CANADA LANDS COMPANY
REPORT NUMBER: 19M-00609-00-CLC

GEOTECHNICAL STUDY 530
TREMBLAY ROAD, OTTAWA, ON

NOVEMBER 2019

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SIGNATURES

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INTRODUCTION

WSP Canada Group Limited ("WSP") was retained by Canada Lands Company CLC Limited ("CLC") to carry out a geotechnical study for the new development located at 530 Tremblay Road, Ottawa, Ontario.

The main purpose of the geotechnical study is to apply for Draft Plan of Subdivision to the City of Ottawa and to determine the nature and properties of subsurface conditions, the groundwater conditions, seismic/liquefaction potentials and to provide relevant geotechnical recommendations for the development. This report contains the interpretation and recommendation based on WSP Desk Top Study, site visit in May 2019, WSP review of geotechnical investigations conducted previously by LVM (Geotechnical Investigation, Interpretations and Recommendations – March 2014), and WSP review of Stantec Preliminary/Desktop Study Geotechnical Investigation in March 2013. In order to have comprehensive analysis for the entire new concept plan, a geotechnical gap analysis supported by additional geotechnical investigation is proposed at the recommendation section of this report. Any relevant contaminated soil analysis or permit to take water shall be covered within the environmental report.

The scope and limitations of the geotechnical investigation are described in Appendix A. These limitations are essential to properly understand the report content and should be considered as part of the report.

1 SCOPE AND PROJECT DESCRIPTION

1.1 PROJECT DESCRIPTION

The proposed development consists of a mixed-use subdivision consisting of approximately 500 residential units, a mixed-use block a park block, a stormwater management pond, and an open space block. As part of the proposed development, Tremblay Road will be realigned. The realigned Tremblay Road, the park block, and the pedestrian bridge would ultimately be owned and maintained by the City of Ottawa. Therefore the conceptual plan shall comprise the following:

- Residential complex;
- Mixed-use buildings, park and a storm water pond;
- Pedestrian bridge connecting the development to St. Laurent station.

The site was acquired by Public Services and Procurement Canada (PSPC), and will be eventually administered by CLC. The scope of this geotechnical study covers the entire development.

1.2 SITE DESCRIPTION AND TOPOGRAPHY

A site visit was undertaken at 530 Tremblay Road, Ottawa, Ontario in May 2019.The entire site area for 530 Tremblay is 10.67 hectares (23.36 acres), with a generally flat topography and covered by light vegetation, some trees and depressed areas in the southern part of the property. Some monitoring wells were observed distributed in the northeast part of the property. The site is located at the corner of St. Laurent Boulevard and Tremblay Road and south of Highway 417 in Ottawa, Ontario.

The site is located within the central portion of the physiographic region identified by Chapman and Putnam (1984) as the “Ottawa Valley Clay Plains”. This region is typically characterized by clay plains combined with ridges of rock or sand.

2 INVESTIGATIONS

2.1 FIELDWORK – DRILLING

The fieldwork was performed from January 14th, 2014, to January 23rd, 2014 by LVM. A total of eight (8) boreholes with sampling were carried out. The boreholes were labelled BH-01-14 to BH-08-14.

The boreholes were carried out using a drill mounted on a track to a total depth ranging from 10.24 m to 22.33 m. Soil sampling and Standard Penetration Testing (SPT), in accordance with American Society for Testing and Materials (ASTM) Standard D 1586, were performed with a standard split spoon sampler of 51 mm outer diameter.

All boreholes were followed with core sampling on lengths varying from 6.09 m to 18.67 m.

Observation wells were installed in BH-01-14, BH-03-14, BH-06-14 and BH-07-14, allowing water level measurement and sampling.

All fieldwork was carried out under the full supervision of a geotechnical technician from LVM. The subsoil details are presented in the individual borehole logs in Appendix B.

2.2 FIELDWORK – GEOPHYSICS

A Multi-Channel Analysis of Surface Waves (MASW) survey was carried on January 31st, 2014, by GPR Geophysics International Inc. The geophysical report and interpretation are presented in Appendix C. The spectral analysis and liquefaction potential is addressed in the recommendation section as well.

2.3 LABORATORY TESTING

All the samples recovered from the surveys were forwarded to the laboratory for identification, analysis and classification purposes. They were all submitted to a visual examination by a geotechnical engineer.

All recovered samples were carefully preserved and transported to LVM's laboratory for identification, laboratory testing and classification. All soil samples were examined by a geotechnical engineer and were classified in accordance with the requirements specified in ASTM D 2488. The complete laboratory test results are presented in Appendix B. Also included in Appendix B are the borehole logs. Tables 1 and 2 show the laboratory program for soil and rock testing.

Table 1 Geotechnical Laboratory Program – Soils Testing

SAMPLE # (DEPTH (M))	TEST
BH-01-14, SS-2 (0.61 – 1.22)	Sieves analysis and Water content
BH-01-14, SS-6 (3.05 – 3.28)	Water content
BH-02-14, SS-1 (0.61 – 1.22)	Water content
BH-02-14, SS-4 (2.44 – 3.05)	Sieves analysis and Water content
BH-03-14, SS-2 (0.61 – 1.22)	Water content
BH-03-14, SS-6 (3.05 – 3.66)	Corrosion potential
BH-03-14, SS-7 (3.66 – 4.11)	Sieves analysis and Water content

SAMPLE # (DEPTH (M))	TEST
BH-04-14, SS-2 (0.61 – 1.22)	Corrosion potential
BH-04-14, SS-3 (1.22 – 1.83)	Sieves analysis and Water content
BH-04-14, SS-5 (2.44 – 3.05)	Water content
BH-05-14, SS-4 (1.83 – 2.44)	Water content
BH-05-14, SS-7 (3.66 – 4.27)	Sieves analysis and Water content
BH-06-14, SS-3 (1.22 – 1.83)	Water content
BH-06-14, SS-6 (3.05 – 3.66)	Sieves analysis and Water content
BH-07-14, SS-4 (1.83 – 2.44)	Water content
BH-07-14, SS-7 (3.66 – 4.06)	Sieves analysis and Water content
BH-08-14, SS-3 (1.22 – 1.83)	Water content
BH-08-14, SS-6 (3.05 – 3.66)	Sieves analysis and Water content

Table 2 Geotechnical Laboratory Program – Rock Testing

SAMPLE # (DEPTH (M))	TEST
BH-01-14, RC-8 (4.32 – 4.43)	Compressive Strength
BH-01-14, RC-11 (9.88 – 9.99)	Compressive Strength Elastic Modulus of Intact Rock
BH-02-14, RC-8 (6.30 – 6.41)	Compressive Strength
BH-02-14, RC-10 (10.00 – 10.11)	Compressive Strength Elastic Modulus of Intact Rock
BH-03-14, RC-9 (5.80 – 5.91)	Compressive Strength Petrographic and chemical potential for swelling
BH-03-14, RC-11 (8.01 – 8.19)	Petrographic and chemical potential for swelling
BH-03-14, RC-13 (11.02 – 11.30)	Petrographic and chemical potential for swelling
BH-04-14, RC-10 (7.90 – 8.11)	Compressive Strength
BH-04-14, RC-12 (10.40 – 10.51)	Compressive Strength
BH-05-14, RC-12 (9.08 – 9.14)	Compressive Strength Elastic Modulus of Intact Rock
BH-06-14, RC-9 (5.08 – 5.19)	Compressive Strength
BH-07-14, RC-10 (6.37 – 6.48)	Compressive Strength
BH-08-14, RC-12 (10.30 – 10.41)	Compressive Strength Elastic Modulus of Intact Rock

3 NATURE AND PROPERTIES OF SUBSOIL

The following sections present a summary of the different soil layers encountered in the boreholes. The detailed borehole logs are presented in Appendix B. Table 3 presents stratigraphy encountered in the boreholes.

Table 3 Borehole Summary

BOREHOLE # (ELEVATION-M)	STRATIGRAPHY /THICKNESS (M)				END OF BOREHOLE (ELEVATION-M)
	HETERO-GENEOUS FILL	TILL	FRACTURED ROCK	ROCK	
BH-01-14 (68.14)	–	0.00 – 3.66 (3.66)	–	3.66 – 22.33 (18.67)	22.33 (45.91)
BH-02-14 (67.68)	–	0.61 – 3.35 (2.74)	3.35 – 3.61 (0.26)	3.61 – 10.24 (6.63)	10.24 (57.44)
BH-03-14 (68.02)	–	0.00 – 4.39 (4.39)	–	4.75 – 15.42 (10.67)	15.42 (52.60)
BH-04-14 (67.75)	0.00 – 1.83 (1.83)	1.83 – 3.45 (1.62)	3.45 – 4.09 (0.64)	4.09 – 16.23 (12.14)	16.23 (51.52)
BH-05-14 (68.24)	0.00 – 3.05 (3.05)	3.05 – 4.27 (1.22)	4.27 – 4.39 (0.12)	4.39 – 10.74 (6.35)	10.74 (57.50)
BH-06-14 (68.06)	–	0.00 – 4.27 (4.27)	4.27 – 4.75 (0.48)	4.75 – 21.16 (16.41)	21.16 (46.90)
BH-07-14 (67.90)	–	0.00 – 4.17 (4.17)	4.17 – 4.78 (0.61)	4.78 – 16.89 (12.11)	16.87 (51.01)
BH-08-14 (68.07)	0.00 – 0.61 (0.61)	0.61 – 4.17 (3.56)	–	4.17 – 10.87 (6.70)	10.87 (57.20)

3.1 ORGANIC SOILS

Organic soils were encountered at the surface on almost every borehole. WSP site visit reported organic soil at the south portion of the site.

Moreover, at depths from 1.83 m to 3.05 m, a layer of probable peat was encountered within heterogeneous fill at the location of borehole BH-05-14. No laboratory analysis was done to identify the nature of this layer.

3.2 HETEROGENEOUS FILL

A granular fill was intercepted at depths varying between 0.61 m to 3.05 m in boreholes BH-04-14, BH-05-14 and BH-08-14. One (1) sieve analysis was performed based on the fill sample. It is important to note that due to its heterogeneous nature, the composition and properties may be variable. Table 4 shows the results of the analysis which is also presented in Appendix C.

Table 4 Sieve Analysis of Granular Fill

BOREHOLE #	SAMPLE #	DEPTH (M)	GRAVEL > 4.75 MM (%)	SAND < 4.75 MM AND > 75 MM (%)	SILT AND CLAY < 75 MM (%)	WATER CONTENT (%)	USCS
BH-04-14	SS-3	1.22 -1.83	45	48.2	6.8	15.5	SW-SM

Based on the grain size distribution, the soil sample is sand and gravel with traces of silt. According to the Unified Soil Classification System (USCS), the sample analyzed is classified as a well graded sand, to silty sand (SW-SM) . According to O. REG. 213/91, this material would be Type 2 soil.

3.3 TILL

A till was encountered at every borehole either directly at the surface or below heterogeneous fill described above. The till was generally well graded, variable in its proportion of gravel, sand and silt. No boulder was encountered at the location of the borehole.

Standard penetration test N values near the surface were generally below 10, indicating that the density of the till is loose to very loose. N values were higher at lower elevation, until refusal was encountered within the till, fractured rock or bedrock. It is to be noted that water content was higher where density is lower.

Figure 1 presents SPT-N distribution obtained in till deposit.

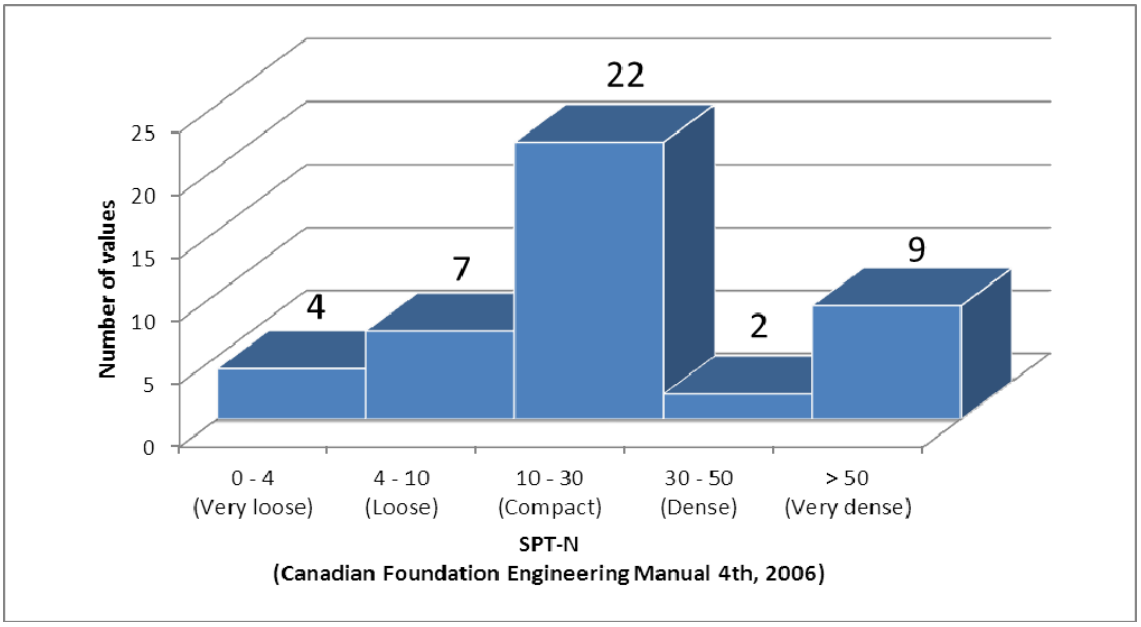


Figure 1: SPT-N Distribution

Table 5 shows the results of the analysis which are also presented in Appendix B.

Table 5 Sieve Analysis of Till

BOREHOLE #	SAMPLE #	DEPTH (M)	GRAVEL > 4.75 MM (%)	SAND < 4.75 MM AND > 75 MM (%)	SILT AND CLAY < 75 MM (%)	WATER CONTENT (%)	USCS
BH-01-14	SS-2	0.61 – 1.22	0	23.6	76.4	29.8	---
BH-02-14	SS-4	2.44 – 3.05	16	44.7	39.3	9.5	SM
BH-03-14	SS-7	3.66 – 4.11	19	42.8	38.2	10.6	SM
BH-05-14	SS-7	3.66 – 4.27	32	39.0	29.0	7.3	SM
BH-06-14	SS-6	3.05 – 3.66	18	44.6	37.4	8.1	SM
BH-07-14	SS-7	3.66 – 4.06	34	46.3	19.7	9.2	SM
BH-08-14	SS-6	3.05 – 3.66	14	54.0	32.0	7.3	GM

Based on the grain size distribution, the soil sample is gravel and sand with trace of silt. According to the Unified Soil Classification System (USCS), the sample analyzed is classified as a silty sand (SM) or silty gravel (GM). According to O. REG. 213/91, this material would be Type 2 soil. Various analyses were carried out on two (2) soil samples to assess the potential for corrosion of ductile iron pipe.

Table 6 shows the results of the analysis.

Table 6 Results of Soil Analyses

	BH-3, SS-6	BH-4, SS-2
SOIL CHARACTERISTIC	RESULT	RESULT
Resistivity (ohm-cm)	1,700	140
pH	7.83	11.8
Redox Potential (mV)	130	-64
Sulphides	0.54	12.0
Moisture	9.4	14

3.4 FRACTURED/WEATHERED ROCK

A layer of fractured and weathered rock encountered under the till layer, sample was collected with both spoon and NQ drilling. Its nature was similar to the underlying bedrock, thus indicating its origin as the studied site itself or very close to it. Its thickness at the location of the boreholes varies between 0.12 m and 0.64 m.

Poor recovery was obtained in this unit, thus making it difficult to accurately identify its properties. No laboratory testing was done on the collected samples. According to O. REG. 213/91, this material would be Type 1 soil.

3.5 BEDROCK

Underlying the fill materials described above, the bedrock is intercepted at a depth varying between 3.61 m and 4.78 m. Rock was drilled with a core barrel at lengths varying between 6.09 and 18.67 m. A single unit of rock was encountered. It is described as a non-calcareous mudstone; break on fissile plans, non-fossiliferous. A thin deposit of calcite was locally found in the joint. The mineral hardness on Mohs scale is 1 or 2 due to being scratchable with a nail. It belongs to the Billings formation.

In the borehole, a total of four (4) joints were identified. Generally, the joints are oriented with an angle to core axis of 75° to 85°, which corresponds to bedding discontinuities.

The table “Structural Rock Description,” presented after the borehole report in Appendix B, shows in detail the type and direction of discontinuities as a function of depth. Photographic report of rock cores is presented after the “Structural Rock Description” in Appendix B.

The Rock Quality Designation index (RQD) is an indirect appreciation of the number of fractures and of the degree of rock alteration. The RQD was calculated 64 times on the rock cores of size (47.6 mm diameter) recovered from the borehole. The quality of the rock can generally be qualified as excellent. Figure 2 presents RQD versus elevation.

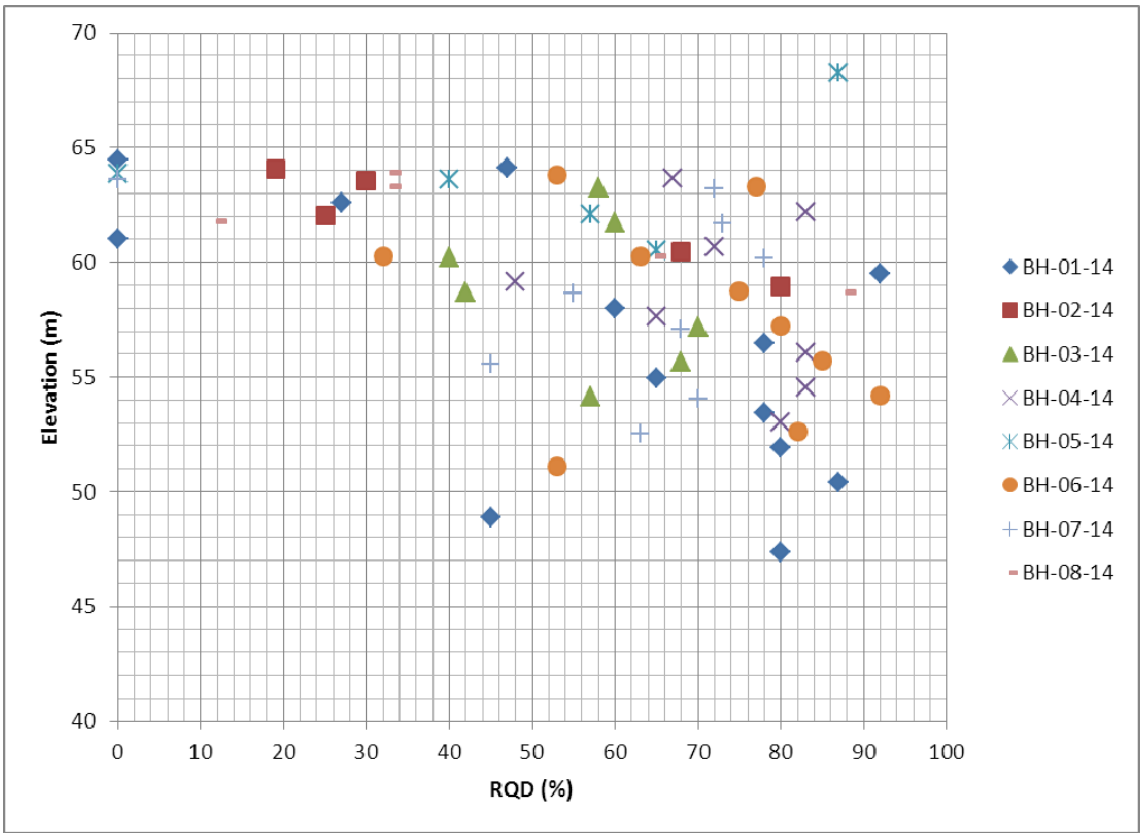


Figure 2: RQD Versus Elevation

Unconfined compressive strength of rock core and modulus of elasticity analysis was performed on representative rock samples. Table 7 shows the results of the analysis which are also presented in Appendix B.

Table 7 Unconfined Compressive Strength and Elastic Modulus of Intact Rock

BOREHOLE #	SAMPLE #	DEPTH (M)	COMPRESSIVE STRENGTH (MPA)	ELASTIC MODULUS OF INTACT ROCK (GPA)
BH-01-14	RC-8	4.32 – 4.43	79.6	---
BH-01-14	RC-11	9.88 – 9.99	71.2	11.18
BH-02-14	RC-8	6.30 – 6.41	37.0	---
BH-02-14	RC-10	10.00 – 10.11	10.0*	1.49*
BH-03-14	RC-9	5.80 – 5.91	97.3	---
BH-04-14	RC-10	7.90 – 8.11	29.2	---
BH-04-14	RC-12	10.40 – 10.51	25.3	---
BH-05-14	RC-12	9.08 – 9.14	66.4	18.82
BH-06-14	RC-9	5.08 – 5.19	100.9	---
BH-07-14	RC-10	6.37 – 6.48	91.6	---
BH-08-14	RC-12	10.30 – 10.41	56.7	10.33

* Results may be not representative of the site due to defects in core sample

Rock Mass Rating (RMR) (after Bieniawski, 1989) had been established for tested rock samples are presented in Table 8. Geological Strength Index (GSI) (after Hoek & Marinos, 2000) are also presented in Table 8 and Table 9. GSI values, obtained on the basis of visual observation (qualitative assessment), provide a general overview of the geomechanical proprieties of the rock mass.

Table 8 Rock Mass Rating (Bieniawski, 1989) and GSI (Hoek & Marinos, 2000)

BORE-HOLE #	SAMPLE #	DEPTH (M)	COMP-RESSSIVE STRENGTH (MPA)	RQD	SPACING OF DISCONTI-NUITIES (M)	DISCON-TINUITIES ORIENTATION (^{O})	CONDITION OF DISCONTI-NUITIES	RMR	GSI
BH-01-14	RC-8	4.32 – 4.43	79.6	47	0.16	75 – 85	Closed, rough	52 Class III Fair	41
BH-01-14	RC-11	9.88 – 9.99	71.2	91	0.11	75 – 85	Closed, rough	64 Class II Good	63
BH-02-14	RC-8	6.30 – 6.41	37.0	25	0.09	75 – 85	Closed, smooth	44 Class III Fair	30
BH-02-14	RC-10	10.00 – 10.11	10.0*	80	0.13	75 – 85	Open and closed, smooth	41 Class III Fair	57
BH-03-14	RC-9	5.80 – 5.91	97.3	58	0.15	75 – 85	Closed, smooth	52 Class III Fair	46

BORE-HOLE #	SAMPLE #	DEPTH (M)	COMP-RESSSIVE STRENGTH (MPA)	RQD	SPACING OF DISCONTI-NUITIES (M)	DISCON-TINUITIES ORIENTATION (°)	CONDITION OF DISCONTI-NUITIES	RMR	GSI
BH-04-14	RC-10	7.90 – 8.11	29.2	72	0.25	60 – 75	Closed, smooth	51 Class III Fair	53
BH-04-14	RC-12	10.40 – 10.51	25.3	65	0.25	15 – 85	Closed, smooth	51 Class III Fair	50
BH-05-14	RC-12	9.08 – 9.14	66.4	65	0.10	60 – 85	Mostly closed, smooth	52 Class III Fair	50
BH-06-14	RC-9	5.08 – 5.19	100.9	77	0.13	75 – 85	Closed, smooth	61 Class II Good	56
BH-07-14	RC-10	6.37 – 6.48	91.6	73	0.11	75 – 85	Closed, smooth	52 Class III Fair	54
BH-08-14	RC-12	10.30 – 10.41	56.7	88	0.17	75 – 85	Closed, smooth	56 Class III Fair	61

Petrographic and chemical potential for swelling tests were carried on three (3) rock samples taken from borehole BH-03-14. Residual pyrite contents are presented in Table 9.

Table 9 Residual Pyrite Content

BOREHOLE #	SAMPLE #	DEPTH (M)	RESIDUAL PYRITE (%)
BH-03-14	RC-9	5.80 – 5.91	1.79
BH-03-14	RC-11	8.01 – 8.19	1.76
BH-03-14	RC-13	11.02 – 11.30	1.63

4 GROUNDWATER

4.1 GROUNDWATER ELEVATION RECORD

As indicated in Section 2.1, perforated plastic tubes were installed into boreholes BH-01-14, BH-03-14, BH-06-14 and BH-07-14 in order to allow further readings of the groundwater level.

Table 10 presents recorded groundwater level in those installations.

Table 10 Groundwater Elevation

BOREHOLE # (ELEVATION (M))	TYPE (DEPTH (M))	GROUNDWATER		
		DATE RECORDED	DEPTH (M)	ELEVATION (M)
BH-01-14 (68.14)	Perforated Pipe (19.20 – 20.24)	2014-02-11	2.59	65.55
BH-03-14 (68.02)	Perforated Pipe (4.17 – 5.69)	2014-01-29	0.71	67.43
		2014-02-11	0.98	67.04
BH-06-14 (68.06)	Perforated Pipe (1.22 – 4.27)	2014-01-29	0.65	67.41
		2014-02-11	0.82	67.24
BH-07-14 (67.90)	Perforated Pipe (2.74 – 4.27)	2014-01-29	0.42	67.42
		2014-02-11	0.84	67.06

It is important to note that stagnant water was encountered at many locations within the studied property, especially in the area surrounding borehole BH-02-14.

4.2 CHEMICAL ANALYSES

To evaluate the potential risk of concrete incompatibility with groundwater, water samples collected from observation wells were tested for the following criteria:

- Chloride Concentration
- Sulphate Concentration
- Conductivity
- pH

Table 11 presents the results of these analyses.

Table 11 Chemical Analyses on Water Samples

PARAMETERS	SAMPLE RESULTS		
BOREHOLE (DEPTH (M))	BH-03-14 (4.17 – 5.69)	BH-06-14 (1.22 – 4.27)	BH-07-14 (2.74 – 4.27)
pH	8.1	7.5	7.0
Conductivity (uS/cm)	1690	2720	2020
Sulphate (mg/L)	31	276	270
Chloride (mg/L)	322	403	203

5 DISCUSSION AND RECOMMENDATIONS

5.1 SITE GRADING

All surficial vegetation, organics, fill and other deleterious materials should be removed from beneath the footprint of the proposed foundations and roadway, and from within the influence zone of the foundations. The influence zone is defined as the material below a line sloping 1 horizontal to 1 vertical, downwards and away from the outer edges of a footing.

Earth removals should be inspected by geotechnical personnel to ensure that all unsuitable materials are removed prior to placement and compaction of fill. Inspection and testing services will be critical to ensure that all fill used is suitable and is placed and compacted to the required degree of compaction.

Structural Fill should be used to raise the grade where required. Structural Fill should consist of Ontario Provincial Standard Specification (OPSS) Granular B Type II and should be placed in lifts no thicker than 300 mm and compacted to at least 100% standard Proctor maximum dry density (SPMDD) for building foundations. In the roadway, the Structural Fill may consist of OPSS Granular B Type I or II, Select Subgrade Material (SSM) or approved, compactible site material compacted to 95 % SPMDD.

Footings should be founded on sound bedrock, clean, undisturbed competent native soil (such as the glacial till) or Structural Fill constructed 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 surfaces to remove any loose materials will be required to achieve the recommended geotechnical bearing resistances in limit states design.

5.2 FOUNDATIONS

The following recommendations are based on the limits states conditions of the structure beyond of which it ceases to fulfil the function for which it was designed. The limits states are divided into two (2) groups:

1. The ultimate limit states which correspond to the mechanisms of collapse and rupture of the structures; they are notions of safety of the works. As an example, the ultimate limit state for the foundation could be a shearing failure of the soil.
2. The serviceability limit states correspond to the mechanisms which limit the proposed use of the structure. These mechanisms are usually associated with movements which stop or limit a structure to fulfill its purpose. As an example, the serviceability limit states for a foundation can be some excessive movements and settlements.

5.2.1 FOUNDATIONS ON TILL

According to the site stratigraphy, previously described, the load of the structures could also be transferred to the till deposit encountered at elevations ranging between 68 m and 64 m using a conventional shallow footing.

$$q_{ult} = q' N_q S_q + 0.5\gamma' B N\gamma S\gamma + c' N_c S_c$$

The following geotechnical parameters can be used for the ultimate limit states (ULS) calculation, Where:

q_u : geotechnical resistance at ultimate limit states

c : cohesion of soil under the foundation, kPa

q_s : vertical stress acting at the elevation of the base of foundation, kPa (= $\gamma_1 D$)

γ_1 : unit weight of soil over the foundation level, kN/m^3

D : foundation embedding, m

γ : unit weight of soil under the foundation level, kN/m^3

B : effective width of foundation accounting for eccentric loads, m

N_c, N_q, N_γ : bearing capacity factors

S_c, S_q, S_γ : modification factors for foundation shape, inclination, depth and tilt and ground slope

In Table 12 below you will find the geotechnical parameters that can be used for the ultimate geotechnical resistance at limit states (ULS) calculation. Definitions and details concerning the other parameters can be found in the Canadian Foundation Engineering Manual 2006 (CFEM 2006).

Table 12 Geotechnical Parameters – Till Deposit

PARAMETERS	TILL DEPOSIT
Effective soil cohesion (c')	0 kPa
Effective angle of internal friction (φ')	30°
Wet unit weight of soil (γ)	19 kN/m³
Submerged unit weight of soil (γ')	9 kN/m³
Bearing capacity factor (Nc)	29
Bearing capacity factor (Nq)	18
Bearing capacity factor (Nγ)	9

A resistance factor of 0.5 must be applied to the value of the ultimate bearing capacity in order to obtain a factored resistance.

A geotechnical resistance at the serviceability limit state (SLS) for footings, of 1.5 m width or less, placed on the compact till deposit at elevations ranging between 66 m and 64 m, of 100 kPa can be used to design the foundations.

Total settlements are expected to be less than 25 mm for the above-mentioned load while differential settlements are expected to be less than 20 mm. This value supposes that the bottom of the excavation is horizontal, undisturbed and without very loose area.

It is important to mention that if engineering fill material is used to reach the foundation elevation, the weight of this fill must be removed from the geotechnical resistance.

5.2.2 FOUNDATIONS ON ENGINEERING FILL

Due to the nature of the Till Deposit and it geotechnical similarities with regard to an engineer fill, the geotechnical properties of the Till indicated in Table 3 can also be used for the engineer fill. Therefore, the ULS values considered for the Till deposit or for the engineer fill should be the same.

If engineering fill is required to reach the level of the foundation, the geotechnical resistance at the Serviceability Limit State (SLS) must be adjusted in function of the height of the engineering fill. The SLS value used to design the foundations will be reduced of 22 KPa for each meter of fill installed.

The engineering fill must be composed of granular materials satisfying the grain size distribution requirements of crushed stone of type “Granular A’’ as defined by the Ministry of Transportation of Ontario (MTO) and be installed by layers of maximum 300 mm of thickness and compacted to at least 98 percent of the Standard Proctor Maximum Dry Density (SPMDD).

5.2.3 FOUNDATIONS ON ROCK

Considering the local stratigraphy and the elevation of the implantation foundation level estimated to 58 m, the support foundation surface will be rock of variable quality from fair to excellent.

A geotechnical rock resistance value at serviceability limit state (SLS) of 1500 kPa may be used for the design of the footing, between 1 m to 5m in width, supported by competent rock. Since the rock constitutes the foundation material, the settlements that will be generated are null or negligible.

A geotechnical rock resistance value at ultimate limit state (ULS) of 3000 kPa may be used for the design of the footing between 1 m to 5 m in width, supported by competent rock. A resistance factor of 0.5 must be applied to the ultimate limit state value (ULS).

The competent rock is defined as bedrock free of mechanically detachable parts using a hydraulic excavator of equivalent capacity of a Caterpillar excavator, model 235.

Also, in order to use the above-mentioned geotechnical rock resistance, the foundation support surface must be the competent rock horizontally.

Once the excavation will reach the elevation of the projected foundation, it is recommended to proceed with an inspection of the rock by a geologist in order to verify the state of all the foundation support surfaces. On the basis of the inspection, the geologist may recommend continuing the excavation or to clean the more friable interbed layers, to use anchor bolts to consolidate the layers or to inject or seal the fractures.

Following the rock inspection, the cavities and over excavation will be filled with a concrete filling having a minimal resistance compression of 30 MPa.

5.3 SEISMIC DESIGN PARAMETERS

5.3.1 SITE CLASS

The 2015 edition of the National Building Code of Canada (NBC 2015) defines site classifications based on the seismic site response (sub-section 4.1.8.4-A).

The following summarizes the main results.

The calculated average V_{S30} value from the Multi-Channel Analysis of Surface Waves (MASW) survey with Extended Spatial Autocorrelation (ESPAC) is 746 m/s for the actual (natural or original) site. S-wave velocity of rock (VS) ranges between 1752 m/s and 1784 m/s.

Based on the V_{S30} value (as determined through the MASW and ESPAC methods) and Table 4.1.8.4.A of the NBC 2015, the investigated site area would be categorized as a class "A" (VS30 > 1 500 m/s), or "Hard Rock", **for a building founded within rock mass**. For a building founded near the surface, the area would be characterized as a class "C" (360 < VS30 < 760), or "Very dense soil and soft rock".

Considering that the construction work would imply an excavation of at least eight (8) meters below the surface, the calculated average V_{S30} value from the MASW and ESPAC sounding would be 1 570 m/s. Based on the V_{S30} value (as determined through the MASW and ESPAC methods) and Table 4.1.8.4.A of the NBC 2015, the investigated site (after the excavation) could be categorized as a class "A" (VS30 > 1 500 m/s), or "Hard rock".

5.3.2 SPECTRAL RESPONSE ACCELERATION

The values of spectral response acceleration for different periods and the values of Peak Ground Acceleration (PGA) for different municipalities are indicated in the NBC 2015. The data related to the study site area are presented in Table 13.

Table 13 Geotechnical Parameters – Earth Pressure Calculation for Temporary Retaining System

AREA OF THE STUDY SITE	SEISMIC DATA				
	SA(0.2)	SA(0.5)	SA(1.0)	SA(2.0)	PGA (G)
Ottawa	0.45	0.24	0.12	0.057	0.287

5.3.3 STATIC AND SEISMIC EARTH PRESSURE COEFFICIENTS

Section 24.9 (pages 386 – 388) of the Canadian Foundation Engineering Manual (2006) provides the equations for calculation of seismic earth pressure coefficients. The horizontal component of active and passive earth pressure coefficient including effects of earthquake loading (K_{ae} and K_{pe}) is calculated as following as following:

$$K_{ae} = \frac{\cos(\delta + \alpha\cos^2(\phi' - \varphi - i)}{\cos^2 i \cos\delta \cos(\delta + i + \varphi)(1 + X_a^{1/2})^2}$$

$$X_a = \frac{\sin(\delta + \varphi')\sin(\phi' - \varphi - \beta)}{\cos(\delta + i + \varphi)\cos(\beta - i)}$$

$$\varphi = \tan^{-1}[k_h/(1 - k_v)]$$

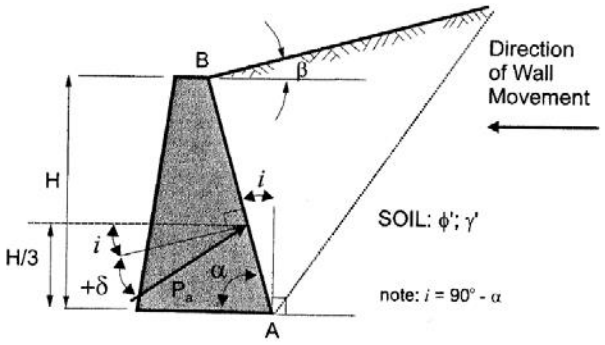
$$i = 90 - \alpha$$

$$P_{ae} = \tfrac{1}{2}\gamma H^2(1-k_v)K_{ae}$$

$$K_{pe} = \frac{\cos(\delta - i)\cos^2(\phi' + i - \varphi)}{\cos^2 i \cos\varphi \cos(\delta - i + \varphi)(1 - X_p^{1/2})^2}$$

$$X_p = \frac{\sin(\delta - \phi')\sin(\phi' + \beta - \varphi)}{\cos(\delta - i + \varphi)\cos(\beta - i)}$$

$$P_{pe} = \tfrac{1}{2}\gamma H^2(1-k_v)K_{pe}$$



δ = 15°

α = 90° for vertical wall

k_h = 0.16 and k_v = 0 for horizontal earth pressure (P_{ae}) calculation

P_{ae} = resultant active lateral earth load including static and dynamic loads

P_{pe} = resultant passive lateral earth load including static and dynamic loads

γ = unit weight of soil behind the wall

k_v = vertical component of the earthquake acceleration (to neglect in the calculation)

k_h = horizontal component of the earthquake acceleration

K_{ae} = horizontal component of active earth pressure coefficient including effects of earthquake loading

K_{pe} = passive earth pressure coefficient including effects of earthquake loading

5.3.4 POTENTIAL OF SOIL LIQUEFACTION

Based on the section 6.6.3.1 of the Canadian Foundation Engineering Manual (CFEM), for a building foundation installed on native, undisturbed and compact till or bedrock (standard penetration resistance (N) > 20), or on an engineered backfill founded on such material, no liquefaction is expected under a seismic event of a magnitude of 6.5.

5.4 SITE SERVICING

Any site servicing works within pyritic shale shall be done carefully to minimize the exposure of shale for water and oxygen (air) in order to avoid heave. If the trenches will be exposed for prolonged time, the side and bottom of trenches should be covered with concrete layer to eliminate the potential heave of the shale. 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 95% of SPMDD. Tapers may be required where the pipe subgrade transitions from soil to bedrock.

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 300 mm thick 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, also placed in 300 mm thick 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. Backfill for service trenches in landscaped areas may consist of excavated, compactible material placed in 300 mm thick lifts and compacted to 92 % SPMDD.

5.5 PAVEMENT DESIGN

5.5.1 PAVEMENT DESIGN CRITERIA

The required pavement design for the realignment of Tremblay Road will be governed in large part by the traffic levels and proportion of heavy vehicles expected to use the roadway.

