

Geotechnical Report

Centre Block Project:
Seismic Upgrade
Visitor Welcome Centre Phases 2 & 3
East Block Underground Services
(EBUS)
Parliament Hill, Ottawa, ON



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1.0 INTRODUCTION

The Centre Block Project consists of three distinct design aspects which may either be constructed simultaneously or independently in parts. The three distinct aspects include the Seismic Upgrade of the existing Centre Block building, a future Visitor Welcome Centre (VWC) and the proposed East Block Underground Services (EBUS) adjacent to the south and east sides of Centre Block.

This report contains the following:

- The results of a geotechnical borehole drilling investigation, and
- The information contained in the August 2014 Stantec report titled "Draft Geotechnical Data Gap Analysis Centre Block Project Parliament Hill" updated to include the results of the recently completed borehole drilling investigation.

It is understood that the Parliamentary Precinct Branch (PPB), a part of the PWGSC, is launching the Centre Block Project as part of the planning, design and implementation of the projects in the Long Term Vision and Plan (LTVP). As part of the planning process for the Centre Block project, the intent of the proposed preliminary geotechnical investigation is to provide a basis for the development of concept stage options, to permit evaluation of geologic conditions on these options, and for each option to identify those areas for which there are not sufficiently detailed geotechnical data to permit the design to be developed for the next stage (design development stage).

Stantec Consulting Ltd. carried out a data gap analysis in August 2014 (Stantec, 2014) in which geotechnical recommendations were provided for the proposed rehabilitation, based on the geotechnical data gathered from previous investigations. This report contains the information gathered following a geotechnical investigation based on the recommendations and suggestions provided in our August 2014 data gap analysis report. The report also contains updated recommendations to reflect the additional geotechnical investigation results.

Authorization to proceed was provided by Ms. Christine Oates and Mr. Daniel Haché of Public Works and Government Services Canada (PWGSC), under Contract No. EP764-150225/001/FE, on July 11th, 2014, and amended on November 4th, 2014, December 12th, 2014, and February 27th, 2015.

This report has been prepared specifically and solely for the Centre Block rehabilitation project which is described herein.

2.0 PROPOSED DEVELOPMENT

The subject site is the Centre Block, located on a promontory overlooking the Ottawa River between the West Block and the East Block on Parliament Hill. The Centre Block, built between 1916 and 1927 to replace the original Centre Block building destroyed by fire, is a symbol of

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Canada's highly regarded Parliamentary system. The Centre Block site and building in the Parliamentary Precinct is part of a designated National Historic Site and is also a Classified Federal Heritage Building. As such, it is the intention of the Government of Canada to maintain the Centre Block in perpetuity.

The Centre Block is founded on predominantly limestone bedrock with some veins of shale, with the majority of the foundations comprising poured unreinforced concrete walls bearing directly against bedrock.

It is understood that the design stage of the Centre Block Project may include construction of the following:

- A new full basement level beneath the entire Centre Block (likely about 4 m high); this will require blasting rock and underpinning of existing foundations and possibly new foundations;
- Seismic upgrade (retrofit) of the Centre Block which has three distinct structural systems;
- New Centre Block Visitor Welcome Centre (immediately south of Centre Block, full length beneath the entire paved area in front of the Peace Tower) - excavation would be about 150 m x 40 m in plan, extending 3 storeys below grade;
- New East Block Visitor Welcome Centre, north-northwest of the East Block Building, 3 storeys below grade;
- East Block Underground Services (EBUS) Building, 3 storeys below grade, north of East Block; and
- Tunnels and shafts to connect the West Block Visitor Welcome Centre to Centre Block Visitor Welcome Centre to East Block Visitor Welcome Centre – tunnels anticipated to be about 20 m below grade.

3.0 SCOPE OF WORK

The scope of work for this assignment is provided in detail in Stantec proposal No. 1224-B14073 submitted to PWGSC on June 4, 2014, and revised in Amendments 1, 2 & 3. The purpose of this report is to document the findings of a geotechnical field investigation carried out in conjunction with the recommendations provided in our August 2014 report and to update the geotechnical recommendations to reflect the additional field investigation results. The additional scope of work was included in the proposal.

The field program consisted of the following:

- Determination of the location of all private and public utilities in the vicinity of the proposed boreholes. This work will be performed by a private utility locate contractor. Please note that the utility locate process does not determine the depth of the utilities in question, which would require either seismic refraction survey or hydroexcavation;
- Placement of five (5) sampled boreholes around the exterior of the Centre Block to an approximate depth of 24 m;

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- Placement of one (1) sampled borehole exterior to the Centre Block to an approximate depth of 35 m;
- Placement of three (3) interior boreholes to an approximate depth of 24 m; and
- Placement of seven (7) interior boreholes to a maximum depth of 7 m.

Drilling, sampling and testing were in compliance with prescribed recognized standards; our staff was fully qualified to carry out the assigned work. At each borehole location, the required work included activities listed page 12 of the Call-Up ToR that will include the following:

- Standard Penetration tests (SPTs) performed while collecting soil samples at regular depth intervals (every 0.75 m) to the auger refusal depth. Field vane shear tests performed at regular intervals within cohesive material, if observed, to evaluate the undrained shear strength and remoulded shear strength;
- NQ and HQ sized rocks collected continuously;
- Hydraulic conductivity test of all bedrock units conducted in three boreholes.
- Vertical seismic profiling carried out in one borehole to a depth of 35 m.
- Borehole survey using optical viewers performed in three (3) boreholes to depict the bedding, geology, fabric and measurable open fractures in bedrock;
- Ground surface elevations at each testhole location determined and referenced to a Geodetic benchmark made available to Stantec;
- Environmental monitoring and sampling carried out as required; and
- Archaeological monitoring and sampling carried out as required.

On completion of the fieldwork, all testholes backfilled and asphalt or concrete patched, as applicable. Boreholes without monitoring wells grouted along their full length. Landscaping and pavements to be protected and restored to near its original state to the satisfaction of PWGSC.

All soil samples and rock cores will to be retained in storage until directed by PWGSC.

4.0 SITE TOPOGRAPHY

The Centre Block is located on the north side of Parliament Hill, adjacent to the Ottawa River and Wellington Street in Ottawa, Ontario; the site is shown on the Key Plan, Drawing No. 1 in Appendix B.

The Centre Block is flanked to the east and west by the East Block and the West Block, respectively. Immediately to the south is a relatively flat landscaped area, which includes walkways and the Centennial Flame; further to the south is Wellington Street, approximately 3 to 4 m below the Centre Block elevation. To the northwest of Centre Block is the Centre Block Underground Services (CBUS), which is located up to 3 storeys underground. Immediately to the north of Centre Block is a relatively steep slope leading down to the Ottawa River (located approximately 40 m below Parliament Hill). A number of recreational paths are located at the top and bottom of the slope; in addition, the abandoned Lovers' Walk pathway encircles the area fronting the Centre Block approximately midway up the slope. Retaining structures

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associated with Lovers' Walk have been generally noted to be in poor condition, with evidence of path subsidence, loose blocks, etc. Ventilation tunnels, stairs, walls, terraced areas and buildings, generally in poor condition, are located throughout the slope. A staircase is present to the northwest of Centre Block; this staircase is in relatively good condition in comparison to the older structures.

Surveys of the grade show it to be sloped at roughly 2H:1V overall, with several sections steeper than 1H:1V (up to 50°). Some limestone outcrop cliffs are also present. The thin layer of talus and overburden covering the bedrock has undergone erosion and creep in the past, which is likely still occurring. Slope monitoring carried out by the NRC in 1985 showed that the total movement is relatively small, and that it is unlikely that mass block movements are occurring.

A number of statues and monuments surround the Centre Block.

5.0 BACKGROUND

Twenty two (22) geotechnical and/or subsurface reports and supporting documents were provided to Stantec by PWGSC, and are summarized below:

1. *Report by Stantec; Geotechnical Data Gap Analysis, Visitor Welcome Centre Phase 1, Parliament Hill, Ottawa ON, March 2013, Project No. 122410872;*
2. *Report by exp Services Inc.; Detailed Geotechnical Investigation Report, Visitor Welcome Centre Phase 1, Parliament Hill, Ottawa, ON, April 2014;*
3. *Report by Golder Associates; Parliament Hill Site Characterization Study, Ottawa, ON, June 2013, Project No. R.043542.001;*
4. *Report by Golder Associates; Geotechnical Investigation for Centre Block Ventilation Towers No. EP748-104383/001/FE, PWGSC Project No. R.010273.045, August 2010;*
5. *Report by Butts, Ross and Associates, Site Investigation Parliament Hill, June 1st, 1965;*
6. *Report by Wilf Ohlmann Geotechnical Services Ltd.; Borehole Investigation Report, Centre Block Parliament Hill, July 1985;*
7. *Report by Golder Associates; Centre Block Renovations, Phase 2A, Subsurface Geotechnical Investigation and Slope Reconnaissance Survey, April 1990;*
8. *Report by Fondex Ltd.; Foundation Investigation, Proposed Entrances, Speaker of the Senate, Parliament Buildings, Ottawa, Ontario, Nov 18, 1983;*
9. *Report by NRC Canada; Report A1-002613-02, 25 March 2013;*
10. *Report by NRC, Parliament Hill Slope Monitoring, October 1985;*
11. *Report by Surveyor, Nenniger and Chenevert, Subsurface Investigation, Service Tunnel, Centre Block Bypass, Dec 1, 1965;*
12. *Report by Golder Associates; Design Development, Renovations to Library of Parliament, October 1999;*
13. *Report by KIB Consultants + JV; Centre Block Ventilation Towers Rehabilitation, Concept Design Report, May 29, 2012;*
14. *Report by JD Paterson and Associate, Parliament Hill Parking Garage, October 2, 1967;*

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15. *Report by Golder Associates; Subsurface Investigation, Proposed Television Studio, Parliament Hill, Ottawa, Ontario;*
16. *Figure showing Centre Block Basement Headroom;*
17. *Report by Golder VME; Test Blast Program for CBUS Facility, Ottawa, Ontario, May 1996;*
18. *Report by Golder VME; Results of Test Blast Program, CBUS Building Project, Ottawa, Ontario, December 1996;*
19. *Technical Paper by Carter, Pernica and M.V. van Bers; Response of Heritage Buildings to Excavation-Induced Vibrations;*
20. *Site Plan; Figure 1, Site Location Plan and Proposed Borehole Locations, April 2014, COE PWGSC;*
21. *Georeferenced CADD drawings of the proposed site; and*
22. *Report by Golder Associates Ltd.; As-Built Report, Centre Block Underground Services, Rock Excavation Aspects, Parliament Hill, Ottawa, Ontario, May 1998.*

Other project design documents discovered during the desktop study were also included in the background information. Appendix B, Drawing No. 4 Existing Test Hole Location Plan shows the location of the existing boreholes that are in the proximity of Center Block and are contained in the above report. The borehole records for these test holes are provided in the "Draft Geotechnical Data Gap Analysis Center Block Project Parliament Hill" dated August 2014 and are not presented herein.

6.0 INVESTIGATION PROCEDURES (STANTEC 2015)

6.1 FIELD INVESTIGATION (SOIL SAMPLING)

Prior to carrying out the field investigation, Stantec contacted the public utility authorities to clear the borehole locations of public and private utilities.

A geotechnical field investigation consisting of sixteen (16) boreholes was carried out for this assignment. The boreholes were designated BH15-1 to BH15-16, with boreholes BH 15-11, BH 15-14 and BH 15-16 having both a 30° angled hole (I) and a vertical hole (V). The investigation locations are shown on Drawing Nos. 2 and 3 in Appendix B.

Boreholes drilled by Golder Associates (BH 10-1) and exp (BH 1V, BH 3I, BH 5V, BH 6V, BH 7V and BH 10V) that are relevant to the proposed work for the Centre Block Project were also included on Drawing No. 3 in Appendix B.

The field drilling program was carried out between January 5 and January 18, 2015. Six of the boreholes were advanced using a truck-mounted CME drill rig and ten of the boreholes were advanced using portable equipment equipped for soil and bedrock sampling.

The subsurface stratigraphy encountered in each borehole was recorded in the field by an experienced Stantec Field Technologist. Split spoon samples were collected at regularly spaced

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intervals in all of the boreholes. Bedrock coring was carried out in eight boreholes with NQ and HQ size coring equipment.

All samples recovered were returned to Stantec's Ottawa laboratory for detailed classification and testing. Rock core samples were logged and photographed and the Rock Quality Designation (RQD) was estimated for recovered samples.

After completion of drilling, BH 15-1 to BH 15-3 were left open such that they were sealed off with a flushmount cap that was placed approximately 50 mm below the existing concrete slab and covered with cement.

All exterior boreholes with the exception of BH 15-8 were left open such that they were capped with flushmount covers that were placed flush with the asphalt surface and sealed into place with cold patch asphalt and grout.

A monitoring well was installed in BH 15-6 for water sampling purposes because at the time, the overburden could not be properly retained to guarantee that the soil did not cave in.

After completion of drilling, most boreholes were backfilled with grout with the exception of boreholes BH 15-4, BH 15-5, BH 15-6, BH 15-7 and BH 15-9, which were left open for environmental and seismic testing. PVC pipe was used to secure the overburden and the holes were capped with flush mount covers

6.2 FIELD INVESTIGATION (BEDROCK HYDRAULIC CONDUCTIVITY)

Double packer tests were carried out in two exterior boreholes. The tests were carried out using double packers spaced at 3.7 m. Three tests were conducted in each borehole at various intervals at test pressures of 20, 40 and 60 psi as summarized in Table 6.1. The packer tests were done to obtain the hydraulic conductivity of the rock.

Table 6.1: Summary of packer tests locations

| Borehole I.D. | Test Depth / m | Test Pressures/ psi (kPa) |
|---------------|----------------|---------------------------------|
| BH 15-4 | 17.3 to 21.0 | 20 (138), 40 (276) and 60 (413) |
| BH 15-4 | 23.4 to 27.1 | |
| BH 15-4 | 29.5 to 33.2 | |
| BH 15-9 | 7.6 to 11.3 | |
| BH 15-9 | 13.7 to 17.4 | |
| BH 15-9 | 18.9 to 22.6 | |

6.3 FIELD INVESTIGATION (GEOPHYSICAL TESTING)

Geophysical tests were carried out by Geophysic GPR International in three of the exterior boreholes (BH 15-4 & BH 15-9). Optical Televiwer Surveys were carried out in all three boreholes to determine the bedrock structure; the results of the surveys are shown in Appendix E.

A Downhole Seismic Test was carried out in BH 15-4 to determine the in-situ dynamic properties of the soil and rock. The results are also presented in Appendix E.

6.4 LOCATION AND ELEVATION SURVEY

The elevation and coordinates of the exterior boreholes were determined using a Global Positioning System (GPS) navigation device, Trimble GeoXH, capable of decimeter accuracy.

The ground surface elevations of the boreholes are provided in Drawing No. 2 in Appendix B. The ground surface elevations of the boreholes are also shown on the Borehole Records included in Appendix C.

It should be noted that due to an unacceptable level of accuracy of the GPS navigation device within the basement of Centre Block, the ground surface elevations of the interior boreholes were not obtained.

6.5 LABORATORY TESTING

All samples were taken to Stantec’s Ottawa laboratory where they were subjected to a detailed visual examination by a Geotechnical Engineer.

The geotechnical laboratory testing program for the borehole samples is summarized in Table 6.2.

Table 6.2: Geotechnical Laboratory Testing Program

| Test Description | Number of Tests |
|--|-----------------|
| Moisture Content | 22 |
| Grain Size Distribution | 7 |
| Unconfined Compression (rock) | 25 |
| Point Load Index | 15 |
| Unconfined Compression and Elastic Moduli of Intact Rock | 3 |

Samples remaining after testing will be placed in storage for a period of one month after issuance of the final report. After the storage period, the samples will be discarded.

7.0 SUMMARY OF SUBSURFACE CONDITIONS

In our Geotechnical Data Gap Analysis report issued in August 2014, the subsurface conditions were inferred from historical geotechnical reports provided to Stantec by PWGSC, as well as a recent geotechnical investigation carried out by Stantec in April 2012 and February 2014, which included boreholes in the vicinity of East Block. Based on this information, the stratigraphy generally consists of fill material underlain by shallow bedrock with some boreholes indicating clay and till layers over bedrock.

The findings of our January 2015 geotechnical investigation indicated a stratigraphy that consists generally of fill over bedrock; however till layers were encountered in three boreholes located around the exterior of Centre Block, specifically in the area southeast of Centre Block, and just north of East Block; the thickness of these native materials ranged between 0.8 and 1.5 m.

The location, ground surface and bedrock elevations of all boreholes, relevant to the study area, including boreholes from our current (January 2015) investigation are shown on Drawing No. 2 and Drawing No. 3 in Appendix B. The other relevant boreholes shown on Drawing No. 3 were based on investigations carried out by Golder Associates in 2010 and exp in 2013. Ground surface elevations were not collected for the interior boreholes. The location of the Golder and exp boreholes are based on data obtained from PWGSC. Copies of the records for 2015 Stantec boreholes and the Golder (2010) and exp (2013) boreholes are attached in Appendix C of this report. Locations of historical boreholes are shown in Drawing No. 4 and are based on historical data obtained from PWGSC. The historical borehole records are available in digital format from PWGSC.

In general, the stratigraphy consists of fill material underlain by shallow bedrock. Tunnels, both abandoned and in-use, are located throughout the Centre Block area.

7.1 OVERBURDEN

Surficial materials surrounding the Centre Block consist of asphalt pavement, concrete sidewalk, and landscaped grassed areas.

Extensive development on this site has resulted in the majority of the native overburden being replaced with fill. This fill is highly variable, and was observed, based on the Stantec 2015 investigation, to range between 0.6 and 4.8 m in thickness for exterior boreholes and between 50 mm and 660 mm for interior boreholes. Native materials, where encountered, generally consist of glacial till (typically silty sand with gravel and sandy silt). Talus is present on the steep slopes to the north of Centre Block.

7.1.1 Pavement structure

All boreholes were advanced through paved areas or concrete with the exception of boreholes BH15-7 and BH 15-8. The thickness of the asphaltic concrete was approximately 100 mm.

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The asphaltic concrete was underlain by various thicknesses of base material which is discussed in section 7.2 as fill. The base generally appeared to be pit-source sand with crushed gravel particles. The variability in the layering and the gradation of the base material reflects a history of local site modifications and remedial works; the gradation ranged from a sand and gravel to a silty sand. In general, the granular material ranged between 600 mm and 4.3 m thick with the exception of areas with shallow bedrock.

7.1.2 Concrete Slab (Interior Boreholes)

Boreholes BH 15-1 through BH 15-3, and BH 15-10 through BH 15-16 were advanced through the interior Centre Block basement which is surfaced with concrete. The concrete slab was approximately 100 to 660 mm thick and was underlain by 50 mm to 660 mm of sand and gravel fill.

7.1.3 Topsoil

Boreholes BH 15-7 and BH 15-8 were advanced through a grassed area north of the East Block building; the topsoil thickness was observed to be 150 to 200 mm.

7.2 FILL

7.2.1 Exterior Boreholes

Due to extensive development on this site, the majority of the native overburden has been replaced with fill. Fill materials encountered were variable, and consisted of several different strata. This is consistent with what would be expected given the long history of development at this site. The thickness of the fill layer varies between 0.6 and 4.3 m. The fill material in most boreholes extended to bedrock.

A layer of granular fill was encountered in all boreholes, which can generally be described as a silty sand with gravel. Boreholes through paved areas contained a sand and gravel base layer directly beneath the asphalt ranging in thickness from 200 to 700 mm. Grain size analyses carried out on the silty sand material show it to contain 6 to 22% gravel, 36% to 59% sand, and 24% to 46% silt and clay-sized particles. .

The state of compactness of the granular fill was generally noted to range from very loose to very dense.

The grain size analysis results are included on Figure 1 in Appendix D.

Several samples of the fill were tested for moisture content, which ranged from 3% to 15%. The average moisture content of the fill was 8%. The moisture content results are shown on the Borehole Records in Appendix C.

7.2.2 Interior Boreholes

Approximately 50 to 660 mm of fill was encountered directly on top bedrock in all the boreholes drilled in the Centre Block basement, with the exception of boreholes BH 15-1 and BH 15-2, where no fill was encountered. The fill encountered consisted of sand and gravel. The 660 mm layer of fill was encountered in BH 15-16 which is located near the southeast corner of the Centre Block building. The fill on this side of the building ranged between 500 to 660 mm. The table below summarizes the thickness of fill encountered in the interior boreholes.

Table 7.1: Fill Thickness (Interior Boreholes)

| Borehole No | BH 15-1 | BH 15-2 | BH 15-3 | BH 15-10 | BH 15-11 | BH 15-12 | BH 15-13 | BH 15-14 | BH 15-15 | BH 15-16 |
|---------------------|---------|---------|---------|----------|----------|----------|----------|----------|----------|----------|
| Fill Thickness (mm) | 0 | 0 | 560 | 180 | 330 | 200 | 50 | 630 | 510 | 660 |

7.3 TILL

Deposits of sandy silt till were encountered in boreholes BH 15-6, BH 15-7 and BH 15-8. The till layer was encountered between 2.1 and 3.8 m below ground surface and ranged in thickness between 0.8 and 1.5 m. In all cases, the till overlaid bedrock. In BH15-6, at approximately 3.6 m below ground surface, a 300 mm thick layer of sandy gravel was observed over bedrock.

The compactness of the till was noted as ranging from loose to very dense.

The moisture content of a sample of the till was 12% which is shown on the Borehole Records in Appendix C. Grain size analysis of two samples of the till indicated 1 and 2% gravel, 35 and 43% sand, and 55 and 64% silt and clay-sized particles. The till can be classified as primarily a sandy silt (ML). Grain size analysis results are included in Figure 2, Appendix D

7.4 BEDROCK

Bedrock beneath the Centre Block area consists of limestone of the Verulam formation, underlain by limestone of the Bobcaygeon and Gull River formations. Bedrock was proven by coring in all boreholes to end depths ranging between 1.5 m (BH 15-14I) and 34.7 m (BH 15-4).

The depth to bedrock in the exterior boreholes is variable in the vicinity of Centre Block. On the west side of Centre Block, bedrock was encountered between 1.4 m and 3.3 m below existing ground surface, based on boreholes drilled by exp in 2013. Near the southeast corner of Centre Block and north of the East Block, bedrock was encountered between 3.4 and 4.9 m. At the northeast corner of Centre Block, bedrock was observed at 0.7 m (Stantec 2015) and 0.6 m (Golder 2010) below existing ground surface. Bedrock beneath the Centre Block building was encountered at depths below the existing basement slab ranging between 0.15 and 2.9 m. For the exterior boreholes, including the relevant exp and Golder boreholes, the bedrock elevation ranges from approximately 80.2 m to 86.5 m. Drawing No. 3 illustrates these bedrock elevations.

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Parliament Hill has been noted to contain several faults, including 5 near the West Block, and 1 along the Rideau Canal locks to the east of the East Block. Various minor faults were documented during the construction of the tunnels linking the East Block to the Chateau Laurier and to the NAC. Faulting was observed on the cliff face to the northeast of the Centre Block, and was documented in Golder report No. 801-2109, titled "Phase 1 Engineering, Geological Mapping and Geotechnical Considerations for Bedrock and Talus Slopes, Parliament Hill", and was included in documents relating to the renovation of the Centre Block (Golder, 1990). The presence of this fault has not been independently confirmed by Stantec.

The mapped faults in the vicinity of Centre Block are shown on Drawing No. 3 and 4, Appendix B.

7.4.1 Rock Quality Designation

The bedrock observed in the exterior boreholes were generally fair to excellent quality with the upper 0.5 to 1.0 m of bedrock being of very poor quality in BH 15-4 and BH 15-9. Bedrock was shown to be of poorer quality in areas where blasting for rock excavation may have occurred. This was the case for the bedrock encountered beneath the Centre Block basement in which very poor to fair quality rock was observed in BH 15-1, BH 15-2, BH 15-3, BH 15-11 and BH 15-16 in the upper 3 to 4 m of bedrock.

7.4.2 Bedrock Structures

In general, the rock has been noted as being generally horizontally bedded, with shale interbedding and very close to moderately spaced joints (<5 cm to 1 m). Some vertical fractures were also observed. The field bedrock core logs in Appendix C, indicated the discontinuities observed in the rock cores as well as their orientation.

Three optical televiewer surveys were conducted in BH 15-4, BH 15-5 and BH 15-9 to determine the orientation of the structures. Stereographic plots have been created using the Dips program and are included in Appendix E. Based on the optical televiewer data, sub-horizontal fractures dipping mainly 0 to 15° toward southeast are present throughout the length of the boreholes and represent the main joint set in the boreholes. There were a few vertical fractures observed dipping mainly 75 to 79°.

Based on visual observations of the bedrock cores and the orientation of the fractures/joints, two joint sets were observed; one set being identified as a bedding joint and the other identified as a shear plane or vertical fracture. The joint set number, J_n for this investigation, ranged from 1 (no or few joints) to 4 (two joint sets).

7.4.3 Joint Conditions

The joint roughness and joint filling parameters, J_r and J_a were determined for each geological structure during the logging of the bedrock cores. These parameters are used to determine the Tunnelling Quality Index, Q .

Values assigned to J_r ranged from 0.75 to 3, with 40% of the observed joints being assigned a value of 1 (smooth, planar), 21% with a value of 2 (smooth, undulating) and 21% with a value of 3 (rough or irregular, undulating). The greater the assigned J_r value, the greater the Q -value. Values of $Q > 10$ represent good to exceptional rock. In general, the rock joints observed at Centre Block were smooth, planar i.e. $J_r = 1.0$.

Assigned values of J_a ranged from 0.75 to 8 with 70% of the observed joints being assigned a value of 0.75 (tightly healed). The smaller the value of J_a , the greater the Q -value. J_a ranges between 0.75 (tightly healed) to 20 (thick continuous zones or bands). The distribution of assigned J_r and J_a values to the geological structures is illustrated in Appendix E.

7.4.4 Rock Mass Classification

The Rock Mass Classification System used is the NGI-Q system (Barton, 1974) which was used to determine the Tunnelling Quality Index, Q . Q is defined by the following equation:

$$Q = \frac{RQD}{J_n} \times \frac{J_r}{J_a} \times \frac{J_w}{SRF}$$

where RQD is the Rock Quality Designation
 J_n is the joint set number
 J_r is the joint roughness number
 J_a is the joint alteration number
 J_w is the joint water reduction factor
 SRF is the stress reduction factor

The Q index was calculated for each bedrock core run and is shown on the bedrock core records in Appendix C. The distribution of calculated Q indices to the geological structures is illustrated in Appendix E. The graph shows that 42% of the structures in the vicinity of Centre Block have a Q index ranging from 40 to 100 (very good rock), while 25% and 21% range from 10 to 40 (good rock) and 100 to 400 (exceptional rock), respectively. An average Q index for the Centre Block is 63 (very good rock).

7.4.5 Rock Mass Rating

The rock mass rating (RMR) was obtained using a weighting system in which parameters relating to the geometry and mechanical condition of the rock were observed and quantified as shown in the following table.

Table 7.2: Rock Mass Rating (RMR) System (Bieniawski 1989)

| Rating | Categories | | | | | | | |
|--------|------------|--------------------------------|---------------------------|---------------------|-----------------------------|---------------------------|--------------------------|----------------|
| 11 | 1 | Strength of Intact Rock | Point Load Uniaxial Comp. | > 10MPa >250 MPa | 4 - 10 MPa 100 - 250 MPa | 2 - 4 MPa 50 - 100 MPa | 1 - 2 MPa 25 - 50 MPa | 5-25 -5 <1 MPa |
| | | Rating | | 15 | 12 | 7 | 4 | 2 1 0 |

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| Rating | Categories | | | | | | | |
|-----------|------------|--------------------------|--|--|--|--|--|--|
| 15 | 2 | RQD | | 90% - 100% | 75% - 90% | 50 - 75% | 25% - 50% | <25% |
| | | Rating | | 20 | 17 | 13 | 8 | 3 |
| 12 | 3 | Joint Spacing | | >2 m | 0.6 - 2 m | 200 - 600 mm | 60 - 200 mm | < 60 mm |
| | | Rating | | 20 | 15 | 10 | 8 | 5 |
| 18 | 4 | Joint Condition | | Very Rough Not Continuous No Separation Hard Jt. Wall Rk | Slightly Rough Separation < 1mm Slightly weathered walls | Slightly Rough Separation < 1mm Highly weathered walls | Slikensded Gouge < 5mm Open 1 - 5 mm Continuous Jt. | Soft gouge > 5mm Joints open > 5 m Continuous Joints |
| | | Rating | | 30 | 25 | 20 | 10 | 0 |
| 10 | 5 | Ground Water | | Completely Dry | Damp | Wet | Dripping | Flowing |
| | | Rating | | 15 | 10 | 7 | 4 | 0 |
| 0 | 6 | Joint Orientation | | Very Favourable | Favorable | Fair | Unfavorable | Very Unfavorable |
| | | Rating | | 0 | -2 | -5 | -15 | -25 |

RMR = 66

Em (GPa) = 25.1

7.4.6 Intact Rock Properties

Laboratory tests were carried out on intact rock to determine the rock properties. These tests included uniaxial compressive strength, point load and elastic moduli of intact rock tests.

Uniaxial Compressive Strength

Uniaxial compressive strength tests carried out on twenty-five rock cores from three different boreholes to determine the strength and deformability of intact rock. The results are shown below in Table 7.3.

Table 7.3: Unconfined Compressive Strength of Rock Cores

| Borehole I.D. | Ground Surface Elevation (m) | Test Elevation (m) /Test Depth (m) | Unconfined Compressive Strength (MPa) |
|---------------|------------------------------|------------------------------------|---------------------------------------|
| BH 15-1 | - | -/5.5 | 115 |
| BH 15-1 | - | -/23.3 | 130 |
| BH 15-2 | - | -/5.7 | 170 |
| BH 15-2 | - | -/14.6 | 80 |

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| Borehole I.D. | Ground Surface Elevation (m) | Test Elevation (m) /Test Depth (m) | Unconfined Compressive Strength (MPa) |
|---------------|------------------------------|------------------------------------|---------------------------------------|
| BH 15-3 | - | -/4.6 | 125 |
| BH 15-3 | - | -/14.9 | 110 |
| BH 15-4 | 87.1 | 82.1/5.0 | 120 |
| BH 15-4 | 87.1 | 79.8/7.3 | 95 |
| BH 15-4 | 87.1 | 72.2/14.9 | 95 |
| BH 15-4 | 87.1 | 63.8/23.3 | 120 |
| BH 15-4 | 87.1 | 59.3/27.8 | 125 |
| BH 15-4 | 87.1 | 54.7/32.4 | 105 |
| BH 15-5 | 86.8 | 74.1/12.7 | 160 |
| BH 15-5 | 86.8 | 65.1/21.7 | 90 |
| BH 15-6 | 84.1 | 77.1/7.0 | 140 |
| BH 15-6 | 84.1 | 67.7/16.4 | 110 |
| BH 15-7 | 84.4 | 74.2/10.2 | 120 |
| BH 15-7 | 84.4 | 63.5/20.9 | 140 |
| BH 15-8 | 85.8 | 80.7/5.1 | 110 |
| BH 15-8 | 85.8 | 66.4/19.4 | 120 |
| BH 15-9 | 87.1 | 81.5/5.6 | 145 |
| BH 15-9 | 87.1 | 66.5/20.6 | 125 |
| BH 15-10 | - | -/6.9 | 175 |
| BH 15-11I | - | -/2.3 | 90 |
| BH 15-12 | - | -/2.2 | 115 |
| BH 15-13 | - | -/5.5 | 115 |
| BH 15-14I | - | -/1.4 | 110 |
| BH 15-15 | - | -/1.6 | 90 |

Point Load Index Tests

Fifteen bedrock core samples were tested to obtain the point load strength index, I_s . Table 7.4 summarizes this data and also shows the corrected I_s , $I_s(50)$ as well as the inferred unconfined compressive strength of the rock.

Table 7.4: Summary of Results from Point Load Index Tests

| Borehole I.D. | Ground Surface Elevation (m) | Test Elevation (m) / Test Depth (m) | Is (MPa) | Is(50) (MPa) | Inferred Unconfined Compressive Strength (MPa) |
|---------------|------------------------------|-------------------------------------|----------|--------------|--|
| BH 15-4 | 87.1 | 57.7/29.4 | 3.87 | 4.08 | 95 |
| BH 15-4 | 87.1 | 56.5/30.6 | 4.73 | 4.75 | 90 |
| BH 15-4 | 87.1 | 79.2/7.9 | 3.62 | 3.90 | 105 |
| BH 15-4 | 87.1 | 75.7/11.4 | 3.97 | 4.40 | 100 |
| BH 15-6 | 84.1 | 74.1/17.3 | 4.29 | 4.61 | 110 |
| BH 15-6 | 84.1 | 78.4/10.0 | 4.76 | 4.57 | 85 |
| BH 15-6 | 84.1 | 78.4/5.7 | 4.77 | 4.57 | 110 |
| BH 15-6 | 84.1 | 71.9/12.2 | 3.98 | 3.82 | 95 |
| BH 15-6 | 84.1 | 68.3/15.8 | 3.72 | 3.55 | 75 |
| BH 15-9 | 87.1 | 65.2/21.9 | 5.61 | 5.43 | 135 |
| BH 15-9 | 87.1 | 85.5/1.6 | 4.32 | 4.72 | 115 |
| BH 15-9 | 87.1 | 78.4/8.7 | 3.94 | 4.33 | 95 |
| BH 15-9 | 87.1 | 72.7/14.4 | 3.74 | 4.38 | 85 |
| BH 15-9 | 87.1 | 69.2/17.9 | 3.57 | 3.88 | 85 |
| BH 15-9 | 87.1 | 64.4/22.7 | 3.20 | 3.55 | 90 |

Elastic Moduli of Intact Rock

The table below summarizes the results obtained for three samples that were tested to determine the elastic modulus of intact rock in BH 15-4. This borehole was selected since it was the deepest borehole in the vicinity of the proposed future development and to determine the variation of the rock properties with depth.

Table 7.5: Summary of Results from Elastic Moduli of Intact Rock Testing

| Borehole I.D. | Sample No. | Depth (m) | Unconfined Compressive Strength (MPa) | Young's Modulus (GPa) | Poisson's Ratio | Unit Weight (g/cm ³) |
|---------------|------------|-----------|---------------------------------------|-----------------------|-----------------|----------------------------------|
| BH 15-4 | HQ-9 | 5.0 | 120 | 63 | 0.41 | 2.71 |
| BH 15-4 | HQ-21 | 23.3 | 120 | 60 | 0.33 | 2.69 |
| BH 15-4 | HQ-24 | 27.8 | 125 | 60 | 0.34 | 2.78 |

7.5 GROUNDWATER

Groundwater was not encountered during drilling in any of the boreholes with the exception of BH 15-5 in which groundwater was encountered at 4.6 m below existing ground surface.

Groundwater level readings were taken in several of the boreholes between one to ten days after the completion of drilling. Table 7.6 below shows the groundwater level readings measured on the days stated in the table.

Table 7.6: Groundwater Level Readings

| Borehole I.D. | Ground Surface Elevation (m) | Groundwater Elevation (m) /Groundwater Depth (m) | Groundwater Reading Date |
|---------------|------------------------------|--|--------------------------|
| BH 15-1 | - | -/17.4 | January 15, 2015 |
| BH 15-2 | - | -/3.7 | January 15, 2015 |
| BH 15-3 | - | -/15.0 | January 16, 2015 |
| BH 15-4 | 87.1 | 83.8/3.3 | January 19, 2015 |
| BH 15-5 | 86.8 | 81.4/5.4 | January 19, 2015 |
| BH 15-6 | 84.1 | 67.4/16.7 | January 19, 2015 |
| BH 15-7 | 84.4 | 68.4/16.0 | January 19, 2015 |
| BH 15-9 | 87.1 | 77.0/10.1 | January 19, 2015 |

The water levels given above should be considered only as approximate, and may not be an accurate representation of the current groundwater level. It should be noted that groundwater elevations are also expected to change based on time of year and precipitation.

7.6 HYDRAULIC CONDUCTIVITY OF BEDROCK

Hydraulic conductivities of the bedrock unit were determined from the packer tests. Results are shown in Appendix D and are summarized in Table 7.7.

Table 7.7: Hydraulic Conductivity Results

| Borehole I.D. | Test Interval (m) | Net Injection Pressure (kPa) | Average Flow Rate (m ³ /min) | Average Hydraulic Conductivity (m/s) | Comments |
|---------------|-------------------|------------------------------|---|--------------------------------------|--|
| BH 15-4 | 17.3 to 21.0 | - | - | - | There was no change in the volume intake during these tests. |
| BH 15-4 | 23.4 to 27.1 | - | - | - | |
| BH 15-4 | 29.5 to 33.2 | - | - | - | |
| BH 15-9 | 7.6 to 11.3 | - | - | - | Above water table, no pressure build up. |
| BH 15-9 | 13.7 to 17.4 | 247 – 524 | 0.0006 – 0.0012 (rising pressure) 0.0012 – 0.0006 (falling pressure) | 2.77E-08 | - |
| BH 15-9 | 18.9 to 22.6 | 247 – 524 | 0.0005 – 0.0008 (rising pressure) 0.0008 – 0.0004 (falling pressure) | 1.86E-08 | - |

7.7 TUNNELS AND UNDERGROUND INFRASTRUCTURE

Portions of the report not required for the solicitation have been removed.

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

7.7.3 Abandoned Ventilation Ducts

A former ventilation tunnel (C1) runs west from the Centre Block and appears to exit on the cliff face near the former cat shelters. It is understood that the tunnel has been abandoned and is now filled with concrete. In 2002, J.D. Paterson advanced a borehole (BH1) through the tunnel roof. The tunnel crown was encountered at elevation 84.55 m (or 1.73 m below ground surface). The tunnel was constructed of cemented limestone, sandstone and brick blocks.

[REDACTED]

Another tunnel (C5) runs east from the Centre Block and appears to exit on the cliff face north of the East Block. It is understood that the tunnel has been abandoned and is now filled with unshrinkable fill and capped with a concrete wall.

[REDACTED]

[REDACTED]

7.7.6 East Block/Centre Block Tunnels

[REDACTED]

A pre-design report for the pedestrian tunnel (Butts, Ross & Associates, 1965) indicates open-cut was most likely used in construction, and that the planned tunnel floor was at approximate elevation 263 feet (80.2 m).

A second pre-design report, presumably for the same tunnel (Fondex, 1989) indicates a tunnel base elevation of 81.99 m at Centre Block and 78.80 m at the East Block.

7.7.7 Centre Block Underground Services (CBUS)

The Centre Block Underground Services (CBUS) Building is located to the northwest of Centre Block, and extends three storeys below grade, with connections to Centre Block and various tunnels.

7.8 CENTRE BLOCK BASEMENT

A geotechnical investigation into the conditions at Centre Block basement was carried out by Wilf Ohlmann Geotechnical Services Ltd. in 1985. As part of this investigation, 13 boreholes were advanced through the basement slab (4 in lower floor locations, and the remainder in stepped up locations). The basement floor slab was found to be between 37 and 152 mm thick (average of 90 mm), while the overburden thickness beneath the slab varied between 490 mm and 830 mm for lower floor locations, and between 0 mm and 140 mm for stepped up locations. A borehole advanced near an interior column showed that the column is not supported by footings, but rather placed directly on the bedrock.

From the Stantec 2015 investigation, ten (10) boreholes were advanced through the basement floor slab as shown on Figure No. 2, Appendix B. The floor slab thickness ranged from 100 to

660 mm (average 177 mm), while the overburden thickness beneath the slab varied between 50 mm and 660 mm. Boreholes which consisted of more than 600 mm of fill, with the exception of BH 15-1 to BH 15-3, were drilled at a 30 degree angle to the vertical. These inclined boreholes indicated that the foundation walls and columns are likely founded directly on bedrock.

8.0 DISCUSSION AND RECOMMENDATIONS

8.1 GENERAL

Based on discussions with PWGSC, it is understood that the Centre Block is to be rehabilitated. This work will include a seismic upgrade, subexcavation of the basement level, and construction of new Visitor's Welcome Centres (at both East Block and Centre Block).

The predominant geotechnical related features at this site include the following:

- Extensive development on this site has resulted in the majority of the native overburden being replaced with fill. This fill is highly variable.
- Native material (primarily sandy silt till) was encountered discontinuously throughout the site.
- Bedrock at the site is relatively shallow, and generally consists of poor to excellent quality limestone, with a weathered upper section.
- Although a large amount of geotechnical data is available at this site, much of it is historical; conditions may have changed since the original data was recorded due to construction activities.
- The site contains many utilities, both in-service and abandoned. Due to the relatively shallow bedrock, several utilities may have been installed in trenches or tunnels excavated into the rock. These service trenches may result in localized areas of deeper bedrock.
- The existing structures at the site, including the Centre Block, are sensitive to vibration and will require careful excavation sequencing and specialized rock excavation approaches.
- A steep slope is present to the north of the Centre Block; this slope has a history of creep.

8.2 FROST PENETRATION

The typical frost penetration depth for Ottawa is 1.8 m.

The design depth for new perimeter foundation should extend to 1.8 m or to sound bedrock, if shallower, to protect against frost heaving. Due to improved foundation insulation practices, a reduced embedment value for foundations is no longer recommended; past practices assumed that building heat loss reduced the frost penetration depth at the building perimeter.

Conventional footings required to support construction tower cranes or possibly heavy scaffolding (in the case where scaffolding cannot be attached to the building), the footings should extend to 1.8 m or to sound bedrock to protect against frost heaving.

8.3 SITE GRADING AND PREPARATION

Footings for cranes and scaffolding should be founded on sound bedrock, clean, undisturbed native till, or Structural Fill placed on the bedrock or the native till. Exposed bedrock surfaces should be free of loose bedrock, soil, water, bedrock irregularities, bedrock pinnacles and sloping surfaces. Hand cleaning and pressure washing of the bearing areas to remove any loose materials will be required to achieve the recommended bearing pressure. In the vicinity of Centre Block, it is typical for the top 1.0 to 1.5 m of bedrock to be weathered.

Temporary frost protection should be provided for all footings if construction is carried out under winter conditions as described in Section 8.2.

Prepared subgrade surfaces should be inspected by experienced geotechnical personnel prior to placement of either Structural Fill or concrete.

Structural Fill should conform to the requirements of OPSS Granular A or OPSS Granular B Type II. It should be compacted in lifts no thicker than 300 mm to at least 100% Standard Proctor Maximum Dry Density (SPMDD), as per ASTM D698. This material should be tested and approved by a Geotechnical Engineer prior to delivery to the site.

Earth removals should be inspected by a Geotechnical Engineer to ensure that all unsuitable materials are removed prior to placement of fill or concrete.

8.4 FOUNDATIONS

New foundations for the proposed works, if required, are anticipated to be founded on spread footings on limestone bedrock.

8.4.1 Shallow Foundations

Works supported on spread footings should follow the foundation preparation work described in Section 8.3 above. Spread footings should be placed on clean undisturbed sound bedrock, clean undisturbed native till, or Structural Fill.

Table 8.1 provides Geotechnical Bearing Resistances for shallow foundations situated on the above surfaces.

Table 8.1: Geotechnical Bearing Resistance for Shallow Foundations

| Foundation Type | Footing Width (m) | Geotechnical Resistance, ULS, (kPa) | | | Geotechnical Resistance, SLS, (kPa) | |
|-----------------|-------------------|-------------------------------------|------------------------------|-------------|-------------------------------------|-------------|
| | | Bedrock | Structural Fill over Bedrock | Native Till | Structural Fill over Bedrock | Native Till |
| Strip Footing | 0.6 to 2.0 | 4000 | 400 | 200 | 225 | 190 |
| Square Footing | 1.0 to 3.0 | 4000 | 400 | 190 | 200 | 180 |

The factored geotechnical bearing resistance at ultimate limit states (ULS) incorporates a

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resistance factor of 0.5. The geotechnical reaction of a sustained load at Serviceability Limit States (SLS) would be 25 mm of settlement. The settlement of foundations founded on bedrock is expected to be negligible and therefore, the geotechnical reaction at Serviceability Limit States (SLS) is not provided for footings on bedrock.

The bearing capacities provided above reflect axial loading conditions, and do not account for eccentric loads which may occur as a result of towers and scaffolding which cannot be connected to the Centre Block walls. The above values should be reduced to account for the effects of eccentric loading, as per Section 10.2.5, Eccentric Forces and Moments, of the Canadian Foundation Engineering Manual.

The design frost depth is 1.8 m. All footings bearing on soil should be protected from frost action by a minimum soil cover of 1.8 m or equivalent insulation. Where proposed footings bearing on soil have insufficient soil cover for frost protection, the use of insulation will be required. The insulation should consist of extruded polystyrene and should use an exchange rate of 25 mm insulation equal to 450 mm soil. Footings bearing on bedrock are not required to be founded below the frost penetration depth.

The base of all footing excavations should be inspected by a Geotechnical Engineer prior to placing concrete to confirm the design pressures and to ensure that there is no disturbance of the founding soils.

It is possible that a fault impacted area is observed during inspection of the footing excavations. The requirement for special treatment, if any, would be assessed at the time of inspection. Treatment could include excavation of the fault breccia fragments and backfilling with mass concrete.

Various service tunnels and conduits are located beneath the Centre Block. To prevent damage to these infrastructures, which could cause tunnel collapse, foundations should not be placed such that their influence zones will affect the tunnels. The influence zone may be described as the area defined by a line projected at 1H:1V down and out from the edge of the footing, to a depth of B, where B is the footing width. A detailed condition survey of all tunnels should be carried out prior to construction.

Where construction is undertaken during winter conditions, all footing subgrades should be protected from freezing. Foundation walls and columns should be protected against heave due to soil adfreeze.

8.5 EXCAVATION AND BACKFILLING

8.5.1 Excavations in Soil

The fill present at the site should be considered a Type 3 soil in accordance with the Occupational Health and Safety Act (OHSA) and Regulations for Construction Projects. Temporary excavations in the overburden may be supported or should be sloped at 1 horizontal to 1 vertical from the base of the excavation and as per the requirements of OHSA.

Alternatively, soldier piles with lagging, a trench box, or other support methods will be required. Excavations should be inspected regularly for signs of instability and flattened as required. The excavation support system should be designed to resist loads from traffic and foundations from adjacent structures if applicable.

8.5.2 Groundwater

Historical groundwater readings and readings obtained in January 2015 show the groundwater level to vary between less than 2 m to greater than 20 m below ground surface; it has been noted that groundwater typically follows the bedrock profile and could be higher. The proposed Visitors' Welcome Centres, as well as associated tunnels and access shafts, are anticipated to be excavated three stories into bedrock, suggesting a high probability that groundwater will be encountered during construction.

The bedrock at Parliament Hill has been noted to be of generally low permeability due to the tight fractures; however, areas with poorer quality rock could produce larger quantities of inflow. In particular, care should be taken in areas of suspected faulting. Hydraulic conductivity of the bedrock was measured by Golder, exp and Stantec in the vicinity of Centre Block. The readings obtained are summarized in Table 8.2.

Table 8.2: Summary of Hydraulic Conductivity Measurements

| Company (Year test conducted) | Hydraulic Conductivity Measured (m/s) |
|-------------------------------|---|
| Golder (1990) | - 1 x 10 ⁻⁵ to 3 x 10 ⁻³ |
| exp (2013) | - 1 x 10 ⁻⁵ (fractured rock) - 2.1 x 10 ⁻⁷ to 3.7 x 10 ⁻⁶ (upper limestone unit) - 5.6 x 10 ⁻⁸ to 1.2 x 10 ⁻⁷ (lower limestone unit) |
| Stantec (2015) | - 1.8 x 10 ⁻⁸ to 2.7 x 10 ⁻⁸ (lower limestone unit) |

It is anticipated that the groundwater levels provided above and in Section 7.5 may fluctuate seasonally. Based on the current groundwater levels, it is expected that groundwater would be encountered within the depth of excavation and it is recommended that a hydrogeological analysis be conducted to confirm the need for a Permit to Take Water (PTTW). If it is determined that more than 50,000 litres of water is anticipated to be taken each day during the construction and/or dewatering, then a PTTW would be required. At this time, the requirement for the contractor to submit a dewatering plan should also be assessed.

Any structures which are anticipated to be constructed beneath the water table, will need to be designed to be watertight or alternatively to be drained with an appropriate sump and drainage system. An undrained watertight design would need to consider uplift resistance. A drained design would need to consider the potential of contaminant impacted groundwater

being directed from the site. PWGSC has indicated that any new structures are anticipated to be designed as fully drained structures.

8.5.3 Excavations in Bedrock

Excavations in bedrock are anticipated for the proposed development, such as for the lowering of the Centre Block basement and the construction of tunnels and access shafts. The upper portion (approximately 0.5 m to 1.0 m) of the bedrock is weathered, and can likely be excavated using hoe-ramming. Deeper bedrock will require other methods, described below. Excavations in competent rock may be conducted with vertical walls up to a depth of 3 m, except in cases where the excavation is immediately adjacent an existing structure. For excavations deeper than 3 m in rock, rock mass stabilization will be required, as described in Section 8.5.4.

The Centre Block is considered to be of historical significance and comprises of three structural systems – reinforced concrete beams and slabs on concrete columns, walls and piers; steel beams and girders bearing on brick masonry load bearing walls; and a skeleton frame with girders framed into steel columns. The foundation of Centre Block comprises of unreinforced concrete founded on limestone bedrock with a piece of the 1860's stone foundation wall remaining beneath the poured concrete foundations of the southeast pavilion at a depth of 2.1 m. At foundation level, reinforced concrete is found in smaller columns supporting the ground floor level beams. Based on this description, the Centre Block structure may be sensitive to vibrations.

Previous excavations for the CBUS and the Library of Parliament have recommended that no blasting occur within a defined distance from existing walls or foundations; this distance was dependent on the integrity of the nearby structure. Instead, hoe-ramming, hydraulic or chemical rock splitting, or line drilling should be used. For bedrock excavations in areas extremely close to existing structural elements (<3 m, such as in the Centre Block basement), a line-drilling program prior to excavation is recommended to define excavation limits.

Controlled blasting of rock may be an option away from structures, such as for potential access shafts or tunnels. Several test blast programs have been conducted around the vicinity of Parliament Hill. In the past, explosive weights of 0.5 kg to 2.6 kg have been used. It is expected that each blast would only last for 250 milliseconds and be limited to two or three small blasts per day during core business hours except for the changing of the guard between 10:30 to 11:30 am. Each blast would typically be covered with three layers of rubber blasting mats to reduce noise and prevent flying rock.

Due to the historical significance and heritage considerations associated with the Parliamentary Precinct, a detailed pre-construction survey should be performed prior to rock excavation taking place, including monitoring of any existing cracks on the interior and exterior of structures or tunnels. Previously, a limit of 12 mm/sec has been set as a limit of Peak Particle Velocity (PPV) for heritage buildings. For more modern structures, a PPV of 25 mm/sec has been suggested for safe use. The vibration limits provided in Table 8.3 were also provided for rehabilitation of similar structures (East Block, Visitor Welcome Centre) on Parliament Hill. These vibration limits are

intended to prevent cracking and other structural problems, and do not address the needs of any vibration-sensitive equipment, if present. Should particularly vibration-sensitive equipment or facilities be present in the Centre Block area, it is recommended that a site-specific vibration analysis be carried out prior to rock excavation.

Table 8.3: Suggested Peak Vibration Limits at Nearby Structures/Services

| Frequency Range (Hz) | < 10 | 10 to 30 | > 30 |
|-------------------------------|------|------------------------|------|
| Peak Particle Velocity (mm/s) | 5 | 5 to 25(sliding scale) | 25 |

For rock excavation at the West Block rehabilitation project, non-detonating chemical compound rock breaking technology (Nxburst) was used which produces the combination of high frequency, low duration and low magnitude vibration waves, which reduced the risks of vibration related damages. The use of similar rock breaking technologies should be considered for the Centre Block Project.

8.5.4 Rock Mass Stabilization

Based on 3D modeling (Golder 1999) of the rock mass beneath the Library of Parliament, which is anticipated to be similar to that for the remainder of Centre Block, it was concluded that excavation-related vibration (including from mechanical excavation methods) had the potential to cause movement; so too could incorrect excavation sequencing. Horizontal stresses of no more than 0.5 MPa were found to cause movements, although this modelling result was found to be relatively conservative compared to what was noted in the field. Movement was more likely to occur along faults, bedding planes and joints, as opposed to stress-related movements.

A part of the detail design for the proposed Center Block Visitors Welcome Center excavation, detail 3D modelling of the rock mass should be carried out.

The excavations for both the Library of Parliament and the CBUS required pre-support of the rock consisting of untensioned dowels to integrate the rock mass, as well as tensioned rock bolts to provide positive restraint to areas identified as potential wedge or block failures. It is anticipated that a similar approach will be required for the Centre Block.

The rock mass is anticipated to be more fractured in areas where historical tunnels are present. In these areas, additional support of the rock mass may be required, such as consolidation grouting or mesh reinforcement.

Optical televiewer logging was conducted in BH 15-4, BH 15-5 and BH 15-9 by GPR Geophysics. The optical televiewer logging report and logs are provided in Appendix E. Based on the logs, the frequency of fractures in these three boreholes appear to be very low with 2.0 fractures per metre being the highest observed frequency between 4.5 m and 5.5 m in BH 15-4 and between 22.5 m and 24.0 m in BH 15-9.

Based on the fracture frequency observed in the exp 2013 borehole investigation for boreholes drilled near the west and southwest side of Centre Block, a maximum fracture frequency of 10 per 0.25 m was observed in several of the boreholes. This may be due to the presence of tunnels (pedestrian and service tunnels) in the area and as mentioned before, additional support of the rock mass may be required on the west southwest side of Centre Block.

8.5.5 Rock Anchors

It is anticipated that rock anchors may be required to stabilize the rock face in areas that may be identified as potential block or wedge failures.

For rock anchor design there are several possible failure modes. Failure may occur in the steel tendon, in the bond at either the rock-grout or grout-steel interfaces or rock mass conical failure. The structural failure modes i.e. failures in the steel tendon and in the grout-steel bond should be reviewed by a structural engineer.

The following rock parameters were used to develop the anchor design recommendations provided herein.

Table 8.4: Parameters for Rock Anchor Design

| RMR | Hoek and Brown Parameters | | Unconfined Compressive Strength of Intact Rock, U_c (MPa) | Submerged Unit Weight of Rock, (kN/m ³) | ULS Grout to Rock Bond Strength (kPa) | Grout Compressive Strength (MPa) | Apex Angle of Failure Cone (degrees) |
|-----|---------------------------|---------|---|---|---------------------------------------|----------------------------------|--------------------------------------|
| | m | s | | | | | |
| 66 | 0.617 | 0.00346 | 115 | 16 | 1000 | 30 | 90 |

Rock-Grout Failure Mode

When considering the rock-grout failure mode the following should be considered:

- A rock to grout interface bond strength of 1000 kPa at ULS, assuming grout with an unconfined compressive strength of 30 MPa.
- The upper 1.0 m of bedrock should not be included as bonded length when calculating the anchor capacity – i.e. it should be considered a no-load zone.
- Minimum bonded anchor length of 3 m and a maximum bonded length of 8m.
- Minimum bonded length of 3 m, assuming that bar tendons will be used.
- The unbounded length of anchor should be equal to the height of the rock cone and less half the bonded length.
- Grouting of the unbounded length after the anchor has been prestressed.
- A minimum spacing of four times the diameter of the bored hole should be used in order to prevent or minimize excessive stress concentrations being developed around the anchors.

The above applies for both vertical and inclined rock anchors.

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Assuming that the anchor was up to 150 mm in diameter and the maximum bonded length of 8 m was applied, this would suggest a possible geotechnical resistance at ULS at the rock-interface of 3,800 kN.

Rock Mass Conical Failure

To ensure against the possibility of a rock mass failure, the following approach should also be carried out:

- For a single anchor use the calculation method provided on the sheet titled "Rock Anchor: Resistance to Rock Mass Failure" provided in Appendix F.
- Where the centre-to-centre spacing of adjacent rock anchors is less than twice the height of the rock cone, the anchor group resistance to rock mass failure should be reduced to reflect the theoretical rock cone overlap.
- A 90° apex angle should be used to calculate the rock volume within the theoretical cones and the apex should be located at the middle of the bonded length as shown on the sheet titled "Rock Anchor: Resistance to Rock Mass Failure" in Appendix F.
- Submerged unit weight of rock = 16 kN/m³.

Rock Anchor Testing

Proof testing should be carried out on all production anchors to ensure a satisfactory design. In accordance with the Canadian Foundation Engineering Manual, proof tests should be taken to the maximum test load of 1.33 times the working (service) load.

8.5.6 Tunneling

It is understood that tunneling may be considered for required access shafts or tunnels. It was recommended in Stantec's August 2014 Data Gap Analysis that if tunneling is to be undertaken, an analysis should be performed as part of the detailed investigation for this project.

Due to the blasting restrictions at Parliament Hill, it is anticipated that any tunneling would be carried out using a mining approach using horizontal line drilling followed by the use of a hydraulic rock splitter within larger diameter predrilled horizontal holes.

For the design of tunneling and excavation supports, and the length and spacing of rock reinforcement, both the Rock Mass Classification (Q Index) and Rock Mass Rating (RMR) are required. These have been discussed in Sections 7.4.4 and 7.4.5, respectively. Table 8.5 summarizes the bedrock geotechnical design parameters that can be used for the Centre Block project. The table also compares the various parameters obtained from lab and seismic testing as well as from the Rock Mass Rating.

Table 8.5: Geotechnical Bedrock Parameters Comparison

| Unconfined Compressive Strength of Intact Rock, U_c (MPa) | | | Young's Modulus (GPa) | | | Poisson's Ratio, ν | | | Shear Modulus, G_m (GPa) | | |
|---|--------------------------------|-----------------------|-----------------------|---------------------|-----------------|------------------------|---------|-------------------------|----------------------------|---------------------|-----------------|
| Uniaxial Test | Inferred from Point Load Index | UCS from modulus test | Intact Rock (Lab) | Rock Mass (Seismic) | Rock Mass (RMR) | Lab | Seismic | RMR (theoretical value) | Intact Rock (Lab) | Rock Mass (Seismic) | Rock Mass (RMR) |
| 115 | 98 | 123 | 61 | 39 | 18 | 0.36 | 0.29 | 0.32 | 22 | 15 | 7 |

The values identified as Rock Mass (Seismic) may be used where analysis requires the input of “small strain” elastic properties, such as foundation designs. The values identified as Rock Mass (RMR) may be used where analysis requires the input of “large strain” elastic properties such as in the case where static loads apply.

8.5.7 Foundation Backfill

Foundation backfill should be placed and compacted in lifts and should consist of Structural Fill. Structural Fill should conform to the requirements of OPSS Granular A or Granular B Type II. It should be compacted in lifts no thicker than 300 mm to at least 100% Standard Proctor Maximum Dry Density (SPMDD). This material should be tested and approved by a Geotechnical Engineer prior to delivery to the site. Care should be taken immediately adjacent to walls to avoid over compaction of the soil which could result in damage to the walls.

All foundations are expected to be set on bedrock; therefore Structural Fill is only anticipated for foundation backfill.

Bedding for utilities should be placed in accordance with the pipe design requirements. It is recommended that a minimum of 150 mm to 200 mm of OPSS Granular A be placed below the pipe invert as bedding material. Granular pipe backfill placed above the invert should consist of Granular A material. A minimum of 300 mm vertical and side cover should be provided. These materials should be compacted to at least 98% of SPMDD.

Backfill for service trenches in landscaped areas may consist of excavated material replaced and compacted in lifts. Where the service trenches extend below paved areas, the trench should be backfilled with subgrade fill material, meeting the requirements for OPSS Select Subgrade Material, from the top of the pipe cover to within 1.2 m of the proposed pavement surface, placed in lifts and compacted to at least 95% of SPMDD. The material used within the upper 1.2 m and below the subgrade line should be similar to that exposed in the trench walls to prevent differential frost heave, placed in lifts and compacted to at least 95% of SPMDD. Different abutting materials within this zone will require a 3H:1V frost taper in order to minimize the effects of differential frost heaving.

Excavations for manholes (if applicable) should be backfilled with compacted granular material. A 3H:1V frost taper should be built within the upper 1.2 m.

8.5.8 Foundation Drainage

New foundations will require a perimeter drainage system and under slab drainage system. Typically the under slab drainage system will include the following components:

- Concrete basement floor slab
- High quality vapour barrier
- 50 mm minimum of OPSS Granular A waking surface
- 350 mm minimum clear stone drainage media
- Drainage tiles spaced 4 to 6 m apart leading to sump pits or discharging directly into the municipal storm sewer system.

Once the basement elevations have been established, a hydrogeological assessment should be carried out to confirm the “worst-case” groundwater flow volumes which could occur at the proposed foundation level. The below slab drainage system should be designed based on the required hydrogeological interpretation.

The perimeter drainage system should include perimeter drains set at the same level as the underside of the clear stone layer to be placed beneath the proposed floor level. The foundation walls should also be protected against moisture migration.

8.5.9 Pipe Bedding and Backfill

Bedding for utilities should be placed in accordance with the pipe design requirements. It is recommended that a minimum of 150 mm to 200 mm of OPSS Granular A be placed below the pipe invert as bedding material. Granular pipe backfill placed above the invert should consist of Granular A material. A minimum of 300 mm vertical and side cover should be provided. Above the springline, these materials should be compacted to at least 98% of SPMDD (as defined in Section 8.3).

Backfill for service trenches in landscaped areas may consist of excavated material replaced and compacted in lifts. Where the service trenches extend below paved areas, the trench should be backfilled with subgrade fill material, meeting the requirements for OPSS Select Subgrade Material, from the top of the pipe cover to within 1.2 m of the proposed pavement surface, placed in lifts and compacted to at least 95% of SPMDD. The material used within the upper 1.2 m and below the subgrade line should be similar to that exposed in the trench walls to prevent differential frost heave, placed in lifts and compacted to at least 95% of SPMDD. Different abutting materials within this zone will require a 3H:1V frost taper in order to minimize the effects of differential frost heaving.

Excavations for manholes (if applicable) should be backfilled with compacted granular material. A 3H:1V frost taper should be built within the upper 1.2 m.

8.5.10 Material Reuse

Excavations for this project are anticipated to extend through fill, native till and bedrock.

The fill material present at the site is granular in nature and may be reused as subgrade fill beneath landscaped and paved areas. The fill is variable from location to location and therefore will require a more extensive laboratory program to support the on-site compaction control and testing.

The native till material may have variable fines contents and moisture contents which will make them more difficult to compact during construction. Given the variable nature of these materials and its anticipated limited value, it is not recommended to reuse these materials as part of this project.

For cases where excavation into bedrock consists of drilling within bedrock to install anchors or construct caisson foundations, the bedrock cuttings would not be considered suitable as a reusable fill material. In the case where bedrock is excavated by hoe-ramming, line-drilling, splitting and/or blasting, the excavated bedrock would be considered suitable for reuse beneath landscaped and paved areas provided that it is well graded and that all pieces with a maximum dimension of greater than 300 mm are removed. As well, where rockfill is used, the rockfill surface should be chinked such that smaller gravel sizes are exposed at the surface and should be covered with a non-woven geotextile such as a Terrafix 270R to prevent migration of overlying earth or pavement materials through voids which inadvertently form within rockfill.

8.6 LATERAL EARTH PRESSURES

Soldier piles with lagging or other support methods may be required for service trenches excavated as part of the cut and cover operations, and should be designed using the lateral earth parameters provided in Table 8.6.

Table 8.6: Lateral Earth Parameters

| Material | K_o (at rest) | K_a (active) | K_p (passive) | ϕ (friction angle) | Unit Weight |
|-------------------------|--------------------|-------------------|--------------------|----------------------------|----------------------|
| OPSS Granular A | 0.43 | 0.27 | 3.69 | 35° | 22 kN/m ³ |
| OPSS Granular B Type II | 0.47 | 0.31 | 3.25 | 32° | 22 kN/m ³ |
| Sandy Silt Till | 0.48 | 0.32 | 3.12 | 31° | 21 kN/m ³ |
| Insitu Fills | 0.5 | 0.33 | 3.00 | 30° | 21 kN/m ³ |

The design of the shoring system should be carried out by a Professional Engineer specialized in shoring design. The design should consider load effects from the adjacent embankments, existing structures, and construction equipment.

8.7 SEISMIC DESIGN

8.7.1 Seismic Site Class and Liquefaction

As outlined in the 2010 National Building Code of Canada buildings and their foundations must be designed to resist a minimum earthquake force. The majority of the area beneath the Centre Block is underlain by relatively shallow bedrock. This site was analyzed using data obtained from the City of Ottawa seismic site classification map from combined geological/geophysical data, published by the Geological Survey of Canada and developed in conjunction with Carleton University. Figure 8.1 shows the most probable seismic site class for the soils underlying the Centre Block to be a Site Class A ("Hard Rock") and a Site Class B ("Rock").

Four known shear wave velocity measurements were carried out in the vicinity of Centre Block, as shown on Figure 6 in Appendix B in Stantec's August 2014 Geotechnical Data Gap Analysis Report, and summarized in Table 8.7 below.

Table 8.7: Summary of Shear Wave Velocity Tests

| Type of Survey* | Location | Vs30 (m/s) | Foundation Depth (m) | Foundation Elevation (m) | Applicable Seismic Site Class | Study |
|-----------------|------------------------------|------------|----------------------|--------------------------|-------------------------------|----------------|
| VSP | Southeast of the Peace Tower | 2335 | Unknown | Unknown | A | Stantec (2015) |
| MASW | Southwest of Centre Block | 2060 | Unknown | 78.35 | A | exp (2014) |
| | | 2120 | Unknown | 68.45 | A | |
| MASW | West of East Block | 1129.8 | 1.1 m | Unknown | B | Stantec (2014) |
| | | 2125.4 | 3.7 m | Unknown | A | |
| VSP | Northeast of Centre Block | 1724 | Unknown | 87.2 | A | Golder (2010) |
| | | 2205 | Unknown | 83.5 | A | |
| VSP | West Block courtyard | 2034 | 3 m | 79.1 | A | Golder (2010) |
| | | 2880 | 12 m | 70.1 | A | |

* MASW = Multi-channel Analysis of Surface Waves

VSP = Vertical Seismic Profiling

Based on recommendations given in Stantec's August 2014 Geotechnical Data Gap Analysis report, a vertical seismic profile was executed in BH 15-4, approximately 15 m east of the Peace Tower. The seismic survey report is attached in Appendix E. The results of the survey indicated shear wave velocities (Vs30) of 1237 m/s and 2335 m/s (indicated in Table 8.7 above) for foundations on the overburden and for foundations on rock, respectively. Based on these results, foundations on bedrock may be designed using a Site Class A. Where foundations are founded on less than 3 m of overburden composed of structural fill and native soils, Site Class B may be used. Where more than 3 m of overburden is present beneath the footing Site Class C may be used for design.

The soils at this site are not considered liquefiable.

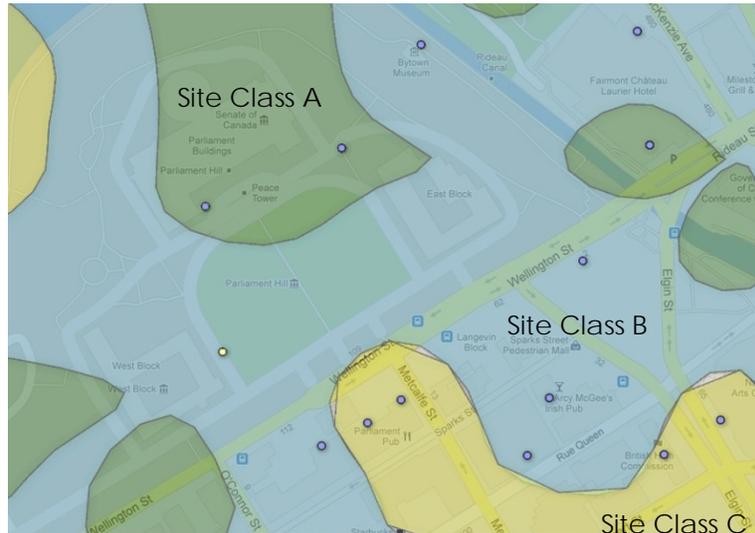


Figure 8.1: Seismic Site Class (from City of Ottawa seismic site classification map from combined geological/geophysical data, published by the Geological Survey of Canada)

8.7.2 Site Period and Elastic Rock Properties

For seismic design purposes, the site period was calculated based on the shear wave measurements carried out by Stantec in 2015. Figure 8.2 summarizes the site period with depth.

The elastic properties of the bedrock are summarized in Table 8.5. For seismic design purposes, the Rock Mass (Seismic) values would apply.

