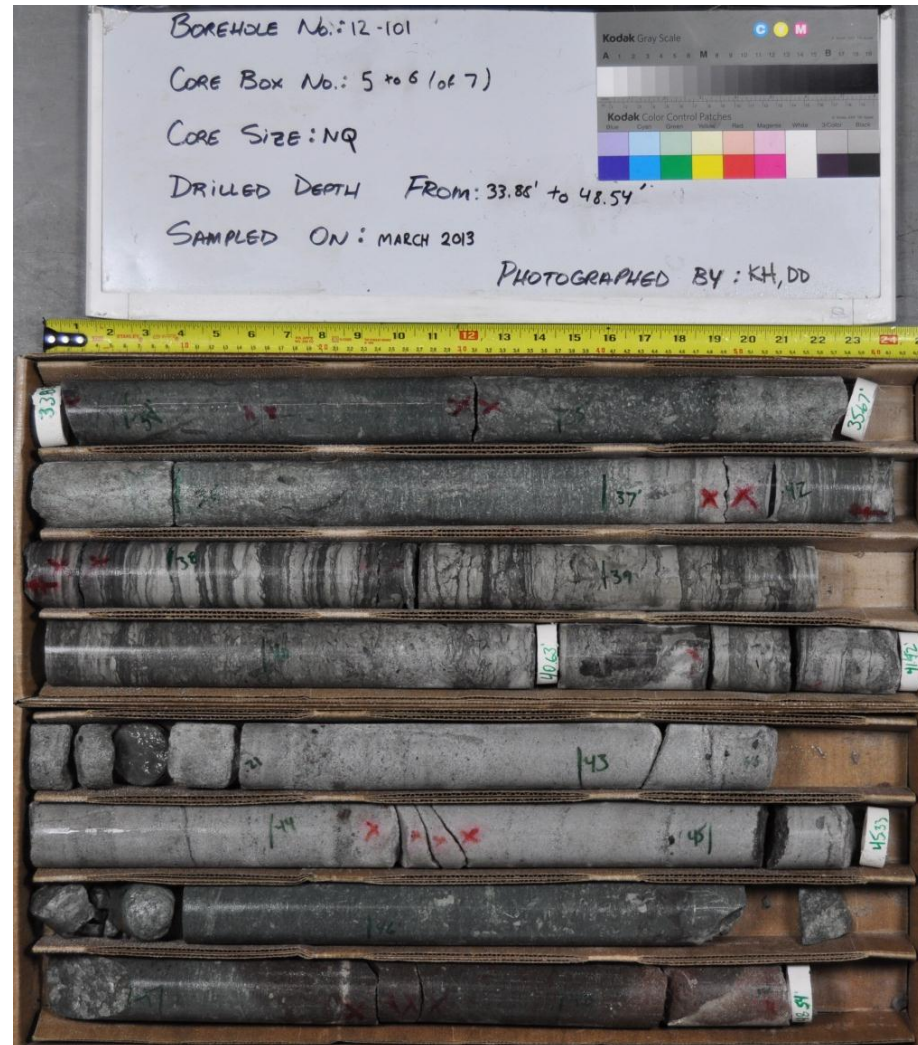



Photo 6: Borehole 12-101 – Core Boxes 5 to 6 of 7 – 10.33 to 14.79 m Depth (wet)

| | | | | |
|---|--------|----------------|---|-----------------|
|  | | | TITLE | |
| | | | | |
| | | DATE June 2013 | GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | DESIGN KE | | |
| PROJECT NO. 11-1121-0290 | REV. 1 | CHECK CK | OTTAWA RIVER ONTARIO-QUEBEC | PLATE 3b |
| | | REVIEW TMS | | |

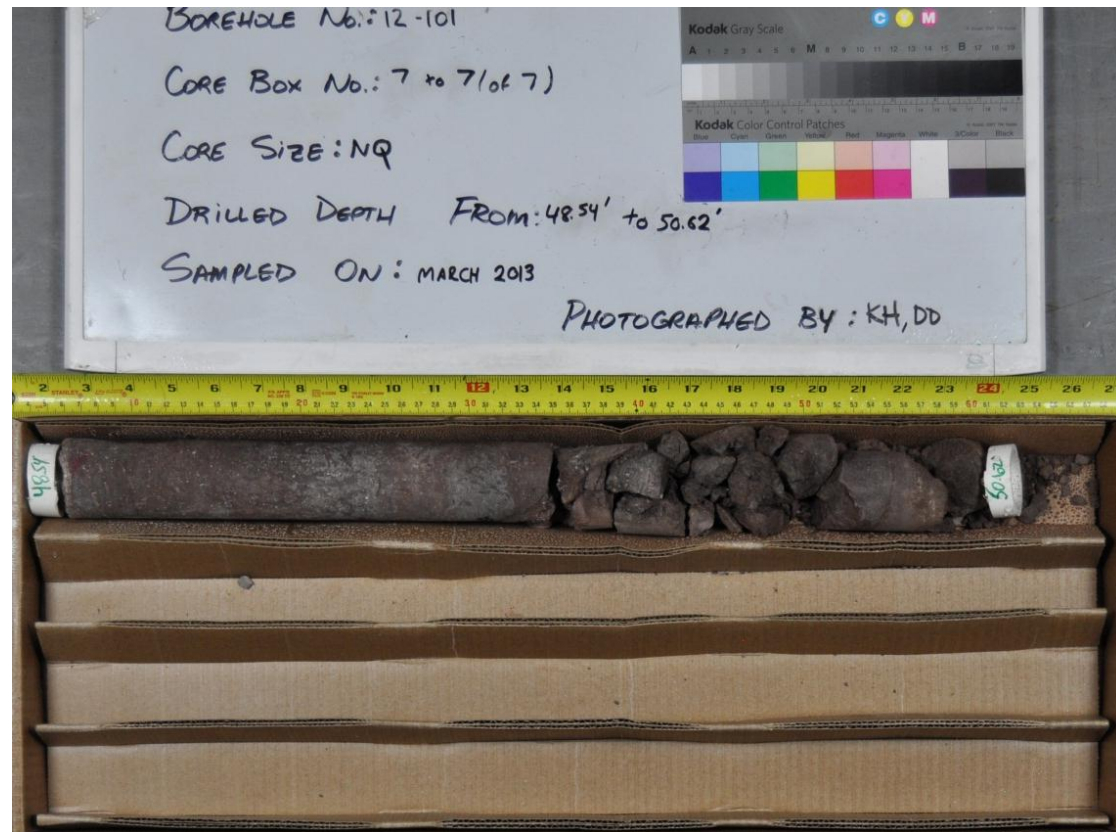



Photo 7: Borehole 12-101 – Core Box 7 of 7 – 14.79 to 15.43 m Depth (dry)

| | | | | | | |
|---|--------------|--------|--------|-----------|---|----------|
|  | | | | TITLE | | |
| | | | | | | |
| | | | | | | |
| | | | DATE | June 2013 | GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | | DESIGN | KE | | |
| | | | CHECK | CK | OTTAWA RIVER ONTARIO-QUEBEC | PLATE 4a |
| PROJECT NO. | 11-1121-0290 | REV. 1 | REVIEW | TMS | | |

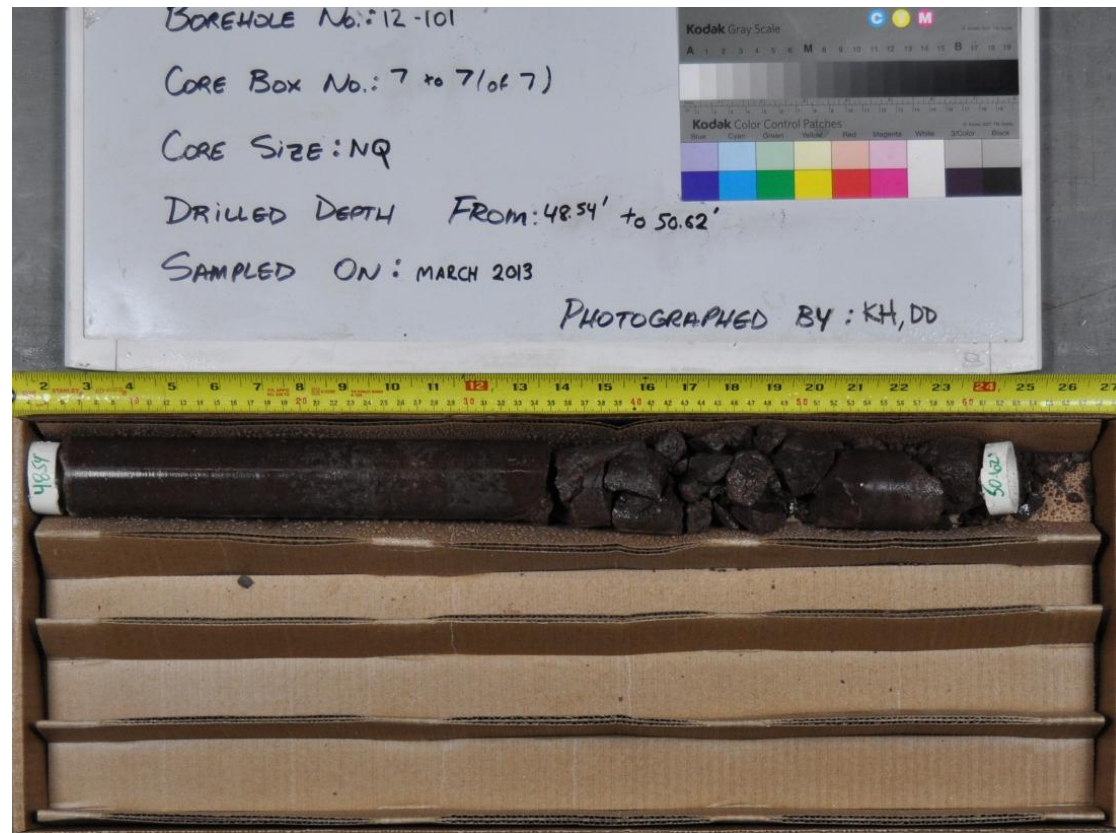



Photo 8: Borehole 12-101 – Core Box 7 of 7 – 14.79 to 15.43 m Depth (wet)

| | | | | | |
|---|--------|--|-------------------|--|----------|
|  | | | | TITLE GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | | | | |
| | | | | | |
| | | | DATE June 2013 | | |
| | | | | | |
| | | | CHECK CK | | |
| PROJECT NO. 11-1121-0290 | REV. 1 | | REVIEW TMS | OTTAWA RIVER ONTARIO-QUEBEC | PLATE 4b |