Pavement design for the roadway is according to City of Ottawa standards. The preliminary pavement structure layer thickness requirements have been assessed using the AASHTO Guide for Design of Pavement Structure, 1993, Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions, Ontario Ministry of Transportation MI-183. The following parameters were assumed:

- AADT (2007), 1000
- Growth Rate, 1%
- AADT (2014), 1072
- A design reliability, R, of
- 80% Standard Deviation of 0.44
- An initial serviceability of 4.2 and a terminal serviceability of 2.2
- Structural layer coefficients of 0.42 for asphalt and 0.14 for both the base and subbase layers
- Percentage of commercial vehicles of
- 10% OC Transpo bus route
- Design life of 20 years
- Subgrade modulus (silty sand and silt) of 25 MPa.

Based on the above parameters, a design structural number of 132 would be required. The following preliminary pavement structure was recommended in the 2008 report for the infrastructure improvements at Tremblay Road, and exceeds the minimum required structural number, while allowing for a moderate increase in traffic levels (associated with the development):

- 150 mm Asphalt (50 mm surface course, 50 mm + 50 mm base courses)
- 150 mm OPSS Granular A

- 500 mm OPSS Granular B Type II

Should traffic parameters differ from what was assumed in the above analysis, the final pavement design may differ.

If bedrock is encountered at less than 650 mm below ground surface, the Granular B Type II layer may be decreased, so long as a minimum thickness of 150 mm is provided to allow for proper drainage.

It is anticipated that the surface course will consist of SP12.5, while the base courses will consist of SP19. The traffic category will be dependent on the level of traffic, and would correspond to a Traffic Category C for the traffic data given above (Design EASL 5,750,000).

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. 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.

5.5.2 PROPOSED STRUCTURE FOR THE ACCESS ROAD AND PARKING AREA

Any future paved parking area proposed in the plan can be assigned the following pavement structure as per table 14 below.

Table 14 Proposed Structure for the Access Road and Parking Area

STRUCTURE ITEM	TYPE OF MATERIAL	THICKNESS (MM)	COMPACTION (%)
Asphaltic material	Surface course HL-3	40	92-98 %
	Binder course HL-8	50	92-98 %
Base	Granular type A	200	100 % min.
Subbase	Granular type B type II*	300	100 % min.
Total		590	
*Note: Excavated material could be reused for the subbase following the approval from the laboratory.			

5.5.3 ADDITIONAL CONSIDERATION

Following the excavation for the parking structure and access road, the subgrade must be inspected by a geotechnical engineer. Any soft areas noted during the inspection should be over excavated and replaced with well-compacted granular fill. Any material required to raise grades beneath the parking areas should comprise of sand and gravel and be placed in 300 mm thick lifts and be compacted to 95% SPMDD.

Samples of both the Granular 'A' and Granular 'B' aggregates should be checked for conformance to OPSS 1010 prior to on-site utilization and during construction. The Granular 'B' subbase and Granular 'A' base courses must be compacted to 100% SPMDD, as verified by *in-situ* density testing.

The asphalt concrete paving materials should comply with the requirements of OPSS 1150. The asphalt should be placed and compacted in accordance with OPSS 310. Performance graded asphalt cement (PGAC) 58-34 should be utilized in the hot mix asphalt in accordance with the OPSS 1101 recommendations.

5.5.4 CURBS AND SIDEWALKS

The concrete for curb and gutter should be proportioned, mixed, placed, and cured in accordance with the requirements of OPSS 353 and OPSS 1350.

The subgrade for the concrete sidewalks should comprise of undisturbed mineral soil or well compacted fill. A minimum 150 mm thick layer of compacted Granular 'A' type aggregate should be placed beneath the sidewalk slabs. Granular 'A' material shall also extend a minimum of 150 mm beyond the edges of the proposed sidewalk. The subgrade and granular base should be prepared in accordance with the requirements of OPSS 315.

5.6 CORROSIVITY/CEMENT TYPE

Three (3) representative water samples were tested for water-soluble sulphates, pH, conductivity, chloride and resistivity and the tests results are summarized on Table 15.

Table 15 Chemical Analyses on Water Samples

PARAMETERS	**SAMPLE RESULTS**		
BOREHOLE (DEPTH (M))	**BH-03-14 (4.17 – 5.69)**	**BH-06-14 (1.22 – 4.27)**	**BH-07-14 (2.74 – 4.27)**
pH	8.1	7.5	7.0
Conductivity (uS/cm)	1690	2720	2020
Sulphate (mg/L)	31	276	270
Chloride (mg/L)	322	403	203
Degrees of exposure for buried concrete structure	Negligible	Negligible	Negligible
Note: Sample testing conducted at Paracel Laboratories in Ottawa, Ontario. Based on the results presented in the table above, the degree of exposure for buried concrete structure is negligible.			

Based on the tests results, the pH value is normal for the soil type and water content, the resistivity value is mild and there is a negligible potential degree of sulphate attack on concrete. Therefore, according to CSA A23.1 normal Portland cement (such as General Use Hydraulic Cement) may be used.

5.7 CORROSION POTENTIAL FOR DUCTILE IRON PIPE

Table 16 provides the results of various analyses carried out on two (2) soil samples to assess the potential for corrosion of ductile iron pipe.

The method used to evaluate corrosion potential with respect to iron pipe is the soil-test evaluation procedure, also called the 10-point system, proposed by The Cast Iron Pipe Research Association (CIPRA). This method serves as a guide for identifying potentially corrosive conditions to iron pipe. Five

(5) tests are done to evaluate this potential: soil resistivity, pH, oxidation-reduction potential, sulfides and moisture. Each parameter is evaluated (points are given based on the tests results) and if the sum of the point is 10 or higher, the soil is considered as potentially corrosive to iron pipe.

This soil test evaluation rating system is provided on the Table 16. One of the two (2) samples show a total point value higher than 10, therefore, corrosion protection may be required for ferrous pipe. It will be recommended to proceed with other chemical test depending of the location and depth of proposed buried pipe.

Table 16 Chemical Analyses on Soil Samples

SOIL CHARACTERISTIC	AWWA RATING SYSTEM		SAMPLE # (DEPTH (M))			
			BH-03-14, SS-6 (3.05 – 3.66)		BH-04-14, SS-2 (0.61 – 1.22)	
	RESULT	POINTS	RESULT	POINTS	RESULT	POINTS
Resistivity (ohm-cm)	<700 700 – 1000 1000 – 1200 1200 – 1500 1500 – 2000 >2000	10 8 5 2 1 0	1,700	1	140	10
pH	0 – 2 2 – 4 4 - 6.5 6.5 – 7.5 7.5 – 8.5 >8.5	5 3 0 0 0 3	7.83	0	11.8	3
Redox Potential (mV)	> +100 +50 – +100 0 – +50 negative	0 3.5 4 5	130	0	-64	5
Sulphides	positive trace negative	3.5 2 0	trace	2	positive	3.5
Moisture	wet moist dry	2 1 0	Wet	1	Wet	1
Total Points				4		22.5

Notes: Sample testing conducted at Maxxam in Ottawa, Ontario.
Corrosion protection required for cast and ductile iron if total points equals or exceeds 10.

5.8 FROST HEAVE PROTECTION

According to Environment Canada's database, the average frost index is of 994°C-day, in the project's region. The corresponding anticipated frost penetration depth is evaluated at 1.8 m. Consequently, frost action exposed foundations have to be buried under at least 1.8 m of soil in order to protect them from harmful frost heave and other effects. In the case of permanently heated foundation structures, this protection thickness can be reduced to 1.5 m.

This frost action protection can alternatively be obtained with the use of thermal insulation. The article by E.I. Robinsky and K.E. Bespflug entitled «Design of Insulated Foundations», issued in the September 1973 edition of the «Journal of the Soils Mechanics and Foundation Division» of the A.S.C.E., is a recommended consultation to determine the proper design principles of thermal insulation; the value of 994°C-day can be used for this design.

Based on the information received by the client, the site conditions and using the recommendation from the Canadian Foundation Engineering Manual (CFEM), referring to the article by E.I. Robinsky and K.E. Bespflug mentioned in the paragraph above, the minimum recommended thickness of insulation for a heated structure is 40 mm. The recommended projection around the building is 1.8 m. A cushion of clean granular fill of type Granular A compacted to at least 98 percent of the Standard Proctor Maximum Dry Density (SPMDD) must be installed directly under the insulation.

5.9 SLOPE STABILITY/EXCAVATION & IMPACTS ON ADJACENT STRUCTURES

WSP recent site visit did not encounter any slope stability hazards. In order to reach the foundation level, excavation will be required in the fill material and in the rock masses.

5.9.1 TEMPORARY EXCAVATIONS IN FILL MATERIAL AND TILL DEPOSIT

Temporary excavations within the surficial materials (heterogeneous fill and till deposits, both Type 2 soil according to the O. Reg. 213/91) may be profiled with a slope of 2 horizontally to 1 vertically or less. This slope is valid down to a maximal depth of 3 m, depending on the compactness of the materials and according to the applicable legislation (Occupational Health and Safety Act - O. Reg. 213/91). Moreover, this slope is valid only if the excavation remains at a level higher than the groundwater level. The excavation work must be completed according to the environmental legislations regarding the disposal of the contaminated soils. In order to complete open-trenched excavations, the recommendations for temporary drainage must be followed during the entire excavation work. Since these are temporary slopes, the contractor is responsible for their stability as well as the safety of the workers.

If unsupported excavations are left opened for a long period, slope inspections should be carried out on a regular basis by a geotechnical engineer or his representative to identify and propose correction methods to any improper/dangerous conditions.

During the excavation work, machinery and heavy-weight traffic shall not be parked on the top of any slope to a distance smaller than the excavation depth. It is also recommended to avoid heavy- weight traffic on top of the slope to a distance smaller than the depth of the excavation in order to limit the vibrations.

On the top of the slopes, excavated materials must always be placed at a greater distance than the excavation depth. This condition must be satisfied at all times, except if special investigations are performed for each particular case.

If open-trenched excavations are not applicable (for example in the case where the proximity of adjacent structures such as sidewalks, streets or existing parking structures does not allow the realization of the above-mentioned slopes), temporary excavations must be realized using retaining walls. Since such a retaining system is temporary, the contractor is responsible for its design. It is important to mention that the design of the retaining walls must take into account the number and the weight of the vehicles circulating on adjacent roads. Since the groundwater level has locally been encountered near the surface, water infiltrations must be considered when designing the retaining system. Table 17 shows the geotechnical parameters that can be used for the calculation of earth pressures.

Table 17 Geotechnical Parameters – Earth Pressure Calculation for Temporary Retaining System

Parameter	Heterogeneous Fill and Surface Till Deposit	Deep Till Deposit
Unit weight (γ)	19 kN/m^3	20 kN/m^3
Effective angle of internal friction (ϕ')	30º	32º
Active earth pressure coefficient (K_a) *	0.33	0.31
At rest earth pressure coefficient (K_0) *	0.50	0.47
Passive earth pressure coefficient (K_p) *	3.00	3.25
*Note: For a vertical wall and a horizontal surface of the supported soil.		

5.9.2 TEMPORARY EXCAVATION IN ROCK MASSES

The over excavation in rock (classified as Type 1 soil according to the O. Reg. 213/91) will be required depending on the construction level and not because of rock quality. Furthermore, the over excavation in rock is required at the building's location.

It is possible to not be able to excavate the rock mass mechanically and as a result, the use of explosives may be required. The contractor should take all precautions for this type of work for the protection of public as well as the surrounding buildings.

Excavation in competent rock may be completed almost vertically. Excavation rock wall must be inspected by an experience geologist or an engineer geologist. It is possible that discontinuities are unfavourably oriented. Rock bolts or anchors can be used to stabilize a block at risk of being detached from the rock wall. To protect fractured rock or closely jointed rock, it would be more appropriate to protect the rock face with a steel wire mat or sprayed concrete, combined with bolting.

Prior to the excavation work in the rock, and in order to avoid damaging the rock beneath the existing building, it is recommended to proceed with a line drilling along the excavation wall. The contractor must take all the necessary precautions in order to ensure that no detachable rock parts are present on the walls of the excavations, and to ensure that no damage is done to adjacent structures during the excavation work.

In general, when the fieldwork can generate perceptible vibrations (pile driving, demolition, excavation, etc.), a vibrations management procedure must be established. The main activities to undertake are:

- Inspection of existing buildings near the site before and after work.
- Identification of acceptable vibration threshold according to the type and tolerance of existing buildings.
- Conducting monitoring by vibration measurements in order to ensure that the vibration threshold is not exceeded.

This kind of monitoring is done by the installation of seismographs on monitored building. At the beginning of the excavation work, it is highly recommended to proceed with an inspection of the rock by a geologist in order to verify the state of the upper part of the rock masses. Based on this inspection, the geologist may recommend to clean detachable or friable parts or to use anchor bolts to consolidate portions of rock masses unfavourably oriented. All the excavation walls must be inspected until depths corresponding to the implantation foundation level.

5.10 UPLIFT FORCES/ROCK ANCHORING

In the event that rock anchors are used to counter the uplift force, the following recommendations may be followed.

The calculation of the maximum load that the anchor can take in the rock is generally done by the inverse cone weight method with a top angle of 60 to 90 degrees, the top being taken at the base of the used length of the anchor.

For the present project, the anchors may be sized using the following parameters indicated in Table 18.

Table 18 Parameters of the Rock Anchors

PARAMETER	RECOMMENDED VALUE
Angle at the top of the cone (φ)	60° (After Littlejohn & Bruce, 1977)
Weight per unit volume of rock (γ)	26 kN/m^3
Effective weight per unit volume of rock (γ')	16 kN/m^3
Friction angle in rock (φ)	32° (After Barton, 1974)

The weight of the deposits overlying the bedrock may also help in dimensioning the anchors. The use of a resistance factor of 0.6 is normally recommended in the cases when the anchors uplift tests are completed.

Since the anchors will be cemented in the rock, the anchors' length must also be designed in function of the grout-rock bond. In this case, a bond limit of 500 kPa may be used at the grout-rock contact on the used length of the anchor if an expending grout of a compression resistance of at least 30 MPa is used. The value of the bond limit includes a resistance factor of 0.4. This last consideration is often the most critical one and generally governs the length of the anchors.

The admissible bond limit is a function of the tie used and must respect the manufacturer's recommendations and relevant guidelines.

When a stress must be taken by more than one anchor, the risk of overlapping the cones of influence must be verified and a reduction factor must be applied when the spacing of the tie anchors is less than twice the radius of the cone of the influence base circle.

In addition, for the calculation of the anchor length, the designers will have to neglect the first meters under the bedrock surface until the rock quality (R.Q.D.) is superior or equal to 60%. This will account for the pronounced rock fractures encountered during the drillings. Therefore, the length of the anchors must be incremented with respect to the inclination of the anchors.

It is strongly recommended that all the anchors be tested in order to verify their capacity.

It's recommended that the length of the anchor should be at least 80 times of the anchor diameter.

In the case that the inclined anchors are put in place to take the lateral stress, the vertical component that the inclination of the anchor will force at the concrete base must be taken into account. During the uplift testing of the anchors, it is recommended to limit the test stress at 125 or 150 percent of the designed force in order to limit the vertical stress transferred to the concrete base.

Petrographic and chemical potential for swelling were carried on three (3) rock samples. Results showed a residual swelling pyrite varying between 1.63% and 1.79%, which indicate that the rock has an extremely high swelling potential to pyrite oxidation. Thus, excavated rock should not be used in any case as backfill for any works sensitive to heaving (building, pavement, sidewalk, etc.).

5.11 DEWATERING

5.11.1 TEMPORARY DEWATERING

On February 11th, 2014, the water level at the three (3) of the four (4) observation wells was between 0.82 to 0.98 m of depth. It was at 2.59 m at BH-01-14, where the observation well is installed in deeper rock. Because it will be necessary to excavate under this level, the groundwater level will be intercepted. As these measurements were taken 5 years ago, it is recommended to continue monitoring the ground water table for these wells to observe the current fluctuation in water level.

Thus, an adequate and effective pumping system must be provided in order to control seepage and/or surface runoff water that can accumulate at the bottom of the excavation.

Based on the amount of dewatering required for the excavations, it is possible that pumped water exceed allowed limits 400,000 L/day. In such case, Permit to Take Water (PTTW) will be required by the contractor.

5.11.2 PERMANENT DEWATERING

The foundation of the buildings will probably be lower than the groundwater level. Therefore, in order to eliminate the water that can be accumulated under the level of the basement, a permanent dewatering system may be required

The permanent drainage system is not required if it is possible to waterproof all the foundation walls and slabs against long-term water infiltration. In this case, the design of structure and the slab must consider the upward hydrostatic pressure of underground water.

The recommendations relative to the permanent flow control in the whole section of the excavation should be done in relation with the final level of the basement slab.

5.12 BASEMENT SLAB

A conventional slab can be used following that the above-mentioned recommendations regarding permanent drainage are respected.

The slab of the building must be placed on a mat of at least 300 mm thickness, composed of granular materials satisfying the grain size distribution requirements of crushed stone of type “Granular A’’. This material must be compacted to at least 98 percent of the Standard Proctor Maximum Dry Density (SPMDD). If the excavation is thicker than 400 mm, the cushion could be preceded by a granular material of type “Granular B type II” compacted to at least 95 percent of the SPMDD.

Following the previous recommendation, the values of subgrade modulus of a slab on compact till could be estimated to 4 MN/m^3 and a slab sitting on rock could be estimated to 60 MN/m^3.

Moreover, it is very important that all the new granular materials used not contain any fine materials with potentially expansive materials, such as shale limestone, which may cause important heaving of the slab.

5.13 FOUNDATION ON PYRITIC ROCK

Table 19 presents swelling potential classification for residual pyrite content.

Table 19 Swelling Potential versus Residual Pyrite Content (CTQ-M200)

RESIDUAL PYRITE CONTENT	SWELLING POTENTIAL
0.00 – 0.50 %	Negligible
0.51 – 0.75 %	Low
0.76 – 1.00 %	Average
1.01 – 1.50 %	High
> 1.50 %	Extreme
0.00 – 0.50 %	Negligible

Table 20 presents residual pyrite content on three (3) selected samples.

Table 20 Residual Pyrite Content

BOREHOLE #	SAMPLE #	DEPTH (M)	RESIDUAL PYRITE (%)	SWELLING POTENTIAL
BH-03-14	RC-9	5.80 – 5.91	1.79	Extreme
BH-03-14	RC-11	8.01 – 8.19	1.76	Extreme
BH-03-14	RC-13	11.02 – 11.30	1.63	Extreme

Important damage will occur to structures from volume changes from the pyrite weathering, particularly on slab-on-grade basement floors. Thus, special precaution must be taken to avoid the differential settlement that can take place with this kind of rock due to its extreme swelling potential.

Based on an article from E. Penner, W.J. Eden and P.E Grattan-Bellew titled “Expansion of Pyritic Shales” published in 1972, the weathering of the pyrite can only proceed in the presence of oxygen. Therefore, effort should be made to minimize the exposure of the rock to air. The following precautions are taken from this article and should be followed when excavating in Pyrite rock:

- Excavate with the least possible disturbance of the shale below the grade line of the basement. Shattering of the bedrock provides easy entry of air to the shale.
- Protect exposed surfaces of shale by a coating of concrete grout or asphalt in all areas where shale will be exposed to the air for more than 24 hours. This includes service trenches and exposed areas that will receive backfill to bring to grade.
- Completely fill footing trenches with concrete.
- Insulate the basement floor under spaces where temperatures are above normal. The rate of the oxidation process and bacterial activity are increased as the temperature rises.
- Avoid placing buildings over badly shattered shale. When it cannot be avoided, give consideration to a structural floor system. Such floor systems will relieve the undesirable effects of heave, but the consequences of the acid produced by the weathering process should be considered in choosing the system.
- Avoid the use of pyritic or other unstable material as fill under basement floors or in-service trenches either from neighboring excavations or from fill sources such as waste dumps from coal mines.

5.14 GEOTECHNICAL GAP ANALYSIS

The following program is suggested to address the gaps in geotechnical information identified in the previous existing reports that are summarized in the sections above. This section will provide a site specific, comprehensive geotechnical investigation for the concept plan.

5.14.1 FIELDWORK

5.14.1.1 *GROUNDWATER TABLE*

All working and accessible piezometers from previous investigations should be checked and monitored to assess the fluctuation of ground water table through a considerable period of time. This will help evaluate the water level expectation during excavation and also for design purpose as well.

5.14.1.2 *TREMBLAY SUBDIVISION ROAD/ SITE SERVICING*

It is recommended that additional boreholes to be advanced along the proposed re-alignment of Tremblay Road, taking into consideration the site servicing works underneath the road. Sets of three (3) boreholes (centerline, shoulder, ditch line/curb line) should be advanced every 60 m. The boreholes shall be advanced to a minimum depth of 1.5 m, with one borehole from each set advanced to a minimum of 2 m beyond the invert of lowest proposed services. If bedrock is encountered within the depth of the investigation, it should be cored (using NQ-size equipment) for a minimum depth of 2 m. A monitoring well to be installed in the deepest borehole to monitor ground water fluctuation. Appendix B shows the proposed locations, total no. of holes to be determined.
Standard Penetration Tests (SPT) should be carried out at regular intervals in each borehole while collecting soil samples. Field vane shear tests should be performed at regular intervals if cohesive material is encountered.

5.14.2 STORM WATER POND

The area proposed as the future storm water pond is expected to have unknown layers of peat or organic based on the site visit to the said development. It is recommended to drill 2 boreholes near the inlet and outlet of the pond and some test pits to define the extent of the organic layer and the soil at the bed of the pond. The 2 boreholes can be drilled to 4 m and 6 m depth. Field shear vane test is recommended to provide census about the shear of the organic or cohesive layer in addition to the frequent SPT for the cohesionless layers if any.

5.14.3 THE PARK

The south west part of the site shall be allocated as a park area with possible light structures. A set of 5 test pits with depth ranges between 2 to 3 m are recommended to be carried out across the park to provide information about the subsurface conditions.

5.14.4 LABORATORY TESTING

The following laboratory tests are recommended for the previous field investigations:

- Moisture content;
- Grain size analysis (Sieves and hydrometers);
- Atterberg limits (for cohesive soils);

- Unconfined compressive strength of rock;
- Some additional testing to define the swelling rate of pyritic shale, if any.
- Corrosion package chemical testing (pH, sulfate, chloride, and resistivity).

The frequency of testing shall be decided based on the findings, depth of boreholes, the foundation depth and type of foundation.

6 CONSTRUCTION CONSIDERATIONS

6.1 INSPECTION/ REVIEW DURING CONSTRUCTION

It is recommended that all excavations be inspected and approved by qualified geotechnical personnel to ensure that soil conditions correspond to those encountered in the boreholes and test pits, that footings are placed within the correct stratigraphic unit and that all excavations subgrades are reasonably dry and free of disturbed soils.

All backfilling operations shall be supervised to ensure that proper material is employed and that full compaction is achieved.

6.2 WINTER CONSTRUCTION

Frost penetration can cause problems to the structure, servicing trenches and pavement. In order to minimize this effect, it is recommended during winter construction that, exposed surfaces to support foundations or paved areas must be protected against frost penetration by means of isolating materials such as straw, polystyrene, heating. The foundations generally should be at least 1.8 from ground surface. In order to minimize frost related differential heaving between the granular backfill which is relatively non-frost susceptible and the generally more frost-susceptible natural soil, it is recommended that the trenches be excavated with appropriate transition slopes within the freezing depth.

6.3 REUSE OF EXCAVATED MATERIAL

The nature and composition of the till material are very heterogeneous (sand, gravel, silt and clay in variable proportions). The reuse of this fill material for the backfilling of the excavation is possible provided the opinion of geotechnical engineer that mostly require grain size analysis. The off-site disposal of the fill material must be according to Ontario environmental regulations. Due to the heaving nature of the pyritic shale, it will not be a suitable material to reuse.

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APPENDIX

A TERMS & CONDITIONS

GENERAL TERMS AND CONDITIONS

1. DEFINITIONS

1.1 Except if a different interpretation is required by the context, the following terms shall have the following meanings:

(a) **Affiliate** has the meaning given to such term in the *Canada Business Corporations Act* or in any replacement thereof or supplement thereto in effect, which meaning shall apply *mutatis mutandis* to partnerships, general partnerships and limited partnerships.

(b) **Agreement** means (i) the Proposal, (ii) the General Terms and Conditions, (iii) the Purchase Order(s) and (iv) all the other attachments indicated in the Proposal, provided the parties have agreed in writing to be bound by the General Terms and Conditions and have not executed a Services Agreement.

(c) **Claim** or **Claims** means, as the case may be, one or more of the following: losses, damages, fees, disbursements, penalties, fines, claims, formal demands, motions, petitions or applications, proceedings, legal hypothecs, charges, obligations imposed by law, liabilities, judgments, decisions, decrees, arbitral awards, taxes of any and all kinds, and any other types of costs or expenses (including reasonable lawyers' fees and reasonable expenses incurred thereby), plus the related interest at a rate of one percent (1%) per month.

(d) **Client** means the party named in the agreement as being the recipient of the services.

(e) **Completion** means the full and complete performance of the services in accordance with the Agreement.

(f) **Confidential Information** means all information of a confidential nature, in whatever form and on whatever medium, that the Client and WSP obtain from the other party to the Agreement, directly or indirectly, including information concerning the Client or WSP, particularly regarding the business, affairs, financial position, assets, operations, activities, prospects or trade secrets of such party, as well as all analyses, assessments, compilations, notes, studies or other documents that the Client or WSP, as the case may be, or their respective Personnel have performed or prepared and that rely on or contain such information.

(g) **Deliverables** means the drawings, plans, models, specifications, reports, photographs, surveys, calculations and other data, including the computer printouts, that shall be used in connection with the Agreement and shall be prepared by or on behalf of WSP.

(h) **Force Majeure Event** means an event or circumstance beyond the control of a party to this Agreement that hinders or delays the performance by said party of its obligations under the Agreement and that, despite reasonable diligence and proper planning, said party was not or is not able to avoid or overcome.

(i) **General Terms and Conditions** means this document entitled "General Terms and Conditions" and forming part of the Agreement.

(j) **Hazardous Substance** means any substance, mixture of substances, product, waste, organism, pollutant, material, chemical product, contaminant, dangerous good, component or other material that is, or becomes, listed in, governed by or subject to a Law or regulation applicable to its use, manufacture, importation, handling, transport, storage, dumping and treatment.

(k) **Law** or **Laws** means, collectively, all valid and applicable common law, federal, provincial, municipal and other local laws, orders, rules, regulations, bylaws and regulatory body decisions, including occupational health and safety, fire, employment insurance, workers' compensation and environmental protection legislation, building codes, anti-corruption laws or international conventions, that apply now or may apply in the future, and other governmental requirements, labour practices and procedures prescribed by law and related to the Project or the Services.

(l) **Person** means a natural person, business corporation, company, joint venture, unincorporated association, union, partnership (limited or general), limited liability partnership, trust, trustee, executor, judicial administrator or other legal representative or any other enterprise or association.

(m) **Personnel** means a party's directors, officers, employees, contractual personnel, representatives, advisors, agents and mandatories, which definition shall also apply *mutatis mutandis* to a party's Affiliates.

(n) **Project** means the project indicated in the Agreement.

(o) **Proposal** means the service proposal submitted to the Client by WSP and dated Proposal date.

(p) **Purchase Order** means, if applicable, the purchase orders established by the Client and bearing the numbers PO number.

(q) **Services Agreement** has the meaning given to such term in Subsection 19.1 hereof.

(r) **Services** means the services indicated in the Agreement.

(s) **Site** means the place where the Project is located.

(t) **WSP** means WSP Canada Inc.

2. INTERPRETATION

2.1 **Precedence.** In the event of conflict or inconsistency between the documents forming part of the Agreement, the following shall have precedence, from first to last:

(a) these General Terms and Conditions;

(b) the Proposal, excluding the General Terms and Conditions and the attachments;

(c) if applicable, the other attachments to the Proposal;

(d) if applicable, the Purchase Orders.

2.2 **Severability.** If any term, covenant or condition of these General Terms and Conditions is, to any extent, held to be invalid or unenforceable, then such invalidity or unenforceability shall not affect the remaining General Terms and Conditions other than the General Terms and Conditions

that were deemed invalid or unenforceable, and each remaining term, condition or covenant shall be separately valid and enforceable to the fullest extent permitted by Law.

3. SCOPE OF SERVICES

3.1 **Services.** WSP shall provide the Services in accordance with the Agreement.

3.2 **Time.** WSP shall provide the Services and deliver each of the Deliverables in accordance with the work schedule included in or attached to the Proposals.

4. OBLIGATIONS

4.1 **Standard of Care**. WSP shall provide the Services with such degree of care, skill and diligence as is normally exercised by engineers or consultants in the performance of comparable services at the time and place where the Services are provided.

4.2 **Obligations of the Client**. The Client shall discharge all of its responsibilities without delay and shall study WSP's requests for information, instructions or decisions without delay and respond thereto diligently within a reasonable time so as not to delay performance of the Services.

4.3 **Information and Data**. The Client shall make available to WSP all Project-related information and data required by WSP for the performance of the Services and, upon receipt of a notice from WSP, shall perform any ancillary service that is necessary to enable WSP to provide the Services.

4.4 **Access to the Site**. The Client shall take the necessary steps to ensure that WSP has access to the Site if such access is necessary for the performance of the Services.

4.5 **Permits**. The Client shall obtain from the government authorities or any other persons all permits, approvals and licences and any other authorizations or rights that are required to carry out the Project.

5. CHANGES

5.1 **Changes**. The Client or WSP may at any time propose to the other party changes to the Services, including the addition or removal of Services, changing the work schedule and advancing or postponing the delivery of all or part of the Services.

5.2 **Change compensation**. If a proposed change causes, directly or indirectly, an increase or decrease in Service delivery times or costs, the Client and WSP shall negotiate in good faith, without delay, a fair adjustment to the schedule or a financial compensation or both, and shall amend the Agreement in writing accordingly.

5.3 **Performance**. WSP shall not proceed with any proposed changes if the Agreement has not been amended in writing by the two parties to reflect the schedule adjustments or a financial compensation or both.

6. OWNERSHIP OF DELIVERABLES AND INTELLECTUAL PROPERTY RIGHTS

6.1 **Deliverables.** The Deliverables shall be the exclusive property of WSP, whether or not work has been performed in connection with the Project. WSP shall retain the copyrights thereon and on any work that may result therefrom. The Client may retain a copy of the Deliverables in its files.

6.2 **Exclusive Use by Client**. Reports, opinions, findings, recommendations, including expert testimony, or other documents prepared under this Agreement are prepared for the exclusive use of the Client identified as the intended recipient. WSP is not responsible for the use of, or reliance on, these documents by any other party without the written consent of WSP. WSP accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on these documents.

6.3 **Intellectual Property Rights.** WSP shall retain all property rights on all patents, trademarks, copyrights, industrial property rights or other intellectual property rights and on the designs, products or processes developed or adapted by it in the performance of the Services. The Client shall not use, infringe or appropriate such exclusive rights without the prior consent of and payment of a financial compensation to WSP.

6.4 **Holdback of Deliverables**. Notwithstanding any contrary provision of the Agreement, if the Client is in default under the Agreement, including if a payment is not made by the Client when due, WSP may hold back all Deliverables until the Client has cured said default.

6.5 **Client Documents**. WSP may retain in its files a copy of all documents provided by the Client relating to performance of the Services.

7. INSURANCE

7.1 **Insurance Coverage**. WSP shall obtain, for the entire term of the Agreement, professional liability insurance with such limits per claim and aggregate annual limits as it deems reasonable, covering the professional liability incurred by WSP in the performance of the Services. At the Client's request, WSP shall provide the certificates of insurance within a reasonable time.

7.2 **Notice**. WSP and the Client shall notify one another in writing, without delay, of any event or incident that could give rise to a Claim under WSP's professional liability insurance referred to in this section, or of any other matter that WSP is required to disclose to its insurer. In addition, the Client shall provide WSP with all information, reports and documents and any assistance that may be reasonably necessary for the insurance claim to be settled without delay.

8. LIABILITY AND INDEMNIFICATION

8.1 **Liability of the Parties**. Subject to the limitations of liability indicated in Section 9, each party shall indemnify and save harmless the other party and their respective Affiliates, mandataries, agents and Personnel from and against Claims attributable to the following:

(a) third persons;

(b) the negligent or wrongful acts or omissions of the indemnifying party or of any person under the indemnifying party's responsibility.

9. LIMITATION OF LIABILITY

9.1 **Limitation of Liability**. Each party's liability with respect to the Claims that may be made against it or its Affiliates, mandataries, agents and Personnel, under the Agreement or affecting the Services in any way whatsoever, whether based in contract, tort (including negligence) or any other theory of liability, notwithstanding any other provision of the Agreement, shall be limited to the aggregate amount payable by the Client in consideration of the Services under the Agreement.

9.2 **Indirect Damages**. The parties shall in no case be liable for indirect or exemplary damages or for damages for loss of profits or income, loss of clients, loss of reputation, loss of financing or loss of business opportunity.

9.3 **Prescription Period**. No claim may be made against WSP or its Affiliates, mandataries or agents, including the insurers and their respective personnel, more than one year (or beyond the prescription period provided by law in the jurisdiction in which the Project is carried out) after the Completion of the Services.

9.4 **Hazardous Substances**. WSP shall not be responsible for the identification, reporting, analysis, presence, handling, removal or elimination of hazardous substances found on or near the Site, unless otherwise indicated in the Agreement, nor shall it be liable for the exposure of persons, property or the environment to such hazardous substances.

9.5 **Information from the Client.** The Consultant shall have the right to assume that all information and data provided by or on behalf of the Client and all information provided by the government authorities and public utilities is accurate and complete.

9.6 **Acts of Third Parties.** The Consultant shall not be liable for the acts or omissions of the Client's consultants, the contractors, the subcontractors, the suppliers or the service providers in relation to the Project or for the work they performed. The Consultant shall not monitor, direct or supervise the methods, means, techniques, sequences or construction processes employed by the contractors, subcontractors or service providers in relation to the Project.

9.7 **Independent Expert.** The Consultant shall not be liable for any opinions provided by any independent expert engaged by the Client, even if said expert is recommended by the Consultant.

9.8 **Manufacturing Defects.** The Consultant shall not be liable for manufacturing defects in equipment, materials or supplies specified or recommended by it.

9.9 **Safety.** The Consultant shall not be responsible for the safety measures and programs required for the Project or for general safety at the Site pursuant to the applicable health and safety laws.

10. FORCE MAJEURE EVENT

10.1 **Force Majeure Event**. If, owing to a Force Majeure Event, either party is unable to fulfill its obligations under the Agreement, the obligations of such party shall be suspended for the period during which and to the extent that the Force Majeure Event continues to have such effect.

11. INDEPENDENT CONTRACTOR

11.1 **Independent Contractor**. Unless otherwise indicated in the Agreement, WSP shall be an independent contractor and not an agent or mandatary of the Client.

12. PAYMENT

12.1 **Payment**. WSP shall invoice the Client every month, and the Client shall pay the invoices within thirty (30) days of receipt thereof. If the Client determines that an invoice contains amounts that, in its estimation, it does not owe to WSP, it shall notify WSP within ten (10) days of receipt of the invoice. If the Client does not notify WSP within said ten (10) days, it shall be deemed to have accepted the amounts indicated on the invoice issued by WSP.

12.2 **No holdback**. Notwithstanding any other provision of the Agreement, there shall be no holdback of payment for the Services.

12.3 **Interest**. The amounts that either party pays to the other party when due under the Agreement shall bear interest as of the initial due date until the actual date of payment, inclusive, at a rate of one percent (1%) per month.

13. SUSPENSION OR TERMINATION

13.1 **Expiry or Termination.** The Agreement shall terminate at the earlier of the following dates:

(a) the Completion date;

(b) the termination date if the termination occurs in accordance with this section.

13.2 **Termination by the Client**. In the event of a material failure by the Consultant to fulfill any of its obligations under the Agreement, the Client shall notify the Consultant that the default must be cured. If the Consultant fails to cure the default within thirty (30) days of receipt of such notice, if the default cannot be cured immediately, or if the Consultant fails to take reasonable measures within such time to cure it, the Client may terminate the Agreement by a new notice to the Consultant. Such termination shall not relieve the Client of its obligation to pay all of the amounts owed by it to the Consultant for the Services provided up to the termination date, in addition to all the costs incurred by the Consultant up to said date, in the manner set forth in the Agreement.

13.3 **Suspension or Termination by WSP**. In the event of a material failure by the Client to fulfill any of its obligations under the Agreement, including if it fails to make the payments in the manner set forth in the Agreement, WSP shall notify it that the default must be cured. If the Client does not cure the default within seven (7) days of receipt of such notice, WSP may cease to provide the Services until it receives payment in full of the amounts owed to it, including accrued interest, or until the default has been cured. If the Client does not cure the default within fifteen (15) days of receipt of the default notice given by WSP, WSP may terminate the Agreement by providing a new notice to the Client. If applicable, the Client shall pay without delay all amounts that it owes to WSP for the Services provided up to the termination date, in addition to all reasonable termination costs, including third party cancellation charges, without prejudice to any other right or remedy available to WSP.

13.4 **Suspension or Termination by the Client**. If the Client does not intend or is not able to implement the Project, it may suspend or terminate the Agreement by thirty (30) days' notice to WSP. Upon receipt of such notice, WSP shall cease to provide the Services, except for those Services that are reasonably necessary to enable the suspension or termination of the part of the Project for which it is responsible. If applicable, the Client shall pay without delay all amounts that it owes to WSP for the Services provided up to the suspension or termination date, in addition to all costs incurred by WSP up to said date and all reasonable suspension or termination costs, including third party cancellation charges, without prejudice to any other right or remedy available to WSP.

13.5 **Rights of WSP**. If the Client suspends the performance of the Services at any time whatsoever for more thirty (30) days, whether those days are consecutive or not, WSP may choose, in its entire discretion, to terminate the Agreement upon

delivery of a notice to the Client. If applicable, the Client shall pay without delay any Compensation that it owes to WSP for the Services provided up to the termination date and all reasonable termination costs, including third party cancellation charges, without prejudice to any other right or remedy available to WSP.

14. CONFIDENTIALITY

14.1 **Confidential Information**. All confidential information received by a party to the Agreement shall be treated as strictly confidential and shall not (i) be disclosed to a third party or (ii) be used in any manner whatsoever, directly or indirectly, for a purpose other than the performance of the Services, subject to the prior consent of the party that provided the confidential information, which consent shall not be unreasonably withheld.