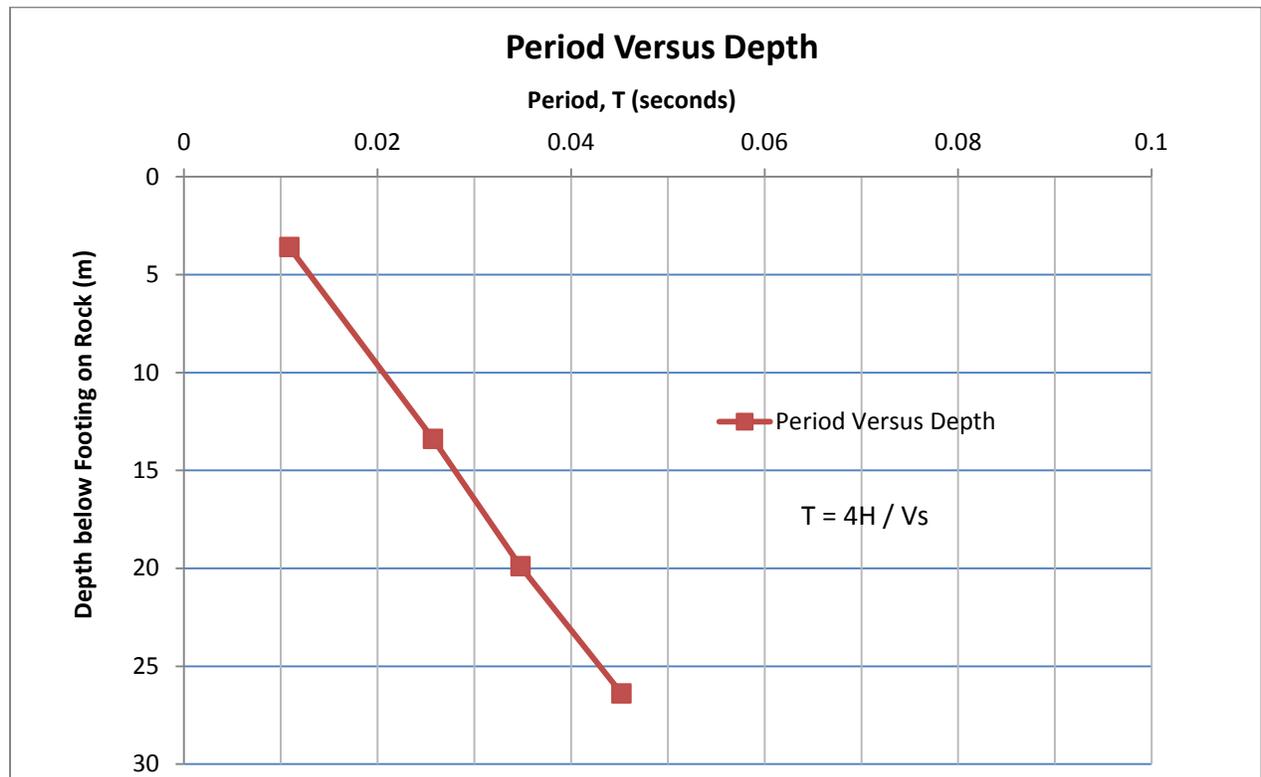


Figure 8.2: Site Period vs. Depth based on results of the Stantec 2015 Seismic Downhole Survey

8.8 SLOPE STABILITY

The area to the north of Centre Block is adjacent a steep slope which may be undergoing creep. Contour lines of the slope show it to have an overall slope of approximately 2H:1V; in several locations, the slope is steeper than 1H:1V (up to 50°). Previous surveys of the slope indicate it to contain remnants of historic and current structures (tunnels, staircases, fences, retaining walls etc.).

It is recommended that a slope stability analysis be performed on this slope once details are known regarding construction equipment loads and placement. Since the actual staging location and loading is unknown, an accurate slope stability analysis could not be performed at this time. However, based on the contours shown on drawings provided by PWGSC, a preliminary global slope stability check was carried out on one cross-section located northeast of the Centre Block building at Section A-A (See Drawing No.3). Section A-A is considered to be within the most critical area due to the grade of the slope itself. Figures 8.3 and 8.4 show the Slope/W outputs for drained and seismic conditions, respectively.

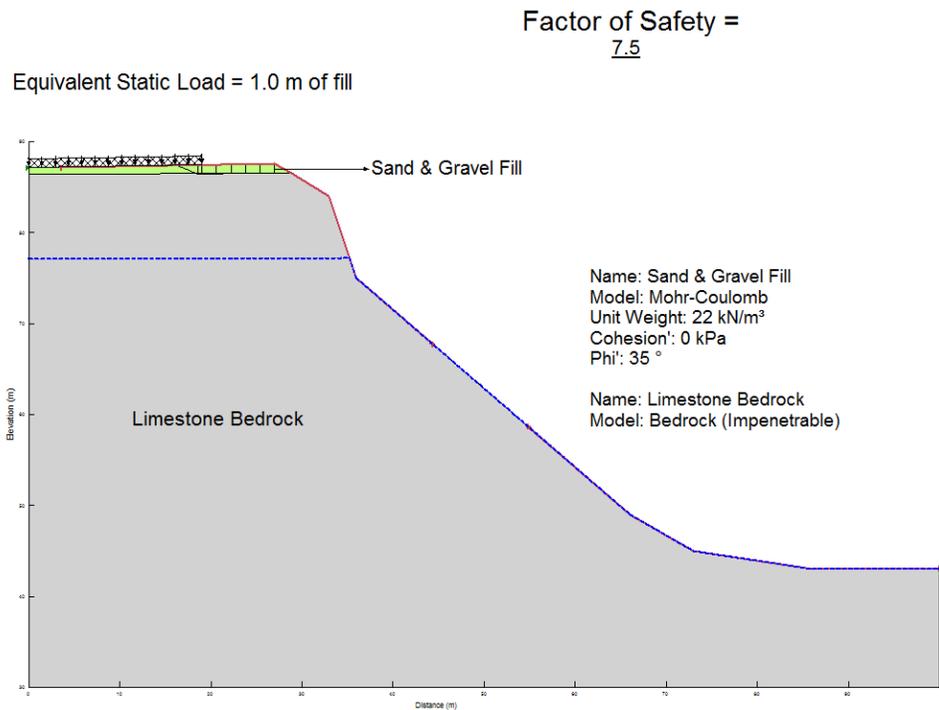


Figure 8.3: Slope/W Global Stability Analysis Output for Drained Conditions

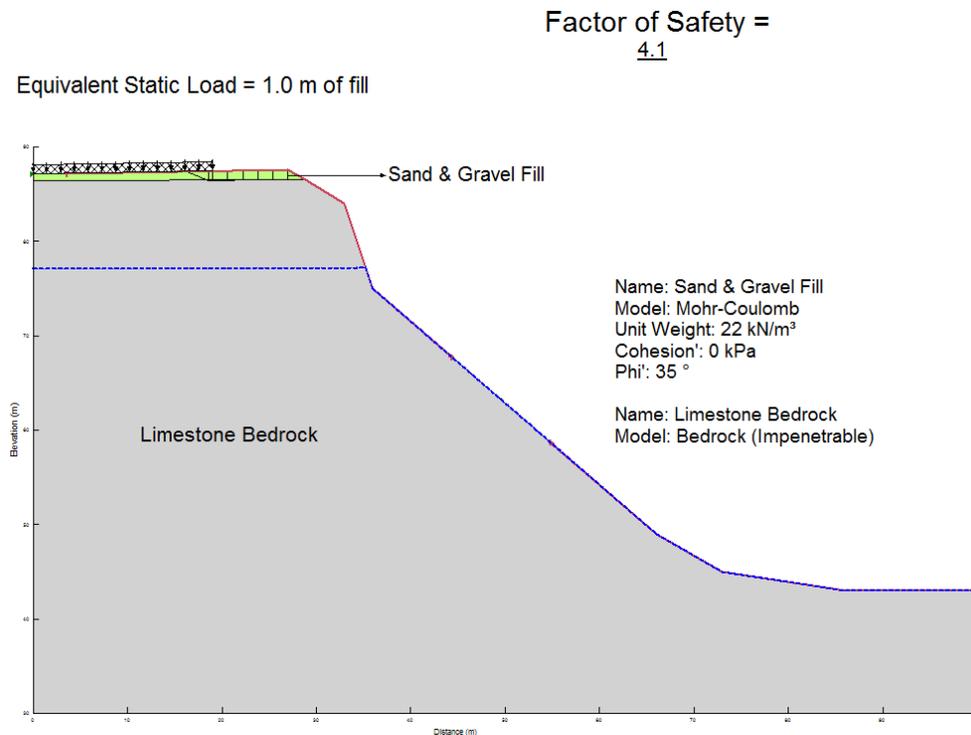


Figure 8.4: Slope/W Global Stability Analysis Output for Seismic Conditions

Slope stability analysis was carried out using the GeoStudio 2012 SLOPE/W computer modeling software. The Morgenstern-Price method as presented in the SLOPE/W software was used for the stability modeling.

The soil conditions on the northeast side of Centre Block generally consist of fill material over bedrock. Table 8.8 provides an idealized soil model for the conditions observed on site, specifically at BH 15-9 (Stantec, 2015) and BH 10-1 (Golder, 2010).

Table 8.8: Soil Parameters

| Soil | Unit Weight (kN/m ³) | Angle of Friction (°) | Effective Cohesion c' (kPa) | Cohesion (kPa) |
|--------------------|----------------------------------|-----------------------|-----------------------------|----------------|
| Sand & Gravel Fill | 22 | 35 | 0 | 0 |

A seismic coefficient of 0.1 g was used in the model to determine the factor of safety under seismic loading.

The phreatic surface (groundwater) was estimated based on our site observations and measurements and was modelled to be at approximately 10 m below the existing ground surface.

An estimated load equivalent to 1.0 m of fill height was also estimated for this preliminary analysis. A factor of safety greater than 4.0 was obtained for both static and seismic analysis which indicates that the slope is stable. This analysis considers only global parameters of the rock mass and does not take into consideration the rock mechanics which accounts for failure mechanisms such as wedge, planar, circular and toppling failure modes.

It is still recommended that this slope stability analysis be re-done once more detailed information on loading and location is known.

8.9 PAVEMENTS

It is anticipated that a temporary roadway may be required for construction and emergency vehicles, should the existing roadway be blocked during construction. In addition, the existing pavement may be affected by the proposed works and may require pavement replacement.

When reinstating pavements affected by utility trench, it is common practice to match existing pavement thicknesses. Jacques Whitford (now Stantec) advanced a number of boreholes through the asphalt to the southeast of the Centre Block, encountering between 30 mm and 180 mm of asphalt, occasionally laid directly over concrete; the asphalt thickness was typically greater than 100 mm. The thickness of the asphalt observed in this investigation was 100 mm and was described as an asphaltic concrete.

The traffic levels for the existing roadway, as well as for any proposed temporary access road, are not known. Traffic has been assumed to consist of light traffic (primarily police cruisers, light delivery vehicles, and Parliament Shuttle Busses) in the case of the existing roadway; it is

GEOTECHNICAL REPORT

April 2015

assumed the same vehicles will use a temporary pavement structure, in addition to construction and emergency vehicles.

The pavement structure presented in Table 8.8 should be used for pavement reinstatement and the temporary roadway.

Table 8.9: Recommended Pavement Design

| Parameter | Pavement Reinstatement | Temporary Roadway |
|-----------------|--------------------------------|--------------------------------|
| Asphalt Surface | 50 mm SP 12.5 | 50 mm SP 12.5 |
| Asphalt Binder | 70 mm SP 19 | 70 mm SP 19 |
| Base | 150 mm OPSS Granular A | 150 mm OPSS Granular A |
| Subbase | 350 mm OPSS Granular B Type II | 350 mm OPSS Granular B Type II |

The following material types are recommended for this project:

- Asphalt performance grade PG 58-34.
- The Superpave mix designs should be in accordance with City of Ottawa S.P. No: F-3106 and should use a Traffic Category of A.
- The compaction of the asphalt layers should follow the City of Ottawa Special Provision No. 3106 and OPSS 310.
- All granular materials should be in accordance with the requirements of City of Ottawa Special Provision F-3147. Both the base and subbase layers should be compacted to 100% SPMDD.
- A tack coat is recommended between asphalt layers and along the edges of any cuts in asphalt.

Proper drainage of the pavement structure must be provided in order to ensure satisfactory performance. The subgrade and granular base/subbase should be graded to ensure positive drainage.

9.0 INSTRUMENTATION AND MONITORING

An instrumentation and monitoring program should be considered to monitor the movement of the existing structure and nearby utilities that are within the influence zone of construction. The program should properly identify the alert criteria and a plan should be put in place to address any movements that may occur.

Instruments should consist of vertical inclinometers, extensometers, inclination sensors, joint meters, vibrating wire piezometers etc. Once the proposed design and construction details have been established, a detailed instrumentation plan should be developed. The consultant undertaking this work should present a detailed instrumentation and monitoring plan.

10.0 REFERENCES

ASTM D7400-07 Standard Test Methods for Downhole Seismic Testing.

ASTM. 2000. Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) (ASTM D2487). ASTM International, West Conshohocken, PA.

ASTM 4.08. Standard D422-63: Standard Test Method for Particle-Size Analysis of Soils.

ASTM 4.08. Standard D1586-99: Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.

ASTM 4.08. Standard D2216-98: Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

ASTM 4.08. Standard D2487-00: Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

Canadian Geotechnical Society. Canadian Foundation Engineering Manual, 4th Edition. Richmond: BiTech Publisher Ltd, 2006.

Chapman, L.J and Putnam, D.F (1984). The Physiography of Southern Ontario (Ontario Geological Survey, Special Volume 2), Third Edition. Ontario, Canada.

Hunt, R.E. (1986). Geotechnical Engineering Techniques and Practices, U.S.A: McGraw-Hill Inc.

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Ministry of Labour. Occupational Health and Safety Act and Regulations for Construction Projects. Toronto, Ontario: Publications Ontario, 2012.

National Resource Council of Canada (2010). National Building Code of Canada (NBC) 2010. NRCC 2010 Ontario, Canada.

Ontario Regulation 332/12 under Building Code Act 1992. Published on e-Laws, 2012.

Thompson, Eric M. (2007). USGS Open File Report 2007-1124, Surface-Source Downhole Seismic Analysis in R.

11.0 CLOSURE

This report has been prepared for the sole benefit of Public Works and Government Services Canada and its agents, and may not be used by any third party without the express written consent of Stantec and the client. Any use which a third party makes of this report is the responsibility of such third party.

We trust the above meets your present requirements. Should you require any further information, please do not hesitate to contact us.

Yours very truly,

STANTEC CONSULTING LTD.

Bridgit Bocage, M.Eng.
Geotechnical Engineering Intern

J.G.A. Raymond Haché, M.Sc., P.Eng.,
Principal and Central Canada Practice Lead
Geotechnical Engineering

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APPENDIX A

Statement of General Conditions

STATEMENT OF GENERAL CONDITIONS

USE OF THIS REPORT: This report has been prepared for the sole benefit of the Client or its agent and may not be used by any third party without the express written consent of Stantec Consulting Ltd. and the Client. Any use which a third party makes of this report is the responsibility of such third party.

BASIS OF THE REPORT: The information, opinions, and/or recommendations made in this report are in accordance with Stantec Consulting Ltd.'s present understanding of the site specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time of the investigation or study. If the proposed site specific project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Stantec Consulting Ltd. is requested by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

STANDARD OF CARE: Preparation of this report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state or province of execution for the specific professional service provided to the Client. No other warranty is made.

INTERPRETATION OF SITE CONDITIONS: Soil, rock, or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Stantec Consulting Ltd. at the time of the work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behavior. Extrapolation of in situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

VARYING OR UNEXPECTED CONDITIONS: Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Stantec Consulting Ltd. must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Stantec Consulting Ltd. will not be responsible to any party for damages incurred as a result of failing to notify Stantec Consulting Ltd. that differing site or subsurface conditions are present upon becoming aware of such conditions.

PLANNING, DESIGN, OR CONSTRUCTION: Development or design plans and specifications should be reviewed by Stantec Consulting Ltd., sufficiently ahead of initiating the next project stage (property acquisition, tender, construction, etc), to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site work relating to the recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Stantec Consulting Ltd. cannot be responsible for site work carried out without being present.

APPENDIX B

Key Plan

Interior Borehole Location Plan

Exterior Borehole Location Plan

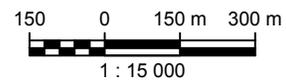
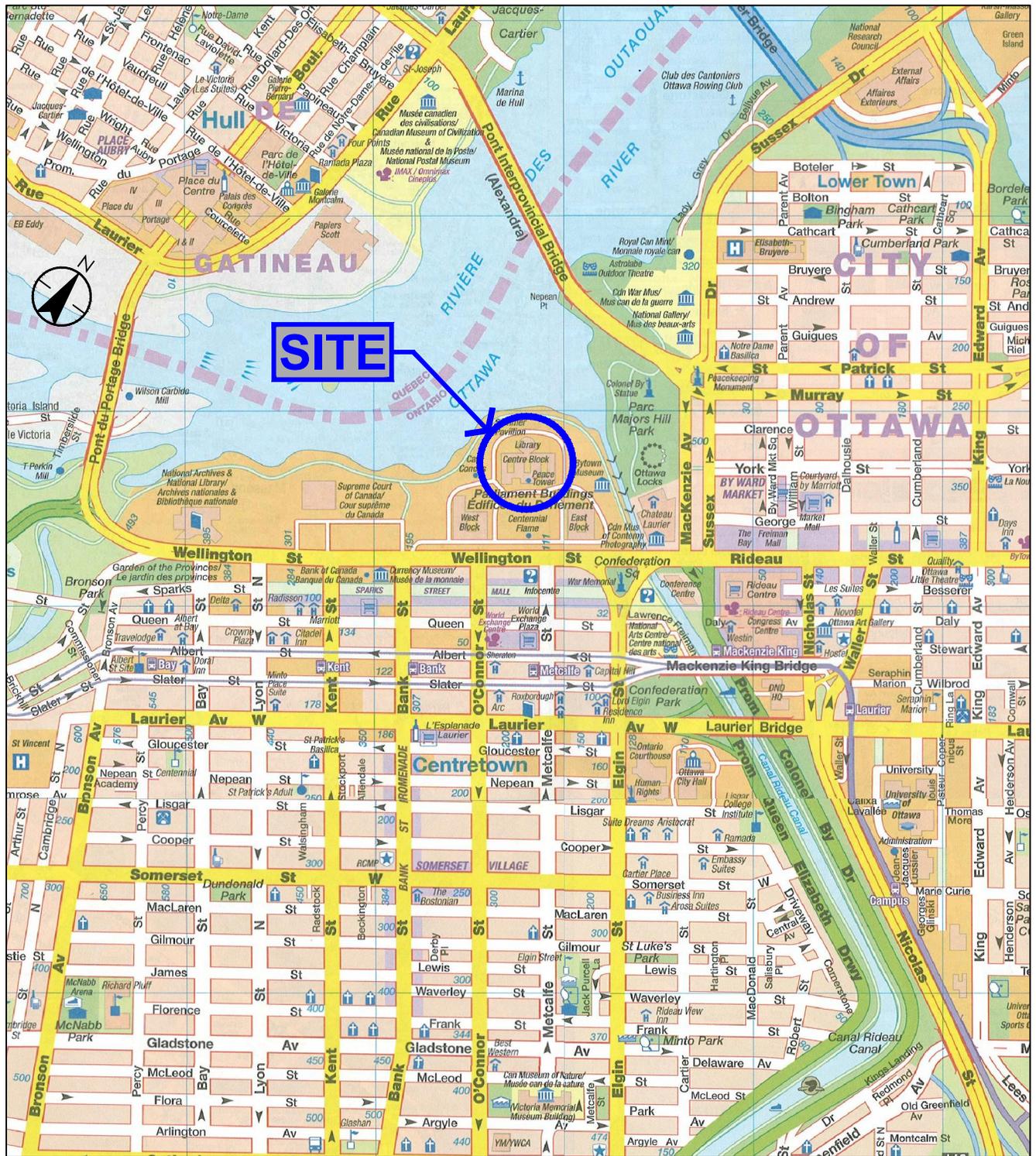
Existing Testhole Location Plan

█ and Underground Infrastructure (Portions of the map not required for the solicitation have been removed)

Seismic Testing Locations

Mapped Faults

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AUGUST 2014
Project No. 12241 1046

Notes

Baseplan from MapArt 2006.

Client/Project

PWGSC

GEOTECHNICAL INVESTIGATION, CENTREBLOCK
111 WELLINGTON ST., OTTAWA, ON

Drawing No.

1

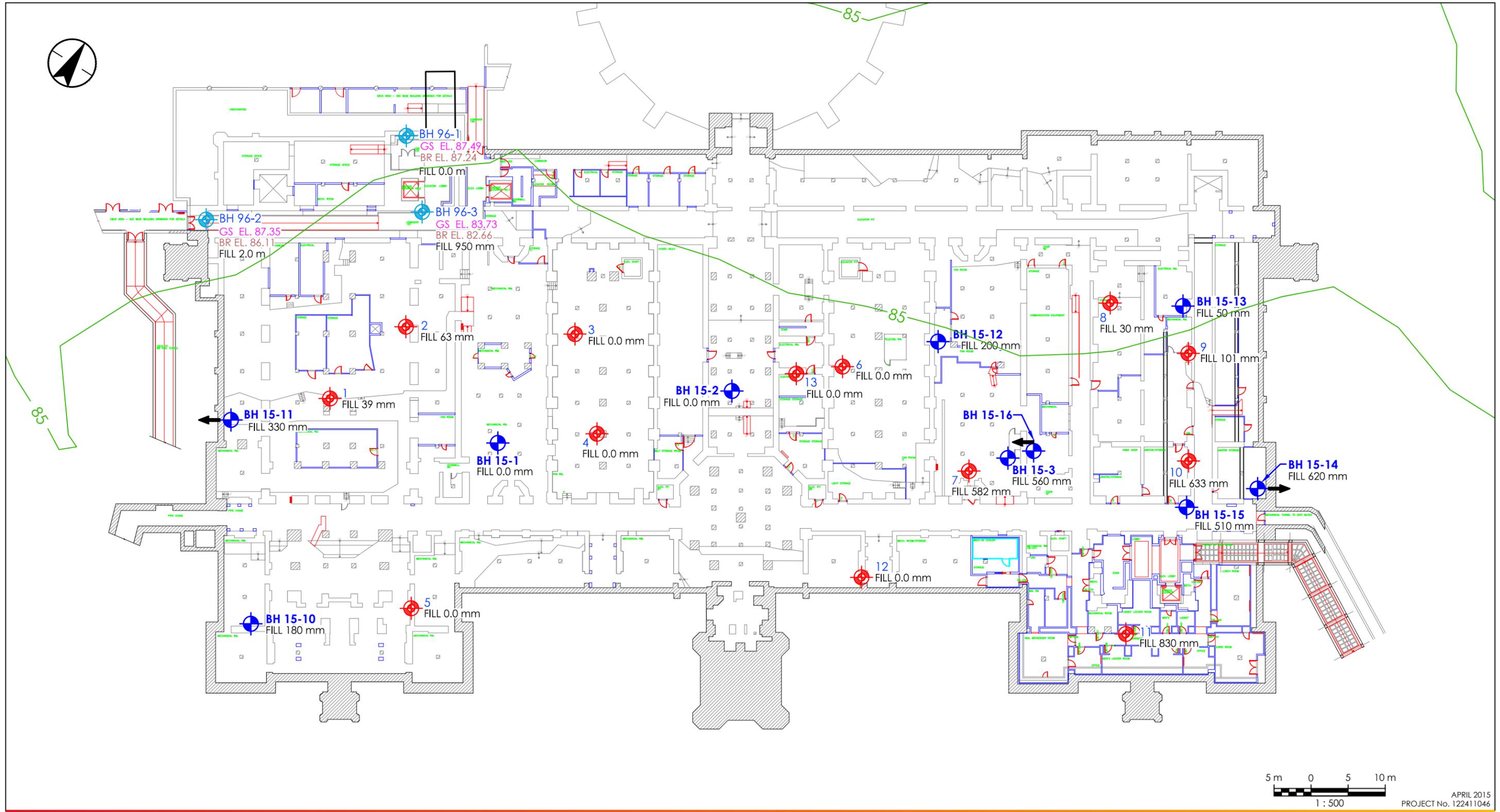
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KEY PLAN



400 - 1331 Clyde Avenue
Ottawa, ON, Canada K2C 3G4
www.stantec.com

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LEGEND

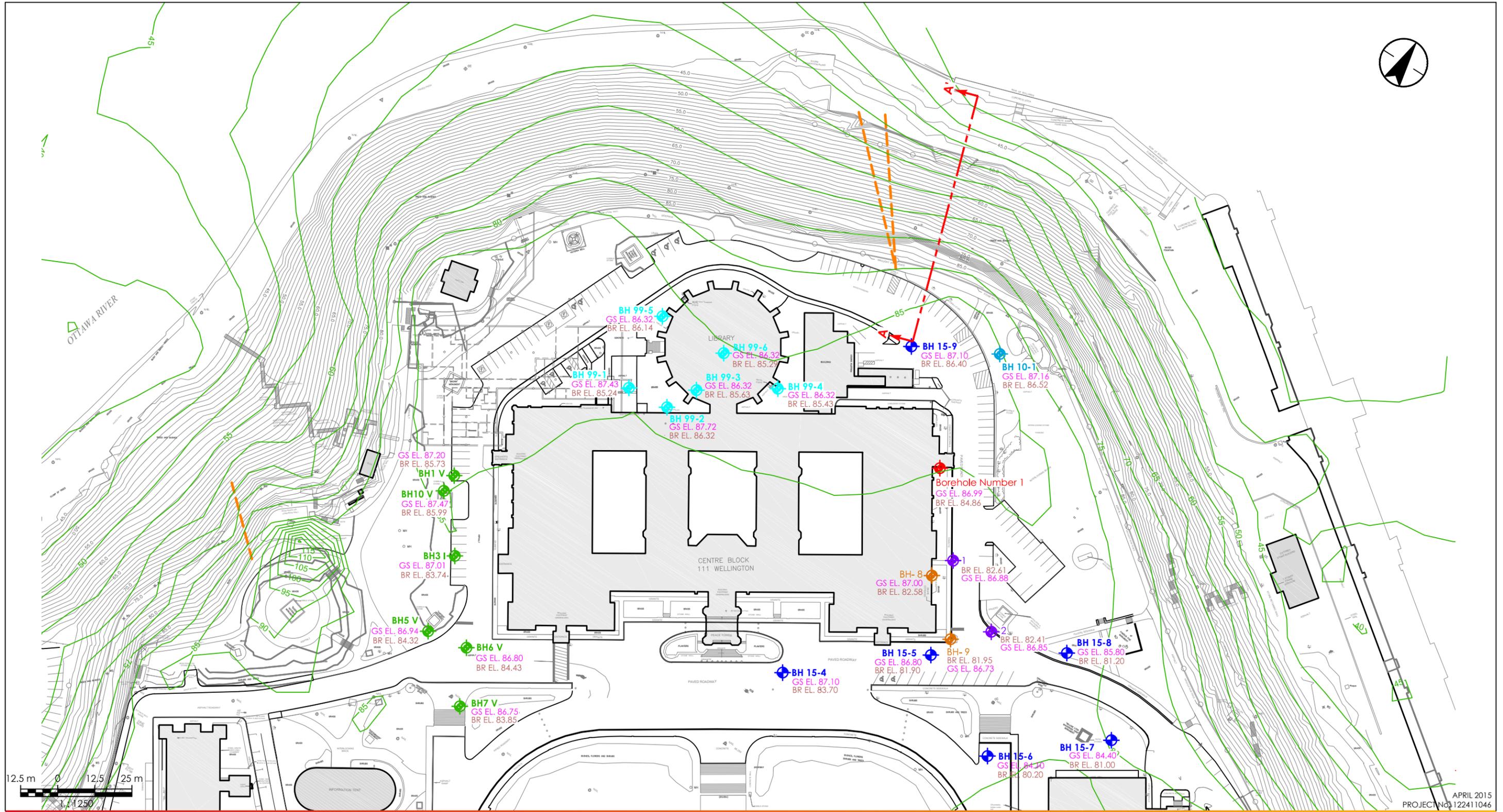
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- BOREHOLE (WILF OHLMANN)
- BOREHOLE (GOLDER, 1996)
- DIRECTION OF INCLINATION
- GS EL. GROUND SURFACE ELEVATION (m)
- BR EL. BEDROCK ELEVATION (m)
- 85 BEDROCK ELEVATION CONTOURS (m)

NOTES

1. COORDINATE SYTEM: NAD 1983 MTM ZONE 9.
2. BASEPLAN PROVIDED BY PWGSC.
3. DIMENSIONS IN METERS UNLESS OTHERWISE NOTED.
4. BACKGROUND DATA INCLUDED IN STANTEC'S 2014 DATA GAP ANALYSIS REPORT.

Client/Project
 PWGSC
 GEOTECHNICAL INVESTIGATION
 CENTREBLOCK, 111 WELLINGTON STREET, OTTAWA, ON
 Drawing No.
 2
 Title
INTERIOR BOREHOLE LOCATION PLAN

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APRIL 2015
 PROJECT NO. 122411046

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 OTTAWA, ON, CANADA K2C 3G4
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| LEGEND | |
|--------|-------------------------------------|
| | BOREHOLE (STANTEC, 2015) |
| | BOREHOLE (EXP, 2013) |
| | BOREHOLE (GOLDER, 2010) |
| | BOREHOLE (GOLDER, 1999) |
| | BOREHOLE (FONDEX, 1989) |
| | BOREHOLE (FONDEX, 1983) |
| | GS EL. GROUND SURFACE ELEVATION (m) |
| | BR EL. BEDROCK ELEVATION (m) |

| | |
|--|-------------------------------|
| | BEDROCK ELEVATION CONTOUR (m) |
| | MAPPED FAULTS |
| | CROSS SECTION LINE A-A' |

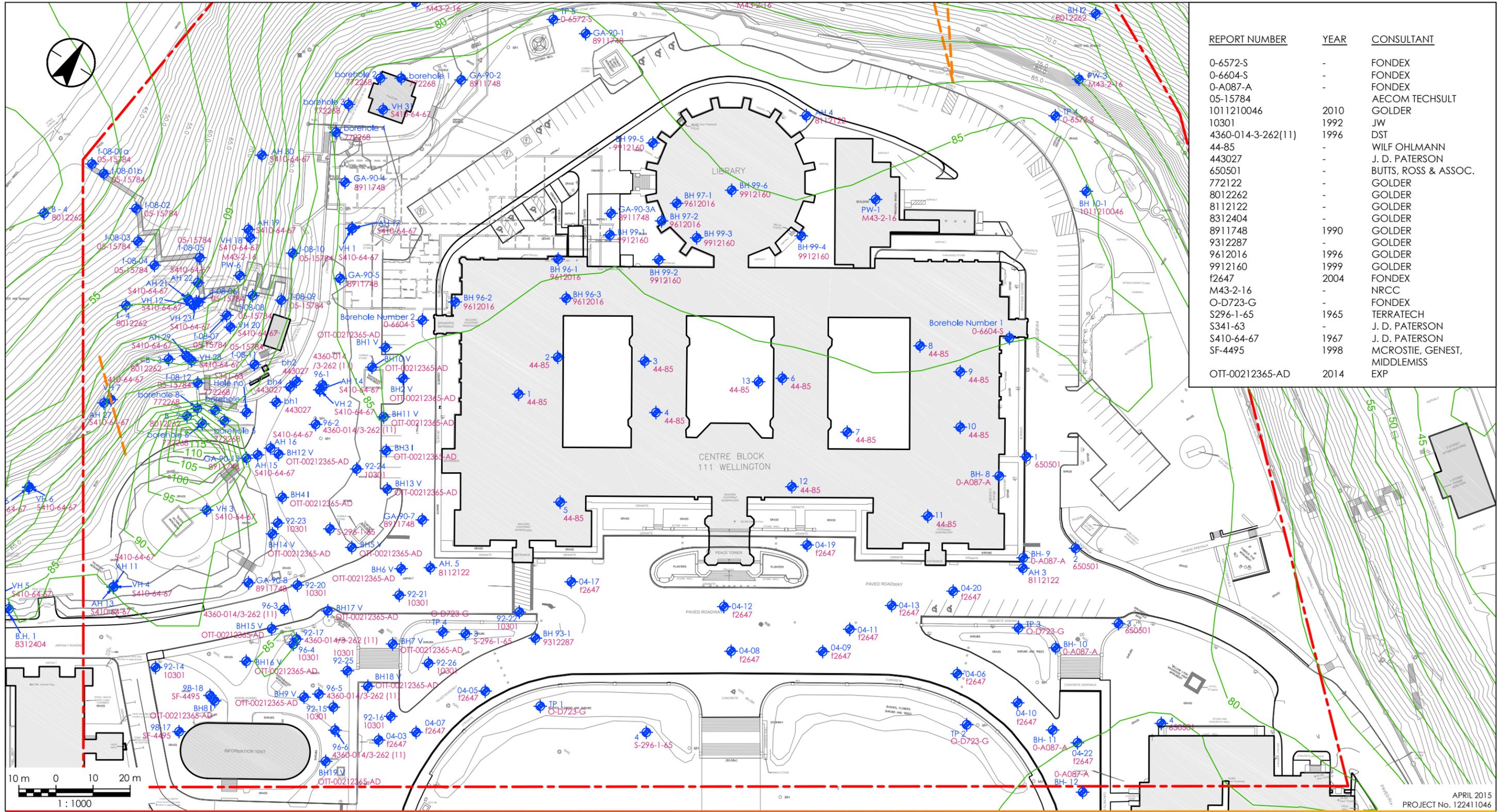
- NOTES**
- COORDINATE SYTEM: NAD 1983 MTM ZONE 9.
 - BASEPLAN PROVIDED BY PWGSC.
 - DIMENSIONS IN METERS UNLESS OTHERWISE NOTED.
 - BACKGROUND DATA INCLUDED IN STANTEC'S 2014 DATA GAP ANALYSIS REPORT.

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 CENTREBLOCK, 111 WELLINGTON STREET, OTTAWA, ON

Drawing No.
 3

Title
EXTERIOR BOREHOLE LOCATION PLAN

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| REPORT NUMBER | YEAR | CONSULTANT |
|--------------------|------|------------------------------|
| 0-6572-S | - | FONDEX |
| 0-6604-S | - | FONDEX |
| 0-A087-A | - | FONDEX |
| 05-15784 | - | AECOM TECHSULT |
| 1011210046 | 2010 | GOLDER |
| 10301 | 1992 | JW |
| 4360-014-3-262(11) | 1996 | DST |
| 44-85 | - | WILF OHLMANN |
| 443027 | - | J. D. PATERSON |
| 650501 | - | BUTTS, ROSS & ASSOC. |
| 772122 | - | GOLDER |
| 8012262 | - | GOLDER |
| 8112122 | - | GOLDER |
| 8312404 | - | GOLDER |
| 8911748 | 1990 | GOLDER |
| 9312287 | - | GOLDER |
| 9612016 | 1996 | GOLDER |
| 9912160 | 1999 | GOLDER |
| f2647 | 2004 | FONDEX |
| M43-2-16 | - | NRCC |
| O-D723-G | - | FONDEX |
| S296-1-65 | 1965 | TERRATECH |
| S341-63 | - | J. D. PATERSON |
| S410-64-67 | 1967 | J. D. PATERSON |
| SF-4495 | 1998 | MCROSTIE, GENEST, MIDDLEMISS |
| OTT-00212365-AD | 2014 | EXP |

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LEGEND

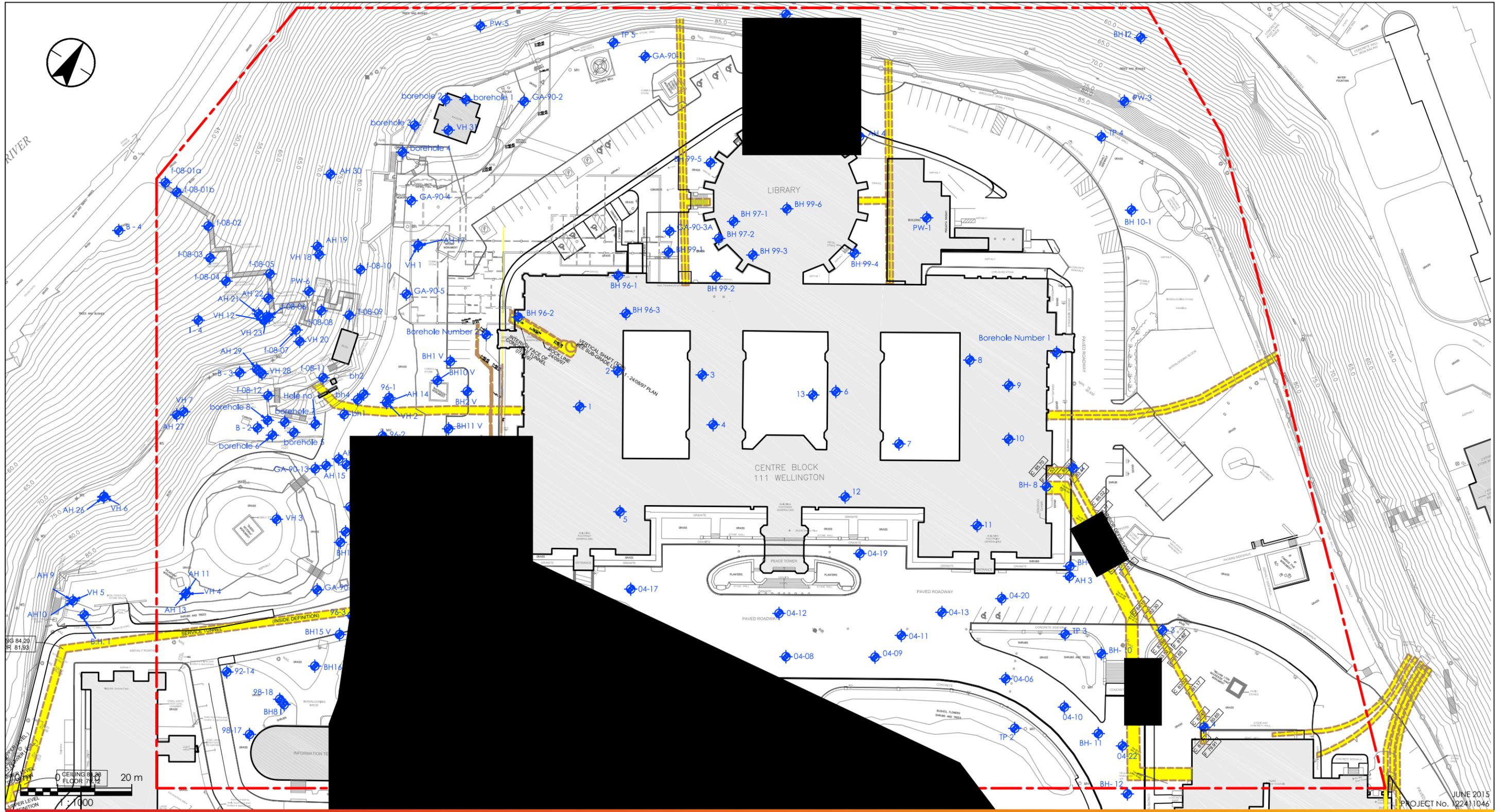
| | |
|--|------------------------------------|
| | AREA OF INTEREST |
| | TEST HOLE NUMBER |
| | REPORT REFERENCE (SEE SECTION 8.0) |
| | BEDROCK ELEVATION CONTOUR (m) |
| | MAPPED FAULTS |

NOTES

- COORDINATE SYTEM: NAD 1983 MTM ZONE 9.
- BASEPLAN PROVIDED BY PWGSC.
- BOREHOLE LOGS PROVIDED IN STANTEC 2014 DATA GAP ANALYSIS REPORT.

Client/Project
 PWGSC
 GEOTECHNICAL INVESTIGATION
 CENTREBLOCK, 111 WELLINGTON ST., OTTAWA, ON
 Drawing No.
4
 Title
EXISTING TEST HOLE LOCATION PLAN

T:\Autocad\Drawings\Project Drawings\2015\122411046\Centreblock\122411046_Extorior_En&Fr_Blacked Out.dwg
 2015/06/26 1:44 PM By: Briones, Glicerio



JUNE 2015
 PROJECT No. 122411046

Stantec
 400 - 1331 CLYDE AVENUE
 OTTAWA, ON, CANADA K2C 3G4
 www.stantec.com

LEGEND

| | |
|---|----------------------|
|  | AREA OF INTEREST |
|  | TEST HOLE AND NUMBER |
|  | TUNNEL |

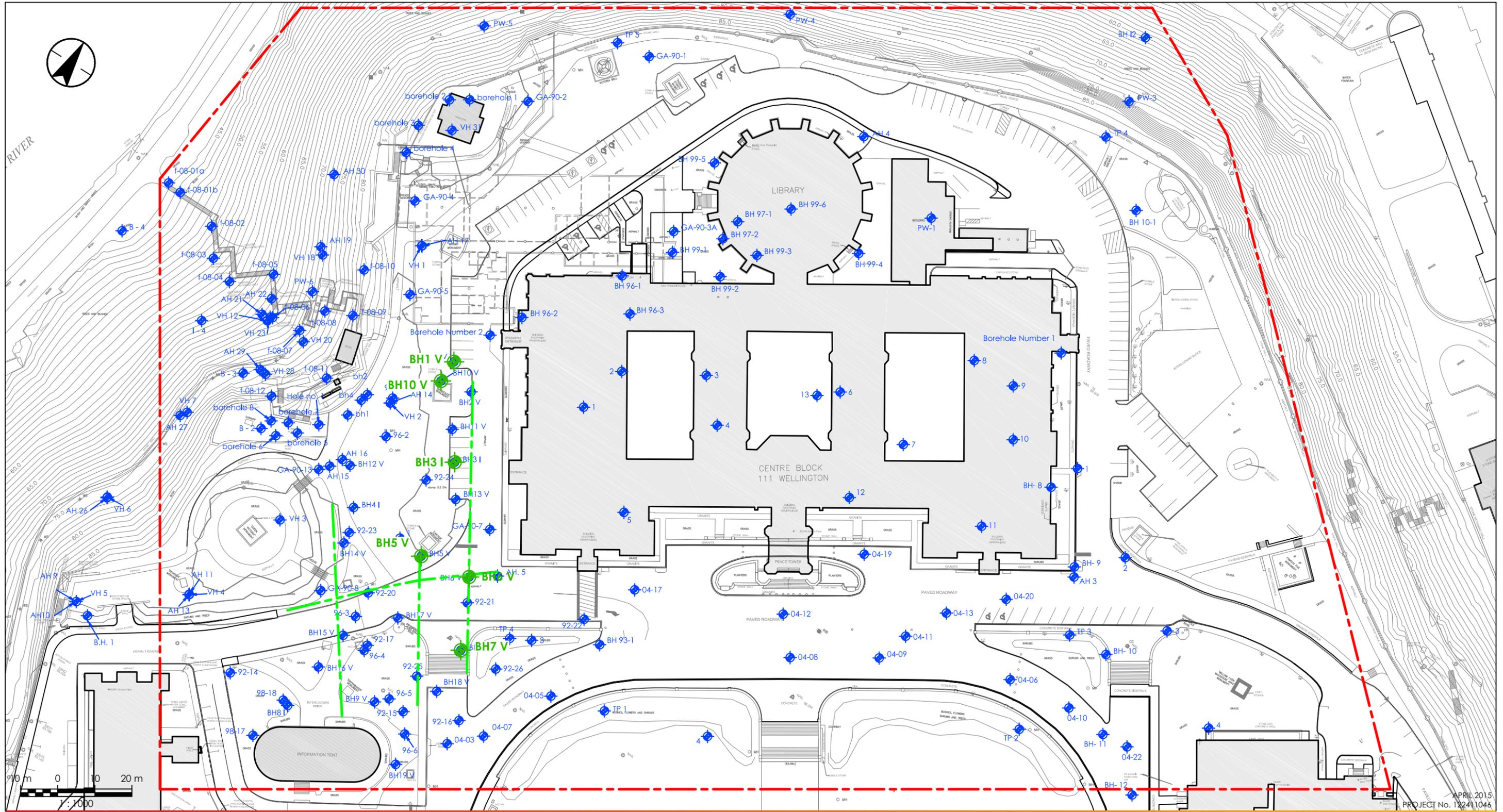
- NOTES**
1. COORDINATE SYTEM: NAD 1983 MTM ZONE 9.
 2. BASEPLAN PROVIDED BY PWGSC.
 3. BACKGROUND DATA INCLUDED IN STANTEC'S 2014 DATA GAP ANALYSIS REPORT.

Client/Project
 PWGSC
 GEOTECHNICAL INVESTIGATION
 CENTREBLOCK, 111 WELLINGTON ST., OTTAWA, ON

Drawing No.
 5

Title
**AND UNDERGROUND
 INFURSTRUCTURE**

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 2015/04/20 2:02 PM By: Briones, Glicerio



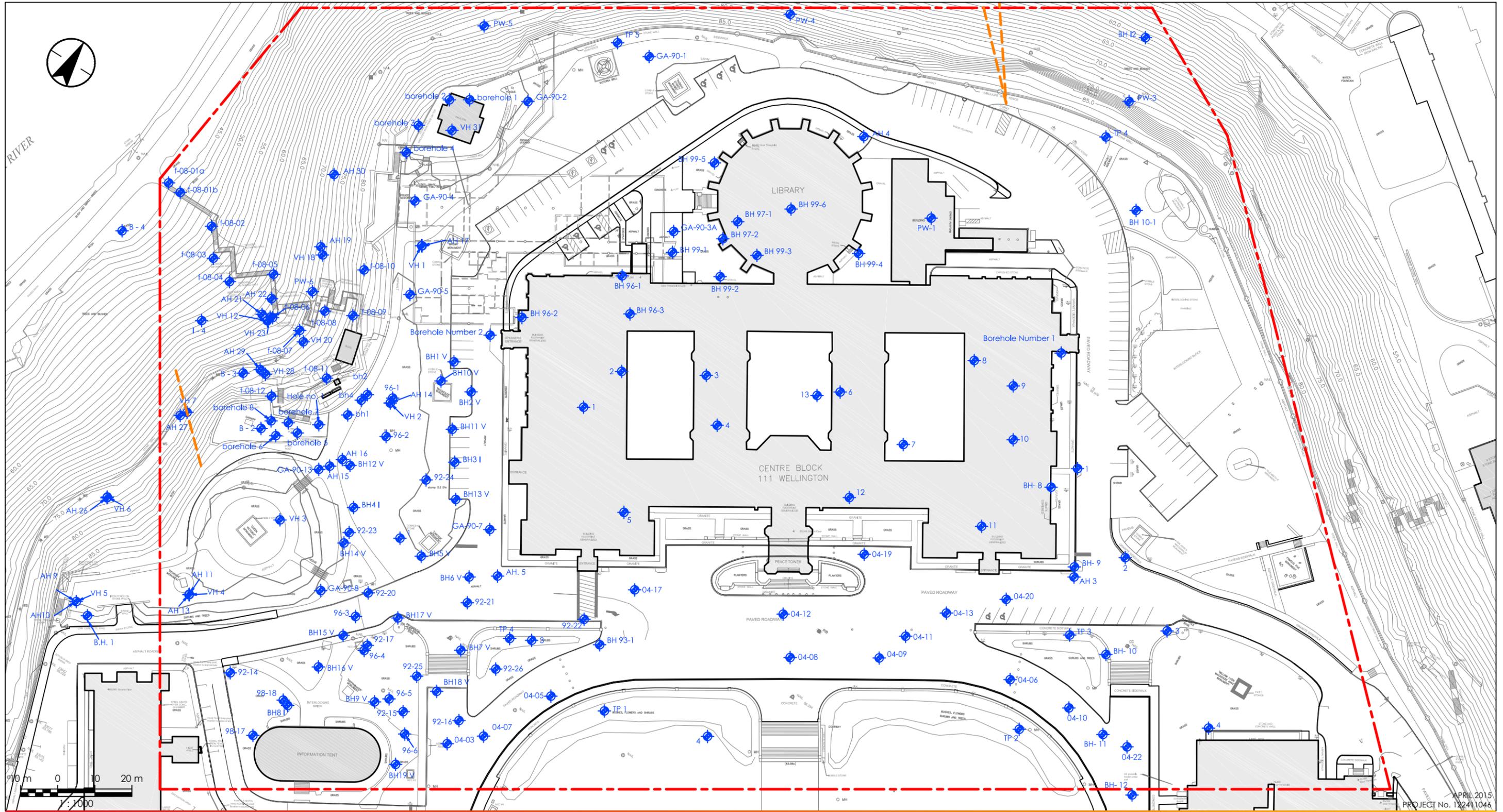
LEGEND

| | |
|--|--------------------------|
| | AREA OF INTEREST |
| | TEST HOLE AND NUMBER |
| | SEISMIC PROFILE LOCATION |

- NOTES**
1. COORDINATE SYTEM: NAD 1983 MTM ZONE 9.
 2. BASEPLAN PROVIDED BY PWGSC.
 3. BACKGROUND DATA INCLUDED IN STANTEC'S 2014 DATA GAP ANALYSIS REPORT.
 4. SEISMIC PROFILE LOCATION FROM EXP REPORT OTT-00212365-AD, DATED APRIL 2014.

Client/Project
 PWGSC
 GEOTECHNICAL INVESTIGATION
 CENTREBLOCK, 111 WELLINGTON ST., OTTAWA, ON
 Drawing No.
 6
 Title
SEISMIC TESTING LOCATIONS

T:\Autocad\Drawings\Project Drawings\2015\122411046\Centreblock\122411046_Exterior.dwg
 2015/04/20 2:02 PM By: Briones, Glicerio



| LEGEND | |
|--------|----------------------|
| | AREA OF INTEREST |
| | TEST HOLE AND NUMBER |
| | MAPPED FAULTS |

NOTES

1. COORDINATE SYTEM: NAD 1983 MTM ZONE 9.
2. BASEPLAN PROVIDED BY PWGSC.
3. BACKGROUND DATA INCLUDED IN STANTEC'S 2014 DATA GAP ANALYSIS REPORT.
4. SEISMIC PROFILE LOCATION FROM EXP REPORT OTT-00212365-AD, DATED APRIL 2014.

| | |
|----------------|--|
| Client/Project | PWGSC GEOTECHNICAL INVESTIGATION CENTREBLOCK, 111 WELLINGTON ST., OTTAWA, ON |
| Drawing No. | 7 |
| Title | MAPPED FAULTS |

APPENDIX C

Symbols and Terms Used on Borehole Records

Stantec January 2015 Borehole Records

Relevant Butts, Ross & Associates, exp & Golder Borehole Records

Bedrock Core Logs

Bedrock Core Photographs

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

| | |
|----------------|---|
| <i>Topsoil</i> | - mixture of soil and humus capable of supporting vegetative growth |
| <i>Peat</i> | - mixture of visible and invisible fragments of decayed organic matter |
| <i>Till</i> | - unstratified glacial deposit which may range from clay to boulders |
| <i>Fill</i> | - material below the surface identified as placed by humans (excluding buried services) |

Terminology describing soil structure:

| | |
|-------------------|--|
| <i>Desiccated</i> | - having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc. |
| <i>Fissured</i> | - having cracks, and hence a blocky structure |
| <i>Varved</i> | - composed of regular alternating layers of silt and clay |
| <i>Stratified</i> | - composed of alternating successions of different soil types, e.g. silt and sand |
| <i>Layer</i> | - > 75 mm in thickness |
| <i>Seam</i> | - 2 mm to 75 mm in thickness |
| <i>Parting</i> | - < 2 mm in thickness |

Terminology describing soil types:

The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488). The classification excludes particles larger than 76 mm (3 inches). The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):

Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present:

| | |
|-----------------------------|---------------|
| <i>Trace, or occasional</i> | Less than 10% |
| <i>Some</i> | 10-20% |
| <i>Frequent</i> | > 20% |

Terminology describing compactness of cohesionless soils:

The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test N-Value (also known as N-Index). A relationship between compactness condition and N-Value is shown in the following table.

| Compactness Condition | SPT N-Value |
|-----------------------|-------------|
| <i>Very Loose</i> | <4 |
| <i>Loose</i> | 4-10 |
| <i>Compact</i> | 10-30 |
| <i>Dense</i> | 30-50 |
| <i>Very Dense</i> | >50 |

Terminology describing consistency of cohesive soils:

The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests.

| Consistency | Undrained Shear Strength | |
|-------------------|--------------------------|-----------|
| | kips/sq.ft. | kPa |
| <i>Very Soft</i> | <0.25 | <12.5 |
| <i>Soft</i> | 0.25 - 0.5 | 12.5 - 25 |
| <i>Firm</i> | 0.5 - 1.0 | 25 - 50 |
| <i>Stiff</i> | 1.0 - 2.0 | 50 - 100 |
| <i>Very Stiff</i> | 2.0 - 4.0 | 100 - 200 |
| <i>Hard</i> | >4.0 | >200 |

ROCK DESCRIPTION

Terminology describing rock quality:

| RQD | Rock Mass Quality |
|--------|-------------------|
| 0-25 | <i>Very Poor</i> |
| 25-50 | <i>Poor</i> |
| 50-75 | <i>Fair</i> |
| 75-90 | <i>Good</i> |
| 90-100 | <i>Excellent</i> |

Rock quality classification is based on a modified core recovery percentage (RQD) in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be due to close shearing, jointing, faulting, or weathering in the rock mass and are not counted. RQD was originally intended to be done on NW core; however, it can be used on different core sizes if the bulk of the fractures caused by drilling stresses are easily distinguishable from *in situ* fractures. The terminology describing rock mass quality based on RQD is subjective and is underlain by the presumption that sound strong rock is of higher engineering value than fractured weak rock.

Terminology describing rock mass:

| Spacing (mm) | Joint Classification | Bedding, Laminations, Bands |
|--------------|------------------------|-----------------------------|
| > 6000 | <i>Extremely Wide</i> | - |
| 2000-6000 | <i>Very Wide</i> | <i>Very Thick</i> |
| 600-2000 | <i>Wide</i> | <i>Thick</i> |
| 200-600 | <i>Moderate</i> | <i>Medium</i> |
| 60-200 | <i>Close</i> | <i>Thin</i> |
| 20-60 | <i>Very Close</i> | <i>Very Thin</i> |
| <20 | <i>Extremely Close</i> | <i>Laminated</i> |
| <6 | - | <i>Thinly Laminated</i> |

Terminology describing rock strength:

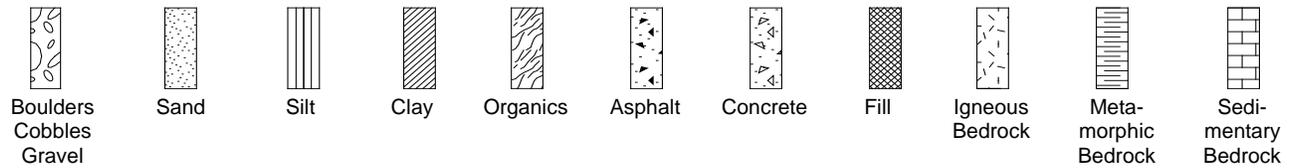
| Strength Classification | Unconfined Compressive Strength (MPa) |
|-------------------------|---------------------------------------|
| <i>Extremely Weak</i> | < 1 |
| <i>Very Weak</i> | 1 – 5 |
| <i>Weak</i> | 5 – 25 |
| <i>Medium Strong</i> | 25 – 50 |
| <i>Strong</i> | 50 – 100 |
| <i>Very Strong</i> | 100 – 250 |
| <i>Extremely Strong</i> | > 250 |

Terminology describing rock weathering:

| Term | Description |
|-----------------------------|--|
| <i>Fresh</i> | No visible signs of rock weathering. Slight discolouration along major discontinuities |
| <i>Slightly Weathered</i> | Discolouration indicates weathering of rock on discontinuity surfaces. All the rock material may be discoloured. |
| <i>Moderately Weathered</i> | Less than half the rock is decomposed and/or disintegrated into soil. |
| <i>Highly Weathered</i> | More than half the rock is decomposed and/or disintegrated into soil. |
| <i>Completely Weathered</i> | All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact. |

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders
Cobbles
Gravel

Sand

Silt

Clay

Organics

Asphalt

Concrete

Fill

Igneous
Bedrock

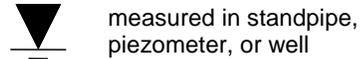
Meta-
morphic
Bedrock

Sedi-
mentary
Bedrock

SAMPLE TYPE

| | |
|------------------|---|
| SS | Split spoon sample (obtained by performing the Standard Penetration Test) |
| ST | Shelby tube or thin wall tube |
| DP | Direct-Push sample (small diameter tube sampler hydraulically advanced) |
| PS | Piston sample |
| BS | Bulk sample |
| WS | Wash sample |
| HQ, NQ, BQ, etc. | Rock core samples obtained with the use of standard size diamond coring bits. |

WATER LEVEL MEASUREMENT



measured in standpipe, piezometer, or well



inferred

RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

N-VALUE

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (64 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (305 mm) into the soil. For split spoon samples where insufficient penetration was achieved and N-values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N value corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to A size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (305 mm) into the soil. The DCPT is used as a probe to assess soil variability.

OTHER TESTS

| | |
|----------|--|
| S | Sieve analysis |
| H | Hydrometer analysis |
| k | Laboratory permeability |
| γ | Unit weight |
| G_s | Specific gravity of soil particles |
| CD | Consolidated drained triaxial |
| CU | Consolidated undrained triaxial with pore pressure measurements |
| UU | Unconsolidated undrained triaxial |
| DS | Direct Shear |
| C | Consolidation |
| Q_u | Unconfined compression |
| I_p | Point Load Index (I_p on Borehole Record equals $I_p(50)$ in which the index is corrected to a reference diameter of 50 mm) |

| | |
|--|---|
| | Single packer permeability test; test interval from depth shown to bottom of borehole |
| | Double packer permeability test; test interval as indicated |
| | Falling head permeability test using casing |
| | Falling head permeability test using well point or piezometer |

CLIENT Public Works and Government Services Canada BOREHOLE No. BH 15-2
 LOCATION Public Works and Government Services Canada PROJECT No. 122411046
 DATES: BORING January 6-12, 2015 WATER LEVEL 15 January 2015 DATUM Geodetic

| DEPTH (m) | ELEVATION (m) | SOIL DESCRIPTION | STRATA PLOT | WATER LEVEL | SAMPLES | | | | UNDRAINED SHEAR STRENGTH - kPa | | | | | | | | | |
|-----------|---------------|-------------------------------|-------------|-------------|---------|--------|---------------|----------------|--|----|----|----|----|----|----|----|----|--|
| | | | | | TYPE | NUMBER | RECOVERY (mm) | N-VALUE OR ROD | WATER CONTENT & ATTERBERG LIMITS | | | | | | | | | |
| | | | | | | | | | 50 100 150 200 W _p W W _L * DYNAMIC PENETRATION TEST, BLOWS/0.3m STANDARD PENETRATION TEST, BLOWS/0.3m ● | | | | | | | | | |
| | | | | | | | | | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | |
| 0 | | 660 mm CONCRETE | | | | | | | | | | | | | | | | |
| 1 | | Continued on Core Boring Log. | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | | |

Inferred Groundwater Level
 Groundwater Level Measured in Standpipe

Field Vane Test, kPa
 Remoulded Vane Test, kPa App'd RH
 Pocket Penetrometer Test, kPa Date _____

CLIENT Public Works and Government Services Canada

 BOREHOLE No. BH 15-2

 LOCATION Centre Block, Parliament Hill, Ottawa, ON

 PROJECT No. 122411046

 DATES: BORING January 6-12, 2015

 WATER LEVEL 15 January 2015

 DATUM Geodetic

| DEPTH (m) | ELEVATION (m) | LITHOLOGICAL DESCRIPTION | STRATA PLOT | WATER LEVEL | DISCONTINUITY DATA | | | | | | | | | | Q ^c -VALUE* (*J _w =1 & SRF=1) | OTHER TESTS | |
|-----------|---------------|--|-------------|-------------|--------------------|--------------|----------------|------------|----------------------------------|-----------------------------|--------------------------|--------------------------|------------------------------|---|--|-------------|----|
| | | | | | SAMPLE TYPE & NO. | TOTAL CORE % | SOLID CORE (%) | R.Q.D. (%) | FRACTURE FREQUENCY (Fractures/m) | ROCK STRENGTH INDEX (RO-R6) | WEATHERING INDEX (WI-W6) | DIP w.r.t. CORE AXIS (°) | DISCONTINUITY DATA | | | | |
| | | | | | | | | | | | | | TYPE AND SURFACE DESCRIPTION | | | | |
| 0 | | Continued from Overburden Boring Log | | | | | | | | | | | | | | | |
| 0.5 | | Limestone BEDROCK (Verulam Formation) - very poor to good rock quality - grey colour - slightly weathered to unweathered joint surfaces - very close to close joint spacing (Refer to Field Bedrock Core Log) | | | | NQ 1 | 98 | 80 | 52 | | | W1 | 2 | 1 | 0.75 | | 35 |
| 1.5 | | | | | | NQ 2 | 100 | 87 | 63 | | | W1 | 2 | 1 | 0.75 | | 42 |
| 2.5 | | | | | | NQ 3 | 95 | 97 | 84 | | | W1 | 2 | 1 | 0.75 | | 56 |
| 3.5 | | | | | | NQ 4 | 99 | 94 | 53 | | | W1 | 2 | 1 | 0.75 | | 35 |
| 4.5 | | | | | | NQ 5 | 100 | 92 | 73 | | | W1 | 2 | 2 | 0.75 | | 97 |
| 5.5 | | | | | | NQ 6 | 98 | 92 | 87 | | R5 | W1 | 2 | 1 | 0.75 | | 58 |
| 6.5 | | | | | | NQ 7 | 100 | 42 | 15 | | | W1 | 4 | 1 | 0.75 | | 5 |
| 7.5 | | | | | | NQ 8 | 94 | 95 | 75 | | | W1 | 2 | 1 | 0.75 | | 50 |
| 8.5 | | | | | | NQ 9 | 100 | 87 | 52 | | | W1 | 2 | 1 | 0.75 | | 35 |
| 9.5 | | | | | | NQ 10 | 93 | 85 | 60 | | | W1 | 2 | 1 | 0.75 | | 40 |

UCS = 170 MPa

Inferred Groundwater Level
 Groundwater Level Measured in Standpipe

App'd RH
 Date _____

STN13-STAN-GEO-BEDROCK-Q 122411046 PARLIAMENT HILL CENTRE BLOCK-REV.GPJ 122411046 PARLIAMENT HILL CENTRE BLOCK.GPJ 22/4/15

CLIENT Public Works and Government Services Canada

 BOREHOLE No. BH 15-3

 LOCATION Centre Block, Parliament Hill, Ottawa, ON

 PROJECT No. 122411046

 DATES: BORING 12 January 2015

 WATER LEVEL 16 January 2015

 DATUM Geodetic

| DEPTH (m) | ELEVATION (m) | LITHOLOGICAL DESCRIPTION | STRATA PLOT | WATER LEVEL | DISCONTINUITY DATA | | | | | | | | | | Q-VALUE* (*Jw=1 & SRF=1) | OTHER TESTS | | | |
|-----------|---------------|--|-------------|-------------|--------------------|-------------------|--------------|----------------|------------|------------------------------------|-----------------------------|--------------------------|--------------------------|----|-----------------------------|-------------|----|----|------------------------------|
| | | | | | DISCONTINUITY | SAMPLE TYPE & NO. | TOTAL CORE % | SOLID CORE (%) | R.Q.D. (%) | 5 FRACTURE FREQUENCY (Fractures/m) | ROCK STRENGTH INDEX (R0-R6) | WEATHERING INDEX (W1-W6) | DIP w.r.t. CORE AXIS (°) | J1 | | | J2 | J3 | TYPE AND SURFACE DESCRIPTION |
| 0 | | Continued from Overburden Boring Log | | | | | | | | | | | | | | | | | |
| 0.5 | | Limestone BEDROCK (Verulam Formation) - very poor to excellent rock quality - grey colour - moderately weathered to unweathered joint surfaces - very close to moderate joint spacing (Refer to Field Bedrock Core Log) | | | | NQ 3 | 94 | 0 | 36 | | | | | | | | | 24 | |
| 1.0 | | | | | | NQ 4 | 96 | 59 | 58 | | | | | | | | | 39 | |
| 2.0 | | | | | | NQ 5 | 96 | 94 | 62 | | | | | | | | | 41 | |
| 4.0 | | | | | | NQ 6 | 100 | 88 | 100 | | R5 | W1 | | | | | | 67 | UCS = 125 MPa |
| 6.0 | | | | | | NQ 7 | 100 | 81 | 85 | | | W1 | | | | | | 57 | |
| 8.0 | | | | | | NQ 8 | 100 | 94 | 83 | | | W1 | | | | | | 55 | |

Inferred Groundwater Level
 Groundwater Level Measured in Standpipe

App'd RH
 Date _____

CLIENT Public Works and Government Services Canada BOREHOLE No. BH 15-4
 LOCATION Centre Block, Parliament Hill, Ottawa, ON PROJECT No. 122411046
 DATES: BORING January 10, 11, 17 & 18, 2015 WATER LEVEL 19 January 2015 DATUM Geodetic

| DEPTH (m) | ELEVATION (m) | LITHOLOGICAL DESCRIPTION | STRATA PLOT | WATER LEVEL | DISCONTINUITY DATA | | | | | | | | | | Q-VALUE* (*Jw=1 & SRF=1) | OTHER TESTS | |
|-----------|---------------|--|-------------|-------------|--------------------|--------------|----------------|------------|------------------------------------|-----------------------------|--------------------------|--------------------------|----|------|-----------------------------|-------------|---------------|
| | | | | | SAMPLE TYPE & NO. | TOTAL CORE % | SOLID CORE (%) | R.Q.D. (%) | 5 FRACTURE FREQUENCY (Fractures/m) | ROCK STRENGTH INDEX (R0-R6) | WEATHERING INDEX (W1-W6) | DIP w.r.t. CORE AXIS (°) | J1 | J2 | | | J3 |
| 20 | | Limestone BEDROCK (Verulam Formation) - very poor to excellent rock quality - grey colour - moderately weathered to unweathered joint surfaces - very close to moderate joint spacing (Refer to Field Bedrock Core Log) | | | HQ 19 | 100 | 88 | 70 | | | W1 | 2 | 3 | 8 | FOL | 13 | |
| 21 | | | | | HQ 20 | 100 | 83 | 74 | | | W1 | 2 | 3 | 0.75 | FOL | 148 | |
| 22 | | | | | HQ 21 | 100 | 82 | 79 | | R5 | W1 | 2 | 3 | 0.75 | FOL | 158 | UCS = 120 MPa |
| 23 | | | | | HQ 22 | 97 | 87 | 74 | | | W1 | 2 | 2 | 0.75 | FOL | 99 | |
| 24 | | | | | HQ 23 | 99 | 90 | 86 | | | W1 | 2 | 2 | 0.75 | FOL | 115 | |
| 25 | | | | | HQ 24 | 100 | 90 | 94 | | R5 | W1 | 2 | 2 | 0.75 | FOL | 125 | UCS = 125 MPa |
| 26 | | | | | | | | | | | | | | | | | |
| 27 | | | | | | | | | | | | | | | | | |
| 28 | | | | | | | | | | | | | | | | | |
| 29 | | | | | | HQ 25 | 97 | 93 | 86 | | R4 | W1 | 2 | 2 | 0.75 | FOL | 115 |
| 30 | 57.1 | | | | | | | | | | | | | | | | |

Inferred Groundwater Level
 Groundwater Level Measured in Standpipe

App'd RH
 Date _____

STN13-STAN-GEO-BEDROCK-Q 122411046 PARLIAMENT HILL CENTRE BLOCK-REV.GPJ 122411046 PARLIAMENT HILL CENTRE BLOCK.GPJ 22/4/15

CLIENT Public Works and Government Services Canada BOREHOLE No. BH 15-4
 LOCATION Centre Block, Parliament Hill, Ottawa, ON PROJECT No. 122411046
 DATES: BORING January 10, 11, 17 & 18, 2015 WATER LEVEL 19 January 2015 DATUM Geodetic

| DEPTH (m) | ELEVATION (m) | LITHOLOGICAL DESCRIPTION | STRATA PLOT | WATER LEVEL | DISCONTINUITY DATA | | | | | | | | | | Q-VALUE* (*Jw=1 & SRF=1) | OTHER TESTS | | | | | | | | | | | | |
|-----------|---------------|--|-------------|-------------|--------------------|-------------------|----------------|----------------|----------------|----------------------------------|-----------------------------|--------------------------|--------------------------------|-------------|-----------------------------|-----------------|------------------------------|-------------|-----------------------|------------------------|-------------|--|--|--|--|-----|--------------|---------------|
| | | | | | DISCONTINUITY | SAMPLE TYPE & NO. | TOTAL CORE % | SOLID CORE (%) | R.Q.D. (%) | FRACTURE FREQUENCY (Fractures/m) | ROCK STRENGTH INDEX (RO-R6) | WEATHERING INDEX (WI-W6) | DIP w.r.t. CORE AXIS (°) | | | | TYPE AND SURFACE DESCRIPTION | | | | | | | | | | | |
| | | | | | FX - FRACTURE | J - JOINT | CLV - CLEAVAGE | VN - VEIN | CONT - CONTACT | SB - BEDDING | F - FAULT | FOL - FOLIATION | RZ - BROKEN CORE / RUBBLE ZONE | PL - PLANAR | ST - STEPPED | UN - UNDULATING | PO - POLISHED | CLN - CLEAN | PC - PARTIALLY COATED | CC - COMPLETELY COATED | IN - FILLED | | | | | | | |
| 30 | | Limestone BEDROCK (Verulam Formation) - very poor to excellent rock quality - grey colour - moderately weathered to unweathered joint surfaces - very close to moderate joint spacing (Refer to Field Bedrock Core Log) | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | HQ 26 | 100 | 92 | 98 | | | | | R4 | W1 | | | | | | | | | | | 115 | UCS = 90 MPa | |
| | | | | | | HQ 27 | 100 | 86 | 96 | | | | | R5 | W1 | | | | | | | | | | | 128 | | UCS = 105 MPa |
| | | | | | | HQ 28 | 100 | 94 | 86 | | | | | | W1 | | | | | | | | | | | 115 | | |
| 35 | 52.4 | End of Borehole Borehole left open and capped with a flushmount cover. | | | | | | | | | | | | | | | | | | | | | | | | | | |

Inferred Groundwater Level
 Groundwater Level Measured in Standpipe

App'd RH
 Date _____

CLIENT Public Works and Government Services Canada BOREHOLE No. BH 15-5
 LOCATION Centre Block, Parliament Hill, Ottawa, ON PROJECT No. 122411046
 DATES: BORING January 10-11, 2015 WATER LEVEL 19 January 2015 DATUM Geodetic

| DEPTH (m) | ELEVATION (m) | LITHOLOGICAL DESCRIPTION | STRATA PLOT | WATER LEVEL | DISCONTINUITY DATA | | | | | | | | | | Q ⁻ VALUE* (*Jw=1 & SRF=1) | OTHER TESTS | | |
|-----------|---------------|---|-------------|-------------|--------------------|--------------|----------------|------------|----------------------------------|-----------------------------|--------------------------|--------------------------|--------------------|----------------|--|-------------|------------------------------|----------------|
| | | | | | SAMPLE TYPE & NO. | TOTAL CORE % | SOLID CORE (%) | R.O.D. (%) | FRACTURE FREQUENCY (Fractures/m) | ROCK STRENGTH INDEX (RO-R6) | WEATHERING INDEX (WI-W6) | DIP w.r.t. CORE AXIS (°) | DISCONTINUITY DATA | | | | TYPE AND SURFACE DESCRIPTION | |
| | | | | | | | | | | | | | J ₁ | J ₂ | | | | J ₃ |
| 0 | 86.8 | | | | | | | | | | | | | | | | | |
| 5 | 81.9 | Continued from Overburden Boring Log | | | | | | | | | | | | | | | | |
| 5 | | Limestone BEDROCK (Verulam Formation) - fair to excellent rock quality - grey colour - moderately weathered to slightly weathered joint surfaces - (Refer to Field Bedrock Core Log) | ▼ | | HQ 8 | 100 | 74 | 72 | 1.1 | - | W3 | 2 | 3 | 4 | FX | 27 | | |
| 6 | | | | | HQ 9 | 97 | 96 | 85 | 0.6 | - | W2 | 2 | 3 | 0.75 | FX | 170 | | |
| 8 | | | | | HQ 10 | 100 | 94 | 91 | 1.4 | - | W3 | 2 | 1.5 | 0.75 | FX IN FX IN | 91 | | |
| 9 | | | | | HQ 11 | 100 | 94 | 96 | | - | W2 | 2 | 1.5 | 0.75 | FOL | 96 | | |
| 10 | 76.8 | | | | | | | | | | | | | | | | | |