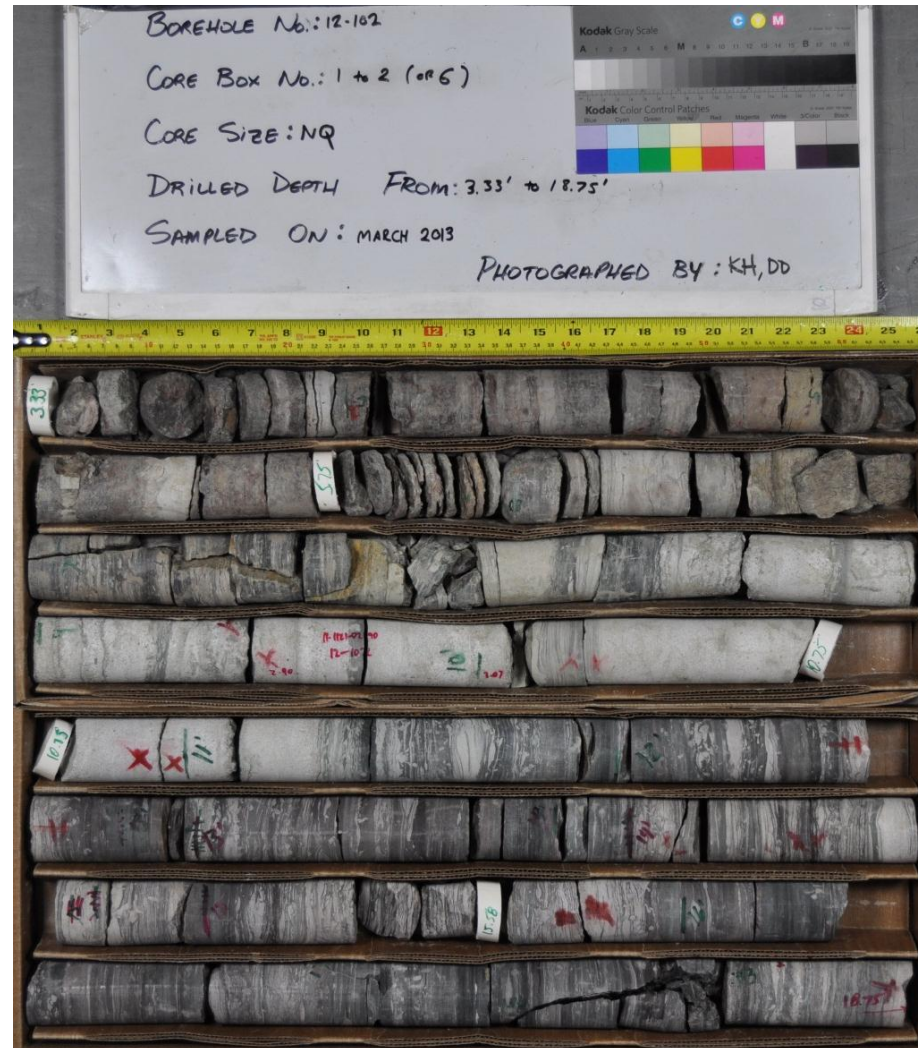



Photo 9: Borehole 12-102 – Core Boxes 1 to 2 of 6 – 1.01 to 5.72 m Depth (dry)

| | | | | |
|---|--------|----------------|---|-----------------|
|  | | | TITLE | |
| | | | | |
| | | DATE June 2013 | GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | DESIGN KE | | |
| PROJECT NO. 11-1121-0290 | REV. 1 | CHECK CK | OTTAWA RIVER ONTARIO-QUEBEC | PLATE 5a |
| | | REVIEW TMS | | |

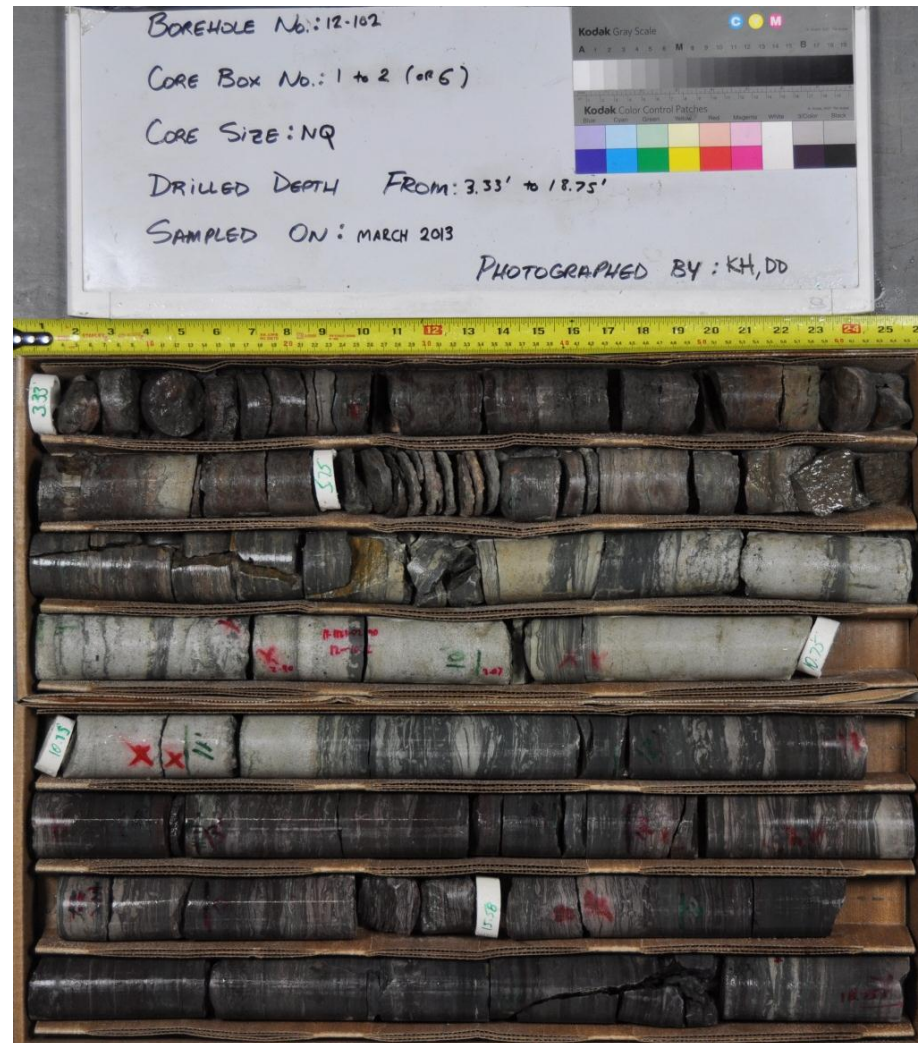


Photo 10: Borehole 12-102 – Core Boxes 1 to 2 of 6 – 1.01 to 5.72 m Depth (wet)



| | | | |
|---|--------------|---|-----------|
|  | | TITLE GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | OTTAWA RIVER ONTARIO-QUEBEC | |
| | | PLATE 5b | |
| | | | |
| PROJECT NO. | 11-1121-0290 | REV. 1 | |
| | | DATE | June 2013 |
| | | DESIGN | KE |
| | | CHECK | CK |
| | | REVIEW | TMS |



Photo 11: Borehole 12-102 – Core Boxes 3 to 4 of 6 – 5.72 to 10.60 m Depth (dry)

| | | | | | |
|---|--------|---------------|-------------------|--|----------|
|  | | | | TITLE GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | | | | |
| | | | DATE June 2013 | | |
| | | | DESIGN KE | | |
| | | | CHECK CK | OTTAWA RIVER ONTARIO-QUEBEC | |
| PROJECT NO. 11-1121-0290 | REV. 1 | REVIEW TMS | | | |
| | | | | | PLATE 6a |

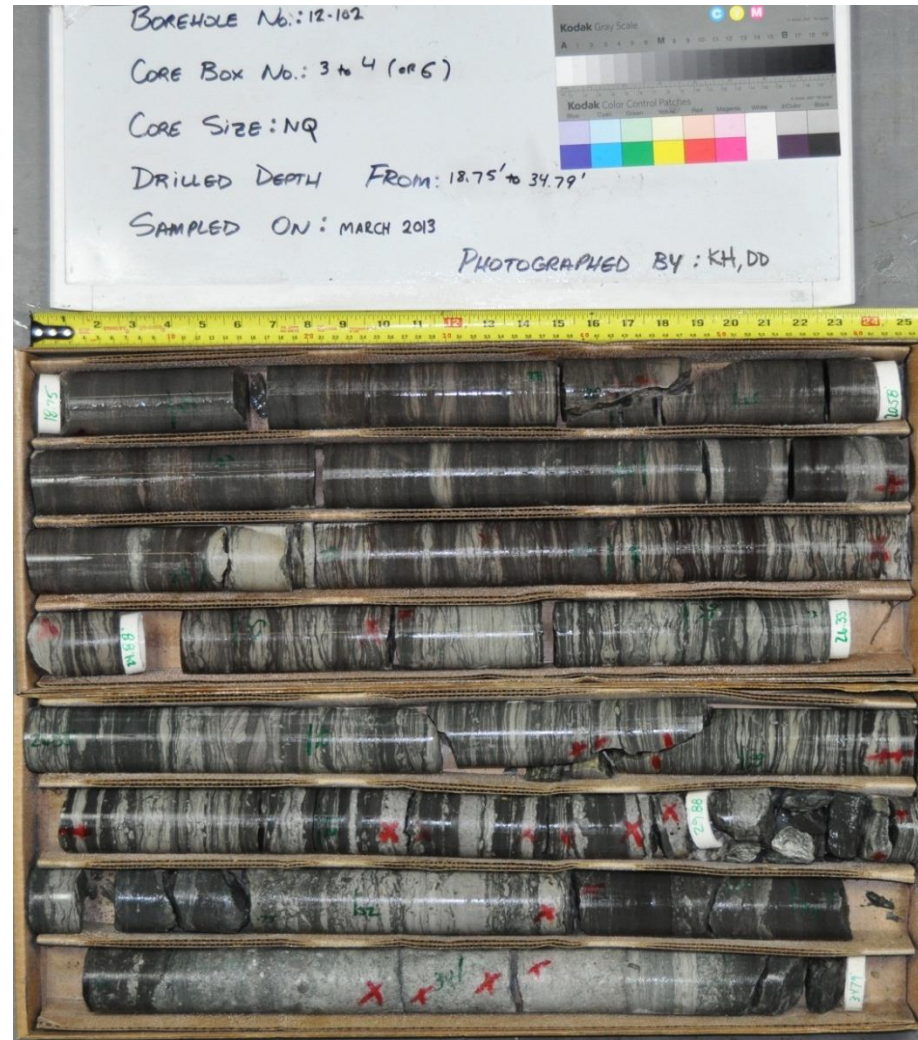



Photo 12: Borehole 12-102 – Core Boxes 3 to 4 of 6 – 5.72 to 10.60 m Depth (wet)

| | | | | |
|---|--------|----------------|---|-----------------|
|  | | | TITLE | |
| | | | | |
| | | DATE June 2013 | GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | DESIGN KE | | |
| PROJECT NO. 11-1121-0290 | REV. 1 | CHECK CK | OTTAWA RIVER ONTARIO-QUEBEC | PLATE 6b |
| | | REVIEW TMS | | |

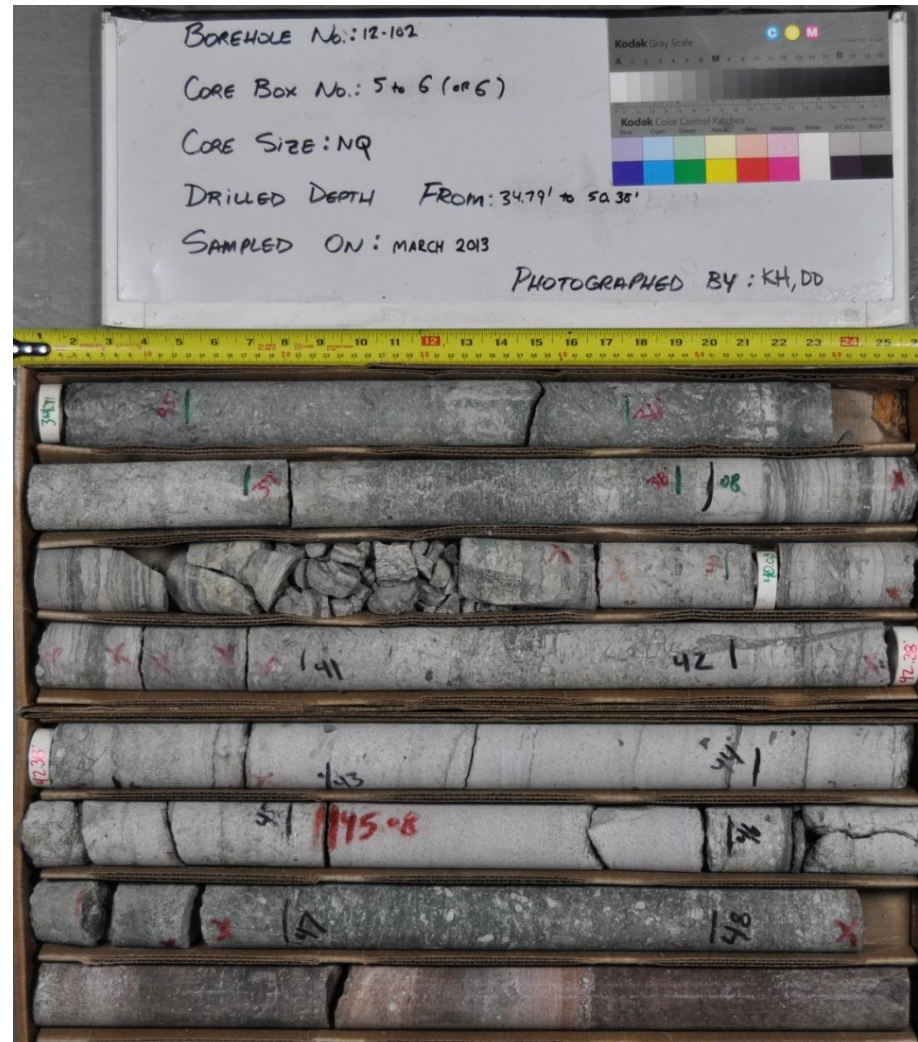



Photo 13: Borehole 12-102 – Core Boxes 5 to 6 of 6 – 10.60 to 15.36 m Depth (dry)

| | | | | |
|---|--------|----------------|---|-----------------|
|  | | | TITLE | |
| | | | | |
| | | DATE June 2013 | GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | DESIGN KE | | |
| PROJECT NO. 11-1121-0290 | REV. 1 | CHECK CK | OTTAWA RIVER ONTARIO-QUEBEC | PLATE 7a |
| | | REVIEW TMS | | |