15. DISPUTE RESOLUTION

15.1 **Negotiations**. In the event of a dispute between the parties regarding the Agreement, the parties shall use all reasonable efforts to resolve the dispute amicably. The parties agree to openly disclose all relevant information and provide all relevant documents within the prescribed time periods without prejudice to the rights and remedies available to them.

15.2 **Unresolved Dispute**. If, after negotiations, a dispute remains unresolved, either party may bring it before the courts or, by mutual agreement, refer it to another dispute resolution process, including mediation or binding arbitration.

16. NOTICES

16.1 **Notices**. Notices shall be given in writing at the party's address indicated in the Agreement. Notices may be delivered in person or by courier or sent by facsimile or electronic mail.

17. SURVIVAL OF PROVISIONS

17.1 **Survival of Provisions**. In addition to the provisions of the Agreement that, by their very nature, shall continue in full force and effect after the termination or expiry of the Agreement, the following sections shall continue in full force and effect after the termination or expiry of the Agreement: Section 6 *Ownership of Deliverables and Intellectual Property Rights*, Section 8 *Liability and Indemnification*, Section 9 *Limitation of Liability*, Section 14 *Confidentiality*, Section 15 *Dispute Resolution*, and Section 18 *Governing Laws*.

18. GOVERNING LAWS

18.1 **Governing Laws and Jurisdiction**. The Agreement shall be governed by and construed in accordance with the laws of the province in which the Project is carried out. The parties agree, subject to Section 15 *Dispute Resolution*, to accept and attorn to the exclusive jurisdiction of the courts of the province in which the Project is carried out.

18.2 **Venue**. The parties hereby waive any objection based on the venue or the doctrine of *forum non conveniens* in respect of Claims resulting from the Agreement or in any way associated with or related to the Client's and WSP's business in respect to the Agreement or related operations, whether they exist on the date hereof or arise thereafter and whether they arise out of contractual, tort or civil liability or out of the application of any other legal system or specific law.

19. GENERAL PROVISIONS

19.1 **Legally Binding Agreement**. Before the performance of the Services commences, the parties will attempt to negotiate in good faith a services agreement (the "**Services Agreement**") containing terms and conditions substantially equivalent to the General Terms and Conditions. If a Services Agreement is entered into between WSP and the Client, it shall constitute the sole legally binding agreement binding them with respect to the performance of the Services. If WSP and the Client do not enter into a Services Agreement, they agree to be bound by the General Terms and Conditions, which, in such an event, shall be the sole legally binding agreement binding them with respect to the performance of the Services.

19.2 **Assignment**. No party may assign the Agreement without the prior written consent of the other party, which consent may not be unreasonably withheld. Notwithstanding the foregoing, WSP may assign the Agreement, without the Client's consent, to any of its Affiliates or to a third party that amalgamates with WSP or acquires all or substantially all of WSP's assets. Subject to the foregoing, the Agreement shall be binding upon, and enure to the benefit of, the parties and their respective successors and, as regards WSP, its assigns.

19.3 **Entire Agreement**. Subject to the provisions of Subsection 19.1 hereof, this Agreement constitutes the entire agreement between the parties and hereby cancels and replaces all previous agreements between the parties in respect of the Services.

19.4 **Changes**. No Change made to the Agreement shall be binding upon WSP and the Client unless it is made in writing and executed by the authorized representatives of the parties.

19.5 **No Waiver**. Any failure by any party to demand compliance with any term, condition or directive or to exercise any right or privilege granted to it in the event of breach or default shall not constitute a waiver of such term, condition, right or privilege.

19.6 **Exclusions**. Unless expressly indicated otherwise in the Agreement, the requests for proposals, tender packages or other similar documents of the Client shall not form part of the Agreement.

END OF DOCUMENT

APPENDIX

B BOREHOLE LOCATIONS, FIELD LOGS & LAB TESTING

EXPLANATION NOTE ON SOUNDING LOGS

The following sounding logs summarize soils and rock geotechnical properties as well as ground water conditions, as collected during field work and/or obtained from laboratory tests. This note explains the different symbols and abbreviations used in these logs.

STRATIGRAPHIC UNITS

Elevation/Depth: Reference to the geodesic elevation of the soil or to a bench mark of arbitrary elevation, at the location of the sounding. Depth of the different geological boundaries as measured from ground surface. On the left, the scale is in meters while on the right, it is in feet.

Description of the stratigraphic units: Every geological formation is detailed.

The proportion of the different elements of the soil, defined according to the size of the particles, is given following the classification hereafter. The relative compactness of cohesionless soils is defined by the "N" index of the Standard Penetration Test. The consistency of cohesive soils is defined by their shear resistance.

Classification	Particle size (mm)
Clay	< 0.002
Clay and silt (undifferentiated)	< 0.08
Sand	0.08 to 5
Gravel	5 to 80
Cobble	80 to 300
Boulder	> 300

Descriptive terminology	Proportion (%)
"Traces" (tr.)	1 to 10
"Some" (s.)	10 to 20
Adjective (ex.: sandy, silty)	20 to 35
"And" (ex.: sand and gravel)	35 to 50

Compactness of cohesionless soils	Standard Penetration Test index ("N" value), ASTM D-1586 (blows for a 300mm penetration)
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	> 50

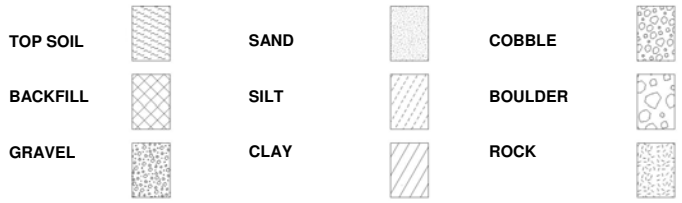
Consistency of cohesive soils	Undrained shear strength (kPa)
Very soft	< 12
Soft	12 to 25
Firm	25 to 50
Stiff	50 to 100
Very stiff	100 to 200
Hard	> 200

Plasticity of cohesive soils	Liquid limit (%)
Low	< 30
Medium	30 to 50
High	> 50

Sensitivity of cohesive soils	$S_t = (C_u/C_{ur})$
Low	$S_t < 2$
Medium	$2 < S_t < 4$
High	$4 < S_t < 8$
Extra-sensitive	$8 < S_t < 16$
Quick (sensitive) clay	$S_t > 16$

Classification of rock	RQD (%)
Very poor quality	< 25
Poor quality	25 to 50
Fair quality	50 to 75
Good quality	75 to 90
Excellent quality	90 to 100

SYMBOLS



WATER LEVEL

This column shows the ground water level, as measured at a given time during the geotechnical investigation. The details of the installation (type and depth) are also illustrated in this column.

SAMPLES

Type and number: Each sample is labelled in accordance with the number of this column and the given notation refers to samples types.

Sub-sample: When a sample contains two or more different stratigraphic units, it is sometimes necessary to separate it and create sub-samples. This column allows for the identification of the latter and the association to *in situ* or laboratory measurements to these sub-samples.

Condition: The position, length and condition of each sample are shown in this column. The symbol shows the condition of the sample, following the legend given on the sounding log.

Size: This column indicates the split spoon sampler size.

"N" index The standard penetration index shown in this column is expressed with the letter "N". This index is obtained with the Standard Penetration Test. It corresponds to the number of blows required to drive the last 300mm of the split spoon, using a 622 Newton hammer falling freely from a height of 762mm (ASTM D-1586). For a 610mm long split spoon, the "N" index is obtained by adding the number of blows required for the driving of the 2nd and 3rd 150mm of the split spoon. Refusal (R) indicates a number of blows greater than 100. A set of numbers such as 28-30-50/60mm indicates that the number of blows required to drive the 1st and 2nd 150mm of the split spoon are respectively 28 and 30. Moreover, it indicates that 50 blows were necessary to get a penetration of 60mm, whereupon the test was suspended.

RQD index: Rock Quality Designation index: This index is defined as the ratio between the total length of all rock cores of 100mm and more in length over the total length of the core run. The RQD index is an indirect measurement of the number of "natural" fractures and of the amount of the alteration in a rock mass.

TESTS

Results: This column shows, for the corresponding depth, the results of tests carried out in the field or in the laboratory (shear strength, dynamic penetration, Atterberg limits with the cone, etc.). For more information, please refer to the legend in the upper part of the sounding log. However, an abbreviation indicating the type of analysis performed is shown next to the sample tested.

Graph: This graph shows the undrained shear strength resistance of cohesive soils, as measured *in situ* or in the laboratory (NQ 2501-200). It is also used to present the Dynamic Cone Penetration Test (NQ 2501-145) results.

Moreover, this graph is used for the representation of the water content and Atterberg limits test results.

Client :

PUBLIC WORKS & GOVERNMENT SERVICES CANADA

BOREHOLE REPORT

File n°: **B-0008257-1(E)**
Borehole n°: **BH-01-14**
Date: **2014-01-21**

Project: **Geotechnical Investigation - Block 1A**

Location: **530 Tremblay Road, Ottawa, On**

Coordinates (m): North 5031366,7 (Y)
East 372342,5 (X)
Geodetic Elevation **68,14 (Z)**
Bedrock: 4,04 m End depth: 22,33 m

Sample condition
Intact | Remoulded | Lost | Core

Organoleptic soil examination:
Visual aspect: Non-existent(N); Disseminated(D); Soaked(S)
Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

Sample type

SS	Split Spoon
TM	Thin wall Tube
PS	Piston Tube
RC	Rock core
AS	Auger
MA	Bulk sample
TU	Transparent tube
PW	LVM Mega-Sampler
FG	Frozen ground

Tests

L	Consistency Limits
W_L	Liquid Limit (%)
W_P	Plastic Limit (%)
I_P	Plasticity Index (%)
I_L	Liquidity Index
W	Natural Water Content (%)
GS	Grain Size Analysis
S	Hydrometer analysis
R	Refusal
VBS	Methylene Blue Value
WR	Weight of Rods
O.M.	Organic Matter (%)
K	Permeability (cm/s)
UW	Unit Weight (kN/m³)
A	Absorption (l/min. m)
U	Uniaxial Compressive strength (MPa)
RQD	Rock Quality Designation (%)
CA	Chemical Analysis
P_L	Limit Pressure (kPa)
E_M	Pressuremeter Modulus (MPa)
E_r	Modulus of subgrade reaction (MPa)
SP_O	Segregation Potential (mm²/H °C)
▼	Water Level
N	Std Penetration test (blows/300mm)
N_C	Dyn. Penetration test (blows/300mm) ●
σ'_P	Preconsolidation Pressure (kPa)
SCI	Soil Corrosivity Index

Undrained shear strength (Field ▲ / Laboratory ■)
C_U Undisturbed (kPa)
C_{UR} Remoulded (kPa) (Field △ / Laboratory □)

DEPTH - ft	DEPTH - m	ELEVATION - m / DEPTH - m	SOIL OR BEDROCK DESCRIPTION	SYMBOLS	WATER LEVEL (m) / DATE	TYPE AND NUMBER	SUB-SAMPLE	CONDITION	SIZE	RECOVERY %	Blows/150mm	"N" or RQD	Organo. Exam: Odor	Organo. Exam: Visual	RESULTS
		68,14													
1-2	1	0,00	***Till:*** Brown sandy silt, moist, with some vegetation the surface, loose to compact (SM)			SS-1				8	1-3 5-3	8			
3-4	1	66,92				SS-2				29	2-3 2-2	5			GS W = 29.8
4-5-6	2	1,22	Grey sand with some silt, trace of gravel, moist, compact (SM)		el. 65,55 m 2014-02-11	SS-3				58	2-5 5-9	10			
7-8	2					SS-4				62	6-11 9-7	20			
9	3					SS-5				62	2-5 7-14	12			
10	3					SS-6				66	3-50 /8 cm	R			W = 7.3
11-12	3	64,48													
13	4	3,66 64,10	***Bedrock:*** Highly weathered and fractured mudstone			RC-7				40		0			
14-15-16	4-5	4,04	Dark brown mudstone, poor to very poor quality Angle of joints varying from 75° to 85°			RC-8				100		47			U = 79.6 MPa
17-18-19-20	5-6					RC-9				98		27			
21-22-23-24	6-7					RC-10				100		0			
25-26-27	8														
28	8	59,53													
29-30	9	8,61													U = 71.2 MPa Ei = 11.18 GPa

FIELD AND LABORATORY TESTS

NATURAL WATER CONTENT AND LIMITS (%)
Wp W WL
20 40 60 80 100 120

UNDRAINED SHEAR STRENGTH (kPa) OR DYNAMIC PENETRATION
20 40 60 80 100 120

Vertical Scale = 1 : 77

Remarks: Ground covered with snow
Ei : Elastic Modulus of Intact Rocks

Borehole type: **Tarière évidée et tubage NQ** Boring equipment: **CME-55**

Prepared by: **S. Séguin, tech.** | Approved by: **T. Lampron, Jr. Eng.** | 2014-05-09 | Page: 1 of 2

Client :

PUBLIC WORKS & GOVERNMENT SERVICES CANADA

BOREHOLE REPORT

File n°: **B-0008257-1(E)**
Borehole n°: **BH-01-14**
Date: **2014-01-21**

Project: **Geotechnical Investigation - Block 1A**

Location: **530 Tremblay Road, Ottawa, On**

Coordinates (m): North 5031366,7 (Y)
East 372342,5 (X)
Geodetic Elevation **68,14 (Z)**
Bedrock: 4,04 m End depth: 22,33 m

DEPTH - ft	DEPTH - m	STRATIGRAPHY: ELEVATION - m / DEPTH - m	SOIL OR BEDROCK DESCRIPTION	SYMBOLS	WATER LEVEL (m) / DATE	SAMPLES: TYPE AND NUMBER	SUB-SAMPLE	CONDITION	SIZE	RECOVERY %	Blows/150mm	"N" or RQD	Organo. Exam: Odor	Organo. Exam: Visual	FIELD AND LABORATORY TESTS: RESULTS	NATURAL WATER CONTENT AND LIMITS (%) Wp W WL 20 40 60 80 100 120 / UNDRAINED SHEAR STRENGTH (kPa) OR DYNAMIC PENETRATION 20 40 60 80 100 120
31			Quality varying from fair to excellent			RC-11				100		92			U= 71.2 MPa Ei= 11.18 GPa	
32																
33	10		Angle of joints varying from 15° to 85°													
34																
35																
36	11					RC-12				95		60				
37																
38																
39	12															
40																
41						RC-13				97		78				
42																
43	13															
44																
45																
46	14					RC-14				100		65				
47																
48																
49	15															
50																
51						RC-15				100		78				
52																
53	16															
54																
55																
56	17					RC-16				93		80				
57																
58																
59	18															
60																
61						RC-17				100		87				
62																
63	19															
64																
65																
66	20					RC-18				93		45				
67																
68																
69	21															
70																
71						RC-19				100		80				
72	22															
73		45,91														
74		22,33	End of borehole													

Remarks: Ground covered with snow
Ei : Elastic Modulus of Intact Rocks

Borehole type: **Tarière évidée et tubage NQ** Boring equipment: **CME-55**

Prepared by: **S. Séguin, tech.**	Approved by: **T. Lampron, Jr. Eng.**	2014-05-09	Page: 2 of 2

Vertical Scale = 1 : 77

Client :

PUBLIC WORKS & GOVERNMENT SERVICES CANADA

BOREHOLE REPORT

File n°: **B-0008257-1(E)**
Borehole n°: **BH-02-14**
Date: **2014-01-22**

Project: **Geotechnical Investigation - Block 1A**

Location: **530 Tremblay Road, Ottawa, On**

Coordinates (m): North 5031329,5 (Y)
East 372351,2 (X)
Geodetic Elevation **67,68 (Z)**
Bedrock: 3,61 m End depth: 10,24 m

Sample condition
Intact | Remoulded | Lost | Core

Organoleptic soil examination:
Visual aspect: Non-existent(N); Disseminated(D); Soaked(S)
Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

Sample type

SS	Split Spoon
TM	Thin wall Tube
PS	Piston Tube
RC	Rock core
AS	Auger
MA	Bulk sample
TU	Transparent tube
PW	LVM Mega-Sampler
FG	Frozen ground

Tests

L	Consistency Limits	O.M.	Organic Matter (%)		Water Level
W_L	Liquid Limit (%)	K	Permeability (cm/s)	N	Std Penetration test (blows/300mm)
W_P	Plastic Limit (%)	UW	Unit Weight (kN/m³)	N_C	Dyn. Penetration test (blows/300mm) ●
I_P	Plasticity Index (%)	A	Absorption (l/min. m)	σ'_P	Preconsolidation Pressure (kPa)
I_L	Liquidity Index	U	Uniaxial Compressive strength (MPa)	SCI	Soil Corrosivity Index
W	Natural Water Content (%)	RQD	Rock Quality Designation (%)		
GS	Grain Size Analysis	CA	Chemical Analysis		Undrained shear strength (Field ▲ / Laboratory ■)
S	Hydrometer analysis	P_L	Limit Pressure (kPa)	C_U	Undisturbed (kPa)
R	Refusal	E_M	Pressuremeter Modulus (MPa)	C_{UR}	Remoulded (kPa)
VBS	Methylene Blue Value	E_r	Modulus of subgrade reaction (MPa)		
WR	Weight of Rods	SP_O	Segregation Potential (mm²/H °C)		

DEPTH - ft	DEPTH - m	ELEVATION - m / DEPTH - m	SOIL OR BEDROCK DESCRIPTION	SYMBOLS	WATER LEVEL (m) / DATE	TYPE AND NUMBER	SUB-SAMPLE	CONDITION	SIZE	RECOVERY %	Blows/150mm	"N" or RQD	Organo. Exam: Odor	Organo. Exam: Visual	RESULTS
		67,68													
		0,00	No sampling due to standing water												
		67,07													
		0,61	***Till:*** Well graded brown sand with some silt traces of gravel, loose, saturated (SM)			SS-1				54	1-4 5-6	9			W = 21.3
		66,46													
		1,22	Well graded grey sand and gravel with some silt, compact, moist (SM)			SS-2				75	5-8 10-11	18			
						SS-3				62	5-7 7-7	14			
						SS-4				50	6-5 10-14	15			GS W = 9.5
		64,33				SS-5	A			80	10-40 50 /8	R			
		3,35	Fractured rock				B								
		64,07	***Bedrock :*** Highly fractured and weathered mudstone			RC-6				76		19			
		3,61													
		63,54													
		4,14	Angle of joint 80°												
			Poor quality, dark brown mudstone			RC-7				100		30			
			Angle of joints varying from 15° to 85°												
						RC-8				100		25			U = 37,0 MPa
		60,49													
		7,19	Quality ranging from fair to good												
			Angle of joints varying from 45° to 85°			RC-9				100		68			

FIELD AND LABORATORY TESTS — NATURAL WATER CONTENT AND LIMITS (%) Wp W WL — 20 40 60 80 100 120 — UNDRAINED SHEAR STRENGTH (kPa) OR DYNAMIC PENETRATION — 20 40 60 80 100 120

Vertical Scale = 1 : 75

Remarks: Standing water and muddy soil at the surface
Ei : Elastic Modulus of Intact Rocks

Borehole type: **Tarière évidée et tubage NQ** Boring equipment: **CME-55**

Prepared by: **S. Séguin, tech.** | Approved by: **T. Lampron, Jr. Eng.** | 2014-04-24 | Page: 1 of 2

Client :

PUBLIC WORKS & GOVERNMENT SERVICES CANADA

BOREHOLE REPORT

File n°: **B-0008257-1(E)**
Borehole n°: **BH-02-14**
Date: **2014-01-22**

Project: **Geotechnical Investigation - Block 1A**

Location: **530 Tremblay Road, Ottawa, On**

Coordinates (m): North 5031329,5 (Y)
East 372351,2 (X)
Geodetic Elevation **67,68 (Z)**
Bedrock: 3,61 m End depth: 10,24 m

DEPTH - ft	DEPTH - m	STRATIGRAPHY: ELEVATION - m / DEPTH - m	STRATIGRAPHY: SOIL OR BEDROCK DESCRIPTION	STRATIGRAPHY: SYMBOLS	WATER LEVEL (m) / DATE	SAMPLES: TYPE AND NUMBER	SAMPLES: SUB-SAMPLE	SAMPLES: CONDITION	SAMPLES: SIZE	SAMPLES: RECOVERY %	SAMPLES: Blows/150mm	SAMPLES: "N" or RQD	SAMPLES: Organo. Exam: Odor	SAMPLES: Organo. Exam: Visual	FIELD AND LABORATORY TESTS: RESULTS	FIELD AND LABORATORY TESTS: NATURAL WATER CONTENT AND LIMITS (%) Wp W WL; 20 40 60 80 100 120 / UNDRAINED SHEAR STRENGTH (kPa) OR DYNAMIC PENETRATION; 20 40 60 80 100 120
30																
31																
32																
33	10	57,44				RC-10				100		80			U = 10,0 MPa E_i = 1,49 GPa	
34		**10,24**	End of borehole													
35																
36	11															
37																
38																
39	12															
40																
41																
42																
43	13															
44																
45																
46	14															
47																
48																
49	15															
50																
51																
52																
53	16															
54																
55																
56	17															
57																
58																
59	18															
60																
61																
62																
63	19															
64																
65																
66	20															
67																
68																
69	21															
70																
71																
72	22															

Vertical Scale = 1 : 75

Remarks: Standing water and muddy soil at the surface
Ei : Elastic Modulus of Intact Rocks

Borehole type: **Tarière évidée et tubage NQ** Boring equipment: **CME-55**

Prepared by: **S. Séguin, tech.**	Approved by: **T. Lampron, Jr. Eng.**	2014-04-24	Page: 2 of 2

Client :

PUBLIC WORKS & GOVERNMENT SERVICES CANADA

BOREHOLE REPORT

File n°: **B-0008257-1(E)**
Borehole n°: **BH-03-14**
Date: **2014-01-17**

Project: **Geotechnical Investigation - Block 1A**

Location: **530 Tremblay Road, Ottawa, On**

Coordinates (m): North 5031275,1 (Y)
East 372432,3 (X)
Geodetic Elevation **68,02 (Z)**
Bedrock: 4,75 m End depth: 15,42 m

Sample condition
Intact | Remoulded | Lost | Core

Organoleptic soil examination:
Visual aspect: Non-existent(N); Disseminated(D); Soaked(S)
Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

Sample type

SS	Split Spoon
TM	Thin wall Tube
PS	Piston Tube
RC	Rock core
AS	Auger
MA	Bulk sample
TU	Transparent tube
PW	LVM Mega-Sampler
FG	Frozen ground

Tests

L	Consistency Limits
W_L	Liquid Limit (%)
W_P	Plastic Limit (%)
I_P	Plasticity Index (%)
I_L	Liquidity Index
W	Natural Water Content (%)
GS	Grain Size Analysis
S	Hydrometer analysis
R	Refusal
VBS	Methylene Blue Value
WR	Weight of Rods
O.M.	Organic Matter (%)
K	Permeability (cm/s)
UW	Unit Weight (kN/m³)
A	Absorption (l/min. m)
U	Uniaxial Compressive strength (MPa)
RQD	Rock Quality Designation (%)
CA	Chemical Analysis
P_L	Limit Pressure (kPa)
E_M	Pressuremeter Modulus (MPa)
E_r	Modulus of subgrade reaction (MPa)
SP_O	Segregation Potential (mm²/H °C)
	Water Level
N	Std Penetration test (blows/300mm)
N_C	Dyn. Penetration test (blows/300mm) ●
σ'_P	Preconsolidation Pressure (kPa)
SCI	Soil Corrosivity Index

Undrained shear strength (Field ▲ / Laboratory ■)
C_U Undisturbed (kPa)
C_{UR} Remoulded (kPa) (△ / □)

DEPTH - ft	DEPTH - m	ELEVATION - m / DEPTH - m	SOIL OR BEDROCK DESCRIPTION	SYMBOLS	WATER LEVEL (m) / DATE	TYPE AND NUMBER	SUB-SAMPLE	CONDITION	SIZE	RECOVERY %	Blows/150mm	"N" or RQD	Organo. Exam: Odor	Organo. Exam: Visual	RESULTS
		68,02													
1		0,00	***Till :*** Grey silty sand with traces of gravel, saturated, with vegetation near the surface, very loose to compact (SM)		el. 67,04 m 2014-02-11	SS-1				8	0-0 1-0	1			
2															
3	1					SS-2				50	1-0 1-2	1			W = 17.5
4															
5						SS-3				42	4-2 1-4	3			
6															
7	2					SS-4				42	1-2 3-7	5			
8															
9						SS-5				33	1-3 9-7	12			
10	3														
11						SS-6				38	3-4 6-23	10			
12		64,36 3,66													
13	4		Very dense, poorly graded sand and silt with some gravel, moist (SM)			SS-7				72	16-17 36-50 /15 cm	53			GS W = 10.6
14		63,63													
15		4,39 63,27	No recovery			RC-8				0		0			
16	5	4,75	***Bedrock :*** Dark brown mudstone, poor to fair quality												
17															
18						RC-9				93		58			U = 97,3 MPa Pyrite = 1.63%
19															
20	6														
21															
22															
23	7					RC-10				100		60			
24															
25															
26	8														
27						RC-11				98		40			Pyrite = 1.76%
28															
29															

FIELD AND LABORATORY TESTS
NATURAL WATER CONTENT AND LIMITS (%) — Wp W WL — 20 40 60 80 100 120
UNDRAINED SHEAR STRENGTH (kPa) OR DYNAMIC PENETRATION — 20 40 60 80 100 120

Vertical Scale = 1 : 75

Remarks: Ground covered with snow

Borehole type: **Tarière évidée et tubage NQ** Boring equipment: **CME-55**

Prepared by: **S. Séguin, tech.** | Approved by: **T. Lampron, Jr. Eng.** | 2014-05-09 | Page: 1 of 2

Client :

PUBLIC WORKS & GOVERNMENT SERVICES CANADA

BOREHOLE REPORT

File n°: **B-0008257-1(E)**
Borehole n°: **BH-03-14**
Date: **2014-01-17**

Project: **Geotechnical Investigation - Block 1A**

Location: **530 Tremblay Road, Ottawa, On**

Coordinates (m): North 5031275,1 (Y)
East 372432,3 (X)
Geodetic Elevation **68,02 (Z)**
Bedrock: 4,75 m End depth: 15,42 m

DEPTH - ft	DEPTH - m	STRATIGRAPHY: ELEVATION - m / DEPTH - m	STRATIGRAPHY: SOIL OR BEDROCK DESCRIPTION	STRATIGRAPHY: SYMBOLS	WATER LEVEL (m) / DATE	SAMPLES: TYPE AND NUMBER	SAMPLES: SUB-SAMPLE	SAMPLES: CONDITION	SAMPLES: SIZE	SAMPLES: RECOVERY %	SAMPLES: Blows/150mm	SAMPLES: "N" or RQD	SAMPLES: Organo. Exam: Odor	SAMPLES: Organo. Exam: Visual	FIELD AND LABORATORY TESTS: RESULTS
30	10					RC-12				97		42			
35	11														
40	12					RC-13				98		70			Pyrite = 1.79%
45	13					RC-14				100		68			
50	14														
55	15					RC-15				100		57			
		52,60													
51		15,42	End of borehole												
60	16														
65	17														
70	18														
75	19														
80	20														
85	21														
90	22														

FIELD AND LABORATORY TESTS

NATURAL WATER CONTENT AND LIMITS (%)
Wp W WL
20 40 60 80 100 120

UNDRAINED SHEAR STRENGTH (kPa) OR DYNAMIC PENETRATION
20 40 60 80 100 120

Remarks: Ground covered with snow

Borehole type: **Tarière évidée et tubage NQ** Boring equipment: **CME-55**

Prepared by: **S. Séguin, tech.**	Approved by: **T. Lampron, Jr. Eng.**	2014-05-09	Page: 2 of 2

Client :

PUBLIC WORKS & GOVERNMENT SERVICES CANADA

BOREHOLE REPORT

File n°: **B-0008257-1(E)**
Borehole n°: **BH-04-14**
Date: **2014-01-20**

Project: **Geotechnical Investigation - Block 1A**

Location: **530 Tremblay Road, Ottawa, On**

Coordinates (m): North 5031328,6 (Y)
East 372431,2 (X)
Geodetic Elevation **67,75 (Z)**
Bedrock: 4,09 m End depth: 16,23 m

Sample condition
Intact | Remoulded | Lost | Core

Organoleptic soil examination:
Visual aspect: Non-existent(N); Disseminated(D); Soaked(S)
Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

Sample type

SS	Split Spoon
TM	Thin wall Tube
PS	Piston Tube
RC	Rock core
AS	Auger
MA	Bulk sample
TU	Transparent tube
PW	LVM Mega-Sampler
FG	Frozen ground

Tests

L	Consistency Limits	O.M.	Organic Matter (%)
W_L	Liquid Limit (%)	K	Permeability (cm/s)
W_P	Plastic Limit (%)	UW	Unit Weight (kN/m³)
I_P	Plasticity Index (%)	A	Absorption (l/min. m)
I_L	Liquidity Index	U	Uniaxial Compressive strength (MPa)
W	Natural Water Content (%)	RQD	Rock Quality Designation (%)
GS	Grain Size Analysis	CA	Chemical Analysis
S	Hydrometer analysis	P_L	Limit Pressure (kPa)
R	Refusal	E_M	Pressuremeter Modulus (MPa)
VBS	Methylene Blue Value	E_r	Modulus of subgrade reaction (MPa)
WR	Weight of Rods	SP_O	Segregation Potential (mm²/H °C)

▼	Water Level
N	Std Penetration test (blows/300mm)
N_C	Dyn. Penetration test (blows/300mm) ●
σ'_P	Preconsolidation Pressure (kPa)
SCI	Soil Corrosivity Index

Undrained shear strength (Field ▲ △ / Laboratory ■ □)
C_U Undisturbed (kPa)
C_{UR} Remoulded (kPa)

DEPTH - ft	DEPTH - m	ELEVATION - m / DEPTH - m	SOIL OR BEDROCK DESCRIPTION	SYMBOLS	WATER LEVEL (m) / DATE	TYPE AND NUMBER	SUB-SAMPLE	CONDITION	SIZE	RECOVERY %	Blows/150mm	"N" or RQD	Organo. Exam: Odor	Organo. Exam: Visual	RESULTS
		67,75													
1		0,00 / 67,65	Silt and organic material												
2		0,10 / 67,14	***Remblai hétérogène:*** Sable avec un peu de silt, des traces de gravier, humide			SS-1	A			42	1-2 7-9	9			
3	1	0,61 / 66,53	Sand with some gravel, traces of silt and concrete debris, moist				B								
4		1,22 / 65,92	Sand and gravel with traces of silt, moist. Presence of crushed stone.			SS-2				29	7-9 8-8	17			
5		1,83	***Till :*** Grey silty sand with some gravel, compact to very dense, moist			SS-3				46	6-8 50-28	58			GS W = 15.5
6	2					SS-4				50	3-3 7-17	10			
7						SS-5				50	3-8 10-11	18			W = 10.5
8						SS-6	A			83	5-3 50-50	53			
9						SS-7	B								
10	3														
11		64,30													
12		3,45	Fractured rock												
13	4	63,66													
14		4,09	***Bedrock :*** Dark brown mudstone, fair to good quality												
15															
16			Angle of joints varying from 60° to 85°			RC-8				91		68			
17	5														
18															
19															
20	6														
21						RC-9				100		83			
22															
23	7														
24															
25															
26	8					RC-10				95		72			U = 29,2 MPa
27															
28		59,14													
29		8,61													

FIELD AND LABORATORY TESTS
NATURAL WATER CONTENT AND LIMITS (%) — Wp W WL — 20 40 60 80 100 120
UNDRAINED SHEAR STRENGTH (kPa) OR DYNAMIC PENETRATION — 20 40 60 80 100 120

Vertical Scale = 1 : 75

Remarks: Ground covered with snow

Borehole type: **Tarière évidée et tubage NQ** Boring equipment: **CME-55**

Prepared by: **S. Séguin, tech.** | Approved by: **T. Lampron, Jr. Eng.** | 2014-04-24 | Page: 1 of 2

Client : **PUBLIC WORKS & GOVERNMENT SERVICES CANADA**

BOREHOLE REPORT

File n°: **B-0008257-1(E)**
Borehole n°: **BH-04-14**
Date: **2014-01-20**

Project: **Geotechnical Investigation - Block 1A**

Location: **530 Tremblay Road, Ottawa, On**

Coordinates (m): North 5031328,6 (Y)
East 372431,2 (X)
Geodetic Elevation **67,75 (Z)**
Bedrock: 4,09 m End depth: 16,23 m

DEPTH - ft	DEPTH - m	STRATIGRAPHY: ELEVATION - m / DEPTH - m	SOIL OR BEDROCK DESCRIPTION	SYMBOLS	WATER LEVEL (m) / DATE	SAMPLES: TYPE AND NUMBER	SUB-SAMPLE	CONDITION	SIZE	RECOVERY %	Blows/150mm	"N" or RQD	Organo. Exam: Odor	Organo. Exam: Visual	FIELD AND LABORATORY TESTS: RESULTS	NATURAL WATER CONTENT AND LIMITS (%) Wp W WL / UNDRAINED SHEAR STRENGTH (kPa) OR DYNAMIC PENETRATION
			Poor quality Angle of joints is 85°			RC-11				100		48				
		57,62 10,14	Quality varying from fair to good Angle of joints varying from 10° to 85°			RC-12				100		65			U = 25,3 MPa	
						RC-13				100		83				
						RC-14				100		83				
						RC-15				100		80				
		51,52 16,23	End of borehole													

Vertical Scale = 1 : 75

Remarks: Ground covered with snow

Borehole type: **Tarière évidée et tubage NQ** Boring equipment: **CME-55**

Prepared by: **S. Séguin, tech.**	Approved by: **T. Lampron, Jr. Eng.**	2014-04-24	Page: 2 of 2

Client :

PUBLIC WORKS & GOVERNMENT SERVICES CANADA

BOREHOLE REPORT

File n°: **B-0008257-1(E)**
Borehole n°: **BH-05-14**
Date: **2014-01-14**

Project: **Geotechnical Investigation - Block 1A**

Location: **530 Tremblay Road, Ottawa, On**

Coordinates (m): North 5031213,5 (Y)
East 372483,2 (X)
Géodésique Elevation **68,24 (Z)**
Bedrock: 4,47 m End depth: 10,74 m

Sample condition
Intact | Remoulded | Lost | Core

Organoleptic soil examination:
Visual aspect: Non-existent(N); Disseminated(D); Soaked(S)
Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

Sample type

SS	Split Spoon
TM	Thin wall Tube
PS	Piston Tube
RC	Rock core
AS	Auger
MA	Bulk sample
TU	Transparent tube
PW	LVM Mega-Sampler
FG	Frozen ground

Tests

L	Consistency Limits
W_L	Liquid Limit (%)
W_P	Plastic Limit (%)
I_P	Plasticity Index (%)
I_L	Liquidity Index
W	Natural Water Content (%)
GS	Grain Size Analysis
S	Hydrometer analysis
R	Refusal
VBS	Methylene Blue Value
WR	Weight of Rods
O.M.	Organic Matter (%)
K	Permeability (cm/s)
UW	Unit Weight (kN/m³)
A	Absorption (l/min. m)
U	Uniaxial Compressive strength (MPa)
RQD	Rock Quality Designation (%)
CA	Chemical Analysis
P_L	Limit Pressure (kPa)
E_M	Pressuremeter Modulus (MPa)
E_r	Modulus of subgrade reaction (MPa)
SP_O	Segregation Potential (mm²/H °C)
	Water Level
N	Std Penetration test (blows/300mm)
N_C	Dyn. Penetration test (blows/300mm) ●
σ'_P	Preconsolidation Pressure (kPa)
SCI	Soil Corrosivity Index

Undrained shear strength (Field ▲ △ / Laboratory ■ □)
C_U Undisturbed (kPa)
C_{UR} Remoulded (kPa)

DEPTH - ft	DEPTH - m	ELEVATION - m / DEPTH - m	SOIL OR BEDROCK DESCRIPTION	SYMBOLS	WATER LEVEL (m) / DATE	TYPE AND NUMBER	SUB-SAMPLE	CONDITION	SIZE	RECOVERY %	Blows/150mm	"N" or RQD	Organo. Exam: Odor	Organo. Exam: Visual	RESULTS
		68,24													
1		0,00	***Fill :*** Grey-brown silty sand with some gravel, moist (SM)			SS-1				54	3-7 7-11	14			
2						SS-2				62	10-16 18-10	34			
3	1	67,02 1,22	Silty clay, grey-green, with traces of sand			SS-3				50	2-2 3-5	5			
4		66,41													
5		1,83	Sand and silt, grey-black, with traces of gravel. Probable organic content (SM)			SS-4				21	3-5 6-9	11			W = 8.6
6						SS-5				58	12-8 4-42	12			
7	2					SS-6				67	6-5 8-9	13			
8		65,19 3,05	***Till :*** Well graded gravel with some sand and silt, compact, moist (SM)			SS-7				54	3-5 10-49	15			GS W = 7.3
9															
10	3														
11															
12		63,97 4,27	Rock fragment			SS-8				100	50 /13 cm	R			
13	4	63,85				RC-9				40		0			
14		4,39	***Bedrock :*** Dark-brown mudstone, quality varying from poor to fair												
15															
16	5		Angle of joints varying from 15° to 85°			RC-10				100		40			
17															
18															
19															
20	6														
21															
22															
23	7					RC-11				100		57			
24															
25															
26	8														
27						RC-12				97		65			U = 66,4 MPa E_i = 18,82 GPa
28															
29															

NATURAL WATER CONTENT AND LIMITS (%) — Wp W WL — 20 40 60 80 100 120
UNDRAINED SHEAR STRENGTH (kPa) OR DYNAMIC PENETRATION — 20 40 60 80 100 120

Vertical Scale = 1 : 75

Remarks: Sol recouvert de neige
Ei: module élastique des roches intactes

Borehole type: **Tarière évidée et tubage NQ** Boring equipment: **CME-55**

Prepared by: **S. Séguin, tech.** | Approved by: **T. Lampron, Jr. Eng.** | 2014-04-24 | Page: 1 of 2