▼ Inferred Groundwater Level
 ▼ Groundwater Level Measured in Standpipe

App'd RH
Date _____

CLIENT Public Works and Government Services Canada BOREHOLE No. BH 15-5
 LOCATION Centre Block, Parliament Hill, Ottawa, ON PROJECT No. 122411046
 DATES: BORING January 10-11, 2015 WATER LEVEL 19 January 2015 DATUM Geodetic

| DEPTH (m) | ELEVATION (m) | LITHOLOGICAL DESCRIPTION | STRATA PLOT | WATER LEVEL | DISCONTINUITY DATA | | | | | | | | | | | | Q'-VALUE* (*Jw=1 & SRF=1) | OTHER TESTS | | |
|-----------|---------------|--|--------------|----------------|--------------------|----------------------------------|-----------------------------|--------------------------|--------------------------------|-------------|------------------------------|--------------------------|----------------|----------------|--------------------|--------------|------------------------------|-------------|--|--|
| | | | | | DISCONTINUITY | | CONT - CONTACT | | RZ - BROKEN CORE / RUBBLE ZONE | | UN - UNDULATING | | CLN - CLEAN | | DISCONTINUITY DATA | | | | | |
| | | | | | FX - FRACTURE | J - JOINT | So - BEDDING | PL - PLANAR | UN - UNDULATING | CLN - CLEAN | TYPE AND SURFACE DESCRIPTION | DIP w.r.t. CORE AXIS (°) | | | | | | | | |
| 20 | | Limestone BEDROCK (Verulam Formation) - fair to excellent rock quality - grey colour - moderately weathered to slightly weathered joint surfaces (Refer to Field Bedrock Core Log) | | | FX - FRACTURE | J - JOINT | So - BEDDING | PL - PLANAR | UN - UNDULATING | CLN - CLEAN | TYPE AND SURFACE DESCRIPTION | J _a | J _r | J _b | 109 | UCS = 90 MPa | | | | |
| | HQ 18 | | TOTAL CORE % | SOLID CORE (%) | R.O.D. (%) | FRACTURE FREQUENCY (Fractures/m) | ROCK STRENGTH INDEX (RO-R6) | WEATHERING INDEX (WI-W6) | DIP w.r.t. CORE AXIS (°) | | | | | | | | | | | |
| 21 | | | | | | | | | | | | | | | | | | | | |
| | HQ 19 | | | | | | | | | | | | | | | | | | | |
| 22 | | | | | | | | | | | | | | | | | | | | |
| 23 | | | | | | | | | | | | | | | | | | | | |
| 24 | 62.8 | End of Borehole Borehole left open and capped with a flushmount cover | | | | | | | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | | | | | | | | | |
| 26 | | | | | | | | | | | | | | | | | | | | |
| 27 | | | | | | | | | | | | | | | | | | | | |
| 28 | | | | | | | | | | | | | | | | | | | | |
| 29 | | | | | | | | | | | | | | | | | | | | |
| 30 | | | | | | | | | | | | | | | | | | | | |

Inferred Groundwater Level
 Groundwater Level Measured in Standpipe

App'd RH
 Date

CLIENT Public Works and Government Services Canada BOREHOLE No. BH 15-6
 LOCATION Centre Block, Parliament Hill, Ottawa, ON PROJECT No. 122411046
 DATES: BORING January 5-9, 2015 WATER LEVEL 19 January 2015 DATUM Geodetic

| DEPTH (m) | ELEVATION (m) | LITHOLOGICAL DESCRIPTION | STRATA PLOT | WATER LEVEL | DISCONTINUITY DATA | | | | | | | | | | Q-VALUE* (*Jw=1 & SRF=1) | OTHER TESTS | |
|-----------|---------------|---|-------------------|-------------|--------------------|--------------|----------------|------------|----------------------------------|-----------------------------|--------------------------|--------------------------|------------------------------|----|-----------------------------|-------------|---------------|
| | | | | | SAMPLE TYPE & NO. | TOTAL CORE % | SOLID CORE (%) | R.O.D. (%) | FRACTURE FREQUENCY (Fractures/m) | ROCK STRENGTH INDEX (RO-R6) | WEATHERING INDEX (WI-W6) | DIP w.r.t. CORE AXIS (°) | TYPE AND SURFACE DESCRIPTION | | | | |
| | | | | | | | | | | | | | J1 | Jr | | | Jb |
| 0 | 84.1 | | | | | | | | | | | | | | | | |
| 3.8 | 80.2 | Continued from Overburden Boring Log | | | | | | | | | | | | | | | |
| 4.0 | | Limestone BEDROCK (Verulam Formation) - very poor to excellent rock quality - grey colour - moderately weathered to slightly weathered joint surfaces (Refer to Field Bedrock Core Log) | [Bedrock Pattern] | | | | | | | | | | | | | | |
| 4.8 | | | | | NQ 8 | 100 | 89 | 84 | | R5 | W2 | | | 2 | 2 | 0.75 | 112 |
| 5.8 | | | | | | | | | | R5 | | | | | | | UCS = 110 MPa |
| 6.2 | | | | | NQ 9 | 96 | 88 | 80 | | | W2 | | | 2 | 2 | 0.75 | 107 |
| 7.8 | | | | | | | | | | | | | | | | | UCS = 140 MPa |
| 8.2 | | | | | NQ 10 | 97 | 91 | 73 | | | W2 | | | 2 | 2 | 0.75 | 97 |
| 9.2 | | | | | | | | | | | | | | | | | |
| 9.8 | | | | | NQ 11 | 100 | 91 | 90 | | | W2 | | | 2 | 2 | 0.75 | 120 |
| 10.0 | 74.1 | | | | | | | | | | | | | | | | UCS = 85 |

Inferred Groundwater Level
 Groundwater Level Measured in Standpipe

App'd RH
 Date

CLIENT Public Works and Government Services Canada BOREHOLE No. BH 15-6
 LOCATION Centre Block, Parliament Hill, Ottawa, ON PROJECT No. 122411046
 DATES: BORING January 5-9, 2015 WATER LEVEL 19 January 2015 DATUM Geodetic

| DEPTH (m) | ELEVATION (m) | LITHOLOGICAL DESCRIPTION | STRATA PLOT | WATER LEVEL | DISCONTINUITY DATA | | | | | | | | | | Q-VALUE* (*Jw=1 & SRF=1) | OTHER TESTS | | | |
|-----------|---------------|---|-------------|-------------|--------------------|--------------|----------------|------------|----------------------------------|-----------------------------|--------------------------|--------------------------|----------------|----------------|-----------------------------|-------------|------------------------------|----|---------------|
| | | | | | SAMPLE TYPE & NO. | TOTAL CORE % | SOLID CORE (%) | R.Q.D. (%) | FRACTURE FREQUENCY (Fractures/m) | ROCK STRENGTH INDEX (RO-R6) | WEATHERING INDEX (WI-W6) | DIP w.r.t. CORE AXIS (°) | | | | | TYPE AND SURFACE DESCRIPTION | | |
| | | | | | | | | | | | | J _a | J _r | J _b | | | | | |
| 20 | | Limestone BEDROCK (Verulam Formation) - very poor to excellent rock quality - grey colour - moderately weathered to slightly weathered joint surfaces (Refer to Field Bedrock Core Log) | | | NQ 18 | 100 | 71 | 66 | | | W3 | | | | 2 | 1.5 | 3 | 17 | UCS = 135 MPa |
| 21 | | | NQ 19 | 100 | 83 | 84 | | | RS | W3 | | | | 2 | 3 | 3 | 42 | | |
| 22 | | | NQ 20 | 95 | 83 | 68 | | | | W3 | | | | 2 | 3 | 3 | 34 | | |
| 23 | | | | | | | | | | | | | | | | | | | |
| 24 | 60.2 | End of Borehole Monitoring Well Installed | | | | | | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | | | | | | | | |
| 26 | | | | | | | | | | | | | | | | | | | |
| 27 | | | | | | | | | | | | | | | | | | | |
| 28 | | | | | | | | | | | | | | | | | | | |
| 29 | | | | | | | | | | | | | | | | | | | |
| 30 | | | | | | | | | | | | | | | | | | | |

Inferred Groundwater Level
 Groundwater Level Measured in Standpipe

App'd RH
 Date

CLIENT Public Works and Government Services Canada BOREHOLE No. BH 15-7
 LOCATION Centre Block, Parliament Hill, Ottawa, ON PROJECT No. 122411046
 DATES: BORING January 15-16, 2015 WATER LEVEL 19 January 2015 DATUM Geodetic

| DEPTH (m) | ELEVATION (m) | LITHOLOGICAL DESCRIPTION | STRATA PLOT | WATER LEVEL | DISCONTINUITY | | | | | | | | | | Q ⁻ VALUE* (*Jw=1 & SRF=1) | OTHER TESTS | |
|-----------|---------------|---|-------------------|-------------|-------------------|--------------|----------------|------------|----------------------------------|-----------------------------|--------------------------|--------------------------|--------------------|----------------|--|-------------|----------------|
| | | | | | SAMPLE TYPE & NO. | TOTAL CORE % | SOLID CORE (%) | R.O.D. (%) | FRACTURE FREQUENCY (Fractures/m) | ROCK STRENGTH INDEX (R0-R6) | WEATHERING INDEX (W1-W6) | DIP w.r.t. CORE AXIS (°) | DISCONTINUITY DATA | | | | |
| | | | | | | | | | | | | | J _a | J _r | | | J _s |
| 0 | 84.4 | | | | | | | | | | | | | | | | |
| 3.1 | 81.1 | Continued from Overburden Boring Log | | | | | | | | | | | | | | | |
| 3.5 | | Limestone BEDROCK (Verulam Formation) - fair to excellent rock quality - grey colour - highly weathered to slightly weathered joint surfaces - (Refer to Field Bedrock Core Log) | [Bedrock Pattern] | | | HQ 6 | 100 | 82 | 60 | | | W3 | 2 | 3 | 0.75 | | 120 |
| 4.8 | | | [Bedrock Pattern] | | | HQ 7 | 100 | 93 | 94 | | | W3 | 2 | 2 | 0.75 | | 125 |
| 6.2 | | | [Bedrock Pattern] | | | HQ 8 | 100 | 90 | 90 | | | W3 | 2 | 2 | 0.75 | | 120 |
| 7.8 | | | [Bedrock Pattern] | | | HQ 9 | 100 | 94 | 99 | | | W3 | 2 | 1.5 | 0.75 | | 99 |
| 9.2 | | | [Bedrock Pattern] | | | HQ 10 | 100 | 98 | 100 | | R5 | W3 | 2 | 3 | 0.75 | | 200 |
| 10 | 74.4 | | | | | | | | | | | | | | | | |

Inferred Groundwater Level
 Groundwater Level Measured in Standpipe

App'd RH
 Date _____

STN13-STAN-GEO-BEDROCK-Q 122411046 PARLIAMENT HILL CENTRE BLOCK-REV.GPJ 122411046 PARLIAMENT HILL CENTRE BLOCK.GPJ 22/4/15

CLIENT Public Works and Government Services Canada BOREHOLE No. BH 15-7
 LOCATION Centre Block, Parliament Hill, Ottawa, ON PROJECT No. 122411046
 DATES: BORING January 15-16, 2015 WATER LEVEL 19 January 2015 DATUM Geodetic

| DEPTH (m) | ELEVATION (m) | LITHOLOGICAL DESCRIPTION | STRATA PLOT | WATER LEVEL | DISCONTINUITY DATA | | | | | | | | | | Q ² -VALUE* (*Jw=1 & SRF=1) | OTHER TESTS | |
|-----------|---------------|--|-------------|-------------|--------------------|--------------|----------------|------------|----------------------------------|-----------------------------|--------------------------|--------------------------|------------------------------|------|---|---------------|--|
| | | | | | SAMPLE TYPE & NO. | TOTAL CORE % | SOLID CORE (%) | R.Q.D. (%) | FRACTURE FREQUENCY (Fractures/m) | ROCK STRENGTH INDEX (R0-R6) | WEATHERING INDEX (W1-W6) | DIP w.r.t. CORE AXIS (°) | DISCONTINUITY DATA | | | | |
| | | | | | | | | | | | | | TYPE AND SURFACE DESCRIPTION | | | | |
| 10 | | Limestone BEDROCK (Verulam Formation) - fair to excellent rock quality - grey colour - highly weathered to slightly weathered joint surfaces (Refer to Field Bedrock Core Log) | | | HQ 10 | 100 | 98 | 100 | | R5 | W3 | 2 | 3 | 0.75 | 200 | UCS = 120 MPa | |
| 11 | | | HQ 11 | 100 | 93 | 96 | | W2 | 2 | 2 | 0.75 | 128 | | | | | |
| 12 | | | HQ 12 | 96 | 93 | 90 | | W2 | 2 | 2 | 0.75 | 120 | | | | | |
| 13 | | | HQ 13 | 100 | 88 | 95 | | W3 | 2 | 3 | 0.75 | 190 | | | | | |
| 14 | | | HQ 14 | 95 | 95 | 89 | | W4 | 2 | 2 | 4 | 22 | | | | | |
| 15 | | | HQ 15 | 100 | 90 | 96 | | W3 | 2 | 3 | 0.75 | 192 | | | | | |
| 16 | | | HQ 16 | 98 | 89 | 79 | | W3 | 2 | 1 | 4 | 10 | | | | | |
| 17 | | | HQ 17 | 100 | 85 | 69 | | W3 | 2 | 2 | 4 | 17 | | | | | |
| 18 | | | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | | | |
| 20 | 64.4 | | | | | | | | | | | | | | | | |

Inferred Groundwater Level
 Groundwater Level Measured in Standpipe

App'd RH
 Date

CLIENT Public Works and Government Services Canada BOREHOLE No. BH 15-8
 LOCATION Centre Block, Parliament Hill, Ottawa, ON PROJECT No. 122411046
 DATES: BORING January 9-13, 2015 WATER LEVEL _____ DATUM Geodetic

| DEPTH (m) | ELEVATION (m) | LITHOLOGICAL DESCRIPTION | STRATA PLOT | WATER LEVEL | DISCONTINUITY DATA | | | | | | | | | | Q-VALUE* (*Jw=1 & SRF=1) | OTHER TESTS | | |
|-----------|---------------|--|----------------------------|-------------|--------------------|-------------------|--------------|----------------|------------|------------------------------------|-----------------------------|--------------------------|--------------------------|-----|-----------------------------|-------------|-----|---------------|
| | | | | | DISCONTINUITY | SAMPLE TYPE & NO. | TOTAL CORE % | SOLID CORE (%) | R.O.D. (%) | 5 FRACTURE FREQUENCY (Fractures/m) | ROCK STRENGTH INDEX (R0-R6) | WEATHERING INDEX (W1-W6) | DIP w.r.t. CORE AXIS (°) | J1 | | | Jr | J8 |
| 0 | 85.8 | | | | | | | | | | | | | | | | | |
| 81.2 | | Continued from Overburden Boring Log | | | | | | | | | | | | | | | | |
| 5 | | Limestone BEDROCK (Verulam Formation) - fair to excellent rock quality - grey colour - highly weathered to slightly weathered joint surfaces (Refer to Field Bedrock Core Log) | [Bedrock Core Log Diagram] | | NQ 7 | 100 | 77 | 73 | | R5 | W3 | | 2 | 3 | 0.75 | | 146 | UCS = 110 MPa |
| 6 | | | | | NQ 8 | 100 | 77 | 80 | | - | W3 | | 2 | 3 | 4 | | 30 | |
| 8 | | | | | NQ 9 | 96 | 75 | 73 | | - | W3 | | 2 | 1.5 | 4 | | 14 | |
| 9 | | | | | NQ 10 | 100 | 94 | 100 | | - | W3 | | 2 | 3 | 0.75 | | 200 | |
| 10 | 75.8 | | | | | | | | | | | | | | | | | |

Inferred Groundwater Level
 Groundwater Level Measured in Standpipe

App'd RH
 Date _____

CLIENT Public Works and Government Services Canada BOREHOLE No. BH 15-9
 LOCATION Centre Block, Parliament Hill, Ottawa, ON PROJECT No. 122411046
 DATES: BORING 17 January 2015 WATER LEVEL 19 January 2015 DATUM Geodetic

| DEPTH (m) | ELEVATION (m) | LITHOLOGICAL DESCRIPTION | STRATA PLOT | WATER LEVEL | DISCONTINUITY DATA | | | | | | | | | | Q-VALUE* (*Jw=1 & SRF=1) | OTHER TESTS | |
|-----------|---------------|---|-------------|-------------|--------------------|--------------|----------------|------------|----------------------------------|-----------------------------|--------------------------|--------------------------|--------------------|-----|-----------------------------|---------------|--------------|
| | | | | | SAMPLE TYPE & NO. | TOTAL CORE % | SOLID CORE (%) | R.Q.D. (%) | FRACTURE FREQUENCY (Fractures/m) | ROCK STRENGTH INDEX (RO-R6) | WEATHERING INDEX (WI-W6) | DIP w.r.t. CORE AXIS (°) | DISCONTINUITY DATA | | | | |
| | | | | | | | | | | | | | FX | FOL | | | RZ |
| 0 | 87.1 | | | | | | | | | | | | | | | | |
| 0.4 | 86.4 | Continued from Overburden Boring Log | | | | | | | | | | | | | | | |
| 0.5 | | Limestone BEDROCK (Verulam Formation) | | | | | | | | | | | | | | | |
| 0.6 | | - very poor to excellent rock quality | | | | | | | | | | | | | | | |
| 0.7 | | - grey colour | | | | | | | | | | | | | | | |
| 0.8 | | - highly weathered to slightly weathered joint surfaces | | | | | | | | | | | | | | | |
| 0.9 | | - | | | | | | | | | | | | | | | |
| 1.0 | | (Refer to Field Bedrock Core Log) | | | | | | | | | | | | | | | |
| 1.1 | | | HQ 2 | 96 | 48 | 16 | | | W4 | | | 2 | 3 | 3 | 8 | UCS = 115 MPa | |
| 1.6 | | | HQ 3 | 95 | 71 | 79 | 0.6 | | W3 | | | 2 | 3 | 3 | 40 | | |
| 3.6 | | | HQ 4 | 100 | 93 | 93 | 1.3 | | W2 | | | 2 | 3 | 3 | 47 | | |
| 4.6 | | | HQ 5 | 100 | 95 | 98 | | R5 | W2 | | | 2 | 3 | 3 | 49 | | |
| 6.6 | | | HQ 6 | 100 | 95 | 82 | | | W3 | | | 2 | 3 | 4 | 31 | | |
| 7.6 | | | HQ 7 | 100 | 85 | 85 | | | W3 | | | 2 | 3 | 4 | 32 | | |
| 8.6 | | | HQ 8 | 100 | 84 | 98 | 0.6 | | W3 | | | 4 | 1.5 | 4 | 9 | | |
| 9.1 | | | | | | | | | | | | | | | | | UCS = 95 MPa |
| 10 | 77.1 | | | | | | | | | | | | | | | | |

Inferred Groundwater Level
 Groundwater Level Measured in Standpipe

App'd RH
Date _____

CLIENT Public Works and Government Services Canada BOREHOLE No. BH 15-9
 LOCATION Centre Block, Parliament Hill, Ottawa, ON PROJECT No. 122411046
 DATES: BORING 17 January 2015 WATER LEVEL 19 January 2015 DATUM Geodetic

| DEPTH (m) | ELEVATION (m) | LITHOLOGICAL DESCRIPTION | STRATA PLOT | WATER LEVEL | DISCONTINUITY | | | | | | | | | | Q-VALUE* (*Jw=1 & SRF=1) | OTHER TESTS | |
|-----------|---------------|---|-------------|-------------|-------------------|--------------|----------------|------------|----------------------------------|-----------------------------|--------------------------|--------------------------|--------------------|------|-----------------------------|--------------|----|
| | | | | | SAMPLE TYPE & NO. | TOTAL CORE % | SOLID CORE (%) | R.Q.D. (%) | FRACTURE FREQUENCY (Fractures/m) | ROCK STRENGTH INDEX (RO-R6) | WEATHERING INDEX (W1-W6) | DIP w.r.t. CORE AXIS (°) | DISCONTINUITY DATA | | | | |
| | | | | | | | | | | | | | J1 | J2 | | | J3 |
| 10 | | Limestone BEDROCK (Verulam Formation) - very poor to excellent rock quality - grey colour - highly weathered to slightly weathered joint surfaces (Refer to Field Bedrock Core Log) | | ▼ | HQ 8 | 100 | 84 | 98 | 0.6 | - | W3 | 4 | 1.5 | 4 | 9 | | |
| 11 | | | HQ 9 | 100 | 96 | 100 | - | W2 | 2 | 2 | 0.75 | | | | 133 | | |
| 12 | | | HQ 10 | 94 | 91 | 83 | - | W3 | 2 | 3 | 4 | FOL | | | 31 | | |
| 13 | | | | | | | | | | | | FX | | | | | |
| 14 | | | | | | | | | | | | FX | | | | | |
| 14 | | | HQ 11 | 100 | 72 | 96 | 1.3 | W2 | 2 | 3 | 0.75 | FOL | | | 192 | UCS = 85 MPa | |
| 15 | | | | | | | | | | | | FX | | | | | |
| 16 | | | HQ 12 | 100 | 84 | 84 | 0.7 | W3 | 2 | 3 | 4 | FOL | | | 32 | | |
| 16 | | | | | | | | | | | | FX | | | | | |
| 17 | | | HQ 13 | 95 | 82 | 88 | - | W3 | 2 | 1.5 | 0.75 | FOL | | | 88 | | |
| 18 | | | | | | | | | | | R4 | | | | UCS = 85 MPa | | |
| 18 | | | | | | | | | | | FOL | | | | | | |
| 19 | | HQ 14 | 98 | 80 | 69 | - | W3 | 2 | 3 | 8 | | | | 13 | | | |
| 19 | | | | | | | | | | | FOL | | | | | | |
| 20 | 67.1 | | | | | | | | | | R5 | 2 | 3 | 0.75 | 188 | | |

Inferred Groundwater Level
 Groundwater Level Measured in Standpipe

App'd RH
 Date _____

CLIENT Public Works and Government Services Canada BOREHOLE No. BH 15-10
 LOCATION Centre Block, Parliament Hill, Ottawa, ON PROJECT No. 122411046
 DATES: BORING 13 January 2015 WATER LEVEL _____ DATUM Geodetic

| DEPTH (m) | ELEVATION (m) | LITHOLOGICAL DESCRIPTION | STRATA PLOT | WATER LEVEL | DISCONTINUITY | | | | | | | | | | Q-VALUE* (*Jw=1 & SRF=1) | OTHER TESTS | | |
|-----------|---------------|--|-------------|-------------|-------------------|--------------|----------------|------------|----------------------------------|-----------------------------|--------------------------|--------------------------|--------------------|----|-----------------------------|-------------|------|------------------------------|
| | | | | | SAMPLE TYPE & NO. | TOTAL CORE % | SOLID CORE (%) | R.Q.D. (%) | FRACTURE FREQUENCY (Fractures/m) | ROCK STRENGTH INDEX (R0-R6) | WEATHERING INDEX (W1-W6) | DIP w.r.t. CORE AXIS (°) | DISCONTINUITY DATA | | | | | |
| | | | | | | | | | | | | | J1 | J2 | | | J3 | TYPE AND SURFACE DESCRIPTION |
| 0 | | Continued from Overburden Boring Log | | | | | | | | | | | | | | | | |
| 0.5 | | Limestone BEDROCK (Verulam Formation) - fair to excellent rock quality - grey colour - unweathered joint surfaces - very close to close joint spacing (Refer to Field Bedrock Core Log) | | | HQ 1 | 100 | 87 | 100 | | | W1 | | | | 2 | 1 | 0.75 | 67 |
| 1.0 | | | | | NQ 2 | 98 | 79 | 63 | | | W1 | | | | 2 | 1 | 0.75 | 42 |
| 2.0 | | | | | NQ 3 | 98 | 83 | 73 | | | W1 | | | | 2 | 1 | 0.75 | 49 |
| 3.5 | | | | | NQ 4 | 100 | 84 | 50 | | | W1 | | | | 2 | 1 | 0.75 | 33 |
| 4.5 | | | | | NQ 5 | 98 | 88 | 68 | | | W1 | | | | 2 | 1 | 0.75 | 45 |
| 6.0 | | | | | NQ 6 | 98 | 83 | 78 | | RS | W1 | | | | 2 | 1 | 0.75 | 52 |
| 7.0 | | End of Borehole Borehole backfilled with grout | | | | | | | | | | | | | | | | UCS = 175 MPa |

Inferred Groundwater Level
 Groundwater Level Measured in Standpipe

App'd RH
Date _____

CLIENT Public Works and Government Services Canada BOREHOLE No. BH 15-111
 LOCATION Centre Block, Parliament Hill, Ottawa, ON PROJECT No. 122411046
 DATES: BORING 11 January 2015 WATER LEVEL _____ DATUM Geodetic

| DEPTH (m) | ELEVATION (m) | LITHOLOGICAL DESCRIPTION | STRATA PLOT | WATER LEVEL | DISCONTINUITY DATA | | | | | | | | | | | | Q-VALUE* (*Jw=1 & SRF=1) | OTHER TESTS |
|-----------|---------------|--|-------------|-------------|--------------------|--------------|----------------|------------|----------------------------------|-----------------------------|--------------------------|--------------------------|--------------------|----------------|--------------------------------|-----------------|-----------------------------|-------------|
| | | | | | SAMPLE TYPE & NO. | TOTAL CORE % | SOLID CORE (%) | R.Q.D. (%) | FRACTURE FREQUENCY (Fractures/m) | ROCK STRENGTH INDEX (RO-R6) | WEATHERING INDEX (WI-W6) | DIP w.r.t. CORE AXIS (°) | DISCONTINUITY DATA | | | | | |
| | | | | | | | | | | | | | FX - FRACTURE | CONT - CONTACT | RZ - BROKEN CORE / RUBBLE ZONE | UN - UNDULATING | | |
| 0 | | | | | | | | | | | | | | | | | | |
| 1 | | | | | | | | | | | | | | | | | | |
| 2 | | Continued from Overburden Boring Log Limestone BEDROCK (Verulam Formation) - poor rock quality, grey colour, unweathered joint surfaces (Refer to Field Bedrock Core Log) | | | NQ 2 | 97 | 56 | 34 | | R4 | W1 | | 2 | 1 | 0.75 | 23 | UCS = 90 MPa | |
| 3 | | End of Borehole | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | | |

Inferred Groundwater Level
 Groundwater Level Measured in Standpipe

App'd RH
 Date _____

CLIENT Public Works and Government Services Canada BOREHOLE No. BH 15-12
 LOCATION Public Works and Government Services Canada PROJECT No. 122411046
 DATES: BORING January 10-11, 2015 WATER LEVEL _____ DATUM Geodetic

| DEPTH (m) | ELEVATION (m) | SOIL DESCRIPTION | STRATA PLOT | WATER LEVEL | SAMPLES | | | | UNDRAINED SHEAR STRENGTH - kPa | | | | | | | | | | | |
|-----------|---------------|--|-------------|-------------|---|--------|---------------|----------------|---|----|----|----|----|--|--|--|--|--|--|--|
| | | | | | TYPE | NUMBER | RECOVERY (mm) | N-VALUE OR ROD | WATER CONTENT & ATTERBERG LIMITS W_p W W_L | | | | | | | | | | | |
| | | | | | DYNAMIC PENETRATION TEST, BLOWS/0.3m * STANDARD PENETRATION TEST, BLOWS/0.3m ● | | | | | | | | | | | | | | | |
| | | | | | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | | | | | | | |
| 0 | | 100 mm CONCRETE FILL: gravel Continued on Core Boring Log. | | | | | | | | | | | | | | | | | | |
| 1 | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | | | | |

Inferred Groundwater Level
 Groundwater Level Measured in Standpipe

Field Vane Test, kPa
 Remoulded Vane Test, kPa App'd RH
 Pocket Penetrometer Test, kPa Date _____

STN13-STAN-GEO-SOIL 122411046 PARLIAMENT HILL CENTRE BLOCK-REV.GPJ 122411046 PARLIAMENT HILL CENTRE BLOCK.GPJ 22/4/15

CLIENT Public Works and Government Services Canada BOREHOLE No. BH 15-12
 LOCATION Centre Block, Parliament Hill, Ottawa, ON PROJECT No. 122411046
 DATES: BORING January 10-11, 2015 WATER LEVEL _____ DATUM Geodetic

| DEPTH (m) | ELEVATION (m) | LITHOLOGICAL DESCRIPTION | STRATA PLOT | WATER LEVEL | DISCONTINUITY DATA | | | | | | | | | | Q-VALUE* (*Jw=1 & SRF=1) | OTHER TESTS | |
|-----------|---------------|--|-------------|-------------|--------------------|--------------|----------------|------------|----------------------------------|-----------------------------|--------------------------|--------------------------|--------------------|----|-----------------------------|-------------|----|
| | | | | | SAMPLE TYPE & NO. | TOTAL CORE % | SOLID CORE (%) | R.Q.D. (%) | FRACTURE FREQUENCY (Fractures/m) | ROCK STRENGTH INDEX (RO-R6) | WEATHERING INDEX (WI-W6) | DIP w.r.t. CORE AXIS (°) | DISCONTINUITY DATA | | | | |
| | | | | | | | | | | | | | J1 | J2 | | | J3 |
| 0 | | Continued from Overburden Boring Log | | | | | | | | | | | | | | | |
| 0.5 | | Limestone BEDROCK (Verulam Formation) - fair to excellent rock quality, - grey colour, - unweathered joint surfaces - close joint spacing (Refer to Field Bedrock Core Log) | | | NQ 1 | 100 | 86 | 100 | - | W1 | | | 2 | 1 | 0.75 | | 67 |
| 1.0 | | | | | NQ 2 | 100 | 94 | 89 | - | W1 | | | 2 | 1 | 0.75 | | 59 |
| 2.0 | | | | | NQ 3 | 100 | 77 | 94 | | R5 | W1 | | 2 | 1 | 0.75 | | 63 |
| 3.0 | | | | | NQ 4 | 100 | 80 | 78 | - | W1 | | | 2 | 1 | 0.75 | | 52 |
| 4.0 | | | | | NQ 5 | 100 | 86 | 54 | - | W1 | | | 2 | 1 | 0.75 | | 36 |
| 5.0 | | | | | NQ 6 | 100 | 88 | 98 | - | W1 | | | 2 | 1 | 0.75 | | 65 |
| 6.0 | | | | | NQ 7 | 100 | 82 | 61 | - | W1 | | | 2 | 1 | 0.75 | | 41 |
| 7.0 | | End of Borehole Borehole backfilled with grout | | | | | | | | | | | | | | | |
| 8.0 | | | | | | | | | | | | | | | | | |
| 9.0 | | | | | | | | | | | | | | | | | |
| 10.0 | | | | | | | | | | | | | | | | | |

Inferred Groundwater Level
 Groundwater Level Measured in Standpipe

App'd RH
 Date _____

CLIENT Public Works and Government Services Canada BOREHOLE No. BH 15-13
 LOCATION Public Works and Government Services Canada PROJECT No. 122411046
 DATES: BORING January 8-9, 2015 WATER LEVEL _____ DATUM Geodetic

| DEPTH (m) | ELEVATION (m) | SOIL DESCRIPTION | STRATA PLOT | WATER LEVEL | SAMPLES | | | | UNDRAINED SHEAR STRENGTH - kPa | | | | | | | | | | | | | |
|-----------|---------------|--|-------------|-------------|--------------------------------------|--------|---------------|----------------|---|---------------------------------------|----|----|----|----|----|----|----|----|----|----|----|----|
| | | | | | TYPE | NUMBER | RECOVERY (mm) | N-VALUE OR ROD | WATER CONTENT & ATTERBERG LIMITS W_p W W_L | | | | | | | | | | | | | |
| | | | | | DYNAMIC PENETRATION TEST, BLOWS/0.3m | | | | | STANDARD PENETRATION TEST, BLOWS/0.3m | | | | | | | | | | | | |
| | | | | | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 |
| 0 | | 100 mm CONCRETE FILL: gravel Continued on Core Boring Log. | | | | | | | | | | | | | | | | | | | | |
| 1 | | | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | | | | | | |

Inferred Groundwater Level
 Groundwater Level Measured in Standpipe

Field Vane Test, kPa
 Remoulded Vane Test, kPa App'd RH
 Pocket Penetrometer Test, kPa Date _____

STN13-STAN-GEO-SOIL 122411046 PARLIAMENT HILL CENTRE BLOCK-REV.GPJ 122411046 PARLIAMENT HILL CENTRE BLOCK.GPJ 22/4/15

CLIENT Public Works and Government Services Canada BOREHOLE No. BH 15-13
 LOCATION Centre Block, Parliament Hill, Ottawa, ON PROJECT No. 122411046
 DATES: BORING January 8-9, 2015 WATER LEVEL _____ DATUM Geodetic

| DEPTH (m) | ELEVATION (m) | LITHOLOGICAL DESCRIPTION | STRATA PLOT | WATER LEVEL | DISCONTINUITY DATA | | | | | | | | | | Q-VALUE* (*Jw=1 & SRF=1) | OTHER TESTS | |
|-----------|---------------|--|-------------|-------------|--------------------|--------------|----------------|------------|----------------------------------|-----------------------------|--------------------------|--------------------------|--------------------|----------------|-----------------------------|-------------|-----------------|
| | | | | | SAMPLE TYPE & NO. | TOTAL CORE % | SOLID CORE (%) | R.Q.D. (%) | FRACTURE FREQUENCY (Fractures/m) | ROCK STRENGTH INDEX (RO-R6) | WEATHERING INDEX (WI-W6) | DIP w.r.t. CORE AXIS (°) | DISCONTINUITY DATA | | | | |
| | | | | | | | | | | | | | FX - FRACTURE | CLV - CLEAVAGE | | | UN - UNDULATING |
| 0 | | Continued from Overburden Boring Log | | | | | | | | | | | | | | | |
| 0.5 | | Limestone BEDROCK (Verulam Formation) - fair to excellent rock quality, - grey colour, - unweathered joint surfaces - close joint spacing (Refer to Field Bedrock Core Log) | | | NQ 1 | 100 | 93 | 100 | | | W1 | 2 | 1 | 0.75 | | 67 | |
| 1.0 | | | NQ 2 | 98 | 88 | 68 | | | W1 | 2 | 1 | 0.75 | | | | 45 | |
| 2.0 | | | NQ 3 | 100 | 90 | 73 | | | W1 | 2 | 1 | 0.75 | | | | 49 | |
| 3.0 | | | NQ 4 | 100 | 96 | 90 | | | W1 | 2 | 1 | 0.75 | | | | 60 | |
| 4.0 | | | NQ 5 | 96 | 88 | 71 | | | W1 | 2 | 1 | 0.75 | | | | 47 | |
| 5.0 | | | NQ 6 | 100 | 94 | 100 | | R5 | W1 | 2 | 1 | 0.75 | | | | 67 | |
| 6.0 | | | NQ 7 | 100 | 88 | 82 | | | W1 | 2 | 1 | 0.75 | | | | 55 | |
| 7.0 | | End of Borehole Borehole backfilled with grout | | | | | | | | | | | | | | | |
| 8.0 | | | | | | | | | | | | | | | | | |
| 9.0 | | | | | | | | | | | | | | | | | |
| 10.0 | | | | | | | | | | | | | | | | | |

Inferred Groundwater Level
 Groundwater Level Measured in Standpipe

App'd RH
 Date _____

CLIENT Public Works and Government Services Canada BOREHOLE No. BH 15-15
 LOCATION Centre Block, Parliament Hill, Ottawa, ON PROJECT No. 122411046
 DATES: BORING January 7-8, 2015 WATER LEVEL _____ DATUM Geodetic

| DEPTH (m) | ELEVATION (m) | LITHOLOGICAL DESCRIPTION | STRATA PLOT | WATER LEVEL | DISCONTINUITY | | | | | | | | | | Q-VALUE* (*Jw=1 & SRF=1) | OTHER TESTS | |
|-----------|---------------|---|-------------|-------------|-------------------|--------------|----------------|------------|----------------------------------|-----------------------------|--------------------------|--------------------------|--------------------|------|-----------------------------|-------------|----|
| | | | | | SAMPLE TYPE & NO. | TOTAL CORE % | SOLID CORE (%) | R.Q.D. (%) | FRACTURE FREQUENCY (Fractures/m) | ROCK STRENGTH INDEX (RO-R6) | WEATHERING INDEX (WI-W6) | DIP w.r.t. CORE AXIS (°) | DISCONTINUITY DATA | | | | |
| | | | | | | | | | | | | | J1 | J2 | | | J3 |
| 0 | | Continued from Overburden Boring Log | | | | | | | | | | | | | | | |
| 0.5 | | Limestone BEDROCK (Verulam Formation) - good to excellent rock quality, - grey colour, - unweathered joint surfaces; top 150 mm highly weathered - close joint spacing (Refer to Field Bedrock Core Log) | █ | | NQ 1 | 100 | 80 | 87 | | R4 | W1 | 2 | 1 | 0.75 | 58 | UCS = 90 | |
| 1.5 | | | █ | | NQ 2 | 100 | 91 | 80 | | - | W1 | 2 | 1 | 0.75 | 53 | | |
| 2.5 | | | █ | | NQ 3 | 100 | 90 | 88 | | - | W1 | 2 | 1 | 0.75 | 59 | | |
| 3.5 | | | █ | | NQ 4 | 100 | 92 | 75 | | - | W1 | 2 | 1 | 0.75 | 50 | | |
| 4.5 | | | █ | | NQ 5 | 100 | 85 | 87 | | - | W1 | 2 | 1 | 0.75 | 58 | | |
| 5.5 | | | █ | | NQ 6 | 100 | 94 | 100 | | - | W1 | 2 | 1 | 2 | 25 | | |
| 7 | | End of Borehole Borehole backfilled with grout | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | |

Inferred Groundwater Level
 Groundwater Level Measured in Standpipe

App'd RH
 Date _____



ROCK CORE RECORD

1 of 1
BH 15-16I

CLIENT Public Works and Government Services Canada BOREHOLE No. BH 15-16I
 LOCATION Centre Block, Parliament Hill, Ottawa, ON PROJECT No. 122411046
 DATES: BORING January 7-8, 2015 WATER LEVEL _____ DATUM Geodetic

| DEPTH (m) | ELEVATION (m) | LITHOLOGICAL DESCRIPTION | STRATA PLOT | WATER LEVEL | DISCONTINUITY DATA | | | | | | | | | | Q-VALUE* (*Jw=1 & SRF=1) | OTHER TESTS | | | | |
|-----------|---------------|--|-------------|-------------|--------------------|-------------------|--------------|----------------|------------|------------------------------------|-----------------------------|--------------------------|--------------------------|----------------|-----------------------------|-------------|----------------|----------------|------------------------------|----|
| | | | | | DISCONTINUITY | SAMPLE TYPE & NO. | TOTAL CORE % | SOLID CORE (%) | R.Q.D. (%) | 5 FRACTURE FREQUENCY (Fractures/m) | ROCK STRENGTH INDEX (RQ-R6) | WEATHERING INDEX (WI-W6) | DIP w.r.t. CORE AXIS (°) | J _a | | | J _r | J _s | TYPE AND SURFACE DESCRIPTION | |
| 0 | | | | | | | | | | | | | | | | | | | | |
| 0.5 | | Continued from Overburden Boring Log | | | | | | | | | | | | | | | | | | |
| 1.0 | | Limestone BEDROCK (Verulam Formation) (Refer to Field Bedrock Core Log) | █ | | HQ 1 | 100 | 50 | 100 | | | W2 | | | | | | | | | |
| 1.5 | | | █ | | NQ 2 | 97 | 56 | 30 | | | W3 | | | 2 | 2 | 2 | | | | 15 |
| 2.0 | | End of Borehole | █ | | | | | | | | | | | | | | | | | |
| 3.0 | | | | | | | | | | | | | | | | | | | | |
| 4.0 | | | | | | | | | | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | | | | | | | | | | |
| 7.0 | | | | | | | | | | | | | | | | | | | | |
| 8.0 | | | | | | | | | | | | | | | | | | | | |
| 9.0 | | | | | | | | | | | | | | | | | | | | |
| 10.0 | | | | | | | | | | | | | | | | | | | | |

Inferred Groundwater Level
 Groundwater Level Measured in Standpipe

App'd RH
 Date _____

Log of Borehole 1V



Project No: OTT-000212365-A0

Figure No. 7

Project: Geotechnical Investigation - Proposed Visitor Welcome Centre - Phase I

Page. 1 of 1

Location: Parliament Hill, City of Ottawa, Ontario

Date Drilled: November 30 2013

Split Spoon Sample

Combustible Vapour Reading

Drill Type: CME-75 (Track Mount)

Auger Sample

Natural Moisture Content

SPT (N) Value

Atterberg Limits

Datum: Geodetic

Dynamic Cone Test

Undrained Triaxial at % Strain at Failure

Shelby Tube

Shear Strength by Penetrometer Test

Logged by: AN Checked by: SKA

Shear Strength by Vane Test

| G W L | S O B Y L | SOIL DESCRIPTION | Geodetic m | D e p t h m | Standard Penetration Test N Value | | | | Combustible Vapour Reading (ppm) | | | S O I L T E S T R E S S E S | N a t u r a l U n i t W t. kN/m ³ |
|-------------|-----------------------|--|---------------|----------------------------|-----------------------------------|----|----|----|---|-----|-----|--|---|
| | | | | | 20 | 40 | 60 | 80 | 250 | 500 | 750 | | |
| | | | | | Shear Strength kPa | | | | Natural Moisture Content % Atterberg Limits (% Dry Weight) | | | | |
| | | ASPHALTIC CONCRETE 75 mm | 87.2 | 0 | | | | | | | | | |
| | | FILL Crusher-run to sand and gravel, moist, brown. | 87.1 | | | | | | | | | | |
| | | FILL Sand and gravel, some brick pieces, boulder, moist, brown (compact) | 86.5 | | | | | | | | | | |
| | | FILL Sand and gravel, some brick pieces, boulder, moist, brown (compact) | 85.7 | 1 | 28 | | | | | | | | |
| | | Auger Refusal at 1.5 m For bedrock information see subsequent pages | | | | | | | | | | | |

LOG OF BOREHOLE GINT_LOGS OF BOREHOLES_NEW.GPJ TROW OTTAWA.GDT 2/4/14

NOTES:
 1. Borehole data requires interpretation by exp. before use by others
 2. A 50 mm Monitoring Well was installed upon completion of drilling.
 3. Field work was supervised by an exp representative.
 4. See Notes on Sample Descriptions
 5. This Figure is to read with exp. Services Inc. report OTT-000212365-A0

| WATER LEVEL RECORDS | | |
|---------------------|-----------------|------------------|
| Elapsed Time | Water Level (m) | Hole Open To (m) |
| Dec. 1, 2013 | 6.7 | |
| Dec. 2, 2013 | 5.8 | |
| Dec. 4, 2013 | 8.6 | |
| Mar. 10, 2014 | 20.4 | |

| CORE DRILLING RECORD | | | |
|----------------------|-----------|--------|-------|
| Run No. | Depth (m) | % Rec. | RQD % |
| | | | |

Log of Borehole 5V



Project No: OTT-000212365-A0
 Project: Geotechnical Investigation - Proposed Visitor Welcome Centre - Phase I
 Location: Parliament Hill, City of Ottawa, Ontario
 Date Drilled: December 2 to 4, 2013
 Drill Type: CME-75 (Track Mount)
 Datum: Geodetic
 Logged by: AN Checked by: SKA

Figure No. 11
 Page. 1 of 1

Split Spoon Sample
 Auger Sample
 SPT (N) Value
 Dynamic Cone Test
 Shelby Tube
 Shear Strength by Vane Test
 Combustible Vapour Reading
 Natural Moisture Content
 Atterberg Limits
 Undrained Triaxial at % Strain at Failure
 Shear Strength by Penetrometer Test

| GWL | SOIL DESCRIPTION | Geodetic m | Depth | Standard Penetration Test N Value | | | | Combustible Vapour Reading (ppm) | | | Natural Unit Wt. kN/m ³ |
|-----|---|------------|-------|-----------------------------------|----|----|----|----------------------------------|-----|-----|------------------------------------|
| | | | | Shear Strength kPa | | | | Natural Moisture Content % | | | |
| | | | | 20 | 40 | 60 | 80 | 250 | 500 | 750 | |
| | TOPSOIL 200 mm | 86.94 | 0 | | | | | | | | |
| | FILL Silty sand to sandy silt, some gravel, occasional roots, brown, to reddish brown, moist (loose to compact) | 86.7 | 0.5 | 5 | | | | | X | | |
| | | | 1 | 10 | | | | | X | | |
| | | | 1.5 | 13 | | | | | X | | |
| | Auger Refusal at 2.6 m For bedrock information see subsequent pages | 84.3 | 2 | | | | | | X | | |
| | | | | | | | | | | | |

LOG OF BOREHOLE GINT_LOGS OF BOREHOLES_NEW.GPJ TROW OTTAWA.GDT 2/4/14

NOTES:
 1. Borehole data requires interpretation by exp. before use by others
 2. A 50 mm Monitoring Well was installed upon completion of drilling.
 3. Field work was supervised by an exp representative.
 4. See Notes on Sample Descriptions
 5. This Figure is to read with exp. Services Inc. report OTT-000212365-A0

| WATER LEVEL RECORDS | | |
|---------------------|-----------------|------------------|
| Elapsed Time | Water Level (m) | Hole Open To (m) |
| Dec. 4, 2013 | 7.7 | |
| Dec. 5, 2013 | 8.6 | |
| Dec. 6, 2013 | 9.3 | |

| CORE DRILLING RECORD | | | |
|----------------------|-----------|--------|-------|
| Run No. | Depth (m) | % Rec. | RQD % |
| | | | |

Log of Borehole 6V



Project No: OTT-000212365-A0

Figure No. 12

Project: Geotechnical Investigation - Proposed Visitor Welcome Centre - Phase I

Page. 1 of 1

Location: Parliament Hill, City of Ottawa, Ontario

Date Drilled: 'December 4 & 5, 2013

Split Spoon Sample

Combustible Vapour Reading

Drill Type: CME-75 (Track Mount)

Auger Sample

Natural Moisture Content

SPT (N) Value

Atterberg Limits

Datum: Geodetic

Dynamic Cone Test

Undrained Triaxial at % Strain at Failure

Shelby Tube

Shear Strength by Penetrometer Test

Logged by: AN Checked by: SKA

Shear Strength by Vane Test

| GWL | SOIL DESCRIPTION | Geodetic m | Depth | Standard Penetration Test N Value | | | | Combustible Vapour Reading (ppm) | | | Natural Unit Wt. kN/m ³ |
|-----|---|------------|-------|-----------------------------------|----|----|----|--|-----|-----|------------------------------------|
| | | | | Shear Strength kPa | | | | 250 | 500 | 750 | |
| | | | | 20 | 40 | 60 | 80 | Natural Moisture Content % Atterberg Limits (% Dry Weight) | | | |
| | ASPHALTIC CONCRETE 100mm | 86.8 | 0 | | | | | | | | |
| | FILL Crusher-run limestone/sand and gravel pit-run, grey/brown, moist | 86.7 | | | | | | | | | |
| | FILL Sand and gravel, grey, moist (compact) | 86.1 | 1 | | | | | | | | |
| | | | | 15 | | | | | | | |
| | | | | 8 | | | | | | | |
| | | | 2 | | | | | | | | |
| | | | | | | | | | | | |
| | | 84.4 | | | | | | | | | |
| | Auger Refusal at 2.4 m | | | | | | | | | | |
| | For bedrock information see subsequent pages | | | | | | | | | | |

LOG OF BOREHOLE GINT_LOGS OF BOREHOLES_NEW.GPJ TROW OTTAWA.GDT 2/4/14

NOTES:
 1. Borehole data requires interpretation by exp. before use by others
 2. A 50 mm Monitoring Well was installed upon completion of drilling.
 3. Field work was supervised by an exp representative.
 4. See Notes on Sample Descriptions
 5. This Figure is to read with exp. Services Inc. report OTT-000212365-A0

| WATER LEVEL RECORDS | | |
|---------------------|-----------------|------------------|
| Elapsed Time | Water Level (m) | Hole Open To (m) |
| Dec. 5, 2013 | 10.2 | |
| Dec. 6, 2013 | 7.2 | |
| Mar. 10, 2014 | 20.3 | |

| CORE DRILLING RECORD | | | |
|----------------------|-----------|--------|-------|
| Run No. | Depth (m) | % Rec. | RQD % |
| | | | |

Log of Borehole 7V



Project No: OTT-000212365-A0

Figure No. 13

Project: Geotechnical Investigation - Proposed Visitor Welcome Centre - Phase I

Page. 1 of 1

Location: Parliament Hill, City of Ottawa, Ontario

Date Drilled: November 18 to 20, 2013

Split Spoon Sample

Combustible Vapour Reading

Drill Type: CME-75 (Track Mount)

Auger Sample

Natural Moisture Content

SPT (N) Value

Atterberg Limits

Datum: Geodetic

Dynamic Cone Test

Undrained Triaxial at % Strain at Failure

Shelby Tube

Shear Strength by Penetrometer Test

Logged by: AN Checked by: SKA

Shear Strength by Vane Test

| G W L | S O B O L | SOIL DESCRIPTION | Geodetic m | D e p t h | Standard Penetration Test N Value | | | | Combustible Vapour Reading (ppm) | | | S M P L E S | Natural Unit Wt. kN/m ³ |
|-------------|-----------------------|---|---------------|-----------------------|-----------------------------------|----|----|----|---|-----|-----|----------------------------|--|
| | | | | | Shear Strength | | | | Natural Moisture Content % Atterberg Limits (% Dry Weight) | | | | |
| | | | | | 20 | 40 | 60 | 80 | 250 | 500 | 750 | | |
| | | CONCRETE 200 mm | 86.75 86.6 | 0 | | | | | | | | | |
| | | FILL Crusher-run limestone to sand and gravel, some bricks pieces, occasional boulders and rock fragments, brown, moist to very moist (loose to compact) | | 1 | | | | | | | | | |
| | | | | 2 | | | | | | | | | |
| | | Auger Refusal at 2.9 m For bedrock information see subsequent pages | 83.9 | | | | | | | | | | |

LOG OF BOREHOLE GINT_LOGS OF BOREHOLES_NEW.GPJ TROW OTTAWA.GDT 2/4/14

NOTES:
 1. Borehole data requires interpretation by exp. before use by others
 2. A 50 mm Monitoring Well was installed upon completion of drilling.
 3. Field work was supervised by an exp representative.
 4. See Notes on Sample Descriptions
 5. This Figure is to read with exp. Services Inc. report OTT-000212365-A0

| WATER LEVEL RECORDS | | |
|---------------------|-----------------|------------------|
| Elapsed Time | Water Level (m) | Hole Open To (m) |
| Nov. 20, 2013 | 3.8 | |
| Nov. 25, 2013 | 5.7 | |
| Dec. 6, 2013 | 5.5 | |
| Mar. 10, 2014 | 12.0 | |

| CORE DRILLING RECORD | | | |
|----------------------|-----------|--------|-------|
| Run No. | Depth (m) | % Rec. | RQD % |
| | | | |



BOREHOLE REPORT

BOREHOLE N° 7V

| DEPTH (m) | DEPTH (ft) | ELEVATION / DEPTH (m) | ROCK TYPE DESCRIPTION | SYMBOLS | ALPHA/STRUCTURES | FRACTURES per 0.25m | | | RQD (%) | | | STRENGTH INDEX | | | | HYDRAULIC CONDUCTIVITY k (m/s) | | | |
|-----------|------------|-----------------------|--|---------|------------------|---------------------|---|---|---------|-----|----|----------------|-------------|----------------|------|--------------------------------|------------------|--|--|
| | | | | | | 8 | 6 | 4 | 2 | 25 | 50 | 75 | TCR (%) | STRENGTH INDEX | | | Q INDEX (Barton) | | |
| | | | | | | | | | | | | Jn (Barton) | Jr (Barton) | Ja (Barton) | | | | | |
| 16 | | | Fractured shale beds from 15,32 to 15,38 m, 17,25 to 17,40 m and 20,15 to 20,26 m. | | | | | | 90 | 100 | R4 | 2 | 1.5 | 4 | 16.9 | | | | |
| 17 | 55 | | | | | | | | 90 | 100 | R4 | 2 | 1.5 | 3 | 22.5 | | | | |
| 18 | 60 | | | | | | | | 83 | 100 | R4 | 3 | 1.5 | 4 | 10.4 | | | | |
| 19 | 65 | | | | | | | | 84 | 100 | R4 | 2 | 1.5 | 1 | 63.0 | | | | |
| 20 | 70 | | | | | | | | 90 | 100 | R4 | 3 | 1.5 | 4 | 11.3 | | | | |
| 21 | 75 | | | | | | | | 100 | 100 | R4 | 1 | 1 | 3 | 33.3 | | | | |
| 23 | 63.53 | 23.22 | End of borehole at 23,2 m depth. | | | | | | | | | | | | | | | | |
| 24 | 80 | | | | | | | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | | | | | | | | |
| 26 | 85 | | | | | | | | | | | | | | | | | | |
| 27 | | | | | | | | | | | | | | | | | | | |
| 28 | 90 | | | | | | | | | | | | | | | | | | |
| 29 | 95 | | | | | | | | | | | | | | | | | | |
| 30 | 100 | | | | | | | | | | | | | | | | | | |
| 31 | | | | | | | | | | | | | | | | | | | |
| 32 | 105 | | | | | | | | | | | | | | | | | | |
| 33 | | | | | | | | | | | | | | | | | | | |

Log_Forage_ROC_(83)_2013_02-22.sty

PROJECT: 10-1121-0046

RECORD OF DRILLHOLE: 10-1

SHEET 1 OF 3

LOCATION: N 5032089 931, E 367462 446 (See Site Plan)

DRILLING DATE: July 2-3, 2010

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: GME 75

DRILLING CONTRACTOR: Marathon Drilling

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No | PENETRATION RATE (m/min) | FRESH FRACTURE F-FAULT | | | S-SMOOTH | | | FL FLEXURED | | | BC BROKEN CORE | | | DIAMETRAL POINT LOG INDEX (mm) | NOTES WATER LEVELS INSTRUMENTATION |
|--------------------|---|-------------|--------------|-----------------|--------|--------------------------|------------------------|------------|------------|----------|-----------|----------------|-------------|----------|---------------|----------------|--|--|--------------------------------|------------------------------------|
| | | | | | | | C-CLEAVAGE | | J-JOINT | R-ROUGH | | U-UNEVEN | | | MS-MECH BREAK | | | HYDRAULIC CONDUCTIVITY (K _{sat} cm/sec) | | |
| | | | | | | | SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING | S-SLICKERSIDED | PL-PLANAR | C-CURVED | | | | | | |
| 0 | GROUND SURFACE | | | A7 16 0.00 | | | | | | | | | | | | | | | | |
| 0.5 | P.A. (P.S.) Brown poorly graded sand, with silt and gravel (FILL) - SPT N' value of 14 blows per 300mm for SA 1 | | | M.S. 0.04 | | | | | | | | | | | | | | | | |
| 1 | Fresh finely to medium bedded grey LIMESTONE BEDROCK, with thin shale interbedding | | | | C1 | 100 | | | | | | | | | | | | | | |
| 2 | | | | | C2 | 100 | | | | | | | | | | | | | | |
| 3 | | | | | C3 | 100 | | | | | | | | | | | | | | |
| 4 | | | | | C4 | 100 | | | | | | | | | | | | | | |
| 5 | | | | | C5 | 100 | | | | | | | | | | | | | | |
| 6 | | | | | C6 | 100 | | | | | | | | | | | | | | |
| 7 | | | | | C7 | 100 | | | | | | | | | | | | | | |
| 8 | | | | | C8 | 100 | | | | | | | | | | | | | | |
| 9 | | | | | C9 | 100 | | | | | | | | | | | | | | |
| 10 | | | | | C10 | 100 | | | | | | | | | | | | | | |
| 11 | | | | | C11 | 100 | | | | | | | | | | | | | | |
| 12 | | | | | C12 | 100 | | | | | | | | | | | | | | |
| 13 | | | | | C13 | 100 | | | | | | | | | | | | | | |
| 14 | | | | | C14 | 100 | | | | | | | | | | | | | | |
| 15 | | | | | C15 | 100 | | | | | | | | | | | | | | |

CONTINUED NEXT PAGE

VSP Installation (63.5mm Dia. PVC Pipe)

MIS-RCK-001 10-1121-0046.GPJ GAL-MISS.GDT 2/9/11 JM

DEPTH SCALE
1 : 75



LOGGED: J.C.
CHECKED: B.D.G.

PROJECT: 10-1121-0046

LOCATION: N 5032089.931, E 367462.446 (See Site Plan)

INCLINATION: -90° AZIMUTH: —

RECORD OF DRILLHOLE: 10-1

DRILLING DATE: July 2-3, 2010

DRILL RIG: CME 75

DRILLING CONTRACTOR: Marathon Drilling

SHEET 3 OF 3

DATUM: Geodetic

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV DEPTH (m) | RUNING DEPTH (m) | PENETRATION RATE (mm/min) | FLUSH VOLUME RETURN | FRACTURE/FRACTURE/F-FAULT | | | SM-SMOOTH | | | FL-FLEXURED | | | BC-BROKEN CORE | | | REMARKS | NOTES WATER LEVELS INSTRUMENTATION | |
|--------------------|----------------------|--|------------------------------|-----------------------|------------------|---------------------------|---------------------|---------------------------|---------|----------------------|--------------------|------------------------|---------------------------------|-------------|--------|----------|----------------|---------------|----------|---------|------------------------------------|----------|
| | | | | | | | | CL-CLEAVAGE | J-JOINT | S-S-SHEAR | R-ROUGH | U-UNEVEN | M-MECH BREAK | B-BEDDING | W-WAVE | C-CURVED | W-WAVE | S-SLICENSIDED | P-PLANAR | | | C-CURVED |
| | | | | | | | | RECOVERY | R.G.D % | FRACT INDEX PER D.S. | DISCONTINUITY DATA | HYDRAULIC CONDUCTIVITY | EMERGENCY CONTROL INDEX (1-100) | | | | | | | | | |
| TOTAL CORE % | SOLID CORE % | INDEX PER D.S. | TYPE AND SURFACE DESCRIPTION | K ₁ cm/sec | | | | | | | | | | | | | | | | | | |
| 30 | | --- CONTINUED FROM PREVIOUS PAGE --- Fresh thinly to medium bedded grey LIMESTONE BEDROCK, with thin shale interbedding | | | | | | | | | | | | | | | | | | | | |
| 31 | | | | | | | | | | | | | | | | | | | | | | |
| 32 | | | | | | | | | | | | | | | | | | | | | | |
| 33 | | | | | | | | | | | | | | | | | | | | | | |
| 34 | Relay C-1 HD Core | | | | | | | | | | | | | | | | | | | | | |
| 35 | | | | | | | | | | | | | | | | | | | | | | |
| 36 | | | | | | | | | | | | | | | | | | | | | | |
| 37 | | | | | | | | | | | | | | | | | | | | | | |
| 38 | | End of Drillhole | | 49.06 37.50 | | | | | | | | | | | | | | | | | | |
| 39 | | Note: Borehole and VSP casing grouted and abandoned on July 16, 2010. | | | | | | | | | | | | | | | | | | | | |
| 40 | | | | | | | | | | | | | | | | | | | | | | |
| 41 | | | | | | | | | | | | | | | | | | | | | | |
| 42 | | | | | | | | | | | | | | | | | | | | | | |
| 43 | | | | | | | | | | | | | | | | | | | | | | |
| 44 | | | | | | | | | | | | | | | | | | | | | | |
| 45 | | | | | | | | | | | | | | | | | | | | | | |

VSP Installation (63.5mm Dia. PVC Pipe)

W.L. in open borehole at 18.30m depth below ground surface on July 9, 2010

MIS-RCK.001 10-1121-0046.GPJ GAL-MISS.GDT 2/9/11 JM

DEPTH SCALE
1 : 75



LOGGED: J.C.
CHECKED: B.D.G.

CLIENT Dept. of Public Works
 LOCATION Walking Tunnel

Centre to East Block

REMARKS _____

BOREHOLE ELEVATION 285.03

| PENETRATION DATA | HAMMER | DROP |
|------------------|---------|--------|
| CASING | | |
| CONE | | |
| SAMPLER | 140 lbs | 30 in. |

DEPTHS MEASURED FROM GROUND LEVEL

| Depth | Cone Penetration | | Description and Remarks | Sample | | M.C. | L.L. | P.L. | P.I. | U.C. | Vane | | | U.W. | Water Table | |
|-------|------------------|----------|--|----------|----------|------|------|------|------|------|------|------|------|------|-------------|------|
| | Blows/ft | Blows/ft | | Type No. | Blows/ft | | | | | | und. | rem. | sen. | | Date | Time |
| 10" | | | Asphalt & concrete | | | | | | | | | | | | | |
| | | | Compact br F to C sand | | | | | | | | | | | | | |
| | | | some silt | | | | | | | | | | | | | |
| 4' | | | Boulders and sand | SS1 | 12 | | | | | | | | | | | |
| | | | | RC2 | | | | | | | | | | | | |
| 6'3" | | | Compact br silty F to M sand | RC3 | | | | | | | | | | | | |
| | | | | SS4 | 13 | | | | | | | | | | | |
| 9'6" | | | Very dense br F to M silty sand, some clay | SS5 | 62 | | | | | | | | | | | |
| 11' | | | | | | | | | | | | | | | | |
| 14' | | | Boulders with sand silt and clay as matrix | RC6 | | | | | | | | | | | | |
| | | | Cored 5'0" | | | | | | | | | | | | | |
| | | | Recovered 4'11 1/2" | | | | | | | | | | | | | |
| | | | 99.2% Recovery | | | | | | | | | | | | | |
| 19' | | | Limestone | | | | | | | | | | | | | |
| | | | Cored 10'4" | | | | | | | | | | | | | |
| | | | Recovered 10'4" | | | | | | | | | | | | | |
| | | | 100% Recovery | | | | | | | | | | | | | |
| | | | Limestone | | | | | | | | | | | | | |
| 29'4" | | | | | | | | | | | | | | | | |

Symbols

- M.C. = Moisture content
- L.L. = Liquid limit
- P.L. = Plastic limit
- P.I. = Plasticity index
- U.C. = Unconfined compressive strength tons sq/ft
- U.W. = Unit weight
- und. = Undisturbed shear strength Tons/sq ft
- rem. = Remoulded
- sen. = Sensitivity - und rem
- br = brown
- F = fine
- M = medium
- C = coarse

CLIENT Dept. of Public Works
LOCATION Walking Tunnel
Centre to East Block
REMARKS _____
BOREHOLE ELEVATION 284.94

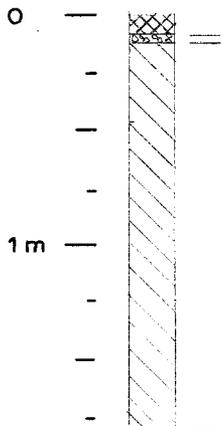
| PENETRATION DATA | HAMMER | DROP |
|------------------|---------|--------|
| CASING | | |
| CONE | | |
| SAMPLER | 140 lbs | 30 in. |

DEPTHS MEASURED FROM GROUND LEVEL

| Depth | Cone Penetration | | Description and Remarks | Sample | | M.C. | L.L. | P.L. | P.I. | U.C. | Vane | | | U.W. | Water Table Date & Time |
|--------|------------------|----------|---|----------|----------|------|------|------|------|------|------|------|------|------|----------------------------|
| | Blows/ft | Blows/ft | | Type No. | Blows/ft | | | | | | und. | rem. | sen. | | |
| 6" | | | Topsoil | | | | | | | | | | | | |
| 4' | | | Compact br silty F to C sand, some crushed stone | SS1 | 7 | | | | | | | | | | |
| | | | Limestone boulders with silty sand | RC2 | | | | | | | | | | | |
| 6'10" | | | Compact to loose gray gravelly F to C sand, some silt, occ. brick pieces | SS4 | 23 | | | | | | | | | | |
| 12'4" | | | Dense br F to M sand some silt | SS6 | 32 | | | | | | | | | | |
| 14'7" | | | Cored 5'0" Recovered 4'3" 85.0% Recovery Limestone | | | | | | | | | | | | |
| 19'7" | | | Cored 9'11" Recovered 9'11" 100% Recovery Limestone | | | | | | | | | | | | |
| 29'6" | | | Cored 2'4" Recovered 2'4" 100% Recovery Limestone | | | | | | | | | | | | |
| 31'10" | | | Limestone | | | | | | | | | | | | |

Symbols

- M.C. = Moisture content
- L.L. = Liquid limit
- P.L. = Plastic limit
- P.I. = Plasticity index
- U.C. = Unconfined compressive strength tons sq/ft
- U.W. = Unit weight
- und = Undisturbed shear strength Tons/sq ft
- rem = Remoulded " " "
- sen = Sensitivity - und rem
- br = brown
- occ = occasional
- F = fine
- M = medium
- C = coarse



Concrete 0 to 76mm
Cinders, gravel and sand from 76mm to 115mm.

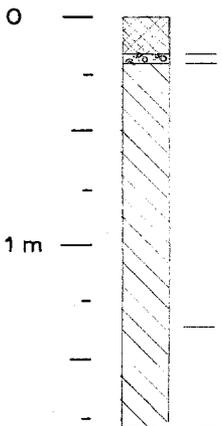
Limestone bedrock

0.115m to 1.790m
Cored 1.675m
Recovered 1.665m
99% recovery.
R.Q.D. = 83%

2 m

3 m

B.H. No. 2



Concrete 0 to 152mm
Sand, gravel, ashes, cinders and wood
from 152mm to 215 mm

Limestone bedrock
Lost wash water at 0.79m

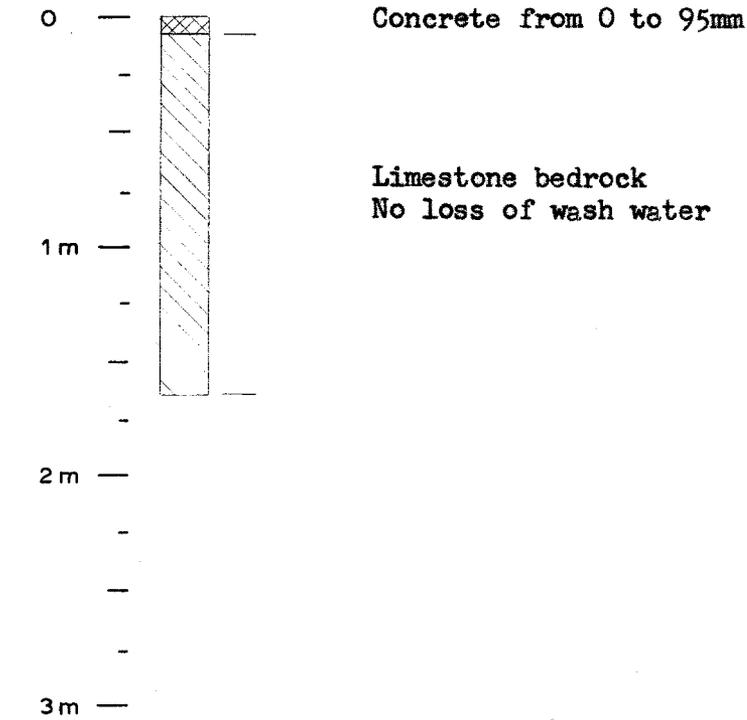
Limestone bedrock
Vertical seam from 1.30m to 1.46m.

0.215m to 1.34m
Cored 1.125m
Recovered 1.09m
96% recovery.
R.Q.D. = 47%

1.34m to 1.80m
Cored 0.46m
Recovered 0.46m
100 % recovery.
R.Q.D. = 61 %

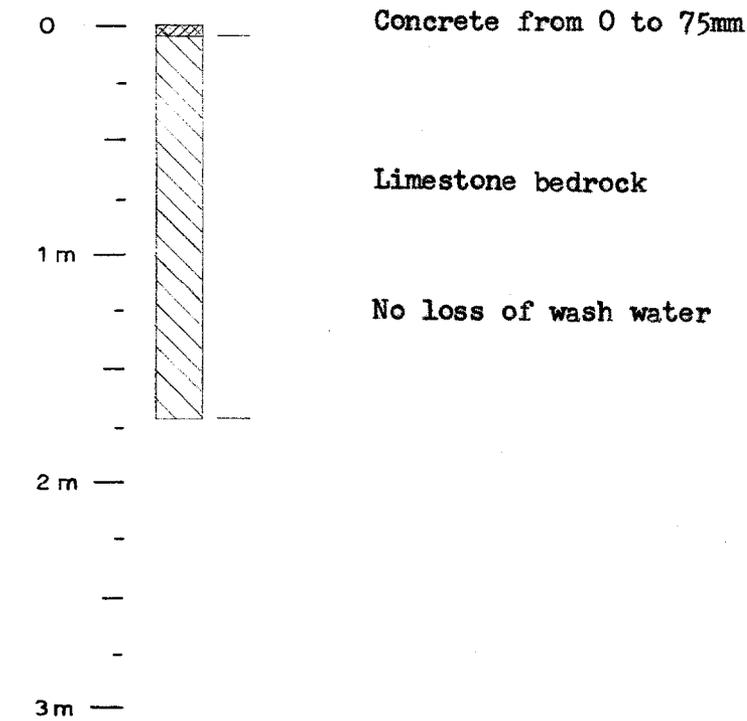
2 m

3 m

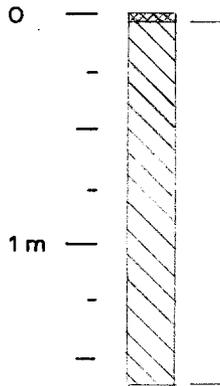


0.095m to 1.66m
Cored 1.565m
Recovered 1.565m
100 % recovery.
R.Q.D. = 25 %

B.H. No. 4



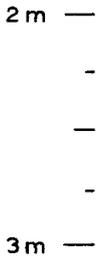
0.075m to 1.775m
Cored 1.7m
Recovered 1.695m
99.7 % recovery
R.Q.D. = 57 %



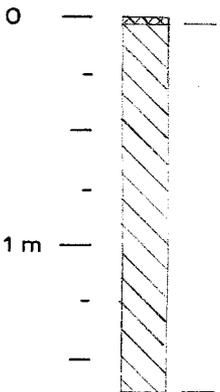
Concrete from 0 to 50mm

Limestone bedrock
 Lost some wash water at .18m
 10mm void from 1.33m to 1.34mm, also lost all
 lost all wash water.