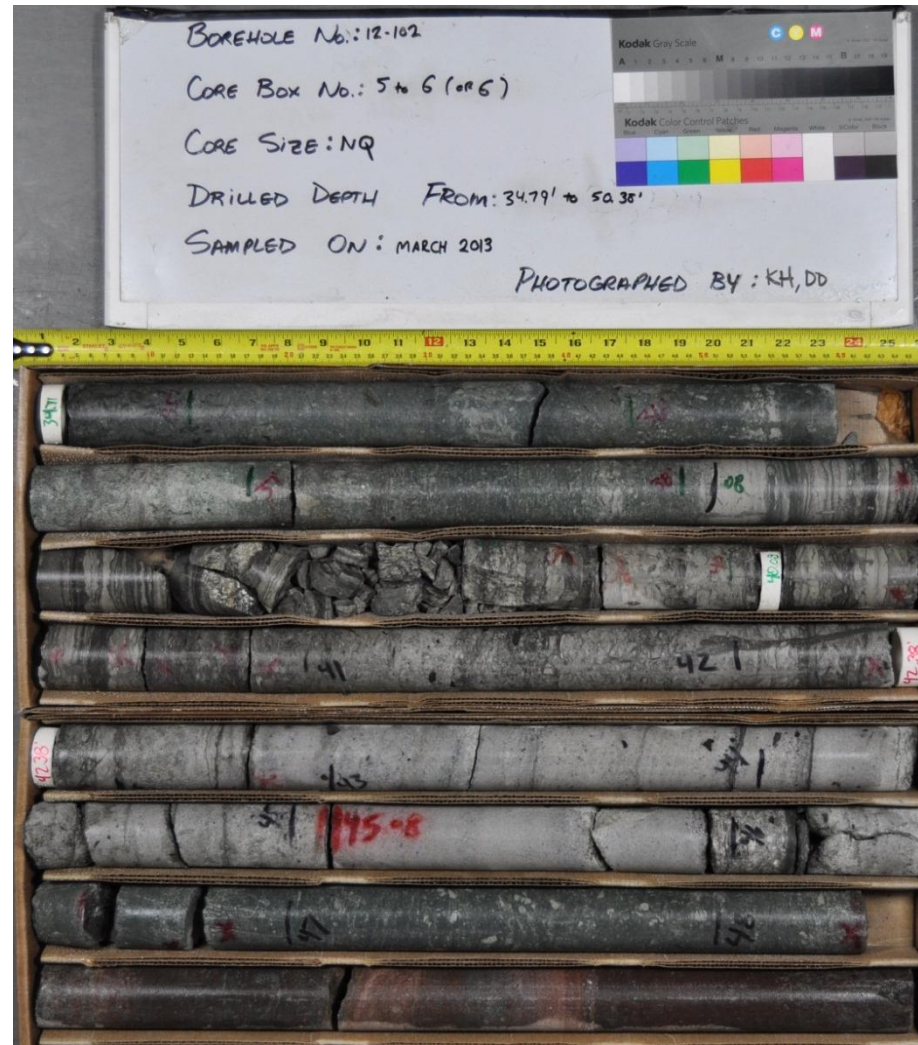


Photo 14: Borehole 12-102 – Core Boxes 5 to 6 of 6 – 10.60 to 15.36 m Depth (wet)



| | | | | | |
|---|--------------|--------------------------------|-----------|---|---|
|  | | | TITLE | | |
| | | | | | |
| | | | | | |
| | | DATE | June 2013 | GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | DESIGN | KE | | |
| CHECK | CK | OTTAWA RIVER ONTARIO-QUEBEC | PLATE 7b | | |
| PROJECT NO. | 11-1121-0290 | | | REV. | 1 |



Photo 15: Borehole 12-103 – Core Boxes 1 to 4 of 4 – 4.06 to 18.75 m Depth (dry)

| | | | |
|---|--------------|---|-----------------|
|  | | TITLE | |
| | | GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | | |
| | | | |
| PROJECT NO. | 11-1121-0290 | REV. | 1 |
| | | DATE | June 2013 |
| | | DESIGN | KE |
| | | CHECK | CK |
| | | REVIEW | TMS |
| | | OTTAWA RIVER ONTARIO-QUEBEC | PLATE 8a |

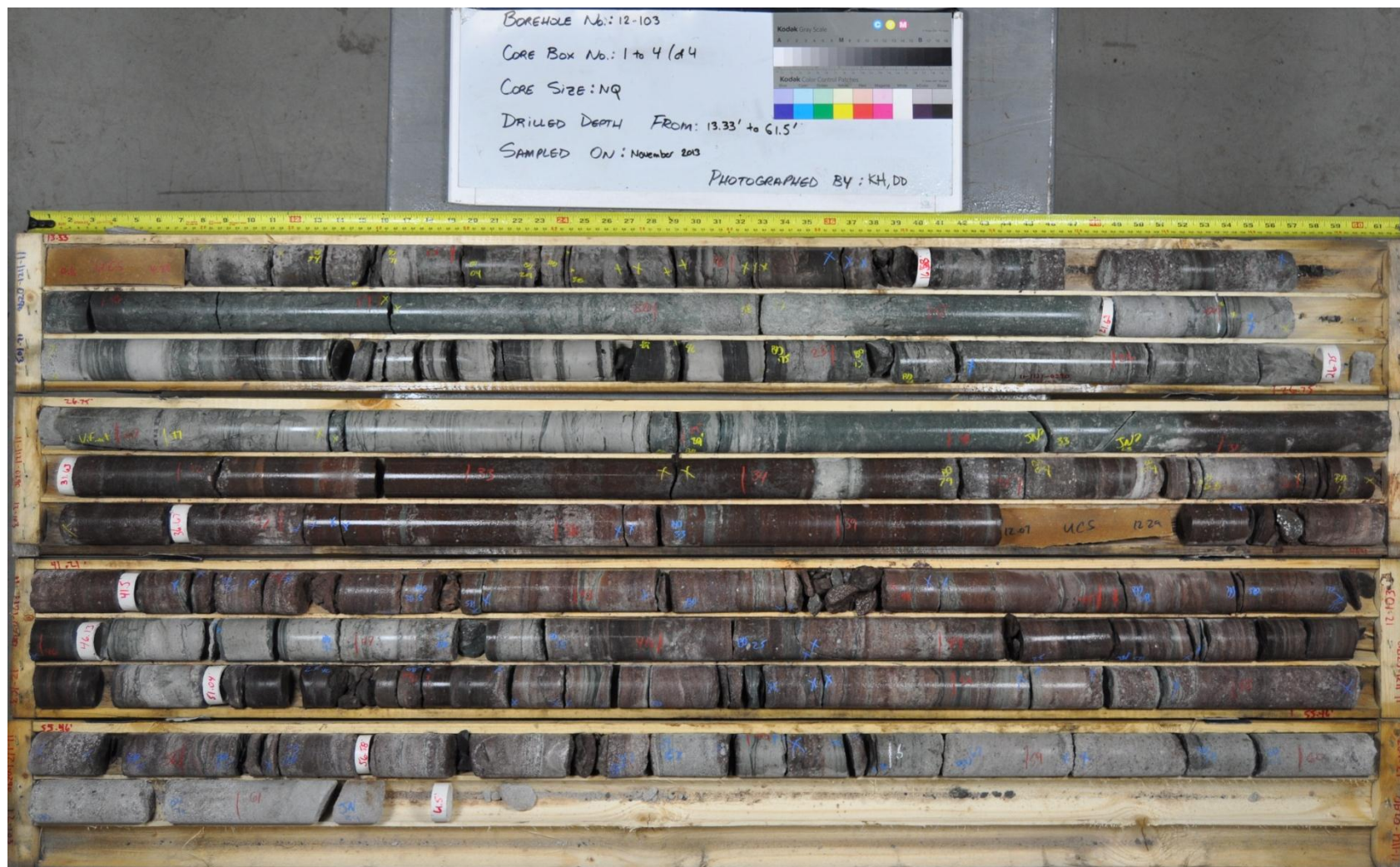


Photo 16: Borehole 12-103 – Core Boxes 1 to 4 of 4 – 4.06 to 18.75 m Depth (wet)


| | | | |
|---|--------------|---|-----------------|
|  | | TITLE | |
| | | GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | | |
| | | | |
| PROJECT NO. | 11-1121-0290 | REV. 1 | REVIEW |
| | | | TMS |
| | | OTTAWA RIVER ONTARIO-QUEBEC | PLATE 8b |



Photo 17: Borehole 12-104 – Core Boxes 1 to 2 of 7 – 3.81 to 8.54 m Depth (dry)


| | | | | | |
|---|--------|---------------|-------------------|--|----------|
|  | | | | TITLE GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | | | | |
| | | | DATE June 2013 | | |
| | | | DESIGN KE | | |
| | | | CHECK CK | OTTAWA RIVER ONTARIO-QUEBEC | PLATE 9a |
| PROJECT NO. 11-1121-0290 | REV. 1 | REVIEW TMS | | | |



Photo 18: Borehole 12-104 – Core Boxes 1 to 2 of 7 – 3.81 to 8.54 m Depth (wet)



| | | | | |
|---|--------|----------------|---|-----------------|
|  | | | TITLE | |
| | | | | |
| | | DATE June 2013 | GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | DESIGN KE | | |
| PROJECT NO. 11-1121-0290 | REV. 1 | CHECK CK | OTTAWA RIVER ONTARIO-QUEBEC | PLATE 9b |
| | | REVIEW TMS | | |



Photo 19: Borehole 12-104 – Core Boxes 3 to 4 of 7 – 8.54 to 13.03 m Depth (dry)

| | | | | | |
|---|--------|---------------|-------------------|--|-----------|
|  | | | | TITLE GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | | | | |
| | | | DATE June 2013 | | |
| | | | DESIGN KE | | |
| | | | CHECK CK | OTTAWA RIVER ONTARIO-QUEBEC | PLATE 10a |
| PROJECT NO. 11-1121-0290 | REV. 1 | REVIEW TMS | | | |