Client : **PUBLIC WORKS & GOVERNMENT SERVICES CANADA**

BOREHOLE REPORT

File n°: **B-0008257-1(E)**
Borehole n°: **BH-05-14**
Date: **2014-01-14**

Project: **Geotechnical Investigation - Block 1A**

Location: **530 Tremblay Road, Ottawa, On**

Coordinates (m): North 5031213,5 (Y)
East 372483,2 (X)
Géodésique Elevation **68,24 (Z)**
Bedrock: 4,47 m End depth: 10,74 m

DEPTH - ft	DEPTH - m	STRATIGRAPHY: ELEVATION - m / DEPTH - m	STRATIGRAPHY: SOIL OR BEDROCK DESCRIPTION	STRATIGRAPHY: SYMBOLS	WATER LEVEL (m) / DATE	SAMPLES: TYPE AND NUMBER	SUB-SAMPLE	CONDITION	SIZE	RECOVERY %	Blows/150mm	"N" or RQD	Organo. Exam: Odor	Organo. Exam: Visual	FIELD AND LABORATORY TESTS: RESULTS	NATURAL WATER CONTENT AND LIMITS (%) Wp W WL 20 40 60 80 100 120 / UNDRAINED SHEAR STRENGTH (kPa) OR DYNAMIC PENETRATION 20 40 60 80 100 120
		59,02														
		9,22	Dark-brown mudstone, good quality Angle of joints varying from 15° to 85°			RC-13				100		87				
		57,50														
		10,74	End of borehole													

Vertical Scale = 1 : 75

Remarks: Sol recouvert de neige
Ei: module élastique des roches intactes

Borehole type: **Tarière évidée et tubage NQ** Boring equipment: **CME-55**

Prepared by: **S. Séguin, tech.**	Approved by: **T. Lampron, Jr. Eng.**	2014-04-24	Page: 2 of 2

Client :

PUBLIC WORKS & GOVERNMENT SERVICES CANADA

BOREHOLE REPORT

File n°: **B-0008257-1(E)**
Borehole n°: **BH-06-14**
Date: **2014-01-15**

Project: **Geotechnical Investigation - Block 1A**

Location: **530 Tremblay Road, Ottawa, On**

Coordinates (m): North 5031208,1 (Y)
East 372404,0 (X)
Geodetic Elevation **68,06 (Z)**
Bedrock: 4,27 m End depth: 21,16 m

Sample condition
Intact | Remoulded | Lost | Core

Organoleptic soil examination:
Visual aspect: Non-existent(N); Disseminated(D); Soaked(S)
Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

Sample type

SS	Split Spoon
TM	Thin wall Tube
PS	Piston Tube
RC	Rock core
AS	Auger
MA	Bulk sample
TU	Transparent tube
PW	LVM Mega-Sampler
FG	Frozen ground

Tests

L	Consistency Limits
W_L	Liquid Limit (%)
W_P	Plastic Limit (%)
I_P	Plasticity Index (%)
I_L	Liquidity Index
W	Natural Water Content (%)
GS	Grain Size Analysis
S	Hydrometer analysis
R	Refusal
VBS	Methylene Blue Value
WR	Weight of Rods
O.M.	Organic Matter (%)
K	Permeability (cm/s)
UW	Unit Weight (kN/m³)
A	Absorption (l/min. m)
U	Uniaxial Compressive strength (MPa)
RQD	Rock Quality Designation (%)
CA	Chemical Analysis
P_L	Limit Pressure (kPa)
E_M	Pressuremeter Modulus (MPa)
E_r	Modulus of subgrade reaction (MPa)
SP_O	Segregation Potential (mm²/H °C)
	Water Level
N	Std Penetration test (blows/300mm)
N_C	Dyn. Penetration test (blows/300mm) ●
σ'_P	Preconsolidation Pressure (kPa)
SCI	Soil Corrosivity Index

Undrained shear strength (Field ▲ / Laboratory ■)
C_U Undisturbed (kPa)
C_{UR} Remoulded (kPa) (Field △ / Laboratory □)

DEPTH - ft	DEPTH - m	ELEVATION - m / DEPTH - m	SOIL OR BEDROCK DESCRIPTION	SYMBOLS	WATER LEVEL (m) / DATE	TYPE AND NUMBER	SUB-SAMPLE	CONDITION	SIZE	RECOVERY %	Blows/150mm	"N" or RQD	Organo. Exam: Odor	Organo. Exam: Visual	RESULTS
		68,06													
1-2	1	0,00	***Till :*** Well graded grey sand and silt with traces of gravel , moist, with organic soils at the surface, very loose to loose (SM)		el. 67,24 m 2014-02-11	SS-1				42	2-2 5-6	7			
3-4						SS-2				46	2-4 2-3	6			
5-6						SS-3				38	0-0 1-12	1			W = 14.3
7-8	2	65,62				SS-4				67	1-3 4-3	7			
		2,44	Well graded sand and silt with some gravel, grey, loose to very dense, moist			SS-5				8	1-1 3-6	4			
9-10	3					SS-6				50	1-7 12-17	19			GS
11-12						SS-7				56	14-47 50 /10 cm	R			W = 8.1
13-14	4	63,79													
		4,27	Rock fragment			RC-8				84		47			
		63,31													
15-16	5	4,75	Angle of joints varying from 30° to 85°												
17-18			***Bedrock :*** Dark-brown mudstone, quality varying from poor to good			RC-9				98		77			U = 100,9 MPa
19-20	6		Angle of joints varying from 15° to 85°												
21-22															
23-24	7					RC-10				100		32			
25-26															
27-28	8					RC-11				100		63			
29															

Vertical Scale = 1 : 75

Remarks: Ground covered with snow with water

Borehole type: **Tarière évidée et tubage NQ** Boring equipment: **CME-55**

Prepared by: **S. Séguin, tech.** | Approved by: **T. Lampron, Jr. Eng.** | 2014-04-24 | Page: 1 of 2

Client :

PUBLIC WORKS & GOVERNMENT SERVICES CANADA

BOREHOLE REPORT

File n°: **B-0008257-1(E)**
Borehole n°: **BH-06-14**
Date: **2014-01-15**

Project: **Geotechnical Investigation - Block 1A**

Location: **530 Tremblay Road, Ottawa, On**

Coordinates (m): North 5031208,1 (Y)
East 372404,0 (X)
Geodetic Elevation **68,06 (Z)**
Bedrock: 4,27 m End depth: 21,16 m

DEPTH - ft	DEPTH - m	ELEVATION - m / DEPTH - m	SOIL OR BEDROCK DESCRIPTION	SYMBOLS	WATER LEVEL (m) / DATE	TYPE AND NUMBER	SUB-SAMPLE	CONDITION	SIZE	RECOVERY %	Blows/150mm	"N" or RQD	Organo. Exam: Odor	Organo. Exam: Visual	RESULTS	FIELD AND LABORATORY TESTS: NATURAL WATER CONTENT AND LIMITS (%) Wp W WL; UNDRAINED SHEAR STRENGTH (kPa) OR DYNAMIC PENETRATION
		58,74														
		9,32	Dark-brown mudstone, quality varying from good to excellent Angle of joints varying from 15° to 85°			RC-12				98		75				
						RC-13				97		80				
						RC-14				100		85				
						RC-15				100		92				
						RC-16				97		82				
		51,12														
		16,94	Dark-brown mudstone, quality from fair to good Angle of joints varying from 45° to 85°			RC-17				100		53				
						RC-18				100		72				
						RC-19				100		70				
		46,90														
		21,16	End of borhole													

Vertical Scale = 1 : 75

Remarks: Ground covered with snow with water

Borehole type: **Tarière évidée et tubage NQ** Boring equipment: **CME-55**

Prepared by: **S. Séguin, tech.**	Approved by: **T. Lampron, Jr. Eng.**	2014-04-24	Page: 2 of 2

Client :

PUBLIC WORKS & GOVERNMENT SERVICES CANADA

BOREHOLE REPORT

File n°: **B-0008257-1(E)**
Borehole n°: **BH-07-14**
Date: **2014-01-16**

Project: **Geotechnical Investigation - Block 1A**

Location: **530 Tremblay Road, Ottawa, On**

Coordinates (m): North 5031285,3 (Y)
East 372368,7 (X)
Geodetic Elevation **67,90 (Z)**
Bedrock: 4,17 m End depth: 16,89 m

Sample condition
Intact | Remoulded | Lost | Core

Organoleptic soil examination:
Visual aspect: Non-existent(N); Disseminated(D); Soaked(S)
Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

Sample type

SS	Split Spoon
TM	Thin wall Tube
PS	Piston Tube
RC	Rock core
AS	Auger
MA	Bulk sample
TU	Transparent tube
PW	LVM Mega-Sampler
FG	Frozen ground

Tests

L	Consistency Limits
W_L	Liquid Limit (%)
W_P	Plastic Limit (%)
I_P	Plasticity Index (%)
I_L	Liquidity Index
W	Natural Water Content (%)
GS	Grain Size Analysis
S	Hydrometer analysis
R	Refusal
VBS	Methylene Blue Value
WR	Weight of Rods
O.M.	Organic Matter (%)
K	Permeability (cm/s)
UW	Unit Weight (kN/m³)
A	Absorption (l/min. m)
U	Uniaxial Compressive strength (MPa)
RQD	Rock Quality Designation (%)
CA	Chemical Analysis
P_L	Limit Pressure (kPa)
E_M	Pressuremeter Modulus (MPa)
E_r	Modulus of subgrade reaction (MPa)
SP_O	Segregation Potential (mm²/H °C)
	Water Level
N	Std Penetration test (blows/300mm)
N_C	Dyn. Penetration test (blows/300mm) ●
σ'_P	Preconsolidation Pressure (kPa)
SCI	Soil Corrosivity Index

Undrained shear strength (Field ▲ / Laboratory ■)
C_U Undisturbed (kPa)
C_{UR} Remoulded (kPa) (Field △ / Laboratory □)

DEPTH - ft	DEPTH - m	ELEVATION - m / DEPTH - m	SOIL OR BEDROCK DESCRIPTION	SYMBOLS	WATER LEVEL (m) / DATE	TYPE AND NUMBER	SUB-SAMPLE	CONDITION	SIZE	RECOVERY %	Blows/150mm	"N" or RQD	Organo. Exam: Odor	Organo. Exam: Visual	RESULTS
		67,90													
1-2	1	0,00	***Till :*** Well graded sand and silt, moist, with organic soils at the surface, compact (SM)			SS-1				67	6-11 11-7	22			
		67,29													
3		0,61	Gravelly sand with some silt,			SS-2				46	3-5 6-7	11			
4	1	66,68	compact, saturated (SM)												
		1,22	Sand with some silt and gravel,			SS-3				54	1-5 9-12	14			
5		66,07	compact, saturated (SM)												
6		1,83	Gravelly sand with some silt,			SS-4				38	3-4 7-8	11			W = 49.1
7	2		compact to very dense, moist (SM)												
8						SS-5				62	3-4 7-11	11			
9															
10	3					SS-6				75	2-13 21-21	34			
11															
12						SS-7				80	50 /13 cm	R			GS W = 9.2
13	4	63,74													
14		4,17	Rock fragments			RC-8				71		0			
15		63,20	Angle of joints 85°												
16		4,70	***Bedrock :*** Dark-brown mudstone, quality varying from very poor to												
17	5		poor												
18						RC-9				93		72			
19			Angle of joints varying from 70° to												
20	6		85°												
21															
22															
23	7					RC-10				100		73			U = 91.6 MPa
24															
25		60,08													
26	8	7,82	Dark-brown mudstone, quality												
27			varying from fair to good												
28			Angle of joints varying from 45° to			RC-11				100		78			
29			85°												

Vertical Scale = 1 : 75

NATURAL WATER CONTENT AND LIMITS (%) — Wp W WL — 20 40 60 80 100 120
UNDRAINED SHEAR STRENGTH (kPa) OR DYNAMIC PENETRATION — 20 40 60 80 100 120

Remarks: Ground covered with snow

Borehole type: **Tarière évidée et tubage NQ** Boring equipment: **CME-55**

Prepared by: **S. Séguin, tech.** | Approved by: **T. Lampron, Jr. Eng.** | 2014-04-24 | Page: 1 of 2

Client :

PUBLIC WORKS & GOVERNMENT SERVICES CANADA

BOREHOLE REPORT

File n°: **B-0008257-1(E)**
Borehole n°: **BH-07-14**
Date: **2014-01-16**

Project: **Geotechnical Investigation - Block 1A**

Location: **530 Tremblay Road, Ottawa, On**

Coordinates (m): North 5031285,3 (Y)
East 372368,7 (X)
Geodetic Elevation **67,90 (Z)**
Bedrock: 4,17 m End depth: 16,89 m

DEPTH - ft	DEPTH - m	STRATIGRAPHY: ELEVATION - m / DEPTH - m	SOIL OR BEDROCK DESCRIPTION	SYMBOLS	WATER LEVEL (m) / DATE	SAMPLES: TYPE AND NUMBER	SUB-SAMPLE	CONDITION	SIZE	RECOVERY %	Blows/150mm	"N" or RQD	Organo. Exam: Odor	Organo. Exam: Visual	FIELD AND LABORATORY TESTS: RESULTS	NATURAL WATER CONTENT AND LIMITS (%) Wp W WL 20 40 60 80 100 120 / UNDRAINED SHEAR STRENGTH (kPa) OR DYNAMIC PENETRATION 20 40 60 80 100 120
30																
31																
32																
33	10					RC-12				100		55				
34																
35																
36	11															
37																
38						RC-13				95		68				
39	12															
40																
41																
42																
43	13					RC-14				100		45				
44																
45																
46	14															
47																
48						RC-15				100		45				
49	15															
50																
51																
52																
53	16					RC-16				100		63				
54																
55		51,01														
56	17	16,89	End of borehole													
57																
58																
59	18															
60																
61																
62	19															
63																
64																
65																
66	20															
67																
68																
69	21															
70																
71																
72	22															

Vertical Scale = 1 : 75

Remarks: Ground covered with snow

Borehole type: **Tarière évidée et tubage NQ** Boring equipment: **CME-55**

Prepared by: **S. Séguin, tech.**	Approved by: **T. Lampron, Jr. Eng.**	2014-04-24	Page: 2 of 2

Client :

PUBLIC WORKS & GOVERNMENT SERVICES CANADA

BOREHOLE REPORT

File n°: **B-0008257-1(E)**
Borehole n°: **BH-08-14**
Date: **2014-01-16**

Project: **Geotechnical Investigation - Block 1A**

Location: **530 Tremblay Road, Ottawa, On**

Coordinates (m): North 5031238,7 (Y)
East 372329,5 (X)
Geodetic Elevation **68,07 (Z)**
Bedrock: 4,17 m End depth: 10,87 m

Sample condition
Intact | Remoulded | Lost | Core

Organoleptic soil examination:
Visual aspect: Non-existent(N); Disseminated(D); Soaked(S)
Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

Sample type

SS	Split Spoon
TM	Thin wall Tube
PS	Piston Tube
RC	Rock core
AS	Auger
MA	Bulk sample
TU	Transparent tube
PW	LVM Mega-Sampler
FG	Frozen ground

Tests

L	Consistency Limits	O.M.	Organic Matter (%)		Water Level
W_L	Liquid Limit (%)	K	Permeability (cm/s)	N	Std Penetration test (blows/300mm)
W_P	Plastic Limit (%)	UW	Unit Weight (kN/m³)	N_C	Dyn. Penetration test (blows/300mm) ●
I_P	Plasticity Index (%)	A	Absorption (l/min. m)	σ'_P	Preconsolidation Pressure (kPa)
I_L	Liquidity Index	U	Uniaxial Compressive strength (MPa)	SCI	Soil Corrosivity Index
W	Natural Water Content (%)	RQD	Rock Quality Designation (%)		
GS	Grain Size Analysis	CA	Chemical Analysis		Undrained shear strength (Field / Laboratory)
S	Hydrometer analysis	P_L	Limit Pressure (kPa)	C_U	Undisturbed (kPa) ▲ ■
R	Refusal	E_M	Pressuremeter Modulus (MPa)	C_{UR}	Remoulded (kPa) △ □
VBS	Methylene Blue Value	E_r	Modulus of subgrade reaction (MPa)		
WR	Weight of Rods	SP_O	Segregation Potential (mm²/H °C)		

DEPTH - ft	DEPTH - m	ELEVATION - m / DEPTH - m	SOIL OR BEDROCK DESCRIPTION	SYMBOLS	WATER LEVEL (m) / DATE	TYPE AND NUMBER	SUB-SAMPLE	CONDITION	SIZE	RECOVERY %	Blows/150mm	"N" or RQD	Organo. Exam: Odor	Organo. Exam: Visual	RESULTS
		68,07													
1-		0,00	***Heterogeneous fill:*** Gravelly sand with some silt, traces of asphalt, with organic soils at the surface, compact (SM)			SS-1				67	6-11 11-7	22			
2-		67,46 0,61													
3-	1		***Till :*** Well graded sand and silt with traces of gravel, moist, compact to very dense (SM)			SS-2				46	3-5 6-7	11			
4-															
5-						SS-3				54	1-5 9-12	14			W = 9.5
6-															
7-	2					SS-4				38	3-4 7-8	11			
8-															
9-						SS-5				62	3-4 7-11	11			
10-	3														
11-						SS-6				75	2-13 21-21	34			GS W = 7.3
12-						SS-7				80	50 /13 cm	R			
13-	4	63,90													
14-		4,17	***Bedrock :*** Dark-brown mudstone, quality varying from poor to very poor Angle of joints varying from 15° to 85°			RC-8				92		33			
15-															
16-															
17-	5														
18-						RC-9				100		33			
19-															
20-	6														
21-															
22-															
23-	7					RC-10				100		12			
24-															
25-		60,25													
26-	8	7,82	Dark-brown mudstone, quality varying from fair to good Angle of joints varying from 75° to 85°			RC-11				100		65			
27-															
28-															
29-															

FIELD AND LABORATORY TESTS

NATURAL WATER CONTENT AND LIMITS (%) — Wp W WL — 20 40 60 80 100 120

UNDRAINED SHEAR STRENGTH (kPa) OR DYNAMIC PENETRATION — 20 40 60 80 100 120

Vertical Scale = 1 : 75

Remarks: Ground covered with snow
Ei : Elastic Modulus of Intact Rocks

Borehole type: **Tarière évidée et tubage NQ** Boring equipment: **CME-55**

Prepared by: **S. Séguin, tech.** | Approved by: **T. Lampron, Jr. Eng.** | 2014-04-24 | Page: 1 of 2

Client :

PUBLIC WORKS & GOVERNMENT SERVICES CANADA

BOREHOLE REPORT

File n°: **B-0008257-1(E)**
Borehole n°: **BH-08-14**
Date: **2014-01-16**

Project: **Geotechnical Investigation - Block 1A**

Location: **530 Tremblay Road, Ottawa, On**

Coordinates (m): North 5031238,7 (Y)
East 372329,5 (X)
Geodetic Elevation **68,07 (Z)**
Bedrock: 4,17 m End depth: 10,87 m

DEPTH - ft	DEPTH - m	STRATIGRAPHY: ELEVATION - m / DEPTH - m	SOIL OR BEDROCK DESCRIPTION	SYMBOLS	WATER LEVEL (m) / DATE	SAMPLES: TYPE AND NUMBER	SUB-SAMPLE	CONDITION	SIZE	RECOVERY %	Blows/150mm	"N" or RQD	Organo. Exam: Odor	Organo. Exam: Visual	FIELD AND LABORATORY TESTS: RESULTS	NATURAL WATER CONTENT AND LIMITS (%) Wp W WL 20 40 60 80 100 120 / UNDRAINED SHEAR STRENGTH (kPa) OR DYNAMIC PENETRATION 20 40 60 80 100 120
30																
31																
32	10															
33						RC-12				95		88			U = 56,7 MPa E_i = 10,33 GPa	
34																
35		57,20														
36	11	10,87	End of borehole													
37																
38																
39	12															
40																
41																
42																
43	13															
44																
45																
46	14															
47																
48																
49	15															
50																
51																
52																
53	16															
54																
55																
56	17															
57																
58																
59	18															
60																
61																
62																
63	19															
64																
65																
66	20															
67																
68																
69	21															
70																
71																
72	22															

Vertical Scale = 1 : 75

Remarks: Ground covered with snow
Ei : Elastic Modulus of Intact Rocks

Borehole type: **Tarière évidée et tubage NQ** Boring equipment: **CME-55**

Prepared by: **S. Séguin, tech.**	Approved by: **T. Lampron, Jr. Eng.**	2014-04-24	Page: 2 of 2

LVM

Calculs liés aux analyses chimiques

Date de l'analyse: 19 février 2014

Numéro de projet :	***B-0008257-1***
No échantillon :	***3***
Soufre total :	***0,88 %***
Sulfate hydrosoluble :	***0,038 %***

Masses Moléculaires

Soufre (S) = 32

Gypse ($CaSO_4 * 2H_2O$) = 172

Radical sulfate (SO_4) = 96

Pyrite ($Fe S_2$) = 120

Valeurs calculées

Pyrite initiale :	***1,6500%***
Gypse formé :	***0,0681%***
Soufre oxydé :	***0,01%***
Soufre résiduel :	***0,8673 %***
Taux d'oxydation :	***1,44%***
Pyrite résiduelle:	***1,63%***

Formules utilisée

(Soufre total X 120 / (2 X 32))

(172 X Sulfate hydrosoluble / 96)

(Gypse formé X 32 / 172)

(Soufre total - Soufre oxydé)

(Soufre oxydé / Soufre total)

(Soufre résiduel X 120 / (2 X 32))

Marcel Plourde, géo.
Chargé de projet

GÉOLOGUE / GEOLOGIST
MARCEL PLOURDE
1020
QUÉBEC

Imprimé le 19 février 2014

LVM

Calculs liés aux analyses chimiques

Date de l'analyse: 19 février 2014

Numéro de projet :	***B-0008257-1***
No échantillon :	***13***
Soufre total :	***0,95 %***
Sulfate hydrosoluble :	***0,036 %***

Masses Moléculaires

Soufre (S) = 32

Gypse ($CaSO_4 * 2H_2O$) = 172

Radical sulfate (SO_4) = 96

Pyrite ($Fe S_2$) = 120

Valeurs calculées

Pyrite initiale :	***1,7813%***
Gypse formé :	***0,0645%***
Soufre oxydé :	***0,01%***
Soufre résiduel :	***0,9380 %***
Taux d'oxydation :	***1,26%***
Pyrite résiduelle:	***1,76%***

Formules utilisée

(Soufre total X 120 / (2 X 32))

(172 X Sulfate hydrosoluble / 96)

(Gypse formé X 32 / 172)

(Soufre total - Soufre oxydé)

(Soufre oxydé / Soufre total)

(Soufre résiduel X 120 / (2 X 32))

Marcel Plourde, géo.
Chargé de projet

GÉOLOGUE / GÉOLOGIST
MARCEL PLOURDE
1020
QUÉBEC

Imprimé le 19 février 2014

LVM

Calculs liés aux analyses chimiques

Date de l'analyse: 19 février 2014

Numéro de projet :	***B-0008257-1***
No échantillon :	***26***
Soufre total :	***0,97 %***
Sulfate hydrosoluble :	***0,043 %***

Masses Moléculaires

Soufre (S) = 32

Gypse ($CaSO_4 * 2H_2O$) = 172

Radical sulfate (SO_4) = 96

Pyrite ($Fe S_2$) = 120

Valeurs calculées

Pyrite initiale :	***1,8188%***
Gypse formé :	***0,0770%***
Soufre oxydé :	***0,01%***
Soufre résiduel :	***0,9557 %***
Taux d'oxydation :	***1,48%***
Pyrite résiduelle:	***1,79%***

Formules utilisée

(Soufre total X 120 / (2 X 32))

(172 X Sulfate hydrosoluble / 96)

(Gypse formé X 32 / 172)

(Soufre total - Soufre oxydé)

(Soufre oxydé / Soufre total)

(Soufre résiduel X 120 / (2 X 32))

Marcel Plourde, géo.
Chargé de projet

GÉOLOGUE / GEOLOGIST
MARCEL PLOURDE # 1020
QUÉBEC

Imprimé le 19 février 2014

LVM

STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-01-14**

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-7																	
3.66	**4.04**	**0**	**40**		**64.48**	**64.10**											
3.66	4.04				64.48	64.10	Rock fragments								A-C <1 mm		
RC-8																	
4.04	**5.56**	**47**	**100**		**64.10**	**62.58**											
	4.29					63.85	Joint	1	85°	✓				7	A-C <1 mm		
	4.43					63.71	Joint	1	75°	✓				3	A-C <1 mm		
	4.52					63.62	Joint	1	80°	✓				3	A-C <1 mm		
	4.69					63.45	Joint	1	80°	✓				10	A-C <1 mm		
4.72	5.30				63.42	62.84	Rock fragments every 2 to 7 cm	1	80°	✓				8	A-C <1 mm		
	5.46					62.68	Joint	1	85°	✓				10	A-C <1 mm		
RC-9																	
5.56	**7.09**	**27**	**98**		62.58	61.05											
	5.62					62.52	Joint	1	75°	✓				8	A-C <1 mm		
	5.68					62.46	Joint	1	85°	✓				9	A-C <1 mm		
	5.72					62.42	Joint	1	75°	✓				9	A-C <1 mm		

REMARKS :

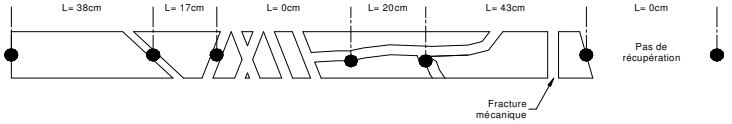
(X) C= Calcite
G= Graphite
I= Iron Oxyde
K= Chlorite
E= Epidote
B= Biotite
R= Rust
P= Pyrite
S= Clay gouge
A= Silt / Clay

(XX) w= White
p= Pink
g= Gray
v= Green
y= Yellow
b= Brown
r = Reddish
bl = Black

ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-24*	***Tommy Lampron, Jr Eng.***	*2014-01-24*

LVM

STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-01-14**

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-9																	
	5.80					62.34	Joint	1	75°	✓				3	A-C <1 mm		
	5.88					62.26	Joint	1	80°	✓				4	A-C <1 mm		
	5.90					62.24	Joint	1	80°	✓				6	A-C <1 mm		
	5.97					62.17	Joint	1	85°	✓				6	A-C <1 mm		
	6.00					62.14	Joint	1	85°	✓				5	A-C <1 mm		
6.00	6.16				62.14	61.98	Joint every 2 to 5 cm	1	80°	✓				6	A-C <1 mm		
	6.32					61.82	Joint	1	75°	✓				7	A-C <1 mm		
	6.38					61.76	Joint	1	85°	✓				2	A-C <1 mm		
	6.50					61.64	Joint	1	85°	✓				4	A-C <1 mm		
	6.69					61.45	Joint	1	75°	✓				8	A-C <1 mm		
	6.77					61.37	Joint	1	80°	✓				4	A-C <1 mm		
	6.82					61.32	Joint	1	85°	✓				6	A-C <1 mm		
	8.86					59.28	Joint	1	75°	✓				4	A-C <2 mm		
	7.00					61.14	Joint	1	80°	✓				5	A-C <1 mm		

REMARKS : From 6.06 to 6.19 m, petroleum odor

(X) C= Calcite
G= Graphite
I= Iron Oxyde
K= Chlorite
E= Epidote
B= Biotite
R= Rust
P= Pyrite
S= Clay gouge
A= Silt / Clay

(XX) w= White
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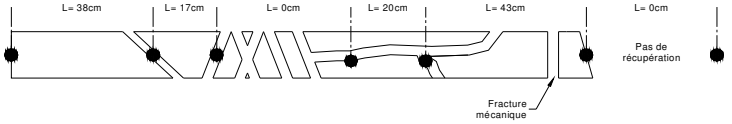
r = Reddish
bl = Black

ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-24*	***Tommy Lampron, Jr Eng.***	*2014-01-24*

LVM

STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-01-14**

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-10																	
7.09	**8.61**	**0**	**100**		61.05	59.53											
7.09	8.05				61.05	60.09	Joint every 2 to 7 cm	29	80-85	✓				8	A-C <1 mm		
	7.36					60.78	Joint	1	30°	✓				2	A-C <1 mm		
	8.24					59.90	Joint	1	20°	✓				2	A-C <1 mm		
	8.28					59.86	Joint	1	85°	✓				2	A-C <1 mm		
	8.30					59.84	Joint	1	85°	✓				6	A-C <1 mm		
	8.40					59.74	Joint	1	75°		✓			6	A-C <2mm		
	8.46					59.68	Joint	1	80°	✓				4	A-C <1 mm		
	8.54					59.60	Joint	1	85°	✓		✓		8	A-C <1 mm		
RC-11																	
8.61	**10.13**	**92**	**100**		59.53	58.01											
	8.64					59.50	Joint	1	85°	✓				3	A-C <1 mm		
	8.69					59.45	Joint	1	80°	✓				8	A-C <1 mm		
	8.80					59.34	Joint	1	75°	✓				11	A-C <1 mm		
	8.98					59.16	Joint	1	80°	✓				10	A-C <1 mm		
	9.00					59.14	Joint	1	85°	✓				5	A-C <1 mm		

REMARKS :

(X)
- G= Graphite
- I= Iron Oxyde
- K= Chlorite
- E= Epidote
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- R= Rust
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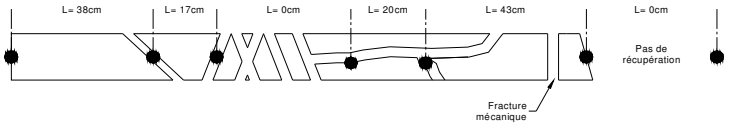
ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-27*	***Tommy Lampron, Jr Eng.***	*2014-01-27*

LVM

STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-01-14**

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-11																	
	9.20					58.94	Joint	1	80°	✓				4	A-C <1 mm		
	9.54					58.60	Joint	1	85°	✓				4	A-C <1 mm		
	9.57					58.57	Joint	1	85°	✓				5	A-C <1 mm		
RC-12																	
10.13	**11.66**	**60**	**95**		58.01	56.48											
	10.38					57.76	Joint	1	85°	✓				5	A-C <1 mm		
	10.52					57.62	Joint	1	85°	✓				7	A-C <1 mm		
	10.62					57.52	Joint	1	85°	✓		✓		14	A-C <1 mm		
	10.71					57.43	Joint	1	75°	✓				6	A-C <1 mm		
	10.79					57.35	Joint	1	60°	✓				4	A-C <1 mm		
	10.91					57.23	Joint	1	75°	✓			✓	14	A-C <1 mm		
	10.97					57.17	Joint	1	60°	✓			✓	10	A-C <1 mm		
	11.03					57.11	Joint	1	80°	✓			✓	11	A-C <1 mm		
	11.31					56.83	Joint	1	80°	✓				3	A-C <1 mm		
	11.35					56.79	Joint	1	85°	✓				8	A-C <1 mm		
	11.38					56.76	Joint	1	80°	✓				8	A-C <1 mm		

REMARKS :

(X)
- G= Graphite
- I= Iron Oxyde
- K= Chlorite
- E= Epidote
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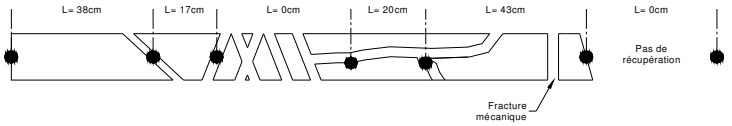
ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-27*	***Tommy Lampron, Jr Eng.***	*2014-01-27*

LVM

STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-01-14**

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-13																	
11.66	**13.18**	**78**	**97**		56.48	54.96											
	11.72					56.42	Joint	1	75°	✓				4	A-C <1 mm		
	11.78					56.36	Joint	1	85°	✓		✓	✓	10	A-C <1 mm		
	11.82					56.32	Joint	1	80°	✓				4	A-C <1 mm		
	11.84					56.30	Joint	1	20°	✓				3	A-C <1 mm		
	11.90					56.24	Joint	1	75°	✓				2	A-C <1 mm		
	12.01					56.13	Joint	1	80°	✓			✓	8	A-C <1 mm		
	12.13					56.01	Joint	1	80°	✓				4	A-C <1 mm		
	12.15					55.99	Joint	1	85°	✓				8	A-C <1 mm		
	12.43					55.71	Joint	1	75°	✓				2	A-C <1 mm		
	12.62					55.52	Joint	1	75°	✓			✓	8	A-C <1 mm		
	12.84					55.30	Joint	1	80°	✓			✓	3	A-C <1 mm		

REMARKS :

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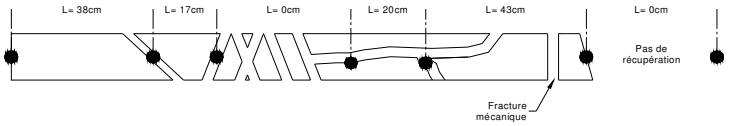
EXAMPLE :



DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-27*	***Tommy Lampron, Jr Eng.***	*2014-01-27*

LVM

STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-01-14**

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-14																	
13.18	**14.71**	**65**	**100**		54.96	53.43											
	13.28					54.86	Joint	1	85°	✓				10	A-C <1 mm		
	13.38					54.76	Joint	1	75°				✓	8	A-C <1 mm		
	13.83					54.31	Joint	1	75°	✓				6	A-C <1 mm		
	14.11					54.03	Joint	1	75°	✓				7	A-C <1 mm		
	14.21					53.93	Joint	1	10°	✓				2	A-C <1 mm		
	14.29					53.85	Joint	1	75°	✓				3	A-C <1 mm		
	14.33					53.81	Joint	1	85°	✓				7	A-C <1 mm		
	14.38					53.76	Joint	1	80°	✓			✓	10	A-C <1 mm		
	14.43					53.71	Joint	1	75°	✓				5	A-C <1 mm		
	14.49					53.65	Joint	1	75°	✓	✂			5	A-C <1 mm		
	14.60					53.54	Joint	1	80°	✓				6	A-C <1 mm		
	14.64					53.50	Joint	1	85°	✓				4	A-C <1 mm		

REMARKS :

(X)
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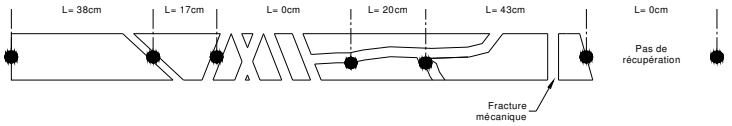

DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-27*	***Tommy Lampron, Jr Eng.***	*2014-01-27*

LVM

STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-01-14**

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-15																	
14.71	**16.23**	**78**	**100**		53.43	51.91											
	14.93					53.21	Joint	1	75°	✓				6	A-C <1 mm		
	15.12					53.02	Joint	1	75°	✓				8	A-C <1 mm		
	15.20					52.94	Joint	1	75°	✓				4	A-C <1 mm		
	15.33					52.81	Joint	1	85°	✓				8	A-C <1 mm		
	15.63					52.51	Joint	1	25°	✓				2	A-C <1 mm		
	15.90					52.24	Joint	1	85°	✓				4	A-C <1 mm		
	16.09					52.05	Joint	1	85°	✓				6	A-C <1 mm		
	16.13					52.01	Joint	1	85°	✓		✓		5	A-C <1 mm		
	16.17					51.97	Joint	1	15°	✓				5	A-C <1 mm		
RC-16																	
16.23	**17.75**	**80**	**93**		51.91	50.39											
	16.40					51.74	Joint	1	85°	✓				5	A-C <1 mm		
	16.42					51.72	Joint	1	80°	✓				5	A-C <1 mm		
	16.46					51.68	Joint	1	85°	✓				5	A-C <1 mm		
	16.70					51.44	Joint	1	80°	✓				2	A-C <1 mm		

REMARKS :

(X)
- G= Graphite
- I= Iron Oxyde
- K= Chlorite
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- S= Clay gouge
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(XX)
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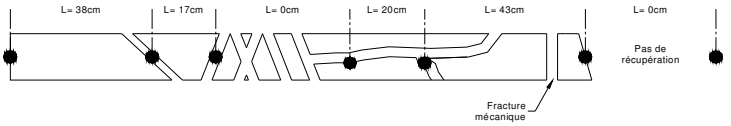
- bl = Black

ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-27*	***Tommy Lampron, Jr Eng.***	*2014-01-27*

LVM

STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-01-14**

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-16																	
	16.92					51.22	Joint	1	85°	✓				4	A-C <1 mm		
	17.00					51.14	Joint	1	85°	✓				2	A-C <1 mm		
	17.16					50.98	Joint	1	80°	✓		✓		4	A-C <1 mm		
	17.31					50.83	Joint	1	85°	✓				8	A-C <1 mm		
	17.49					50.65	Joint	1	75°	✓				2	A-C <1 mm		
RC-17																	
17.75	**19.28**	**87**	**100**		50.39	48.86											
	17.90					50.24	Joint	1	80°	✓				2	A-C <1 mm		
	18.25					49.89	Joint	1	80°	✓				4	A-C <1 mm		
	18.43					49.71	Joint	1	75°	✓				4	A-C <1 mm		
	18.70					49.44	Joint	1	80°	✓				4	A-C <1 mm		
	19.08					49.06	Joint	1	85°	✓				4	A-C <1 mm		
	19.15					48.99	Joint	1	85°	✓				10	A-C <1 mm		
	19.19					48.95	Joint	1	85°		✓			8	A-C <2mm		
	19.23					48.91	Joint	1	85°		✓			8	A-C <2 mm		

REMARKS :

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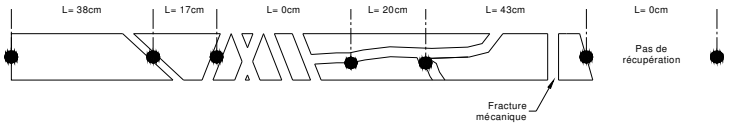
ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-27*	***Tommy Lampron, Jr Eng.***	*2014-01-27*