.050m to 1.65m
 Cored 1.60m
 Recovered 1.57m
 98 % recovery
 R.Q.D. = 53 %



B.H.No. 6

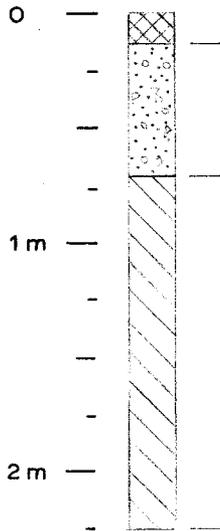


Concrete from 0 to 65mm

Limestone bedrock
 Vertical seam from 1.05m to 1.14m.
 Lost wash water at .76m

.065m to 1.65m
 Cored 1.585m
 Recovered 1.56m
 98 % recovery
 R.Q.D. = 43 %



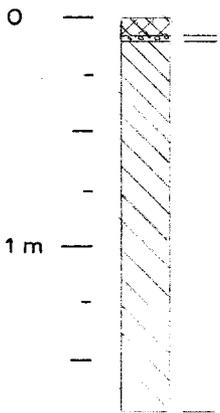


Concrete from 0 to 130mm
 Loose to compact sand, gravel, ashes and
 cinders.
 N- values 9,11
 Ground water table at .60m

Limestone bedrock
 Lost most of wash water at 1.12m

0.71m to 2.25m
 Cored 1.54m
 Recovered 1.54m
 100 % recovery
 R.Q.D. = 41 %

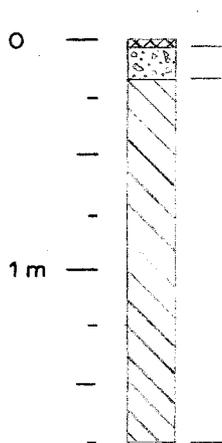
B.H.No. 8



Concrete from 0 to 100mm
 Sand, gravel, ashes and cinders

Limestone bedrock
 Lost wash water at .80m
 Vertical seam from 1.25m to 1.33m

.13m to 1.71m
 Cored 1.58m
 Recovered 1.53m
 97 % recovery
 R.Q.D. = 35 %

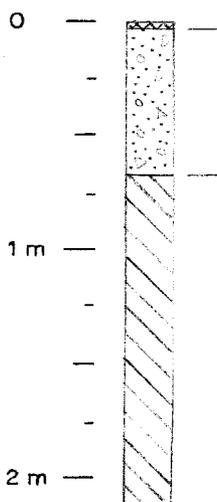


Concrete from 0 to 64mm
Sand, gravel, ashes and cinders

Limestone bedrock
6mm void from .633m to .639m
Lost all wash water in void.

0.165m to 1.74m
Cored 1.575m
Recovered 1.544m
98 % recovery
R.Q.D. = 61 %

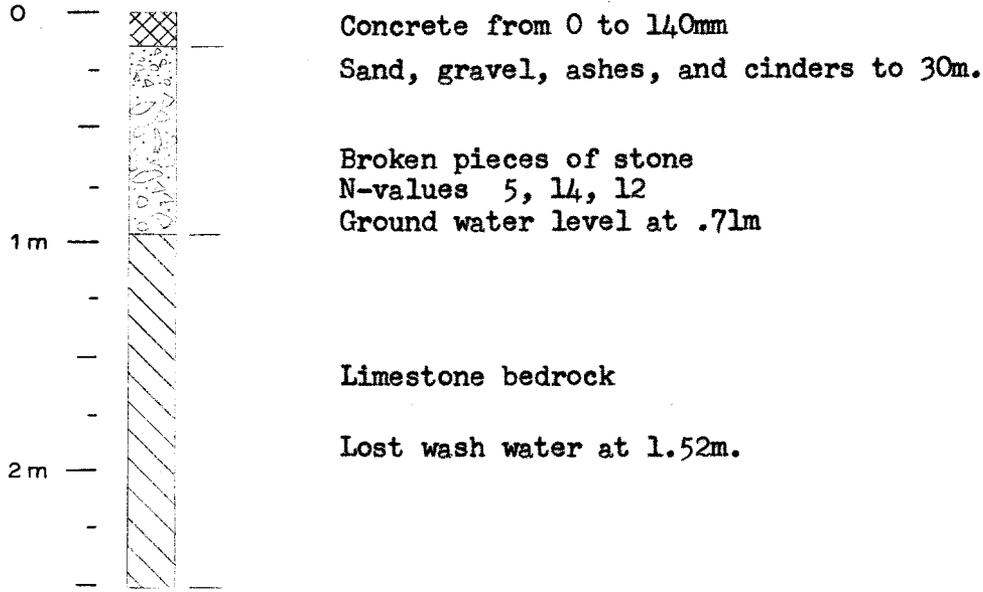
B.H.No. 10



Concrete from 0 to 37mm
37mm of ashes, cinders, sand and gravel
203 mm of sand then mostly broken stone pieces to bedrock.
N-values 4,22
Ground water level at .51m

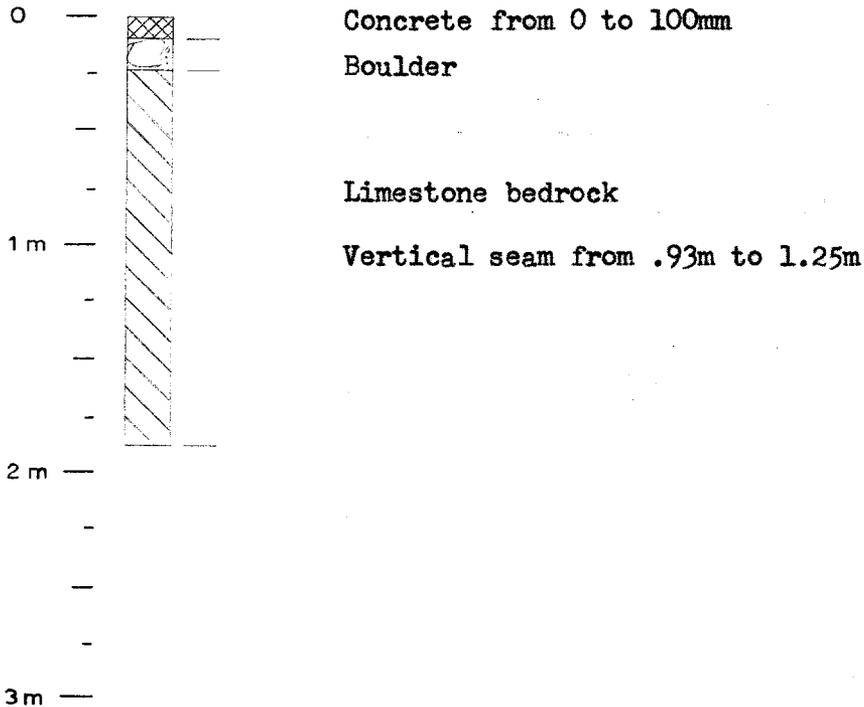
Limestone bedrock
Lost wash water at .81m

0.67m to 2.13m
Cored 1.46m
Recovered 1.45m
99 % recovery
R.Q.D. = 31 %

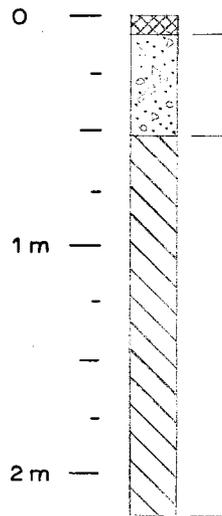


0.97m to 2.51m
 Cored 1.54m
 Recovered 1.54m
 100 % recovery
 R.Q.D. = 67 %

B.H. No. 12



0.24m to 1.88m
 Cored 1.64m
 Recovered 1.61m
 98 % recovery
 R.Q.D. = 67 %



Concrete from 0 to 100mm
Sand, gravel, pieces of wood and ashes.
N-value 4

Limestone bedrock
Lost wash water at 1.30m

.59m to 2.16m
Cored 1.57m
Recovered 1.51m
96 % recovery
R.Q.D. = 62 %

B.H. No.



PROJECT: 961-2016

RECORD OF DRILLHOLE: 96-1

SHEET 1 OF 1



LOCATION: See Plan

DRILLING DATE: Aug. 19, 1996

DATUM: Geodetic

INCLINATION: AZIMUTH:

DRILL RIG: Portable Drill

DRILLING CONTRACTOR: OLHMAN GEOTECHNICAL SERVICES

C 96-1-016 DRF

ROCKMVS DATA INPUT c 96-1-016 DRFS L

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE (mm/min) | FLUSH | RECOVERY | R.Q.D. % | FRACT. INDEX per | DISCONTINUITY DATA | | HYDRAULIC CONDUCTIVITY k, cm/sec | DIAMETRAL POINT LOG INDEX (mm) | NOTES WATER LEVELS INSTRUMENTATION |
|--------------------|-----------------|--|--------------|-------------------------------|---------|---------------------------|-------|----------|----------|------------------|------------------------------|----------|----------------------------------|--------------------------------|------------------------------------|
| | | | | | | | | | | | TYPE AND SURFACE DESCRIPTION | | | | |
| | | | | | | | | | | | FR. FRACTURE | F. FAULT | | | |
| 0 | | Asphalt Surface ASPHALTIC CONCRETE CONCRETE | | 87.49 0.00 0.12 0.25 | | | | | | | | | | | |
| 1 | BW Casting | Fresh to slightly weathered fine grained grey LIMESTONE; prominent near vertical fracture present. | | 86.27 1.22 | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | |
| 8 | AW Core | Fresh to faintly weathered fine grained grey LIMESTONE; nodules and stylolites present; fractures commonly coincident with bedding planes. Slightly open vertical fracture extends to 2.4m depth. Some 45° coated joints at 1.86m, 2.75m and 3.1m. | | | | | | | | | | | | | |
| 9 | | Joints at 1.86m and 3.1m are weathered and slightly open. | | | | | | | | | | | | | |
| 10 | Rotary Drill | | | 77.50 8.96 | | | | | | | | | | | |
| 11 | | End of Hole | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | |

DEPTH SCALE: 1 to 60

Golder Associates

LOGGED: P.A.H
DATE: MARCH 25/97
CHECKED: GSW/TGC

PROJECT: 961-2018

RECORD OF DRILLHOLE: 96-2

SHEET 1 OF 1



LOCATION: See Plan

DRILLING DATE: Aug. 20, 1998

DATUM: Geodetic

INCLINATION: AZIMUTH:

DRILL RIG: Portable Drill

DRILLING CONTRACTOR: OLHMAN GEOTECHNICAL SERVICES

C 96-2-018 DRF

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE (rpm) | FLUSH | FR-FRACTURE | | F-FAULT | | SM-SMOOTH | | FL-FLEXURED | | BC-BROKEN CORE | | DIAMETRAL LOG (mm) | NOTES WATER LEVELS INSTRUMENTATION | | | |
|--------------------|-----------------|---|--------------|-----------------|---------|------------------------|-------|-------------|------------|------------|-----------|---------------|-----------|--------------|--------------|----------------|----------------|--------------------|------------------------------------|-----------------------------------|------------------------------|----------------------------------|
| | | | | | | | | CL-GLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH BREAK | B-BEDDING | RECOVERY | | R.Q.D. % | FRACT. INDEX % | | | DISCONTINUITY DATA | | HYDRAULIC CONDUCTIVITY k, cm/sec |
| | | | | | | | | SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | PL-PLANAR | C-CURVED | TOTAL CORE % | SOLID CORE % | | | | | DP #11 CORE AXES | TYPE AND SURFACE DESCRIPTION | |
| 0 | | Ground Surface | | 87.35 | | | | | | | | | | | | | | | | | | |
| 0 | BW Casting | Loose brown silty sand, some gravel, trace organics, brick (FILL) | | 0.00 | | | | | | | | | | | | | | | | | | |
| 1 | | | | 86.11 | | | | | | | | | | | | | | | | | | |
| 1 | | Fresh to faintly weathered fine grained grey LIMESTONE, prominent near vertical fractures present | | 1.24 | | | | | | | | | | | | | | | | B, R, Stained | | |
| 2 | | | | 85.06 | | | | | | | | | | | | | | | | Near Vert. Frac, B, U, E, Stained | | |
| 2 | | | | 2.29 | | | | | | | | | | | | | | | | J, U, E, Stained | | |
| 3 | | | | | | | | | | | | | | | | | | | | J, U, E, Stained | | |
| 3 | AW Core | Fresh to faintly weathered fine grained grey LIMESTONE, nodules and stylolites present; fractures commonly coincident with bedding. Some prominent vertical fracturing at 2.1m depth. | | | | | | | | | | | | | | | | | | B, U, E, Stained | | |
| 4 | | | | | | | | | | | | | | | | | | | | B, U, E, Stained | | |
| 5 | | | | | | | | | | | | | | | | | | | | B, U, E, Stained | | |
| 6 | | | | | | | | | | | | | | | | | | | | B, U, E, Stained | | |
| 7 | | | | | | | | | | | | | | | | | | | | B, U, E, Stained | | |
| 8 | | | | | | | | | | | | | | | | | | | | B, U, E, Stained | | |
| 9 | | | | | | | | | | | | | | | | | | | | B, U, E, Stained | | |
| 10 | | | | | | | | | | | | | | | | | | | | B, U, E, Stained | | |
| 10 | Rotary Drill | End of Hole | | 77.67 | | | | | | | | | | | | | | | | B, U, E, Stained | | |
| 10 | | | | 9.68 | | | | | | | | | | | | | | | | B, U, E, Stained | | |

ROCK/MVS DATA INPUT c 96-2-018.DRF/S L

DEPTH SCALE: 1 to 60

Golder Associates

LOGGED: P.A.H
DATE: MARCH 25/97
CHECKED: GSW/TGC

PROJECT: 861-2016

RECORD OF DRILLHOLE: 96-3

SHEET 1 OF 1

LOCATION: See Plan

DRILLING DATE: Aug. 21, 22, 1996

DATUM: Geodetic

INCLINATION: AZIMUTH:

DRILL RIG: Portable Drill

DRILLING CONTRACTOR: OLHMAN GEOTECHNICAL SERVICES



C 96-3-016 DRF

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE (mm/min) | COLOR RETURN | FR-FRACTURE | | F-FAULT | | SM-SMOOTH | | FL-FLEXURED | | BC-BROKEN CORE | | DIAMETRAL POINT LOAD INDEX (MPa) | NOTES WATER LEVELS INSTRUMENTATION | |
|--------------------|-----------------|--|-----------------|------------------------------|---------|--|--------------|-------------|---------------|------------|-----------|---------------|-----------|-------------|--|----------------|--|----------------------------------|------------------------------------|--|
| | | | | | | | | CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH BREAK | G-BEDDING | | | | | | | |
| | | | | | | | | SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | | | | | | | | | |
| | | | | | | | | VN-VEIN | S-SUCKENSIDED | PL-PLANAR | C-CURVED | | | | | | | | | |
| RECOVERY | | R.Q.D. % | FRACT INDEX PER | DISCONTINUITY DATA | | HYDRAULIC CONDUCTIVITY k _v cm/sec | | | | | | | | | | | | | | |
| TOTAL CORE % | SOLID CORE % | | | TYPE AND SURFACE DESCRIPTION | | | | | | | | | | | | | | | | |
| 0 | | Basement Floor CONCRETE | | 63.73 0.00 0.12 | | | | | | | | | | | | | | | | |
| | BW Casing | Loose rubble, mortar, brick, gravel, cinders (FILL) | | | 1 | | | | | | | | | | | | | | | |
| 1 | | | | 62.58 1.07 | 2 | | | | | | | | | | | | | | | |
| 2 | | | | | 3 | | | | | | | | | | | | | | | |
| 3 | | | | | 4 | | | | | | | | | | | | | | | |
| 4 | APY Core | Fresh to faintly weathered fine grained grey LIMESTONE, nodules and stylolites present; fracturing commonly coincident with bedding. Prominent vertical joints at 1.37m and 2.13m. | | | 5 | | | | | | | | | | | | | | | |
| 5 | | | | | 6 | | | | | | | | | | | | | | | |
| 6 | | | | | 7 | | | | | | | | | | | | | | | |
| 7 | Rotary Drill | End of Hole | | 77.41 8.32 | | | | | | | | | | | | | | | | |

ROCK MASS DATA INPUT - C 96-3-016 DRF/SL

DEPTH SCALE
1 to 60

Golder Associates

LOGGED: P.A.H
DATE: MARCH 25/97
CHECKED: GSW/TGC

O-A-087-A

FONDEX

BOREHOLE NUMBER **BH-8**

PROJECT Geotechnical Investigation - East Block Tunnel

DRILLING DATE 89-07-14

LOCATION Parliament Hill, Ottawa

REPORT DATE 89-07

DATUM Geodetic BOREHOLE TYPE Electric Wink

DRAWN BY MTW

| GEOLOGIC PROFILE | | SAMPLES | | | | DYNAMIC PENETRATION RESISTANCE BLOWS | | | | | CONSISTENCY : | | | | | | |
|-------------------------|-------------|---|--------|------|-----------|--------------------------------------|--------------------|----|----|----|---------------|------------------------------|--|--|--|--|--|
| Elev. Depth | DESCRIPTION | STRATIGRAPHY | NUMBER | TYPE | BLOWS (N) | % RECOVERY | RESISTANCE BLOWS | | | | | NATURAL MOISTURE CONTENT (W) | | | | | |
| | | | | | | | 0 | 20 | 40 | 60 | 80 | LIQUID LIMIT (W) | | | | | |
| | | | | | | | SHEAR STRENGTH kPa | | | | | PLASTIC LIMIT (Wp) | | | | | |
| | | | | | | | FIELD VANE SHEAR | | | | | | | | | | |
| | | | | | | | LAB VANE SHEAR | | | | | | | | | | |
| | | | | | | | | | | | | % | | | | | |
| 87.00 | 0.00 | Grass and Topsoil over Fill: fine sand, some gravel, trace of clay, brick, and mortar, loose, brown, moist | 1 | SS | 5 | | | | | | | | | | | | |
| 85.78 | 1.22 | Fill: mixture of fine sand, gravel, silt, and boulders with brick and mortar fragments, compact, brown, moist | 2 | SS | 3 | | | | | | | | | | | | |
| 85.00 | 2.00 | Fill: mixture of fine sand, gravel, silt, and boulders with brick and mortar fragments, compact, brown, moist | 3 | SS | 15 | | | | | | | | | | | | |
| 84.41 | 2.59 | Fine Sand (Fill): with some clay and gravel, trace of brick, loose to very dense, brown, wet | 4 | SS | 2 | | | | | | | | | | | | |
| 84.00 | 3.00 | Fine Sand (Fill): with some clay and gravel, trace of brick, loose to very dense, brown, wet | 5 | SS | 40 | | | | | | | | | | | | |
| 83.19 | 3.81 | Till: silty sand, trace gravel, compact, olive grey, moist | 6 | SS | 26 | | | | | | | | | | | | |
| 82.58 | 4.42 | Limestone Bedrock: with horizontal shale seams, some fracturing of core along seams | 7 | RC | 88 | | | | | | | | | | | | |
| 82.00 | 5.00 | Limestone Bedrock: with horizontal shale seams, some fracturing of core along seams | 8 | RC | 97 | | | | | | | | | | | | |
| 81.00 | 6.00 | | | | | | | | | | | | | | | | |
| 80.68 | 6.32 | END OF BOREHOLE | | | | | | | | | | | | | | | |
| Notes: | | | | | | | | | | | | | | | | | |
| 1. Piezometer installed | | | | | | | | | | | | | | | | | |
| 2. Water Level Records | | | | | | | | | | | | | | | | | |
| | Time | Water Level | | | | | | | | | | | | | | | |
| | 89-07-16 | 4.1m | | | | | | | | | | | | | | | |
| | 89-07-17 | 5.0m | | | | | | | | | | | | | | | |
| | 89-07-21 | 4.1m | | | | | | | | | | | | | | | |
| | 89-07-27 | 4.1m | | | | | | | | | | | | | | | |
| | 89-07-31 | 4.1m | | | | | | | | | | | | | | | |

G.W.L.
July 31/89

RQD=77%

RQD = 57%

O-A-087-A

FONDEX

BOREHOLE NUMBER BH-10

PROJECT Geotechnical Investigation - East Block Tunnel

DRILLING DATE 89-07-12

LOCATION Parliament Hill, Ottawa

REPORT DATE 89-07

DATUM Geodetic BOREHOLE TYPE Electric Wink

DRAWN BY MTW

| GEOLOGIC PROFILE | | SAMPLES | | | | DYNAMIC PENETRATION RESISTANCE BLOWS | | | | | CONSISTENCY: | | | | | |
|------------------|---|--------------|--------|------|-----------|--------------------------------------|--------------------|----|----|----|--------------|------------------------------|----|----|----|---|
| Elev. Depth | DESCRIPTION | STRATIGRAPHY | NUMBER | TYPE | BLOWS (N) | % RECOVERY | RESISTANCE BLOWS | | | | | NATURAL MOISTURE CONTENT (W) | | | | |
| | | | | | | | 0 | 20 | 40 | 60 | 80 | PLASTIC LIMIT (Wp) | | | | |
| | | | | | | | SHEAR STRENGTH kPa | | | | | LIQUID LIMIT (W) | | | | |
| | | | | | | | FIELD VANE SHEAR | | | | | PLASTIC LIMIT (Wp) | | | | |
| | | | | | | | LAB VANE SHEAR X | | | | | | | | | |
| | | | | | | | | | | | | 20 | 40 | 60 | 80 | % |
| 85.48 0.00 | 150mm concrete over Fill: drilling through wood and soil to 2.51 m depth | | | | | | | | | | | | | | | |
| 85.48 1.00 | | | | | | | | | | | | | | | | |
| 84.48 2.00 | | | | | | | | | | | | | | | | |
| 83.48 3.00 | -Fill: fine sand with some gravel and clay, trace brick and mortar loose to compact, brown, moist | | 1 | SS | 6 | | | | | | | | | | | |
| 82.67 3.81 | -greenish-brown, moist Fine to Medium Sand (Fill): with trace silt, gravel, loose to compact brown, moist | | 2 | SS | 10 | | | | | | | | | | | |
| 81.94 5.00 | -difficult drilling through 75mm of metal | | 3 | SS | 7 | | | | | | | | | | | |
| 80.94 5.54 | Limestone Bedrock: with some fracturing along horizontal shale seams | | 4 | SS | 10 | | | | | | | | | | | |
| 80.48 6.00 | | | 5 | RC | 93 | | | | | | | | | | | |
| 79.42 7.06 | END OF BOREHOLE | | 6 | RC | 96 | | | | | | | | | | | |

Notes:

- Piezometer installed
- Highly permeable zones at 0.20m (in fill) and 5.56m (in bedrock)
- Water Level Records:

| | |
|----------|-------------|
| Time | Water Level |
| 89-07-17 | 6.1m |
| 89-07-31 | 6.1m |

W GWL July 17/89

PROJECT: 991-2160

RECORD OF BOREHOLE: 99-1

SHEET 1 OF 4

LOCATION: See Site Plan

BORING DATE: August 21&22, 1999

DATUM: Geodetic

SAMPLER HAMMER, 84kg; 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 | BLOWS/0.3m | 20 | 40 | 60 | 80 | 20 | 40 | | |
| | | | | | | SHEAR STRENGTH Cu, kPa | | nat V. + rem V. ⊕ ⊗ | | U - ● | | | | | |
| 0 | | Ground Surface | | 87.43 | | | | | | | | | | | |
| | | CONCRETE | | 0.00 | | | | | | | | | | | |
| | | Grey crushed stone. (FILL) | | 87.30 | | | | | | | | | | | |
| | | | | 0.16 | | | | | | | | | | | |
| 1 | Rotary Drill NW casing | | | 86.37 | | | | | | | | | | | |
| | | Probably brown sand. (FILL) | | 1.22 | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | |

BOREHOLE 991-2160.GPJ_GLDR_CAN.GDT 28/9/99

DEPTH SCALE
1 : 25



LOGGED: D.J.S./K.A.M.
CHECKED:

PROJECT: 991-2160

RECORD OF DRILLHOLE: 99-1

SHEET 4 OF 4

LOCATION: See Site Plan

DRILLING DATE: August 21&22, 1999

DATUM: Geodetic

INCLINATION: -60° AZIMUTH: N 148°E

DRILL RIG:

DRILLING CONTRACTOR:

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE (m/min) | FLUSH | RECOVERY | | R.O.D. % | FRACT. INDEX PER 0.3 | DISCONTINUITY DATA | | HYDRAULIC CONDUCTIVITY K _{eff} (mD/ft) | | | DIAMETRAL POINT LOAD INDEX (NPS) | NOTES WATER LEVELS INSTRUMENTATION | |
|--------------------|-----------------|---|-------------------------------|-----------------|---------|--------------------------|-------|---|--|----------|----------------------|------------------------------|----------------------|---|----------------|----------------|----------------------------------|------------------------------------|---|
| | | | | | | | | TOTAL CORE % | SOLID CORE % | | | TYPE AND SURFACE DESCRIPTION | DIP W.R.T. CORE AXIS | b ₁ | b ₂ | b ₃ | | | |
| | | | | | | | | FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN | F-FAULT J-JOINT P-POLISHED S-SLICKENSIDED | | | | | | | | | | SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR |
| 13 | NO Core | Fresh to slightly weathered fine grained grey LIMESTONE, occasional fracture, commonly coincident with shaly partings, occasional nodules, stylolites common. Fracture from 11.63m to 11.92m characterized by secondary calcite deposition and iron staining. (continued) | [Symbolic Log: Brick pattern] | 9 | | | | | | | | | | | | | | | |
| | | END OF BOREHOLE | | 73.03 13.02 | | | | | | | | | | | | | | | |

B, SM Coincident with 3-4cm shaly parting
B, SM Secondary calcite deposition
B, SM Has fine fracture perpendicular to primary fracture
B, VE (4mm thick)
B, VE

DRILLHOLE 991-2160.SPJ GLDR CAN.GDT 28/9/99



PROJECT: 991-2180

RECORD OF BOREHOLE: 99-2

SHEET 1 OF 4

LOCATION: See Site Plan

BORING DATE: August 28, 29, 1999

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. | NUMBER | TYPE | SHEAR STRENGTH | | | | WATER CONTENT PERCENT | | | | | | |
| | | | | | | | Cu, kPa | | c, kPa | | Wp | | W | | | | |
| 0 | Rotary Drill NM Casing | Ground Surface | 87.72 | | | | | | | | | | | | | | |
| | | TOPSOIL | 8.00 | | | | | | | | | | | | | | |
| | | Brown sandy silt, some gravel, trace red brick (FILL) | 87.82 | 0.12 | | | | | | | | | | | | | |
| 1 | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | |

BOREHOLE 991-2180.GPJ GLDR. CAN 60T 28/9/99

DEPTH SCALE
1 : 25



LOGGED: D.J.S./K.A.M.
CHECKED:

PROJECT: 991-2160

RECORD OF DRILLHOLE: 99-2

SHEET 2 OF 4

LOCATION: See Site Plan

DRILLING DATE: August 28, 1999

DATUM: Geodetic

INCLINATION: -60° AZIMUTH: N 13°E

DRILL RIG:

DRILLING CONTRACTOR:

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE (m/min) | FLUSH | RECOVERY | | R Q.D. % | FRACT. INDEX PER 0.3 | DISCONTINUITY DATA | | HYDRAULIC CONDUCTIVITY K, cm/sec | DIAMETRAL LOG INDEX (MPI) | NOTES WATER LEVELS INSTRUMENTATION | |
|--------------------|-----------------|---|--------------|-----------------|---------|--------------------------|-------|---|--|----------|----------------------|---|--|----------------------------------|---------------------------|------------------------------------|--|
| | | | | | | | | TOTAL CORE % | SOLID CORE % | | | TYPE AND SURFACE DESCRIPTION | DPW.I. CORE AXIS | | | | |
| | | | | | | | | FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN | F-FAULT J-JOINT P-POLISHED S-SLICKENSIDED | | | SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR | FL-FLEXURED UE UNEVEN W-WAVY C-CURVED | | | | BC-BROKEN CORE MB-MECH BREAK B-BEDDING |
| | | Fresh to moderately weathered fine grained grey LIMESTONE fractured with staining and soil material along fracture surfaces; stylolites common; some secondary calcite calcification. | | 88.51 1.40 | | | | | | | | | | | | | |
| 1 | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | |
| | | | | 82.16 | | | | | | | | | | | | | |

CONTINUED NEXT PAGE

DRILLHOLE 991-2160.CPJ GLDR_CAN.GDT 28/8/99

DEPTH SCALE

1 : 25



LOGGED: D.J.S.K.A.M.

CHECKED:

PROJECT: 991-2160
 LOCATION: See Site Plan
 INCLINATION: -60° AZIMUTH: N 13°E

RECORD OF DRILLHOLE: 99-2

SHEET 4 OF 4
 DRILLING DATE: August 28, 1999
 DRILL RIG:
 DRILLING CONTRACTOR:

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE (m/min) | FLUSH LOSS (L/min) | FR-FRACTURE | | F-FAULT | | SM-SMOOTH | | FL-FLEXURED | | BC-BROKEN CORE | | DIAMETRAL POINT LOAD INDEX (MPa) | NOTES WATER LEVELS INSTRUMENTATION | |
|--------------------|-----------------|--|------------------------|------------------------------|---------|--|--------------------|----------------------------------|--|----------------|--|------------|--|-------------|--|----------------|--|----------------------------------|------------------------------------|--|
| | | | | | | | | CL-CLEAVAGE | | J-JOINT | | R-ROUGH | | UE-UNEVEN | | MB-MECH BREAK | | | | |
| | | | | | | | | SH-SHEAR | | P-POLISHED | | ST-STEPPED | | W-WAVY | | B-BEDDING | | | | |
| | | | | | | | | VN-VEN | | S-SLICKENSIDED | | PL-PLANAR | | C-CURVED | | | | | | |
| RECOVERY | | R.Q.D. % | | FRAGT. INDEX PER 0.3 | | DISCONTINUITY DATA | | HYDRAULIC CONDUCTIVITY k, cm/sec | | | | | | | | | | | | |
| TOTAL CORE % | | SOLID CORE % | | TYPE AND SURFACE DESCRIPTION | | b ₁ b ₂ b ₃ | | | | | | | | | | | | | | |
| 12 | NO Core | Fresh to moderately weathered fine grained grey LIMESTONE occasional fracture commonly coincident with shaly partings; occasional nodules. (continued) | [Symbolic Log: Bricks] | 78.58 12.24 | 0 | | | FR, UE | | | | | | | | | | | | |
| | | END OF BOREHOLE | | | | | | | | | | | | | | | | | | |

DRILLHOLE 991-2160.GPJ GLDR_CAN.GDT 28/8/99

DEPTH SCALE
1 : 25



LOGGED: D.J.S./K.A.M.
 CHECKED:

PROJECT: 991-2160

RECORD OF BOREHOLE: 99-3

SHEET 1 OF 3

LOCATION: See Site Plan

BORING DATE: August 28&29, 1999

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 780mm

| DEPTH SCALE METRES | BORING METH-OD | 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 | SHEAR STRENGTH | | | | WATER CONTENT PERCENT | | | | | |
| | | | | | | | 20 | 40 | 60 | 80 | nat. Cu, kPa | rem. V. \oplus | U. \ominus | | | Q. \bullet |
| 0 | Rotary Drill BW Casing | Floor Surface | | 0.00 | | | | | | | | | | | | |
| | | CONCRETE. | | 0.14 | | | | | | | | | | | | |
| | | Brown fine sand. (FILL) | | 0.18 | | | | | | | | | | | | |
| 1 | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | |

BOREHOLE 991-2160.GPJ GLDR. CAN. GDT. 28/9/99

DEPTH SCALE

1 : 25



LOGGED: H.E.C./K.A.M.

CHECKED:

PROJECT: 991-2180

RECORD OF DRILLHOLE: 99-3

SHEET 2 OF 3

LOCATION: See Site Plan

DRILLING DATE: August 28&29, 1999

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG:

DRILLING CONTRACTOR:

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE (m/min) | FLUSH | COLOUR | FR-FRACTURE | | F-FAULT | | SM-SMOOTH | | FL-FLEXURED | | DG-BROKEN CORE | | DIAMETRAL POINT LOAD INDEX (N/CM²) | NOTES WATER LEVELS INSTRUMENTATION | | | | |
|--------------------|-----------------|--|------------------------|-----------------|----------------------|------------------------------|-------|----------------------------------|-------------|--|------------|--|------------|--|-------------|--|----------------|--|------------------------------------|------------------------------------|-------------------------------|--|--|--|
| | | | | | | | | | CL-CLEAVAGE | | J-JOINT | | R-ROUGH | | UE-UNEVEN | | MB-MECH. BREAK | | | | | | | |
| | | | | | | | | | SH-SHEAR | | P-POLISHED | | ST-STEPPED | | W-WAYVED | | B-BEDDING | | | | | | | |
| VN-VEIN | | S-SLICKENISED | | PL-PLANAR | | C-CURVED | | | | | | | | | | | | | | | | | | |
| | | RECOVERY | | R Q D % | FRACT. INDEX PER D.3 | DISCONTINUITY DATA | | HYDRAULIC CONDUCTIVITY k, cm/sec | | | | | | | | | | | | | | | | |
| | | TOTAL CORE % | SOLID CORE % | | | TYPE AND SURFACE DESCRIPTION | b | b | b | | | | | | | | | | | | | | | |
| 1 | | Fresh to faintly weathered fine grained grey LIMESTONE, occasional fractured commonly coincident with shaly partings; nodular, some secondary mineralization and staining. | [Symbolic Log: Bricks] | 85.53 | | | | | | | | | | | | | | | | | W.L. @ 0.73m depth Sept. 2/99 | | | |
| 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | | | | | | | | |

CONTINUED NEXT PAGE

DRILLHOLE 991-2180.GPJ GLDR_CAN.GDT 28/9/99

DEPTH SCALE

1 : 25



LOGGED: H.E.C./K.A.M.

CHECKED:

PROJECT: 991-2160
 LOCATION: See Site Plan
 INCLINATION: -90° AZIMUTH: --

RECORD OF DRILLHOLE: 99-3

SHEET 3 OF 3
 DRILLING DATE: August 28&29, 1999
 DRILL RIG:
 DRILLING CONTRACTOR:

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE (m/min) | FLUSH | COROSION | NEUTRAL | FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE | DISCONTINUITY DATA | HYDRAULIC CONDUCTIVITY k, cm/sec | DIAMETRAL POINT LOAD INDEX (kPa) | NOTES WATER LEVELS INSTRUMENTATION |
|--------------------|-----------------|--|--------------|-----------------|---------|--------------------------|-------|----------|---------|--------------|--------------|----------------------|---|----------------|--------------------|----------------------------------|----------------------------------|------------------------------------|
| | | | | | | | | | | CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK | | | | |
| | | | | | | | | | | SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING | | | | |
| | | | | | | | | | | RECOVERY | R Q.D. % | FRACT. INDEX PER 0.3 | DISCONTINUITY DATA | | | | | |
| | | | | | | | | | | TOTAL CORE % | SOLID CORE % | | TYPE AND SURFACE DESCRIPTION | | | | | |
| 6 | | Fresh to faintly weathered fine grained grey LIMESTONE, occasional fractured commonly conchoidal with shale partings; nodular, some secondary mineralization and staining. (continued) | | | | | | | | | | | B, UE B, UE B, SM B, SM B, SM B, UE FR, UE B, VE-SM B, UE B, SM B, SM FR-VE B, VE B, VE V, VE-M F, SM mechanical break B, VE-SM B, VE hole: 7.41m to 7.92m healed non vertical fracture infilled with secondary mineralization. (calcite and metallic minerals) B, UE B, UE B, SM B, SM B, UE B, UE-SM B, UE B, UE B, UE B, SM B, SM B, UE B, UE-SM | | | | | |
| 7 | | | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | | |
| | | END OF BOREHOLE | | 77.25 9.07 | | | | | | | | | | | | | | |

DRILLHOLE 991-2160 GPJ GLDR CAN.GDT 20/05/99

DEPTH SCALE
1 : 25



LOGGED: H.E.C./K.A.M.
CHECKED:

PROJECT: 091-2160

RECORD OF BOREHOLE: 99-4

SHEET 1 OF 3

LOCATION: See Site Plan

BORING DATE: August 26&27, 1999

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 | BLOWS/0.3m | SHEAR STRENGTH | | | | WATER CONTENT PERCENT | | | | | |
| | | | | | | | | Cu, kPa | | c, kPa | | Wp | | | | L | |
| 0 | Rotary Drill BW Casing | Floor Surface | | M 22 | | | | | | | | | | | | | |
| | | CONCRETE. | | M 22 | | | | | | | | | | | | | |
| | | CLAY TILE. | | M 07 | | | | | | | | | | | | | |
| | | Fine brown sand. (FILL) | | M 25 | | | | | | | | | | | | | |
| 1 | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | |

BOREHOLE 091-2160.GPJ GLDR_CAV.GDT 28/9/99

DEPTH SCALE

1 : 25



LOGGED: H.E.C.K.A.M.

CHECKED:

PROJECT: 091-2160

RECORD OF DRILLHOLE: 99-4

SHEET 3 OF 3

LOCATION: See Site Plan

DRILLING DATE: August 26&27, 1999

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: --

DRILL RIG:

DRILLING CONTRACTOR:

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE (m/min) | FLUSH | COLOR | % RETURN | FR-FRACTURE | | F-FAULT | | SM-SMOOTH | | FL-FLEXURED | | BC-BROKEN CORE | | DIAMETRAL POINT LOAD INDEX (MPa) | NOTES WATER LEVELS INSTRUMENTATION | | | | | | |
|--------------------|-----------------|---|--------------|-----------------|----------------|--------------------------|-------|-------|----------|-------------|----------------|-----------|------------|-----------|------------|-------------|----------------------|--------------------|-----------|----------------------------------|------------------------------------|----------------------------------|--|--|--|--|--|
| | | | | | | | | | | CL-CLEAVAGE | SH-SHEAR | J-JOINT | P-POLISHED | R-ROUGH | ST-STEPPED | UE-UNEVEN | W-WAVY | M8-MECH. BREAK | B-BEDDING | | | | | | | | |
| | | | | | | | | | | VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED | RECOVERY | | ROD % | FRACT. INDEX PER D.3 | DISCONTINUITY DATA | | | | HYDRAULIC CONDUCTIVITY k, cm/sec | | | | | |
| TOTAL CORE % | SOLID CORE % | TYPE AND SURFACE DESCRIPTION | | k ₁ | k ₂ | k ₃ | | | | | | | | | | | | | | | | | | | | | |
| 6 | Bo Core | Fresh to faintly weathered fine grained grey LIMESTONE, occasional fracture commonly coincident with shaly partings; nodular spherulites, some secondary calcite mineralization and staining. (continued) | | 6 | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | | END OF BOREHOLE | | 78.42 7.90 | | | | | | | | | | | | | | | | | | | | | | | |

DRILLHOLE 091-2160.GPJ GLODR_CAN.GDT 28/09/99

DEPTH SCALE
1 : 25



LOGGED: H.E.C./K.A.M.
CHECKED:

PROJECT: 991-2160

RECORD OF BOREHOLE: 99-5

SHEET 1 OF 3

LOCATION: See Site Plan

BORING DATE: August 25&26, 1999

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 | BLOWS/0.3m | SHEAR STRENGTH | | | | WATER CONTENT PERCENT | | | | | |
| | | | | | | | | 20 | 40 | 60 | 80 | nat V. + Cu, kPa | rem V. ⊕ U - ○ | | | Q - ● | U - ○ |
| 0 | Rotary Drill No Casings | Floor Surface CONCRETE | | 66.32 0.00 | | | | | | | | | | | | | |

BOREHOLE 991-2160 GPJ GLDR CAN GDT 29/9/99

DEPTH SCALE
1 : 25



LOGGED: H.E.C./K.A.M.
CHECKED:

PROJECT: 991-2160

RECORD OF DRILLHOLE: 99-5

SHEET 2 OF 3

LOCATION: See Site Plan

DRILLING DATE: August 25&26, 1999

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ...

DRILL RIG:

DRILLING CONTRACTOR:

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. (m) | RUN No. | PENETRATION RATE (cm/min) | FLUSH | RECOVERY | | R Q D. % | FRACT. INDEX PER 0.3 | DISCONTINUITY DATA | | HYDRAULIC CONDUCTIVITY k cm/sec | | | DIAMETRAL POINT LOAD INDEX (MPa) | NOTES WATER LEVELS INSTRUMENTATION |
|--------------------|-----------------|-------------|--------------|-----------|---------|---------------------------|-------|--------------|--------------|----------|----------------------|------------------------------|---------|---------------------------------|----------------|-----------|----------------------------------|------------------------------------|
| | | | | | | | | TOTAL CORE % | SOLID CORE % | | | TYPE AND SURFACE DESCRIPTION | b | b | b | | | |
| | | | | | | | | FR-FRACTURE | CL-CLEAVAGE | | | J-JOINT | R-ROUGH | BC-BROKEN CORE | MB-MECH. BREAK | B-BEDDING | | |
| | | | | 86.14 | 1 | | | | | | | | | | | | | |
| | | | | 86.16 | 2 | | | | | | | | | | | | | |
| | | | | | 3 | | | | | | | | | | | | | |
| | | | | | 4 | | | | | | | | | | | | | |
| | | | | | 5 | | | | | | | | | | | | | |
| | | | | | 6 | | | | | | | | | | | | | |
| | | | | | 7 | | | | | | | | | | | | | |
| | | | | | 8 | | | | | | | | | | | | | |
| | | | | | 9 | | | | | | | | | | | | | |
| | | | | | 10 | | | | | | | | | | | | | |

CONTINUED NEXT PAGE

DRILLHOLE 991-2160.GPJ GLDR, CAN, GDT 2/28/99

DEPTH SCALE
1 : 25



LOGGED: H.E.C./K.A.M.
CHECKED:

PROJECT: 891-2180

RECORD OF DRILLHOLE: 99-5

SHEET 3 OF 3

LOCATION: See Site Plan

DRILLING DATE: August 25&26, 1999

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG:

DRILLING CONTRACTOR:

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE (m/min) | FLUSH RETURN | RECOVERY | | R.Q.D. % | FRACT. INDEX PER 0.3 m | DISCONTINUITY DATA | | HYDRAULIC CONDUCTIVITY k cm/sec | | | DIAMETRAL POINT LOAD INDEX (MPa) | NOTES WATER LEVELS INSTRUMENTATION | |
|--------------------|-----------------|---|----------------|-----------------|---------|--------------------------|--------------|--|--|----------|------------------------|---|--|---|----------------|--|----------------------------------|------------------------------------|--|
| | | | | | | | | TOTAL CORE % | SOLID CORE % | | | TYPE AND SURFACE DESCRIPTION | b ₁ | b ₂ | b ₃ | | | | |
| | | | | | | | | FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEN | F-FAULT J-JOINT P-POLISHED S-SLICKENVICED | | | SM-SMOOTH R-ROUGH ST-BTAPPED PL-PLANAR | FL-FLEXURED UE-UNEVEN W-WAVY C-CURVED | BC-BROKEN CORE MB-MECH. BREAK B-BEDDING | | | | | |
| 6 | | Fresh to faintly weathered fine grained grey LIMESTONE, fractures commonly coincident with shaly partings and sphyolites, nodular, occasional staining. (continued) | [Symbolic Log] | | | | | | | | | | | | | | | | |
| 7 | BC Core | | | | 10 | | | | | | | | | | | | | | |
| 8 | | END OF BOREHOLE | | 78.42 7.90 | | | | | | | | | | | | | | | |

DRILLHOLE 891-2180.GPJ_GLDK_CAN.GDT 25/9/99

DEPTH SCALE

1 : 25



LOGGED: H.E.C./K.A.M.

CHECKED:

PROJECT: 991-2160

RECORD OF BOREHOLE: 99-6

SHEET 1 OF 3

LOCATION: See Site Plan

BORING DATE: August 23&24, 1999

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 | BLOWS/0.3m | SHEAR STRENGTH | | | | WATER CONTENT PERCENT | | | | | |
| | | | | | | | | Cu, kPa | | nat. V. rem V. % | | + Q - U - | | | | Wp | |
| 0 | Rotary Drill No Casing | Floor Surface | | 86.32 | | | 20 | 40 | 60 | 80 | 10 ⁻⁴ | 10 ⁻³ | 10 ⁻² | 10 ⁻¹ | | | |
| | | CONCRETE. | | 0.00 | | | | | | | | | | | | | |
| | | VOID duct work and piping. | | 0.12 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| 1 | | CONCRETE. | | 85.48 | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | |

BOREHOLE 991-2160.GPJ GLDR_CAN.GDT 28/3/99

DEPTH SCALE

1 : 25



LOGGED: H.E.C./K.A.M.

CHECKED:

PROJECT: 991-2180

RECORD OF DRILLHOLE: 99-6

SHEET 2 OF 3

LOCATION: See Site Plan

DRILLING DATE: August 23&24, 1999

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG:

DRILLING CONTRACTOR:

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE (m/min) | FLUSH | COLOUR RETURN | RECOVERY | | R.Q.D. % | FRACT. INDEX PER 0.3 | DISCONTINUITY DATA | | | HYDRAULIC CONDUCTIVITY k, cm/sec | | | DIAMETRAL POINT LOAD INDEX (MPa) | NOTES WATER LEVELS INSTRUMENTATION | |
|--------------------|-----------------|--|--------------|-----------------|---------|--------------------------|-------|---------------|---|---|----------|----------------------|---|--|--|----------------------------------|----|-----|----------------------------------|------------------------------------|--|
| | | | | | | | | | TOTAL CORE % | LIQUID CORE % | | | TYPE AND SURFACE DESCRIPTION | | | 10' | 5' | 10' | | | |
| | | | | | | | | | FR-FRACTURE CL-CLEAVAGE BM-BHEAR VN-VEIN | F-FAULT P-POLISHED S-SLICKENSIDED | | | SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR | FL-FLEXURED UE-UNEVEN W-WAVY C-CURVED | BC-BROKEN CORE MB-MECH BREAK B-BEDDING | | | | | | |
| | | | | 85.28 | | | | | | | | | | | | | | | | | |
| | | Fresh to slightly weathered fine granular grey LIMESTONE, fractured with secondary calcite mineralization and staining common. | | 1.00 | | | | | | | | | | | | | | | | | |
| | | | | 2 | | | | | | | | | | | | | | | | | |
| | | | | 3 | | | | | | | | | | | | | | | | | |
| | | | | 4 | | | | | | | | | | | | | | | | | |
| | | | | 5 | | | | | | | | | | | | | | | | | |
| | | Fresh to faintly weathered fine grained grey LIMESTONE, fractured commonly coincident with shaly partings/stylolites nodular, some staining. | | 24.42 | | | | | | | | | | | | | | | | | |
| | | | | 1.90 | | | | | | | | | | | | | | | | | |
| | | | | 6 | | | | | | | | | | | | | | | | | |
| | | | | 7 | | | | | | | | | | | | | | | | | |
| | | | | 8 | | | | | | | | | | | | | | | | | |
| | | | | 9 | | | | | | | | | | | | | | | | | |
| | | | | 10 | | | | | | | | | | | | | | | | | |
| | | | | 11 | | | | | | | | | | | | | | | | | |
| | | | | 12 | | | | | | | | | | | | | | | | | |
| | | | | 13 | | | | | | | | | | | | | | | | | |

W.L. @ 1.33m depth Sept. 2999

CONTINUED NEXT PAGE

DRILLHOLE 991-2180.GPJ GLDR. CAN.GOT 28/9/99

DEPTH SCALE

1 : 25



LOGGED: H.E.C./K.A.M.

CHECKED:

PROJECT: 991-2180

RECORD OF DRILLHOLE: 99-6

SHEET 3 OF 3

LOCATION: See Site Plan

DRILLING DATE: August 23&24, 1998

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG:

DRILLING CONTRACTOR:

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE (m/min) | RECOVERY | | R.O.D. % | FRAGT. INDEX PER 0.3 | DISCONTINUITY DATA | | HYDRAULIC CONDUCTIVITY k, cm/sec | EMULSION POINT LOAD INDEX (MPa) | NOTES WATER LEVELS INS RUMENTATION |
|--------------------|-----------------|---|-------------------------------|-----------------|---------|--------------------------|--------------|--------------|----------|----------------------|--------------------|------------------------------|----------------------------------|---------------------------------|------------------------------------|
| | | | | | | | TOTAL CORE % | SOLID CORE % | | | DIP #11 CORE AXIS | TYPE AND SURFACE DESCRIPTION | | | |
| | | | | | | | FLUS | W. LOSS | | | W. LOSS | W. LOSS | | | |
| | | Fresh to faintly weathered fine grained gray LIMESTONE fractures commonly coincident with shaly partings/stylolites nodular, some staining. (continued) | [Symbolic Log: Brick pattern] | 12 | | | ██████ | ██████ | ██████ | ██████ | ██████ | | | | |
| 7 | BD Core | | | 13 | | | ██████ | ██████ | ██████ | ██████ | ██████ | | | | |
| | | END OF BOREHOLE | | 78.78 7.54 | | | | | | | | | | | |

DRILLHOLE 991-2180.GPJ GLDR_CAN.GDT 28/8/98

DEPTH SCALE
1 : 25



LOGGED: H.E.C./K.A.M.
CHECKED:

Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: OGS Drilling Inc.

Project No.: 122411046 Task 300.101
Date: January 5, 2015
Borehole No.: BH15-1
Logger: ZP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS | |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|-----------------------|--|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | | |
| 0.43 | NQ 1 | 100 | 0 | 0.61 | Grey to dark grey shale & limestone | | H | N/A | | | | | | | | | |
| 0.61 | NQ 2 | 100 | 0 | 0.76 | Grey limestone with shale partings | | H | N/A | | | | | | | | | |
| 0.76 | NQ 3 | 100 | 60 | 1.78 | Grey limestone with shale partings ; 7 joints | | U | 1 | B | F | C | RU | | T | | | |
| 1.78 | NQ 4 | 93 | 36 | 2.13 | Grey limestone with shale partings; 3 joints | | U | 1 | B | F | C | RU | | SA | | | |

| | | | |
|--|--|---|--|
| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
|--|--|---|--|

Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: OGS Drilling Inc.

Project No.: 122411046 Task 300.101
Date: January 5, 2015
Borehole No.: BH15-1
Logger: ZP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|------------|---------|-----------------|-------|----------|---|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|--|-----------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 2.13 | NQ 5 | 100 | 20 | 3.28 | Grey limestone with shale partings; 5 bedding joints; vertical fracture | | M | 2 | B J | F V | C - | SU RP | | T Si | - Bottom 29" reddish brown silty sand seam down middle of core, oxidized | |
| 3.28 | NQ 6 | 100 | 36 | 4.32 | Grey limestone with shale partings; 7 bedding joints - Vertical fracture, oxidized | | M | 2 | B J | F V | C - | SU RP | | T O | - Vertical fracture through whole run, oxidized | |
| 4.32 | NQ 7 | 100 | 66 | 5.44 | Grey limestone with shale partings; 9 bedding joints | | U | 1 | B | F | C | SU | | T | | |
| 5.44 | NQ 8 | 100 | 80 | 6.58 | Grey limestone with shale partings; 6 bedding joints | VS | U | 1 | B | F | C | SU | | T | | |

| | | | |
|--|--|---|--|
| <p>STRENGTH (MPa) EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
|--|--|---|--|

Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: OGS Drilling Inc.

Project No.: 122411046 Task 300.101
Date: January 5, 2015
Borehole No.: BH15-1
Logger: ZP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS | |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------------------|-----------------------|---------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | | | FILLING |
| 6.58 | NQ 9 | 100 | 78 | 7.59 | Grey limestone with shale partings; 6 bedding joints | | U | 1 | B | F | C | SU | | SA | | |
| 7.59 | NQ 10 | 100 | 84 | 8.69 | Grey limestone with shale partings; 8 bedding joints | | U | 1 | B | F | C | SU | | SA | | |
| 8.69 | NQ 11 | 91 | 23 | 9.25 | Grey limestone with shale partings; 6 bedding joints | | U | 1 | B | F | C | SU | | SA | | |
| 9.25 | NQ 12 | 100 | 96 | 9.96 | Grey limestone with shale partings; 3 bedding joints | | U | 1 | B | F | C | SP | | T | | |

| | | | |
|--|--|---|--|
| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
|--|--|---|--|

Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: OGS Drilling Inc.

Project No.: 122411046 Task 300.101
Date: January 6, 2015
Borehole No.: BH15-1
Logger: ZP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|-----------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 9.96 | NQ 13 | 96 | 80 | 11.13 | Grey limestone with shale partings; 6 bedding joints | | U | 1 | B | F | C | SP | | T | | |
| 11.13 | NQ 14 | 89 | 36 | 12.32 | Grey limestone with shale partings; 8 bedding joints | | U | 1 | B | F | C | SP | | SA | | |
| 12.32 | NQ 15 | 98 | 80 | 13.46 | Grey limestone with shale partings; 7 bedding joints | | U | 1 | B | F | C | SP | | T | | |
| 13.46 | NQ 16 | 98 | 70 | 14.48 | Grey limestone with shale partings; 7 bedding joints | | U | 1 | B | F | C | SP | | T | | |

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|--|---|---|--|
| <p>STRENGTH (MPa) EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> | <p>DISCONTINUITY TYPE B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> | <p>ORIENTATION F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> | <p>FILLING T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Project No.: 122411046 Task 300.101
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Logger: ZP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|-----------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 14.48 | NQ 17 | 100 | 55 | 15.6 | Grey limestone with shale partings; 8 bedding joints | | U | 1 | B | F | C | SP | | T | | |
| 15.6 | NQ 18 | 96 | 60 | 16.74 | Grey limestone with shale partings, some poor quality soft shale layers; 11 bedding joints | | U | 1 | B | F | C | SP | | SA | | |
| 16.74 | NQ 19 | 90 | 10 | 18.06 | Grey limestone with shale partings, interbedded shale layers; 15 bedding joints | | S | 1 | B | F | VC-C | SP | | SA | | |
| 18.06 | NQ 20 | 93 | 31 | 18.85 | Grey limestone with shale partings, interbedded shale layers; 5 bedding joints | | U | 1 | B | F | VC-C | SP | | SA | | |

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|--|--|---|--|
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: OGS Drilling Inc.

Project No.: 122411046 Task 300.101
Date: January 8, 2015
Borehole No.: BH15-1
Logger: ZP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS | | | | | | | | |
|---|--|--|---|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|-----------------------|--|---|---|---|--|--|--|--|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | | | | | | | | | |
| 18.82 | NQ 21 | 94 | 78 | 19.28 | Grey limestone with shale partings; 2 bedding joints | | U | 1 | B | F | C | SP | | T | | | | | | | | | | |
| 19.28 | NQ 22 | 95 | 67 | 21.89 | Grey limestone with shale partings; 6 bedding joints | | U | 1 | B | F | C | SP | | T | | | | | | | | | | |
| 21.89 | NQ 23 | 96 | 76 | 24.00 | Grey limestone with shale partings; 6 bedding joints | VS | U | 1 | B | F | C | SP | | T | | Lost water at 23.6 m | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| <table border="0" style="width:100%"> <tr> <td style="width:25%"> <u>STRENGTH (MPa)</u> EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25 </td> <td style="width:25%"> <u>DISCONTINUITY TYPE</u> B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane </td> <td style="width:25%"> <u>ORIENTATION</u> F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50° </td> <td style="width:25%"> <u>FILLING</u> T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay </td> </tr> <tr> <td> <u>WEATHERING</u> U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like </td> <td> <u>SPACING</u> VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm </td> <td> <u>ROUGHNESS</u> RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar </td> <td></td> </tr> </table> | | | | | | | | | | | | | | | | | <u>STRENGTH (MPa)</u> EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25 | <u>DISCONTINUITY TYPE</u> B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane | <u>ORIENTATION</u> F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50° | <u>FILLING</u> T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay | <u>WEATHERING</u> U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like | <u>SPACING</u> VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm | <u>ROUGHNESS</u> RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar | |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: OGS Drilling Inc.

Project No.: 122411046 Task 300.101
Date: January 6, 2015
Borehole No.: BH15-2
Logger: ZP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|--|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 0.66 | NQ1 | 98 | 52 | 1.3 | Grey limestone with shale partings; 4 bedding joints | | U | 1 | B | F | C | SP | | T | | - better quality rock than start of BH15-1 |
| 1.3 | NQ2 | 100 | 64 | 2.41 | Grey limestone with shale partings; 8 bedding joints | | U | 1 | B | F | C | SP | | T | | |
| 2.41 | NQ3 | 96 | 84 | 3.56 | Grey limestone with shale partings; 6 bedding joints | | U | 1 | B | F | C | SP | | T | | |
| 3.56 | NQ4 | 99 | 53 | 4.65 | Grey limestone with shale partings; 5 bedding joints | | U | 1 | B | F | C | SP | | T | | |

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|--|---|---|--|
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|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|-----------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 4.65 | NQ5 | 100 | 74 | 5.61 | Grey limestone with shale partings; 6 bedding joints | | U | 1 | B | F | C | SU | | T | | |
| 5.61 | NQ6 | 98 | 87 | 6.78 | Grey limestone with shale partings; 7 bedding joints | VS | U | 1 | B | F | C | SP | | T | | |
| 6.78 | NQ7 | 100 | 15 | 7.47 | Grey limestone with shale partings; 6 bedding joints; vertical fracture observed | | U | 2 | B | F | C | SP | | T | | |
| | | | | | | | | | J | V | - | SP | | T | | |
| 7.47 | NQ8 | 94 | 75 | 8.28 | Grey limestone with shale partings; 4 bedding joints | | U | 1 | B | F | C | SP | | T | | |

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|--|---|---|--|
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|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|--------------------------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 8.28 | NQ 9 | 100 | 52 | 9.4 | Grey limestone with shale partings; 7 bedding joints | | U | 1 | B | F | C | SP | | T | | |
| 9.4 | NQ 10 | 93 | 60 | 10.54 | Grey limestone with shale partings; 6 bedding joints | | U | 1 | B | F | C | SP | | T | | |
| 10.54 | NQ 11 | 98 | 63 | 11.76 | Grey limestone with shale partings; 7 bedding joints | | U | 1 | B | F | C | SP | | T | | - Breaks are at shale bedding layers |
| 11.76 | NQ 12 | 92 | 63 | 12.98 | Grey limestone with shale partings; 5 bedding joints | | U | 1 | B | F | C | SP | | T | | - Breaks are at shale bedding layers |

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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: OGS Drilling Inc.

Project No.: 122411046 Task 300.101
Date: January 10, 2015
Borehole No.: BH15-2
Logger: ZP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS | |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------------------|-----------------------|--------------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | | | FILLING |
| 12.98 | NQ 13 | 100 | 33 | 13.89 | Grey limestone with shale partings; 5 bedding joints | | U | 1 | B | F | VC-C | SU | | SA | | - Breaks at shale layers |
| | | | | | | | | | J | V | - | SP | | T | | |
| 13.89 | NQ 14 | 100 | 85 | 14.76 | Grey limestone with shale partings; 3 bedding joints | S | U | 1 | B | F | C | SP | | T | | - Breaks at shale layers |
| | | | | | | | | | | | | | | | | |
| 14.76 | NQ 15 | 100 | 63 | 15.77 | Grey limestone with shale partings; 4 bedding joints | | U | 1 | B | F | C | SP | | T | | - Breaks at shale layers |
| | | | | | | | | | | | | | | | | |
| 15.77 | NQ 16 | 93 | 78 | 16.79 | Grey limestone with shale partings; 5 bedding joints | | U | 1 | B | F | C | SP | | T | | - Breaks at shale layers |
| | | | | | | | | | | | | | | | | |

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Project No.: 122411046 Task 300.101
Date: January 10, 2015
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Logger: ZP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|--|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 16.79 | NQ 17 | 96 | 78 | 17.93 | Grey limestone with shale partings; 7 bedding joints | | U | 1 | B | F | C | SP | | T | | |
| 17.93 | EW 18 | 83 | 0 | 18.67 | Grey limestone with shale partings; 10 bedding joints | | U | 1 | B | F | VC | SP | | T | | - Running 'EW' casing instead because drill shaking too much |
| 18.67 | EW 19 | 100 | 67 | 19.28 | Grey limestone with shale partings; 5 bedding joints | | U | 1 | B | F | C | SP | | T | | |
| 19.28 | EW 20 | 93 | 43 | 20.8 | Grey limestone with shale partings; 9 bedding joints | | U | 1 | B | F | C | SP | | T | | - Breaks at shale layers |

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|--|--|---|--|
| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: OGS Drilling Inc.

Project No.: 122411046 Task 300.101
Date: January 10, 2015
Borehole No.: BH15-2
Logger: ZP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS | |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------------------|-----------------------|--------------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | | | FILLING |
| 20.80 | EW 21 | 92 | 63 | 22.63 | Grey limestone with shale partings; 8 bedding joints | | U | 1 | B | F | C | SP | | T | | - Breaks at shale layers |
| 22.63 | EW 22 | 94 | 44 | 24.00 | Grey limestone with shale partings; 7 bedding joints | | U | 1 | B | F | C | SP | | T | | - Breaks at shale layers |
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| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: OGS Drilling Inc.

Project No.: 122411046 Task 300.101
Date: January 12, 2015
Borehole No.: BH15-3
Logger: ZP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS | |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------------------|-----------------------|---------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | | | FILLING |
| 0.66 | NQ3 | 94 | 36 | 1.12 | Grey limestone with shale partings; 4 bedding joints | | S | 1 | B | F | C | SP | | T | | |
| 1.12 | NQ4 | 96 | 58 | 1.73 | Grey limestone with shale partings; 6 bedding joints | | U | 1 | B | F | C | SP | | T | | |
| 1.73 | NQ5 | 96 | 62 | 3.66 | Grey limestone with shale partings; 10 bedding joints | | U | 1 | B | F | C | SP | | T | | |
| 3.66 | NQ6 | 100 | 100 | 5.36 | Grey limestone with shale partings; 5 bedding joints | VS | U | 1 | B | F | C-M | SP | | T | | |

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| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: OGS Drilling Inc.

Project No.: 122411046 Task 300.101
Date: January 14, 2015
Borehole No.: BH15-3
Logger: ZP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|-----------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 5.36 | NQ7 | 100 | 100 | 8.13 | Grey limestone with shale partings; 2 bedding joints | | U | 1 | B | F | C | SP | | T | | |
| 8.13 | NQ8 | 100 | 84 | 10.44 | Grey limestone with shale partings; 8 bedding joints | | U | 1 | B | F | C-M | SP | | T | | |
| 10.44 | NQ9 | 98 | 74 | 12.65 | Grey limestone with shale partings; 10 bedding joints | | U | 1 | B | F | VC-M | SP | | T | | |
| 12.65 | NQ10 | 91 | 45 | 13.21 | Grey limestone with shale partings; 6 bedding joints | | U | 1 | B | F | C | SP | | T | | |

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| <p>STRENGTH (MPa) EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> | <p>DISCONTINUITY TYPE B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> | <p>ORIENTATION F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> | <p>FILLING T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
| <p>WEATHERING U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>SPACING VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ROUGHNESS RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | |

Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: OGS Drilling Inc.

Project No.: 122411046 Task 300.101
Date: January 14, 2015
Borehole No.: BH15-3
Logger: ZP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|--|------------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 13.21 | NQ 11 | 98 | 83 | 14.4 | Grey limestone with shale partings; 6 bedding joints | | U | 1 | B | F | VC-C | SP | | T | | Breaks at shale layers |
| 14.4 | NQ 12 | 94 | 84 | 16.18 | Grey limestone with shale partings; 9 bedding joints | VS | U | 1 | B | F | C | SP | | T | | Breaks at shale layers |
| 16.18 | NQ 13 | 98 | 75 | 17.83 | Grey limestone with shale partings; 7 bedding joints | | U | 1 | B | F | C | SP | | T | | Breaks at shale layers |
| 17.83 | NQ 14 | 93 | 57 | 18.9 | Grey limestone with shale partings; 7 bedding joints | | U | 1 | B | F | C | SP | | Si & T | Sand seams at 18.1m & 18.6m Filling is dark grey moist sand with silt and small pieces of shale | |

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| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: OGS Drilling Inc.

Project No.: 122411046 Task 300.101
Date: January 14, 2015
Borehole No.: BH15-3
Logger: ZP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|------------|---------|-----------------|-------|----------|---|----------|------------|-----------------|--------|-------------|---------|-----------|----------|-----------|--|--|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 18.9 | NQ 15 | 83 | 52 | 19.63 | Grey limestone with shale partings; 5 bedding joints | | U | 1 | B | F | C | SP | | T & NC | - 1" clayey silt seam at 19.1 m (stored in bag) | - casing is getting stuck |
| 19.63 | EW 16 | 91 | 52 | 20.75 | Grey limestone with shale partings; 9 bedding joints - traces of clay at some breaks | | U | 1 | B | F | C | SP | | T, SA, NC | - 1" silty clay seam at 20.7 m - traces of mud at some breaks | - switching to 'EW' casing to avoid further problems |
| 20.75 | EW 17 | 77 | 0 | 21.41 | Grey limestone with shale partings; 10 bedding joints | | M | 1 | B | F | VC | SP | | SA | | |
| 21.41 | EW 18 | 91 | 0 | 21.69 | Grey limestone with shale partings; 4 bedding joints | | M | 1 | B | F | VC | SP | | T | | |

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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: OGS Drilling Inc.