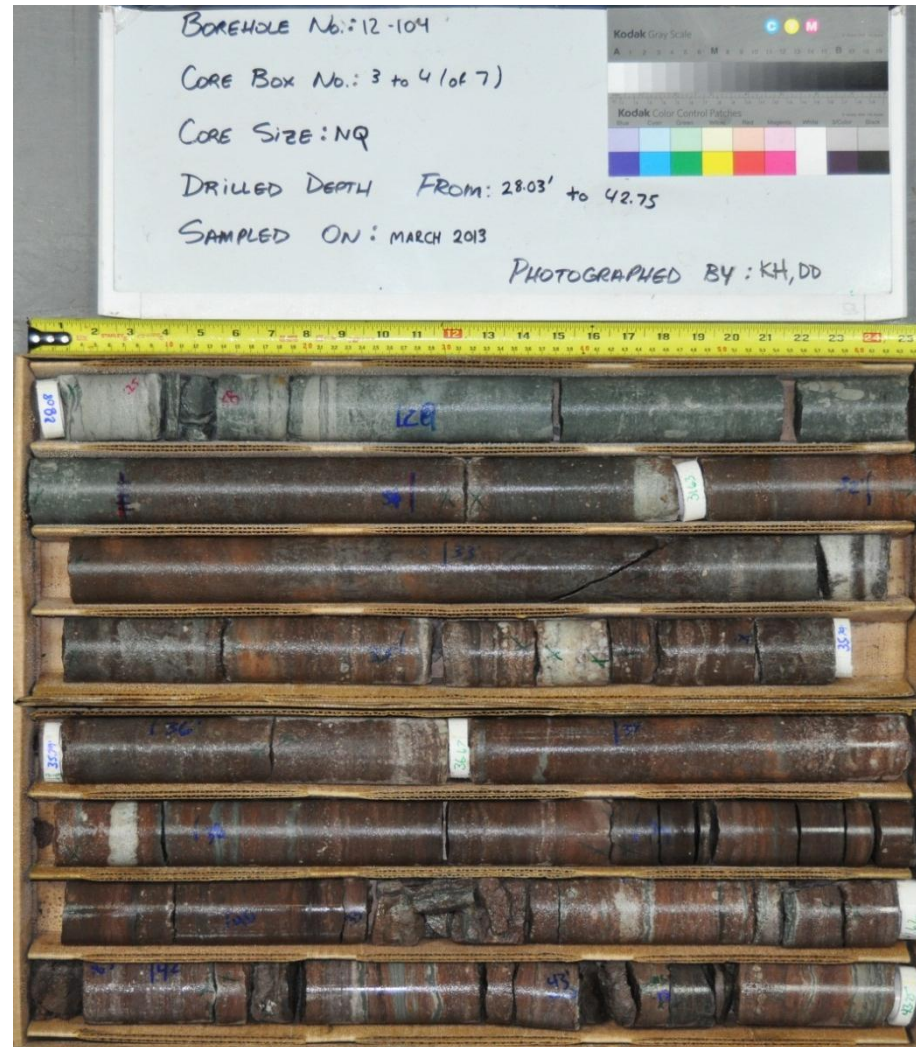



Photo 20: Borehole 12-104 – Core Boxes 3 to 4 of 7 – 8.54 to 13.02 m Depth (wet)

| | | | | | |
|---|--------|---------------|-------------------|--|--------------------------------|
|  | | | | TITLE GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | | | | |
| | | | DATE June 2013 | | |
| | | | DESIGN KE | | |
| | | | | CHECK CK | OTTAWA RIVER ONTARIO-QUEBEC |
| PROJECT NO. 11-1121-0290 | REV. 1 | REVIEW TMS | | | |

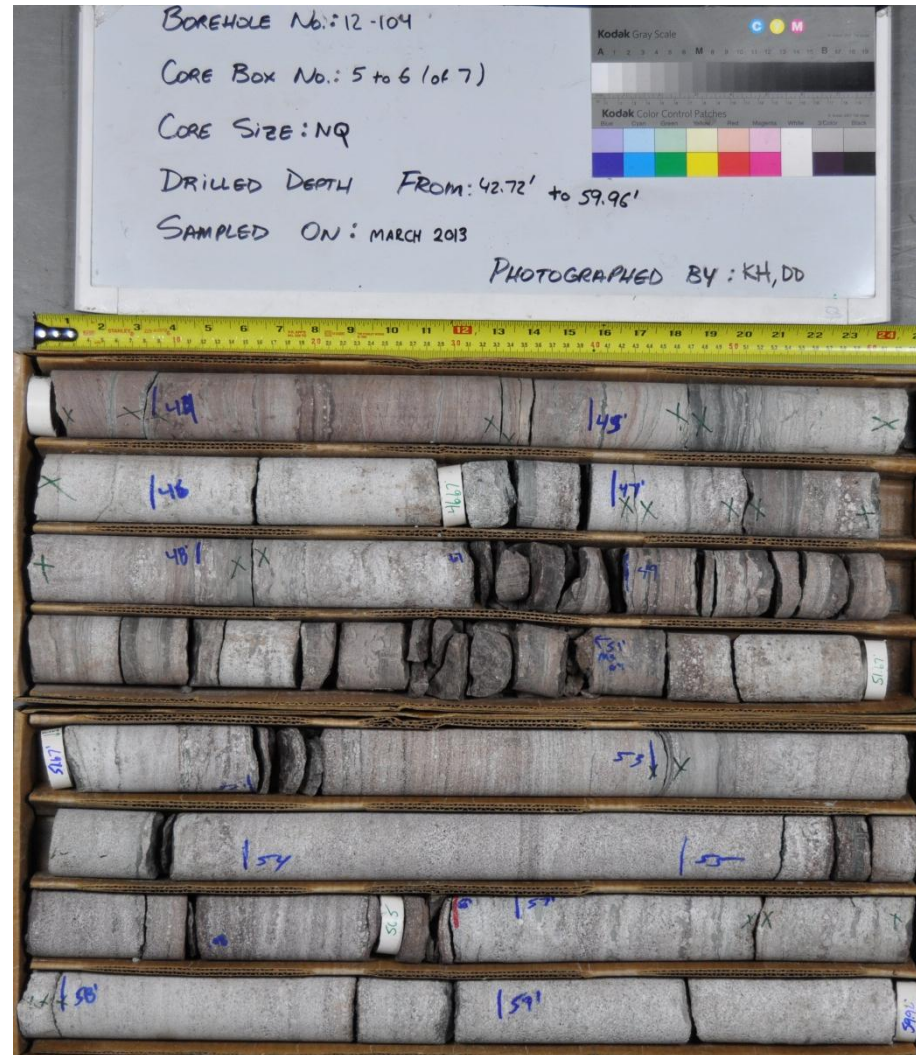



Photo 21: Borehole 12-104 – Core Boxes 5 to 6 of 7 –13.02 to 18.28 m Depth (dry)

| | | | | | |
|---|--------|---------------|-------------------|--|-----------|
|  | | | | TITLE GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | | | | |
| | | | DATE June 2013 | | |
| | | | DESIGN KE | | |
| | | | CHECK CK | OTTAWA RIVER ONTARIO-QUEBEC | PLATE 11a |
| PROJECT NO. 11-1121-0290 | REV. 1 | REVIEW TMS | | | |

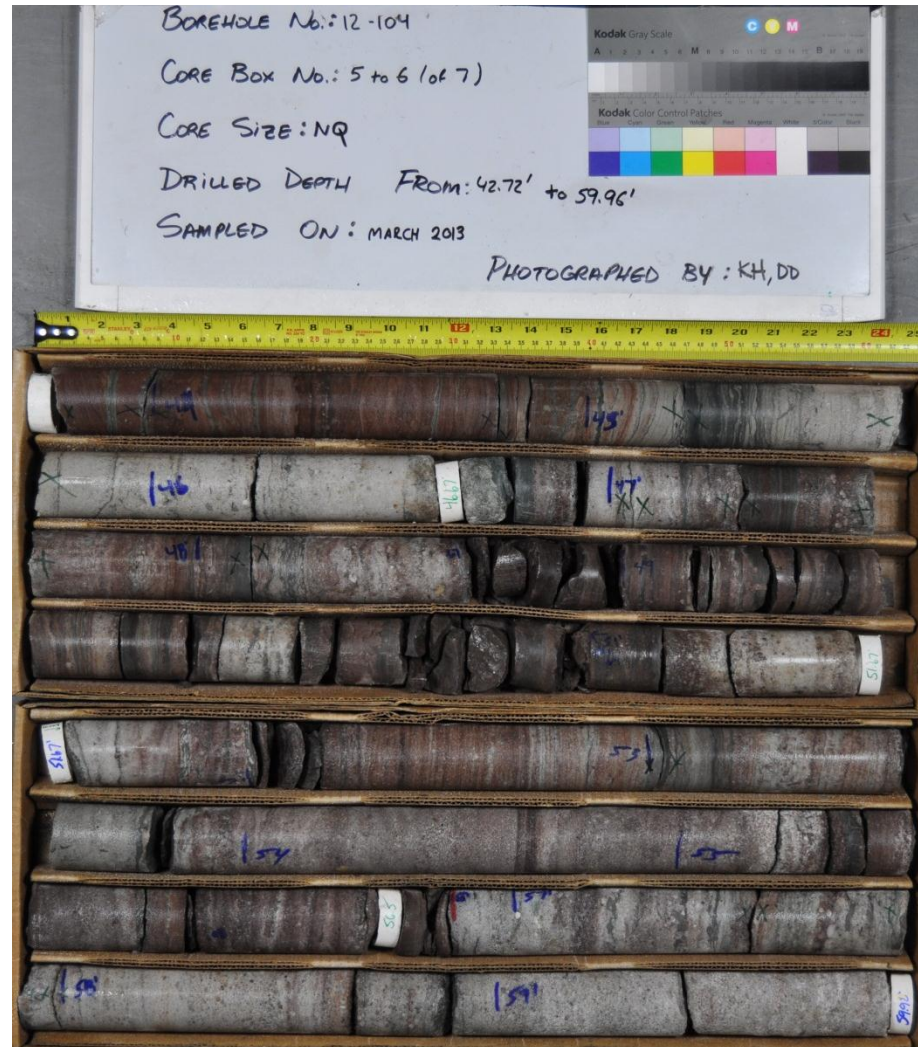



Photo 22: Borehole 12-104 – Core Boxes 5 to 6 of 7 –13.02 to 18.28 m Depth (wet)

| | | | |
|---|--------------|--|------------|
|  | | <div>TITLE</div> <div>GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT</div> | |
| | | | |
| | | | |
| | | | |
| PROJECT NO. | 11-1121-0290 | REV. 1 | REVIEW TMS |
| | | <div>OTTAWA RIVER ONTARIO-QUEBEC</div> <div>PLATE 11b</div> | |

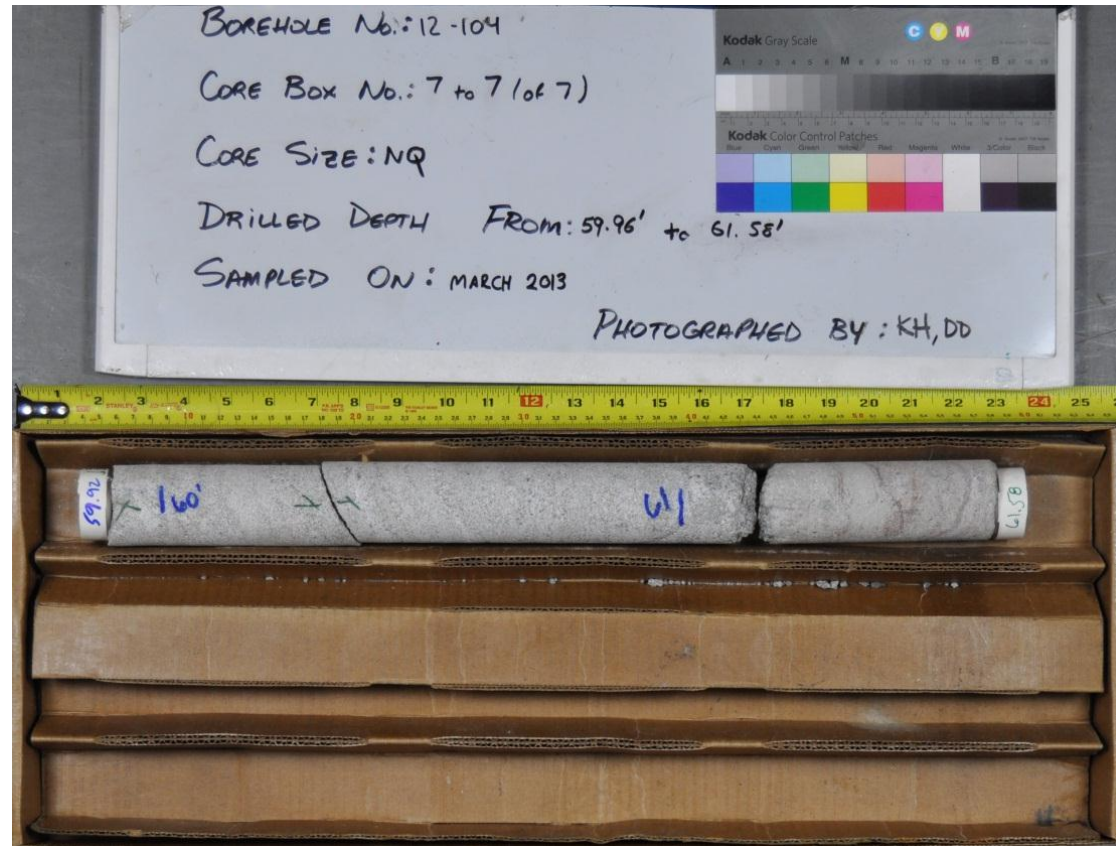



Photo 23: Borehole 12-104 – Core Box 7 of 7 – 18.28 to 18.77 m Depth (dry)

| | | | | | |
|---|--------|--|-------------------|--|--|
|  | | | | TITLE GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | | | | |
| | | | DATE June 2013 | | |
| | | | DESIGN KE | | |
| | | | CHECK CK | OTTAWA RIVER ONTARIO-QUEBEC | |
| | | | REVIEW TMS | | |
| PROJECT NO. 11-1121-0290 | REV. 1 | | PLATE 12a | | |