LVM

STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-01-14**

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-18																	
19.28	**20.80**	**45**	**93**		48.86	47.34	Joint	1	85°	✓				10	A-C <1 mm		
	19.34					48.80	Joint	1	80°	✓				2	A-C <1 mm		
	19.63					48.51	Joint	1	85°	✓				3	A-C <1 mm		
	19.80					48.34	Joint	1	85°	✓				4	A-C <1 mm		
	19.84					48.30	Joint	1	80°	✓				4	A-C <1 mm		
	19.88					48.26	Joint	1	85°	✓				4	A-C <1 mm		
	19.90					48.24	Joint	1	25°	✓				4	A-C <1 mm		
	19.92					48.22	Joint	1	80°	✓				2	A-C <1 mm		
	19.95					48.19	Joint	1	80°	✓				2	A-C <1 mm		
	19.99					48.15	Joint	1	75°	✓				7	A-C <1 mm		
	20.06					48.08	Joint	1	80°	✓				3	A-C <1 mm		
	20.09					48.05	Joint	1	85°		✓			5	A-C <3 mm		
	20.13					48.01	Joint	1	80°	✓				4	A-C <1 mm		
	20.19					47.95	Joint	1	85°	✓				5	A-C <1 mm		
	20.29					47.85	Joint	1	80°	✓				4	A-C <1 mm		
	20.36					47.78	Joint	1	80°	✓				6	A-C <1 mm		
	20.49					47.65	Joint	1	80°	✓				5	A-C <1 mm		

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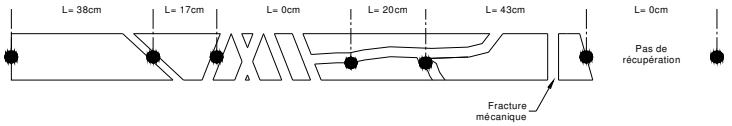

DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-27*	***Tommy Lampron, Jr Eng,***	*2014-01-27*

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STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-01-14**

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-18																	
	20.55					47.59	Joint	1	80°	✓				3	A-C <1 mm		
	20.72					47.42	Joint	1	85°	✓				4	A-C <1 mm		
	20.74					47.40	Joint	1	80°	✓				3	A-C <1 mm		
RC-19																	
20.80	**22.33**	**80**	**100**		47.34	45.81											
	20.90					47.24	Joint	1	85°	✓				5	A-C <1 mm		
	21.10					47.04	Joint	1	85°	✓				4	A-C <1 mm		
	21.15					46.99	Joint	1	80°	✓				4	A-C <1 mm		
	21.30					46.84	Joint	1	80°	✓				3	A-C <1 mm		
	21.58					46.56	Joint	1	85°		✓			5	A-C <1 mm		
	21.63					46.51	Joint	1	85°	✓				5	A-C <1 mm		
	21.65					46.49	Joint	1	80°	✓				5	A-C <1 mm		
	21.84					46.30	Joint	1	85°	✓				4	A-C <1 mm		
	21.85					46.29	Joint	1	15°	✓				2	A-C <1 mm		
	22.00					46.14	Joint	1	80°	✓				2	A-C <1 mm		
	22.04					46.10	Joint	1	85°	✓				2	A-C <1 mm		

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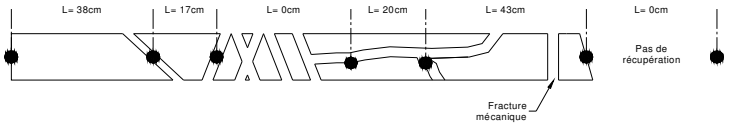

DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-27*	***Tommy Lampron, Jr Eng.***	*2014-01-27*

LVM

STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-01-14**

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-19																	
	22.15					45.99	Joint	1	85°	✓				8	A-C <1 mm		
	22.17					45.97	Joint	1	80°	✓				4	A-C <1 mm		
	22.27					45.87	Joint	1	80°	✓				4	A-C <1 mm		
	22.30					45.84	Joint	1	80°	✓				3	A-C <1 mm		

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ROCK QUALITY DESIGNATION (RQD)

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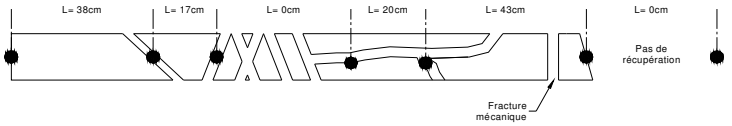

DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-27*	***Tommy Lampron, Jr Eng.***	*2014-01-27*

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STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-02-14**

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-6																	
3.61	**4.14**	**19**	**76**		64.07	63.54											
3.61	4.00				64.07	63.68	Rock fragments								A-C <1 mm		
	4.00					63.68	Joint	1	80°	✓				2-4	A-C <1 mm		
RC-7																	
4.14	**5.66**	**30**	**100**		63.54	62.02											
	4.20					63.48	Joint	1	15°	✓				2-4	A-C <1 mm		
	4.24					63.44	Joint	1	85°	✓				4-6	A-C <1 mm		
	4.40					63.28	Joint	1	80°	✓				2-4	A-C <1 mm		
	4.43					63.25	Joint	1	75°	✓				6-8	A-C <1 mm		
	4.52					63.16	Joint	1	85°	✓				4-6	A-C <1 mm		
4.52	4.76				63.16	62.92	Rock fragments every 2 to 5 cm	6	80-85	✓				4-6	A-C <1 mm		
	4.96					62.72	Joint	1	75°	✓				2-4	A-C <1 mm		
	4.98					62.70	Joint	1	85°		✓			8-10	A-C <2 mm		
	5.01					62.67	Joint	1	75°	✓				8-10	A-C <1 mm		
	5.04					62.64	Joint	1	75°	✓				8-10	A-C <1 mm		
	5.16					62.52	Joint	1	60°	✓				4-6	A-C <1 mm		
	5.30					62.38	Joint	1	80°	✓				8-10	A-C <1 mm		

REMARKS :

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ROCK QUALITY DESIGNATION (RQD)

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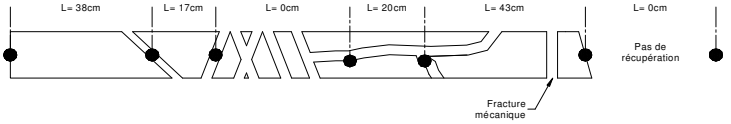

DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-24*	***Tommy Lampron, Jr Eng.***	*2014-01-24*

LVM

STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-02-14**

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-7																	
	5.34					62.34	Joint	1	80°	✓				8-10	A-C <1 mm		
	5.38					62.30	Joint	1	75°	✓				8-10	A-C <1 mm		
RC-8																	
5.66	**7.19**	**25**	**100**		62.02	60.49											
5.66	5.80				62.02	61.88	Rock fragments	1							A-C <1 mm		
	5.83					61.85	Joint	1	85°	✓				2-4	A-C <1 mm		
	5.90					61.78	Joint	1	85°	✓				2-4	A-C <1 mm		
	6.09					61.59	Joint	1	75°	✓				2-4	A-C <1 mm		
	6.12					61.56	Joint	1	85°	✓				2-4	A-C <1 mm		
	6.15					61.53	Joint	1	75°	✓				2-4	A-C <1 mm		
	6.18					61.50	Joint	1	80°	✓				2-4	A-C <1 mm		
	6.25					61.43	Joint	1	60°	✓				2-4	A-C <2 mm		
	6.28					61.40	Joint	1	80°	✓				2-4	A-C <1 mm		
	6.34					61.34	Joint	1	80°	✓				2-4	A-C <1 mm		
	6.43					61.25	Joint	1	80°	✓				4-6	A-C <1 mm		
	6.52					61.16	Joint	1	85°	✓				4-6	A-C <1 mm		

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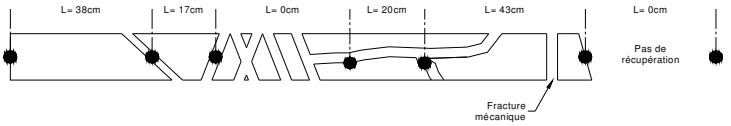

DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-24*	***Tommy Lampron, Jr Eng.***	*2014-01-24*

LVM

STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-02-14**

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-8																	
	6.60					61.08	Joint	1	85°	✓				4-6	A-C <1 mm		
	6.80					60.88	Joint	1	85°	✓				4-6	A-C <1 mm		
	6.84					60.84	Joint	1	75°	✓			✓	6-8	A-C <1 mm		
	6.88					60.80	Joint	1	80°	✓				4-6	A-C <1 mm		
6.88	7.19					60.49	Rock fragments										
RC-9																	
7.19	**8.71**	**68**	**100**		60.49	58.97											
7.19	7.40				60.49	60.28	Rock fragments every 2 to 6 cm				✓						
	7.43					60.25	Joint	1	45°	✓				5	A-C <2 mm		
	7.50					60.18	Joint	1	75°	✓				3	A-C <1 mm		
	7.68					60.00	Joint	1	80°	✓				4	A-C <1 mm		
	7.78					59.90	Joint	1	85°	✓				4	A-C <1 mm		
	7.81					59.87	Joint	1	85°	✓				4	A-C <1 mm		
	7.94					59.74	Joint	1	80°	✓		✓		4	A-C <1 mm		
	7.97					59.71	Joint	1	80°	✓				3	A-C <1 mm		
	8.01					59.67	Joint	1	85°	✓				3	A-C <1 mm		

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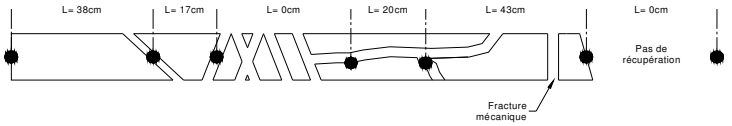


DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-24*	***Tommy Lampron, Jr Eng.***	*2014-01-24*

LVM

STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-02-14**

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-9																	
	8.04					59.64	Joint	1	75°	✓		✓		3	A-C <1 mm		
	8.25					59.43	Joint	1	80°	✓				3	A-C <1 mm		
	8.27					59.41	Joint	1	85°	✓				3	A-C <1 mm		
	8.49					59.19	Joint	1	75°	✓				6	A-C <1 mm		
	8.61					59.07	Joint	1	15°	✓				5	A-C <1 mm		
RC-10																	
8.71	**10.24**	**80**	**100**		58.97	57.44											
	8.84					58.84	Joint	1	75°	✓				5	A-C <1 mm		
	8.91					58.77	Joint	1	75°	✓			✓	12	A-C <1 mm		
	8.98					58.70	Joint	1	80°	✓				3	A-C <1 mm		
	9.17					58.51	Joint	1	80°	✓				3	A-C <1 mm		
	9.36					58.32	Joint	1	85°	✓		✓		4	A-C <2 mm		
	9.41					58.27	Joint	1	75°		✓			6	A-C <2 mm		
	9.61					58.07	Joint	1	85°	✓		✓		5	A-C <1 mm		
	9.67					58.01	Joint	1	80°	✓		✓		5	A-C <1 mm		
	9.83					57.85	Joint	1	75°	✓				3	A-C <1 mm		

REMARKS :

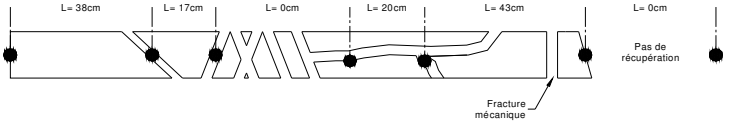
(X) C= Calcite
G= Graphite
I= Iron Oxyde
K= Chlorite
E= Epidote
B= Biotite
R= Rust
P= Pyrite
S= Clay gouge
A= Silt / Clay

(XX) w= White
p= Pink
g= Gray
v= Green
y= Yellow
b= Brown
r = Reddish
bl = Black

ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-24*	***Tommy Lampron, Jr Eng.***	*2014-01-24*

LVM

STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-02-14**

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-10																	
	9.95					57.73	Joint	1	85°	✓				3	A-C <1 mm		
	10.04					57.64	Joint	1	80°		✓			5	A-C <2 mm		
	10.06					57.62	Joint	1	80°	✓				3	A-C <1 mm		

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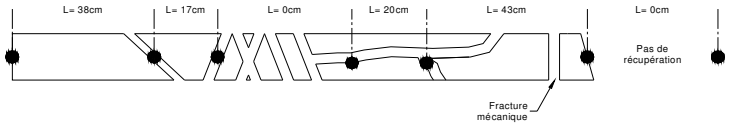
ROCK QUALITY DESIGNATION (RQD)

$$\text{RQD \%} = \frac{\text{Total} > 100\text{ mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-24*	***Tommy Lampron, Jr Eng.***	*2014-01-24*

LVM

STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-03-14**

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-9																	
4.75	**6.27**	**58**	**93**		63.27	61.75											
	4.82					63.20	Joint	1	85°	✓		✓		8	A-C <1 mm		
	4.89					63.13	Joint	1	85°	✓				2	A-C <1 mm		
	5.12					62.90	Joint	1	75°	✓				4	A-C <1 mm		
	5.16					62.86	Joint	1	85°	✓				4	A-C <1 mm		
	5.24					62.78	Joint	1	85°	✓				4	A-C <1 mm		
	5.44					62.58	Joint	1	85°	✓				4	A-C <1 mm		
	5.50					62.52	Joint	1	85°	✓				2	A-C <1 mm		
	5.72					62.30	Joint	1	85°	✓				2	A-C <1 mm		
	5.93					62.09	Joint	1	85°	✓				2	A-C <1 mm		
	6.23					61.79	Joint	1	85°	✓				2	A-C <1 mm		
RC-10																	
6.27	**7.80**	**60**	**100**		61.75	60.22											
	6.49					61.53	Joint	1	85°	✓				2	A-C <1 mm		
	6.68					61.34	Joint	1	85°	✓		✓		10	A-C <1 mm		
	6.73					61.29	Joint	1	85°	✓				4	A-C <1 mm		

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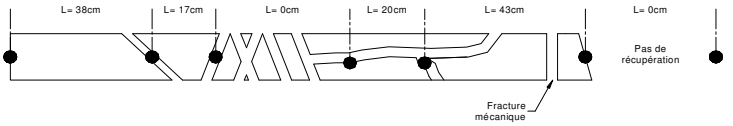
ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-28*	***Tommy Lampron, Jr Eng.***	*2014-01-28*

LVM

STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-03-14**

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-10																	
	6.84					61.18	Joint	1	85°	✓				3	A-C <1 mm		
	6.98					61.04	Joint	1	75°	✓				2	A-C <1 mm		
	7.08					60.94	Joint	1	80°	✓				2	A-C <1 mm		
	7.18					60.84	Joint	1	80°	✓				12	A-C <1 mm		
	7.27					60.75	Joint	1	80°	✓				3	A-C <1 mm		
	7.30					60.72	Joint	1	80°	✓				3	A-C <1 mm		
	7.59					60.43	Joint	1	85°	✓				6	A-C <1 mm		
	7.65					60.37	Joint	1	80°	✓				2	A-C <1 mm		
	7.70					60.32	Joint	1	85°	✓				2	A-C <1 mm		
	7.75					60.27	Joint	1	75°	✓				2	A-C <1 mm		
RC-11																	
7.80	**9.32**	**40**	**98**		60.22	58.70											
	7.89					60.13	Joint	1	80°	✓				2	A-C <1 mm		
	7.94					60.08	Joint	1	75°	✓				2	A-C <1 mm		
	8.18					59.84	Joint	1	85°	✓				6	A-C <1 mm		
	8.24					59.78	Joint	1	80°	✓				4	A-C <1 mm		

REMARKS :

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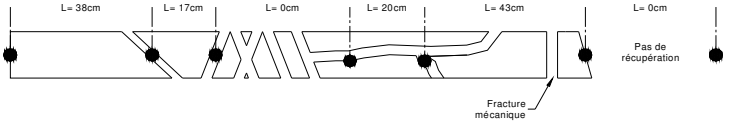
ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-28*	***Tommy Lampron, Jr Eng.***	*2014-01-28*

LVM

STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-03-14**

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-11																	
	8.31					59.71	Joint	1	75°	✓				3	A-C <1 mm		
	8.38					59.64	Joint	1	80°	✓				2	A-C <1 mm		
	8.40					59.62	Joint	1	80°	✓				2	A-C <1 mm		
	8.51					59.51	Joint	1	75°	✓				2	A-C <1 mm		
	8.59					59.43	Joint	1	60°	✓				2	A-C <1 mm		
	8.64					59.38	Joint	1	85°	✓				2	A-C <1 mm		
	8.75					59.27	Joint	1	85°	✓				4	A-C <1 mm		
	8.77					59.25	Joint	1	75°	✓				4	A-C <1 mm		
	8.81					59.21	Joint	1	60°	✓		✓		4	A-C <1 mm		
	9.08					58.94	Joint	1	75°		✓			6	A-C <4 mm		
	9.15					58.87	Joint	1	80°	✓				3	A-C <1 mm		
	9.23					58.79	Joint	1	75°	✓			✓	8	A-C <1 mm		
	9.27					58.75	Joint	1	80°	✓				4	A-C <2 mm		
	9.30					58.72	Joint	1	60°	✓				3	A-C <1 mm		

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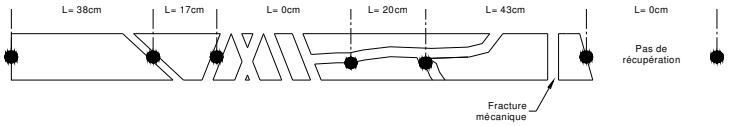
ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-29*	***Tommy Lampron, Jr Eng.***	*2014-01-29*

LVM

STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** B-0008257-1

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE :** BH-03-14

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-12																	
9.32	**10.85**	**42**	**97**		58.70	57.17											
	9.36					58.66	Joint	1	75°	✓				3	A-C <1 mm		
	9.48					58.54	Joint	1	75°	✓				3	A-C <1 mm		
	9.56					58.46	Joint	1	70°	✓				2	A-C <1 mm		
	9.64					58.38	Joint	1	85°	✓				2	A-C <1 mm		
	9.69					58.33	Joint	1	75°	✓		✓		2	A-C <1 mm		
	9.71					58.31	Joint	1	70°	✓				2	A-C <1 mm		
	9.74					58.28	Joint	1	85°	✓				2	A-C <1 mm		
	9.77					58.25	Joint	1	60°	✓				4	A-C <1 mm		
	9.82					58.20	Joint	1	60°	✓				4	A-C <1 mm		
	9.90					58.12	Joint	1	75°	✓				2	A-C <1 mm		
	10.01					58.01	Joint	1	85°	✓				2	A-C <1 mm		
	10.11					57.91	Joint	1	70°	✓				4	A-C <1 mm		
	10.22					57.80	Joint	1	75°	✓				2	A-C <1 mm		
	10.29					57.73	Joint	1	70°	✓				2	A-C <1 mm		
	10.36					57.66	Joint	1	75°	✓				4	A-C <2 mm		
	10.44					57.58	Joint	1	75°	✓		✓		4	A-C <1 mm		
	10.54					57.48	Joint	1	60°	✓				3	A-C <1 mm		
	10.64					57.38	Joint	1	70°	✓		✓		4	A-C <1 mm		

REMARKS :

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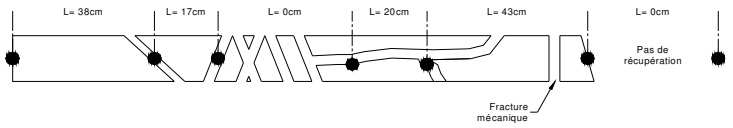
ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-29*	***Tommy Lampron, Jr Eng.***	*2014-01-29*

LVM

STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-03-14**

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-13																	
10.85	**12.37**	**70**	**98**		57.17	55.65											
	10.90					57.12	Joint	1	80°	✓				2	A-C <1 mm		
	11.02					57.00	Joint	1	85°	✓				2	A-C <1 mm		
	11.29					56.73	Joint	1	80°	✓				2	A-C <1 mm		
	11.46					56.56	Joint	1	85°	✓			✓	10	A-C <1 mm		
	11.55					56.47	Joint	1	75°	✓				2	A-C <1 mm		
	11.69					56.33	Joint	1	65°	✓				2	A-C <1 mm		
	12.07					55.95	Joint	1	75°	✓				2	A-C <1 mm		
	12.14					55.88	Joint	1	75°	✓				3	A-C <1 mm		
	12.19					55.83	Joint	1	75°	✓			✓	12	A-C <1 mm		
	12.27					55.75	Joint	1	80°	✓				2	A-C <1 mm		
RC-14																	
12.37	**13.89**	**68**	**100**		55.65	54.13											
	12.46					55.56	Joint	1	80°	✓				2	A-C <1 mm		
	12.61					55.41	Joint	1	75°	✓				2	A-C <1 mm		
							Joint	1	85°	✓				2	A-C <1 mm		

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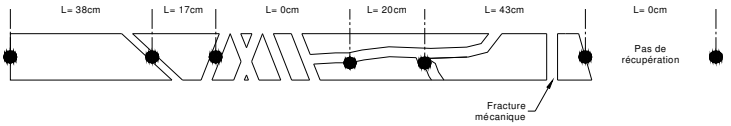

DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-29*	***Tommy Lampron, Jr Eng.***	*2014-01-29*

LVM

STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-03-14**

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-14																	
	12.79					55.23	Joint	1	80°	✓		✓		2	A-C <1 mm		
	12.95					55.07	Joint	1	75°	✓				2	A-C <1 mm		
	13.06					54.96	Joint	1	85°	✓				4	A-C <1 mm		
	13.17					54.85	Joint	1	60°	✓				2	A-C <1 mm		
	13.24					54.78	Joint	1	75°	✓			✓	8	A-C <1 mm		
	13.27					54.75	Joint	1	85°	✓			✓	9	A-C <1 mm		
	13.31					54.71	Joint	1	85°	✓				2	A-C <1 mm		
	13.41					54.61	Joint	1	80°	✓				2	A-C <1 mm		
	13.51					54.51	Joint	1	80°	✓				2	A-C <1 mm		
	13.55					54.47	Joint	1	85°	✓				2	A-C <1 mm		
	13.71					54.31	Joint	1	85°	✓				2	A-C <1 mm		
	13.79					54.23	Joint	1	55°	✓				2	A-C <1 mm		
	13.84					54.18	Joint	1	75°	✓				3	A-C <1 mm		

REMARKS :

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B= Biotite
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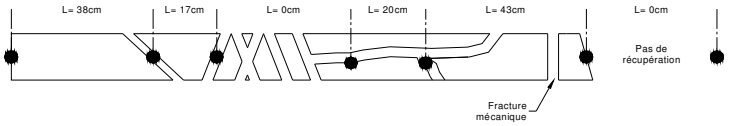

DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-29*	***Tommy Lampron, Jr Eng.***	*2014-01-29*

LVM

STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-03-14**

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-15																	
13.89	**15.42**	**57**	**100**		54.13	52.60											
	13.94					54.08	Joint	1	75°	✓				2	A-C <1 mm		
	14.03					53.99	Joint	1	85°	✓				2	A-C <1 mm		
	14.11					53.91	Joint	1	60°	✓				2	A-C <1 mm		
	14.18					53.84	Joint	1	80°	✓				2	A-C <1 mm		
	14.26					53.76	Joint	1	75°	✓				2	A-C <1 mm		
	14.36					53.66	Joint	1	75°	✓				2	A-C <1 mm		
	14.47					53.55	Joint	1	60°	✓				2	A <1 mm		
	14.60					53.42	Joint	1	75°	✓				2	A <1 mm		
	14.69					53.33	Joint	1	75°	✓				2	A <1 mm		
	14.79					53.23	Joint	1	60°	✓				2	A <1 mm		
	14.89					53.13	Joint	1	45°	✓				4	A-C <1 mm		
	14.94					53.08	Joint	1	80°	✓			✓	10	A-C <1 mm		
	15.13					52.89	Joint	1	80°	✓				4	A-C <1 mm		
	15.16					52.86	Joint	1	60°	✓				2	A-C <1 mm		
	15.25					52.77	Joint	1	60°	✓				2	A-C <1 mm		
	15.30					52.72	Joint	1	60°	✓				2	A <1 mm		
	15.36					52.66	Joint	1	85°	✓				2	A <1 mm		

REMARKS :

(X) C= Calcite
G= Graphite
I= Iron Oxyde
K= Chlorite
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S= Clay gouge
A= Silt / Clay

(XX) w= White
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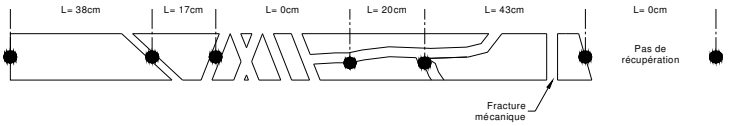
v= Green
y= Yellow
b= Brown
r = Reddish
bl = Black

ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-29*	***Tommy Lampron, Jr Eng.***	*2014-01-29*

LVM

STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-04-14**

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-8																	
4.09	**5.56**	**67**	**91**		63.66	62.19											
	4.14					63.61	Joint	1	85°	✓				2	A-C <1 mm		
	4.21					63.54	Joint	1	85°	✓		✓		2	A-C <1 mm		
	4.25					63.50	Joint	1	85°	✓				2	A-C <1 mm		
	4.29					63.46	Joint	1	85°	✓				2	A-C <1 mm		
	4.53					63.22	Joint	1	75°	✓			✓	9	A-C <1 mm		
	4.75					63.00	Joint	1	85°	✓				2	A-C <1 mm		
	4.86					62.89	Joint	1	80°	✓				2	A-C <1 mm		
	5.27					62.48	Joint	1	75°	✓				2	A <1 mm		
	5.31					62.44	Joint	1	80°	✓				2	A <1 mm		
RC-9																	
5.56	**7.09**	**83**	**100**		62.19	60.66											
	5.85					61.90	Joint	1	85°	✓				2			
	5.92					61.83	Joint	1	75°	✓				10	A-C <1 mm		
	5.98					61.77	Joint	1	80°	✓			✓	8	A-C <1 mm		
	6.10					61.65	Joint	1	75°		✓			6	A-C <20 mm		

REMARKS :

(X) C= Calcite
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(XX) w= White
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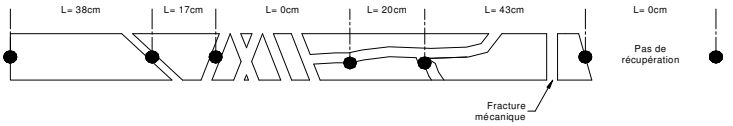
r = Reddish
bl = Black

ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-28*	***Tommy Lampron, Jr Eng.***	*2014-01-28*

LVM

STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-04-14**

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-9																	
	6.28					61.47	Joint	1	80°		✓			4	A-C <3 mm		
	6.41					61.34	Joint	1	75°	✓				3	A-C <1 mm		
	6.46					61.29	Joint	1	85°	✓				2	A-C <1 mm		
	6.62					61.13	Joint	1	55°	✓				2	A-C <1 mm		
	6.86					60.89	Joint	1	60°		✓			2	A-C <4 mm		
RC-10																	
7.09	**8.61**	**72**	**95**		60.66	59.14											
	7.24					60.51	Joint	1	75°	✓				2	A <1 mm		
	7.27					60.48	Joint	1	75°	✓				2	A <1 mm		
	7.33					60.42	Joint	1	60°	✓				2	A <1 mm		
	7.40					60.35	Joint	1	60°	✓			✓	10	A <1 mm		
	7.47					60.28	Joint	1	75°	✓				2	A <1 mm		
	8.59					59.16	Joint	1	85°		✓			4	A-C <4mm		

REMARKS :

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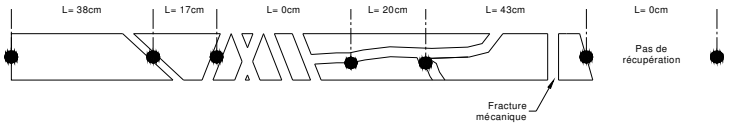
bl = Black

ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-28*	***Tommy Lampron, Jr Eng.***	*2014-01-28*

LVM

STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-04-14**

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-11																	
8.61	**10.13**	**48**	**100**		59.14	57.62											
	8.73					59.02	Joint	1	85°	✓				2	A-C <1 mm		
	8.97					58.78	Joint	1	85°		✓			6	A-C <3 mm		
8.97	9.07				58.78	58.68	Rock fragments										
	9.11					58.64	Joint	1	80°	✓				2	A-C <1 mm		
	9.15					58.60	Joint	1	80°	✓				3	A-C <1 mm		
	9.26					58.49	Joint	1	80°		✓			4	A-C <3 mm		
	9.33					58.42	Joint	1	60°	✓				2	A-C <1 mm		
	9.36					58.39	Joint	1	75°	✓				2	A-C <1 mm		
	9.39					58.36	Joint	1	75°		✓			4	A-C <5 mm		
	9.50					58.25	Joint	1	85°	✓			✓	10	A-C <1 mm		
9.50	9.60				58.25	58.15	Rock fragments										
	9.67					58.08	Joint	1	80°	✓				3	A-C <1 mm		
	9.93					57.82	Joint	1	15°	✓			✓	8	A-C <1 mm		
	10.00					57.75	Joint	1	85°	✓				3	A-C <1 mm		

REMARKS : The rock can be sRCatched with fingernail

(X) C= Calcite
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(XX) w= White
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y= Yellow
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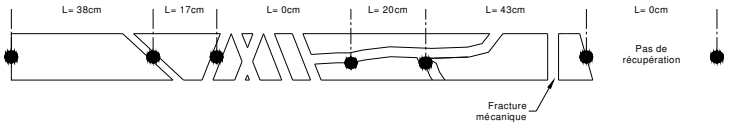
bl = Black

ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-28*	***Tommy Lampron, Jr Eng.***	*2014-01-28*

LVM

STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-04-14**

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-12																	
10.13	**11.66**	**65**	**100**		57.62	56.09											
	10.60					57.15	Joint	1	80°	✓				2	A-C <1 mm		
	10.64					57.11	Joint	1	80°	✓				2	A-C <1 mm		
	10.72					57.03	Joint	1	80°	✓				2	A-C <1 mm		
	10.80					56.95	Joint	1	60°	✓				2	A <1 mm		
	10.98					56.77	Joint	1	85°	✓				2	A-C <1 mm		
	11.12					56.63	Joint	1	15°	✓				4	A <1 mm		
	11.27					56.48	Joint	1	85°	✓				2	A <1 mm		
RC-13																	
11.66	**13.18**	**83**	**100**		56.09	54.57											
	11.89					55.86	Joint	1	80°	✓				2	A-C <1 mm		
	12.41					55.34	Joint	1	85°	✓				2	A <1 mm		
	12.90					54.85	Joint	1	80°	✓				2	A <1 mm		
	12.97					54.78	Joint	1	85°	✓				3	A <1 mm		
	13.08					54.67	Joint	1	75°	✓				4	A <1 mm		
	13.11					54.64	Joint	1	85°	✓				3	A <1 mm		

REMARKS :

(X) C= Calcite
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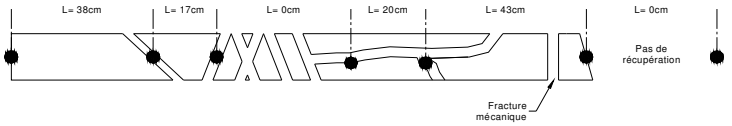
bl = Black

ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-28*	***Tommy Lampron, Jr Eng.***	*2014-01-28*

LVM

STRUCTURAL ROCK DESRCIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-04-14**

CORE RUN					DESRCIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESRCIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-14																	
13.18	**14.71**	**83**	**100**		54.57	53.04											
	13.31					54.44	Joint	1	85°	✓				2	A <1 mm		
	13.44					54.31	Joint	1	85°	✓				2	A <1 mm		
	13.48					54.27	Joint	1	80°	✓				2	A <1 mm		
	13.60					54.15	Joint	1	10°	✓			✓	2	A-C <1 mm		
	13.70					54.05	Joint	1	80°	✓			✓	2	A <1 mm		
	14.40					53.35	Joint	1	60°	✓				2	A-C <1 mm		
14.40	14.52					53.23	Rock fragments										
RC-15																	
14.71	16.23	80	100		53.04	51.52											
	14.74					53.01	Joint	1	80°	✓				2	A-C <1 mm		
	15.16					52.59	Joint	1	85°	✓				2	A-C <1 mm		
	15.36					52.39	Joint	1	15°	✓				2	A-C <1 mm		
	15.48					52.27	Joint	1	75°	✓				2	A-C <1 mm		
	15.75					52.00	Joint	1	80°	✓				2	A-C <1 mm		
	16.02					51.73	Joint	1	85°	✓			✓	10	A <1 mm		

REMARKS :

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r = Reddish
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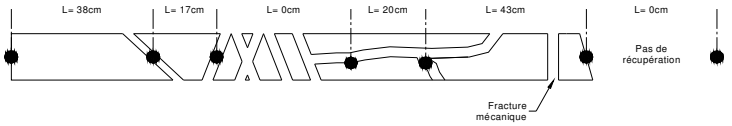
ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



DesRCiption by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-28*	***Tommy Lampron, Jr Eng.***	*2014-01-28*

LVM

STRUCTURAL ROCK DESCRIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-05-14**

CORE RUN					DESCRIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESCRIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-9																	
4.39	**4.65**	**0**	**40**		63.85	63.59											
4.39	4.65				63.85	63.59	Rock fragments										
RC-10																	
4.65	**6.17**	**40**	**100**		63.59	62.07											
	4.68					63.56	Joint	1	75°	✓				3	A-C <1 mm		
	4.79					63.45	Joint	1	80°	✓				3	A-C <1 mm		
	4.89					63.35	Joint	1	85°	✓				2	A-C <1 mm		
	4.95					63.29	Joint	1	80°	✓				3	A-C <1 mm		
	5.00					63.24	Joint	1	75°	✓				3	A-C <1 mm		
	5.04					63.20	Joint	1	60°	✓				2	A-C <1 mm		
	5.10					63.14	Joint	1	85°	✓				2	A-C <1 mm		
	5.14					63.10	Joint	1	85°	✓		✓		3	A-C <1 mm		
	5.24					63.00	Joint	1	80°	✓		✓		4	A-C <1 mm		
	5.28					62.96	Joint	1	85°	✓				2	A-C <1 mm		
	5.35					62.89	Joint	1	75°	✓				3	A-C <1 mm		
	5.51					62.73	Joint	1	85°	✓				2	A-C <1 mm		
	5.58					62.66	Joint	1	85°	✓				3	A-C <1 mm		

REMARKS :

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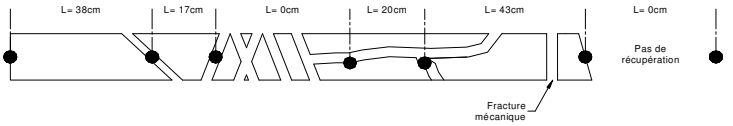
ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



Description by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-02-10*	***Tommy Lampron, Jr Eng.***	*2014-02-10*

LVM

STRUCTURAL ROCK DESCRIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-05-14**

CORE RUN					DESCRIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESCRIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-10																	
	5.65					62.59	Joint	1	75°					2	A-C <1 mm		
	5.82					62.42	Joint	1	15°	✓				2	A-C <1 mm		
	5.87					62.37	Joint	1	85°					2	A-C <1 mm		
RC-11																	
6.17	**7.70**	**57**	**100**		62.07	60.54											
	6.29					61.95	Joint	1	15°	✓				2	A-C <1 mm		
	6.32					61.92	Joint	1	85°	✓				2	A-C <1 mm		
	6.46					61.78	Joint	1	85°	✓		✓		3	A-C <1 mm		
	6.58					61.66	Joint	1	85°	✓		✓		3	A-C <1 mm		
	6.73					61.51	Joint	6	80°	✓				4	A-C <1 mm		
	6.78					61.46	Joint	1	80°	✓			✓	8	A-C <1 mm		
	6.84					61.40	Joint	1	80°	✓			✓	8	A-C <1 mm		
	6.90					61.34	Joint	1	75°	✓		✓		4	A-C <1 mm		
	6.94					61.30	Joint	1	80°	✓				2	A-C <1 mm		
	6.98					61.26	Joint	1	85°	✓				4	A-C <1 mm		
	7.02					61.22	Joint	1	80°		✓			4	A-C <1 mm		

REMARKS :

(X) C= Calcite
G= Graphite
I= Iron Oxyde
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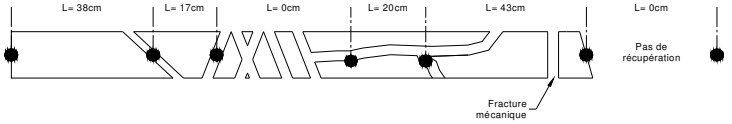
ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



Description by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-02-10*	***Tommy Lampron, Jr Eng.***	*2014-02-10*

LVM

STRUCTURAL ROCK DESCRIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-05-14**

CORE RUN					DESCRIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESCRIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-11																	
	7.15					61.09	Joint	1	85°	✓				3	A-C <1 mm		
7.15	7.30				61.09	60.94	Rock fragments										
	7.30					60.94	Joint	1	85°	✓				9	A-C <1 mm		
	7.51					60.73	Joint	1	85°	✓				3	A-C <1 mm		
	7.57					60.67	Joint	1	85°	✓				5	A-C <1 mm		
RC-12																	
7.70	**9.22**	**65**	**97**		60.54	59.02											
	7.86					60.38	Joint	1	85°	✓		✓		6	A-C <1 mm		
	7.91					60.33	Joint	1	70°	✓				5	A-C <1 mm		
	7.95					60.29	Joint	1	85°	✓			✓	8	A-C <1 mm		
	7.97					60.27	Joint	1	85°	✓				3	A-C <1mm		
	8.02					60.22	Joint	1	80°		✓		✓	6	A-C <3 cm		
	8.05					60.19	Joint	1	85°		✓			3	A-C <3cm		
	8.18					60.06	Joint	1	75°	✓				8	A-C <1 mm		
	8.33					59.91	Joint	1	60°	✓				3	A-C <1 mm		
	8.37					59.87	Joint	1	85°	✓				2	A-C <1 mm		

REMARKS :

(X) C= Calcite
G= Graphite
I= Iron Oxyde
K= Chlorite
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R= Rust
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S= Clay gouge
A= Silt / Clay

(XX) w= White
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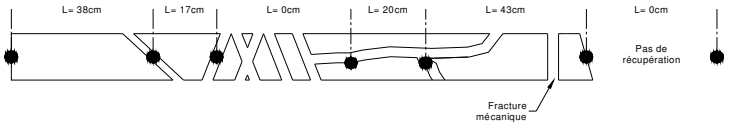
v= Green
y= Yellow
b= Brown
r = Reddish
bl = Black

ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



Description by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-02-10*	***Tommy Lampron, Jr Eng.***	*2014-02-10*

LVM

STRUCTURAL ROCK DESCRIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-05-14**

CORE RUN					DESCRIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESCRIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-12																	
	8.43					59.81	Joint	1	80°		✓			5	A-C <1 mm		
	8.60					59.64	Joint	1	60°	✓				3	A-C <1 mm		
	8.66					59.58	Joint	1	85°	✓				2	A-C <1 mm		
	8.77					59.47	Joint	1	85°	✓				2	A <1 mm		
	8.88					59.36	Joint	1	85°	✓				9	A-C <1 mm		
8.88	9.22				59.36	59.02	Samples for testing										

REMARKS :

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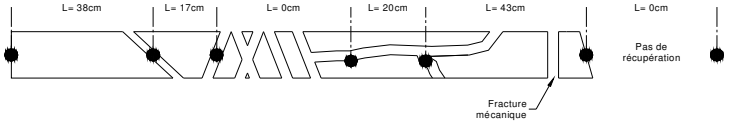
$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



Description by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-02-10*	***Tommy Lampron, Jr Eng.***	*2014-02-10*

LVM

STRUCTURAL ROCK DESCRIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-05-14**

CORE RUN					DESCRIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESCRIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-13																	
9.22	**10.74**	**87**	**100**		68.24	57.50											
	9.27					58.97	Joint	1	85°	✓				2	A-C <1 mm		
9.27	9.42				68.24	58.82	Samples for testing										
	9.42					58.82	Joint	1	80°	✓				6	A-C <1 mm		
	9.63					58.61	Joint	1	85°	✓				3	A <1 mm		
	9.80					58.44	Joint	1	85°	✓				4	A <1 mm		
	9.92					58.32	Joint	1	85°	✓				3	A <1 mm		
	10.04					58.20	Joint	1	85°	✓				2	A-C <1 mm		
	10.24					58.00	Joint	1	85°	✓				3	A <1 mm		
	10.34					57.90	Joint	1	85°	✓				4	A-C <1 mm		
	10.45					57.79	Joint	1	85°	✓				2	A-C <1 mm		
	10.60					57.64	Joint	1	15°	✓				2	A-C <1 mm		
	10.67					57.57	Joint	1	85°	✓				2	A-C <1 mm		

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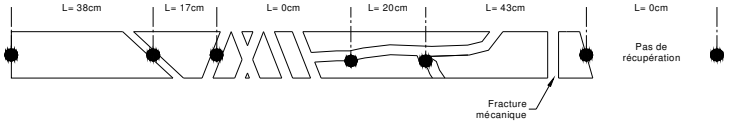
ROCK QUALITY DESIGNATION (RQD)

$$\text{RQD \%} = \frac{\text{Total} > 100\text{ mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



Description by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-02-10*	***Tommy Lampron, Jr Eng.***	*2014-02-10*

LVM

STRUCTURAL ROCK DESCRIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-06-14**

CORE RUN					DESCRIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESCRIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-8																	
4.27	**4.75**	**53**	**94**		63.79	63.31											
	4.40					63.66	Joint	1	30°	✓				6	A-C <1 mm		
	4.47					63.59	Joint	1	85°	✓				6	A-C <1 mm		
	4.53					63.53	Joint	1	80°	✓				3	A-C <1 mm		
	4.64					63.42	Joint	1	85°	✓				3	A-C <1 mm		
RC-9																	
4.75	**6.27**	**77**	**98**		63.31	61.79											
	4.83					63.23	Joint	1	75°	✓			✓	10	A-C <1 mm		
	4.89					63.17	Joint	1	60°	✓				4	A-C <1 mm		
	5.06					63.00	Joint	1	75°	✓				4	A-C <1 mm		
	5.19					62.87	Joint	1	80°	✓				4	A-C <1 mm		
	5.22					62.84	Joint	1	85°	✓				5	A-C <1 mm		
	5.29					62.77	Joint	1	75°	✓				4	A-C <1 mm		
	5.45					62.61	Joint	1	80°	✓				3	A-C <1 mm		
	5.62					62.44	Joint	1	80°	✓				3	A-C <1 mm		
	5.81					62.25	Joint	1	85°	✓				2	A-C <1 mm		

REMARKS :

(X) C= Calcite
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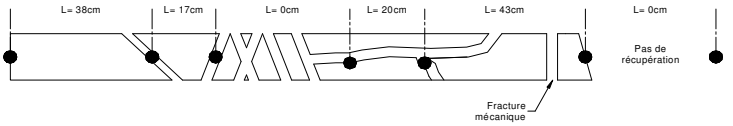
ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



Description by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-27*	***Tommy Lampron, Jr Eng.***	*2014-01-27*

LVM

STRUCTURAL ROCK DESCRIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-06-14**

CORE RUN					DESCRIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESCRIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-9																	
	6.05					62.01	Joint	1	85°	✓				3	A-C <1 mm		
	6.07					61.99	Joint	1	80°	✓				2	A-C <1 mm		
	6.12					61.94	Joint	1	80°	✓				3	A-C <1 mm		
RC-10																	
6.27	**7.80**	**32**	**100**		61.79	60.26											
	6.29					61.77	Joint	1	75°	✓				9	A-C <1 mm		
	6.32					61.74	Joint	1	30°	✓				6	A-C <1 mm		
	6.35					61.71	Joint	1	60°	✓				8	A-C <1 mm		
	6.45					61.61	Joint	1	75°	✓				4	A-C <1 mm		
	6.60					61.46	Joint	1	80°	✓				3	A-C <1 mm		
	6.72					61.34	Joint	1	85°	✓				3	A-C <1 mm		
	6.74					61.32	Joint	1	75°	✓				5	A-C <1 mm		
	6.86					61.20	Joint	1	80°	✓				4	A-C <1 mm		
	6.90					61.16	Joint	1	15°	✓				5	A-C <1 mm		
	7.03					61.03	Joint	1	85°	✓				5	A-C <1 mm		
7.03	7.21					60.85	Rock fragments										

REMARKS : The rock can be scratched with fingernail

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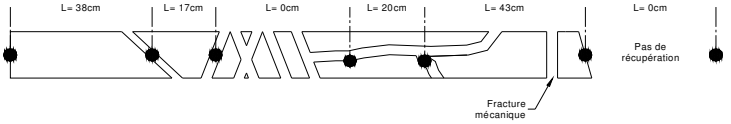
EXAMPLE :



Description by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-27*	***Tommy Lampron, Jr Eng.***	*2014-01-27*

LVM

STRUCTURAL ROCK DESCRIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-06-14**

CORE RUN					DESCRIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESCRIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-10																	
	7.38					60.68	Joint	1	85°	✓				2	A-C <1 mm		
	7.60					60.46	Joint	1	80°		✓			5	A-C <4 mm		
	7.72					60.34	Joint	1	85°	✓				2	A-C <1 mm		
	7.80					60.26	Joint	1	15°	✓				2	A-C <1 mm		
RC-11																	
7.80	**9.32**	**63**	**100**		60.26	58.74											
	7.97					60.09	Joint	1	75°	✓				2	A-C <1 mm		
	8.07					59.99	Joint	1	85°	✓				2	A-C <1 mm		
	8.28					59.78	Joint	1	85°	✓				2	A-C <1 mm		
	8.50					59.56	Joint	1	85°	✓				5	A-C <1 mm		
	8.63					59.43	Joint	1	85°	✓				3	A-C <1 mm		
	8.67					59.39	Joint	1	85°	✓				5	A-C <1 mm		
	8.76					59.30	Joint	1	85°	✓				3	A-C <1 mm		
	8.83					59.23	Joint	1	85°	✓				4	A-C <1 mm		
	8.87					59.19	Joint	1	75°	✓				5	A-C <1 mm		
	9.10					58.96	Joint	1	80°	✓				3	A-C <1 mm		

REMARKS : The rock can be scratched with fingernail

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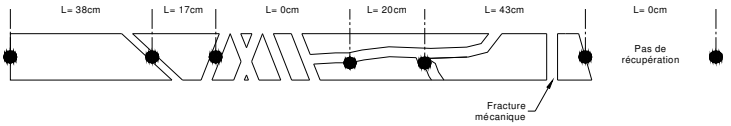
EXAMPLE :



Description by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-27*	***Tommy Lampron, Jr Eng.***	*2014-01-27*

LVM

STRUCTURAL ROCK DESCRIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-06-14**

CORE RUN					DESCRIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESCRIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-11																	
	9.18					58.88	Joint	1	85°	✓				2	A-C <1 mm		
	9.20					58.86	Joint	1	80°	✓				3	A-C <1 mm		
RC-12																	
9.32	**10.85**	**75**	**98**		58.74	57.21											
	9.36					58.70	Joint	1	80°	✓				5	A-C <1 mm		
	9.41					58.65	Joint	1	85°	✓				4	A-C <1 mm		
	9.86					58.20	Joint	1	80°	✓				6	A-C <1 mm		
	10.04					58.02	Joint	1	85°	✓				5	A-C <1 mm		
	10.29					57.77	Joint	1	75°	✓				9	A-C <1 mm		
	10.37					57.69	Joint	1	75°	✓				4	A-C <1 mm		
	10.40					57.66	Joint	1	75°	✓				3	A-C <1 mm		
	10.47					57.59	Joint	1	80°	✓				9	A-C <1 mm		
	10.65					57.41	Joint	1	85°	✓				4	A-C <1 mm		
	10.75					57.31	Joint	1	85°	✓				4	A-C <1 mm		

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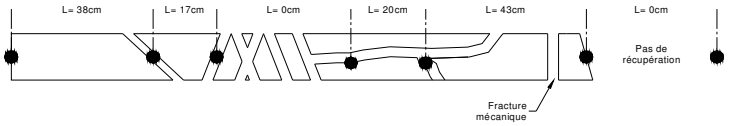

Description by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-27*	***Tommy Lampron, Jr Eng.***	*2014-01-27*

LVM

STRUCTURAL ROCK DESCRIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-06-14**

CORE RUN					DESCRIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESCRIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-13																	
10.85	**12.37**	**80**	**97**		57.21	55.69											
	11.62					56.44	Joint	1	30°		✓			3	A-C <2 mm	v	w
	11.76					56.30	Joint	1	85°	✓				5	A-C <1 mm		
	11.82					56.24	Joint	1	80°	✓				5	A-C <1 mm		
	11.84					56.22	Joint	1	85°	✓				5	A-C <1 mm		
	12.25					55.81	Joint	1	80°	✓				4	A-C <1 mm		
	12.31					55.75	Joint	1	85°	✓				3	A-C <1 mm		
RC-14																	
12.37	**13.89**	**85**	**100**		55.69	54.17											
	12.50					55.56	Joint	1	85°	✓				2	A-C <1 mm		
	12.58					55.48	Joint	1	65°	✓		✓		7	A-C <1 mm		
	12.82					55.24	Joint	1	80°	✓				6	A-C <1 mm		
	13.17					54.89	Joint	1	15°	✓		✓		4	A-C <1 mm		
	13.21					54.85	Joint	1	85°	✓				2	A-C <1 mm		
	13.42					54.64	Joint	1	85°	✓				4	A-C <1 mm		
	13.60					54.46	Joint	1	85°	✓				6	A-C <1 mm		
	13.87					54.19	Joint	1	85°	✓				3	A-C <1 mm		

REMARKS : The rock can be scratched with fingernail

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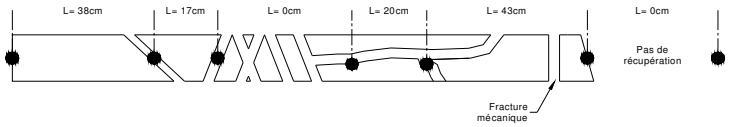

Description by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-27*	***Tommy Lampron, Jr Eng.***	*2014-01-27*

LVM

STRUCTURAL ROCK DESCRIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-06-14**

CORE RUN					DESCRIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESCRIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-15																	
13.89	**15.42**	**92**	**100**		54.17	52.64											
	14.08					53.98	Joint	1	85°	✓				2	A-C <1 mm		
	14.31					53.75	Joint	1	30°		✓			5	A-C <3 mm		
	14.40					53.66	Joint	1	80°	✓				4	A-C <1 mm		
	14.42					53.64	Joint	1	75°	✓				7	A-C <1 mm		
	14.45					53.61	Joint	1	75°	✓				6	A-C <1 mm		
	14.62					53.44	Joint	1	85°	✓				3	A-C <1 mm		
	14.81					53.25	Joint	1	60°	✓				2	A-C <1 mm		
	15.07					52.99	Joint	1	85°	✓				2	A-C <1 mm		
RC-16																	
15.42	**16.94**	**82**	**97**		52.64	51.12											
	15.59					52.47	Joint	1	85°	✓		✓		2	A-C <1 mm		
	15.84					52.22	Joint	1	85°	✓				2	A-C <1 mm		
	16.01					52.05	Joint	1	30°	✓				3	A-C <1 mm		
	16.36					51.70	Joint	1	85°	✓				2	A-C <1 mm		
	16.69					51.37	Joint	1	45°	✓				8	A-C <1 mm		
	16.81					51.25	Joint	1	85°	✓				3	A-C <1 mm		

REMARKS :

(X) C= Calcite
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(XX) w= White
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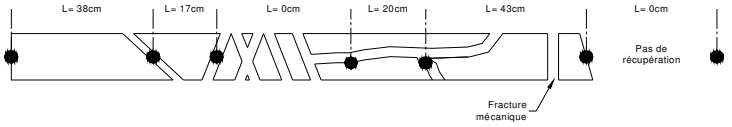
r = Reddish
bl = Black

ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



Description by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-28*	***Tommy Lampron, Jr Eng.***	*2014-01-28*

LVM

STRUCTURAL ROCK DESCRIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-06-14**

CORE RUN					DESCRIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESCRIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-17																	
16.94	**18.47**	**53**	**100**		51.12	49.59											
	17.08					50.98	Joint	1	85°	✓				2	A-C <1 mm		
	17.26					50.80	Joint	1	85°	✓				2	A-C <1 mm		
	17.33					50.73	Joint	1	75°	✓				3	A-C <1 mm		
	17.50					50.56	Joint	1	75°	✓			✓	10	A-C <1 mm		
	17.57					50.49	Joint	1	85°	✓				3	A-C <1 mm		
	17.59					50.47	Joint	1	80°	✓				2	A-C <1 mm		
	18.82					49.24	Joint	1	85°	✓				2	A-C <1 mm		
	18.03					50.03	Joint	1	85°	✓				2	A-C <1 mm		
	18.08					49.98	Joint	1	85°	✓				2	A-C <1 mm		
	18.12					49.94	Joint	1	75°	✓				2	A-C <1 mm		
	18.15					49.91	Joint	1	75°	✓				3	A-C <1 mm		
	18.23					49.83	Joint	1	60°	✓				2	A-C <1 mm		
	18.30					49.76	Joint	1	80°		✓			4	A-C <2 mm		
	18.45					49.61	Joint	1	85°		✓			4	A-C <1 mm		

REMARKS :

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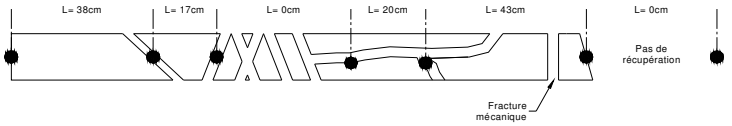
bl = Black

ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



Description by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-28*	***Tommy Lampron, Jr Eng.***	*2014-01-28*

LVM

STRUCTURAL ROCK DESCRIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-06-14**

CORE RUN					DESCRIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESCRIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-18																	
18.47	**19.99**	**72**	**100**		49.59	48.07											
	18.58					49.48	Joint	1	85°	✓				10	A-C <1 mm		
	18.64					49.42	Joint	1	80°	✓			✓	8	A-C <1 mm		
	18.66					49.40	Joint	1	80°	✓				8	A-C <1 mm		
	18.69					49.37	Joint	1	80°	✓				4	A-C <1 mm		
	18.72					49.34	Joint	1	80°		✓			8	A-C <4 mm		
	18.78					49.28	Joint	1	75°	✓		✓		4	A-C <1 mm		
	18.82					49.24	Joint	1	75°					6	A-C <1 mm		
	18.86					49.20	Joint	1	85°		✓			4	A-C <2 mm		
	18.89					49.17	Joint	1	80°	✓				4	A-C <1 mm	v	w
	19.17					48.89	Joint	1	85°	✓				3	A-C <1 mm		
	19.25					48.81	Joint	1	60°	✓				4	A-C <1 mm		
	19.48					48.58	Joint	1	85°	✓				2	A-C <1 mm		
	19.62					48.44	Joint	1	85°	✓				2	A-C <1 mm		
	19.66					48.40	Joint	1	85°	✓				2	A-C <1mm		

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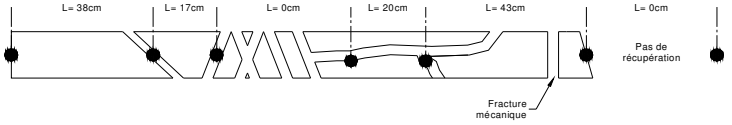
ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



Description by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-28*	***Tommy Lampron, Jr Eng.***	*2014-01-28*

LVM

STRUCTURAL ROCK DESCRIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-06-14**

CORE RUN					DESCRIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESCRIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-19																	
19.99	**21.16**	**70**	**100**		48.07	46.90											
	20.02					48.04	Joint	1	85°	✓				2	A-C <1 mm		
	20.39					47.67	Joint	1	60°	✓				4	A-C <1 mm		
	20.46					47.60	Joint	1	45°	✓				4	A-C <1 mm		
	20.53					47.53	Joint	1	65°	✓				4	A-C <1 mm		
	20.55					47.51	Joint	1	85°	✓				2	A-C <1 mm		
	20.73					47.33	Joint	1	45°	✓				2	A-C <1 mm		
	20.86					47.20	Joint	1	85°	✓				6	A-C <1 mm		
	20.88					47.18	Joint	1	60°		✓			6	A-C <3mm		
	20.98					47.08	Joint	1	80°	✓				2	A-C <1 mm		
	21.07					46.99	Joint	1	80°	✓				2	A-C <1 mm		

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ROCK QUALITY DESIGNATION (RQD)

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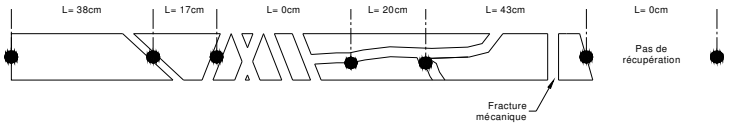
EXAMPLE :



Description by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-28*	***Tommy Lampron, Jr Eng.***	*2014-01-28*

LVM

STRUCTURAL ROCK DESCRIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-07-14**

CORE RUN					DESCRIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESCRIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-8																	
4.27	**4.70**	**0**	**88**		63.63	63.20											
4.27	4.44				63.63	63.46	Rock fragments										
	4.50					63.40	Joint	1	85°	✓				4	A <1 mm		
	4.57					63.33	Joint	1	80°	✓			✓	6	A <1 mm		
	4.65					63.25	Joint	1	85°	✓				4	A <1 mm		
4.65	4.70				63.25	63.20	Rock fragments										
RC-9																	
4.70	**6.22**	**72**	**93**		63.20	61.68											
	4.79					63.11	Joint	1	85°	✓				3	A-C <1 mm		
	4.84					63.06	Joint	1	85°	✓			✓	6	A-C <1 mm		
	4.92					62.98	Joint	1	85°	✓				2	A-C <1 mm		
	5.07					62.83	Joint	1	85°	✓				2	A <1 mm		
	5.20					62.70	Joint	1	85°	✓				2	A <1 mm		
	5.33					62.57	Joint	1	85°	✓				2	A <1 mm		
	5.47					62.43	Joint	1	70°	✓		✓		5	A <1 mm		
	5.53					62.37	Joint	1	75°	✓		✓		5	A-C <1 mm		
	5.68					62.22	Joint	1	85°	✓				2	A-C <1 mm		

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ROCK QUALITY DESIGNATION (RQD)

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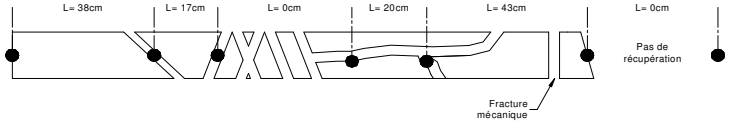
EXAMPLE :



Description by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-02-06*	***Tommy Lampron, Jr Eng.***	*2014-02-06*

STRUCTURAL ROCK DESCRIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** B-0008257-1

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** BH-07-14

CORE RUN					DESCRIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESCRIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
CR-9																	
	5.80					62.10	Joint	1	85°	✓				2	A-C <1 mm		
	6.20					61.70	Joint	1	85°	✓				2	A-C <1 mm		
CR-10																	
6.22	7.75	73	100		61.68	60.15											
	6.23					61.67	Joint	1	80°	✓				2	A-C <1 mm		
	6.35					61.55	Joint	1	75°	✓				2	A-C <1 mm		
	6.64					61.26	Joint	1	85°	✓				4	A-C <1 mm		
	6.68					61.22	Joint	1	85°	✓				4	A-C <1 mm		
	6.71					61.19	Joint	1	85°	✓				4	A-C <1 mm		
	6.74					61.16	Joint	1	80°	✓				5	A-C <1 mm		
	6.91					60.99	Joint	1	80°	✓				2	A-C <1 mm		
	6.98					60.92	Joint	1	85°	✓				2	A-C <1 mm		
	7.13					60.77	Joint	1	75°	✓		✓		4	A-C <1 mm		
	7.28					60.62	Joint	1	85°	✓				3	A-C <1 mm		
	7.43					60.47	Joint	1	85°	✓				2	A-C <1 mm		
	7.53					60.37	Joint	1	85°	✓				2	A-C <1 mm		
	7.56					60.34	Joint	1	80°	✓				2	A-C <1 mm		
	7.71					60.19	Joint	1	75°	✓				2	A-C <1 mm		

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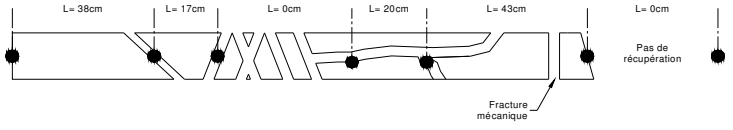
EXAMPLE :



Description by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-02-06*	***Tommy Lampron, Jr Eng.***	*2014-02-06*

LVM

STRUCTURAL ROCK DESCRIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-07-14**

CORE RUN					DESCRIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESCRIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-11																	
7.75	**9.27**	**78**	**100**		60.15	58.63											
7.75	7.77				60.15	60.13	Rock fragments										
	7.77					60.13	Joint	1	85°	✓				2	A <1 mm		
	7.81					60.09	Joint	1	85°	✓				2	A-C <1 mm		
	8.11					59.79	Joint	1	85°	✓		✓		4	A-C <1 mm		
	8.23					59.67	Joint	1	85°	✓				4	A-C <1 mm		
	8.45					59.45	Joint	1	75°	✓		✓		5	A-C <1 mm		
	8.47					59.43	Joint	1	85°	✓				3	A-C <1 mm		
	8.67					59.23	Joint	1	85°	✓				4	A-C <1 mm		
	8.74					59.16	Joint	1	75°	✓				3	A-C <1 mm		
	8.79					59.11	Joint	1	85°	✓			✓	6	A-C <1mm		
	8.81					59.09	Joint	1	85°	✓				2	A-C <1mm		
	8.90					59.00	Joint	1	85°	✓		✓		4	A-C <1mm		
	9.00					58.90	Joint	1	85°	✓				3	A-C <1 mm		
	9.13					58.77	Joint	1	75°	✓				4	A-C <1 mm		

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ROCK QUALITY DESIGNATION (RQD)

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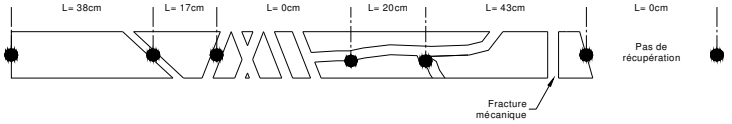

Description by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-02-06*	***Tommy Lampron, Jr Eng.***	*2014-02-06*

LVM

STRUCTURAL ROCK DESCRIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-07-14**

CORE RUN					DESCRIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESCRIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-12																	
9.27	**10.80**	**55**	**100**		58.63	57.10											
	9.44					58.46	Joint	1	85°	✓		✓		5	A-C <1 mm		
	9.68					58.22	Joint	1	80°	✓				5	A-C <1 mm		
	9.73					58.17	Joint	1	85°	✓				2	A-C <1 mm		
	9.77					58.13	Joint	1	85°	✓				3	A-C <1 mm		
	9.81					58.09	Joint	1	85°	✓				3	A-C <1 mm		
	9.85					58.05	Joint	1	80°	✓		✓		3	A-C <1 mm		
	10.03					57.87	Joint	1	85°	✓				2	A-C <1 mm		
	10.19					57.71	Joint	1	85°	✓				2	A-C <1 mm		
	10.32					57.58	Joint	1	80°	✓		✓		4	A-C <1 mm		
	10.37					57.53	Joint	1	85°	✓				3	A-C <1 mm		
	10.43					57.47	Joint	1	75°	✓				4	A-C <1 mm		
	10.57					57.33	Joint	1	85°	✓		✓		3	A-C <1 mm		
	10.65					57.25	Joint	1	85°	✓			✓	6	A-C <1 mm		
	10.73					57.17	Joint	1	85°	✓			✓	5	A-C <1 mm		

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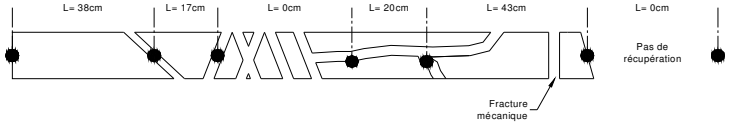

Description by :		Verified by :	
Sylvain Séguin	*2014-02-06*	***Tommy Lampron, Jr Eng.***	*2014-02-06*

LVM

STRUCTURAL ROCK DESCRIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-07-14**

CORE RUN					DESCRIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESCRIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-13																	
10.80	**12.32**	**68**	**95**		57.10	55.58											
	10.90					57.00	Joint	1	45°	✓		✓		3	A-C <1 mm		
	11.01					56.89	Joint	1	85°	✓				2	A-C <1 mm		
	11.16					56.74	Joint	1	85°	✓				2	A-C <1 mm		
	11.37					56.53	Joint	1	80°	✓				2	A-C <1 mm		
	11.47					56.43	Joint	1	80°	✓				3	A-C <1 mm		
	11.50					56.40	Joint	1	60°	✓				4	A-C <1 mm		
	11.64					56.26	Joint	1	85°	✓				3	A-C <1 mm		
	11.81					56.09	Joint	1	85°	✓				2	A-C <1 mm		
	11.88					56.02	Joint	1	85°	✓				2	A-C <1 mm		
	11.94					55.96	Joint	1	85°	✓				2	A-C <1 mm		
	12.01					55.89	Joint	1	60°	✓				2	A-C <1 mm		
	12.08					55.82	Joint	1	75°	✓				2	A-C <1 mm		
	12.30					55.60	Joint	1	80°	✓		✓		2	A-C <1 mm		

(X) C= Calcite
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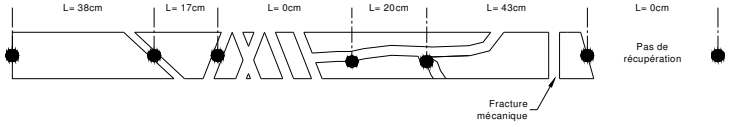
v= Green
y= Yellow
b= Brown
r = Reddish
bl = Black

ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



Description by :		Verified by :	
Sylvain Séguin	*2014-02-06*	***Tommy Lampron, Jr Eng.***	*2014-02-06*

LVM

STRUCTURAL ROCK DESCRIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-07-14**

CORE RUN					DESCRIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESCRIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-14																	
12.32	**13.84**	**45**	**100**		55.58	54.06											
	12.39					55.51	Joint	1	85°	✓				3	A-C <1 mm		
	12.44					55.46	Joint	1	50°	✓				5	A-C <1 mm		
	12.54					55.36	Joint	1	80°	✓			✓	7	A-C <1 mm		
	12.69					55.21	Joint	1	85°	✓				3	A-C <1 mm		
	12.76					55.14	Joint	1	85°	✓				3	A-C <1 mm		
	12.84					55.06	Joint	1	60°	✓		✓		2	A-C <1 mm		
	12.96					54.94	Joint	1	85°	✓				4	A-C <1 mm		
	13.04					54.86	Joint	1	85°	✓				4	A-C <1 mm		
	13.13					54.77	Joint	1	75°	✓		✓		3	A-C <1 mm		
	13.30					54.60	Joint	1	80°	✓				3	A-C <1 mm		
	13.40					54.50	Joint	1	75°	✓				4	A-C <1 mm		
	13.45					54.45	Joint	1	85°	✓				3	A-C <1 mm		
	13.55					54.35	Joint	1	80°	✓			✓	6	A-C <1 mm		
	13.63					54.27	Joint	1	80°	✓				4	A-C <1 mm		
13.77	13.84				54.13	54.06	Rock fragments										

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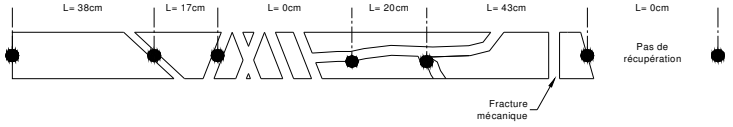
ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



Description by :		Verified by :	
Sylvain Séguin	*2014-02-06*	***Tommy Lampron, Jr Eng.***	*2014-02-06*

LVM

STRUCTURAL ROCK DESCRIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-07-14**

CORE RUN					DESCRIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESCRIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-15																	
13.84	**15.37**	**70**	**100**		54.06	52.53											
	13.89					54.01	Joint	1	85°	✓				4	A-C <1 mm		
	14.07					53.83	Joint	1	85°	✓				3	A-C <1 mm		
	14.27					53.63	Joint	1	85°	✓				2	A-C <1 mm		
	14.51					53.39	Joint	1	75°	✓		✓		6	A-C <1 mm		
	14.63					53.27	Joint	1	85°	✓				3	A-C <1 mm		
	14.82					53.08	Joint	1	85°	✓				2	A-C <1 mm		
	14.97					52.93	Joint	1	85°	✓				2	A-C <1 mm		
	15.07					52.83	Joint	1	75°	✓				4	A-C <1 mm		
	15.13					52.77	Joint	1	85°	✓				2	A-C <1 mm		
	15.20					52.70	Joint	1	80°	✓				4	A-C <1 mm		
	15.27					52.63	Joint	1	85°	✓				4	A-C <1 mm		
	15.32					52.58	Joint	1	70°	✓		✓		3	A-C <1 mm		

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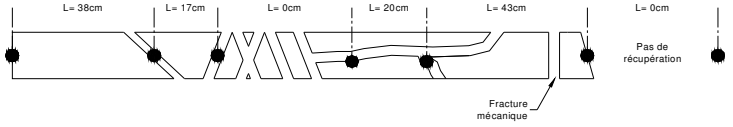
ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



Description by :		Verified by :	
Sylvain Séguin	*2014-02-06*	***Tommy Lampron, Jr Eng.***	*2014-02-06*

LVM

STRUCTURAL ROCK DESCRIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-07-14**

CORE RUN					DESCRIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESCRIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-16																	
15.37	**16.89**	**63**	**100**		52.53	51.01											
	15.52					52.38	Joint	1	55°	✓				3	A-C <1 mm		
	15.66					52.24	Joint	1	85°	✓				5	A-C <1 mm		
	15.86					52.04	Joint	1	85°	✓				2	A-C <1 mm		
	15.93					51.97	Joint	1	85°	✓				3	A-C <1 mm		
	15.99					51.91	Joint	1	85°	✓				3	A-C <1 mm		
	16.10					51.80	Joint	1	85°	✓				2	A <1 mm		
	16.16					51.74	Joint	1	85°	✓				2	A <1 mm		
	16.22					51.68	Joint	1	80°	✓				2	A <1 mm		
	16.30					51.60	Joint	1	80°	✓				2	A <1 mm		
	16.42					51.48	Joint	1	85°	✓		✓		5	A <1 mm		
	16.48					51.42	Joint	1	80°	✓				3	A <1 mm		
	16.55					51.35	Joint	1	85°	✓				3	A <1 mm		
	16.62					51.28	Joint	1	85°	✓				5	A <1 mm		
	16.68					51.22	Joint	1	85°	✓				3	A <1 mm		

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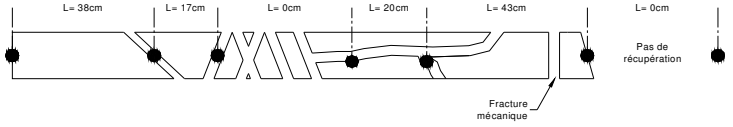
ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



Description by :		Verified by :	
Sylvain Séguin	*2014-02-06*	***Tommy Lampron, Jr Eng.***	*2014-02-06*

LVM

STRUCTURAL ROCK DESCRIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-08-14**

CORE RUN					DESCRIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESCRIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-8																	
4.17	**4.78**	**33**	**92**		63.90	63.29											
	4.22					63.85	Joint	1	80°	✓				4	A-C <1 mm		
	4.24					63.83	Joint	1	80°	✓				4	A-C <1 mm		
	4.25					63.82	Joint	1	55°	✓				2	A-C <1 mm		
	4.27					63.80	Joint	1	75°	✓				2	A-C <1 mm		
	4.33					63.74	Joint	1	60°	✓				2	A-C <1 mm		
	4.53					63.54	Joint	1	75°	✓				4	A-C <1 mm		
	4.57					63.50	Joint	1	80°	✓		✓		6	A-C <1 mm		
4.57	4.69				63.50	63.38	Rock fragments										
	4.69					63.38	Joint	1	65°	✓				2	A-C <1 mm		
RC-9																	
4.78	**6.30**	**33**	**100**		63.29	61.77											
	4.88					63.19	Joint	1	85°	✓				2	A-C <1 mm		
	4.93					63.14	Joint	1	85°	✓				2	A-C <1 mm		
	4.96					63.11	Joint	1	80°	✓				4	A-C <1 mm		
	5.05					63.02	Joint	1	75°	✓				3	A-C <1 mm		

REMARKS :

(X) C= Calcite
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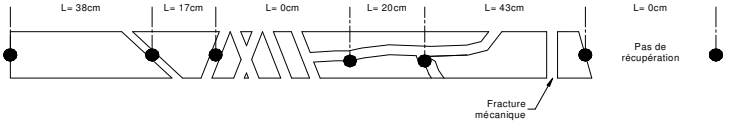
ROCK QUALITY DESIGNATION (RQD)

$$RQD\ \% = \frac{\text{Total} > 100\ \text{mm}}{\text{Core Run Length}} \times 100$$

EXAMPLE :



Description by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-30*	***Tommy Lampron, Jr Eng.***	*2014-01-30*

LVM

STRUCTURAL ROCK DESCRIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-08-14**

CORE RUN					DESCRIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESCRIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-9																	
5.05	5.18				63.02	62.89	Rock fragments										
	5.18					62.89	Joint	1	80°	✓				3	A-C <1 mm		
	5.25					62.82	Joint	1	15°	✓				3	A-C <1 mm		
	5.29					62.78	Joint	1		✓				2	A-C <1 mm		
	5.47					62.60	Joint	1	85°	✓				2	A-C <1 mm		
	5.58					62.49	Joint	1	85°	✓				2	A-C <1 mm		
	5.69					62.38	Joint	1	85°	✓				2	A-C <1 mm		
	5.82					62.25	Joint	1	85°	✓				2	A-C <1 mm		
	5.90					62.17	Joint	1	80°	✓				4	A-C <1 mm		
	5.96					62.11	Joint	1	85°	✓				3	A-C <1 mm		
	6.00					62.07	Joint	6	80°	✓				4	A-C <1 mm		
	6.13					61.94	Joint	1	80°	✓				6	A-C <1 mm		
	6.19					61.88	Joint	1	15°	✓				6	A-C <1 mm		
	6.20					61.87	Joint	1	85°	✓				6	A-C <1 mm		

REMARKS : From 4.57 to 4.69 m and 5,05 to 5.18 m, the rock is heavily fragmented possibly mechanically

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ROCK QUALITY DESIGNATION (RQD)

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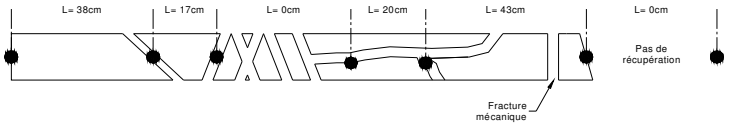
EXAMPLE :



Description by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-30*	***Tommy Lampron, Jr Eng.***	*2014-01-30*

LVM

STRUCTURAL ROCK DESCRIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-08-14**

CORE RUN					DESCRIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESCRIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
RC-10																	
6.30	**7.82**	**12**	**100**		61.77	60.25											
	6.46					61.61	Joint	1	75°	✓				2	A-C <1 mm		
	6.50					61.57	Joint	1	80°					2			
	6.58					61.49	Joint	1	80°	✓				2	A-C <1 mm		
	6.70					61.37	Joint	1	85°	✓				2	A-C <1 mm		
6.70	7.60				61.37	60.47	Rock fracture										
	7.60					60.47	Joint	1	85°	✓				2	A-C <1 mm		
	7.61					60.46	Joint	1	15°	✓				2	A-C <1 mm		
RC-11																	
7.82	**9.35**	**65**	**100**		60.25	58.72											
	7.92					60.15	Joint	1	75°	✓				2	A-C <1 mm		
	7.98					60.09	Joint	1	75°	✓				2	A-C <1 mm		
	8.11					59.96	Joint	1	80°	✓				4	A-C <1 mm		
	8.23					59.84	Joint	1	85°	✓				2	A-C <1 mm		
	8.33					59.74	Joint	1	85°	✓				2	A-C <1 mm		
	8.42					59.65	Joint	1	80°	✓				2	A-C <1 mm		