Project No.: 122411046 Task 300.101
Date: January 15, 2015
Borehole No.: BH15-3
Logger: ZP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|--|-----------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 21.69 | EW 19 | 87 | 0 | 22.28 | Grey limestone with shale partings; 9 bedding joints | | | 2 | B J | F V | VC - | SP SP | | T T | - calcite down middle of core from 0.4 m to 22.4 m | |
| 22.28 | EW 20 | 94 | 0 | 23.19 | Grey limestone with shale partings; 12 bedding joints | | | 1 | B | F | VC | SP | | T | | |
| 23.19 | EW 21 | 100 | 53 | 24.00 | Grey limestone with shale partings; 6 bedding joints | | | 1 | B | F | C | SP | | T | | |
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| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: Marathon Drilling

Project No.: 122411046 Task 300.101
Date: January 11, 2015
Borehole No.: BH15-4
Logger: BB

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---|-----------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 3.43 | HQ6 | 100 | 0 | 3.89 | Light grey limestone, fine-grained - 5 joints | | S | 1 | B | F | VC-C | RU | | Si | - silty sand filling at 3.63 m | |
| 3.89 | HQ7 | 90 | 43 | 4.27 | Light grey limestone, fine-grained - 3 joints | | S-M | 1 | B | F | VC-C | RU | | | | - Lost water |
| 4.27 | HQ8 | 100 | 0 | 4.45 | Light grey limestone, fine grained - 1 joint | | S-M | 1 | B | F | VC-C | RU | | | - top 4" of badly fractured rock pieces | |
| 4.45 | HQ9 | 91 | 81 | 5.97 | Light grey limestone, fine grained - 5 joints | VS | U-S | 1 | B | F | C-M | RU | | | | |

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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: Marathon Drilling

Project No.: 122411046 Task 300.101
Date: January 11, 2015
Borehole No.: BH15-4
Logger: BB

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS | |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|-----------------------|---|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | | |
| 5.97 | HQ 10 | 96 | 94 | 7.49 | Light grey limestone, fine-grained, shale interbedded - 6 joints | S | U | 1 | B | F | VC-M | RU | | | | | |
| 7.49 | HQ 11 | 100 | 86 | 9.02 | Light grey limestone, fine-grained, shale interbedded - 6 joints (horizontal), 1 joint (vertical) | | U-S | 2 | B | F | VC-M | RU | | | | | - silty sand seam observed between fractures between 8.53 m to 8.61 m |
| 9.02 | HQ 12 | 98 | 70 | 10.57 | Light grey limestone, fine-grained, shale interbedded - 6 joints (horizontal), 1 joint (vertical) | | S-M | 2 | B | F | C-M | RU | | | | | |
| 10.57 | HQ 13 | 100 | 99 | 12.09 | Light grey limestone, fine-grained, shale interbedded - 6 joints horizontal | | U | 1 | B | F | C-M | RU-SU | | | | | |

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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: Marathon Drilling

Project No.: 122411046 Task 300.101
Date: January 11, 2015
Borehole No.: BH15-4
Logger: BB

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS | |
|------------|---------|-----------------|-------|----------|---|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|--|-----------------------|--|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | | |
| 12.09 | HQ 14 | 100 | 100 | 13.59 | Light grey limestone, fine-grained, shale interbedded - 4 joints | | U | 1 | B | F | C-M | RU-SU | | | | | |
| 13.59 | HQ 15 | 100 | 99 | 15.11 | Light grye limestone, fine-grained, shale interbedded | S | U | 1 | B | F | C-M | RU-SU | | | - Vertical shear plan observed at 14.66 m - 1" clay seam at 15.09 | | |
| 15.11 | HQ 16 | 71 | 68 | 16.56 | Light grey limestone, fine-grained, shale interbedded - 3 joints | | U | 1 | B | F | VC-M | SU | | NC | 1" clay seam at 16.76 m | | |
| 16.56 | HQ 17 | 100 | 90 | 18.03 | Light grey limestone, fine-grained, shale interbedded - 5 joints | | U | 1 | B | F | C-M | SU | | | | | |

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| <p>WEATHERING U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>SPACING VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ROUGHNESS RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | |

Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: Marathon Drilling

Project No.: 122411046 Task 300.101
Date: January 17, 2015
Borehole No.: BH15-4
Logger: BB

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS | |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|---------------------------|--|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | | |
| 18.03 | HQ 18 | 100 | 82 | 19.58 | Light grey limestone, fine-grained, shale interbedded - 7/8 joints | | U | 1 | B | F | VC-M | SU | | | | | |
| 19.58 | HQ 19 | 100 | 70 | 21.13 | Light grey limestone, fine-grained, shale interbedded - 15 joints | | U | 1 | B | F | VC-C | RU-SU | | | | - 3" clay seam at 19.61 m | |
| 21.13 | HQ 20 | 100 | 74 | 22.58 | Light grey limestone, fine-grained, shale interbedded - 15 joints | | U | 1 | B | F | VC-C | RU-SU | | | | | |
| 22.58 | HQ 21 | 100 | 79 | 24.08 | Light grey limestone, fine-grained, shale interbedded - 13 joints | VS | U | 1 | B | F | VC-C | RU-SU | | | | | |

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| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: Marathon Drilling

Project No.: 122411046 Task 300.101
Date: January 17, 2015
Borehole No.: BH15-4
Logger: BB

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS | |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|-----------------------|--------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | | |
| 24.08 | HQ 22 | 97 | 74 | 25.63 | Light grey limestone, fine-grained, shale interbedded - 13 joints | | U | 1 | B | F | VC-C | SU | | | | | Water Return |
| 25.63 | HQ 23 | 99 | 86 | 27.23 | Light grey limestone, fine-grained, shale interbedded - 9 joints | | U | 1 | B | F | C | SU-SP | | | | | Water Return |
| 27.23 | HQ 24 | 100 | 94 | 28.75 | Light grey limestone, fine-grained, shale interbedded - 8 joints | VS | U | 1 | B | F | VC-C | SU | | | | | Water Return |
| 28.75 | HQ 25 | 97 | 86 | 30.2 | Light grey limestone, fine-grained, shale interbedded - 8 joints | | U | 1 | B | F | C | SU | | | | | Water Return |

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| <p>STRENGTH (MPa) EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: Marathon Drilling

Project No.: 122411046 Task 300.101
Date: January 17, 2015
Borehole No.: BH15-4
Logger: BB

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS | |
|--|---------|-----------------|-------|----------|---|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|-----------------------|--------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | | |
| 30.2 | HQ 26 | 100 | 98 | 31.65 | Light grey limestone, fine-grained, shale interbedded - 7 joints | | U | 1 | B | F | VC-C | SU-SP | | | | | Water Return |
| 31.65 | HQ 27 | 100 | 96 | 33.17 | Light grey limestone, fine-grained, shale interbedded - 7 joints | VS | U | 1 | B | F | C-M | SU-SP | | | | | Water Return |
| 33.17 | HQ 28 | 100 | 86 | 34.7 | Light grey limestone, fine-grained, shale interbedded - 9 joints | | U | 1 | B | F | VC-C | SU | | | | | Water Return |
| | | | | | | | | | | | | | | | | | |
| <p> STRENGTH (MPa) EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25 VW = Very Weak = 1-5 EW = Extremely Weak = < 1 </p> <p> DISCONTINUITY TYPE B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane </p> <p> ORIENTATION F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50° </p> <p> ROUGHNESS RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar </p> <p> WEATHERING U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like </p> <p> SPACING VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm </p> <p> FILLING T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay </p> | | | | | | | | | | | | | | | | | |

Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: Marathon Drilling

Project No.: 122411046 Task 300.101
Date: January 10, 2015
Borehole No.: BH15-5
Logger: KP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---|-----------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 4.93 | HQ8 | 100 | 72 | 5.84 | Grey limestone - 5 joints | | M | 1 | B | F | VC-M | RU | | | Moderate amount of rock frag btw joints | |
| 5.84 | HQ9 | 97 | 85 | 7.39 | Grey limestone - 6 joints | | S | 1 | B | F | C-M | RU | | | | |
| 7.39 | HQ10 | 100 | 91 | 8.81 | Grey limestone - 6 joints | | M | 1 | B | F | VC-M | RP | | | | |
| 8.81 | HQ11 | 100 | 96 | 10.41 | Grey limestone - 4 joints | | S | 1 | B | F | C-M | RP | | | | |

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| <p>STRENGTH (MPa) EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> | <p>DISCONTINUITY TYPE B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> | <p>ORIENTATION F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> | <p>FILLING T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
| <p>WEATHERING U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>SPACING VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ROUGHNESS RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | |

Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: Marathon Drilling

Project No.: 122411046 Task 300.101
Date: January 10, 2015
Borehole No.: BH15-5
Logger: KP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS | |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|-----------------------|--|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | | |
| 10.41 | HQ12 | 94 | 88 | 11.94 | Grey limestone with shale seams - 6 joints | | S | 1 | B | F | C-M | RP-SU | | | | | |
| 11.94 | HQ13 | 100 | 95 | 13.44 | Grey limestone with shale seams - 4 joints | VS | S | 1 | B | F | C-M | RU-RP | | | | | |
| 13.44 | HQ14 | 100 | 91 | 14.94 | Grey limestone with shale seams - 8 joints | | M | 1 | B | F | VC-M | RP-SU | | | | | |
| 14.94 | HQ15 | 100 | 95 | 16.43 | Grey limestone with shale seams - 5 bedding joints | | M | 2 | B | F | C-M | SP | | | | Shear joint @ 15.93 | |
| | | | | | | | | | S | D | | | | | | | |

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| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
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Project No.: 122411046 Task 300.101
Date: January 10, 2015
Borehole No.: BH15-5
Logger: KP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS | |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|-----------------------|--|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | | |
| 16.43 | HQ16 | 97 | 88 | 18.06 | Grey limestone with shale seams - 3 joints | | M | 1 | B | F | C-M | SP-SU | | | | | |
| 18.06 | HQ17 | 100 | 99 | 19.51 | Grey limestone with shale seams - 9 joints | | M | 1 | B | F | VC-M | SU-SP | | | | | |
| 19.51 | HQ18 | 99 | 82 | 21.01 | Grey limestone with shale seams - 15 joints | | M | 1 | B | F | VC-M | SU-SP | | | | | |
| 21.01 | HQ19 | 100 | 95 | 22.53 | Grey limestone with shale seams - 7 joints | S | M | 1 | B | F | C-M | SU-SP | | | | | |

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| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: Marathon Drilling

Project No.: 122411046 Task 300.101
Date: January 10, 2015
Borehole No.: BH15-5
Logger: KP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS | | |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------------------|-----------------------|---------|--|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | | | FILLING | |
| 22.53 | HQ20 | 100 | 81 | 24.05 | Grey limestone with shale seams - 10 joints | | M | 1 | B | F | C-M | SU-SP | | | | | |
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| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: Marathon Drilling

Project No.: 122411046 Task 300.101
Date: January 5, 2015
Borehole No.: BH15-6
Logger: KP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS | |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|-----------------------|--|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | | |
| 3.89 | NQ7 | 68 | 0 | 3.99 | Grey limestone - 2 joints | | S | 1 | B | F | VC | SU | | | | | |
| 3.99 | NQ8 | 100 | 84 | 5.59 | Grey limestone - 7 joints | VS | S | 1 | B | F | C-M | SU | | | | | |
| 5.59 | NQ9 | 96 | 80 | 7.14 | Grey limestone - 8 joints | | S | 1 | B | F | VC-M | SU | | | | | |
| 7.14 | NQ10 | 97 | 73 | 8.66 | Grey limestone - 10 joints | | S | 1 | B | F | C-M | SU | | | | | |

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| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: Marathon Drilling

Project No.: 122411046 Task 300.101
Date: January 5, 2015
Borehole No.: BH15-6
Logger: KP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS | | |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|-----------------------|----------------------|--|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | | | |
| 8.366 | NQ11 | 100 | 90 | 10.19 | Grey limestone, sand & silt fillings - 7 joints | | S | 1 | B | F | VC-M | SU | | | | | | |
| 10.19 | NQ12 | 100 | 91 | 11.63 | Grey limestone - 6 joints | | S | 2 | B | F | VC-M | RU-SP | | | | | Shear joint at 10.72 | |
| 11.63 | NQ13 | 95 | 91 | 13.23 | Grey limestone, sand & silt fillings - 5 joints | | M | 1 | B | F | C-M | RP-SU | | | | | | |
| 13.23 | NQ14 | 98 | 90 | 14.73 | Grey limestone, sand & silt fillings - 8 joints | | M | 1 | B | F | VC-M | RU-SP | | | | | | |

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| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: Marathon Drilling

Project No.: 122411046 Task 300.101
Date: January 5, 2015
Borehole No.: BH15-6
Logger: KP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|-----------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 14.73 | NQ15 | 98 | 82 | 16.31 | Grey limestone, sand & silt fillings - 7 joints | | M | 1 | B | F | VC-M | RP | | Si | | |
| 16.31 | NQ16 | 100 | 89 | 17.68 | Grey limestone - 5 joints | VS | S | 1 | B | F | C-M | SP | | | | |
| 17.68 | NQ17 | 100 | 65 | 19.3 | Grey limestone, sand & silt fillings - 12 joints | | M | 1 | B | F | VC-C | RU-SU | | Si | | |
| 19.3 | NQ18 | 100 | 66 | 20.85 | Grey limestone, sand & silt fillings - 17 joints | | M | 1 | B | F | VC-C | RP-SP | | Si | | |

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| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: Marathon Drilling

Project No.: 122411046 Task 300.101
Date: January 5, 2015
Borehole No.: BH15-6
Logger: KP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS | |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------------------|-----------------------|---------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | | | FILLING |
| 20.85 | NQ19 | 100 | 84 | 22.40 | Grey limestone, sand & silt fillings - 11 joints | | M | 1 | B | F | VC-C | RU-SP | | Si | | |
| 22.40 | NQ20 | 95 | 68 | 23.90 | Grey limestone, sand & silt fillings - 10 joints | | M | 1 | B | F | VC-C | RU-SP | | Si | | |
| | | | | | | | | | | | | | | | | |
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| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: Marathon Drilling

Project No.: 122411046 Task 300.101
Date: January 15, 2015
Borehole No.: BH15-7
Logger: KP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|--|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|-----------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 3.30 | HQ6 | 100 | 60 | 4.29 | Grey limestone - 10 joints | | M | 1 | B | F | VC-M | RU-RP | | | | |
| 4.29 | HQ7 | 100 | 94 | 5.69 | grey limestone - 5 joints | | M | 1 | B | F | VC-M | SU | | | | |
| 5.69 | HQ8 | 100 | 90 | 7.32 | Grey limestone with shale seams - 11 joints | | M | 1 | B | F | VC-M | SU-SP | | | | |
| 7.32 | HQ9 | 100 | 99 | 8.84 | Grey limestone with shale seams - 9 joints | | M | 1 | B | F | C | RP-SP | | | | |
| 8.84 | HQ10 | 100 | 100 | 10.34 | Grey limestone with shale seams - 3 joints | VS | M | 1 | B | F | M | RU | | | | |
| <p> <u>STRENGTH (MPa)</u> EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25 VW = Very Weak = 1-5 EW = Extremely Weak = < 1 </p> <p> <u>DISCONTINUITY TYPE</u> B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane </p> <p> <u>ORIENTATION</u> F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50° </p> <p> <u>WEATHERING</u> U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like </p> <p> <u>SPACING</u> VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm </p> <p> <u>ROUGHNESS</u> RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar </p> <p> <u>FILLING</u> T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay </p> | | | | | | | | | | | | | | | | |

Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: Marathon Drilling

Project No.: 122411046 Task 300.101
Date: January 15, 2015
Borehole No.: BH15-7
Logger: KP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------------------|-----------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | | |
| 10.34 | HQ11 | 100 | 96 | 11.86 | Grey limestone with shale seams - 6 joints | | S | 1 | B | F | VC-M | SU | | | |
| 11.86 | HQ12 | 96 | 90 | 13.39 | Grey limestone with shale seams - 8 joints | | S | 1 | B | F | C-M | SU-SP | | | |
| 13.39 | HQ13 | 100 | 95 | 14.91 | Grey limestone with shale seams - 7 joints | | M | 1 | B | F | VC-M | RU-RP | | | |
| 14.91 | HQ14 | 95 | 89 | 16.51 | Grey limestone with shale seams, sand and silt fillings - 7 joints | | H | 1 | B | F | C-M | SU-SP | Si | | |

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| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: Marathon Drilling

Project No.: 122411046 Task 300.101
Date: January 15, 2015
Borehole No.: BH15-7
Logger: KP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|------------|---------|-----------------|-------|----------|---|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------------------|-----------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | | |
| 16.51 | HQ15 | 100 | 96 | 17.75 | Grey limestone with shale seams - 8 joints | | M | 1 | B | F | VC-M | RU-SU | | | |
| 17.75 | HQ16 | 98 | 79 | 19.33 | Grey limestone with shale seams, sand & silt fillings - 11 joints | | M | 1 | B | F | C | SP-RP | | Si | |
| 19.33 | HQ17 | 100 | 69 | 20.88 | Grey limestone with shale seams, sand & silt fillings - 11 joints | | M | 1 | B | F | VC-M | SU-SP | | Si | |
| 20.88 | HQ18 | 100 | 77 | 22.5 | Grey limestone with shale seams, sand & silt fillings - 12 joints | VS | M | 1 | B | F | C-M | RP-SP | | Si | |

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| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: Marathon Drilling

Project No.: 122411046 Task 300.101
Date: January 9, 2015
Borehole No.: BH15-8
Logger: KP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS | |
|------------|---------|-----------------|-------|----------|---|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|-----------------------|--|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | | |
| 4.57 | NQ7 | 100 | 73 | 5.56 | Grey limestone - 5 joints | VS | M | 1 | B | F | VC-M | RU | | | | | |
| 5.56 | NQ8 | 100 | 80 | 7.06 | Grey limestone, 60 mm of sand & silt fillings at approx. 6.07 & fillings @ other joints - 12 joints | | M | 1 | B | F | VC-C | RU | | Si | | | |
| 7.06 | NQ9 | 96 | 75 | 8.66 | Grey limestone, 50 mm of sand & silt fillings at 8.61 & fillings @ other joints - 10 joints | | M | 1 | B | F | C-M | RP | | Si | | | |
| 8.66 | NQ10 | 100 | 100 | 10.11 | Grey limestone - 7 joints | | M | 1 | B | F | C-M | RU-RP | | | | | |

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| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: Marathon Drilling

Project No.: 122411046 Task 300.101
Date: January 9, 2015
Borehole No.: BH15-8
Logger: KP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|-----------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 10.11 | NQ11 | 100 | 95 | 11.58 | Grey limestone with shale seams, sand & silt fillings - 6 joints | | M | 1 | B | F | VC-M | SP-SU | | Si | | |
| 11.58 | NQ12 | 100 | 87 | 13.16 | Grey limestone with shale seams, sand & silt fillings - 8 joints | | M | 1 | B | F | C-M | RP-SU | | Si | | |
| 13.16 | NQ13 | 92 | 84 | 14.78 | Grey limestone with shale seams, sand & silt fillings - 6 joints | | M | 1 | B | F | VC-M | SP-SU | | Si | | |
| 14.78 | NQ14 | 100 | 100 | 16.28 | Grey limestone with shale seams - 5 joints | | M | 1 | B | F | C-M | RP-SP | | | | |

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| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: Marathon Drilling

Project No.: 122411046 Task 300.101
Date: January 9, 2015
Borehole No.: BH15-8
Logger: KP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|-----------------------|-----------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 16.28 | NQ15 | 98 | 74 | 17.78 | Grey limestone with shale seams - 10 joints | | M | 1 | B | F | C-M | RP-RP | | Si | Clay joint at 17.02 m | |
| 17.78 | NQ16 | 100 | 94 | 19.30 | Grey limestone with shale seams - 7 joints | VS | M | 1 | B | F | C-M | SP-SU | | | | |
| 19.30 | NQ17 | 94 | 63 | 20.83 | Grey limestone with shale seams - 15 joints | | M | 1 | B | F | VC-C | RU-SP | | | | |
| 20.83 | NQ18 | 100 | 78 | 22.15 | Grey limestone with shale seams, sand & silt fillings - 7 joints | | M | 1 | B | F | VC-M | RP-RU | | Si | | |

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|--|--|---|--|
| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: Marathon Drilling

Project No.: 122411046 Task 300.101
Date: January 17, 2015
Borehole No.: BH15-9
Logger: KP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|--|-----------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 0.71 | HQ2 | 96 | 16 | 1.32 | Grey limestone, sand & silt fillings - 4 joints | | H | 1 | B | F | VC-C | RU | | Si | Top 0.25 m highly fractured rounded pieces | |
| 1.32 | HQ3 | 95 | 79 | 2.87 | Grey limestone - 6 joints | | M | 1 | B | F | VC-M | RU | | Si | Highly weathered b/w 2.06 to 2.41 m | |
| 2.87 | HQ4 | 100 | 93 | 4.39 | Grey limestone with shale seams - 4 joints | | S | 1 | B | F | C-M | RU | | Si | | |
| 4.39 | HQ5 | 100 | 98 | 5.94 | Grey limestone with shale seams - 5 joints | VS | S | 1 | B | F | VC-M | RU | | Si | | |

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| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: Marathon Drilling

Project No.: 122411046 Task 300.101
Date: January 17, 2015
Borehole No.: BH15-9
Logger: KP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|--------------------------------------|-----------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 5.94 | HQ6 | 100 | 82 | 7.42 | Grey limestone with shale seams, sand & silt fillings - 5 joints | | M | 1 | B | F | VC-M | RU | | Si | | |
| 7.42 | HQ7 | 100 | 85 | 8.92 | Grey limestone with shale seams, sand & silt fillings - 9 joints | | M | 1 | B | F | VC-M | RU | | Si | Silt joint at 7.52 m | |
| 8.92 | HQ8 | 100 | 98 | 10.46 | Grey limestone with shale seams, sand & silt fillings - 6 joints | | M | 2 | B | F-D | VC-M | RP | | Si | Highly weathered rock frag @ 10.16 m | |
| 10.46 | HQ9 | 100 | 100 | 11.99 | Grey limestone with shale seams, sand & silt fillings - 3 joints | | S | 1 | B | F | C-M | SU | | T | | |

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| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: Marathon Drilling

Project No.: 122411046 Task 300.101
Date: January 17, 2015
Borehole No.: BH15-9
Logger: KP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|------------|---------|-----------------|-------|----------|---|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|--|-----------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 11.99 | HQ10 | 94 | 83 | 13.51 | Grey limestone with shale seams - 8 joints | | M | 1 | B | F | VC-M | RU | | Si | Core covered in chalk/silt like material | |
| 13.51 | HQ11 | 100 | 96 | 15.01 | Grey limestone with shale seams - 6 joints | | S | 1 | B S | F D | VC-M | RU | | | Shear joint at 14.0 m | |
| 15.01 | HQ12 | 100 | 84 | 16.54 | Grey limestone with shale seams, sand & silt fillings - 10 joints | | M | 1 | B | F | VC-M | RU | | Si | Highly weathered rock at 15.98 - 16.1 m | |
| 16.54 | HQ13 | 95 | 88 | 18.08 | Grey limestone with shale seams - 10 joints | | M | 1 | B | F | VC-M | RP | | T | | |

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| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: Marathon Drilling

Project No.: 122411046 Task 300.101
Date: January 17, 2015
Borehole No.: BH15-9
Logger: KP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|------------|---------|-----------------|-------|----------|---|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|--|-----------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 18.08 | HQ14 | 98 | 69 | 19.61 | Grey limestone with shale seams - 16 joints | | M | 1 | B | F | VC-C | RU-RP | | | Clay seam at 18.08 - 18.11 | |
| 19.61 | HQ15 | 100 | 94 | 21.16 | Grey limestone with shale seams - 11 joints | VS | M | 1 | B | F | VC-M | RU | | | | |
| 21.16 | HQ16 | 100 | 83 | 22.58 | Grey limestone with shale seams - 9 joints | | M | 1 | B | F | VC-M | RP-RU | | | Highly weathered rock frag @ 21.16-21.29 | |
| 22.58 | HQ17 | 98 | 76 | 24.10 | Grey limestone with shale seams, sand & silt fillings - 15 joints | | M | 1 | B | F | VC-C | RP | | | | |

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| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: OGS Drilling Inc.

Project No.: 122411046 Task 300.101
Date: January 13, 2015
Borehole No.: BH15-10
Logger: KP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|-----------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 0.28 | HQ1 | 100 | 100 | 0.51 | Grey limestone; 5 bedding joints | | U | 1 | B | F | C | SP | | T | | |
| 0.51 | NQ2 | 98 | 64 | 1.73 | Grey limestone with dark grey shale partings; 5 bedding joints | | U | 1 | B | F | C | SP | | T | | |
| 1.73 | NQ3 | 96 | 73 | 2.95 | Grey limestone with dark grey shale partings; 3 bedding joints | | U | 1 | B | F | C | SP | | T | | |
| 2.95 | NQ4 | 99 | 53 | 4.09 | Grey limestone with dark grey shale partings; 4 bedding joints | | U | 1 | B | F | C | SP | | T | | |

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| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: OGS Drilling Inc.

Project No.: 122411046 Task 300.101
Date: January 13, 2015
Borehole No.: BH15-10
Logger: KP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|-----------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 4.17 | NQ5 | 98 | 69 | 5.54 | Grey limestone with dark shale partings, 4 bedding joints | | U | 1 | B | F | C | SP | | T | | |
| 5.54 | NQ6 | 98 | 78 | 6.90 | Grey limestone with dark shale partings; 8 bedding joints | VS | U | 1 | B | F | C | SP | | T | | |
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| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: OGS Drilling Inc.

Project No.: 122411046 Task 300.101
Date: January 11, 2015
Borehole No.: BH15-11
Logger: KP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|--|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|-----------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 1.91 | NQ2 | 97 | 34 | 2.90 | Grey limestone with dark grey shale partings; 6 bedding joints | S | U | 1 | B | F | C | SP | | T | | |
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| <p> STRENGTH (MPa) EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25 VW = Very Weak = 1-5 EW = Extremely Weak = < 1 </p> <p> DISCONTINUITY TYPE B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane </p> <p> ORIENTATION F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50° </p> <p> ROUGHNESS RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar </p> <p> FILLING T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay </p> <p> WEATHERING U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like </p> <p> SPACING VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm </p> | | | | | | | | | | | | | | | | |

Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: OGS Drilling Inc.

Project No.: 122411046 Task 300.101
Date: January 10, 2015
Borehole No.: BH15-12
Logger: KP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|-----------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 3.35 | HQ1 | 100 | 100 | 0.51 | Grey limestone with dark grey shale partings | | U | 1 | B | F | C | SP | | T | | |
| 0.51 | NQ2 | 90 | 80 | 1.68 | Grey limestone with dark grey shale partings; 5 bedding joints | | U | 1 | B | F | C | SP | | T | | |
| 1.68 | NQ3 | 100 | 94 | 2.74 | Grey limestone with dark grey shale partings; 5 bedding joints | VS | U | 1 | B | F | C | SP | | T | | |
| 2.74 | NQ4 | 100 | 78 | 3.86 | Grey limestone with dark grey shale partings; 6 bedding joints | | U | 1 | B | F | C | SP | | T | | |

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| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: OGS Drilling Inc.

Project No.: 122411046 Task 300.101
Date: January 9, 2015
Borehole No.: BH15-12
Logger: KP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|-----------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 3.86 | NQ7 | 100 | 54 | 4.45 | Grey limestone with dark shale partings; 4 bedding joints | | U | 1 | B | F | C | SP | | T | | |
| 4.45 | NQ8 | 100 | 98 | 5.64 | Grey limestone with dark shale partings; 5 bedding joints | | U | 1 | B | F | C | SP | | T | | |
| 5.64 | NQ9 | 100 | 61 | 6.70 | Grey limestone with dark shale partings; 6 bedding joints | | U | 1 | B | F | C | SP | | T | | |
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| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: OGS Drilling Inc.

Project No.: 122411046 Task 300.101
Date: January 9, 2015
Borehole No.: BH15-13
Logger: KP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS | | | | |
|--|--|---|--|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|-----------------------|--|--|---|--|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | | | | | |
| 0.15 | NQ1 | 100 | 100 | 0.3 | Grey limestone with dark grey shale partings | | U | 1 | B | F | C | SP | | T | | | | | | |
| 0.3 | NQ2 | 98 | 68 | 1.5 | Grey limestone with dark grey shale partings; 6 bedding joints | | U | 1 | B | F | C | SP | | T | | | | | | |
| 1.5 | NQ3 | 100 | 73 | 2.49 | Grey limestone with dark grey shale partings; 5 bedding joints | | U | 1 | B | F | C | SP | | T | | | | | | |
| 2.49 | NQ4 | 100 | 90 | 3.51 | Grey limestone with dark grey shale partings; 3 bedding joints | | U | 1 | B | F | C | SP | | T | | | | | | |
| <table border="0" style="width:100%; border:none;"> <tr> <td style="width:25%; vertical-align:top;"> <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> </td> <td style="width:25%; vertical-align:top;"> <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> </td> <td style="width:25%; vertical-align:top;"> <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> </td> <td style="width:25%; vertical-align:top;"> <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> </td> </tr> </table> | | | | | | | | | | | | | | | | | <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: OGS Drilling Inc.

Project No.: 122411046 Task 300.101
Date: January 9, 2015
Borehole No.: BH15-13
Logger: KP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS | | | | | | | | |
|---|--|--|---|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|-----------------------|--|---|---|---|--|--|--|---|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | | | | | | | | | |
| 3.51 | NQ5 | 96 | 74 | 4.67 | Grey limestone with dark grey shale partings; 6 bedding joints | | U | 1 | B | F | C | SP | | T | | | | | | | | | | |
| 4.67 | NQ6 | 100 | 100 | 5.77 | Grey limestone with dark grey shale partings | VS | U | 1 | B | F | C | SP | | T | | | | | | | | | | |
| 5.77 | NQ7 | 100 | 82 | 7.00 | Grey limestone with dark grey shale partings | | U | 1 | B | F | C | SP | | T | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| <table border="0" style="width:100%"> <tr> <td style="width:25%"> <u>STRENGTH (MPa)</u> EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25 </td> <td style="width:25%"> VW = Very Weak = 1-5 EW = Extremely Weak = < 1 </td> <td style="width:25%"> <u>DISCONTINUITY TYPE</u> B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane </td> <td style="width:25%"> <u>ORIENTATION</u> F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50° </td> </tr> <tr> <td> <u>WEATHERING</u> U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like </td> <td> <u>SPACING</u> VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm </td> <td> <u>ROUGHNESS</u> RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar </td> <td> <u>FILLING</u> T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay </td> </tr> </table> | | | | | | | | | | | | | | | | | <u>STRENGTH (MPa)</u> EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25 | VW = Very Weak = 1-5 EW = Extremely Weak = < 1 | <u>DISCONTINUITY TYPE</u> B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane | <u>ORIENTATION</u> F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50° | <u>WEATHERING</u> U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like | <u>SPACING</u> VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm | <u>ROUGHNESS</u> RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar | <u>FILLING</u> T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay |
| <u>STRENGTH (MPa)</u> EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25 | VW = Very Weak = 1-5 EW = Extremely Weak = < 1 | <u>DISCONTINUITY TYPE</u> B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane | <u>ORIENTATION</u> F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50° | | | | | | | | | | | | | | | | | | | | | |
| <u>WEATHERING</u> U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like | <u>SPACING</u> VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm | <u>ROUGHNESS</u> RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar | <u>FILLING</u> T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay | | | | | | | | | | | | | | | | | | | | | |

Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: OGS Drilling Inc.

Project No.: 122411046 Task 300.101
Date: January 8, 2015
Borehole No.: BH15-14
Logger: ZP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS | |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------------------|-----------------------|---------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | | | FILLING |
| 0.18 | HQ1 | 100 | 100 | 0.51 | Grey limestone with shale partings | | U | 0 | - | - | - | - | - | - | | |
| 0.51 | NQ2 | 93 | 78 | 1.50 | Grey limestone with shale partings; 5 bedding joints | VS | U | 1 | B | F-D | C | SU | | SA | | |
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|--|--|---|--|
| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: OGS Drilling Inc.

Project No.: 122411046 Task 300.101
Date: January 8, 2015
Borehole No.: BH15-15
Logger: ZP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS | |
|------------|---------|-----------------|-------|----------|---|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------------------|-----------------------|---------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | | | FILLING |
| 0.76 | NQ1 | 100 | 88 | 1.78 | Dark grey limestone with shale partings; 3 bedding joints | S | U | 1 | | F | C | SP | | T | | |
| 1.78 | NQ2 | 100 | 81 | 2.69 | Dark grey limestone with shale partings; 5 bedding joints | | U | 1 | B | F | C | SP | | T | | |
| 2.69 | NQ3 | 100 | 88 | 3.76 | Grey limestone with dark grey shale bedding; 6 bedding joints - 1 cm thick shale at 3.73 m | | U | 1 | B | F | C | SP | | T | | |
| 3.76 | NQ4 | 100 | 75 | 4.98 | Grey limestone with dark grey shale partings; 6 bedding joints | | U | 1 | B | F | C | SP | | T | | |

| | | | |
|--|---|---|--|
| <p>STRENGTH (MPa) EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> | <p>DISCONTINUITY TYPE B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> | <p>ORIENTATION F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> | <p>FILLING T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
| <p>WEATHERING U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>SPACING VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ROUGHNESS RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | |

Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: OGS Drilling Inc.

Project No.: 122411046 Task 300.101
Date: January 8, 2015
Borehole No.: BH15-15
Logger: ZP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|----------------------|-----------------------|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 4.98 | NQ5 | 100 | 88 | 6.20 | Grey limestone with dark grey shale partings | | U | 1 | B | F | C | SP | | T | | |
| 6.20 | NQ6 | 100 | 100 | 7.00 | Grey limestone with dark grey shale partings | | U | 1 | B | F | C | SP | | T | - sand seam at 6.4 m | |
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| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
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Client: Public Works and Government Services Canada
Project: Centre Block Preliminary Geotechnical Investigation
Contractor: OGS Drilling Inc.

Project No.: 122411046 Task 300.101
Date: January 7, 2015
Borehole No.: BH15-16
Logger: ZP

| DEPTH FROM | RUN NO. | % CORE RECOVERY | % RQD | DEPTH TO | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS | |
|------------|---------|-----------------|-------|----------|--|----------|------------|-----------------|--------|-------------|---------|-----------|----------|---------|---------------------|-----------------------|--|
| | | | | | | | | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | | |
| 1.09 | HQ1 | 100 | 100 | 1.32 | Grey limestone with shale partings | | S | N/A | | | | | | | | | |
| 1.32 | NQ2 | 97 | 31 | 2.20 | Grey limestone with shale partings; 5 bedding joints | | M | 1 | B | F | VC-C | SU | | SA | | | |
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|--|--|---|--|
| <p>STRENGTH (MPa)</p> <p>EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25</p> <p>WEATHERING</p> <p>U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like</p> | <p>DISCONTINUITY TYPE</p> <p>B = Bedding Joint J = Cross Joint F = Fault S = Shear Plane</p> <p>SPACING</p> <p>VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm</p> | <p>ORIENTATION</p> <p>F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50°</p> <p>ROUGHNESS</p> <p>RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar</p> | <p>FILLING</p> <p>T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay</p> |
|--|--|---|--|



Project No.: 122411046

Project Name: Centre Block Geotechnical Investigation, Parliament Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 1

Borehole: BH15-1

Depth: 0.45 to 2.74 m



Rock Core Photo No.: 2

Borehole: BH15-1

Depth: 2.74 to 5.13 m



Project No.: 122411046

Project Name: Centre Block Geotechnical
Investigation, Parliament Hill,
Ottawa, ON

Rockcore
Photographs



Rock Core Photo No.: 3

Borehole: BH15-1

Depth: 5.13 to 7.47 m



Rock Core Photo No.: 4

Borehole: BH15-1

Depth: 7.47 to 9.93 m



Project No.: 122411046

Project Name: Centre Block Geotechnical Investigation, Parliament Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 5

Borehole: BH15-1

Depth: 9.93 to 12.42 m



Rock Core Photo No.: 6

Borehole: BH15-1

Depth: 12.42 to 14.78 m



Project No.: 122411046

Rockcore Photographs

Project Name: Centre Block Geotechnical
Investigation, Parliament Hill,
Ottawa, ON



Rock Core Photo No.: 7

Borehole: BH15-1

Depth: 14.78 to 17.19 m



Rock Core Photo No.: 8

Borehole: BH15-1

Depth: 17.19 to 19.84 m



Project No.: 122411046

Project Name: Centre Block Geotechnical
Investigation, Parliament Hill,
Ottawa, ON

Rockcore
Photographs



Rock Core Photo No.: 9

Borehole: BH15-1

Depth: 19.84 to 22.32 m



Rock Core Photo No.: 10

Borehole: BH15-1

Depth: 22.32 to 24.00 m



Project No.: 122411046

Project Name: Centre Block Geotechnical Investigation, Parliament Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 11

Borehole: BH15-2

Depth: 0.66 to 3.10 m



Rock Core Photo No.: 12

Borehole: BH15-2

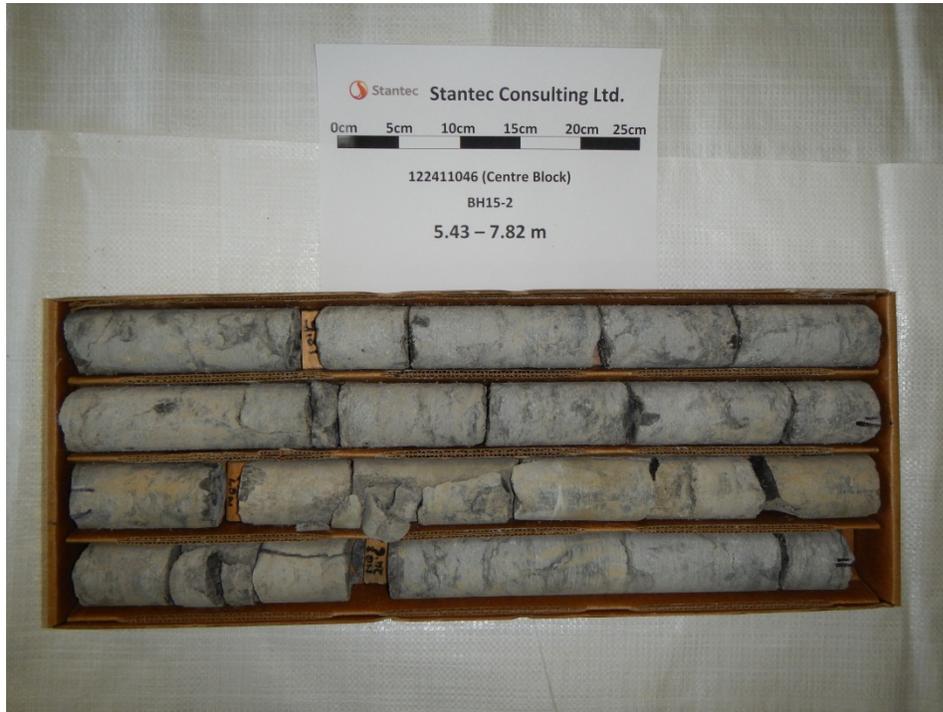
Depth: 3.10 to 5.43 m



Project No.: 122411046

Project Name: Centre Block Geotechnical Investigation, Parliament Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 13

Borehole: BH15-2

Depth: 5.43 to 7.82 m



Rock Core Photo No.: 14

Borehole: BH15-2

Depth: 7.82 to 10.26 m



Project No.: 122411046

Project Name: Centre Block Geotechnical Investigation, Parliament Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 15

Borehole: BH15-2

Depth: 10.26 to 12.70 m



Rock Core Photo No.: 16

Borehole: BH15-2

Depth: 12.70 to 15.06 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 17

Borehole: BH15-2

Depth: 15.06 to 17.35 m



Rock Core Photo No.: 18

Borehole: BH15-2

Depth: 17.35 to 19.78 m



Project No.: 122411046

Rockcore Photographs

Project Name: Centre Block Geotechnical Investigation, Parliament Hill, Ottawa, ON



Rock Core Photo No.: 19

Borehole: BH15-2

Depth: 19.78 to 22.99 m



Rock Core Photo No.: 20

Borehole: BH15-2

Depth: 22.99 to 24.00 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 21

Borehole: BH15-3

Depth: 0.66 to 3.10 m



Rock Core Photo No.: 22

Borehole: BH15-3

Depth: 3.10 to 5.36 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 23

Borehole: BH15-3

Depth: 5.36 to 7.69 m



Rock Core Photo No.: 24

Borehole: BH15-3

Depth: 7.69 to 10.16 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 25

Borehole: BH15-3

Depth: 10.16 to 12.75 m



Rock Core Photo No.: 26

Borehole: BH15-3

Depth: 12.75 to 15.24 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 27

Borehole: BH15-3

Depth: 15.24 to 17.73 m



Rock Core Photo No.: 28

Borehole: BH15-3

Depth: 17.73 to 20.24 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 29

Borehole: BH15-3

Depth: 20.24 to 22.99 m



Rock Core Photo No.: 30

Borehole: BH15-3

Depth: 22.99 to 24.00 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 31

Borehole: BH15-4

Depth: 3.40 to 5.97 m



Rock Core Photo No.: 32

Borehole: BH15-4

Depth: 5.97 to 8.74 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 33

Borehole: BH15-4

Depth: 8.74 to 11.35 m



Rock Core Photo No.: 34

Borehole: BH15-4

Depth: 11.35 to 14.10 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 35

Borehole: BH15-4

Depth: 14.10 to 15.11 m



Rock Core Photo No.: 36

Borehole: BH15-4

Depth: 15.11 to 18.03 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 37

Borehole: BH15-4

Depth: 18.03 to 20.80 m



Rock Core Photo No.: 38

Borehole: BH15-4

Depth: 20.80 to 23.60 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 39

Borehole: BH15-4

Depth: 23.60 to 26.31 m



Rock Core Photo No.: 40

Borehole: BH15-4

Depth: 26.31 to 28.75 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 41

Borehole: BH15-4

Depth: 28.75 to 31.65 m



Rock Core Photo No.: 42

Borehole: BH15-4

Depth: 31.65 to 34.34 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 43

Borehole: BH15-4

Depth: 34.34 to 34.70 m



Rock Core Photo No.: 44

Borehole: BH15-5

Depth: 4.87 to 7.77 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 45

Borehole: BH15-5

Depth: 7.77 to 10.51 m



Rock Core Photo No.: 46

Borehole: BH15-5

Depth: 10.51 to 13.43 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 47

Borehole: BH15-5

Depth: 13.43 to 16.43 m



Rock Core Photo No.: 48

Borehole: BH15-5

Depth: 16.43 to 19.28 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 49

Borehole: BH15-5

Depth: 19.28 to 22.15 m



Rock Core Photo No.: 50

Borehole: BH15-5

Depth: 22.15 to 24.00 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 51

Borehole: BH15-6

Depth: 3.91 to 8.18 m



Rock Core Photo No.: 52

Borehole: BH15-6

Depth: 8.18 to 12.32 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 53

Borehole: BH15-6

Depth: 12.32 to 16.56 m



Rock Core Photo No.: 54

Borehole: BH15-6

Depth: 16.56 to 20.73 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 55

Borehole: BH15-6

Depth: 20.73 to 23.90 m



Rock Core Photo No.: 56

Borehole: BH15-7

Depth: 3.30 to 5.89 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 57

Borehole: BH15-7

Depth: 5.89 to 8.69 m



Rock Core Photo No.: 58

Borehole: BH15-7

Depth: 8.69 to 11.51 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 59

Borehole: BH15-7

Depth: 11.51 to 14.35 m



Rock Core Photo No.: 60

Borehole: BH15-7

Depth: 14.35 to 17.12 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 61

Borehole: BH15-7

Depth: 17.12 to 19.62 m



Rock Core Photo No.: 62

Borehole: BH15-7

Depth: 19.62 to 22.25 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 63

Borehole: BH15-7

Depth: 22.25 to 24.00 m



Rock Core Photo No.: 64

Borehole: BH15-8

Depth: 4.52 to 8.66 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 65

Borehole: BH15-8

Depth: 8.66 to 12.52 m



Rock Core Photo No.: 66

Borehole: BH15-8

Depth: 12.52 to 16.51 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 67

Borehole: BH15-8

Depth: 16.51 to 20.70 m



Rock Core Photo No.: 68

Borehole: BH15-8

Depth: 20.70 to 23.60 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 69

Borehole: BH15-9

Depth: 0.71 to 3.25 m



Rock Core Photo No.: 70

Borehole: BH15-9

Depth: 3.25 to 5.76 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 71

Borehole: BH15-9

Depth: 5.76 to 8.22 m



Rock Core Photo No.: 72

Borehole: BH15-9

Depth: 8.22 to 11.04 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 73

Borehole: BH15-9

Depth: 11.04 to 14.02 m



Rock Core Photo No.: 74

Borehole: BH15-9

Depth: 14.02 to 16.35 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 75

Borehole: BH15-9

Depth: 16.35 to 18.89 m



Rock Core Photo No.: 76

Borehole: BH15-9

Depth: 18.89 to 21.64 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 77

Borehole: BH15-9

Depth: 21.64 to 24.10 m



Rock Core Photo No.: 78

Borehole: BH15-10

Depth: 0.28 to 2.74 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 79

Borehole: BH15-10

Depth: 2.74 to 5.31 m



Rock Core Photo No.: 80

Borehole: BH15-10

Depth: 5.31 to 6.90 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 81

Borehole: BH15-11

Depth: 1.90 to 2.90 m



Rock Core Photo No.: 82

Borehole: BH15-12

Depth: 0.28 to 2.67 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 83

Borehole: BH15-12

Depth: 2.67 to 4.98 m



Rock Core Photo No.: 84

Borehole: BH15-12

Depth: 4.98 to 6.70 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

Rockcore Photographs



Rock Core Photo No.: 85

Borehole: BH15-13

Depth: 0.15 to 2.74 m



Rock Core Photo No.: 86

Borehole: BH15-13

Depth: 2.74 to 5.18 m

| | | |
|--|--|----------------------|
| | Project No.: 122411046 | Rockcore Photographs |
| | Project Name: Centre Block Geotechnical Investigation, Parliament Hill, Ottawa, ON | |



| | | |
|-------------------------|-------------------|-----------------------|
| Rock Core Photo No.: 87 | Borehole: BH15-13 | Depth: 5.18 to 7.00 m |
|-------------------------|-------------------|-----------------------|



| | | |
|-------------------------|-------------------|-----------------------|
| Rock Core Photo No.: 88 | Borehole: BH15-14 | Depth: 0.18 to 1.50 m |
|-------------------------|-------------------|-----------------------|



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

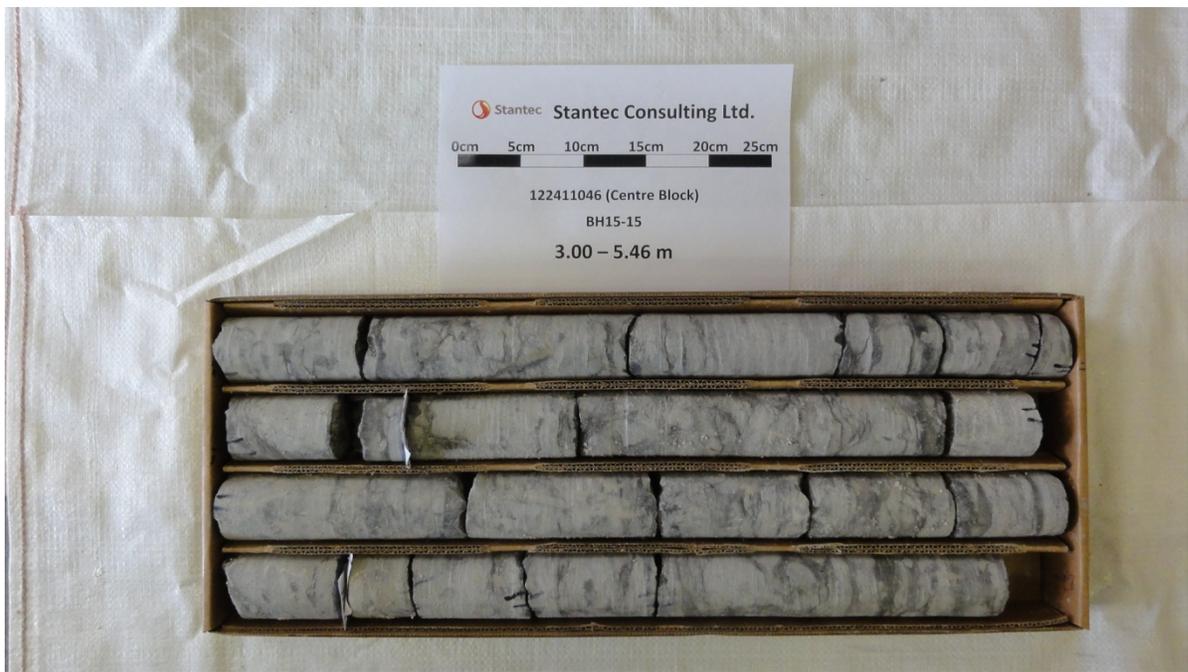
Rockcore Photographs



Rock Core Photo No.: 89

Borehole: BH15-15

Depth: 0.76 to 3.00 m



Rock Core Photo No.: 90

Borehole: BH15-15

Depth: 3.00 to 5.46 m



Project No.: 122411046

Project Name: Centre Block
Geotechnical Investigation, Parliament
Hill, Ottawa, ON

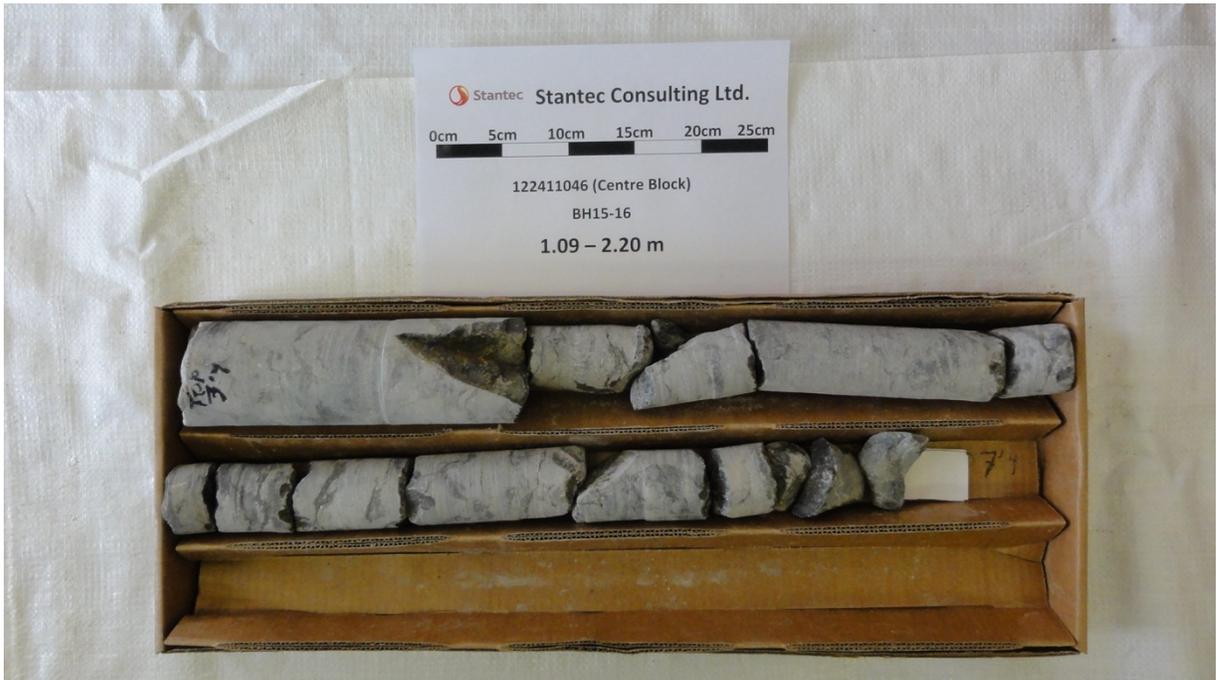
Rockcore Photographs



Rock Core Photo No.: 91

Borehole: BH15-15

Depth: 5.46 to 7.00 m



Rock Core Photo No.: 92

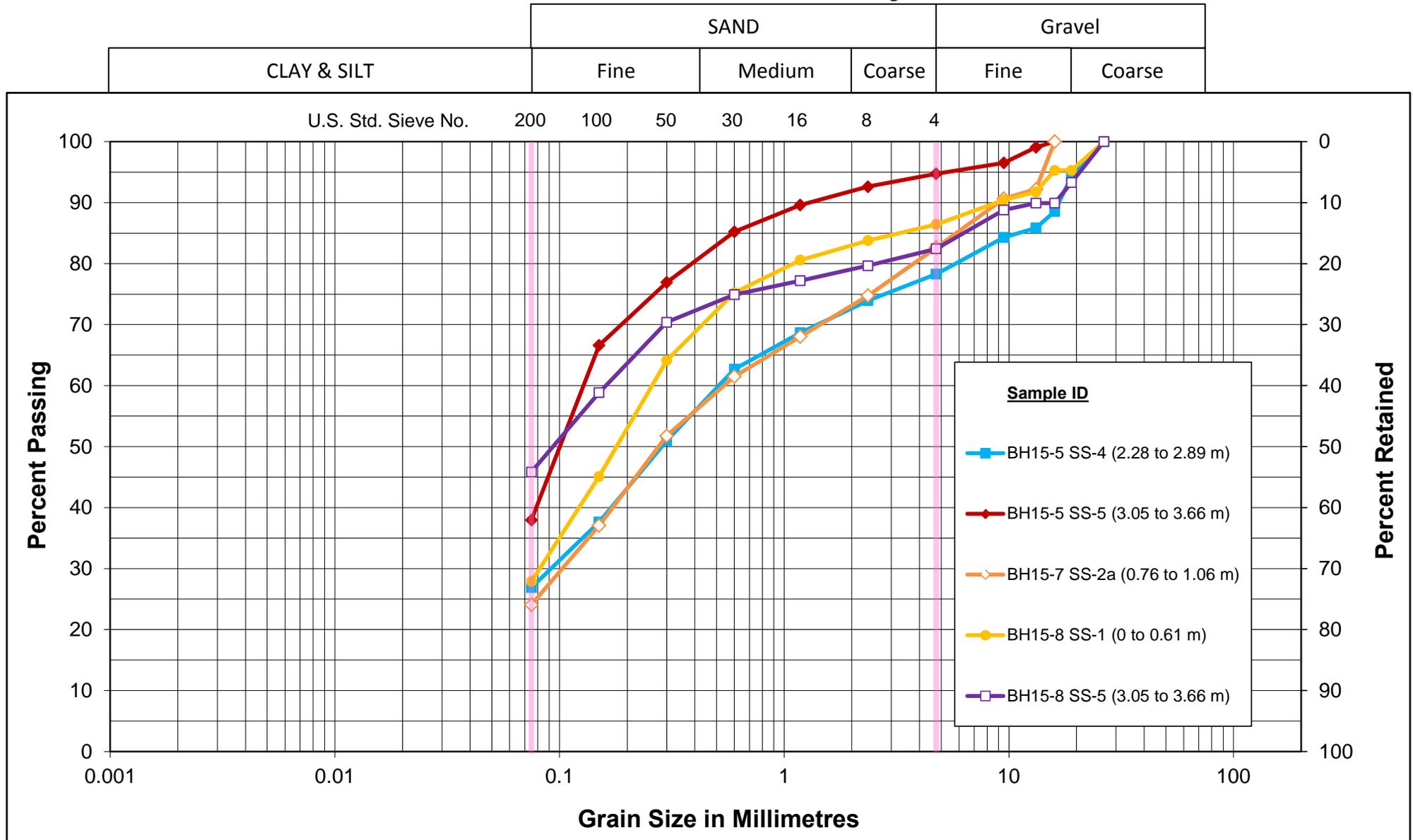
Borehole: BH15-16

Depth: 1.09 to 2.20 m

APPENDIX D

Laboratory and Field Test Results

Unified Soil Classification System

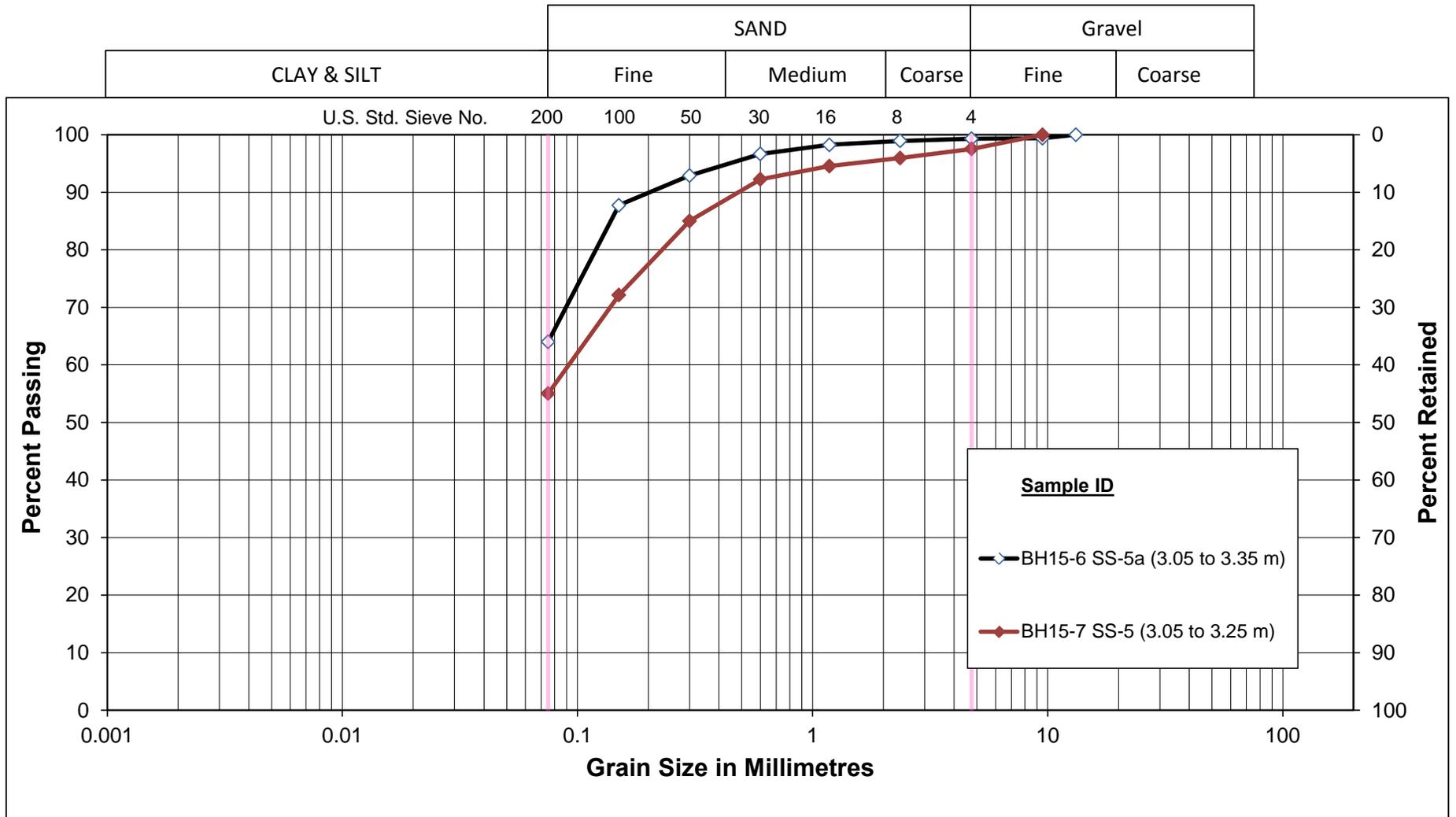


GRAIN SIZE DISTRIBUTION
FILL: Silty Sand (SM) with gravel

Figure No. 1

Project No. 122411046

Unified Soil Classification System



GRAIN SIZE DISTRIBUTION

Sandy Silt (ML), TILL

Figure No. 2

Project No. 122411046

Figure No. 3: Elastic Moduli of Intact Rock
Core Specimens Uniaxial Compressive
Strength
BH 15-4, Sample HQ-9

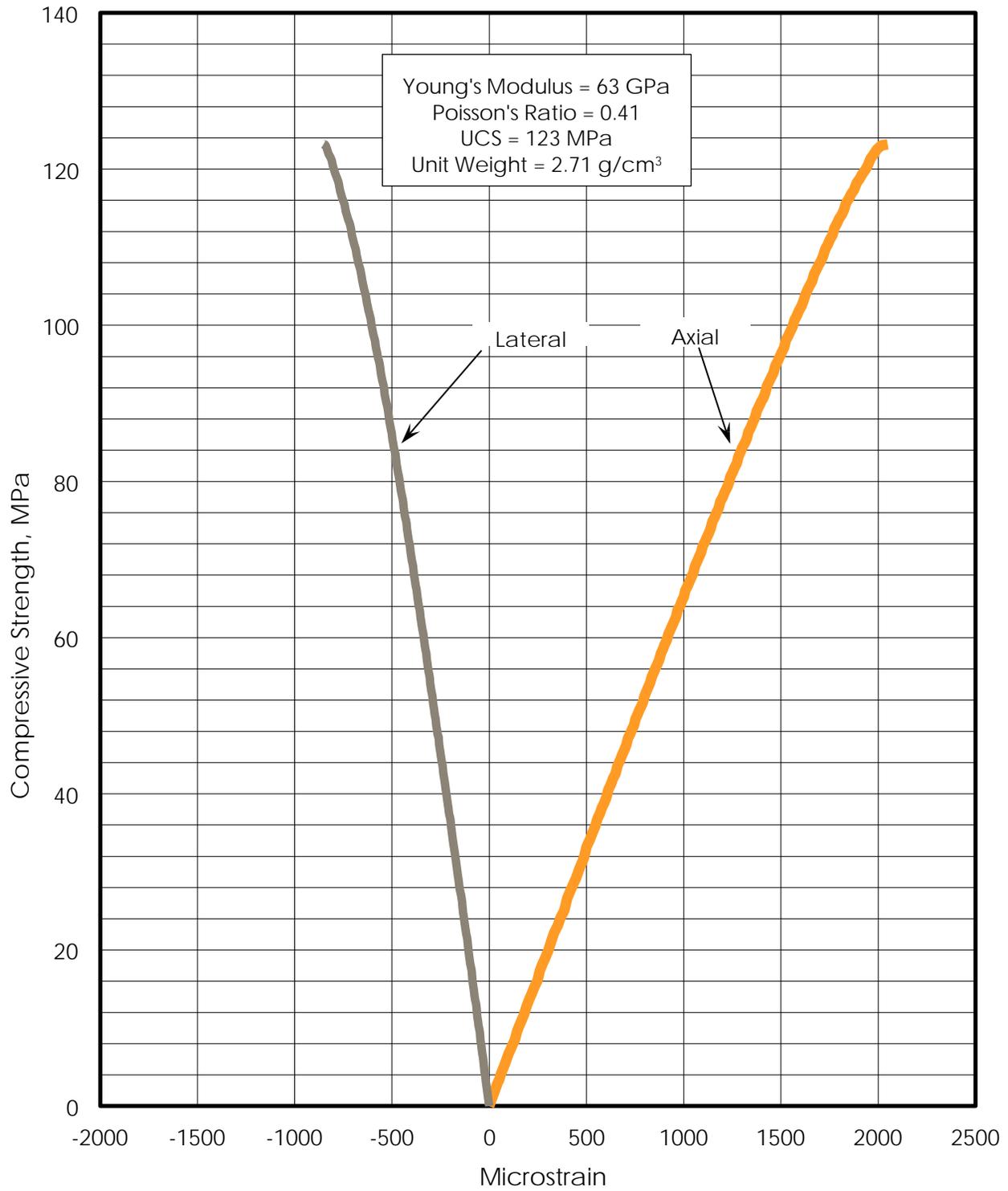


Figure No. 4: Elastic Moduli of Intact Rock
Core Specimens Uniaxial Compressive
Strength
BH 15-4, Sample HQ-21

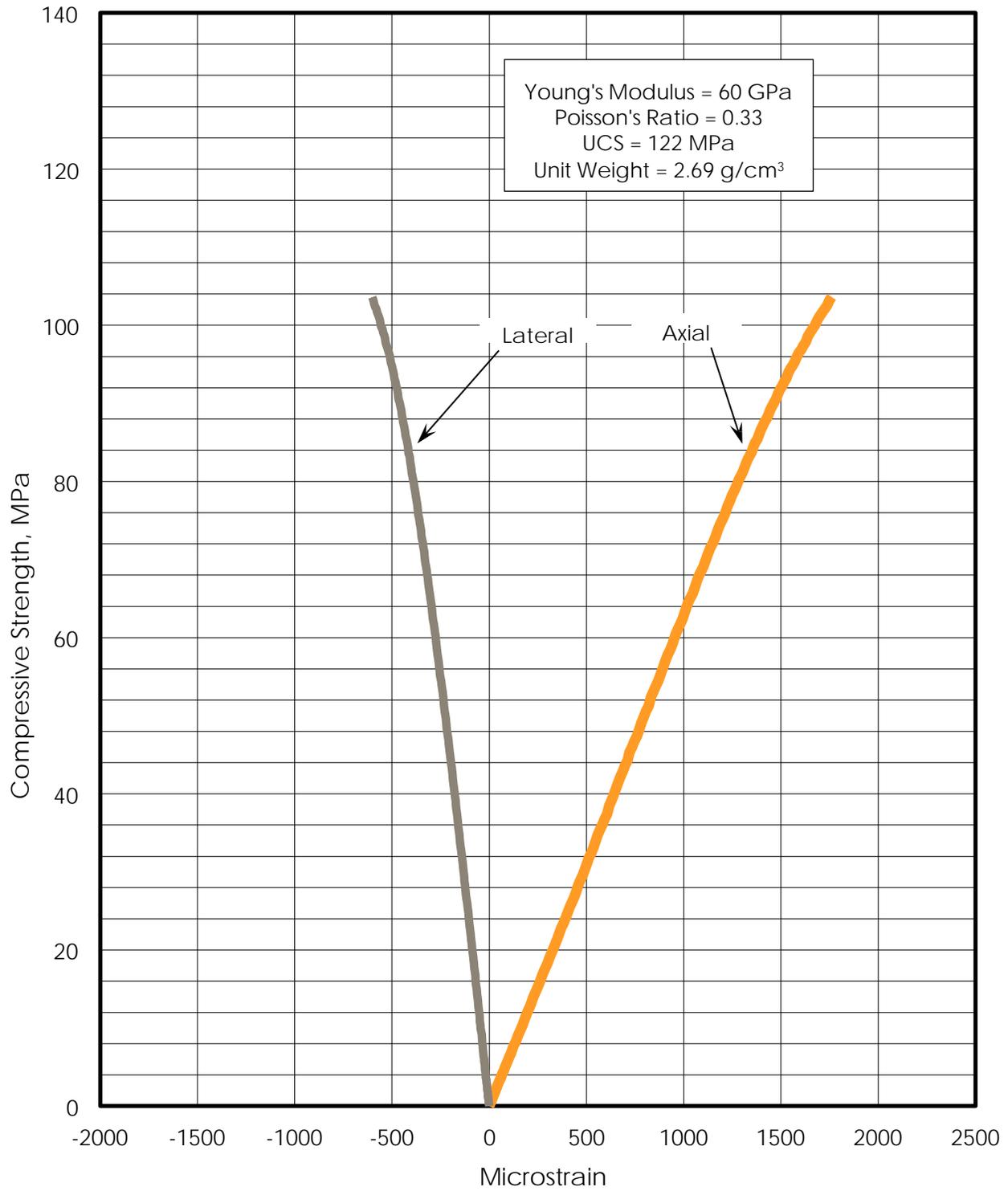
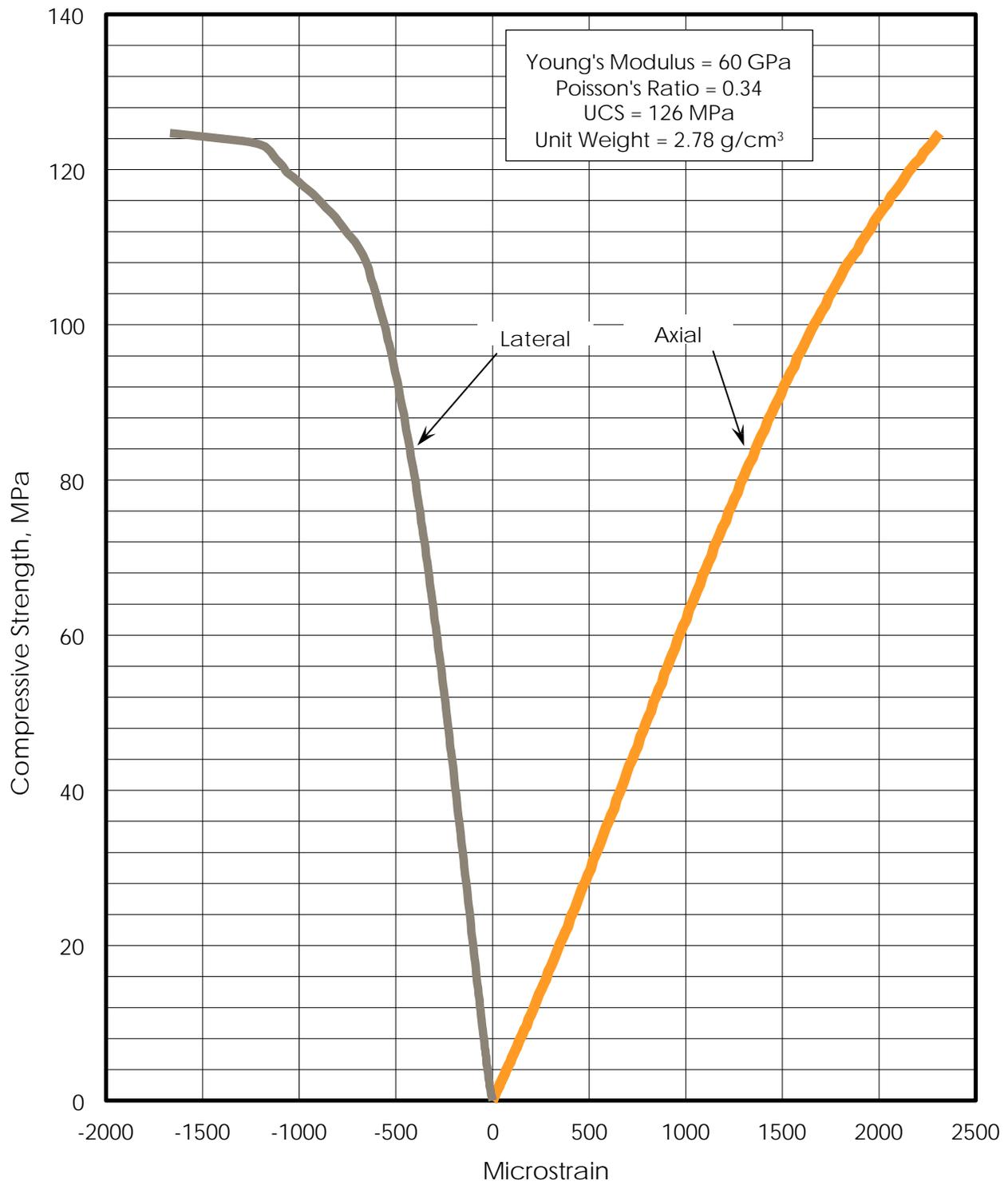
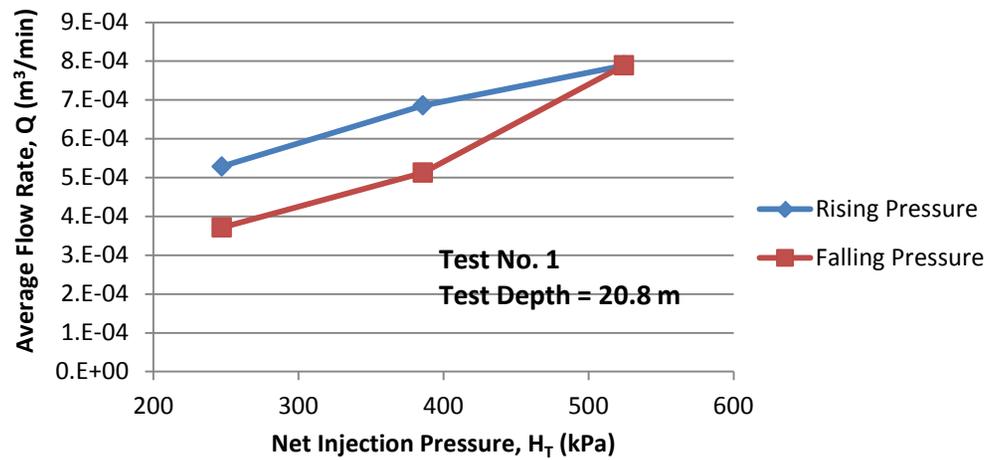
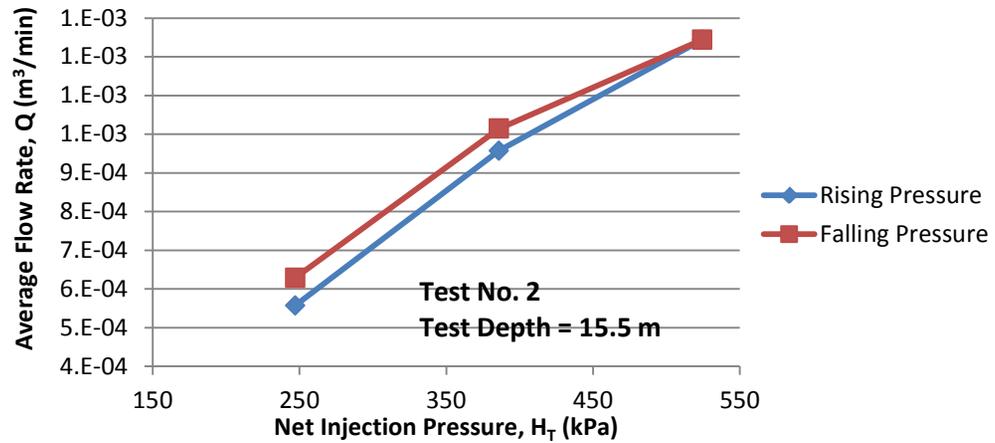
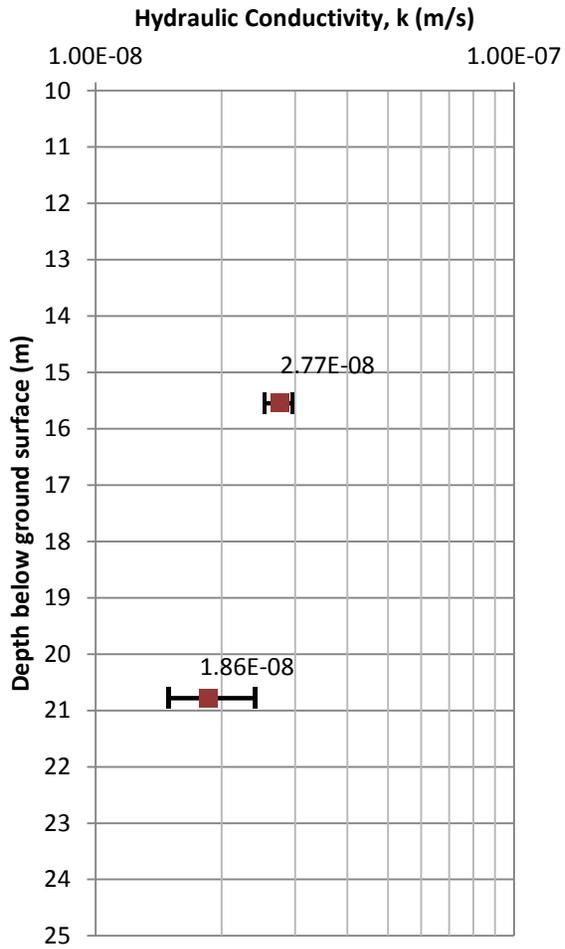


Figure No. 5: Elastic Moduli of Intact Rock
Core Specimens Uniaxial Compressive
Strength
BH 15-4, Sample HQ-24





Packer Testing Results for BH15-9

APPENDIX E

Geophysics GPR Downhole Seismic Survey Report
Geophysics GPR Optical Televiewer Logging Report
Stereographic Plots
Distribution of J_n , J_r , J_a , RQD & Q-Index Values



GEOPHYSICS GPR INTERNATIONAL INC.