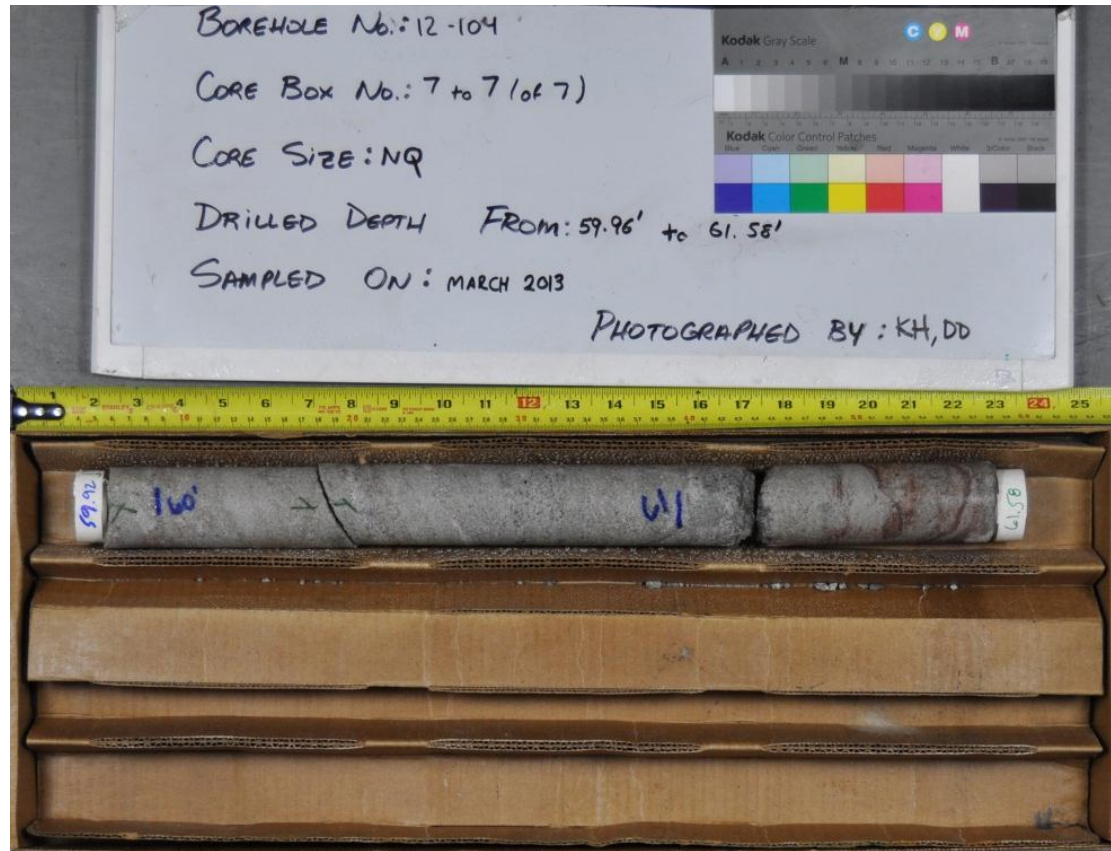



Photo 24: Borehole 12-104 – Core Box 7 of 7 – 18.28 to 18.77 m Depth (wet)

| | | | | | |
|---|-------------|---------------|-------------------|--|------------------|
|  | | | | TITLE GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | | | | |
| | | | | | |
| | | | DATE June 2013 | | |
| | | | | DESIGN KE | |
| | CHECK CK | | | OTTAWA RIVER ONTARIO-QUEBEC | PLATE 12b |
| PROJECT NO. 11-1121-0290 | REV. 1 | REVIEW TMS | | | |

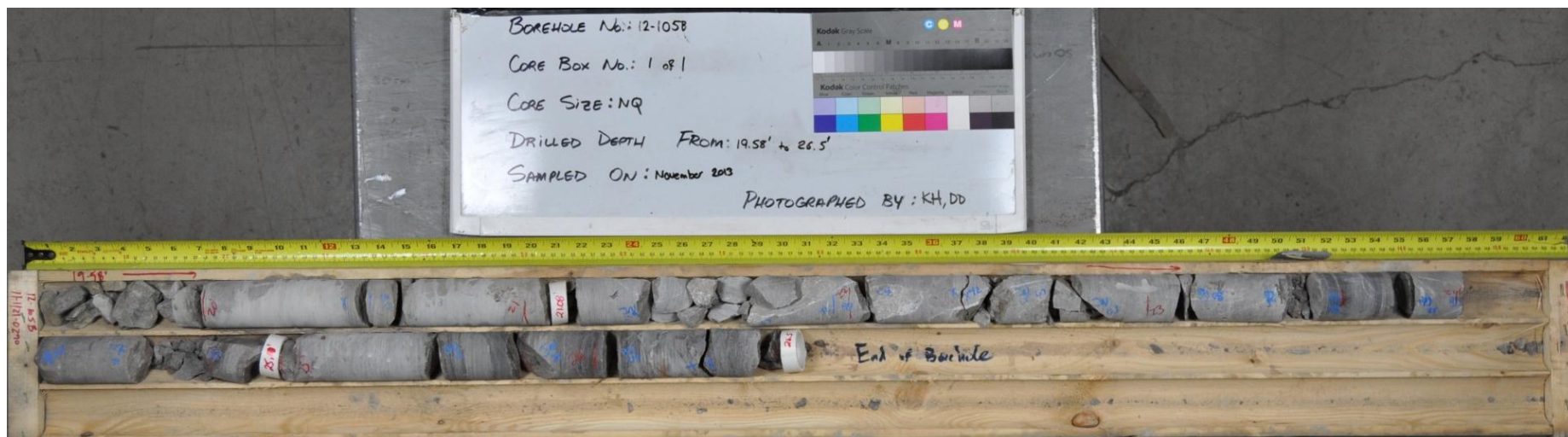



Photo 27: Borehole 12-105B – Core Box 1 of 1 –5.97 to 8.08 m Depth (dry)

| | | | | | |
|---|--|--|-------------------|--|-----------|
|  | | | | TITLE GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | | | | |
| | | | DATE June 2013 | | |
| | | | DESIGN KE | | |
| | | | CHECK CK | OTTAWA RIVER ONTARIO-QUEBEC | |
| PROJECT NO. 11-1121-0290 REV. 1 | | | REVIEW TMS | | |
| | | | | | PLATE 14a |

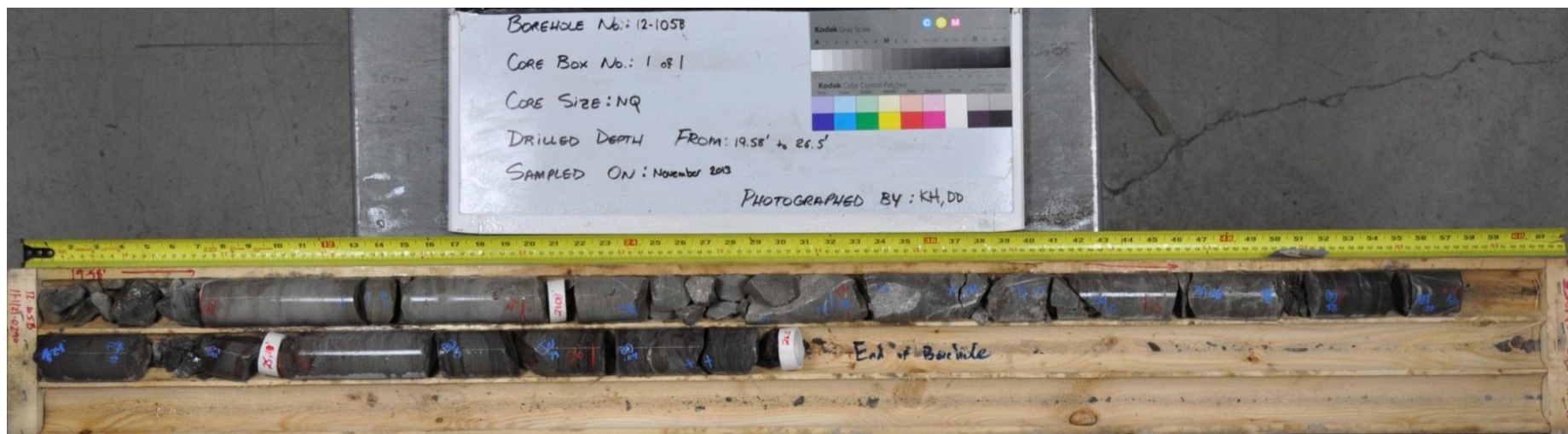


Photo 28: Borehole 12-105B – Core Box 1 of 1 –5.97 to 8.08 m Depth (wet)



| | | | | |
|---|--------|----------------|---|------------------|
|  | | | TITLE | |
| | | | | |
| | | DATE June 2013 | GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | DESIGN KE | | |
| PROJECT NO. 11-1121-0290 | REV. 1 | CHECK CK | OTTAWA RIVER ONTARIO-QUEBEC | PLATE 14b |
| | | REVIEW TMS | | |



Photo 30: Borehole 12-105C – Core Box 1 of 1 –5.72 to 15.19 m Depth (wet)

| | | | |
|---|--------------|---|--------|
|  | | TITLE GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | OTTAWA RIVER ONTARIO-QUEBEC | |
| | | PLATE 15b | |
| | | | |
| PROJECT NO. | 11-1121-0290 | REV. 1 | REVIEW |
| | | | TMS |