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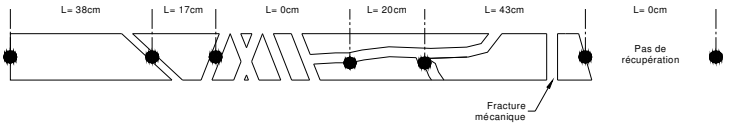

Description by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-30*	***Tommy Lampron, Jr Eng.***	*2014-01-30*

LVM

STRUCTURAL ROCK DESCRIPTION

PROJECT : Geotechnical Investigation - Block 1A (EP168-142026) **OUR FILE :** **B-0008257-1**

LOCATION : 530 Tremblay Road, Ottawa, Ontario **BOREHOLE** **BH-08-14**

CORE RUN					DESCRIPTION AND OBSERVATIONS												
Depth (m)		RQD (%)	Recuperation (%)	Water loss (%)	Elevation (m)		ITEM DESCRIBED	Number of fractures (joints)	Angle to core axis	Close	Open	Curve	Irregular	JRC	Covered with and thickness (X)	Alteration	color (XX)
From	To				From	To											
	8.55					59.52	Joint	1	80°	✓				2	A-C <1 mm		
	8.69					59.38	Joint	1	85°	✓				2	A-C <1 mm		
	8.77					59.30	Joint	1	75°	✓				4	A-C <1 mm		
	8.92					59.15	Joint	1	85°	✓			✓	10	A-C <1 mm		
	9.07					59.00	Joint	1	75°	✓		✓		6	A <1 mm		
	9.15					58.92	Joint	1	75°	✓				2	A-C <1 mm		
	9.30					58.77	Joint	1	80°	✓				4	A <1 mm		
RC-12																	
9.35	**10.87**	**88**	**95**		58.72	57.20											
	9.49					58.58	Joint	1	85°	✓				3	A-C <1 mm		
	9.59					58.48	Joint	1	75°	✓				2	A-C <1 mm		
	9.63					58.44	Joint	1	80°	✓				5	A-C <1 mm		
	9.87					58.20	Joint	1	80°	✓				3	A <1 mm		
	10.17					57.90	Joint	1	75°	✓				2	A <1 mm		
	10.49					57.58	Joint	1	75°	✓				2	A <1 mm		
	10.67					57.40	Joint	1	80°	✓				2	A-C <1 mm		
	10.70					57.37	Joint	1	85°	✓				2	A-C <1 mm		
	10.72					57.35	Joint	1	80°	✓				2	A-C <1 mm		

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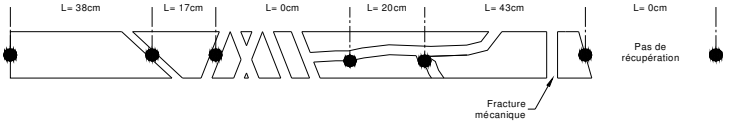


Description by :	Date :	Verified by :	Date :
Sylvain Séguin	*2014-01-30*	***Tommy Lampron, Jr Eng.***	*2014-01-30*

900, boul. de la Carrière, bur. 100
Gatineau, J8Y 6T5
Téléphone: (819) 778-3143

Testing on Soils, Aggregates and Other Materials

Client : PWGSC
Project : Geotechnical Investigation – Block 1A; Interpretation and recommendation
Location : 530, Tremblay Road, Ottawa, ON

Project # : B-0008257-1
Client ref. : EP168-123367/001/F
Report # : 1 **Rev.** 0
Page 1 **of** 1

Sampling

Sampling #	:	1
Your sampling #	:	
Material	:	
Source; location	:	From borehole
Sampling location	:	BH-05-14, SS-7; 3.66 - 4.27 m

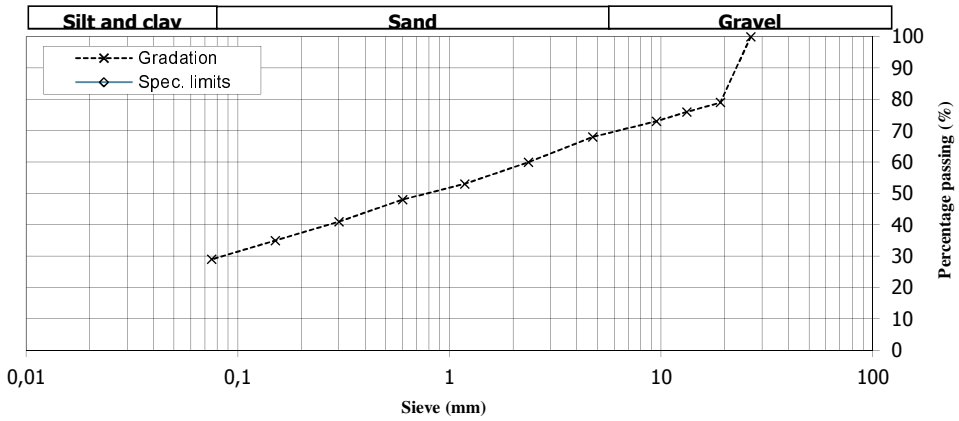
Specification # 1

Reference	:	
Use	:	
Calibre	:	
Class	:	

Sampling date	:	2014-01-14
By	:	Sylvain Séguin, tech.
Date received	:	2014-01-29

Sieve analysis (ASTM C136)

SIEVE (mm)	% PASSING REQUIREMENTS	% PASSING RESULT
150		
75		
50		
37,5		
26,5		100
19		79
13,2		76
9,5		73
4,75		68
2,36		60
1,18		53
0,600		48
0,300		41
0,150		35
0,075		29,0



Cu : Cc : FM : 2,31 | D_{10} : D_{30} : 0,085 D_{60} : 2,399

Maximum dry density kg/m³	Optimum moisture %	Retained 5 mm %

Proportions from sieve analysis (%)

Cobble :	Sand :
Gravel :	Silt and clay :

Other testing	Required	Result
Water content (%)		7,3

Remarks

RESULTS WITH AN ASTERISK DO NOT MEET REQUIREMENTS.

Prepared by :	Date :	Approved by :	Date :
Jean-Pierre Lavoie, chef d'équipe	2014-01-31	**Yaya Coulibaly, ing., P.Eng.**	

LVM

900, boul. de la Carrière, bur. 100
Gatineau, J8Y 6T5
Téléphone: (819) 778-3143

Testing on Soils, Aggregates and Other Materials

Client : PWGSC
Project : Geotechnical Investigation – Block 1A; Interpretation and recommendation
Location : 530, Tremblay Road, Ottawa, ON

Project # : B-0008257-1
Client ref. : EP168-123367/001/F
Report # : 2 **Rev.** 0

Sampling

Sampling #	:	2
Your sampling #	:	
Material	:	
Source; location	:	From borehole
Sampling location	:	BH-05-14, SS-4; 1.83 - 2.44 m

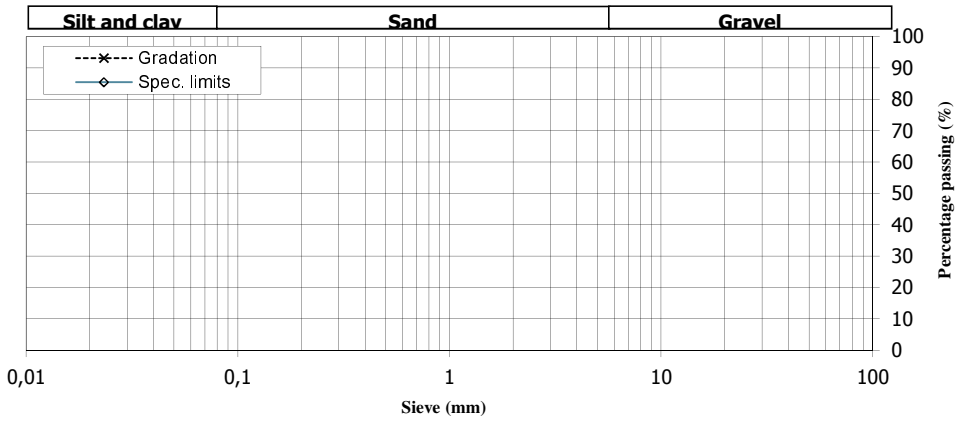
Specification # 1

Reference	:	
Use	:	
Calibre	:	
Class	:	

Sampling date	:	2014-01-14
By	:	Sylvain Séguin, tech.
Date received	:	2014-01-29

Sieve analysis

SIEVE (mm)	% PASSING REQUIREMENTS	% PASSING RESULT



Cu : Cc : FM : D_{10} : D_{30} : D_{60} :

Maximum dry density kg/m³	Optimum moisture %	Retained 5 mm %

Proportions from sieve analysis (%)

Cobble :	Sand :
Gravel :	Silt and clay :

Other testing	Required	Result
Water content (%)		8,6

Remarks

RESULTS WITH AN ASTERISK DO NOT MEET REQUIREMENTS.

Prepared by :	Date :	Approved by :	Date :
Jean-Pierre Lavoie, chef d'équipe	2014-01-31	**Yaya Coulibaly, ing., P.Eng.**	

LVM

900, boul. de la Carrière, bur. 100
Gatineau, J8Y 6T5
Téléphone: (819) 778-3143

Testing on Soils, Aggregates and Other Materials

Client : PWGSC
Project : Geotechnical Investigation – Block 1A; Interpretation and recommendation
Location : 530, Tremblay Road, Ottawa, ON

Project # : B-0008257-1
Client ref. : EP168-123367/001/F
Report # : 4 **Rev.** 0

Sampling

Sampling #	:	4
Your sampling #	:	
Material	:	Rock core
Source; location	:	From borehole
Sampling location	:	BH-05-14, RC-12; 9.08 - 9.19 m

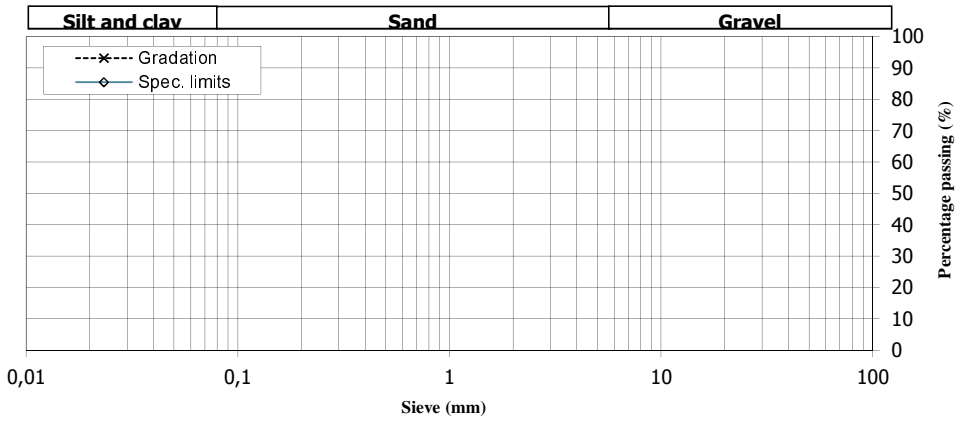
Specification # 1

Reference	:	
Use	:	
Calibre	:	
Class	:	

Sampling date	:	2014-01-14
By	:	Sylvain Séguin, tech.
Date received	:	2014-01-29

Sieve analysis

SIEVE (mm)	% PASSING REQUIREMENTS	% PASSING RESULT



Cu : Cc : FM : D_{10} : D_{30} : D_{60} :

Maximum dry density kg/m³	Optimum moisture %	Retained 5 mm %

Proportions from sieve analysis (%)

Cobble :	Sand :
Gravel :	Silt and clay :

Other testing	Required	Result
Module d'élasticité (GPa)		18,82
Résistance à la compression uniaxiale sur carotte de roc (MPa)		66,4

Remarks

RESULTS WITH AN ASTERISK DO NOT MEET REQUIREMENTS.

Prepared by :	Date :	Approved by :	Date :
Jean-Pierre Lavoie, chef d'équipe	2014-02-10	**Yaya Coulibaly, ing., P.Eng.**	

LVM

900, boul. de la Carrière, bur. 100
Gatineau, J8Y 6T5
Téléphone: (819) 778-3143

Testing on Soils, Aggregates and Other Materials

Client : PWGSC
Project : Geotechnical Investigation – Block 1A; Interpretation and recommendation
Location : 530, Tremblay Road, Ottawa, ON

Project # : B-0008257-1
Client ref. : EP168-123367/001/F
Report # : 5 **Rev.** 0
Page 1 **of** 1

Sampling

Sampling #	:	5
Your sampling #	:	
Material	:	
Source; location	:	From borehole
Sampling location	:	BH-06-14, SS-6; 3.05 - 3.66 m

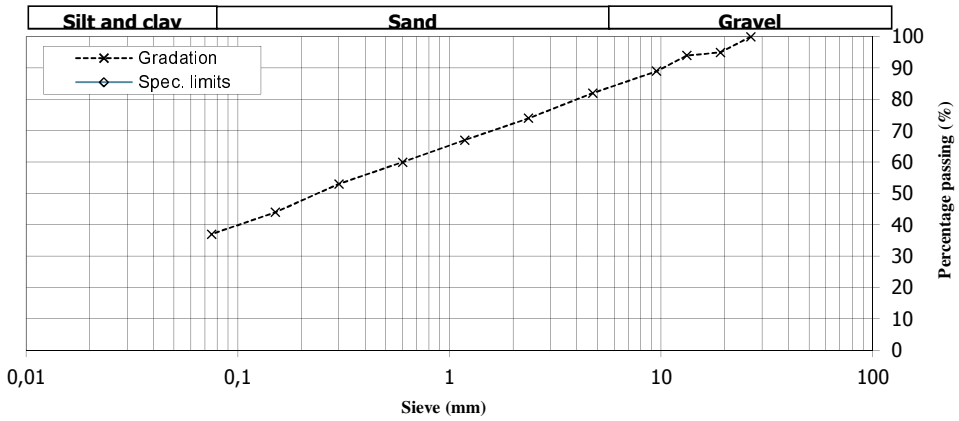
Specification # 1

Reference	:	
Use	:	
Calibre	:	
Class	:	

Sampling date	:	2014-01-15
By	:	Sylvain Séguin, tech.
Date received	:	2014-01-29

Sieve analysis (ASTM C136)

SIEVE (mm)	% PASSING REQUIREMENTS	% PASSING RESULT
150		
75		
50		
37,5		
26,5		100
19		95
13,2		94
9,5		89
4,75		82
2,36		74
1,18		67
0,600		60
0,300		53
0,150		44
0,075		37,4



Cu : Cc : FM : 1,64 D_{10} : D_{30} : D_{60} : 0,589

Maximum dry density kg/m³	Optimum moisture %	Retained 5 mm %

Proportions from sieve analysis (%)

Cobble :	Sand :
Gravel :	Silt and clay :

Other testing	Required	Result
Water content (%)		8,1

Remarks

RESULTS WITH AN ASTERISK DO NOT MEET REQUIREMENTS.

Prepared by : Jean-Pierre Lavoie, chef d'équipe **Date :** 2014-01-31

Approved by : **Yaya Coulibaly, ing., P.Eng.** **Date :**

900, boul. de la Carrière, bur. 100
Gatineau, J8Y 6T5
Téléphone: (819) 778-3143

Testing on Soils, Aggregates and Other Materials

Client : PWGSC
Project : Geotechnical Investigation – Block 1A; Interpretation and recommendation
Location : 530, Tremblay Road, Ottawa, ON

Project # : B-0008257-1
Client ref. : EP168-123367/001/F
Report # : 6 **Rev.** 0

Sampling

Sampling #	:	6
Your sampling #	:	
Material	:	
Source; location	:	From borehole
Sampling location	:	BH-06-14, SS-3; 1.22 - 1.83 m

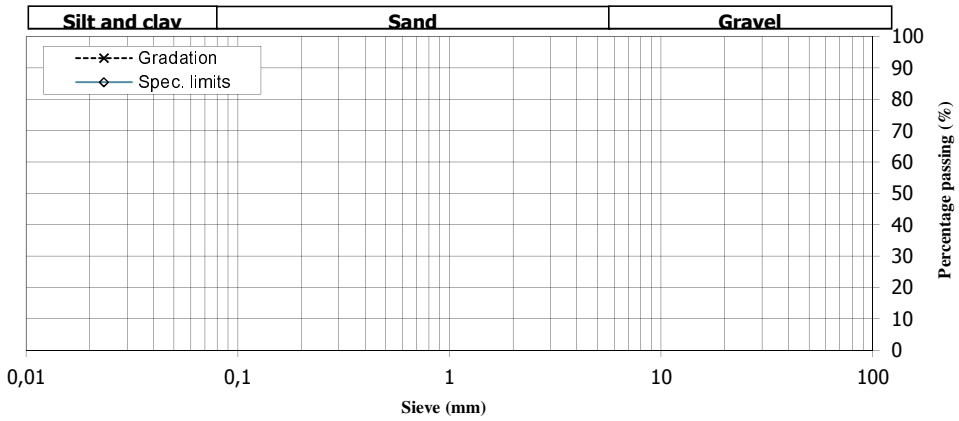
Specification # 1

Reference	:	
Use	:	
Calibre	:	
Class	:	

Sampling date	:	2014-01-15
By	:	Sylvain Séguin, tech.
Date received	:	2014-01-29

Sieve analysis

SIEVE (mm)	% PASSING REQUIREMENTS	% PASSING RESULT



Cu : Cc : FM : D_{10} : D_{30} : D_{60} :

Maximum dry density kg/m³	Optimum moisture %	Retained 5 mm %

Proportions from sieve analysis (%)

Cobble : Sand :
Gravel : Silt and clay :

Other testing	Required	Result
Water content (%)		14,3

Remarks

RESULTS WITH AN ASTERISK DO NOT MEET REQUIREMENTS.

Prepared by : Jean-Pierre Lavoie, chef d'équipe **Date :** 2014-01-31

Approved by : **Yaya Coulibaly, ing., P.Eng.** **Date :**

LVM

900, boul. de la Carrière, bur. 100
Gatineau, J8Y 6T5
Téléphone: (819) 778-3143

Testing on Soils, Aggregates and Other Materials

Client : PWGSC
Project : Geotechnical Investigation – Block 1A; Interpretation and recommendation
Location : 530, Tremblay Road, Ottawa, ON

Project # : B-0008257-1
Client ref. : EP168-123367/001/F
Report # : 8 **Rev.** 0
Page 1 **of** 1

Sampling

Sampling #	:	8
Your sampling #	:	
Material	:	
Source; location	:	From borehole
Sampling location	:	BH-07-14, SS-7; 3.66 - 4.06 m

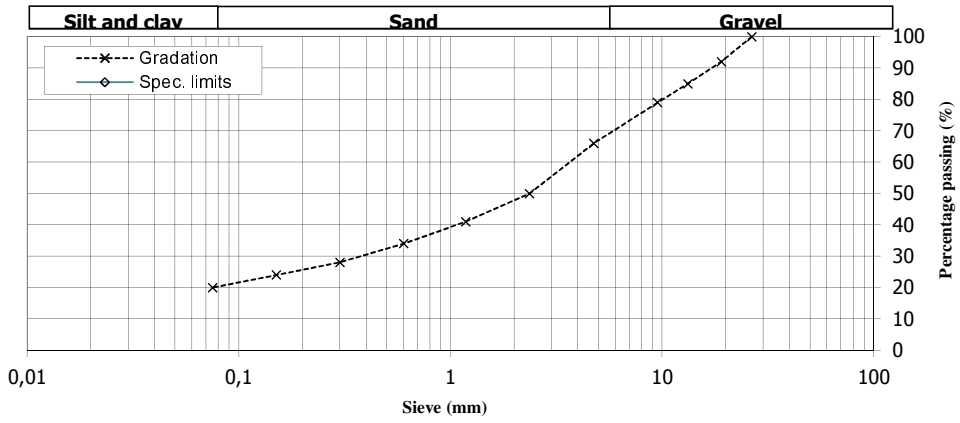
Specification # 1

Reference	:	
Use	:	
Calibre	:	
Class	:	

Sampling date	:	2014-01-16
By	:	Sylvain Séguin, tech.
Date received	:	2014-01-29

Sieve analysis (ASTM C136)

SIEVE (mm)	% PASSING REQUIREMENTS	% PASSING RESULT
150		
75		
50		
37,5		
26,5		100
19		92
13,2		85
9,5		79
4,75		66
2,36		50
1,18		41
0,600		34
0,300		28
0,150		24
0,075		19,7



Cu : Cc : FM : 2,81 D_{10} : D_{30} : 0,372 D_{60} : 3,682

Maximum dry density kg/m³	Optimum moisture %	Retained 5 mm %

Proportions from sieve analysis (%)

Cobble : Sand :
Gravel : Silt and clay :

Other testing	Required	Result
Water content (%)		9,2

Remarks

RESULTS WITH AN ASTERISK DO NOT MEET REQUIREMENTS.

Prepared by : Jean-Pierre Lavoie, chef d'équipe **Date :** 2014-01-31

Approved by : **Yaya Coulibaly, ing., P.Eng.** **Date :**

900, boul. de la Carrière, bur. 100
Gatineau, J8Y 6T5
Téléphone: (819) 778-3143

Testing on Soils, Aggregates and Other Materials

Client : PWGSC
Project : Geotechnical Investigation – Block 1A; Interpretation and recommendation
Location : 530, Tremblay Road, Ottawa, ON

Project # : B-0008257-1
Client ref. : EP168-123367/001/F
Report # : 9 **Rev.** 0

Sampling

Sampling #	:	9
Your sampling #	:	
Material	:	
Source; location	:	From borehole
Sampling location	:	BH-07-14, SS-4; 1.83 - 2.44 m

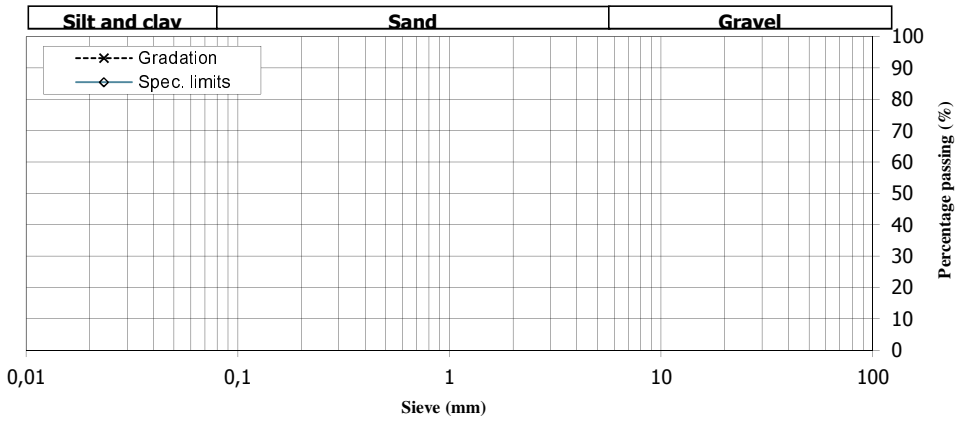
Specification # 1

Reference	:	
Use	:	
Calibre	:	
Class	:	

Sampling date	:	2014-01-16
By	:	Sylvain Séguin, tech.
Date received	:	2014-01-29

Sieve analysis

SIEVE (mm)	% PASSING REQUIREMENTS	% PASSING RESULT



Cu : Cc : FM : D_{10} : D_{30} : D_{60} :

Maximum dry density kg/m³	Optimum moisture %	Retained 5 mm %

Proportions from sieve analysis (%)

Cobble : Sand :
Gravel : Silt and clay :

Other testing	Required	Result
Water content (%)		49,1

Remarks

RESULTS WITH AN ASTERISK DO NOT MEET REQUIREMENTS.

Prepared by : Jean-Pierre Lavoie, chef d'équipe **Date :** 2014-01-31

Approved by : **Yaya Coulibaly, ing., P.Eng.** **Date :**

LVM

900, boul. de la Carrière, bur. 100
Gatineau, J8Y 6T5
Téléphone: (819) 778-3143

Testing on Soils, Aggregates and Other Materials

Client : PWGSC
Project : Geotechnical Investigation – Block 1A; Interpretation and recommendation
Location : 530, Tremblay Road, Ottawa, ON

Project # : B-0008257-1
Client ref. : EP168-123367/001/F
Report # : 11 **Rev.** 0
Page 1 **of** 1

Sampling

Sampling #	:	11
Your sampling #	:	
Material	:	
Source; location	:	From borehole
Sampling location	:	BH-08-14, SS-6; 3.05 - 3.66 m

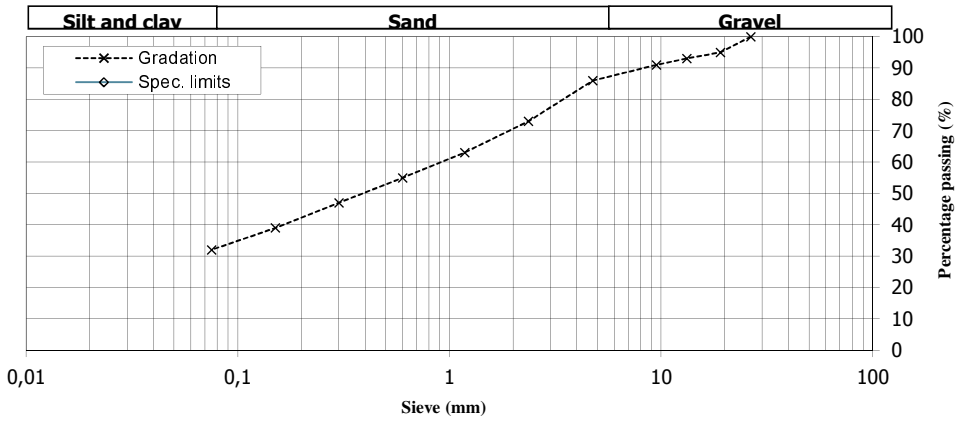
Specification # 1

Reference	:	
Use	:	
Calibre	:	
Class	:	

Sampling date	:	2014-01-15
By	:	Sylvain Séguin, tech.
Date received	:	2014-01-29

Sieve analysis (ASTM C136)

SIEVE (mm)	% PASSING REQUIREMENTS	% PASSING RESULT
150		
75		
50		
37,5		
26,5		100
19		95
13,2		93
9,5		91
4,75		86
2,36		73
1,18		63
0,600		55
0,300		47
0,150		39
0,075		32,0



Cu : Cc : FM : 1,76 D_{10} : D_{30} : D_{60} : 0,929

Maximum dry density kg/m³	Optimum moisture %	Retained 5 mm %

Proportions from sieve analysis (%)

Cobble :	Sand :
Gravel :	Silt and clay :

Other testing	Required	Result
Water content (%)		7,3

Remarks

RESULTS WITH AN ASTERISK DO NOT MEET REQUIREMENTS.

Prepared by : Jean-Pierre Lavoie, chef d'équipe **Date :** 2014-01-31

Approved by : **Yaya Coulibaly, ing., P.Eng.** **Date :**

900, boul. de la Carrière, bur. 100
Gatineau, J8Y 6T5
Téléphone: (819) 778-3143

Testing on Soils, Aggregates and Other Materials

Client : PWGSC
Project : Geotechnical Investigation – Block 1A; Interpretation and recommendation
Location : 530, Tremblay Road, Ottawa, ON

Project # : B-0008257-1
Client ref. : EP168-123367/001/F
Report # : 12 **Rev.** 0
Page 1 **of** 1

Sampling

Sampling #	:	12
Your sampling #	:	
Material	:	
Source; location	:	From borehole
Sampling location	:	BH-08-14, SS-3; 1.22 - 1.83 m

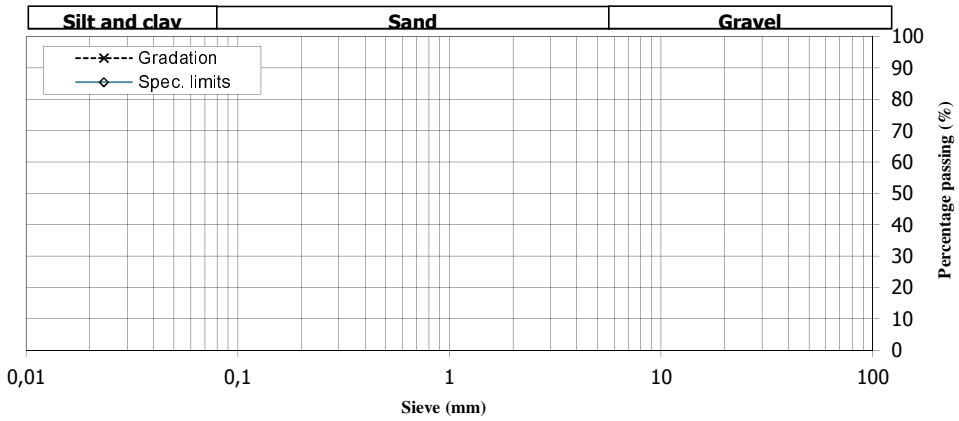
Specification # 1

Reference	:	
Use	:	
Calibre	:	
Class	:	

Sampling date	:	2014-01-15
By	:	Sylvain Séguin, tech.
Date received	:	2014-01-29

Sieve analysis

SIEVE (mm)	% PASSING REQUIREMENTS	% PASSING RESULT



Cu : Cc : FM : D_{10} : D_{30} : D_{60} :

Maximum dry density kg/m³	Optimum moisture %	Retained 5 mm %

Proportions from sieve analysis (%)

Cobble : Sand :
Gravel : Silt and clay :

Other testing	Required	Result
Water content (%)		9,5

Remarks

RESULTS WITH AN ASTERISK DO NOT MEET REQUIREMENTS.

Prepared by : Jean-Pierre Lavoie, chef d'équipe — **Date :** 2014-01-31

Approved by : **Yaya Coulibaly, ing., P.Eng.** — **Date :**

LVM

900, boul. de la Carrière, bur. 100
Gatineau, J8Y 6T5
Téléphone: (819) 778-3143

Testing on Soils, Aggregates and Other Materials

Client : PWGSC
Project : Geotechnical Investigation – Block 1A; Interpretation and recommendation
Location : 530, Tremblay Road, Ottawa, ON

Project # : B-0008257-1
Client ref. : EP168-123367/001/F
Report # : 15 **Rev.** 0

Sampling

Sampling #	:	15
Your sampling #	:	
Material	:	Rock core
Source; location	:	From borehole
Sampling location	:	BH-08-14, RC-12; 10.30 - 10.41 m

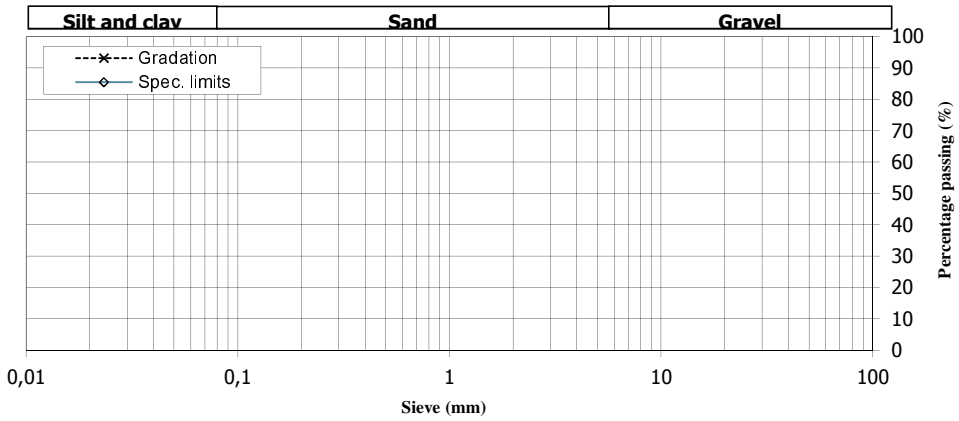
Specification # 1

Reference	:	
Use	:	
Calibre	:	
Class	:	

Sampling date	:	2014-01-15
By	:	Sylvain Séguin, tech.
Date received	:	2014-01-29

Sieve analysis

SIEVE (mm)	% PASSING REQUIREMENTS	% PASSING RESULT



Cu : Cc : FM : D_{10} : D_{30} : D_{60} :

Maximum dry density kg/m³	Optimum moisture %	Retained 5 mm %

Proportions from sieve analysis (%)

Cobble :	Sand :
Gravel :	Silt and clay :

Other testing	Required	Result
Module d'élasticité (GPa)		10,33
Résistance à la compression uniaxiale sur carotte de roc (MPa)		56,7

Remarks

RESULTS WITH AN ASTERISK DO NOT MEET REQUIREMENTS.

Prepared by :	Date :	Approved by :	Date :
Jean-Pierre Lavoie, chef d'équipe	2014-02-10	**Yaya Coulibaly, ing., P.Eng.**	

LVM

900, boul. de la Carrière, bur. 100
Gatineau, J8Y 6T5
Téléphone: (819) 778-3143

Testing on Soils, Aggregates and Other Materials

Client : PWGSC
Project : Geotechnical Investigation – Block 1A; Interpretation and recommendation
Location : 530, Tremblay Road, Ottawa, ON

Project # : B-0008257-1
Client ref. : EP168-123367/001/F
Report # : 16 **Rev.** 0
Page 1 **of** 1

Sampling

Sampling #	:	16
Your sampling #	:	
Material	:	
Source; location	:	From borehole
Sampling location	:	BH-01-14, SS-2; 0.61 - 1.22 m

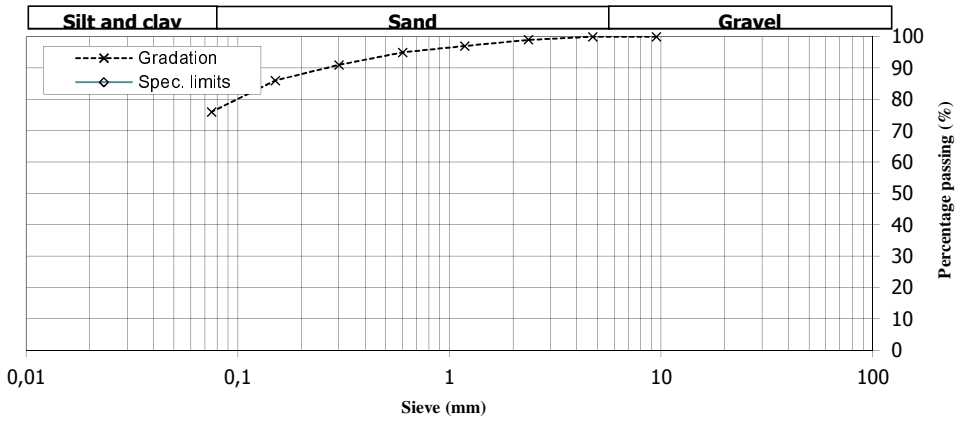
Specification # 1

Reference	:	
Use	:	
Calibre	:	
Class	:	

Sampling date	:	2014-01-21
By	:	Sylvain Séguin, tech.
Date received	:	2014-01-29

Sieve analysis (ASTM C136)

SIEVE (mm)	% PASSING REQUIREMENTS	% PASSING RESULT
150		
75		
50		
37,5		
26,5		
19		
13,2		
9,5		100
4,75		100
2,36		99
1,18		97
0,600		95
0,300		91
0,150		86
0,075		76,4



Cu : Cc : FM : 0,18 D_{10} : D_{30} : D_{60} :

Maximum dry density kg/m³	Optimum moisture %	Retained 5 mm %

Proportions from sieve analysis (%)

Cobble :	Sand :
Gravel :	Silt and clay :

Other testing	Required	Result
Water content (%)		29,8

Remarks

RESULTS WITH AN ASTERISK DO NOT MEET REQUIREMENTS.

Prepared by : Jean-Pierre Lavoie, chef d'équipe **Date :** 2014-01-31

Approved by : **Yaya Coulibaly, ing., P.Eng.** **Date :**

LVM

900, boul. de la Carrière, bur. 100
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Téléphone: (819) 778-3143

Testing on Soils, Aggregates and Other Materials

Client : PWGSC
Project : Geotechnical Investigation – Block 1A; Interpretation and recommendation
Location : 530, Tremblay Road, Ottawa, ON

Project # : B-0008257-1
Client ref. : EP168-123367/001/F
Report # : 18 **Rev.** 0

Sampling

Sampling #	:	18
Your sampling #	:	
Material	:	
Source; location	:	From borehole
Sampling location	:	BH-01-14, SS-6; 3.05 - 3.28 m

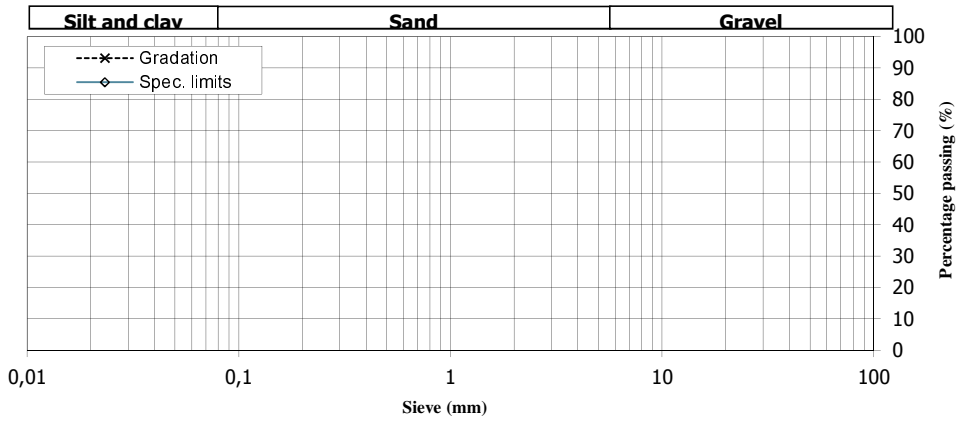
Specification # 1

Reference	:	
Use	:	
Calibre	:	
Class	:	

Sampling date	:	2014-01-21
By	:	Sylvain Séguin, tech.
Date received	:	2014-01-29

Sieve analysis

SIEVE (mm)	% PASSING REQUIREMENTS	% PASSING RESULT



Cu : Cc : FM : D_{10} : D_{30} : D_{60} :

Maximum dry density kg/m³	Optimum moisture %	Retained 5 mm %

Proportions from sieve analysis (%)

Cobble :	Sand :
Gravel :	Silt and clay :

Other testing	Required	Result
Water content (%)		7,3

Remarks

RESULTS WITH AN ASTERISK DO NOT MEET REQUIREMENTS.