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March 6, 2015

GPR file: T15727

Bridgit Bocage, M.Eng., E.I.T.
Geotechnical Engineering
Stantec Consulting Ltd
200 – 2781 Landcaster Road
Ottawa (ON) K1B 1A7
B3A 0A3

RE: Downhole seismic survey of BH4, Parliament Hill, Ottawa, ON

Dear Ms Bocage:

Geophysics GPR International Inc. has been requested by Stantec to carry out a downhole shear-wave seismic survey for the purpose of determining the shear-wave velocities of the bedrock, at a site on Parliament Hill, Ottawa, Ontario.

The survey was performed on January 20th and February 11th, 2015.

The investigation involved a seismic technique to measure the in-situ dynamic properties. The ASTM test method D 7400-07 Down-hole Seismic Testing was applied. This method only requires one borehole. The tested borehole was located at the approximate location indicated in Figure 1.

The purpose of the investigations was to provide the seismic shear wave velocity depth profile.

The following paragraphs describe the survey design, the principles of the test method, the methodology for interpreting the data, and provide a culmination of the results in table format.



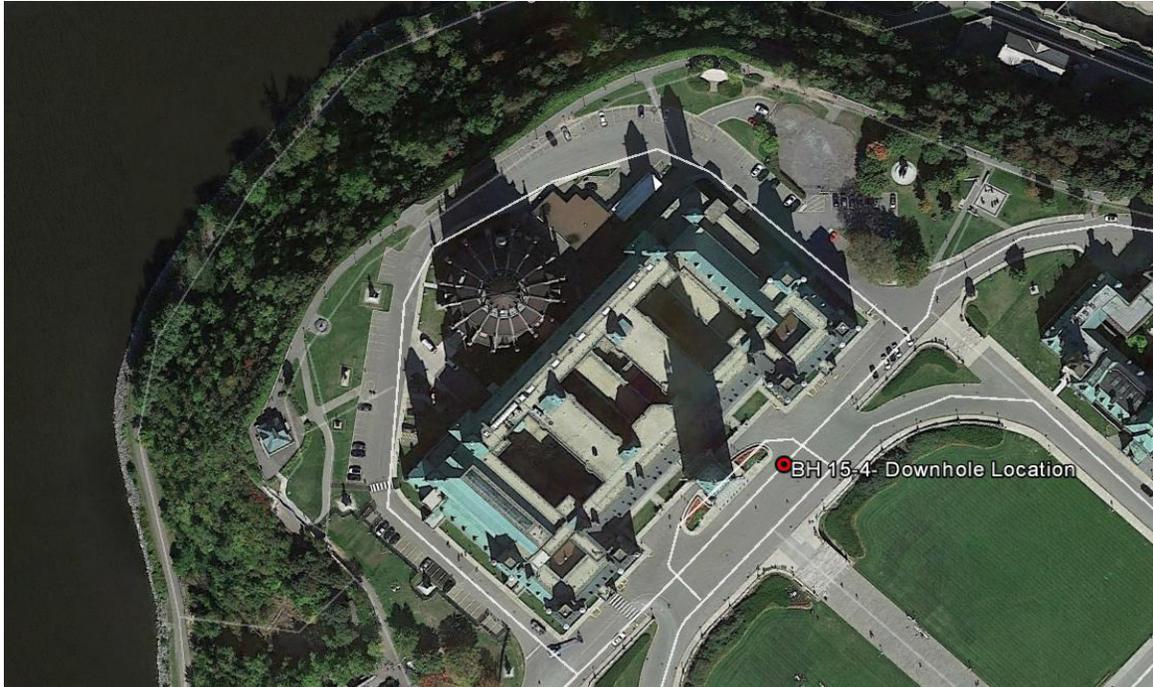


Figure 1: Site Location

Methodology: Down-hole Seismic

Basic Theory

The seismic down-hole method relies on the accurate measurement of the transit time for a generated wave to travel from a shot-point on the surface to a receiver (geophone) at sequential depths within a borehole. The velocities at which the waves propagate are then determined from the arrival times of the impulse signals. Arrival time records are recorded separately for waves with preferential shear (S) wave components and compressional (P) wave components. The seismic "P" wave velocity depends mainly on volumetric elastic ratio of the constituent soil particles and pore water. The seismic "S" wave velocity depends more on the structural elasticity of the material, which is influenced by the size, form and tightness of the particles (for the case of unconsolidated sediments). Unlike the P-wave, a polarized S-wave is can be generated.

Survey Design

Prior to the seismic measurements, a 31-metre deep borehole was prepared under the supervision of Stantec (BH-4). The borehole was cased and grouted in the overburden (approximately the upper 3.6 m).

A tri-axial geophone, containing two orthogonal horizontal geophones, for detecting the shear (S) wave arrivals, and a vertical geophone for detecting the compressional (P) wave arrivals, was used as the receiver. The geophone was held firm to the borehole wall by a motorized wall-lock.

Data were recorded with an ABEM Terraloc Mark 6 seismograph. The sampling interval was set to 50 μ s with 8192 samples for a total record length of 409 ms with a pre-trigger delay of 10 ms. The seismic S-wave source was located 2.25 m from the borehole.



A 15-lb sledgehammer was used as the primary energy source with a minimum of five stacks per shot.

Three seismic records were recorded at each one metre interval with the tri-axial geophone beginning at 31 m depth and ending at 1 m depth. There is a record for the downward hammer blow, which generates a very strong compressional wave from surface to the receiver. The second hammer strike is applied to the side of a block of wood that is orientated perpendicular to the borehole and offset approximately 2.25 m from the hole. The block stays rigid on the ground by putting a weight (vehicle) on top. The last strike is applied to the opposite side of the block. The second and third strokes generate polarized shear waves of opposite polarity to aid in identification. Figure 2 presents the seismic traces for the vertical P-wave shot records.

A small scale MASW survey with 1 m geophone spacing was also carried out on site. This data set would be used in case the seismic shear wave (S) arrivals near the ground surface could not be identifiable due to the compressional (P) wave-train interference.

Interpretation Method and Accuracy of Results

Interpretation of the down-hole seismic data involves identifying the first arrival times of the P-waves and S-waves from the shot records at each depth interval. The seismic traces from each depth interval can be combined into one image with the S-wave traces from opposite polarizations overlapped to aid in the interpretation.

The preferred method for analyzing down-hole data is to produce time-distance plots and calculate the velocities from the slope of the best-fit lines. The selection of the best-fit lines can be visually interpreted by the analyst or can be computer aided. When available, geologic contacts identified in borehole data can be used as for assigning layer contacts along with visual interpretation of changes in slope of the time-distance plots. The *Rvelslant* scripts developed by Eric M. Thompson in the 'R' programming language were used for interactive interpretation of the velocity layer contacts and inversion calculations for determining the layer velocities accounting for refractions and pick confidence. A detailed description of the software used for the interpretation can be found in the USGS Open-File Report 2007-1124, "*Surface-Source Downhole Seismic Analysis in R*" by Eric M. Thompson. Figures 3 through 5 present the arrival time-data and inversion models as generated by the *Rvelslant* software.

Calculation of Elastic Moduli

The elastic moduli are calculated based on the velocities measured from the seismic tests along with the density data. Soil density values were based on an assumed value of 1.9 g/cm³. Bedrock densities, as provided by the client, ranged from 2.6 to 2.75g/cm³. An average density of 2.68 was used for the moduli calculations.



The following equations allow the calculation of the elastic moduli:

Poisson's Ratio:
$$\sigma = \frac{(V_p^2 - 2V_s^2)}{2(V_p^2 - V_s^2)}$$

Shear Modulus:
$$G = \frac{\rho V_s^2}{1000}$$

Young's Modulus:
$$E = \frac{2\rho V_s^2(1 + \sigma)}{1000}$$

Bulk Modulus:
$$K = \frac{E}{3(1 - 2\sigma)}$$

Where V_s = shear wave velocity (m/s)

V_p = compressional wave velocity (m/s)

ρ = density of the material (g/cm³)



RESULTS

The data quality for this particular borehole was poor to very poor. Background noise at the site seemed low to moderate, thus it is suggested that there is poor coupling between the asphalt surface (and/or soils) and the bedrock preventing the seismic pulse from being adequately transmitted. The survey was performed twice with different sets of equipment and increased stacking to try to rule out equipment issues and to attempt to improve the signal to noise ratio. Minimal improvements were noted.

With that said, arrival times interpreted to be from the shear-wave have been picked and velocity models generated. The interpreted models have a higher estimated error than typical and the velocity models are likely to be smoothed.

P-wave arrival times have been interpreted from the vertical hammer blow and vertical geophone as per the standard methodology. In addition, the vertical hammer blow and vertical geophone were used to interpret the S-wave velocities polarized in the vertical plane (Sv-waves).

The horizontally polarized Sh-wave arrival times were interpreted from the horizontal hammer blows and the horizontal and transverse geophones using the Sv-waves as a guide.

Variations between the horizontally and vertically polarized shear-wave may be geologically valid (anisotropic bedrock) or can be due to the quality data and inaccuracies in the identification of the arrival times.

Figures 3, 4 and 5 present the time-distance plots and velocity models for the P-wave, Sv and Sh-wave velocities.

In addition, an MASW sounding was performed, primarily as a cross-check of the shear-wave velocities in the upper few metres of overburden. The MASW data indicates an S-wave velocity on the order of 242 m/s for the upper 2 m and a velocity on the order of 340 m/s between 2 and 3.6 m.

The velocity models for the P-wave, Sv-wave, Sh-wave and MASW data sets are presented in Table 1. Tables 2 and 3 present the elastic moduli and Vs30 calculations based on the Sv and MASW data sets.



| Depth (m) | | Vp | Vs (vert) | Vs (horiz) | Vs (MASW) |
|-----------|------|-------|-----------|------------|-----------|
| from | to | (m/s) | (m/s) | (m/s) | (m/s) |
| 0.0 | 2.0 | 476 | | | 242 |
| 2.0 | 3.6 | 2061 | 491 | 328 | 341 |
| 3.6 | 7.2 | 2977 | 1323 | 2367 | |
| 7.2 | 17.0 | 4348 | 2639 | 2956 | |
| 17.0 | 23.5 | 4748 | 2876 | 2795 | |
| 23.5 | 31.1 | 5143 | 2490 | 2746 | |

Table 1: P-wave and S-wave velocity models

| Depth Interval | P-wave Velocity | S-wave Velocity | Density | Shear Modulus | Poisson's Ratio | Young's Modulus | Bulk Modulus |
|----------------|-----------------|-----------------|----------------------|---------------|-----------------|-----------------|--------------|
| (m) | (m/s) | (m/s) | (g/cm ³) | (Mpa) | | (Mpa) | (Mpa) |
| 0 to 2.0 | 476 | 242 | 1.9 | 111 | 0.33 | 295 | 282 |
| 2.0 to 3.6 | 2061 | 341 | 1.9 | 220 | 0.49 | 655 | 7779 |
| 3.6 to 7.2 | 2977 | 1323 | 2.68 | 4694 | 0.38 | 12925 | 17493 |
| 7.2 to 17 | 4348 | 2639 | 2.68 | 18664 | 0.21 | 45104 | 25772 |
| 17 to 23.5 | 4748 | 2876 | 2.68 | 22160 | 0.21 | 53644 | 30870 |
| 31.1 | 5143 | 2490 | 2.68 | 16622 | 0.35 | 44775 | 48714 |

Table 2: Elastic moduli calculations based on down-hole and MASW data. Densities are assumed for the upper 3.6m. Densities below 3.6m are based on the average density as provided by the client.

| Depth (m) | | Vs | Thickness | Delay | Cum.Delay | Vs to depth |
|-----------|------|-------|-----------|--------|-----------|-------------|
| from | to | (m/s) | (m) | (s) | (s) | (m/s) |
| 0.0 | 2.0 | 242 | 2 | 0.0083 | 0.00826 | 242.0 |
| 2.0 | 3.6 | 341 | 2 | 0.0047 | 0.01296 | 277.9 |
| 3.6 | 7.2 | 1323 | 4 | 0.0027 | 0.01568 | 459.3 |
| 7.2 | 17.0 | 2639 | 10 | 0.0037 | 0.01939 | 876.7 |
| 17.0 | 23.5 | 2876 | 7 | 0.0023 | 0.02165 | 1085.4 |
| 23.5 | 30.0 | 2490 | 7 | 0.0026 | 0.02426 | 1236.6 |

Table 3: Vs30 Calculation from Downhole and MASW Surveys Results



The downhole survey allowed measuring the shear wave velocities of the rock deeper than 3.6 m deep. MASW results complemented the shallow portion, including the overburden materials. The conjugation of these two methods allowed the seismic site classification. Based on these values (determined through the downhole and the MASW/ESPAC methods), Table 4.1.8.4.A of the NBC, and the Building Code, O. Reg. 332/12, the investigated site presented a calculated V_{s30} value of 1237 m/s, corresponding to Site Class "B" ($760 < V_{s30} < 1500$ m/s); however, seismic site class "B" requires the rock to be less than 3.0 m below the foundation. Accordingly, the seismic site class should be considered Site Class "C" for a building founded at the current ground level.

When considering only the bedrock (i.e. from depths below 3.6m) the harmonic mean velocity is 2335 m/s. Thus for buildings founded directly on the bedrock, a seismic site class "A" ($V_{s30} > 1500$ m/s) can be considered.

As discussed above, the quality of the down-hole data was less than ideal. Obtaining clearer velocity data may be possible using a full-wave sonic borehole tool or cross-hole seismic methods as these are measured at depth and the data quality will not be influenced by the shallow soils.

Sincerely,



Milan Situm, P.Geol.
Manager



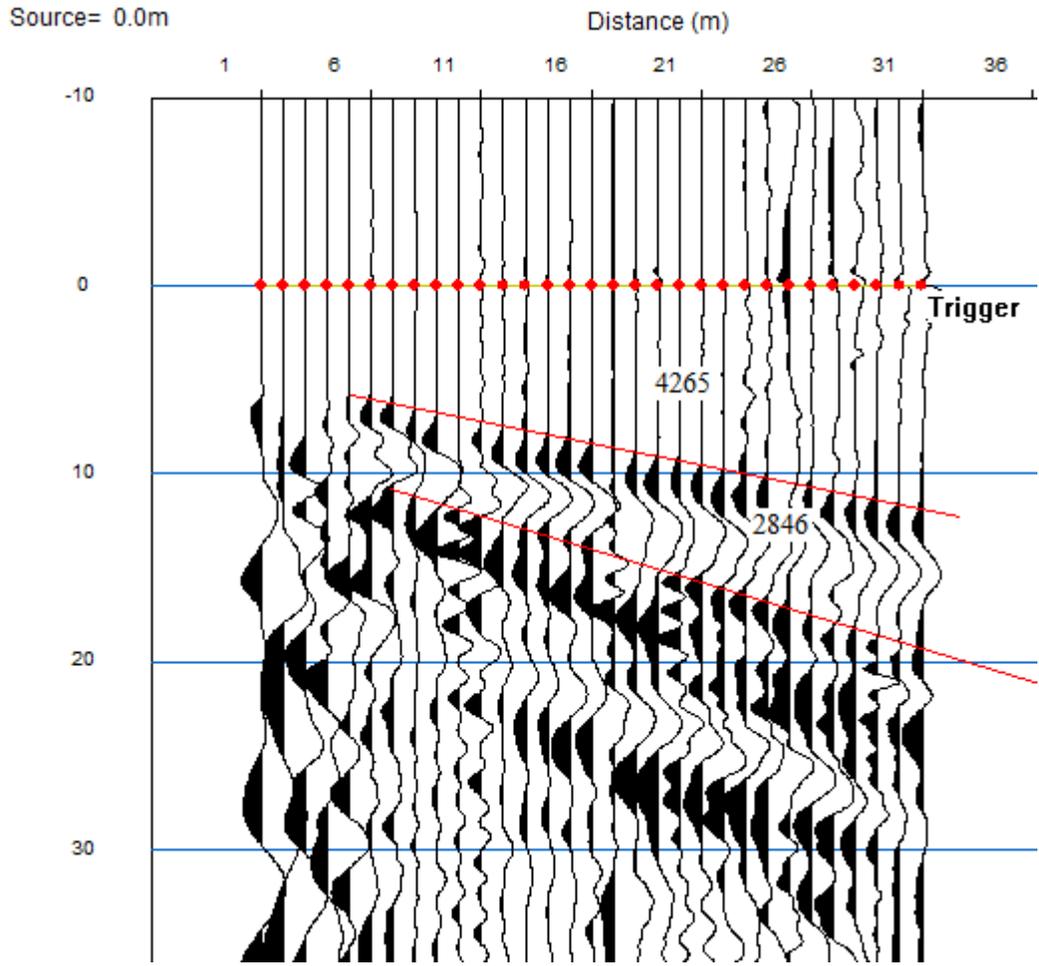


Figure 2: Merged seismic shot records. General trend of the P-wave velocity (4265m/s) and Sv-wave velocity (2846m/s) are indicated



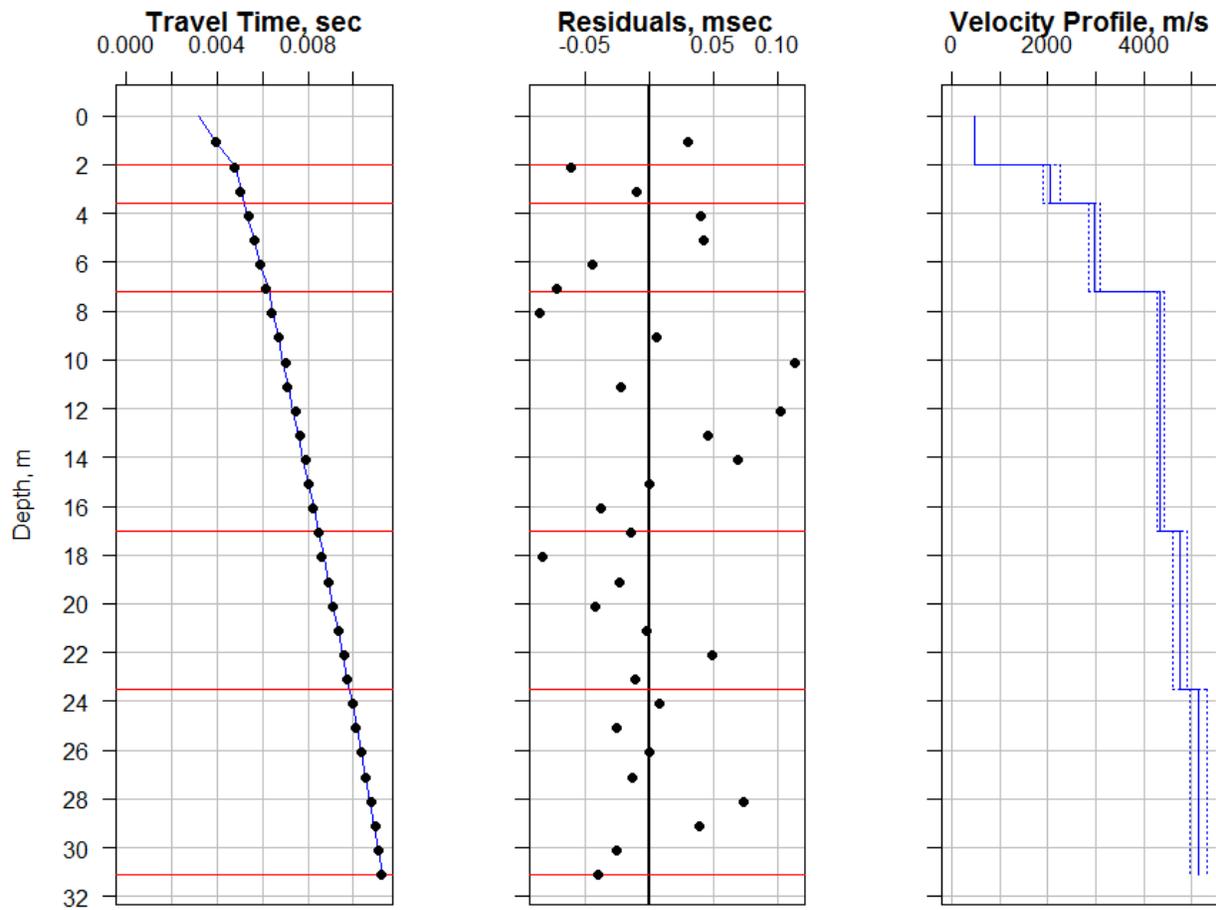


Figure 3: P-wave arrival time data and velocity model



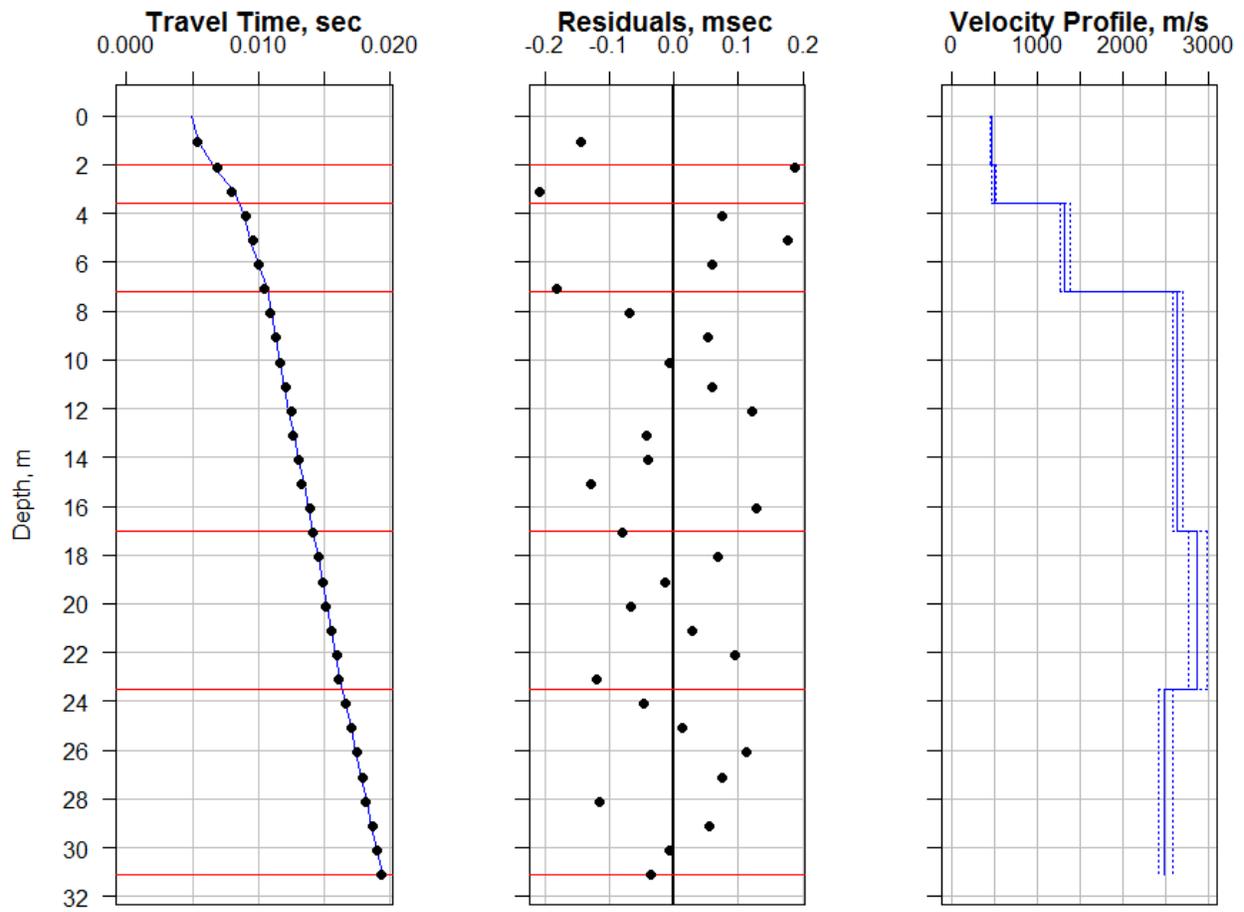


Figure 4: S(vertical)-wave arrival time data and velocity model



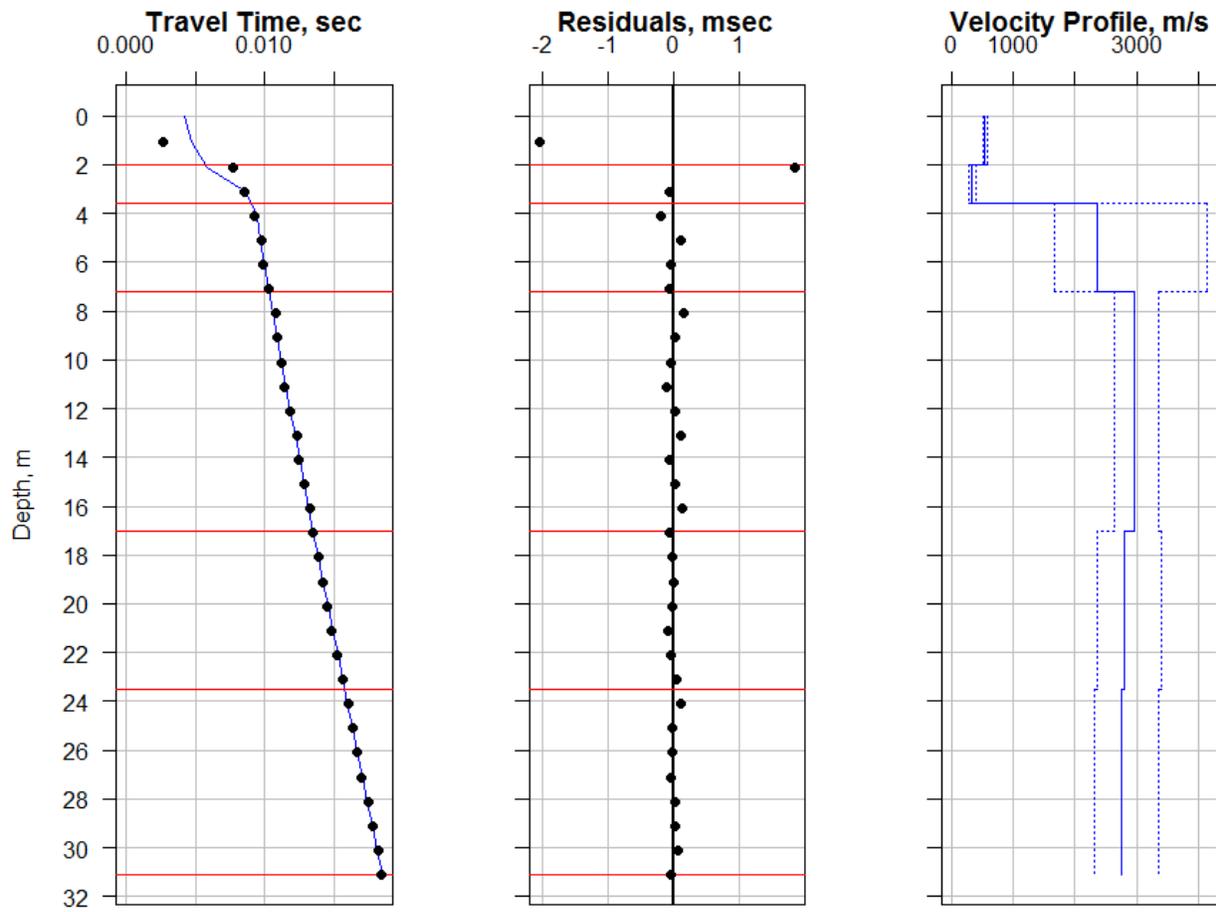


Figure 5: S(horiz)-wave arrival time data and velocity model



**OPTICAL TELEVIEWER LOGGING FOR
THE CENTER BLOCK PARLIAMENT
HILL PROJECT, OTTAWA, ONTARIO**

Presented to:
Stantec Consulting
1331 Clyde Avenue #400
Ottawa, ON
K2G 3H7

Presented by:
Geophysics GPR International Inc.
6741 Columbus Road. Unit 14
Mississauga, Ontario
L5T 2G9

February, 2015

T15727

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| Figure 2: Location of Optical Televiwer Sites, Parliament Hill, Ottawa..... | 2 |

Appendices

- Appendix A: Borehole Logging Equipment and Information Sheets
- Appendix B: Optical Televiwer Logs with dip/azimuth for borehole and strike/dip of discontinuities (tadpole)

1. Introduction

Geophysics GPR International Inc. was requested by Stantec Consulting to carry out a borehole logging survey in order to determine the structure of the bedrock in three boreholes around Parliament Hill. The objective of the survey was to determine the bedrock structure. The general site location is shown in Figure 1. A close-up can be seen in Figure 2.

The geophysical fieldwork was carried out on January 20, 2015 and February 10, 2015.

The following report describes the survey design, the principles of the borehole logging methods, the methodology for interpreting the data and finally a culmination of the interpretations in the form of borehole logs.

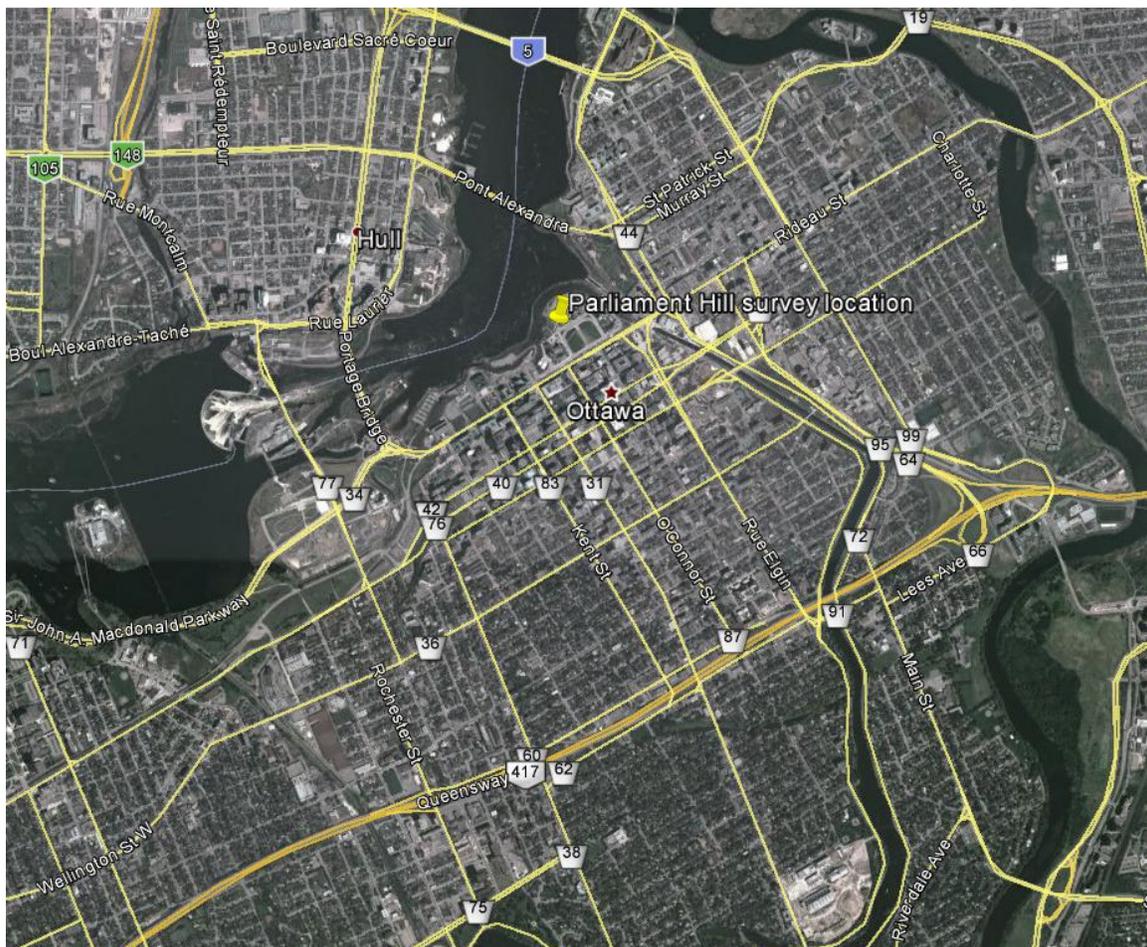


Figure 1: Site Location, Ottawa, Ontario



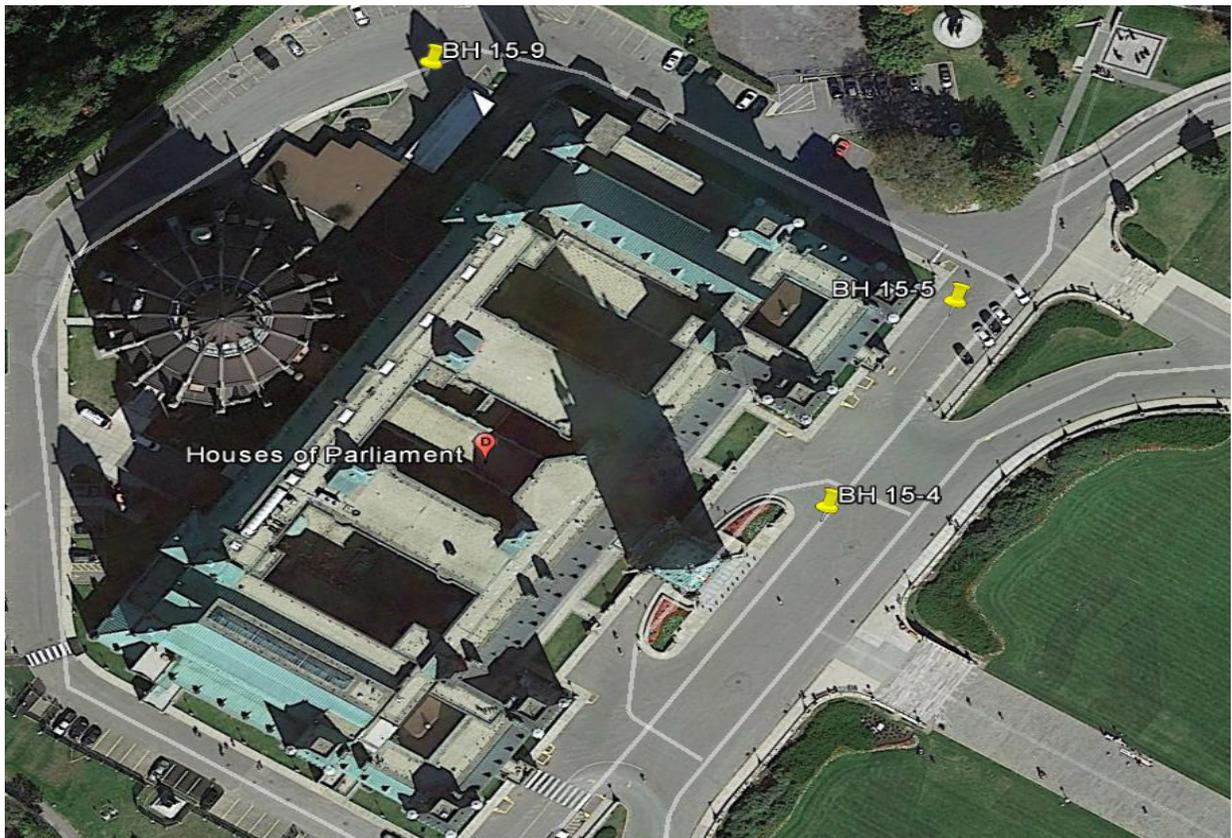


Figure 2: Location of Optical Televiewer Sites, Parliament Hill, Ottawa

2. Methodology

2.1 Personnel

The GPR field personnel involved in this project and the dates that they were on-site are outlined below:

Table 1: Field personnel and survey dates

| Employee | Title | Dates On-Site |
|------------------|-----------------------|--|
| Rick Hall | Tech Operator | January 20 th and February 13 th |
| Tom Westerbloom | Tech Operator | February 13 th |
| Charles Trottier | Geophysicist/Operator | January 20 th |

2.2 Positioning, Topography and Units of Measurement

The survey included 3 different borehole data log records for each of the boreholes using the optical televiewer. Positioning for each of the boreholes was provided by the client. All measurement was taken using SI units. Depth is referred to as metres below ground level.



2.3 Borehole Logging Instruments

The following is a description of the standard borehole logging tools and typical applications.

1)Gamma Ray (GR): Measures the naturally occurring gamma radiation emitted from the formation surrounding the drill-hole – provides an indicator of clay or shale content.

2)Self Potential (SP): Records naturally occurring small voltages in the borehole – can be related to relative water quality and to permeable zones in the stratigraphy.

3)Single-Point Resistivity (SPR): Measures variations in formation resistivity in a qualitative manner.

4)Normal Resistivity (NR): Quantitative measurement of resistivity variations related to water quality, lithological and structural changes. Measurements are taken at 4 different electrode spacings (8'', 16'', 32'' and 64'')

5)Caliper: Measures the diameter of the borehole – useful for calculating drill-hole volumes, indicating zones of caving or roughness and in correcting the responses of other tools.

6)Acoustic Televiewer (ATV): Produces a 2-D image of the inside of the borehole from ultrasound pulses. This data is used to locate fractures in the crystalline rock, and is also used when calculating the porosity.

7)Equal area Stereoplot Dip and Strike – There are 'blue' lines drawn on the acoustic televiewer plot where the borehole has intercepted a fracture. It is possible to calculate a strike and dip angle for each fracture. There is a small blue dot for each fracture on the stereoplot. This is particularly useful in recognizing a pattern in fracture patterns.

8)Optical Televiewer (OTV): Produces a true-colour 2-D image of the inside of the borehole using a CCD camera. This data is used to locate fractures in the crystalline rock, and is also used to determine rock colour.

9)Full Waveform Sonic (FWS): Sonic logs are used to provide formation porosity/permeability and mechanical properties. Under suitable conditions S-wave and Stoneleys wave arrivals can be detected.

Information on the method and equipment are presented in Appendix A.



2.4 Survey Design

A Mount Sopris MATRIX and MX Series mini-Winch system was used in coordination with Logger Suite 11 software to record all the probe data. Using a tripod setup each of the probes were lowered down the borehole recording a “down” file (if required of the probe) and then back up recording an “up” file. In this manner 2 files were collected for each probe in order to compare them to each other for accuracy of results.

3. Results

The optical televiewer logs are presented in Appendix B for each of the three boreholes. A summary table of the identified structures are presented in Appendix C.

Data has also been provided as a separate digital file *.WCL (WellCad format).

Table 1: Locations and tools used for each borehole (Green indicates that a tool was used, while red indicates that a tool was not used).

| Borehole ID | Easting | Northing | Elevation | GR | SP | SPR | NR | Caliper | ATV | OTV | FWS |
|-------------|---------|----------|-----------|----|----|-----|----|---------|-----|-----|-----|
| BH-4 | 445292 | 5030377 | 87.1 | | | | | | | | |
| BH-5 | 445331 | 5030408 | 86.8 | | | | | | | | |
| BH-9 | 445272 | 5030493 | 87.1 | | | | | | | | |

Coordinates for Boreholes are UTM Zone 18T

Elevations are referred to geodetic datum (CGVD28)

Interpretation and presentation of the data was performed by Aleksandra Savic.

This report has been written by Milan Situm, P.Geo.



Milan Situm, P.Geo.
Manager



APPENDIX A

Borehole Logging Equipment and Information Sheets

OBI40, OBI40 GR QL40, OBI optical borehole imager

The optical borehole imager generates a continuous true color image of the borehole wall via an optical imaging system using a downhole CCD camera that records the image of the borehole wall in a prism. A built in high precision orientation package incorporating a 3-axis magnetometer and 3-axis accelerometer allows orientation of the images to a global reference and determination of the borehole's azimuth and inclination.

Resolutions up to 0.5 mm vertical and 720 pixels azimuthal can be achieved. The tool is fully downhole digital and runs on standard wirelines.

The QL40 OBI can be combined with other logging tools of the QL (Quick Link) product line to build tool strings. It can also be operated as a stand alone tool.

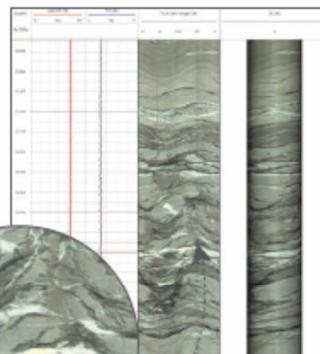
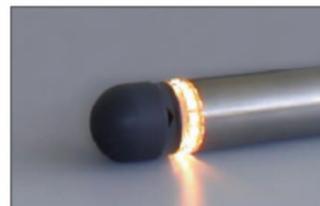
The OBI40.GR has an integrated natural gamma sensor.

An optical televiewer image can complement and even replace a coring survey and its associated problems of core recovery and orientation.

Optical and acoustic televiewers are complementary tools especially when the purpose of the survey is structural analysis.

Application

- Detailed and oriented structural information
- Reference for core orientation
- Fracture detection and evaluation
- Breakout analysis
- Detection of thin beds
- Determination of bedding dip
- Lithology characterisation
- Casing inspection



OBI40, OBI40 GR QL40, OBI optical borehole imager



Principle of measurement

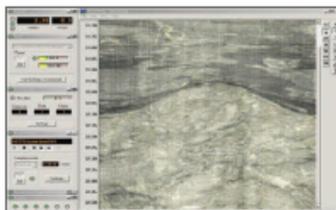
The tool incorporates a high resolution, high sensitivity CCD digital camera with matching Pentax optics. The CCD camera, located above a conical mirror, captures the reflection of the borehole wall. The light source is provided by a light ring assembly located in the optical head. The camera CCD sensor consists of an array of light sensors, each representing one pixel of the complete image. Due to manufacturing limitations individual sensors have a slightly different response and calibration factor. To produce a coherent image the camera processing system checks all the pixels and compensates for variations (white balance). The displayed log image is derived from a single annulus extracted from the total pixel array. Azimuthal resolutions available are 720, 360, 180 and 90 points per recorded circle. By using processed camera data in combination with deviation sensor data, the tool can generate an unwrapped 360° oriented image.

Measurements / Features

- 360° RGB orientated optical image
- Borehole azimuth and dip
- Tool internal temperature
- Relative bearing
- Magnetic field
- Gravity

Operating Conditions

- Dry or water filled hole
- Centralisation necessary
- Compatible with ALTLogger & Matrix
- Digital data transmission up to 500 Kbit per second depending on wireline
- Real time automatic telemetry tuning according to the cable length/type
- Measurement range : 2" to 21" borehole depending on mud conditions



Technical Specifications

- Diameter: 40 mm (1.575")
- Length: approx 1.2 m (47")
- Weight: approx 5 kg
- Max. temp: 50°C
- Max. pressure: 200 bar (2900 psi)

Optical sensor

- Downhole DSP based digital CCD camera
- Optics : plain polycarbonate conic prism system
- Azimuthal resolution : user selected 90/180/360 or 720 pixels /360°
- Vertical resolution : user definable, depth (function of optical encoder resolution) or time sampling rate
- Color resolution : 24 bit RGB value true color calibration system with light color compensation
- White balance : automatic or user adjustable
- Aperture & Shutter : automatic or user adjustable
- Special functions : User configurable real time digital edge enhancing

Orientation sensor

- APS 544 - 3-axis magnetometer – 3-axis accelerometer
- Inclination accuracy : +/- 0.5 degree
- Azimuth accuracy : +/- 1.2 degree

The specifications are not contractual and are subject to modification without notice.



Zoning de Solupla Bât A | route de Niederpallen | L-8506 Redange | Luxembourg | Tel. +352 23 649 289 | www.alt.lu
36th Floor, Menara Maxis | Kuala Lumpur City Centre | 50088 Kuala Lumpur | Malaysia | Tel. +60 3 2615 7261 | www.alt.lu

APPENDIX B

Optical Televiewer with dip/azimuth for borehole and strike/dip of discontinuities
(tadpole)

Contact and Structure Legend

| | |
|---|-----------------------------------|
|  | 10 - Foliation |
|  | 100 - Minor Fracture - Joint |
|  | 101 - Truncated Fracture - Joint |
|  | 102 - Infilled Fracture - Joint |
|  | 110 - Major Fracture - Joint |
|  | 120 - Microfault |
|  | 130 - HFZ - Hanging Wall |
|  | 140 - HFZ - Footwall |
|  | 150 - TDW |
|  | 160 - Casing |
|  | 170 - Possible micro fault |
|  | 180 - Possible geological contact |
|  | 190 - Shear / Vein |
|  | 200 - Foliation |



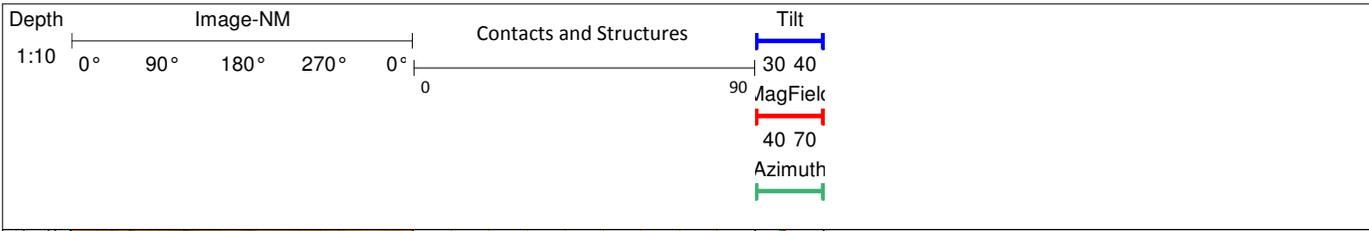


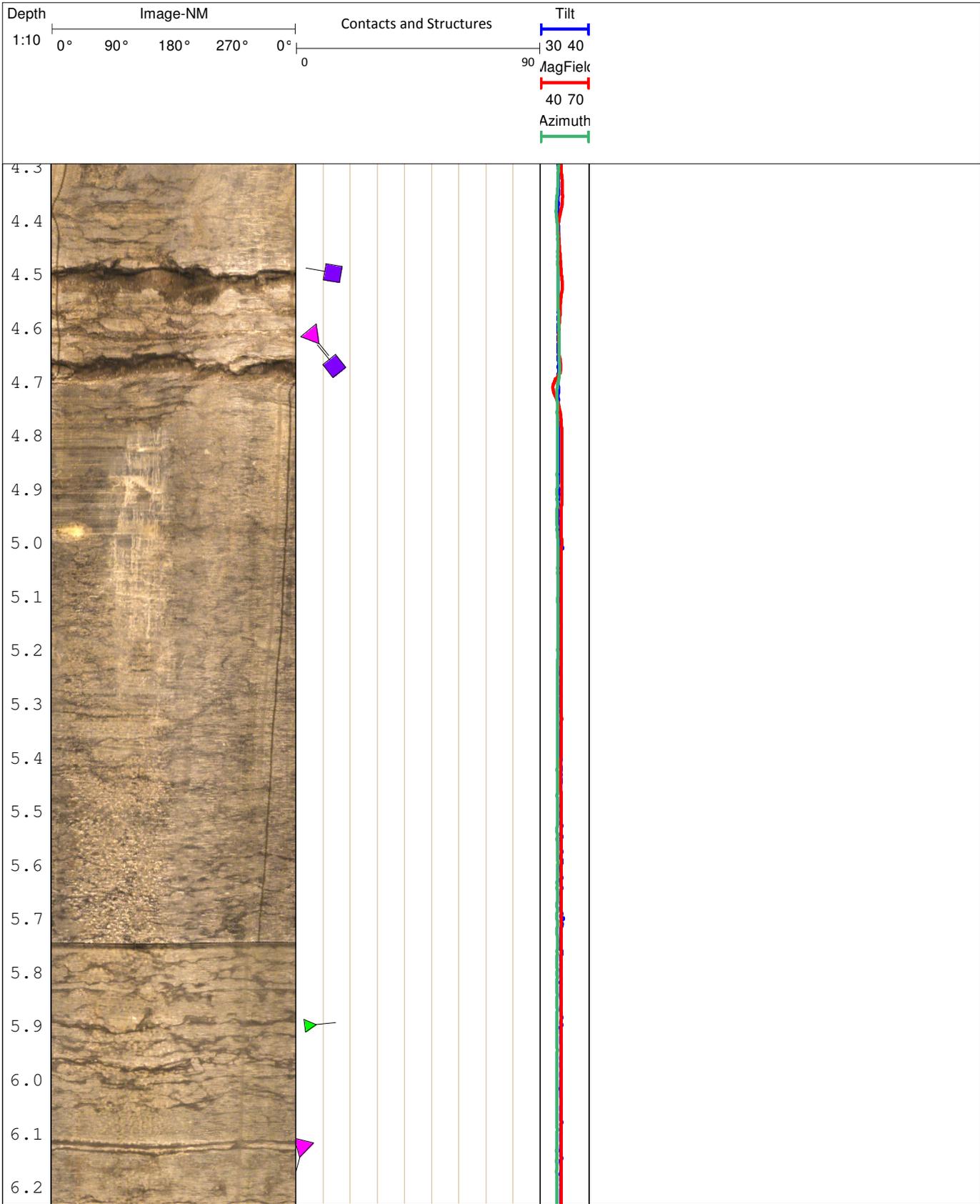
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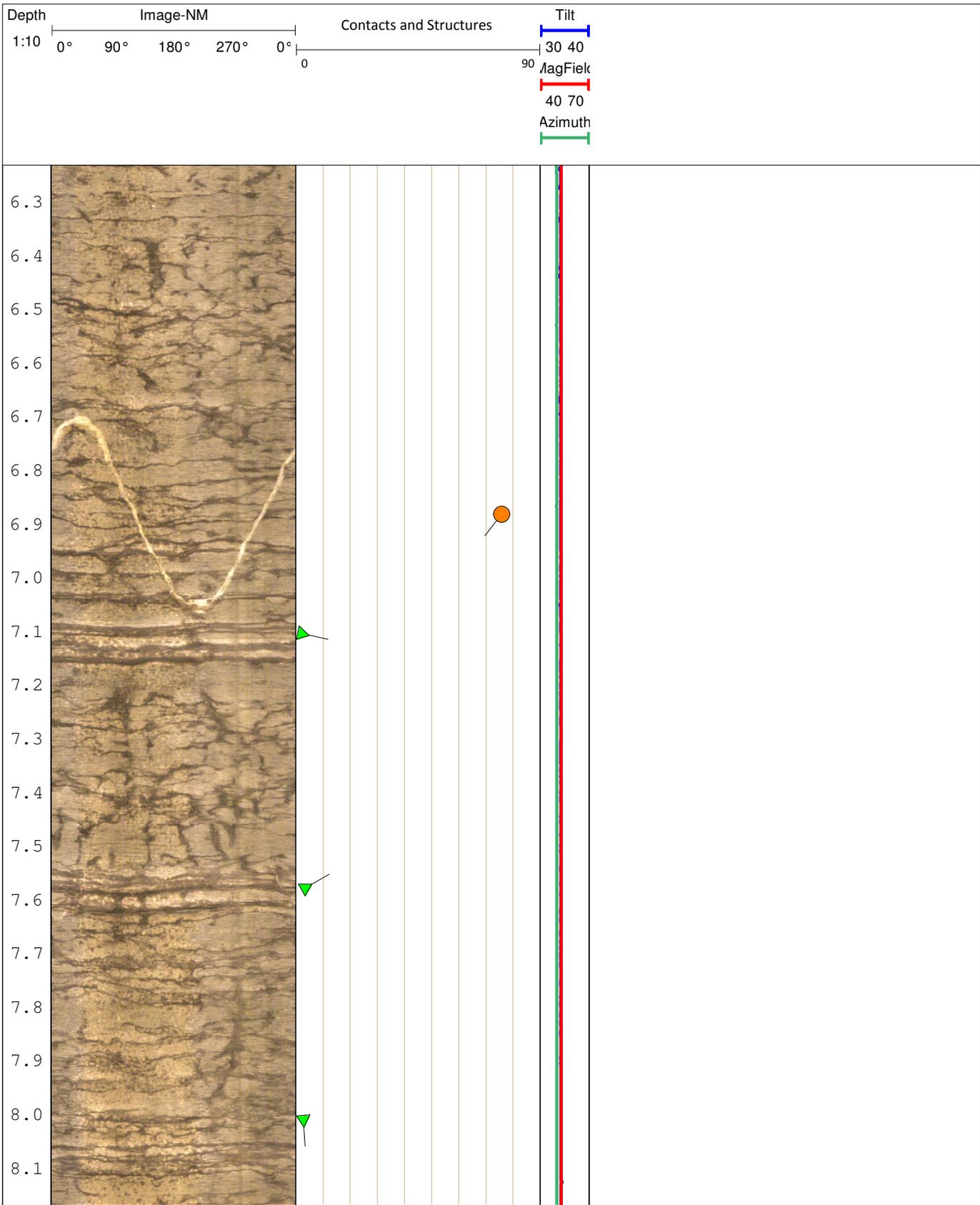
COMPANY : Stantec Consulting Ltd./Public Works and Government Services Canada

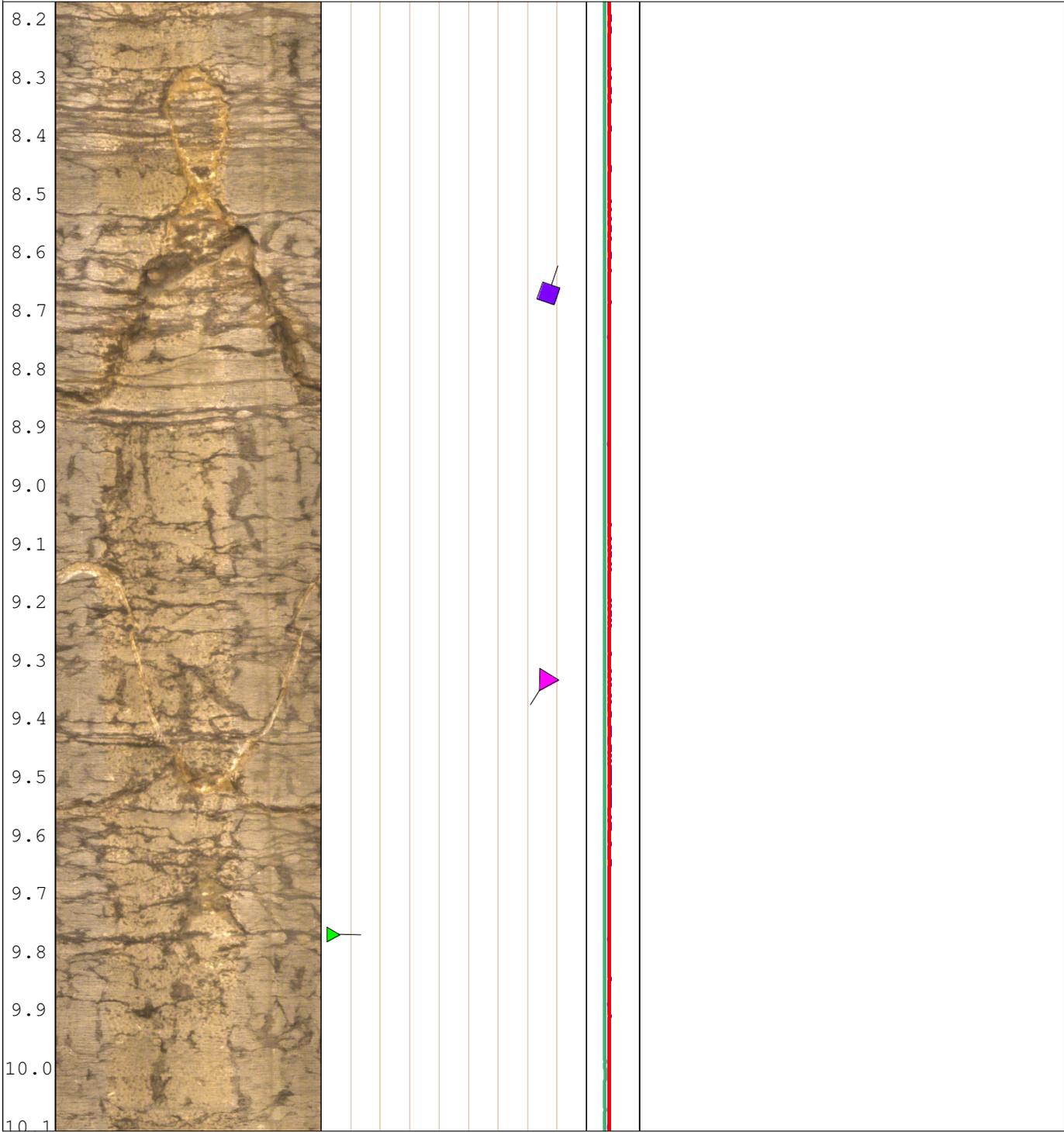
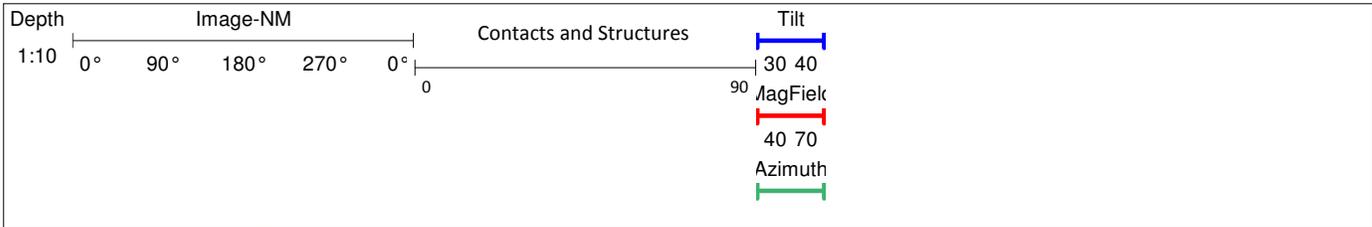
LOCATION : Center Block, Parliament Hill

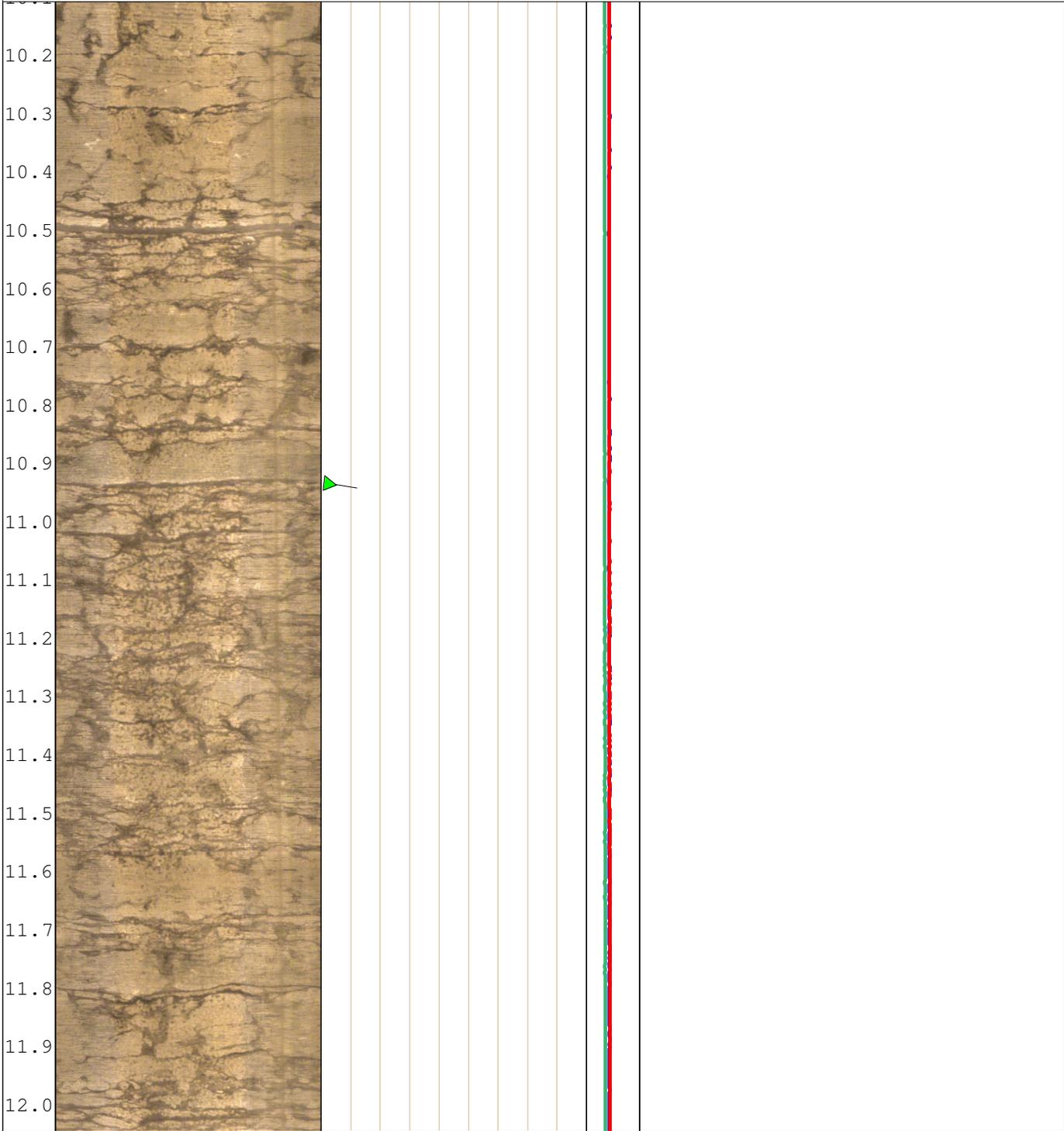
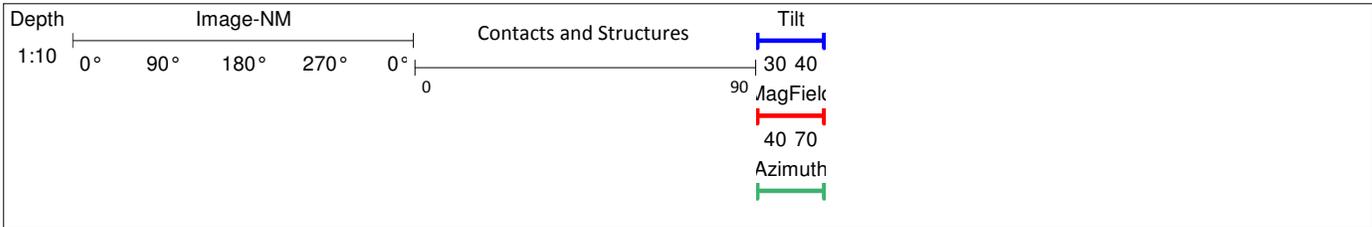
| | | | | |
|----------------------|-------------------|-----------------|----------|--|
| Well | BH15-4 | | | NOTES: Project No. 122411046 UTM coordinates N: 5 030 377 E:445 292 |
| Date | February 10, 2015 | BH Fluid | no fluid | |
| Casing | 3.5" | | | |
| File Name | BH4.wcl | | | |
| Depth Driller | | | | |
| Depth Logger | | | | |
| Logged by | Derrick Hall | | | |
| Witnessed by | Tom Westerblom | | | |