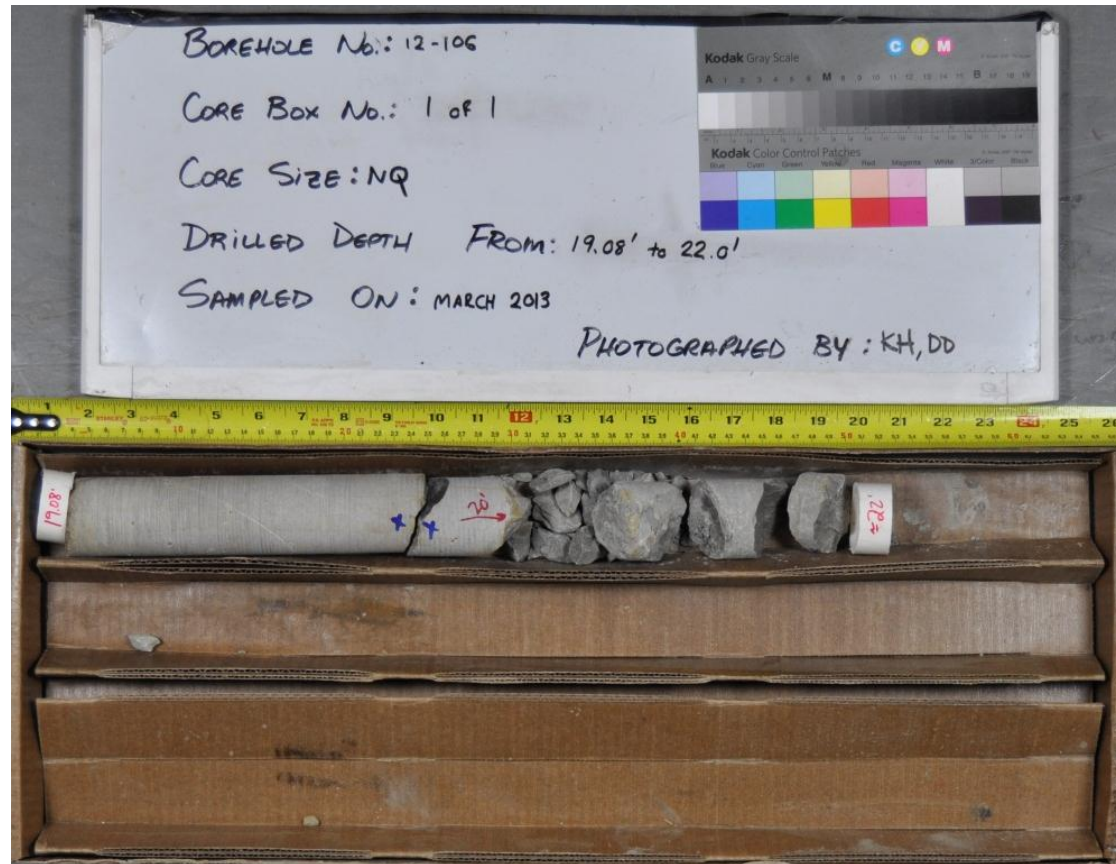



Photo 31: Borehole 12-106 – Core Box 1 of 1 – 5.82 to 6.71 m Depth (dry)

| | | | | | | |
|---|--------------|--------|--------|--|--------------------------------|-----------|
|  | | | | TITLE GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | | |
| | | | | | | |
| | | | DATE | | | June 2013 |
| | | | DESIGN | | | KE |
| | | | CHECK | CK | OTTAWA RIVER ONTARIO-QUEBEC | PLATE 16a |
| PROJECT NO. | 11-1121-0290 | REV. 1 | REVIEW | TMS | | |

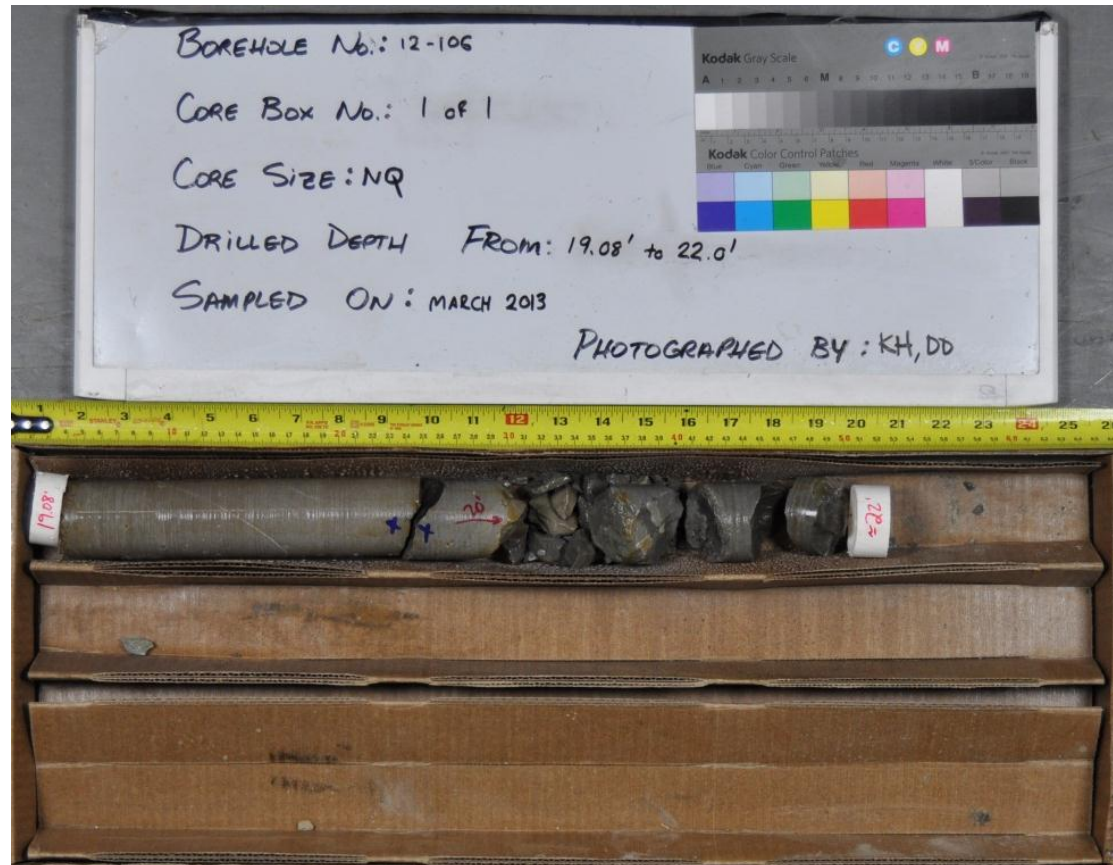



Photo 32: Borehole 12-106 – Core Box 1 of 1 – 5.82 to 6.71 m Depth (wet)

| | | | | | |
|---|--|--|-------------------|--|--|
|  | | | | TITLE GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | | | | |
| | | | | | |
| | | | DATE June 2013 | | |
| | | | | | |
| | | | CHECK CK | | |
| PROJECT NO. 11-1121-0290 REV. 1 | | | REVIEW TMS | PLATE 16b | |

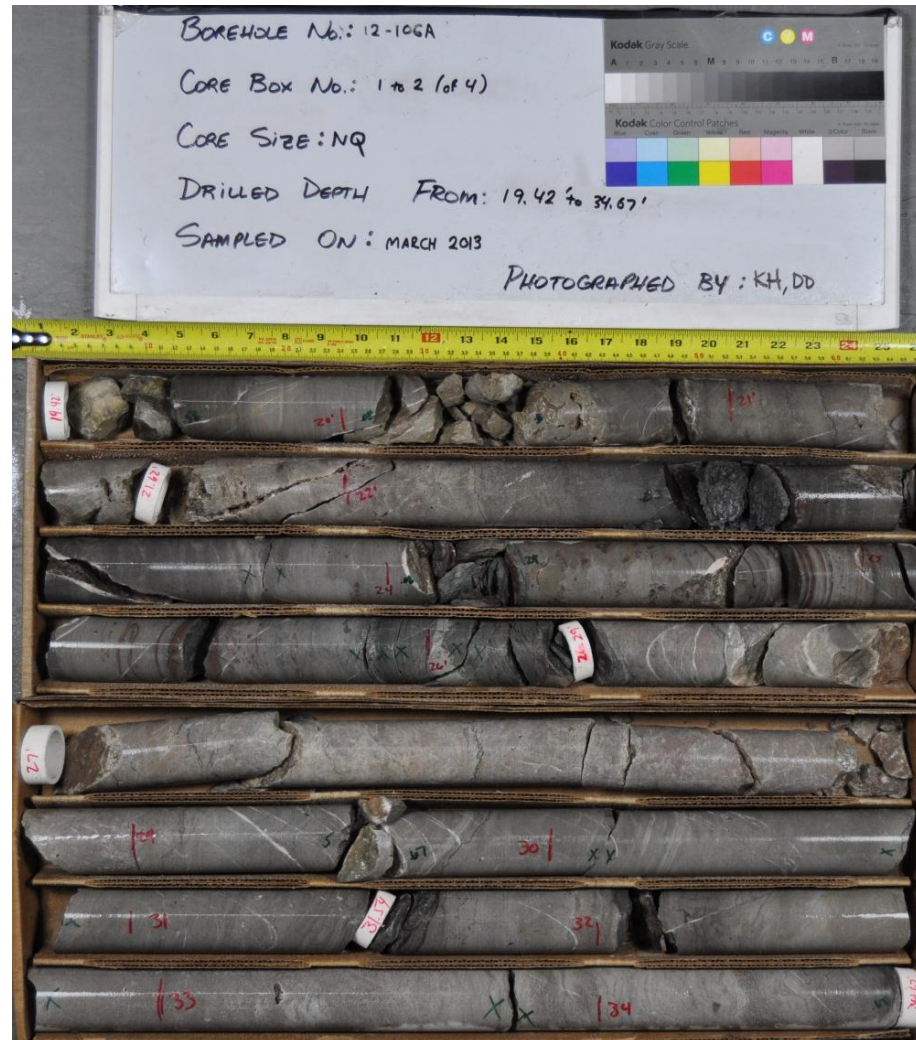



Photo 34: Borehole 12-106A – Core Boxes 1 to 2 of 4 – 5.92 to 10.57 m Depth (wet)

| | | | |
|---|--------------|---|--------|
|  | | TITLE GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | OTTAWA RIVER ONTARIO-QUEBEC | |
| | | PLATE 17b | |
| | | | |
| PROJECT NO. | 11-1121-0290 | REV. 1 | REVIEW |
| | | | TMS |

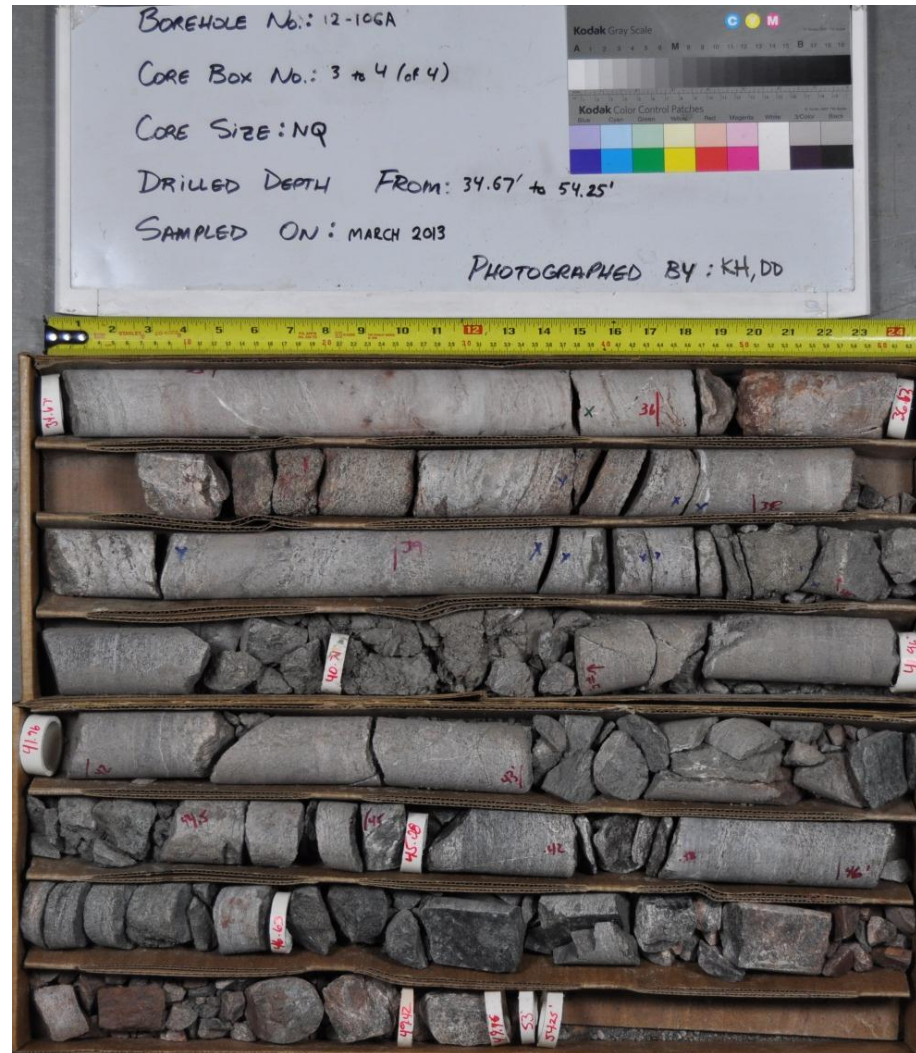


Photo 35: Borehole 12-106A – Core Boxes 3 to 4 of 4 – 10.57 to 16.54 m Depth (dry)



| | | | |
|---|--------------|---|------------------|
|  | | TITLE GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | | |
| | | | |
| | | | |
| PROJECT NO. | 11-1121-0290 | REV. 1 | REVIEW |
| | | | TMS |
| | | OTTAWA RIVER ONTARIO-QUEBEC | PLATE 18a |



Photo 36: Borehole 12-106A – Core Boxes 3 to 4 of 4 – 10.57 to 16.54 m Depth (wet)

| | | | |
|---|--------------|---|--------|
|  | | TITLE GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | OTTAWA RIVER ONTARIO-QUEBEC | |
| | | PLATE 18b | |
| | | | |
| PROJECT NO. | 11-1121-0290 | REV. 1 | REVIEW |
| | | | TMS |

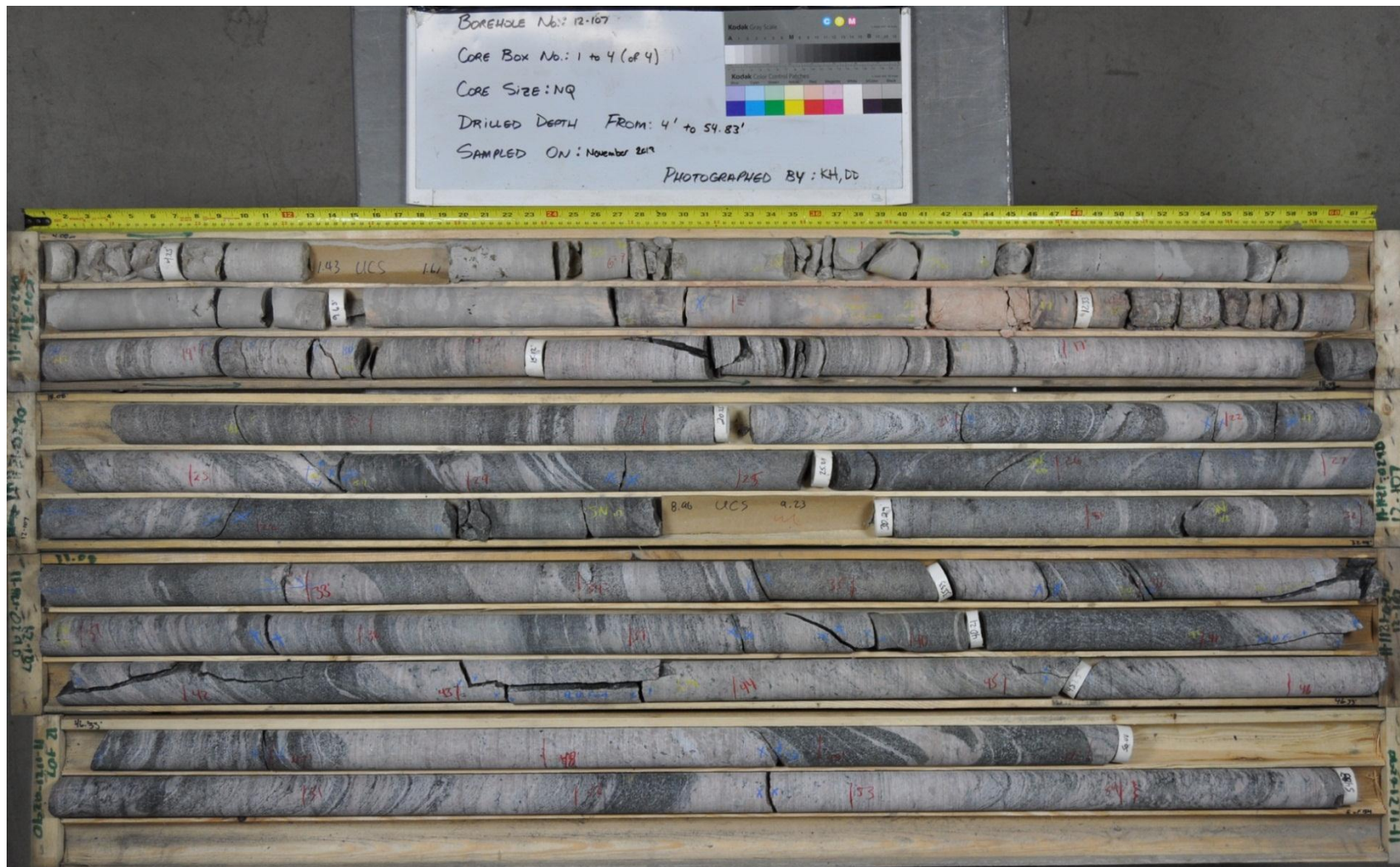



Photo 37: Borehole 12-107 – Core Box 1 to 4 of 4 – 1.22 to 16.71 m Depth (dry)

| | | | |
|---|--------------|---|------------------|
|  | | TITLE | |
| | | GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | | |
| | | | |
| PROJECT NO. | 11-1121-0290 | REV. 1 | REVIEW |
| | | | TMS |
| | | OTTAWA RIVER ONTARIO-QUEBEC | PLATE 19a |

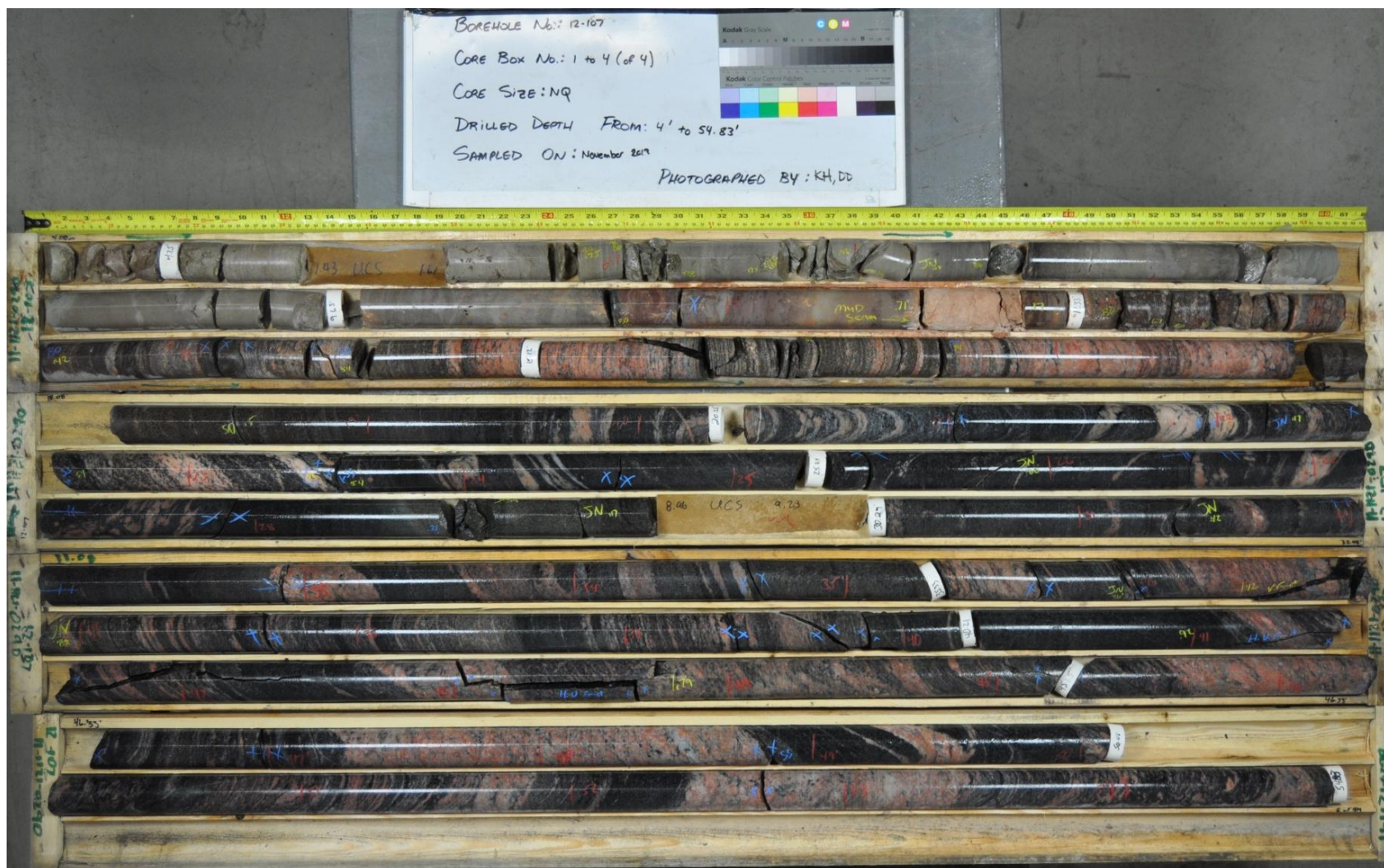



Photo 38: Borehole 12-107 – Core Box 1 to 4 of 4 – 1.22 to 16.71 m Depth (wet)

| | | | |
|---|--------------|---|------------------|
|  | | TITLE | |
| | | GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | | |
| | | | |
| PROJECT NO. | 11-1121-0290 | REV. 1 | REVIEW |
| | | | TMS |
| | | OTTAWA RIVER ONTARIO-QUEBEC | PLATE 19b |