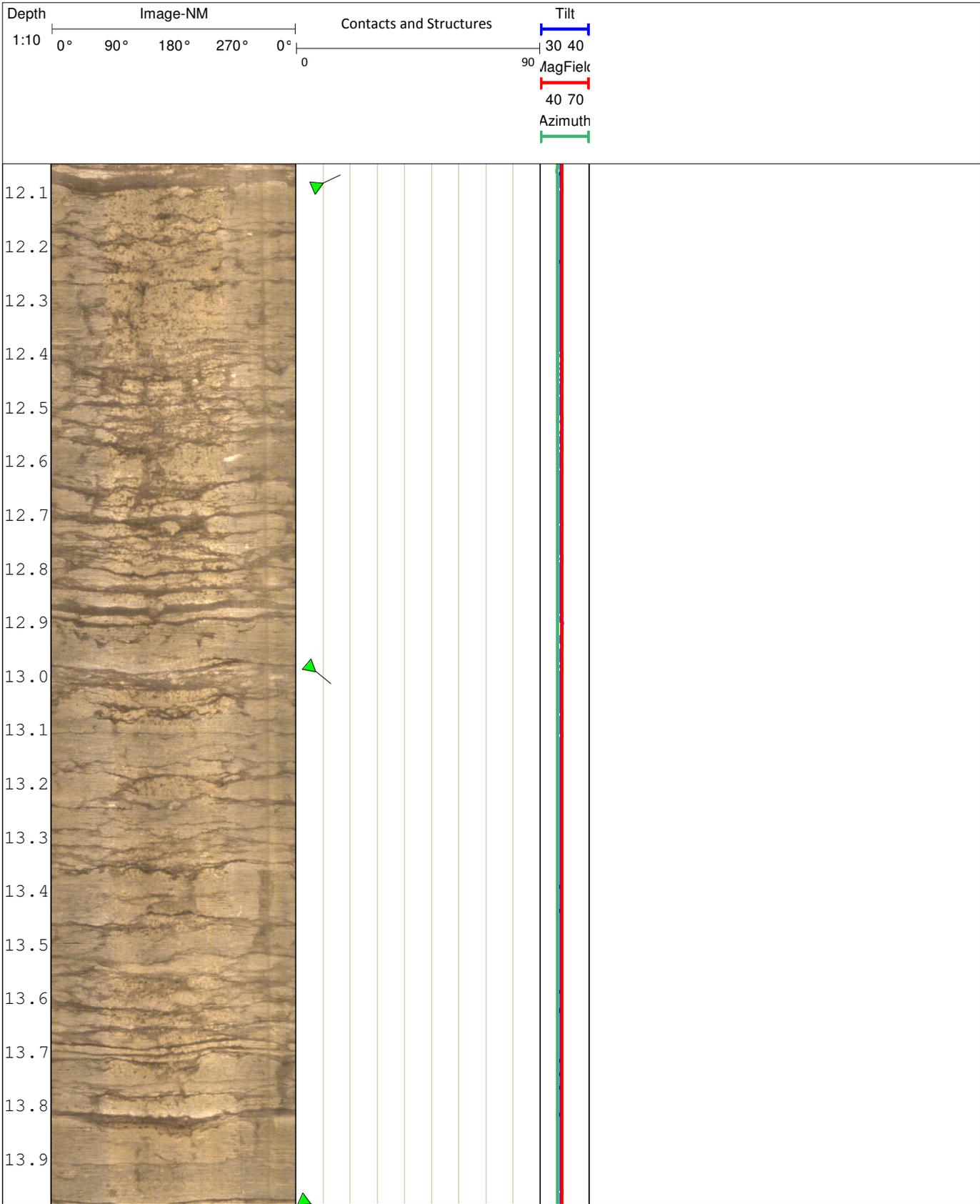


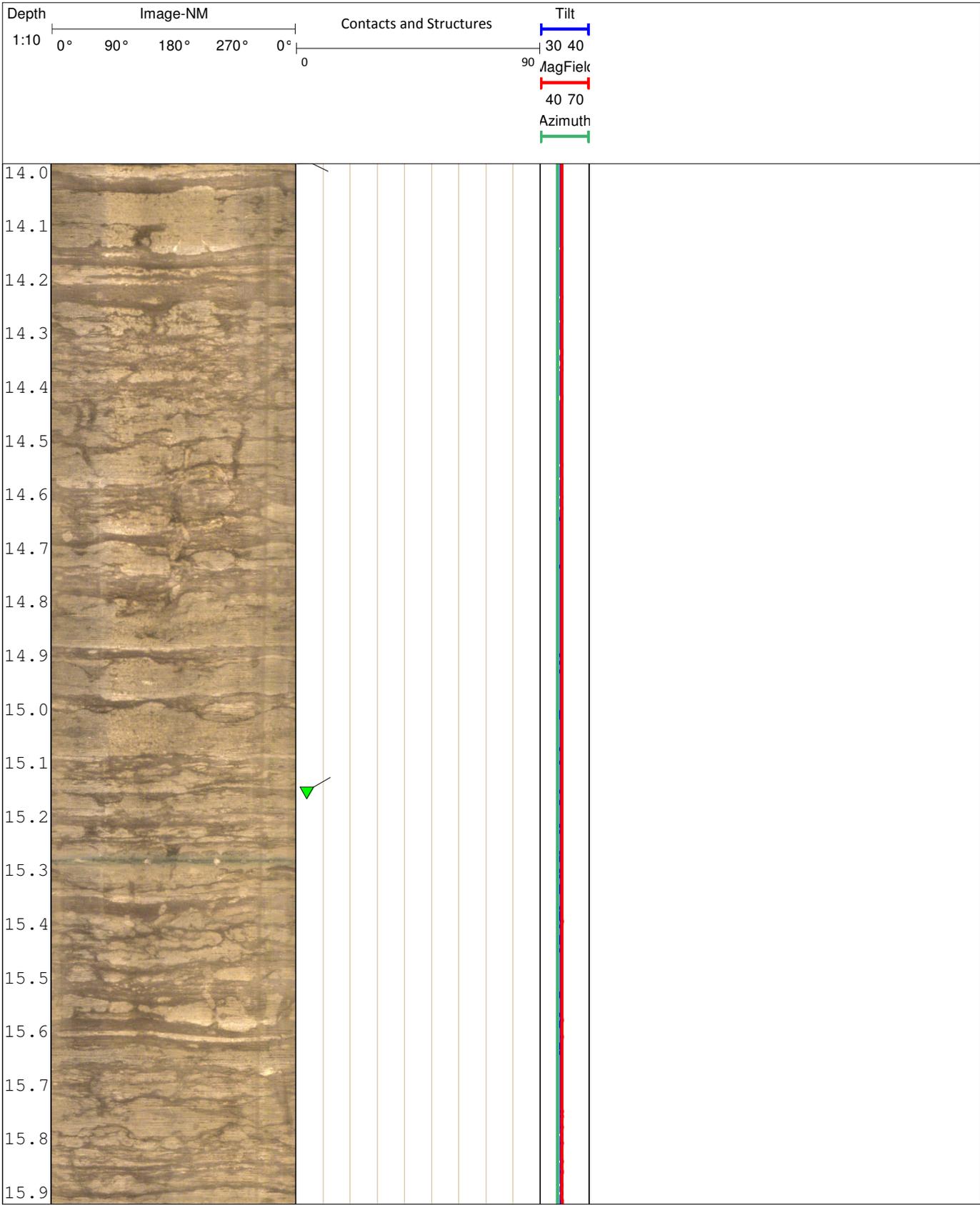


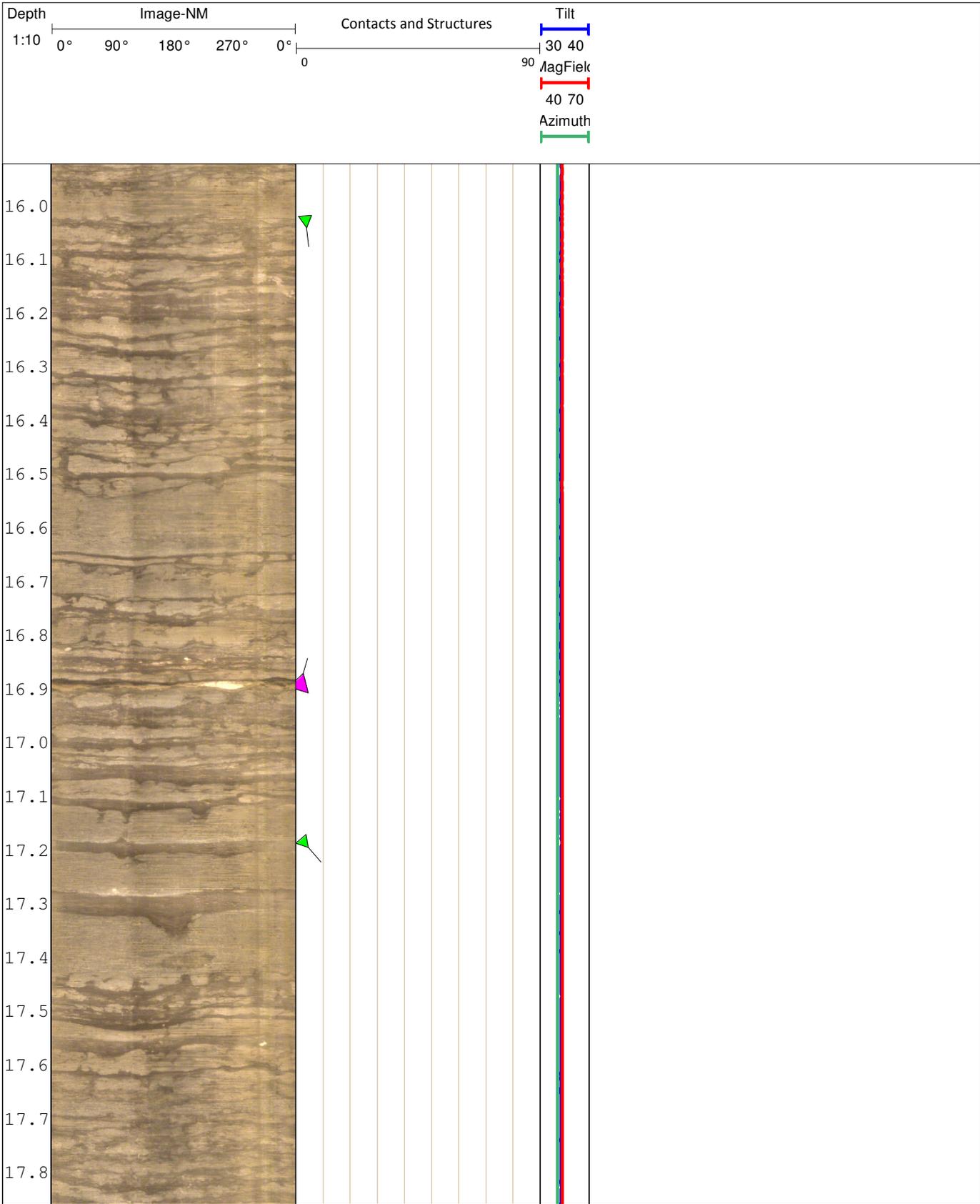


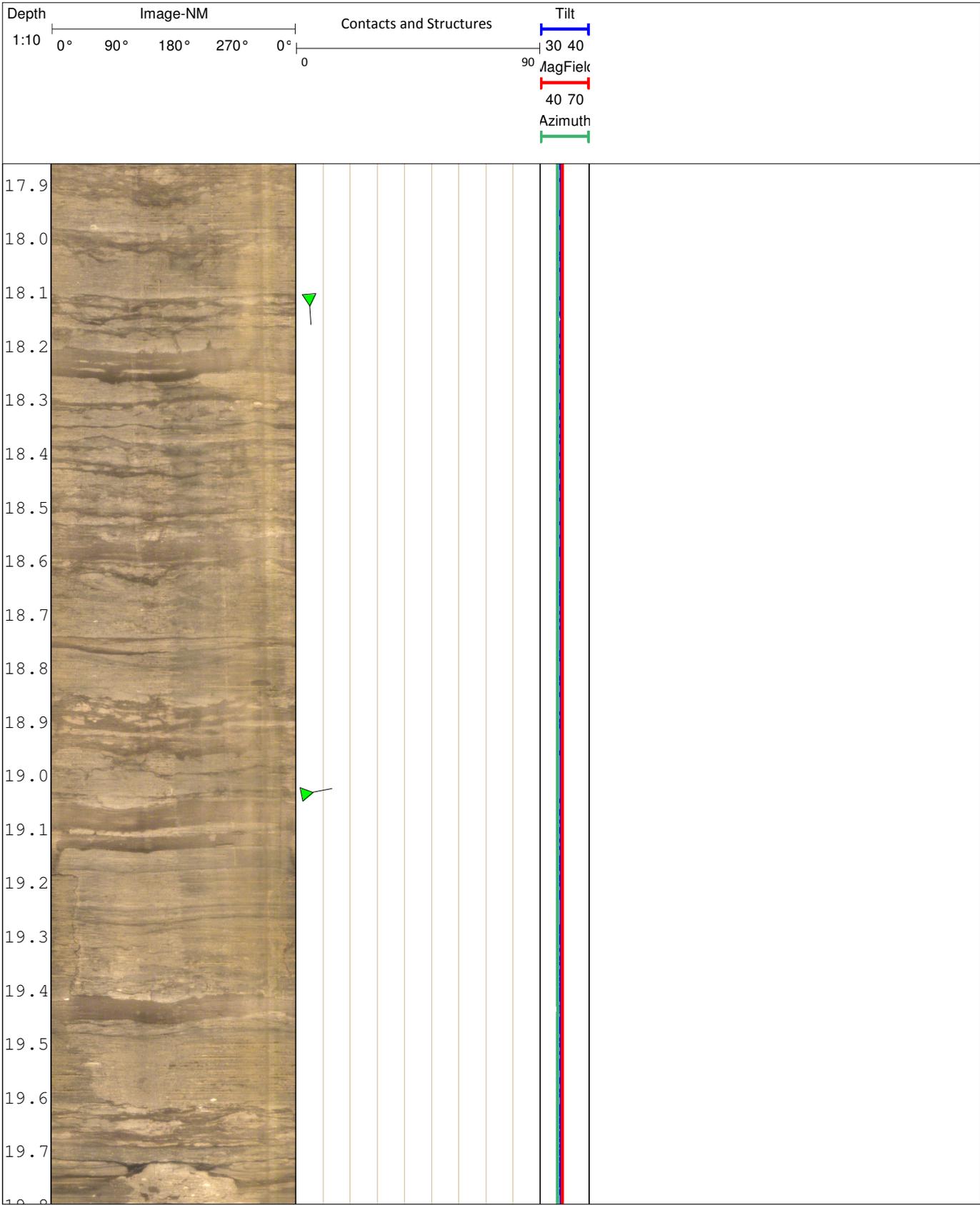


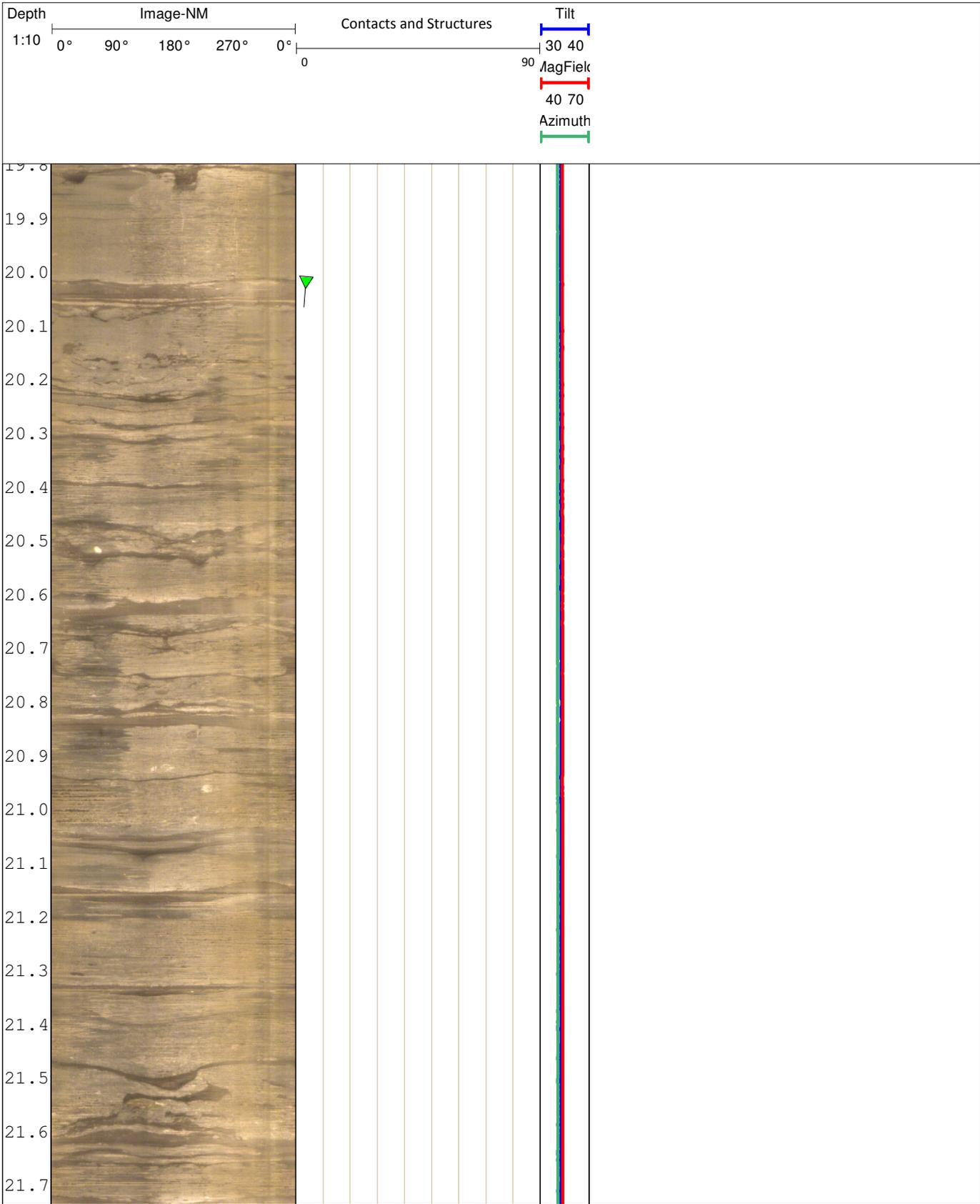


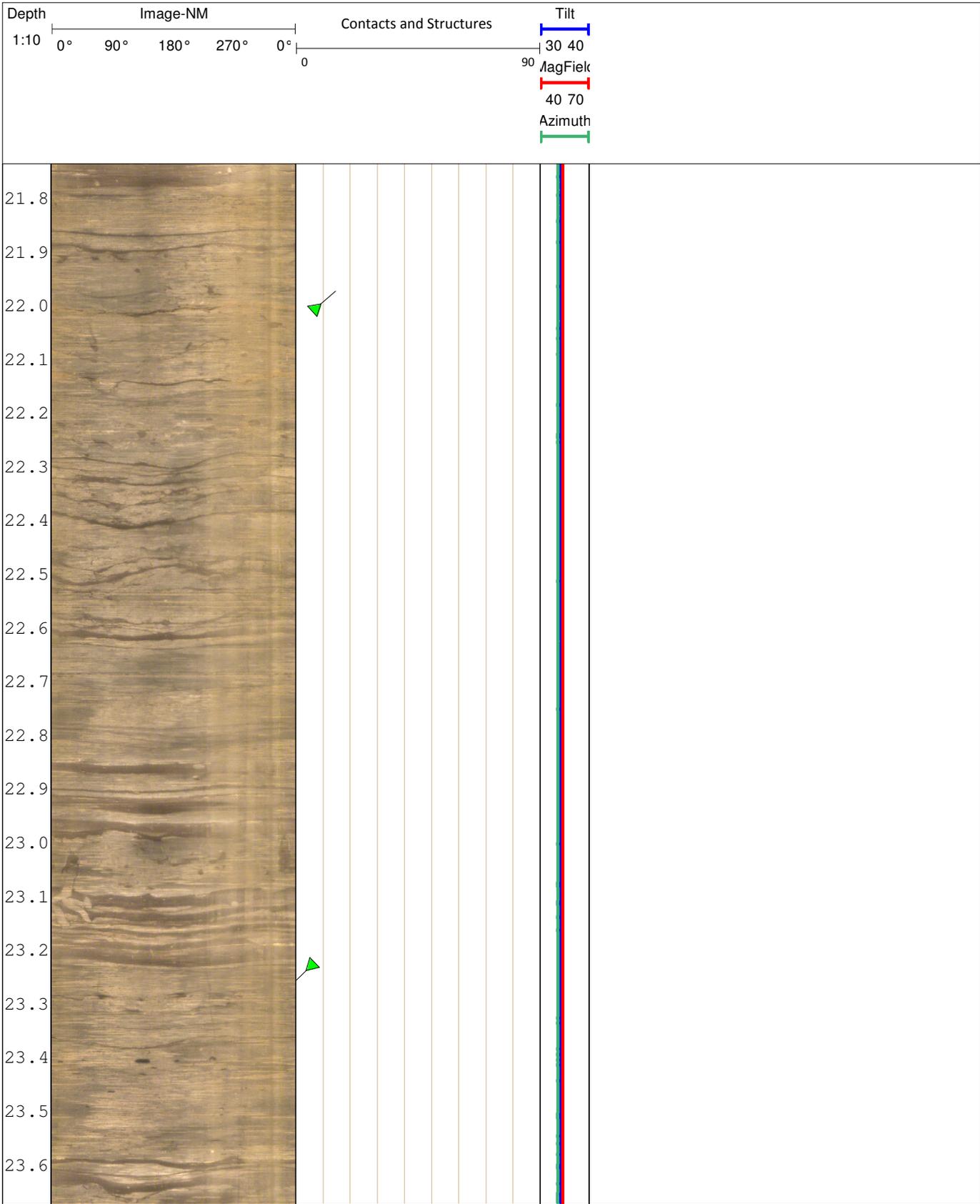


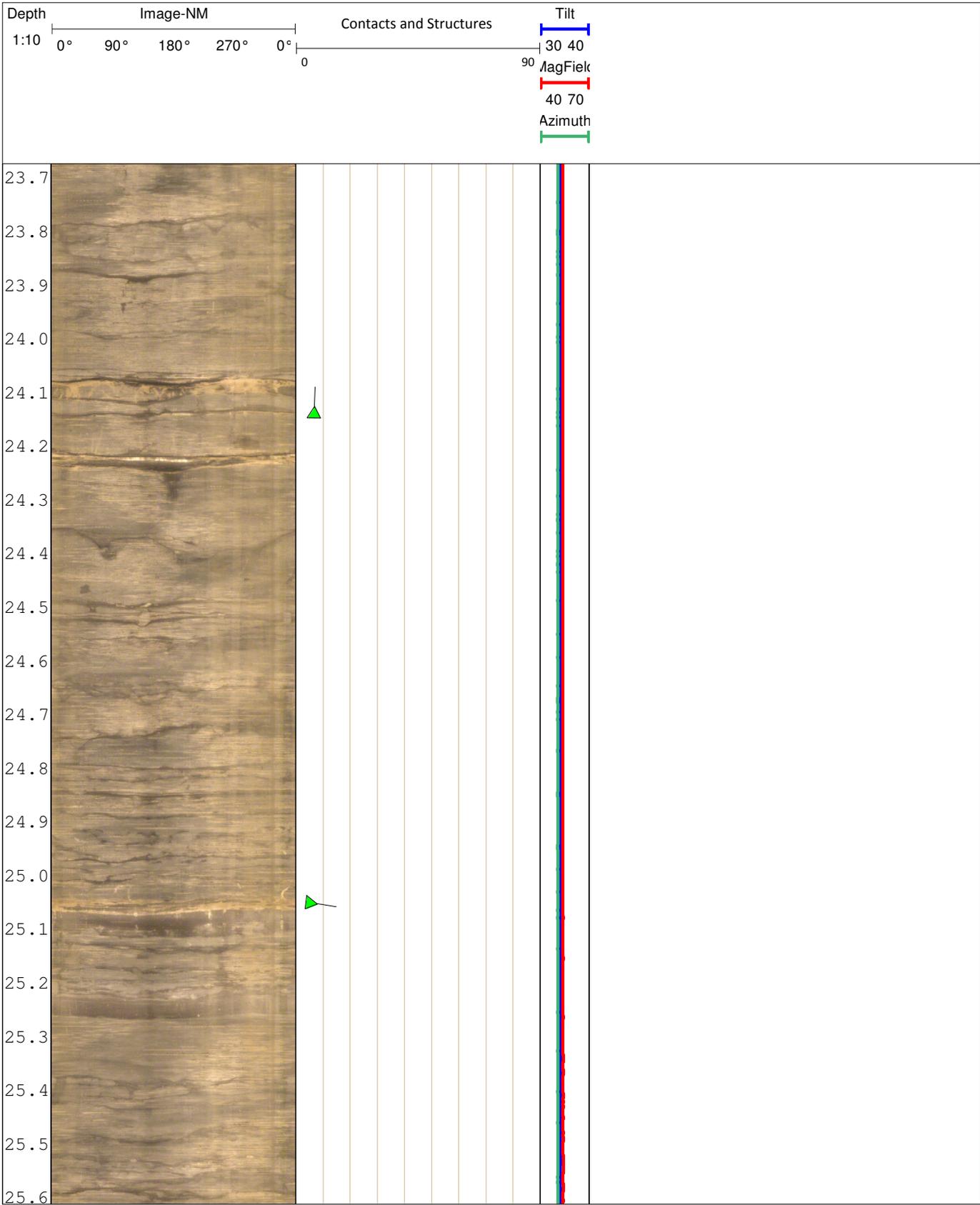


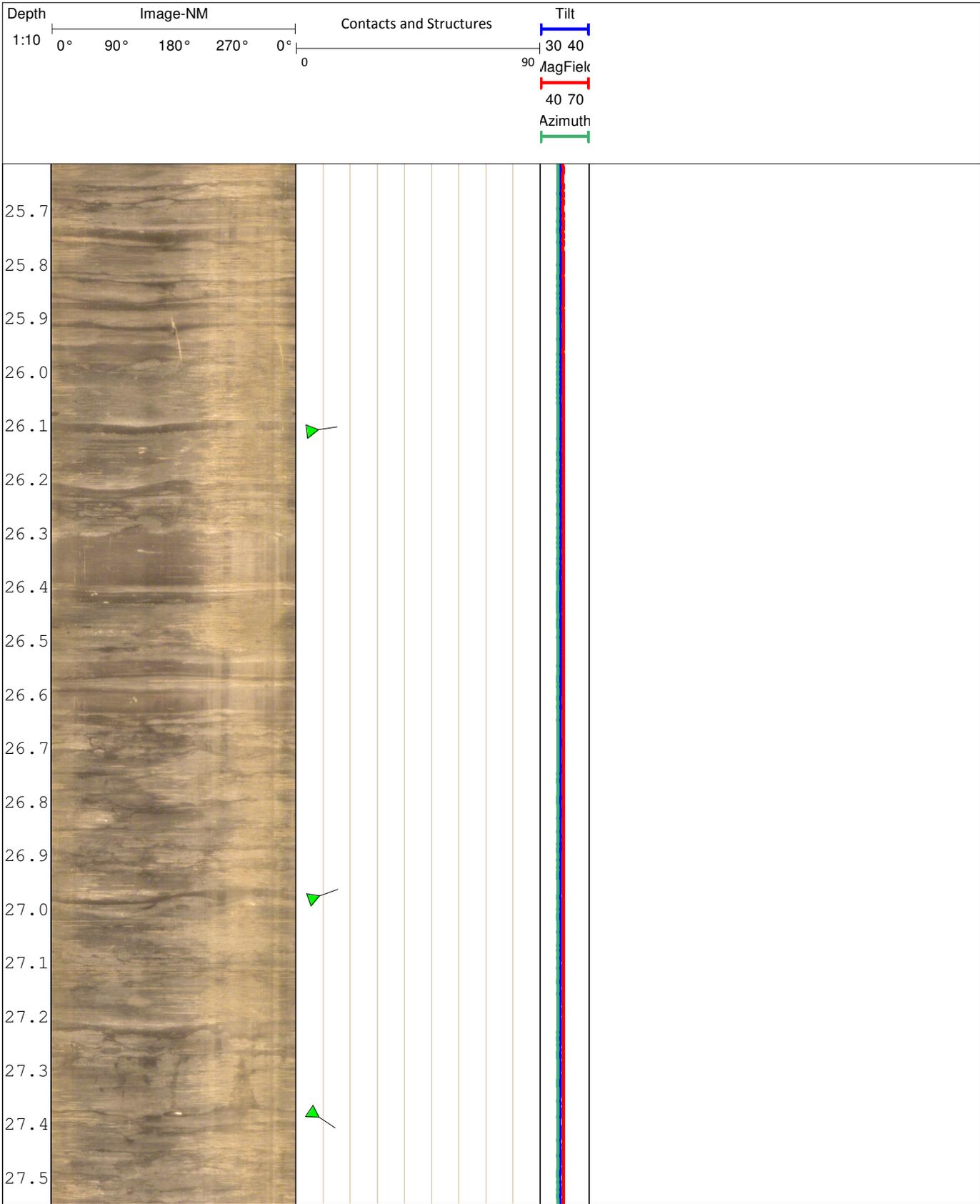


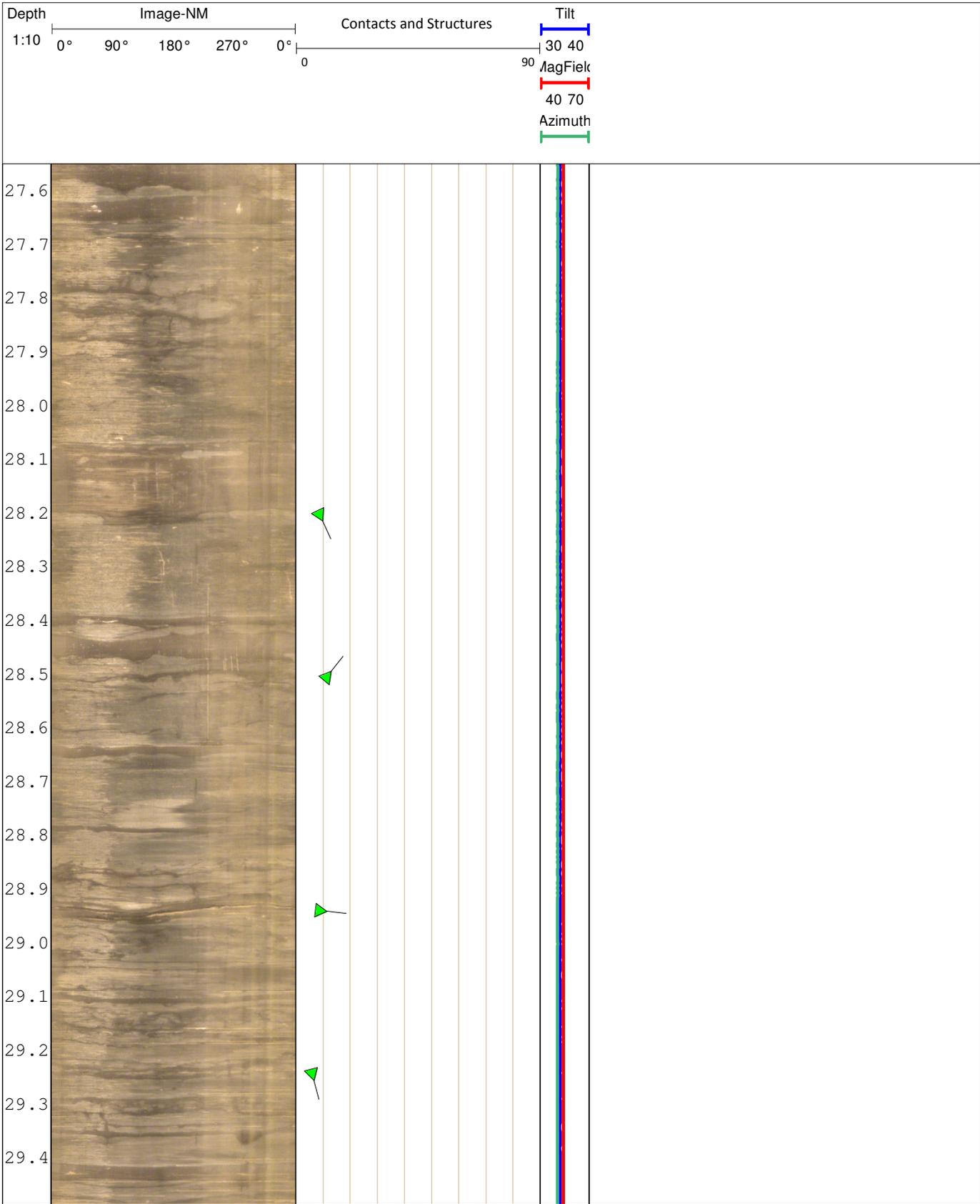


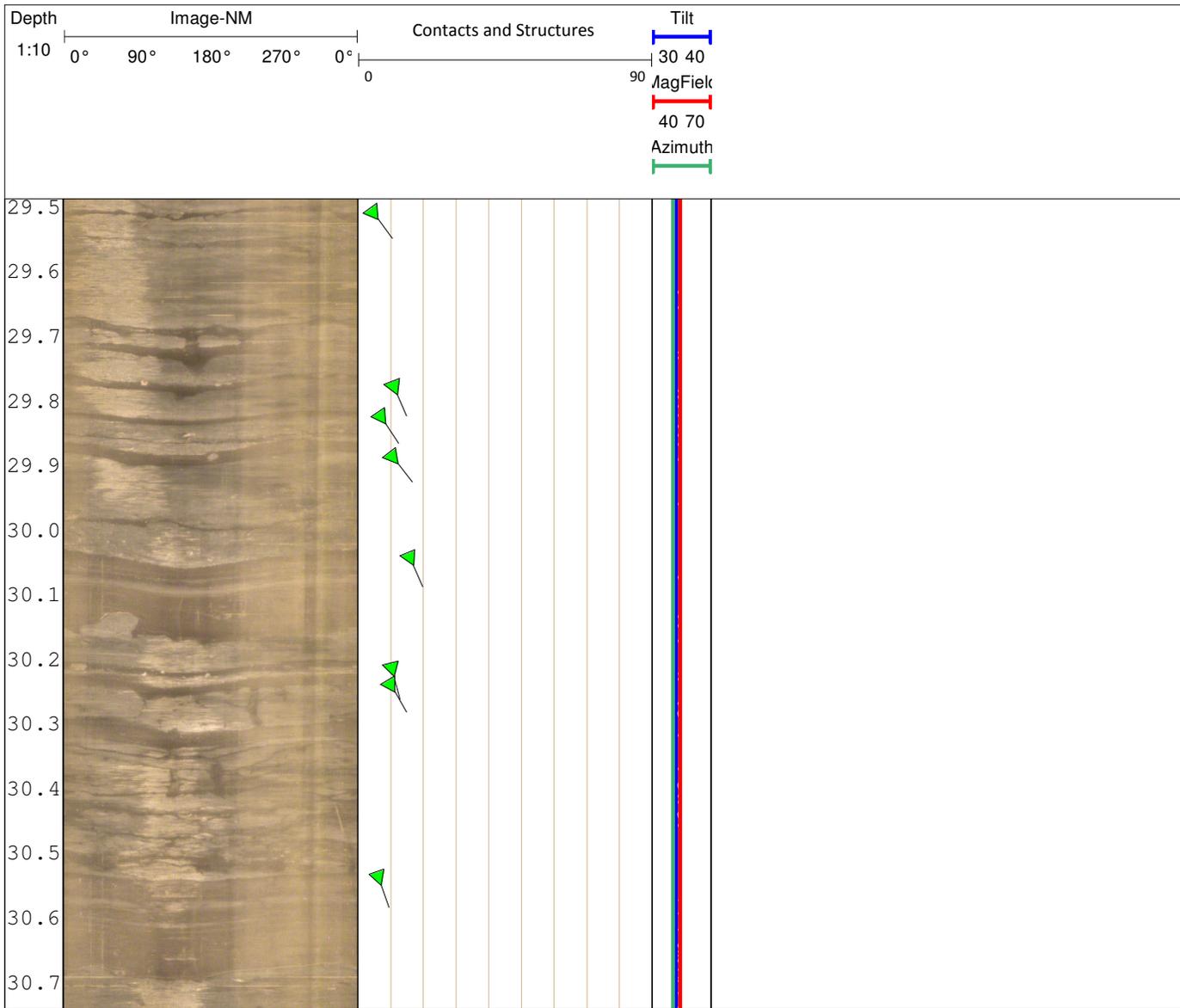












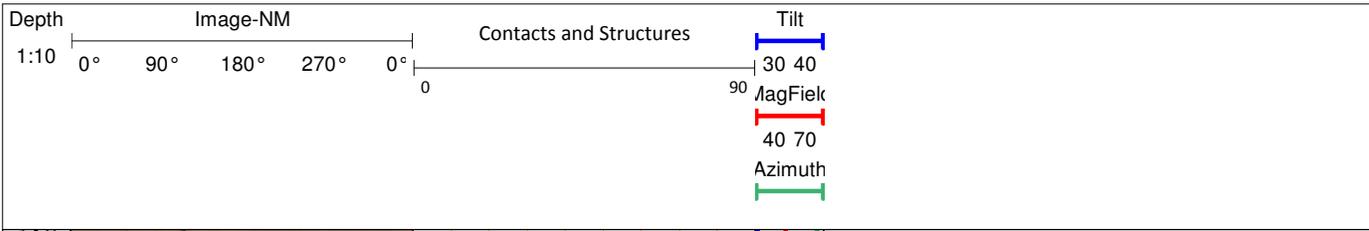


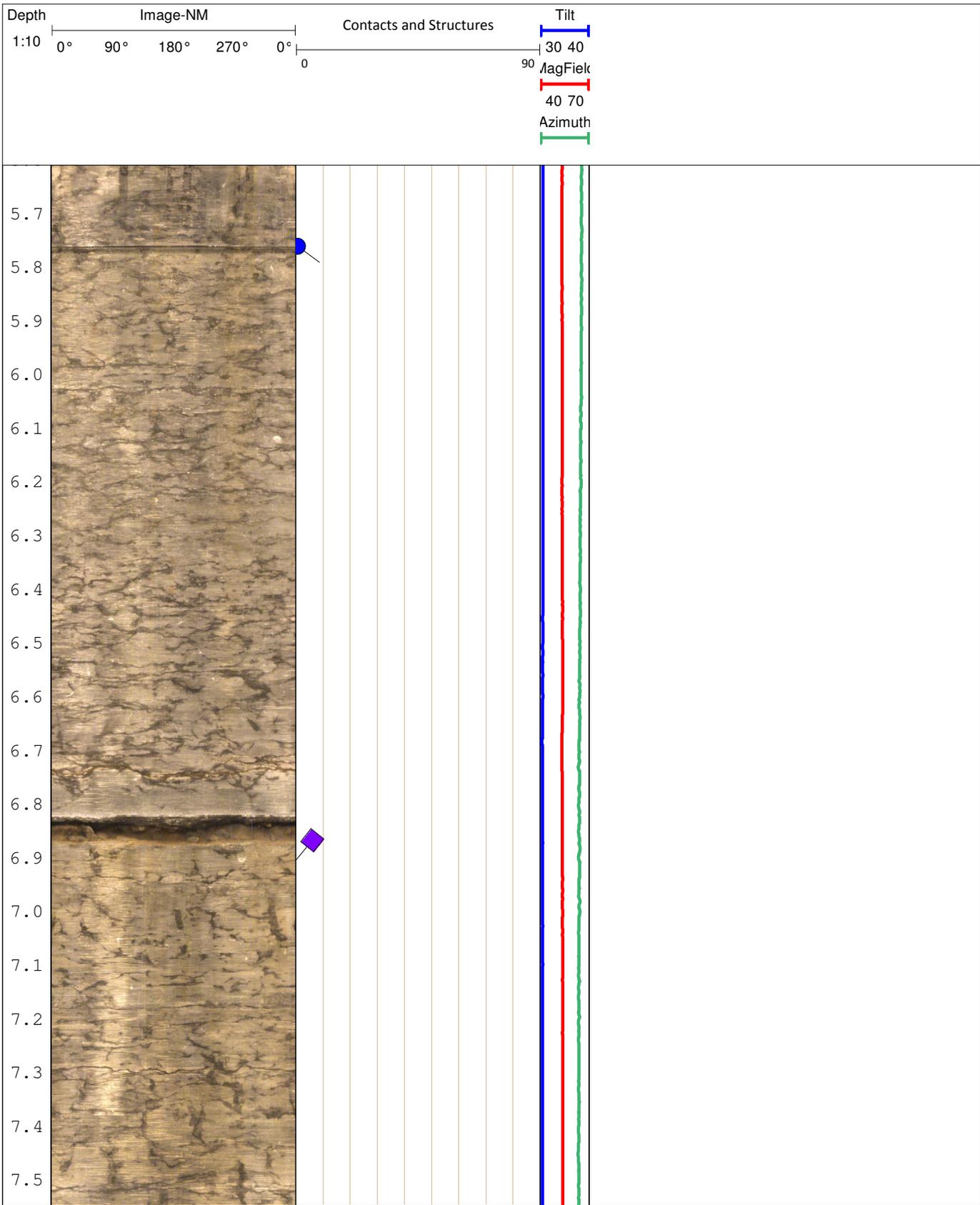
GEOPHYSICS GPR INTERNATIONAL INC.

COMPANY : Stantec Consulting Ltd./Public Works and Government Services Canada

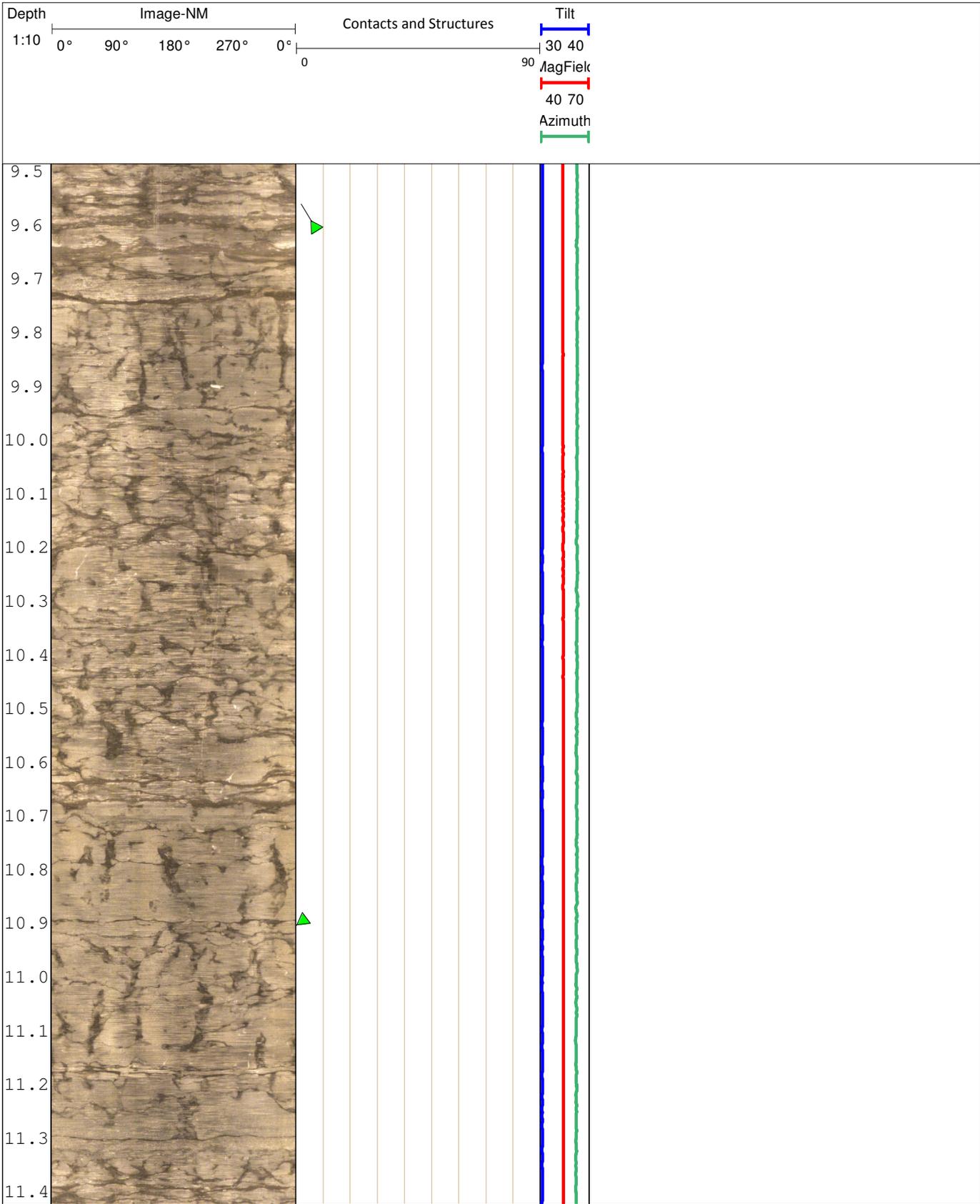
LOCATION : Center Block, Parliament Hill

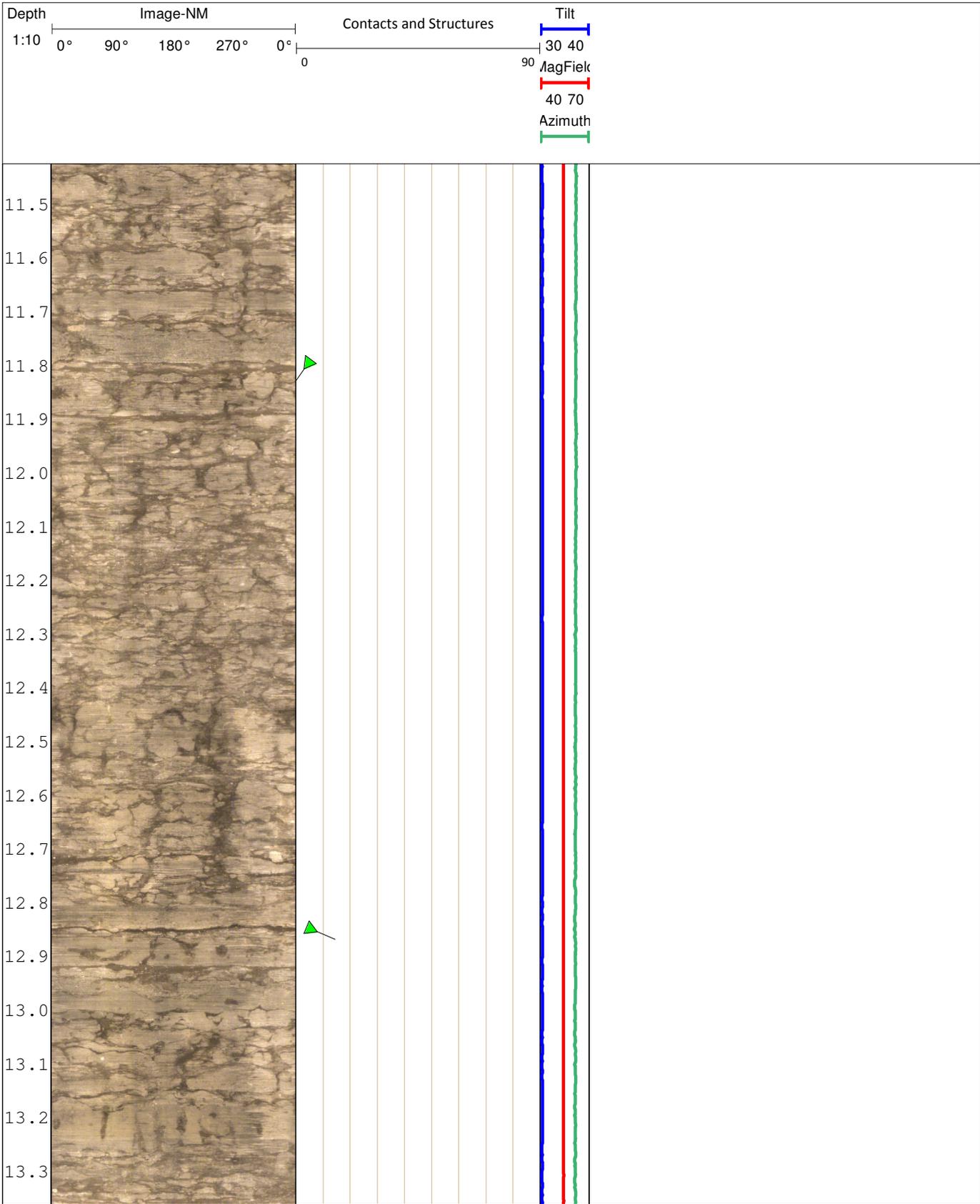
| | | | | |
|----------------------|-------------------|-----------------|----------|---|
| Well | BH15-5 | | | NOTES: Project No. 122411046 UTM coordinates N:5 030 408 E:445 331 |
| Date | February 10, 2015 | BH Fluid | no fluid | |
| Casing | 3.5" | | | |
| File Name | BH5.wcl | | | |
| Depth Driller | | | | |
| Depth Logger | | | | |
| Logged by | Derrick Hall | | | |
| Witnessed by | Tom Westerblom | | | |

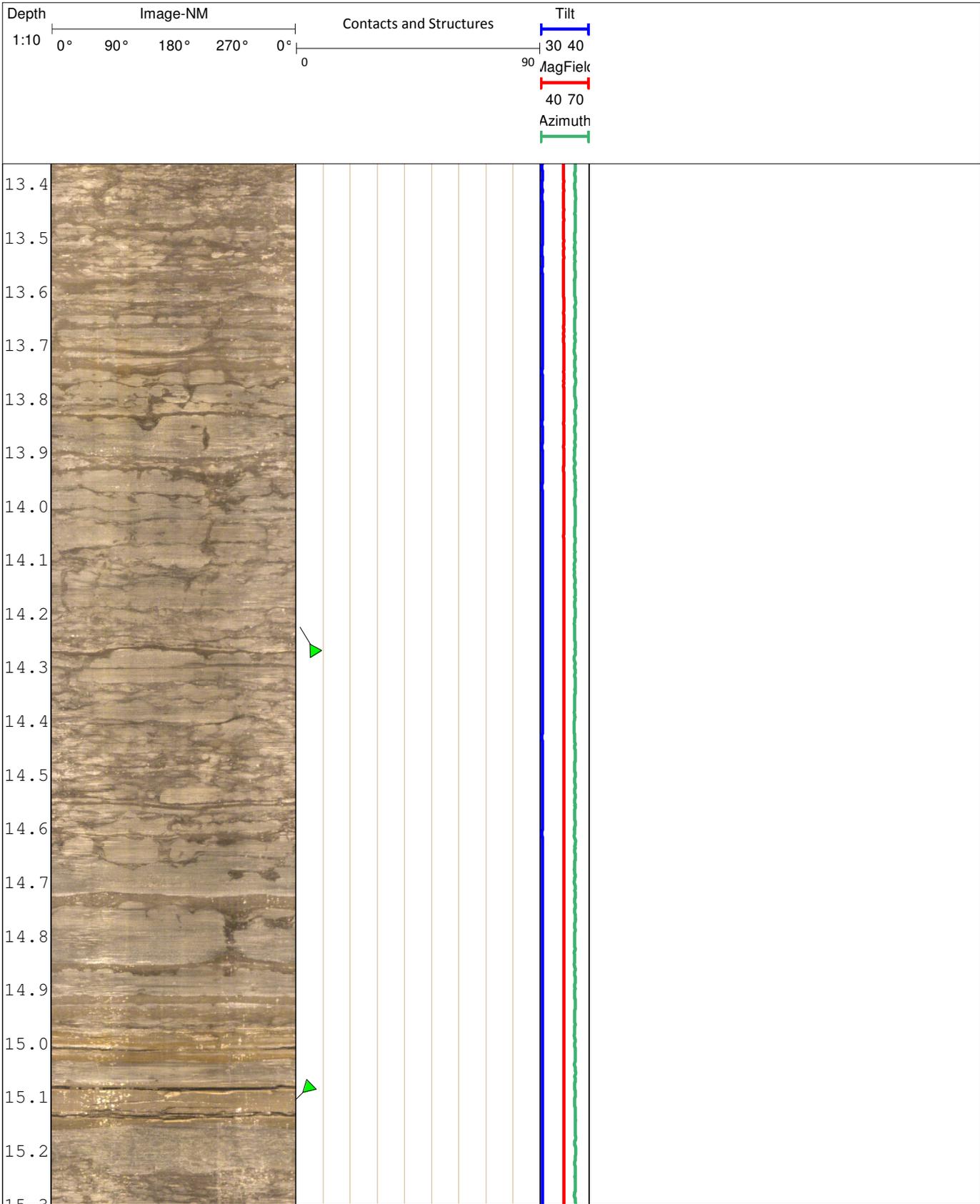


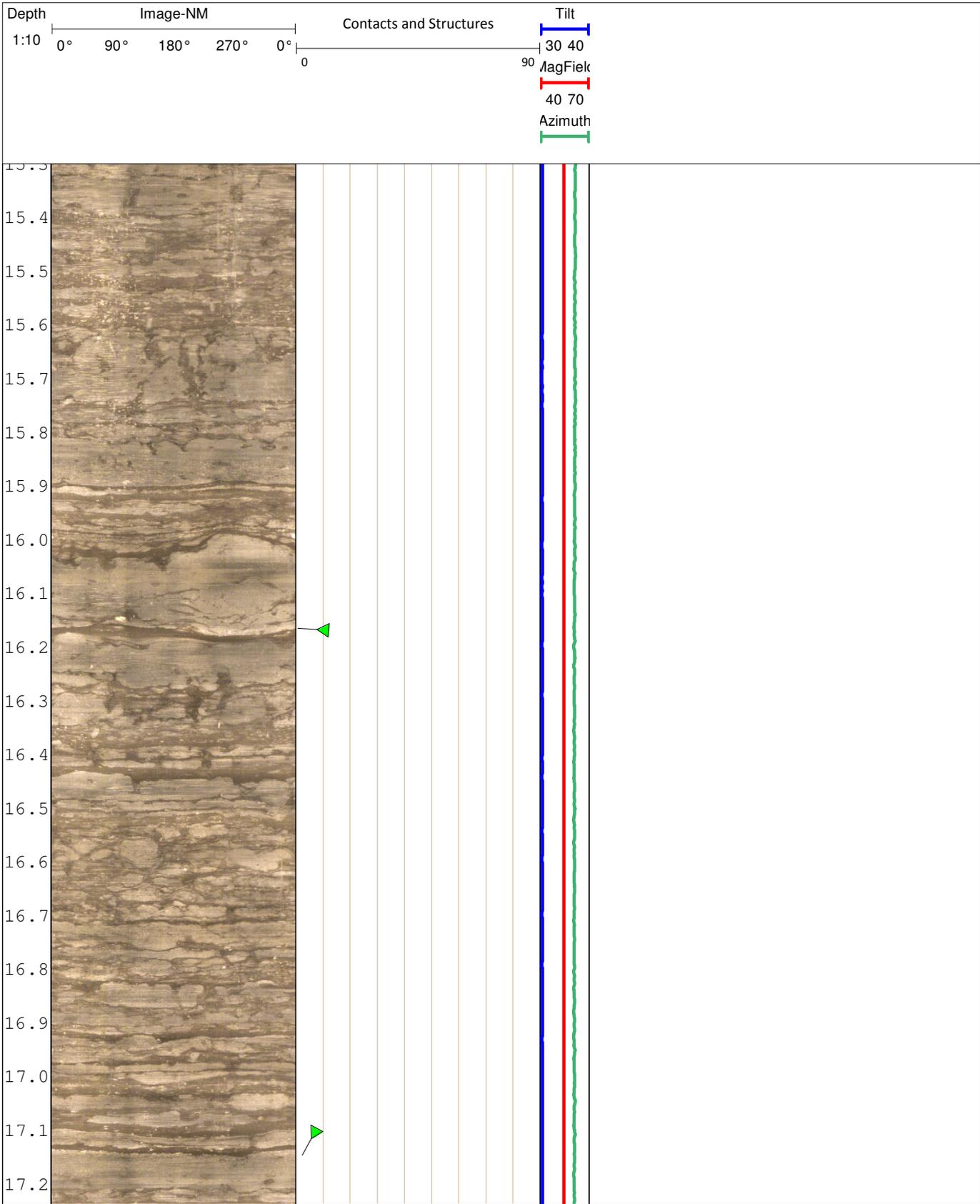


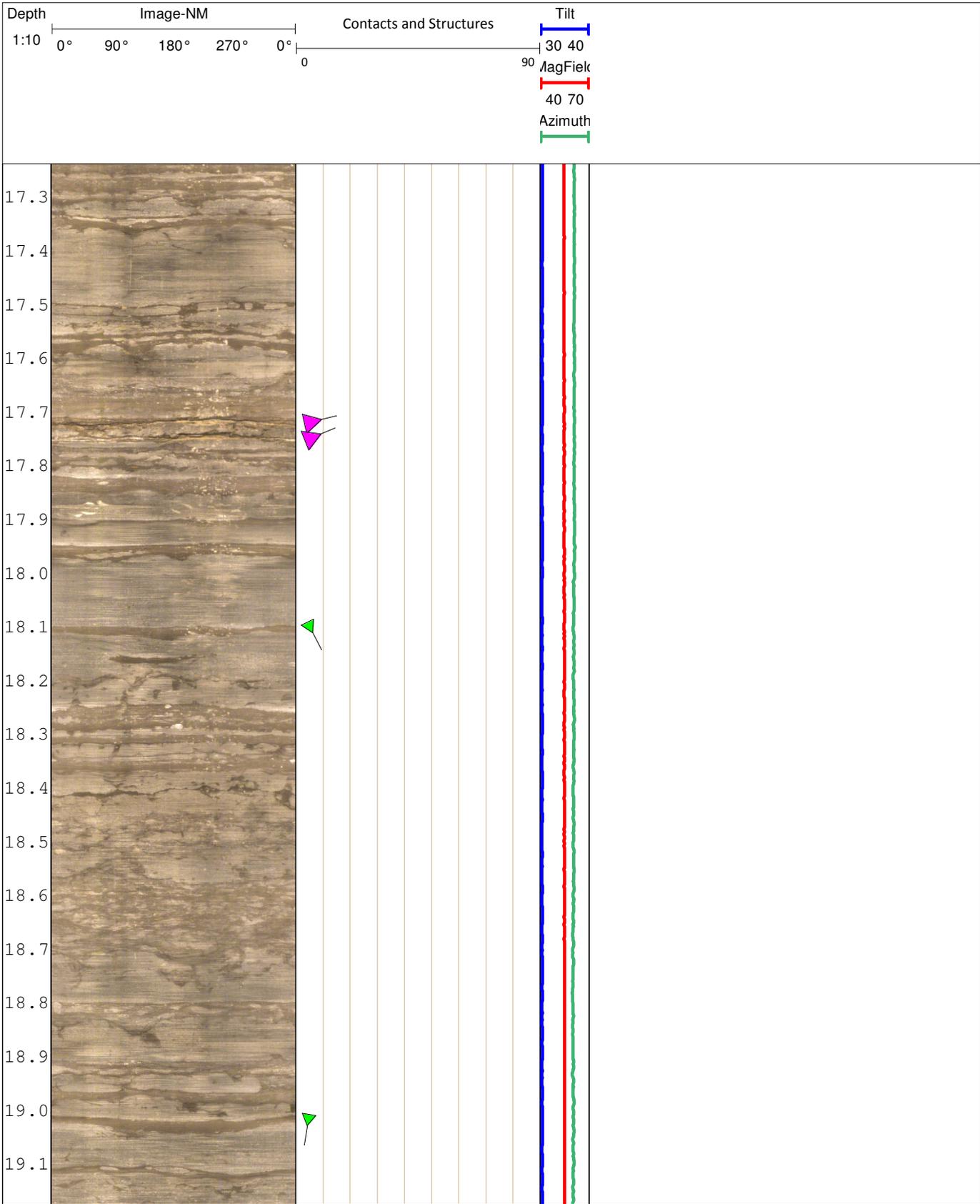


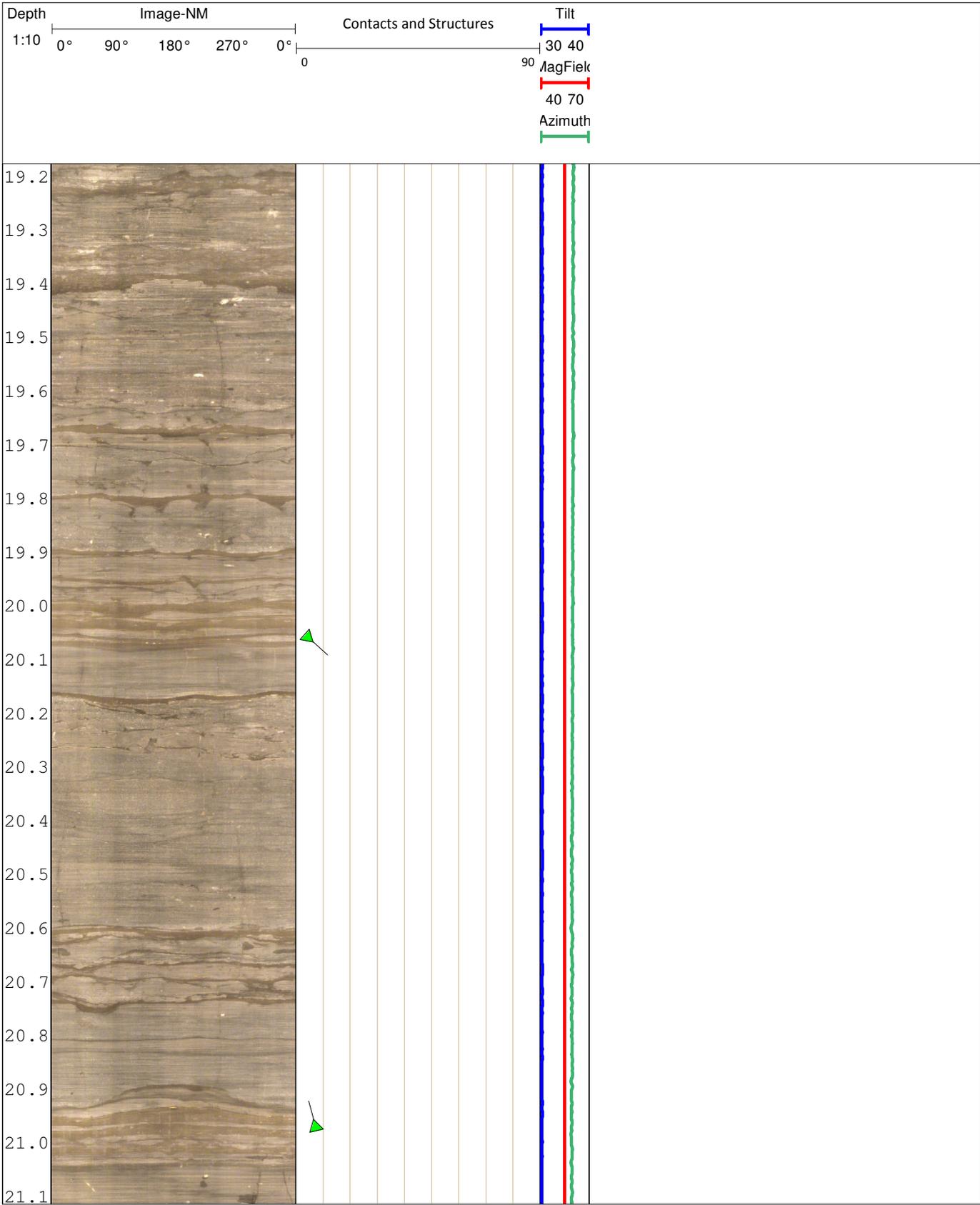


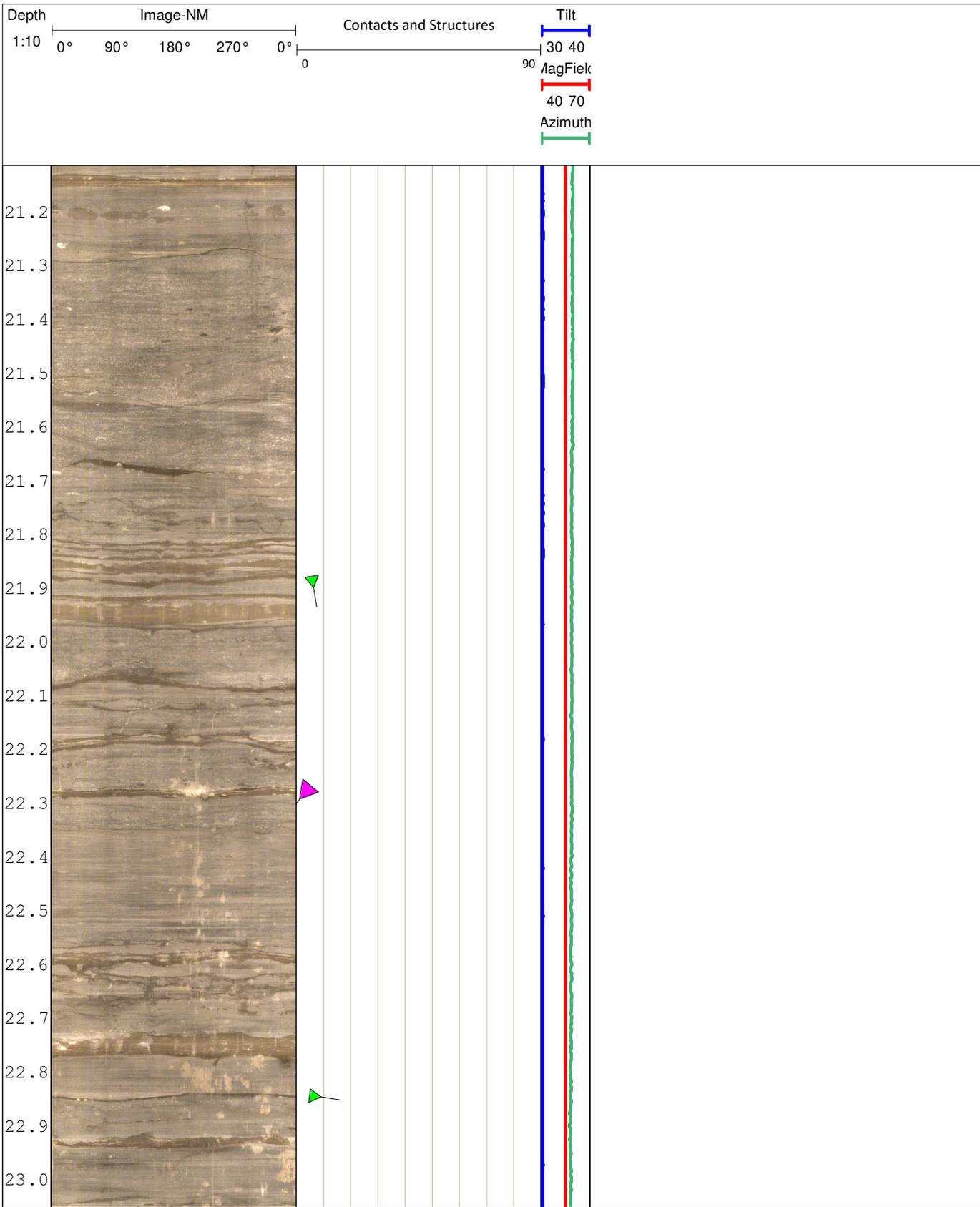


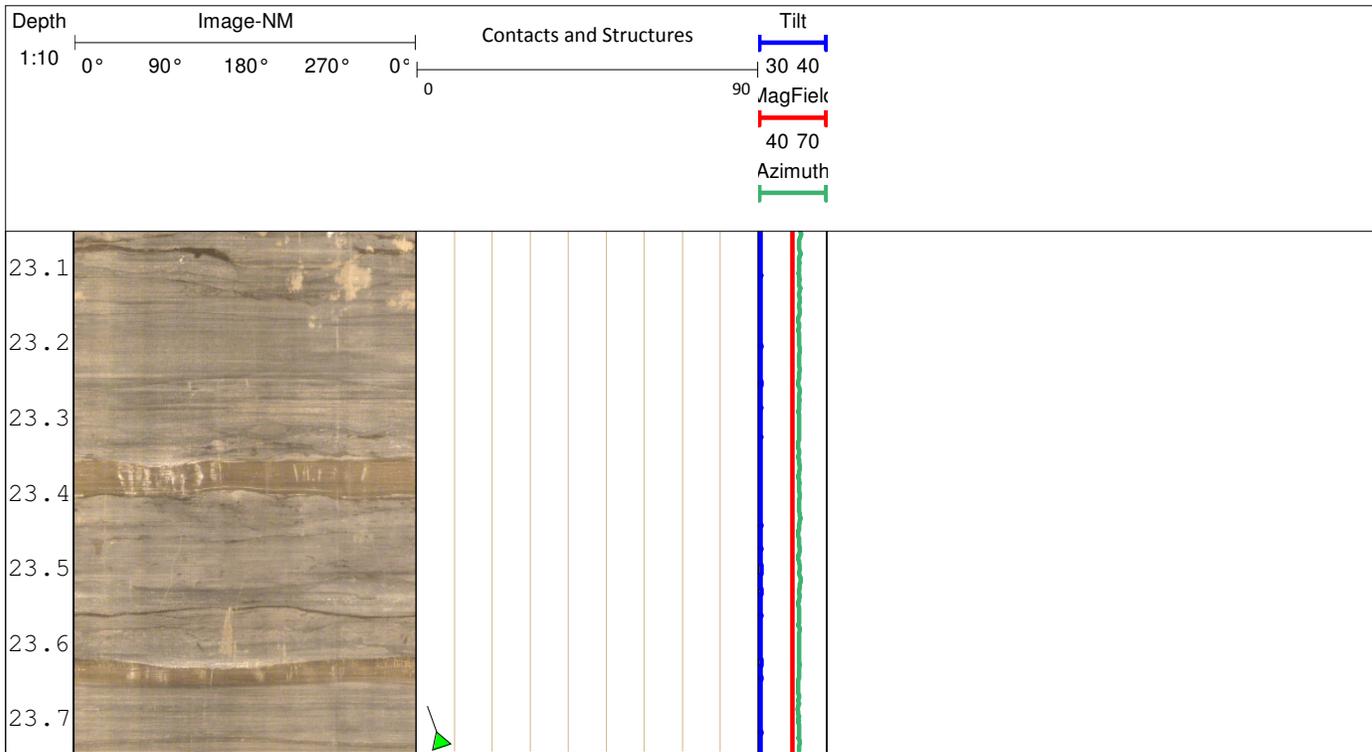












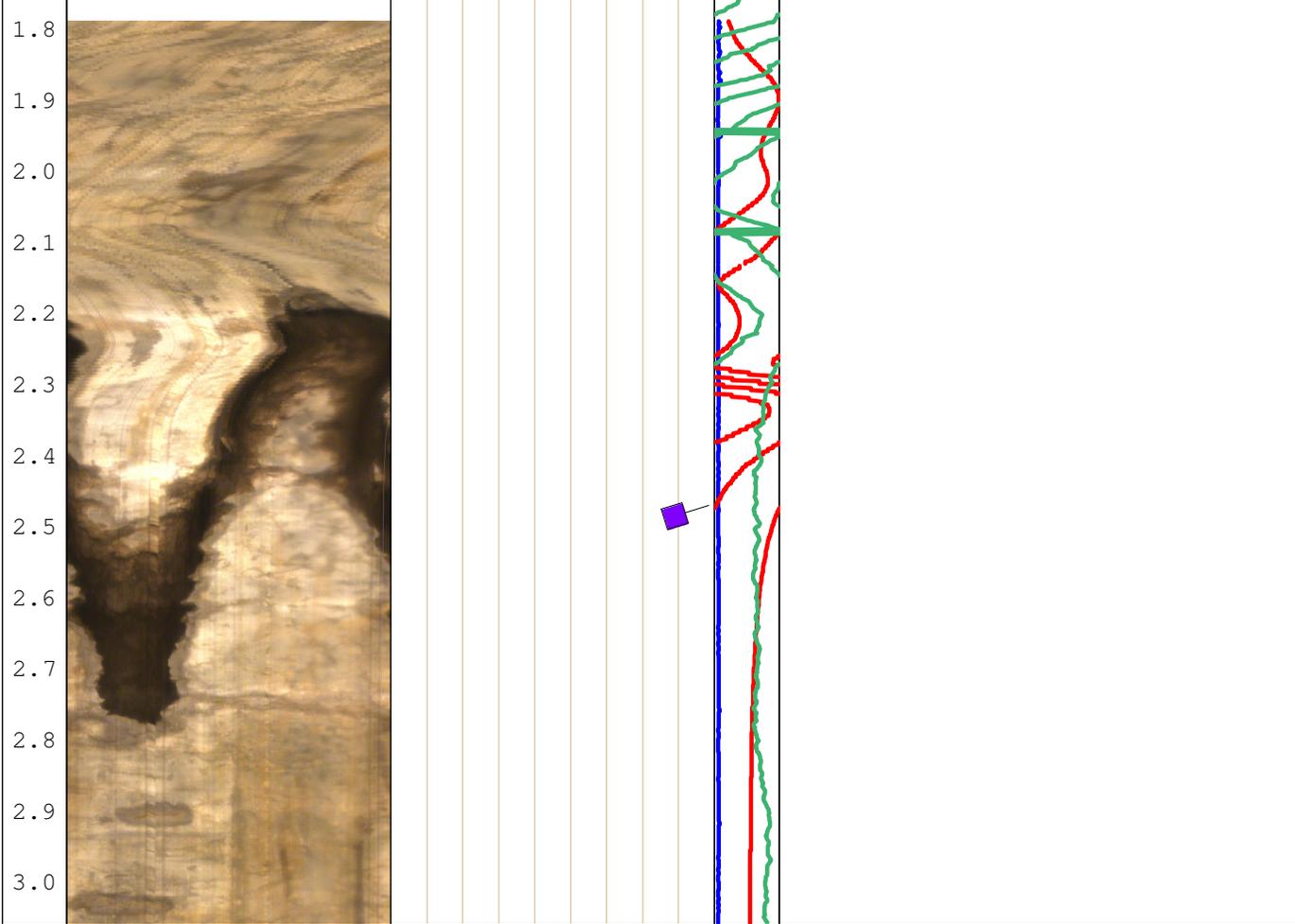
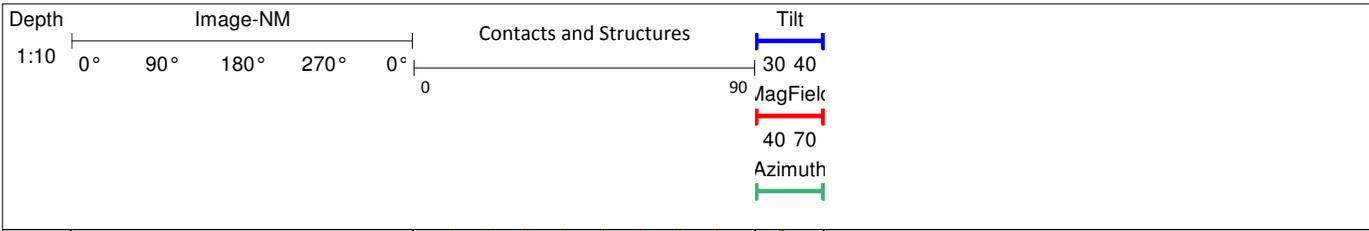