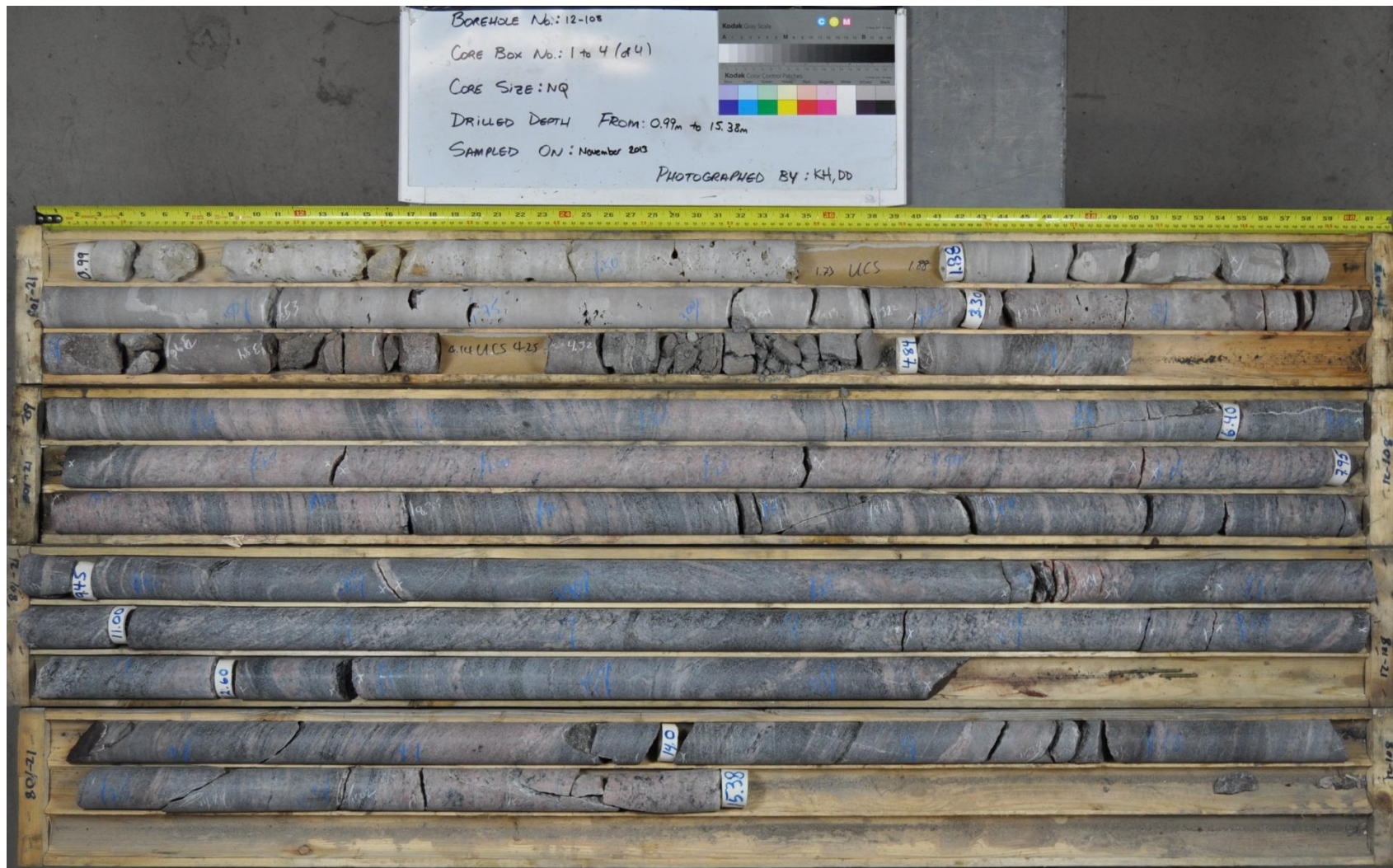



Photo 39: Borehole 12-108 – Core Boxes 1 to 4 of 4 – 0.30 to 4.69 m Depth (dry)

| | | | | |
|---|--|----------------|---|------------------|
|  | | | TITLE | |
| | | | | |
| | | DATE June 2013 | | |
| | | DESIGN KE | GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| PROJECT NO. 11-1121-0290 | | REV. 1 | | |
| | | CHECK CK | OTTAWA RIVER ONTARIO-QUEBEC | PLATE 20a |
| | | REVIEW TMS | | |

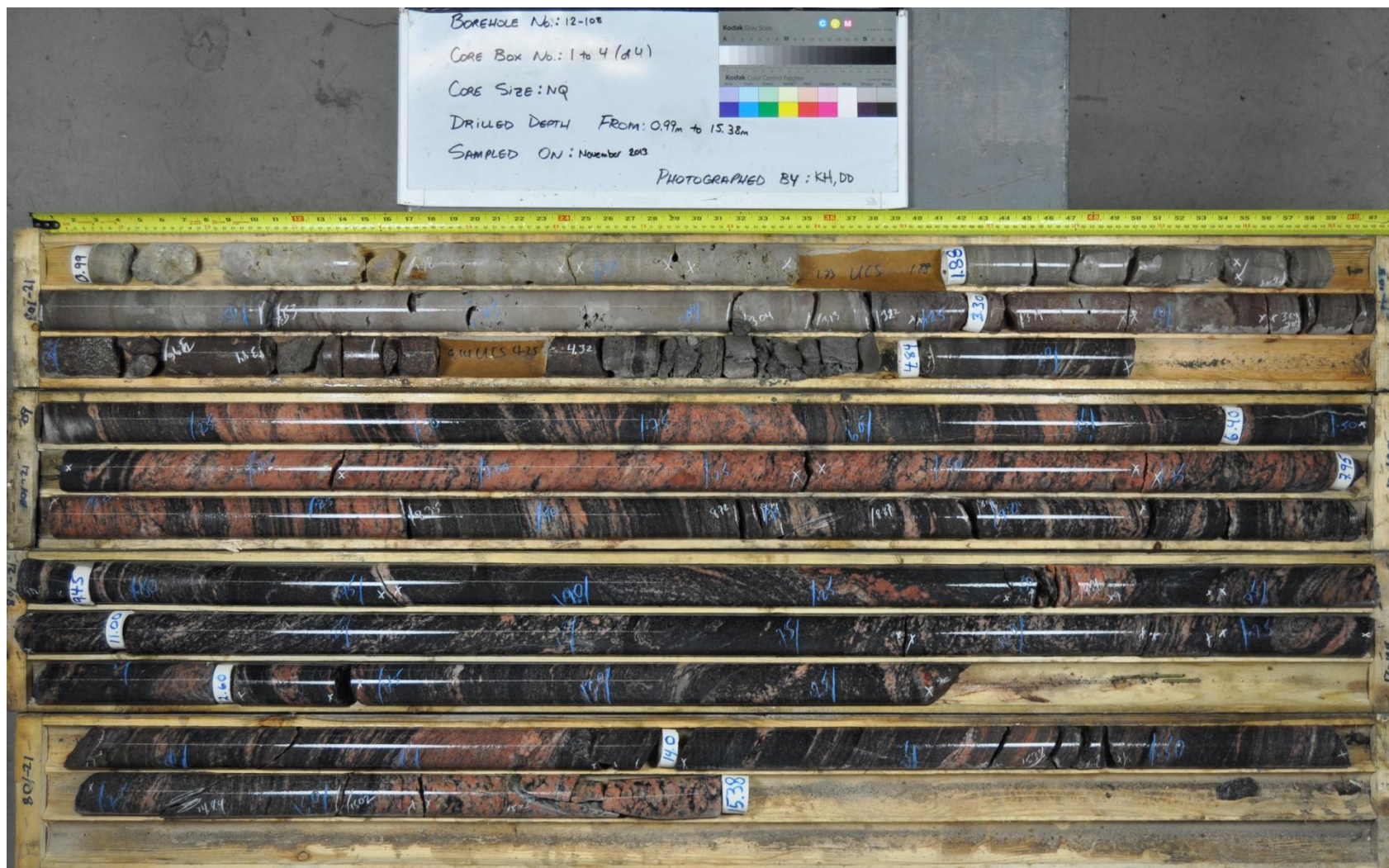



Photo 40: Borehole 12-108 – Core Boxes 1 to 4 of 4 – 0.30 to 4.69 m Depth (wet)

| | | | |
|---|--------------|--|--------|
|  | | TITLE GEOTECHNICAL INVESTIGATION DES ALLUMETTES BRIDGE REPLACEMENT | |
| | | OTTAWA RIVER ONTARIO-QUEBEC | |
| | | PLATE 20b | |
| | | | |
| PROJECT NO. | 11-1121-0290 | REV. 1 | REVIEW |
| | | | TMS |



APPENDIX D

Unconfined Compressive Strength Testing Results



THE ROBERT M. BUCHAN
DEPARTMENT OF MINING

Goodwin Hall
Queen's University
Kingston, Ontario, Canada
K7L 3N6
Tel 613 533-2230
Fax 613 533-6597

January 9, 2013

Mr. Christopher Mangione
Golder Associates Limited
32 Steacie Drive
Kanata, ON K2K 2A9

Re: Rock core testing (Project 11-1121-0290)

Dear Mr. Mangione:

A total of eleven (11) rock core specimens were received from Golder Associates from which unconfined compressive strength determinations were requested. All tests were conducted within the Rock Mechanics Laboratory of the Robert M. Buchan Department of Mining, Queen's University at Kingston.

Failure test results for these specimens are tabled and photographs of pre- and post-test samples are also included, as is a separate summary billing statement for work that has been completed.

Yours sincerely,

J. F. Archibald, Ph.D., P. Eng,

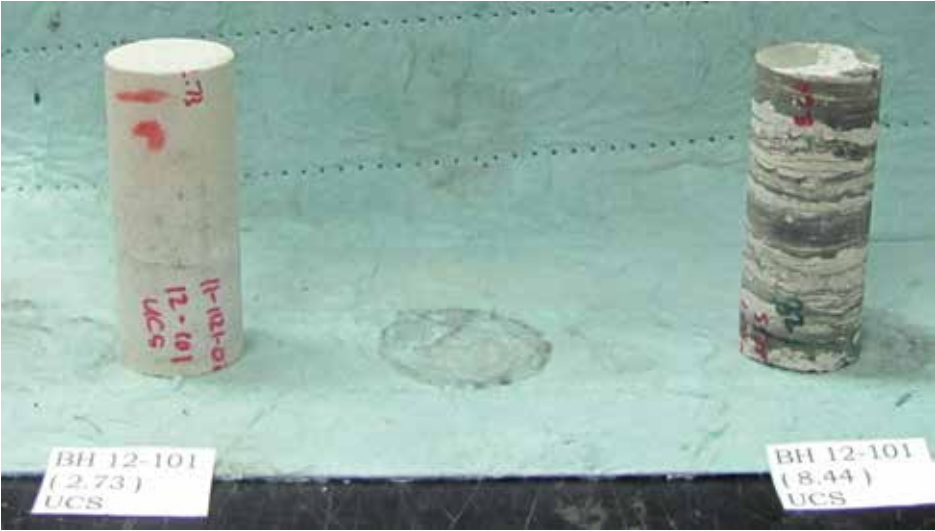
Core Sample Strength Test Results
(Golder Project 11-1121-0290)

| Sample (depth) | Bulk Density (g/cm³) | Young's Modulus (GPa) | Poisson's ratio (μ) | UCS S_C, (MPa) |
|-----------------------|---|---|---|--|
| BH 12-101 (2.73) | 2.52 | 16.476 | 0.10 | 51.0 (pf) |
| BH 12-101 (8.44) | 2.50 | 3.048 | 0.17 | 16.1 |
| BH 12-103 (4.16) | 2.50 | 3.918 | 0.11 | 26.1 |
| BH 12-103 (12.07) | 2.36 | 2.271 | --- | 13.4 |
| BH 12-105C (7.32) | 2.50 | 14.426 | 0.10 | 66.9 |
| BH 12-105C (12.90) | 2.62 | 6.868 | 0.15 | 31.7 |
| BH 12-106B (10.99) | 2.64 | 8.617 | 0.13 | 35.4 |
| BH 12-107 (1.43) | 2.50 | 12.371 | 0.22 | 35.9 |
| BH 12- 107 (8.96) | 2.85 | 7.485 | 0.10 | 29.1 |
| BH 12-108 (1.73) | 2.59 | 7.024 | 0.40 | 28.2 (pf) |
| BH 12-108 (4.14) | 2.63 | 3.332 | 0.12 | 23.9 |

(pf) – indicates sample failure along partially pre-existing foliation surface

SPECIMEN PHOTOGRAPHS

PHOTOGRAPHS of PRE-TEST SAMPLES





PHOTOGRAPHS of POST-TEST SAMPLES







APPENDIX E

Chemical Analysis Results

Client: Golder Associates Ltd. (Ottawa)
32 Steacie Drive
Kanata, ON
K2K 2A9
Attention: Ms. Christine Ko
PO#:
Invoice to: Golder Associates Ltd. (Ottawa)

Report Number: 1315462
Date Submitted: 2013-07-22
Date Reported: 2013-07-26
Project: 11-1121-0290(2220)
COC #: 774072

| | | | | Lab I.D. Sample Matrix Sample Type Sampling Date Sample I.D. | |
|-------------------|--------------|------|-------|--|------|
| | | | | Guideline | |
| Group | Analyte | MRL | Units | Guideline | |
| General Chemistry | Cl | 1 | mg/L | | 11 |
| | Conductivity | 5 | uS/cm | | 120 |
| | pH | 1.00 | | | 7.30 |
| | SO4 | 3 | mg/L | | 6 |

Guideline = * = **Guideline Exceedence**

** = Analysis completed at Mississauga, Ontario.

Results relate only to the parameters tested on the samples submitted.

Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline,
MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable
Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO =
Interim Provincial Water Quality Objective, TDR = Typical Desired Range

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

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|---------------|-------------------|
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| Asia | + 852 2562 3658 |
| Australasia | + 61 3 8862 3500 |
| Europe | + 356 21 42 30 20 |
| North America | + 1 800 275 3281 |
| South America | + 55 21 3095 9500 |

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