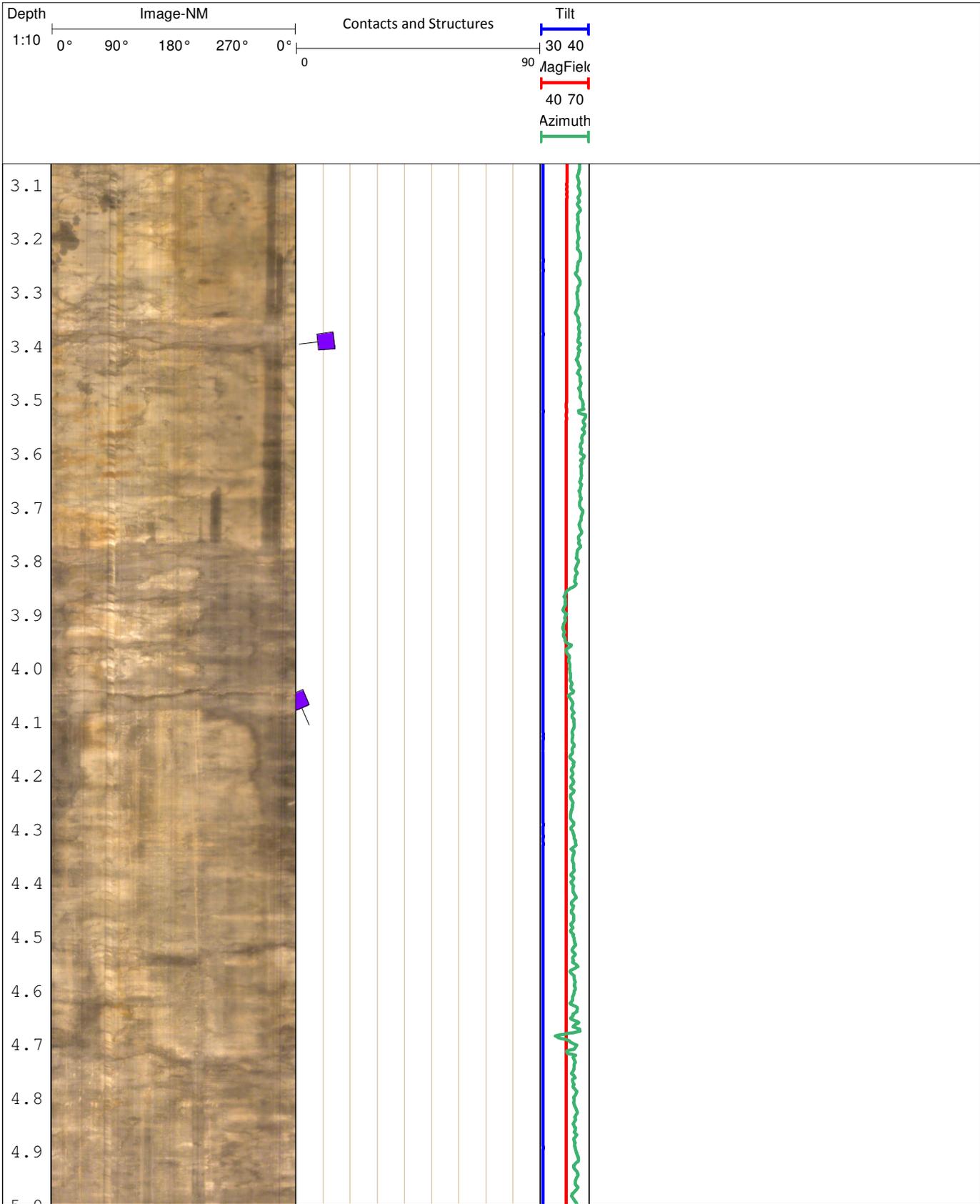
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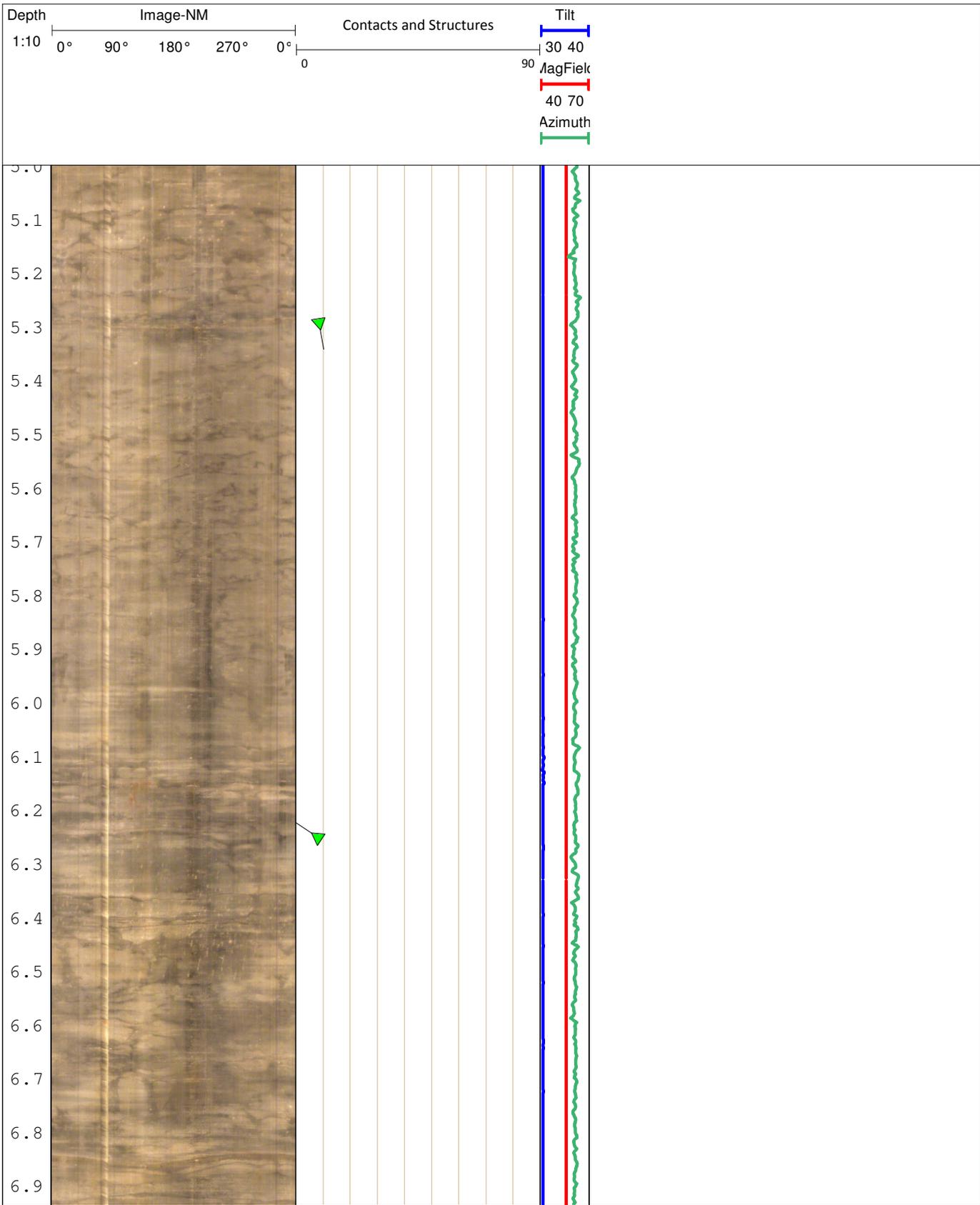
COMPANY : Stantec Consulting Ltd./Public Works and Government Services Canada

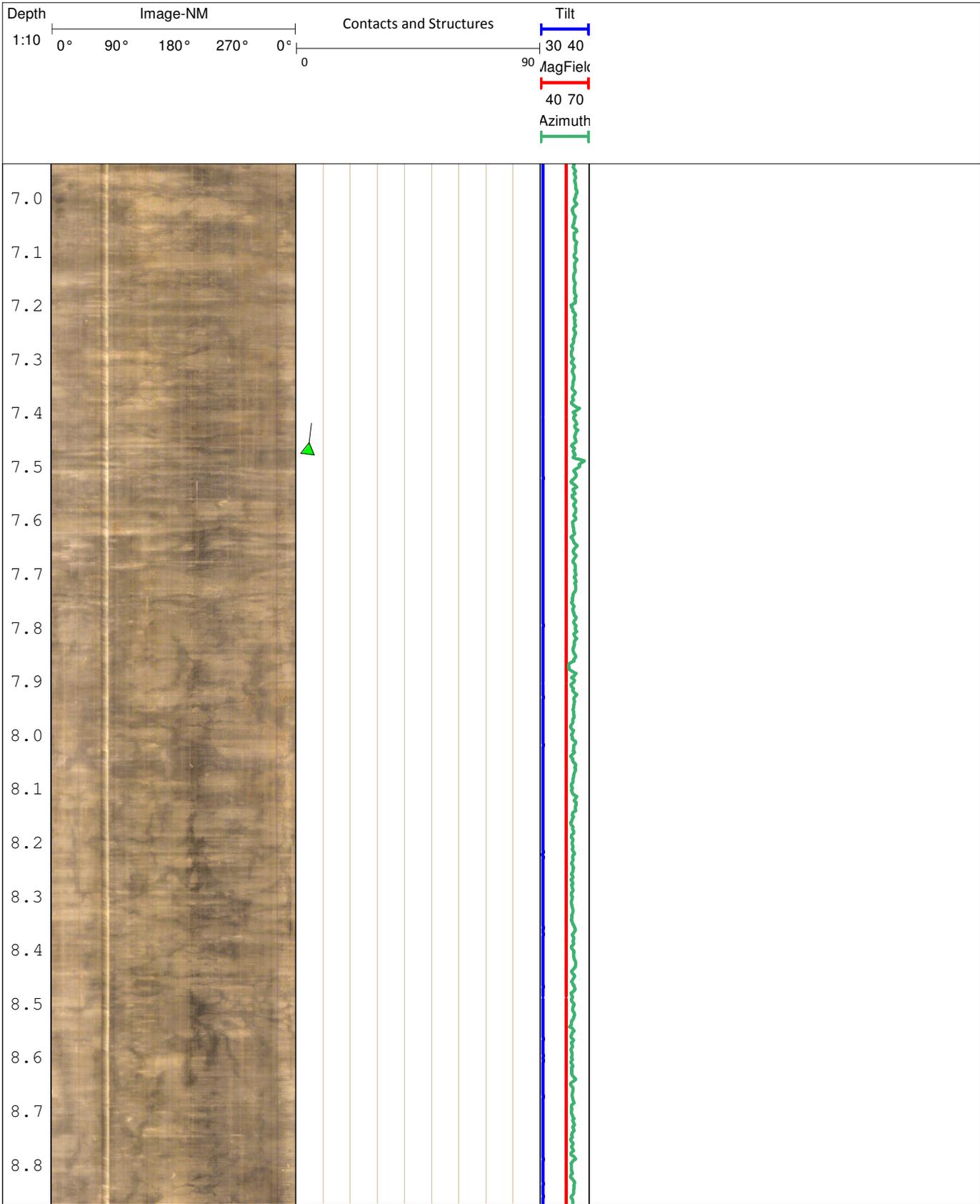
LOCATION : Center Block, Parliament Hill

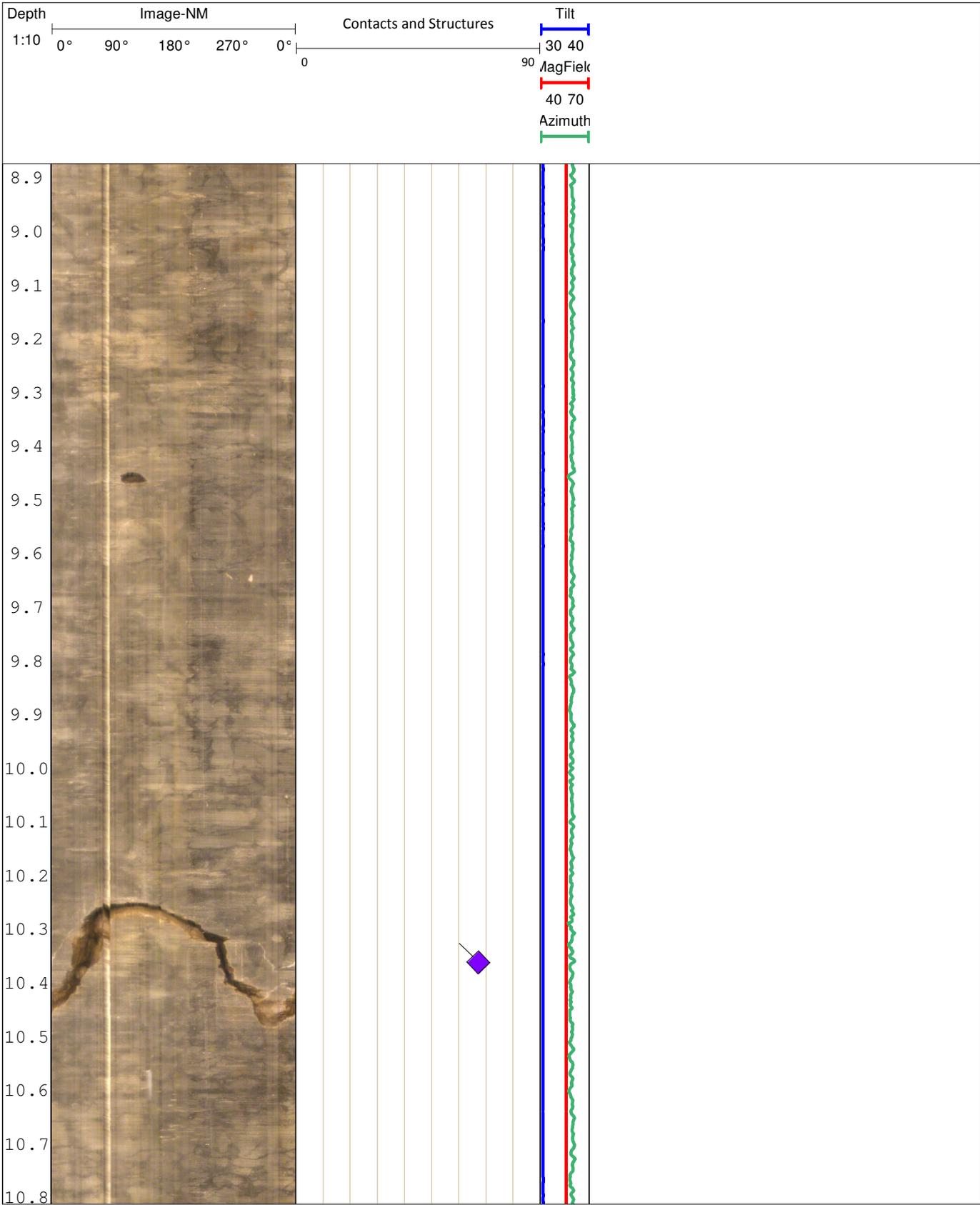
| | | | | |
|----------------------|-------------------|-----------------|----------|---|
| Well | BH15-9 | | | NOTES: Project No. 122411046 UTM coordinates N:5 030 493 E:445 272 |
| Date | February 10, 2015 | BH Fluid | no fluid | |
| Casing | 3.5" | | | |
| File Name | BH9.wcl | | | |
| Depth Driller | | | | |
| Depth Logger | | | | |
| Logged by | Derrick Hall | | | |
| Witnessed by | Tom Westerblom | | | |

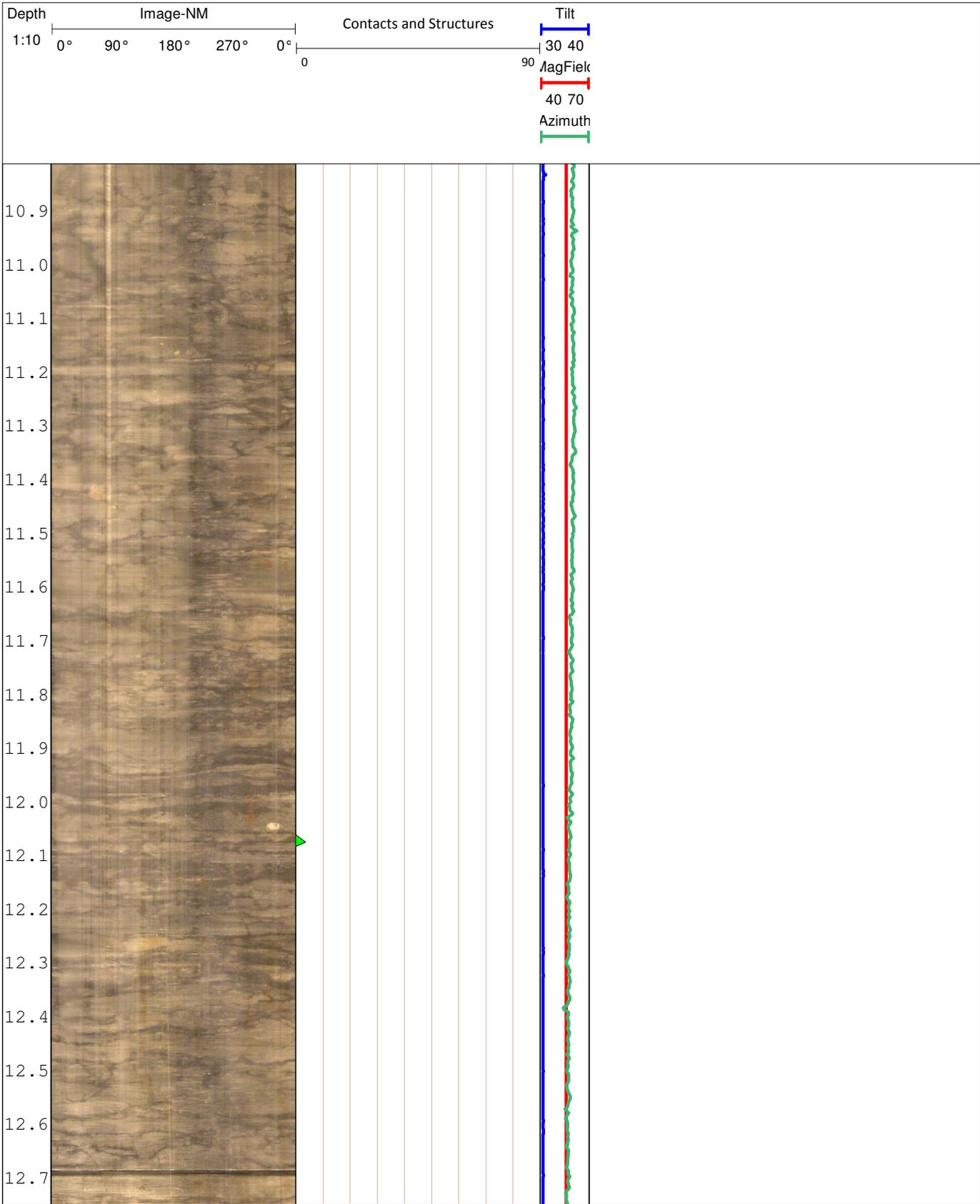


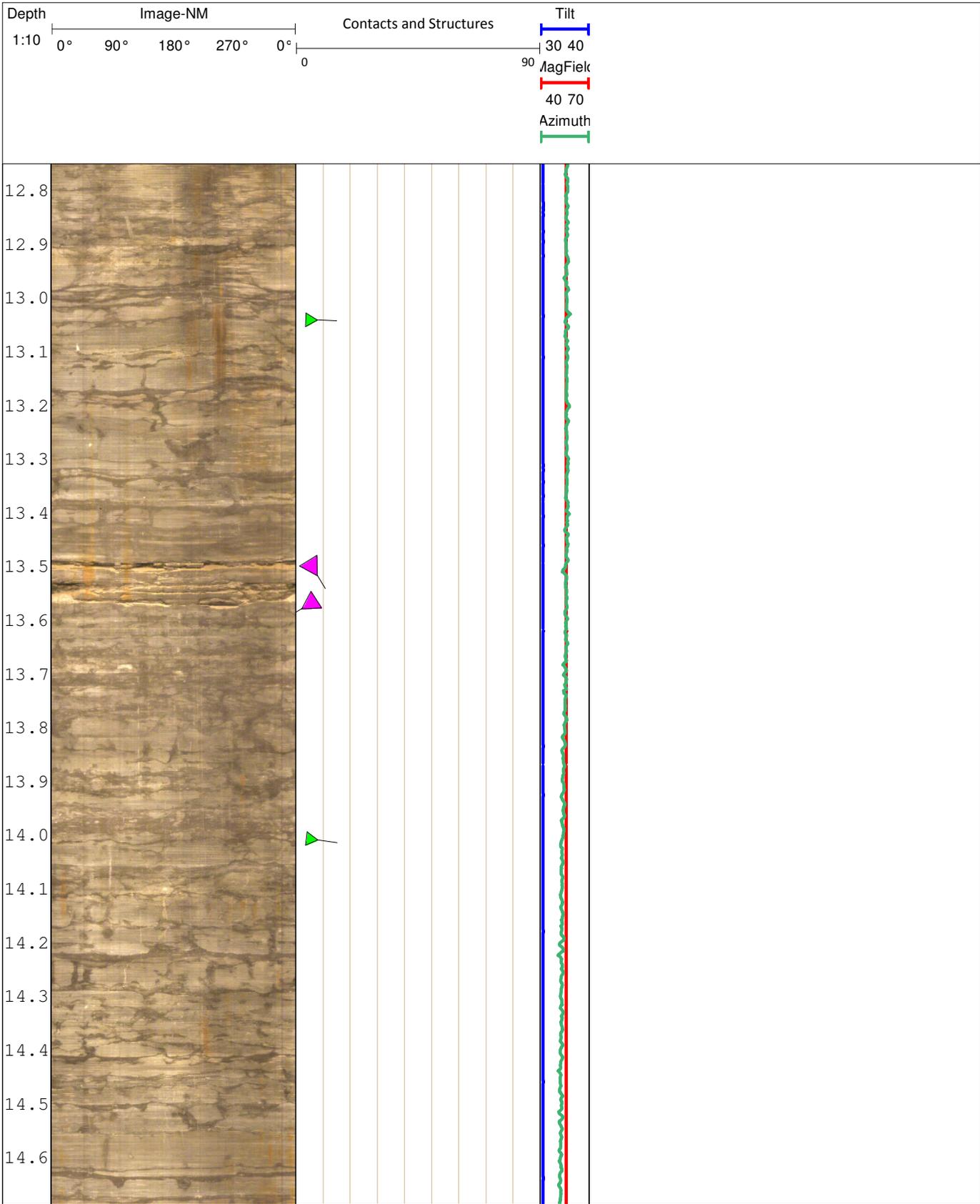


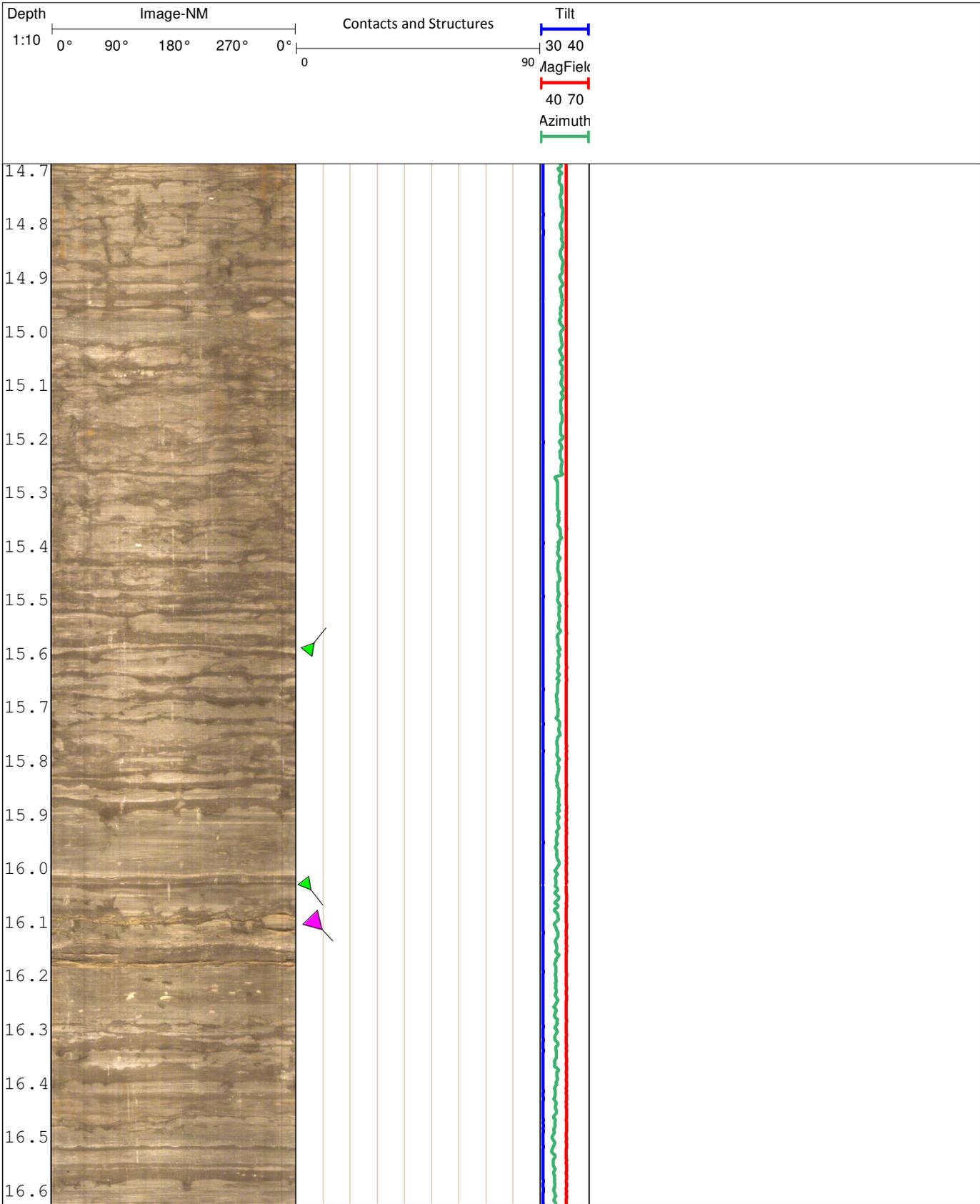


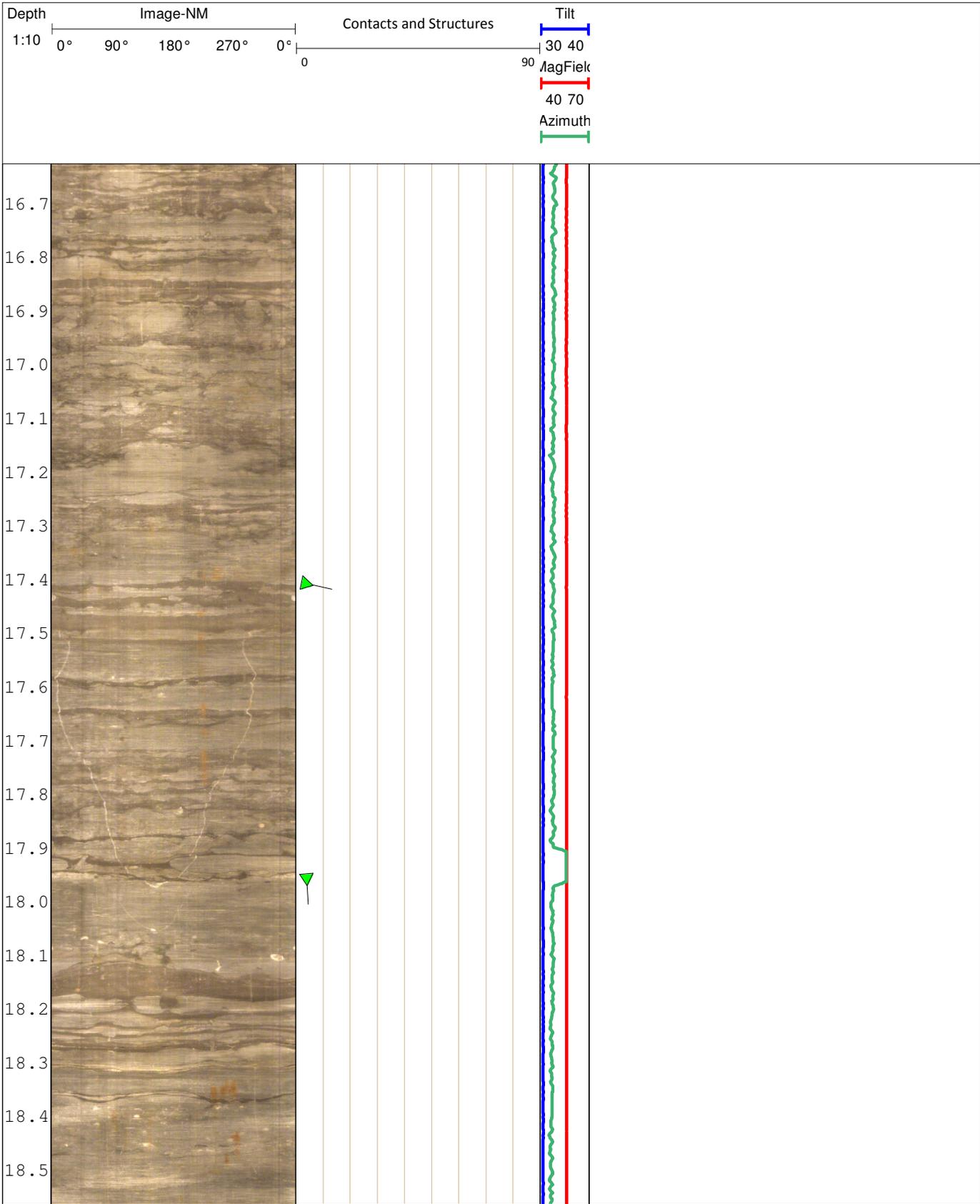


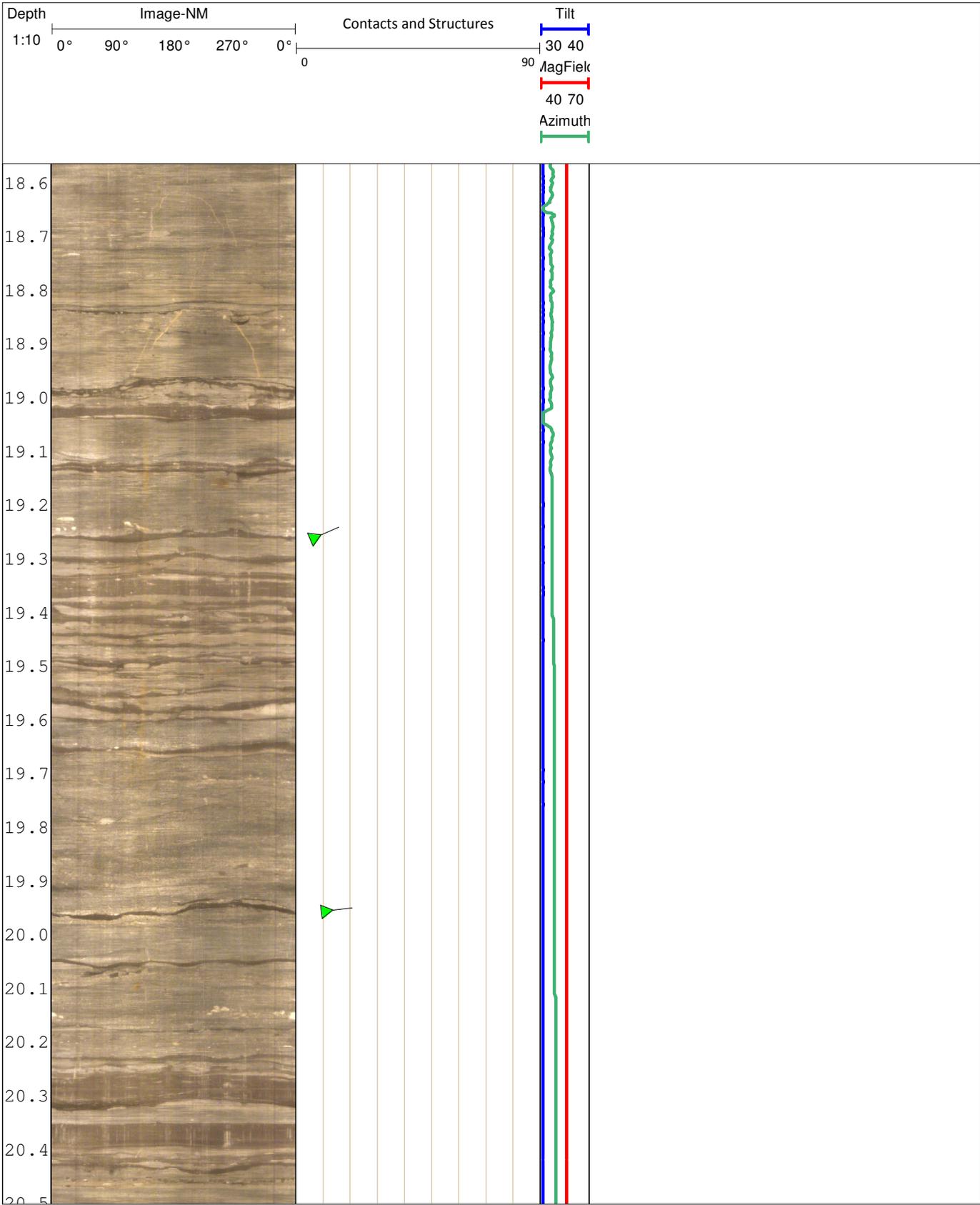


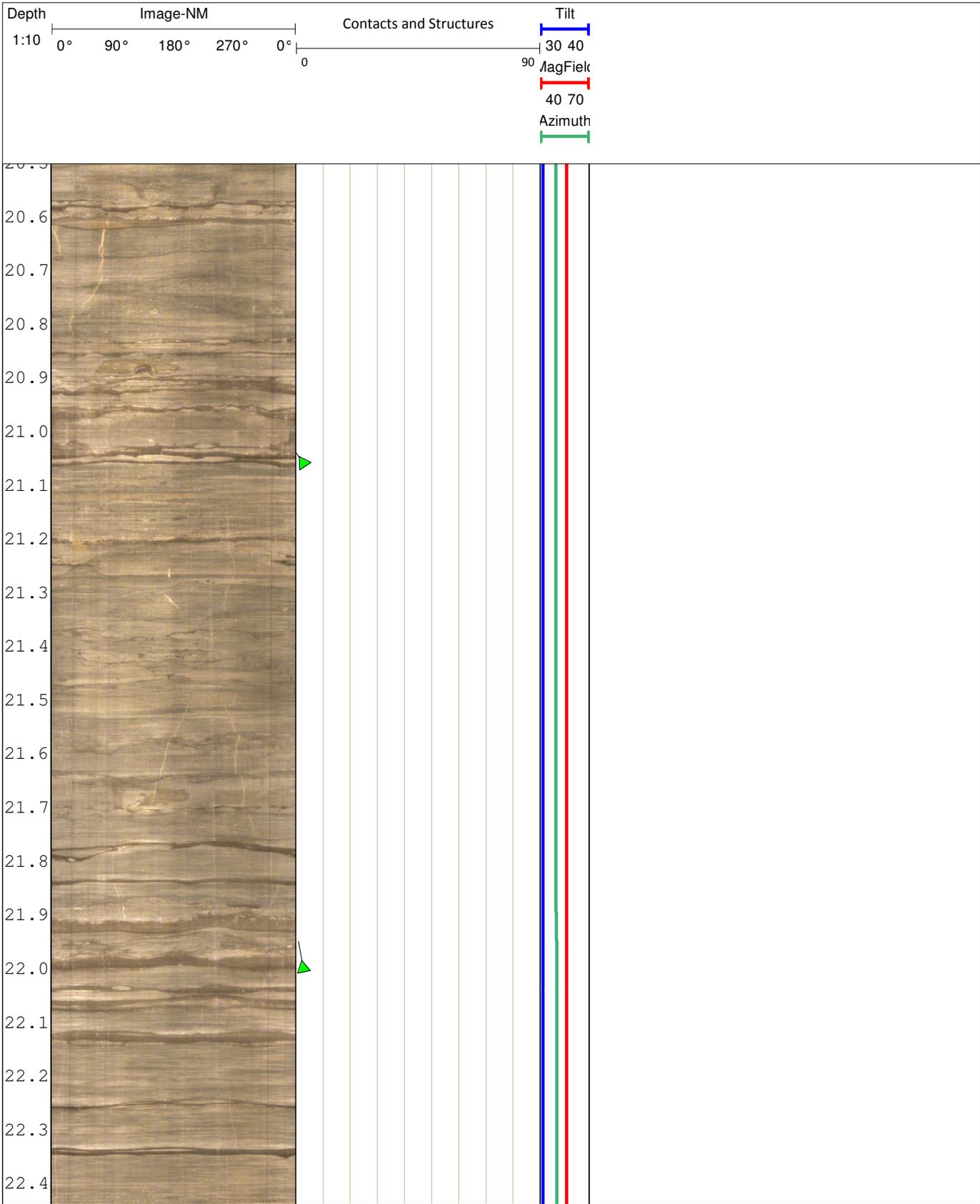


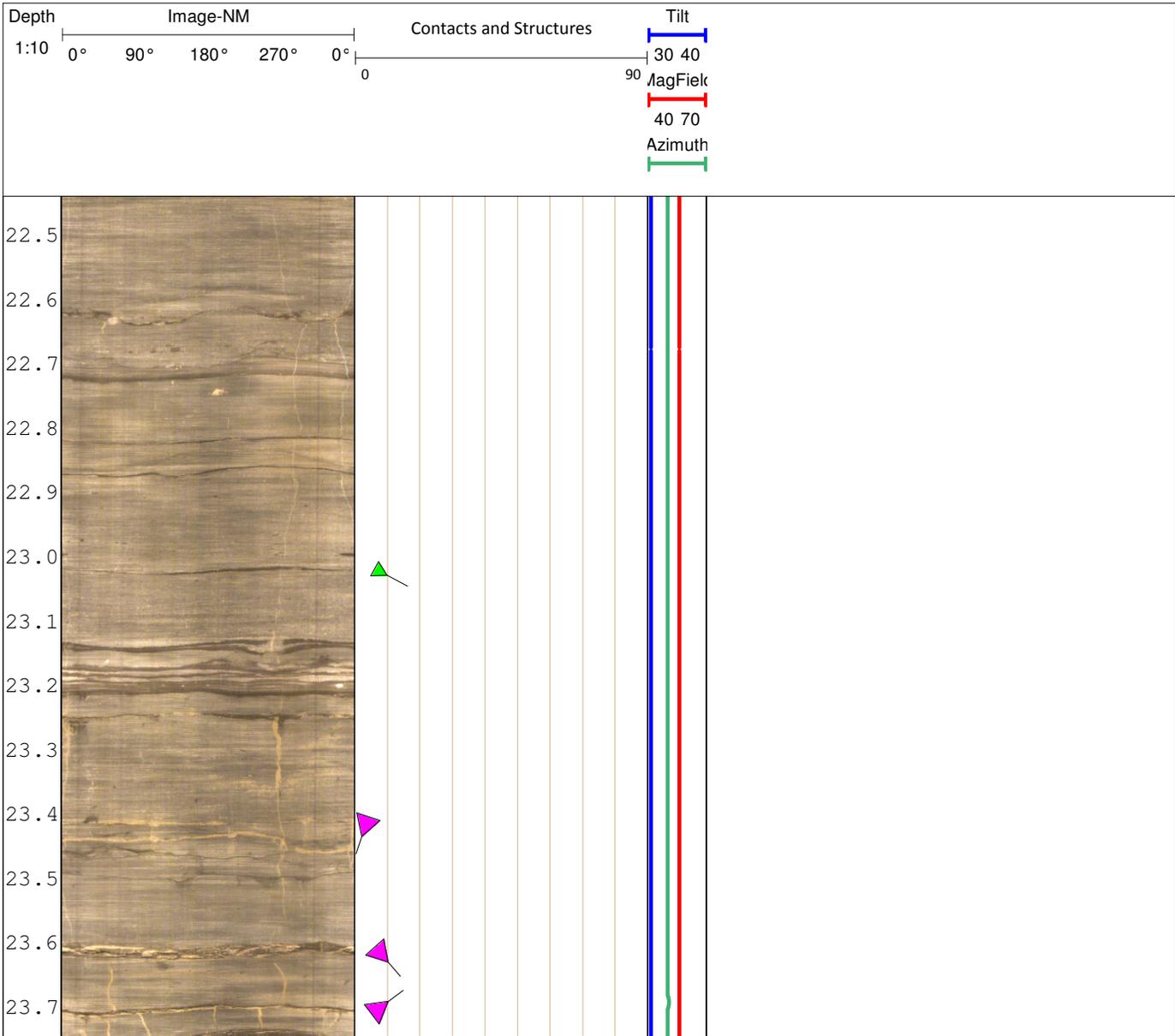


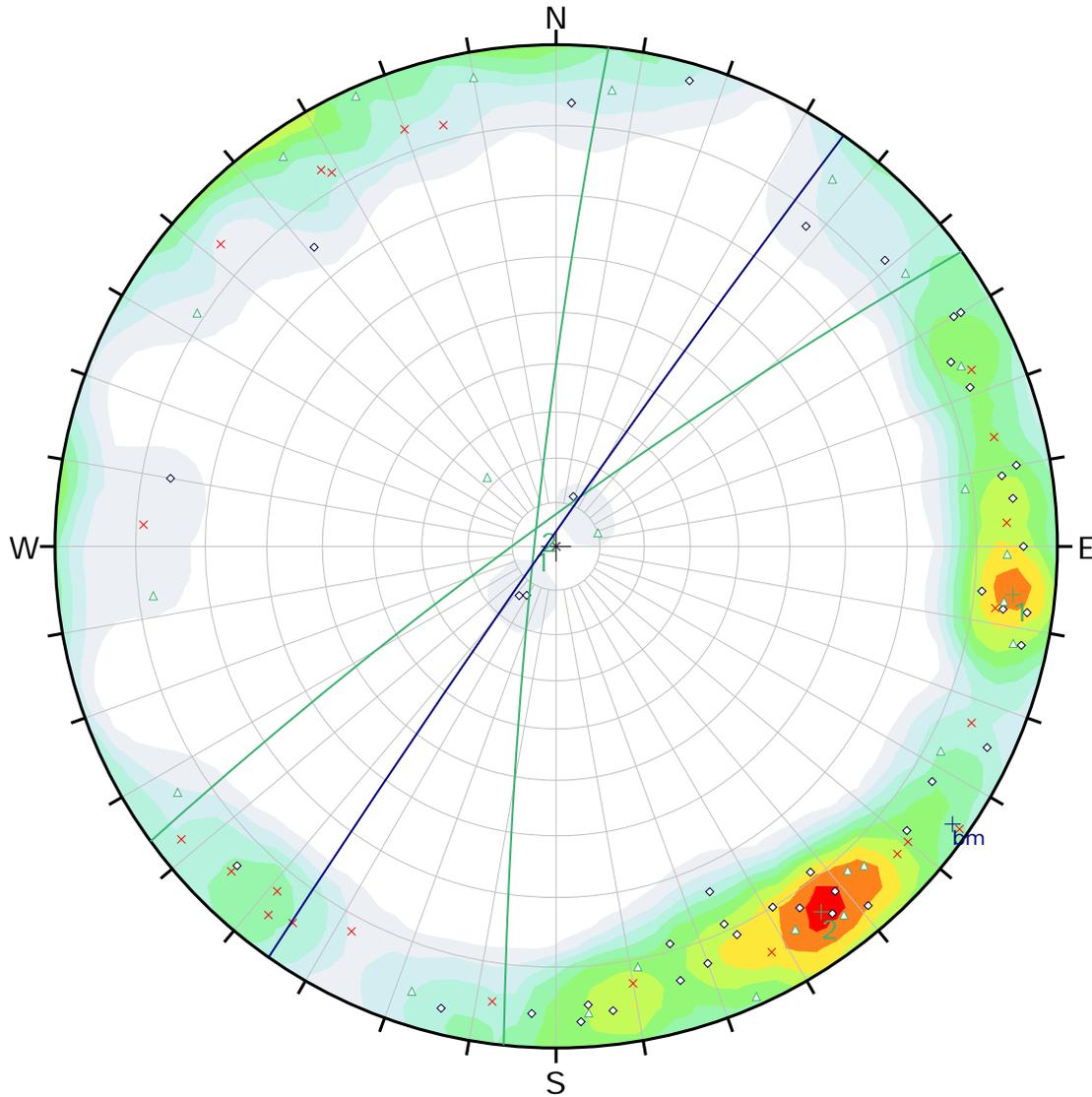












| Symbol | BOREHOLE NO. | Quantity |
|--------|--------------|----------|
| ◇ | 4 | 42 |
| × | 5 | 23 |
| △ | 9 | 25 |

| Color | Density Concentrations |
|-------|------------------------|
| | 0.00 - 1.10 |
| | 1.10 - 2.20 |
| | 2.20 - 3.30 |
| | 3.30 - 4.40 |
| | 4.40 - 5.50 |
| | 5.50 - 6.60 |
| | 6.60 - 7.70 |
| | 7.70 - 8.80 |
| | 8.80 - 9.90 |
| | 9.90 - 11.00 |

| | |
|-----------------------------|-------------|
| Maximum Density | 10.41% |
| Contour Data | Dip Vectors |
| Contour Distribution | Fisher |
| Counting Circle Size | 1.0% |

| | |
|---------------------|-----------------|
| Plot Mode | Dip Vectors |
| Vector Count | 90 (90 Entries) |
| Hemisphere | Lower |
| Projection | Equal Angle |



Project

Centre Block Project Parliament Hill

Analysis Description

BH15-4, BH15-5, & BH15-9

Drawn By

Athir Nader

Company

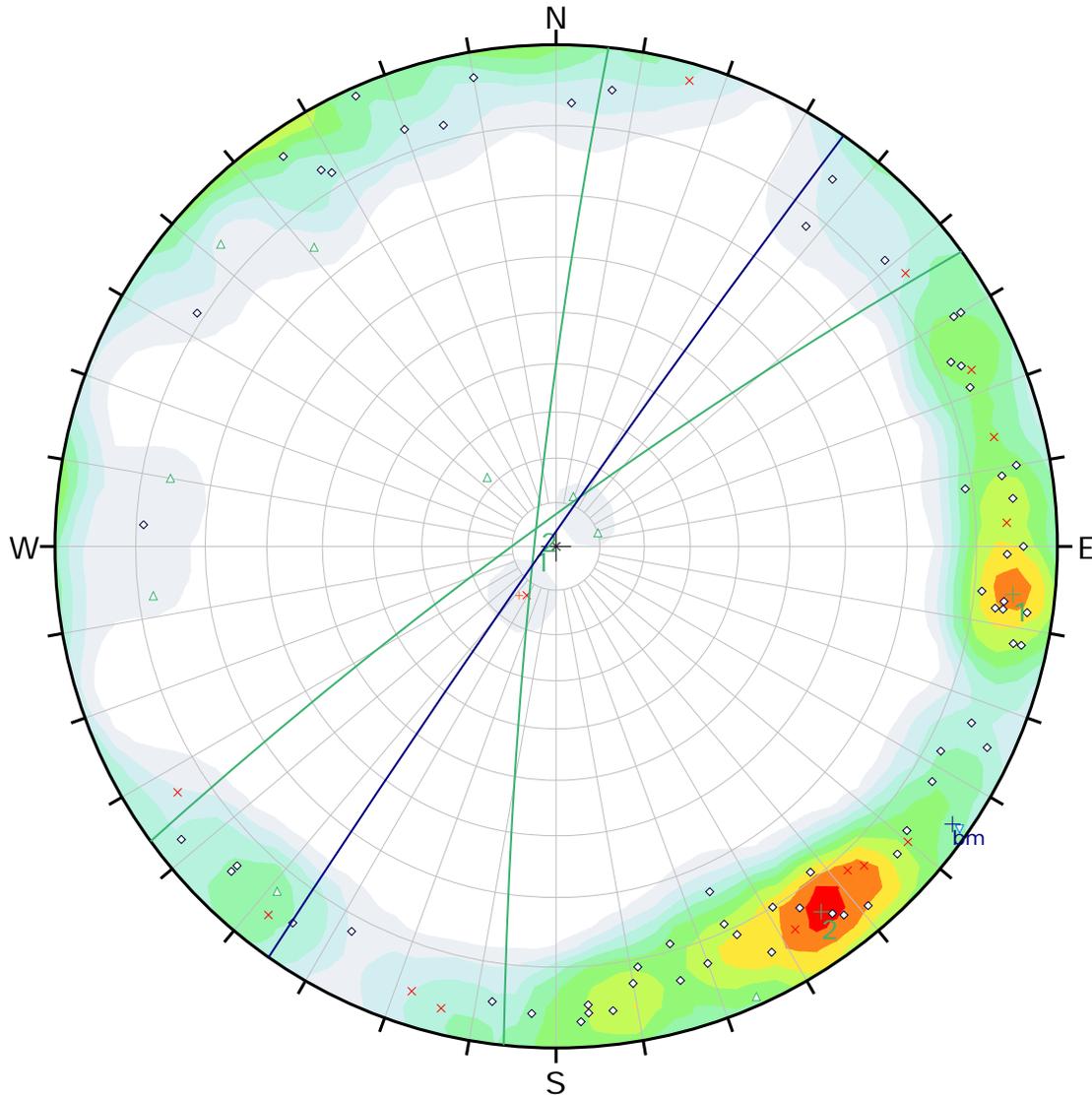
Stantec Consulting Limited

Date

3/11/2015, 9:43:35 AM

File Name

BH15-4,5,&9 (Recovered).dips6



| Symbol | DISCONTINUITY TYPE | Quantity |
|--------|---------------------------|----------|
| ◇ | Foliation | 64 |
| × | Infilled Fracture - Joint | 15 |
| △ | Minor Fracture - Joint | 9 |
| + | Shear/Vein | 1 |
| ▽ | TOW | 1 |

| Color | Density Concentrations |
|-------|------------------------|
| | 0.00 - 1.10 |
| | 1.10 - 2.20 |
| | 2.20 - 3.30 |
| | 3.30 - 4.40 |
| | 4.40 - 5.50 |
| | 5.50 - 6.60 |
| | 6.60 - 7.70 |
| | 7.70 - 8.80 |
| | 8.80 - 9.90 |
| | 9.90 - 11.00 |

| | |
|-----------------------------|-------------|
| Maximum Density | 10.41% |
| Contour Data | Dip Vectors |
| Contour Distribution | Fisher |
| Counting Circle Size | 1.0% |

| | |
|---------------------|-----------------|
| Plot Mode | Dip Vectors |
| Vector Count | 90 (90 Entries) |
| Hemisphere | Lower |
| Projection | Equal Angle |



Project

Centre Block Project Parliament Hill

Analysis Description

BH15-4, BH15-5, & BH15-9

Drawn By

Athir Nader

Company

Stantec Consulting Limited

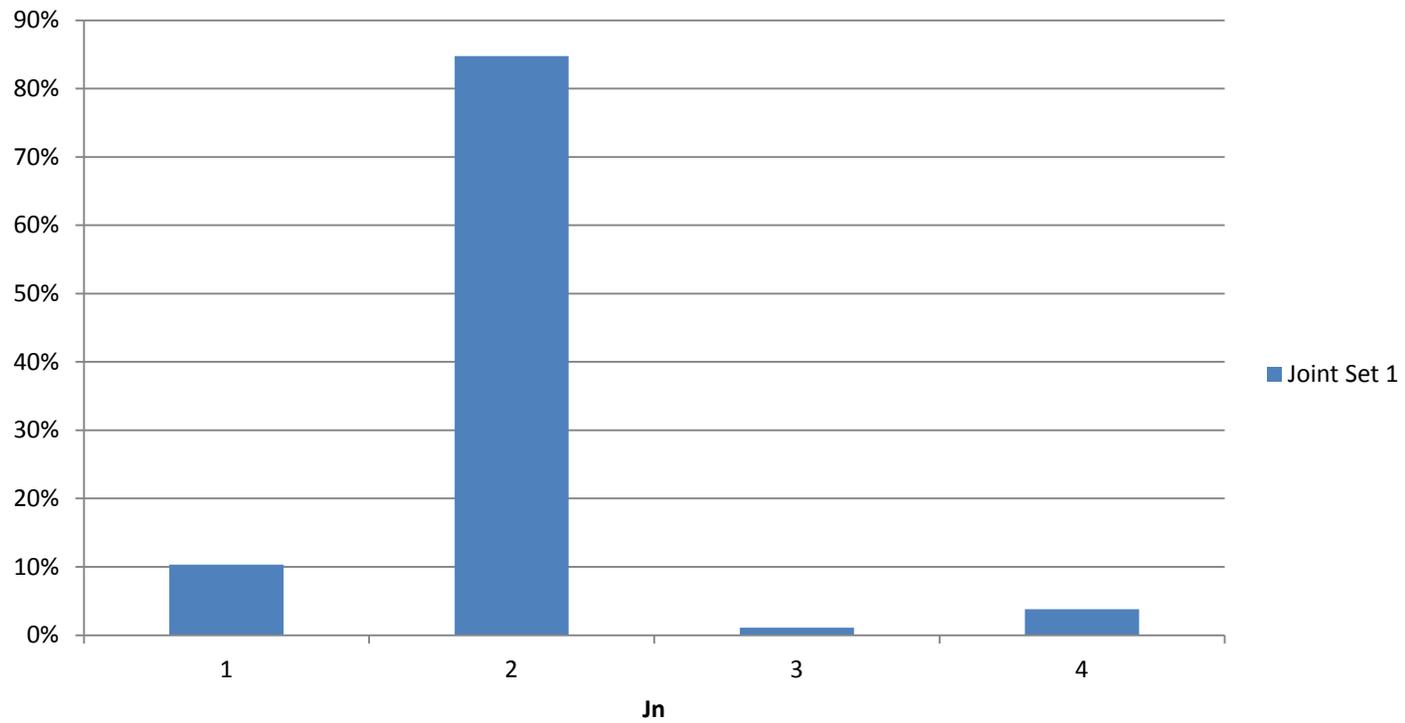
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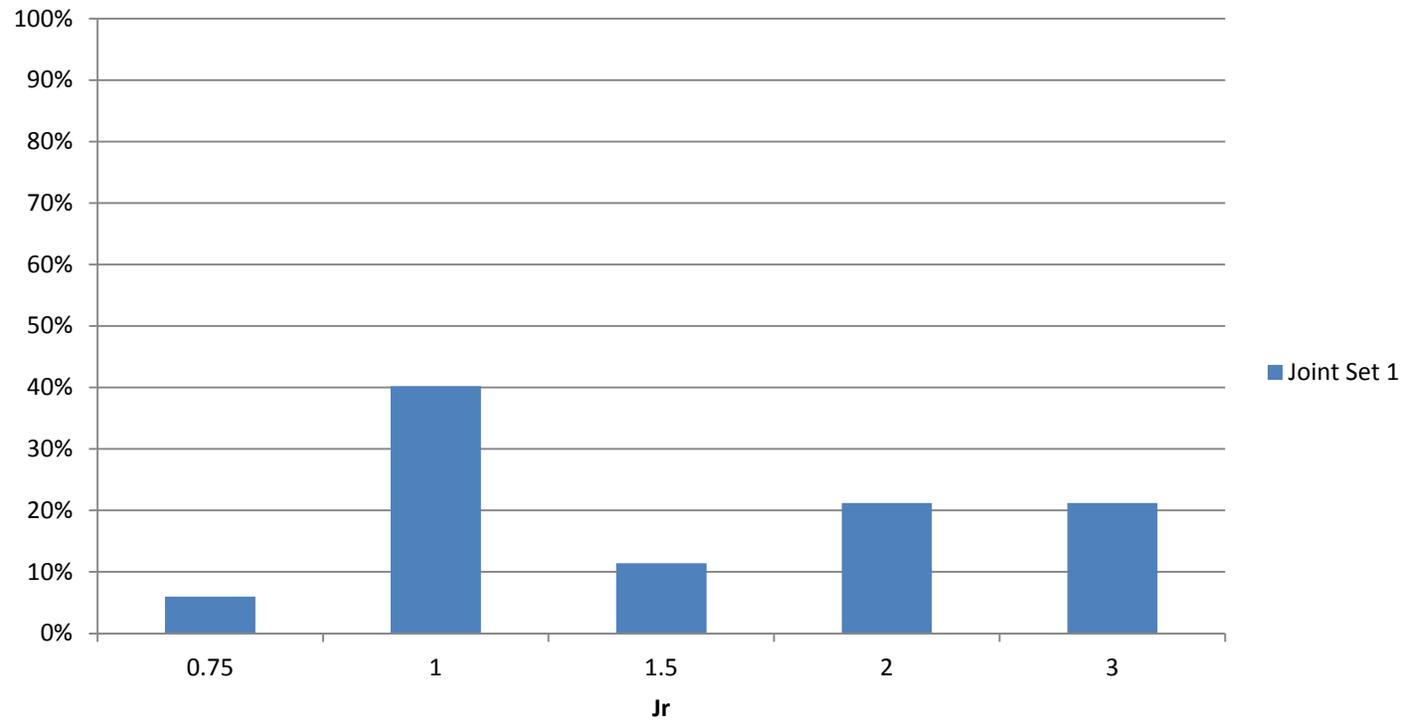
File Name

BH15-4,5,&9 (Recovered).dips6

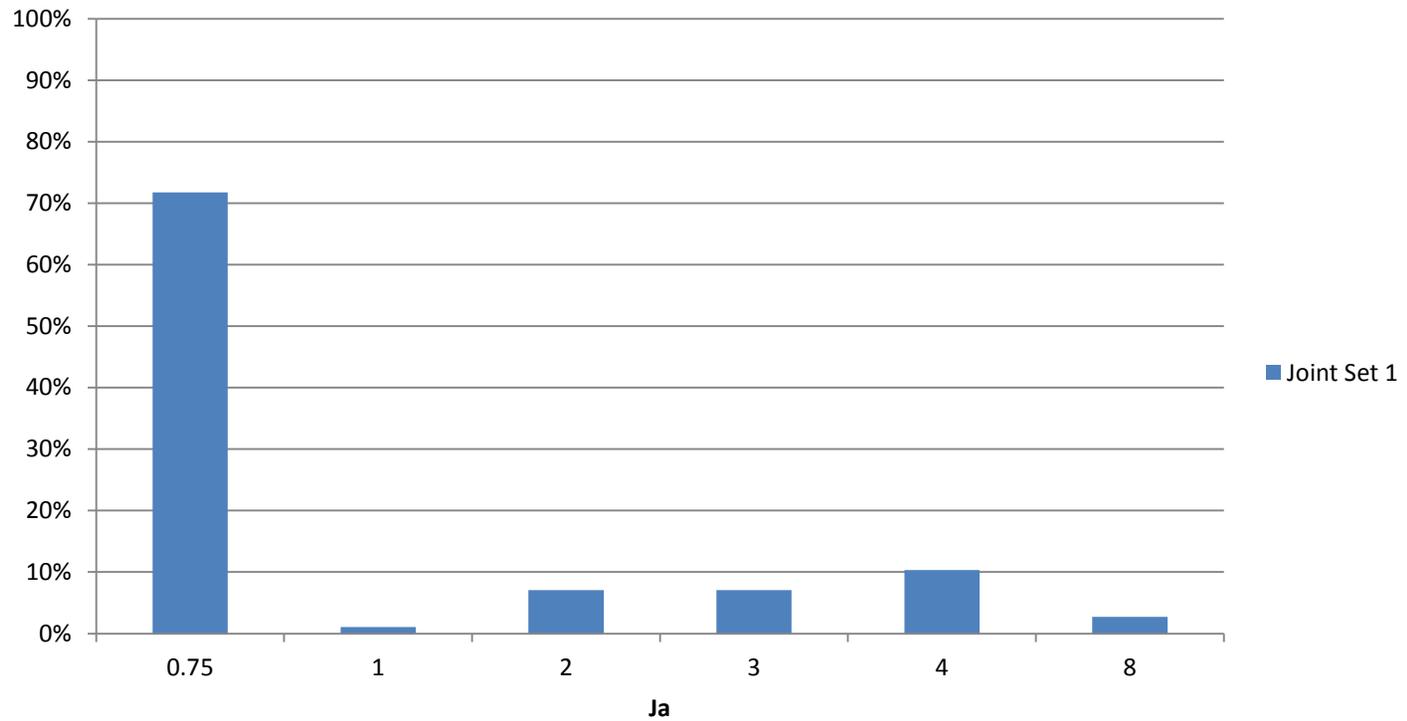
Distribution of Jn Values



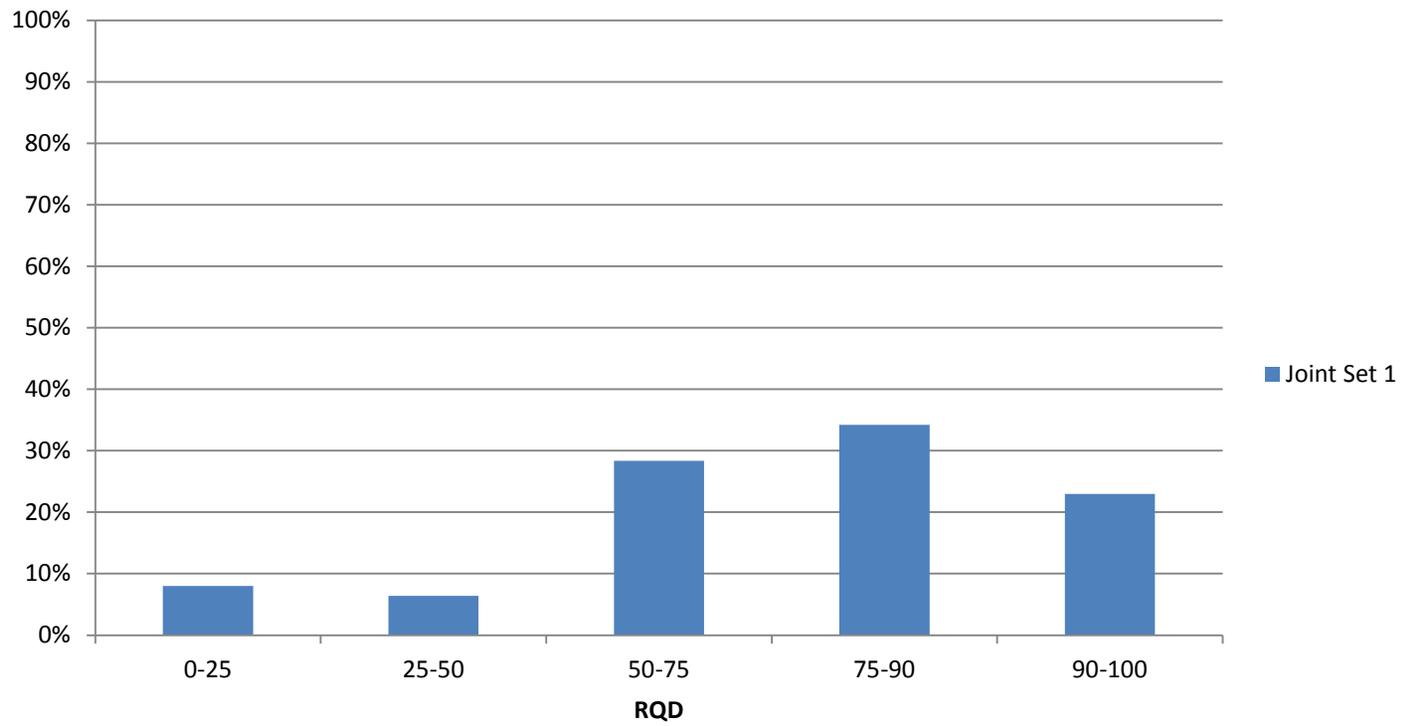
Distribution of Jr Values



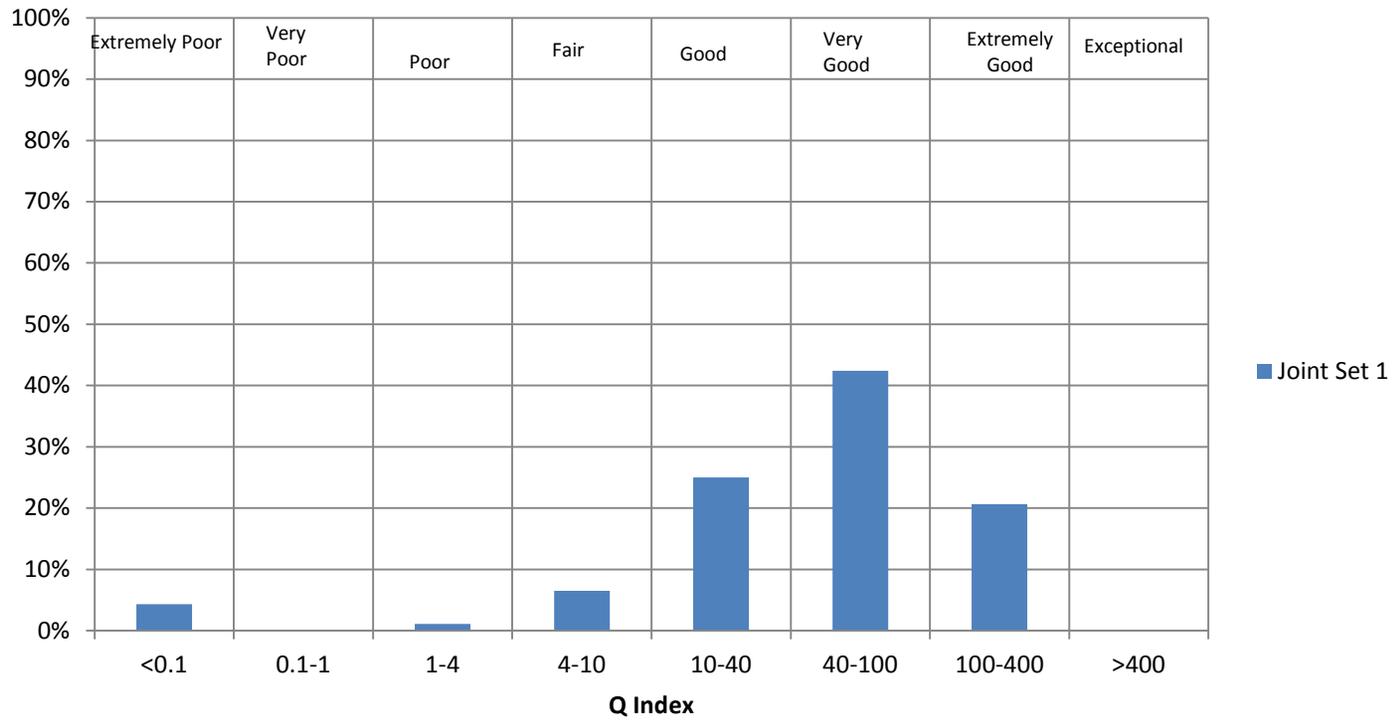
Distribution of Ja Values



Distribution of RQD Values



Distribution of Q Indices



APPENDIX F

Rock Anchor: Resistance to Rock Mass Failure

APPENDIX F

Rock Anchor: Resistance to Rock Mass Failure

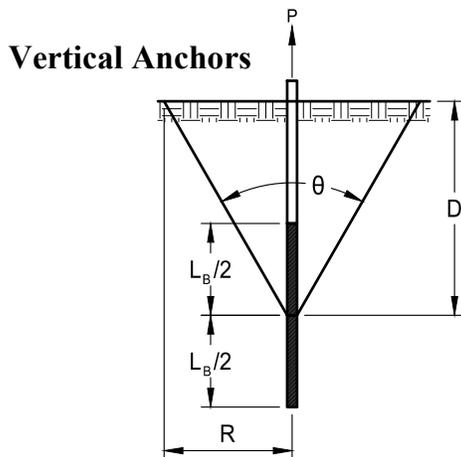
Rock Anchor

Resistance to Rock Mass Failure

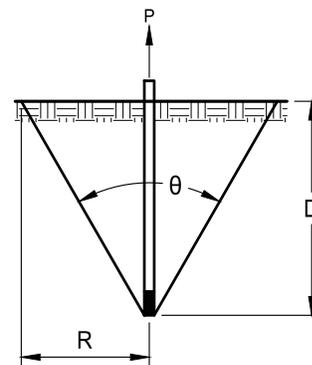
Required Safety Factor for Resistance to Rock Mass Failure: $W_R / P \geq 2.0$

Design Considerations:

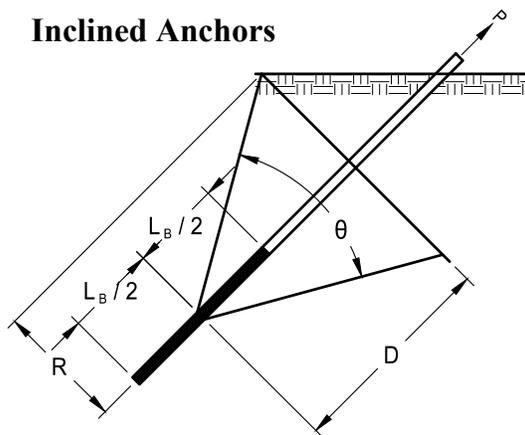
1. Use 60° or 90° apex angle as per recommendations in the geotechnical report



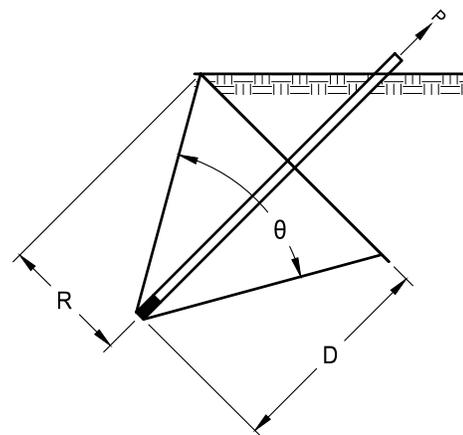
Grouted Rock Anchors



Mechanical Rock Anchors



Grouted Rock Anchors



Mechanical Rock Anchors

- | | | |
|----------|---|--|
| P | = | Resultant of maximum anchor forces |
| D | = | Height of rock cone |
| R | = | Radius of rock cone |
| θ | = | Apex angle |
| L_B | = | Bond Length |
| Y_R | = | Submerged unit weight of bedrock |
| W_R | = | Weight of rock cone ($W_R = 1/3\pi R^2 D Y_R$) |