Prepared by :	Date :	Approved by :	Date :
Jean-Pierre Lavoie, chef d'équipe	2014-01-31	**Yaya Coulibaly, ing., P.Eng.**	

900, boul. de la Carrière, bur. 100
Gatineau, J8Y 6T5
Téléphone: (819) 778-3143

Testing on Soils, Aggregates and Other Materials

Client : PWGSC
Project : Geotechnical Investigation – Block 1A; Interpretation and recommendation
Location : 530, Tremblay Road, Ottawa, ON

Project # : B-0008257-1
Client ref. : EP168-123367/001/F
Report # : 20 **Rev.** 0

Sampling

Sampling #	:	20
Your sampling #	:	
Material	:	
Source; location	:	From borehole
Sampling location	:	BH-02-14, SS-1; 0.61 - 1.22 m

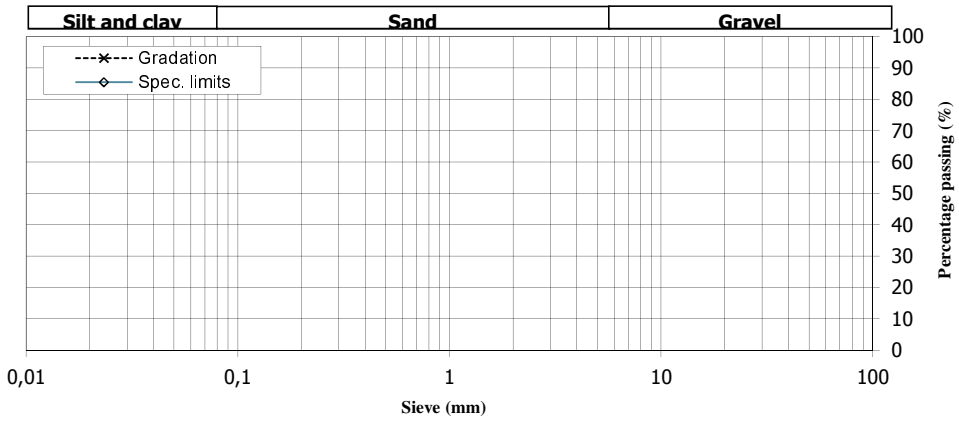
Specification # 1

Reference	:	
Use	:	
Calibre	:	
Class	:	

Sampling date	:	2014-01-22
By	:	Sylvain Séguin, tech.
Date received	:	2014-01-22

Sieve analysis

SIEVE (mm)	% PASSING REQUIREMENTS	% PASSING RESULT



Cu : Cc : FM : D_{10} : D_{30} : D_{60} :

Maximum dry density kg/m³	Optimum moisture %	Retained 5 mm %

Proportions from sieve analysis (%)

Cobble :	Sand :
Gravel :	Silt and clay :

Other testing	Required	Result
Water content (%)		21,3

Remarks

RESULTS WITH AN ASTERISK DO NOT MEET REQUIREMENTS.

Prepared by : Jean-Pierre Lavoie, chef d'équipe **Date :** 2014-01-31

Approved by : **Yaya Coulibaly, ing., P.Eng.** **Date :**

LVM

900, boul. de la Carrière, bur. 100
Gatineau, J8Y 6T5
Téléphone: (819) 778-3143

Testing on Soils, Aggregates and Other Materials

Client : PWGSC
Project : Geotechnical Investigation – Block 1A; Interpretation and recommendation
Location : 530, Tremblay Road, Ottawa, ON

Project # : B-0008257-1
Client ref. : EP168-123367/001/F
Report # : 21 **Rev.** 0
Page 1 **of** 1

Sampling

Sampling #	:	21
Your sampling #	:	
Material	:	
Source; location	:	From borehole
Sampling location	:	BH-02-14, SS-4; 2.44 - 3.05 m

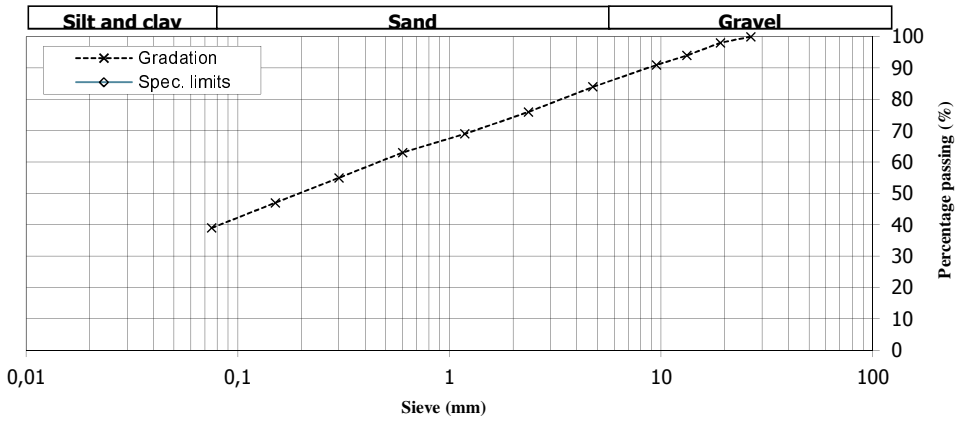
Specification # 1

Reference	:	
Use	:	
Calibre	:	
Class	:	

Sampling date	:	2014-01-22
By	:	Sylvain Séguin, tech.
Date received	:	2014-01-29

Sieve analysis (ASTM C136)

SIEVE (mm)	% PASSING REQUIREMENTS	% PASSING RESULT
150		
75		
50		
37,5		
26,5		100
19		98
13,2		94
9,5		91
4,75		84
2,36		76
1,18		69
0,600		63
0,300		55
0,150		47
0,075		39,3



Cu : Cc : FM : 1,53 D_{10} : D_{30} : D_{60} : 0,476

Maximum dry density kg/m³	Optimum moisture %	Retained 5 mm %

Proportions from sieve analysis (%)

Cobble :	Sand :
Gravel :	Silt and clay :

Other testing	Required	Result
Water content (%)		9,5

Remarks

RESULTS WITH AN ASTERISK DO NOT MEET REQUIREMENTS.

Prepared by : Jean-Pierre Lavoie, chef d'équipe **Date :** 2014-01-31

Approved by : **Yaya Coulibaly, ing., P.Eng.** **Date :**

LVM

900, boul. de la Carrière, bur. 100
Gatineau, J8Y 6T5
Téléphone: (819) 778-3143

Testing on Soils, Aggregates and Other Materials

Client : PWGSC
Project : Geotechnical Investigation – Block 1A; Interpretation and recommendation
Location : 530, Tremblay Road, Ottawa, ON

Project # : B-0008257-1
Client ref. : EP168-123367/001/F
Report # : 23 **Rev.** 0

Sampling

Sampling #	:	23
Your sampling #	:	
Material	:	Rock core
Source; location	:	From borehole
Sampling location	:	BH-02-14, SS-10; 10.00 - 10.11 m

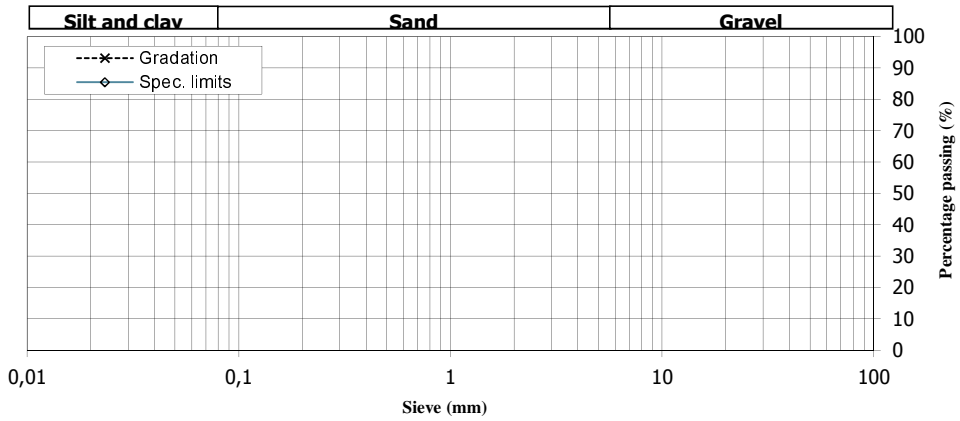
Specification # 1

Reference	:	
Use	:	
Calibre	:	
Class	:	

Sampling date	:	2014-01-22
By	:	Sylvain Séguin, tech.
Date received	:	2014-01-29

Sieve analysis

SIEVE (mm)	% PASSING REQUIREMENTS	% PASSING RESULT



Cu : Cc : FM : D_{10} : D_{30} : D_{60} :

Maximum dry density kg/m³	Optimum moisture %	Retained 5 mm %

Proportions from sieve analysis (%)

Cobble : Sand :
Gravel : Silt and clay :

Other testing	Required	Result
Résistance à la compression uniaxiale sur carotte de roc (ASTM D 7012) (MPa)		56,9
Module d'élasticité (GPa)		1,49
Résistance à la compression uniaxiale sur carotte de roc (MPa)		10,0

Remarks

RESULTS WITH AN ASTERISK DO NOT MEET REQUIREMENTS.

Prepared by : Jean-Pierre Lavoie, chef d'équipe **Date :** 2014-02-10

Approved by : **Yaya Coulibaly, ing., P.Eng.** **Date :**

LVM

900, boul. de la Carrière, bur. 100
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Téléphone: (819) 778-3143

Testing on Soils, Aggregates and Other Materials

Client : PWGSC
Project : Geotechnical Investigation – Block 1A; Interpretation and recommendation
Location : 530, Tremblay Road, Ottawa, ON

Project # : B-0008257-1
Client ref. : EP168-123367/001/F
Report # : 24 **Rev.** 0

Sampling

Sampling #	:	24
Your sampling #	:	
Material	:	
Source; location	:	From borehole
Sampling location	:	BH-03-14, SS-2; 0.61 - 1.22 m

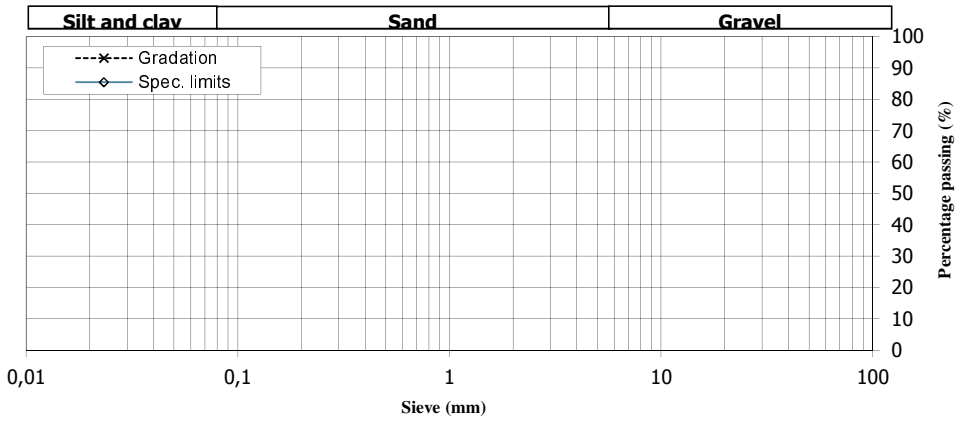
Specification # 1

Reference	:	
Use	:	
Calibre	:	
Class	:	

Sampling date	:	2014-01-17
By	:	Sylvain Séguin, tech.
Date received	:	2014-01-29

Sieve analysis

SIEVE (mm)	% PASSING REQUIREMENTS	% PASSING RESULT



Cu : Cc : FM : D_{10} : D_{30} : D_{60} :

Maximum dry density kg/m³	Optimum moisture %	Retained 5 mm %

Proportions from sieve analysis (%)

Cobble : Sand :
Gravel : Silt and clay :

Other testing	Required	Result
Water content (%)		17,5

Remarks

RESULTS WITH AN ASTERISK DO NOT MEET REQUIREMENTS.

Prepared by : Jean-Pierre Lavoie, chef d'équipe — **Date :** 2014-01-31

Approved by : **Yaya Coulibaly, ing., P.Eng.** — **Date :**

LVM

900, boul. de la Carrière, bur. 100
Gatineau, J8Y 6T5
Téléphone: (819) 778-3143

Testing on Soils, Aggregates and Other Materials

Client : PWGSC
Project : Geotechnical Investigation – Block 1A; Interpretation and recommendation
Location : 530, Tremblay Road, Ottawa, ON

Project # : B-0008257-1
Client ref. : EP168-123367/001/F
Report # : 25 **Rev.** 0
Page 1 **of** 1

Sampling

Sampling #	:	25
Your sampling #	:	
Material	:	
Source; location	:	From borehole
Sampling location	:	BH-03-14, SS-7; 3.66 - 4.11 m

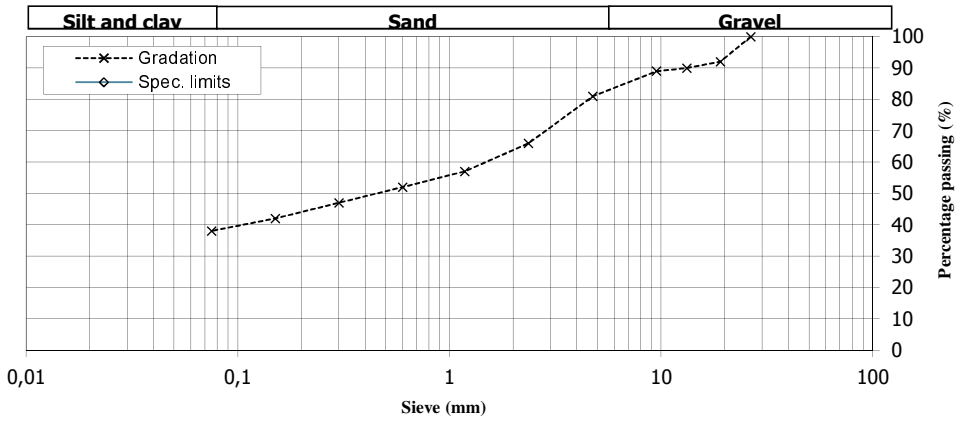
Specification # 1

Reference	:	
Use	:	
Calibre	:	
Class	:	

Sampling date	:	2014-01-17
By	:	Sylvain Séguin, tech.
Date received	:	2014-01-29

Sieve analysis (ASTM C136)

SIEVE (mm)	% PASSING REQUIREMENTS	% PASSING RESULT
150		
75		
50		
37,5		
26,5		100
19		92
13,2		90
9,5		89
4,75		81
2,36		66
1,18		57
0,600		52
0,300		47
0,150		42
0,075		38,2



Cu : Cc : FM : 1,98 | D_{10} : D_{30} : D_{60} : 1,459

Maximum dry density kg/m³	Optimum moisture %	Retained 5 mm %

Proportions from sieve analysis (%)

Cobble :	Sand :
Gravel :	Silt and clay :

Other testing	Required	Result
Water content (%)		10,6

Remarks

RESULTS WITH AN ASTERISK DO NOT MEET REQUIREMENTS.

Prepared by :	Date :	Approved by :	Date :
Jean-Pierre Lavoie, chef d'équipe	2014-01-31	**Yaya Coulibaly, ing., P.Eng.**	

LVM

900, boul. de la Carrière, bur. 100
Gatineau, J8Y 6T5
Téléphone: (819) 778-3143

Testing on Soils, Aggregates and Other Materials

Client : PWGSC
Project : Geotechnical Investigation – Block 1A; Interpretation and recommendation
Location : 530, Tremblay Road, Ottawa, ON

Project # : B-0008257-1
Client ref. : EP168-123367/001/F
Report # : 27 **Rev.** 0
Page 1 **of** 1

Sampling

Sampling #	:	27
Your sampling #	:	
Material	:	
Source; location	:	From borehole
Sampling location	:	BH-04-14, SS-3; 1.22 - 1.83 m

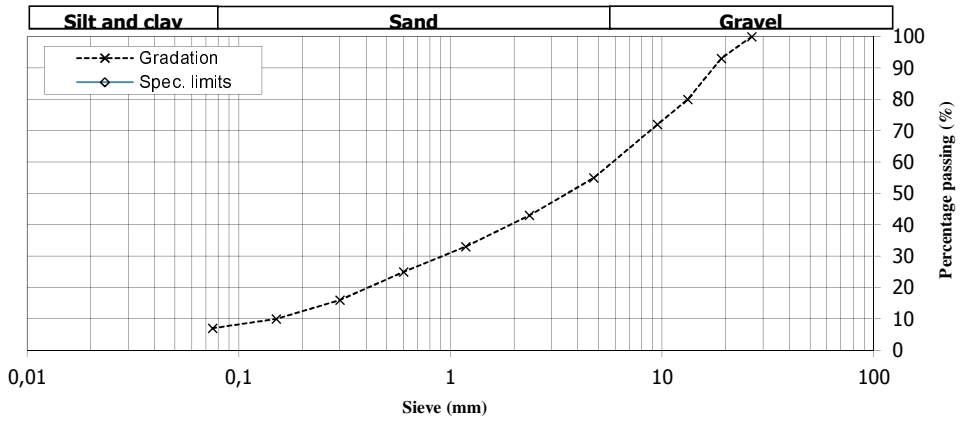
Specification # 1

Reference	:	
Use	:	
Calibre	:	
Class	:	

Sampling date	:	2014-01-20
By	:	Sylvain Séguin, tech.
Date received	:	2014-01-29

Sieve analysis (ASTM C136)

SIEVE (mm)	% PASSING REQUIREMENTS	% PASSING RESULT
150		
75		
50		
37,5		
26,5		100
19		93
13,2		80
9,5		72
4,75		55
2,36		43
1,18		33
0,600		25
0,300		16
0,150		10
0,075		6,8



Cu : 41,6 Cc : 1,0 FM : 3,28 D_{10} : 0,141 D_{30} : 0,910 D_{60} : 5,887

Maximum dry density kg/m³	Optimum moisture %	Retained 5 mm %

Proportions from sieve analysis (%)

Cobble :	Sand :
Gravel :	Silt and clay :

Other testing	Required	Result
Water content (%)		15,5

Remarks

RESULTS WITH AN ASTERISK DO NOT MEET REQUIREMENTS.

Prepared by : Jean-Pierre Lavoie, chef d'équipe **Date :** 2014-01-31

Approved by : **Yaya Coulibaly, ing., P.Eng.** **Date :**

LVM

900, boul. de la Carrière, bur. 100
Gatineau, J8Y 6T5
Téléphone: (819) 778-3143

Testing on Soils, Aggregates and Other Materials

Client : PWGSC
Project : Geotechnical Investigation – Block 1A; Interpretation and recommendation
Location : 530, Tremblay Road, Ottawa, ON

Project # : B-0008257-1
Client ref. : EP168-123367/001/F
Report # : 28 **Rev.** 0

Sampling

Sampling #	:	28
Your sampling #	:	
Material	:	
Source; location	:	From borehole
Sampling location	:	BH-04-14, SS-5; 2.44 - 3.05 m

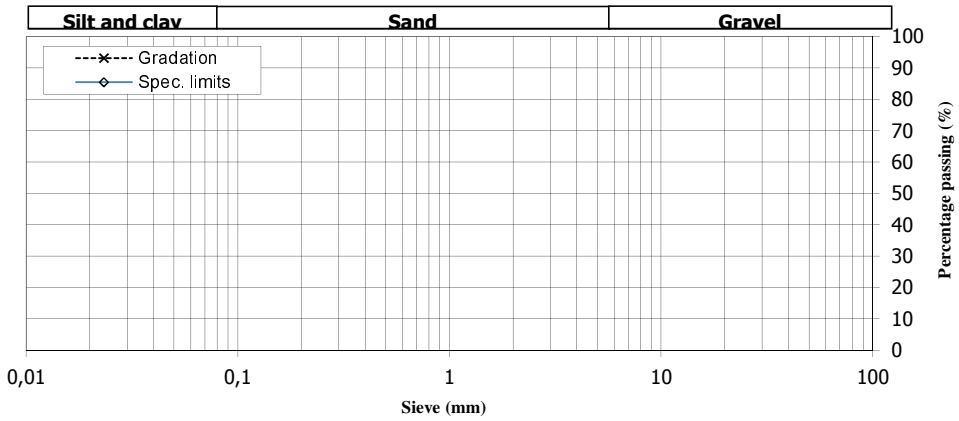
Specification # 1

Reference	:	
Use	:	
Calibre	:	
Class	:	

Sampling date	:	2014-01-20
By	:	Sylvain Séguin, tech.
Date received	:	2014-01-29

Sieve analysis

SIEVE (mm)	% PASSING REQUIREMENTS	% PASSING RESULT



Cu : Cc : FM : D_{10} : D_{30} : D_{60} :

Maximum dry density kg/m³	Optimum moisture %	Retained 5 mm %

Proportions from sieve analysis (%)

Cobble :	Sand :
Gravel :	Silt and clay :

Other testing	Required	Result
Water content (%)		10,5

Remarks

RESULTS WITH AN ASTERISK DO NOT MEET REQUIREMENTS.

Prepared by : Jean-Pierre Lavoie, chef d'équipe — **Date :** 2014-01-31

Approved by : **Yaya Coulibaly, ing., P.Eng.** — **Date :**

LVM

900, boul. de la Carrière, bur. 100
Gatineau, J8Y 6T5
Téléphone: (819) 778-3143

Testing on Soils, Aggregates and Other Materials

Client : PWGSC
Project : Geotechnical Investigation – Block 1A; Interpretation and recommendation
Location : 530, Tremblay Road, Ottawa, ON

Project # : B-0008257-1
Client ref. : EP168-123367/001/F
Report # : 30 **Rev.** 0
Page 1 **of** 1

Sampling

Sampling #	:	30
Your sampling #	:	
Material	:	Rock core
Source; location	:	From borehole
Sampling location	:	BH-04-14, RC-12; 10.40 - 10.51 m

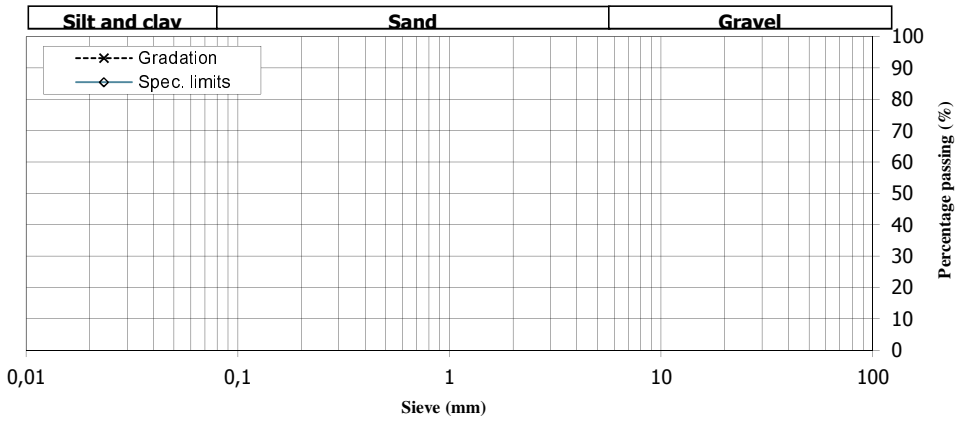
Specification # 1

Reference	:	
Use	:	
Calibre	:	
Class	:	

Sampling date	:	2014-01-20
By	:	Sylvain Séguin, tech.
Date received	:	2014-01-29

Sieve analysis

SIEVE (mm)	% PASSING REQUIREMENTS	% PASSING RESULT



Cu : Cc : FM : D_{10} : D_{30} : D_{60} :

Maximum dry density kg/m³	Optimum moisture %	Retained 5 mm %

Proportions from sieve analysis (%)

Cobble : Sand :
Gravel : Silt and clay :

Other testing	Required	Result
Résistance à la compression uniaxiale sur carotte de roc (ASTM D 7012) (MPa)		25,3

Remarks

RESULTS WITH AN ASTERISK DO NOT MEET REQUIREMENTS.

Prepared by : Jean-Pierre Lavoie, chef d'équipe **Date :** 2014-02-04

Approved by : **Yaya Coulibaly, ing., P.Eng.** **Date :**

Project : Geotechnical Investigation
Location : Block 1A - 530 Tremblay Road, Ottawa, ON

Project # : B-0008257-1, rev. 1
Date : March 31, 2014

Rock Core Photographic Report

Photo 1 : Borehole BH-01-14, RC-7 to RC-9

Photo 2 : Borehole BH-01-14, RC-10 to RC-13

Photo 3 : Borehole BH-01-14, RC-13 to RC-15

Photo 4 : Borehole BH-01-14, RC-13 to RC-15

Photo 5 : Borehole BH-01-14, RC-18 and RC-19

Photo 6 : Borehole BH-02-14, RC-6 to RC-8

Photo 7 : Borehole BH-02-14, RC-9 and RC-10

Photo 8 : Borehole BH-03-14, RC-9 to RC-11

Photo 9 : Borehole BH-03-14, RC-11 to RC-13

Photo 10 : Borehole BH-03-14, RC-14 and RC-15

Project : Geotechnical Investigation
Location : Block 1A - 530 Tremblay Road, Ottawa, ON

Project # : B-0008257-1, rev. 1
Date : March 31, 2014

Rock Core Photographic Report

Photo 11 : Borehole BH-04-14, RC-8 and RC-9

Photo 12 : Borehole BH-04-14, RC-11 to RC-13

Photo 13 : Borehole BH-04-14, RC-13 to RC-15

Photo 14 : Borehole BH-05-14, RC-9 to RC-12

Photo 15 : Borehole BH-05-14, RC-12 and RC-13

Photo 16 : Borehole BH-06-14, RC-8 to RC-10

Photo 17 : Borehole BH-06-14, RC-11 to RC-13

Photo 18: Borehole BH-06-14, RC-14 to RC-16

Photo 19 : Borehole BH-06-14, RC-17 to RC-19

Photo 20 : Borehole BH-07-14, RC-8 to RC-10

Photo 21 : Borehole BH-07-14, RC-11 to RC-13

Photo 22 : Borehole BH-07-14, RC-14 to RC-15

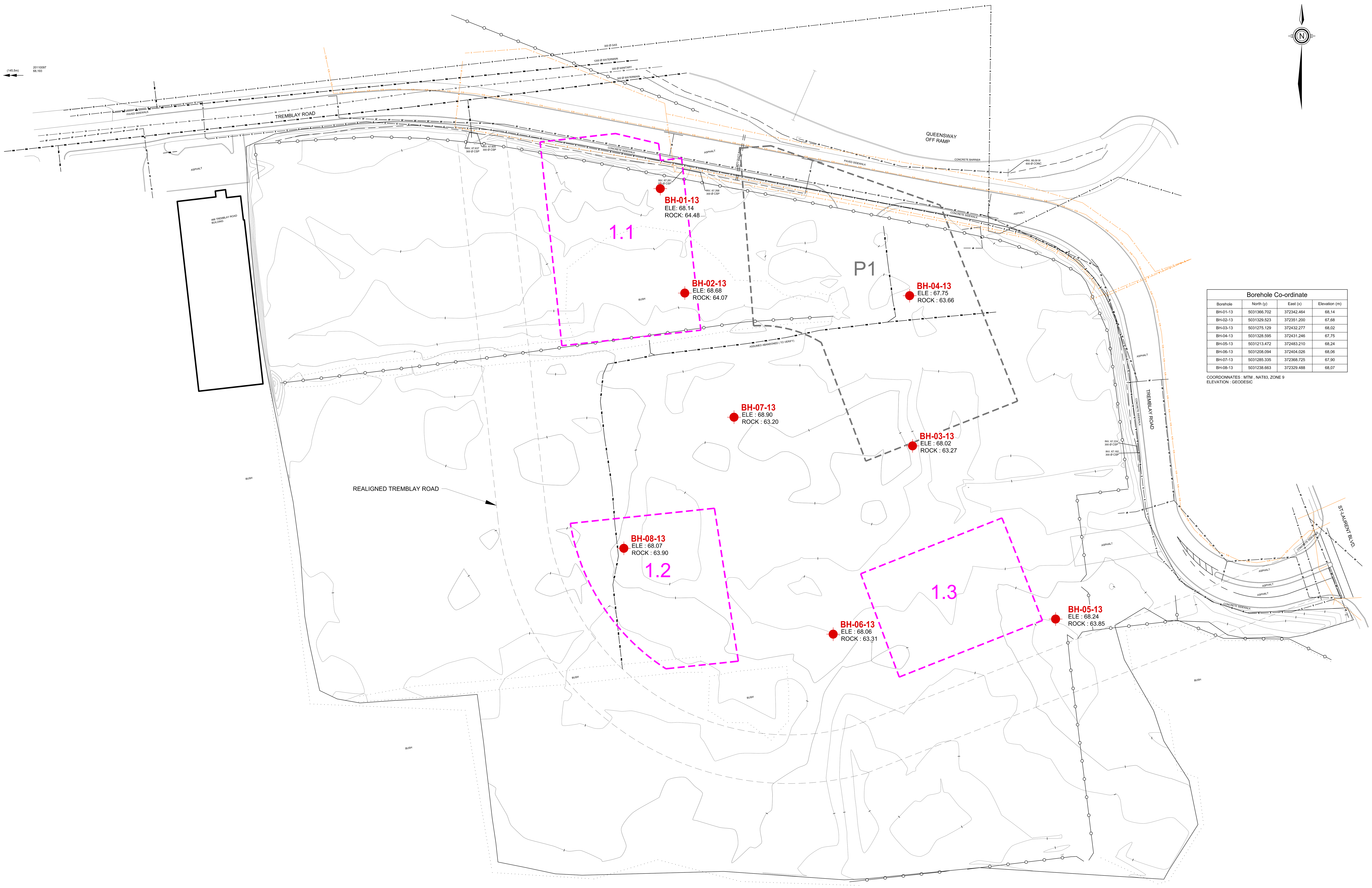
LVM inc.
900 de la Carrière Blvd., Suite 100, Gatineau Quebec J8Y 6T5 – T 1.819.778.3143 – F 1.819.770.1373 – gatineau@lvm.ca - www.lvm.ca

Project : Geotechnical Investigation | Project # : B-0008257-1, rev. 1
Location : Block 1A - 530 Tremblay Road, Ottawa, ON | Date : March 31, 2014

Rock Core Photographic Report

Photo 23 : Borehole BH-08-14, RC-8 to RC-10

Photo 24 : Borehole BH-08-14, RC-11 to RC-12



Borehole Co-ordinate			
Borehole	North (y)	East (x)	Elevation (m)
BH-01-13	5031366.702	372342.464	68,14
BH-02-13	5031329.523	372351.200	67,68
BH-03-13	5031275.129	372432.277	68,02
BH-04-13	5031328.595	372431.246	67,75
BH-05-13	5031213.472	372483.210	68,24
BH-06-13	5031208.094	372404.026	68,06
BH-07-13	5031285.335	372368.725	67,90
BH-08-13	5031238.663	372329.488	68,07

COORDONNATES : MTM , NAT83, ZONE 9
ELEVATION : GEODESIC

This document must be used jointly with the recommendations formulated in the geotechnical study report

SCALE BAR : 1 : 500

Source: Stantec, projet 122410928, drawing 7A, date 2013/06/02; PWGSC, project R.037326.02.2 drawing TRB_001_C_01_12, date 2012/09/13

LEGEND:

BH-NN-AA	BOREHOLE-NUMBER-YEAR
	PROPOSED BUILDING
	PROPOSED PARKING LOT

REV.	Y - M - D DATE	DESCRIPTION	Prepared By	Checked By
01	2014-03-31	Final Report	SS	TL
	2014-03-10	Final Report	SS	TL
	2014-02-26	Draft Report	SS	TL

ISSUES / REVISIONS

ALL DIMENSIONS MUST BE TAKEN AND CHECKED BEFORE BEGINNING THE WORKS

Seal

Client

Public Works and Government Services Canada

Client's references

R.037326.022

Project

Geotechnical Investigation
Block 1A
530 Tremblay Road, Ottawa

Title

Boreholes Location

LVM inc.
900, de la Carrière Blvd, suite 100
Gatineau (Québec) J8Y 6T5
Phone : 819.778.3143
Fax : 819.770.1373

Prepared	S. Séguin	Discipline	Geotechnical
Drawn	R. Frenette	Scale	1:500
Checked	T. Lampron	Date	2014-03-31

Project Manager: Yaya Coulibaly

Sequence No. 1 of 1

Serv. char.	Project	Wbs	Disc.	Type	Drawing No.	Rev.
033	B-0008257	1	GE	D	0001	01

SIZE A0

BRIDGE LANDING
BUS LOOP
417 WB ON RAMP
417 WB
417 EB
EXISTING PEDESTRIAN TUNNEL
180m (APPROX.)
TUNNEL PORTAL TO STATION ENTRANCE
PEDESTRIAN BRIDGE
417 EB OFF RAMP
417 EB ON RAMP
230m
TUNNEL TO EASTERN PED CROSSING
(PER PROPOSED PATHWAY GEOMETRY)
MTO SETBACK (14M OFFSET FROM PL)
PEDESTRIAN RAMP
EXISTING TREMBLAY - REDUCE TO 2 LANES
ST. LAURENT BOULEVARD
N
Test Pit
Set of Borehole
RESIDENTIAL
60mX 202m
1.12ha
REALIGNED TREMBLAY ROAD
26m ROW
FEDERAL OFFICE
3.16ha
* SITE LAYOUT TO BE CONFIRMED THROUGH PSPC RFP DESIGN BUILD PROCESS.
EXISTING TREMBLAY - POTENTIAL TO KEEP
POTENTIAL FUTURE DEVELOPMENT
128m x +/- 34m
0.49ha
EASTWAY GARDENS
EXISTING RESIDENTIAL
18m ROW
LIMIT OF PROPOSED PSPC PARCEL*
REALIGNED TREMBLAY ROAD
26m ROW
MIXED USE/ SWM POND
78mX 219m
1.70ha
24m ROW TO FACILITATE SERVICING
CLV
PLAY AREA
PARK
1.67ha
RAIL SETBACK (30M OFFSET FROM PL)
OPEN SPACE
1.32ha
RAIL

530 Tremblay Road
DRAFT Development Concept Plan
August 6th, 2019

APPENDIX

C SEISMIC SHEAR WAVE ANALYSIS

GEOPHYSICS GPR INTERNATIONAL INC.

100 – 2545 Delorimier Street
Longueuil (Québec)
Canada J4K 3P7

Tel. : (450) 679-2400
Fax : (514) 521-4128
info@gprmtl.com
www.geophysicsgpr.com

February 10th, 2014

Transmitted by email: Tommy.Lampron@lvm.ca

Our Ref.: M-14762

Mr. Tommy Lampron, Jr.Eng.
LVM inc.
900, de la Carrière Blvd, suite 100
Gatineau (QC) J8Y 6T5

Subject: **Shear-wave Velocity Sounding, 530 Tremblay Road, Ottawa**

Dear Sir,

Geophysics GPR International Inc. has been requested by LVM inc. to carry out seismic shear wave surveys on a vacant field located south-west of the intersection of the Highway 417 and the St Laurent Boulevard, Ottawa. The geophysical investigations used the Multi-channel Analysis of Surface Waves (MASW) and the Extended Spatial Auto Correlation (ESPAC) methods, as well as the seismic refraction method. From these results, the V_{S30} value was calculated to identify the Site Class.

The surveys were carried out on January 31st, by Mr. Charles Trottier, M.Sc. phys. and Mr. Nicolas Beaulieu, Jr Eng. Figure 1 shows the regional location of the site, and Figure 2 illustrates with more details the location of the seismic spread. Both figures are presented in the appendix.

The following paragraphs briefly describe the survey design, the principles of the test methods, and the results in graphic and table format.

METHODS PRINCIPLES

MASW Survey

The *Multi-channel Analysis of Surface Waves* (MASW) and the *Extended Spatial Autocorrelation* (ESPAC or MAM for *Microtremors Array Method*) are seismic methods used to evaluate the shear wave velocities of subsurface materials through the analysis of the dispersion properties of the Rayleigh surface waves ("ground roll"). The MASW is considered an "active" method, as the seismic signal is induced at known location and time in the geophones spread axis. Conversely, the ESPAC is considered a "passive" method, using the low frequency "noises" produced far away. The dispersion properties are measured as a change in phase velocity with frequency. Surface wave energy will decay exponentially with depth. Lower frequency surface waves will travel deeper and thus be more influenced by deeper velocity layering than the shallow higher frequency waves. The inversion of the Rayleigh wave dispersion curve yields a shear wave (V_S) velocity depth profile (sounding). Figure 3 outlines the basic operating procedure for the MASW method.

Figure 4 illustrates an example of one of the MASW/ESPAC records, the corresponding spectrogram analysis and resulting 1D V_S model. The ESPAC method allows deeper Vs soundings, but with a poor resolution for the surface portion. Its dispersion curve can then be merged with the higher frequency one from the MASW to permit a more complete inversion of the data. A detailed description of the MASW method can be found in the paper *Multi-channel Analysis of Surface Waves*, Park, C.B., Miller, R.D. and Xia, J. Geophysics, Vol. 64, No. 3 (May-June 1999); p. 800–808. For the ESPAC method, one can refer to the paper *Shear Velocity Profiles Obtained from Microtremor Array Data with an Example from Direct Fitting of SPAC Curves*, Asten, M.W., 2007, Proceedings of the 20th SAGEEP Conference, Denver, Environmental and Engineering Geophysical Society, and for more details: *The Microtremor Survey Method*, Okada, H., S.E.G., Geophysical Monograph Series No. 12.

Seismic Refraction Survey

The method consists to measure the propagation delays of the direct and refracted seismic waves (P and/or S) produced by an artificial source in the axis of the seismic spread. The seismic velocities of the materials can be directly calculated, then the refractors depths. A detailed description of the seismic refraction method is presented in the document *Seismic Refraction Exploration for Engineering Site Investigation*, Redpath, Bruce B., AD-768 710, Explosive Excavation Research Laboratory, Livermore, California, 1973.

Interpretation Method for the MASW surveys

The main processing sequence involved plotting, picking and 1D inversion of the MASW and ESPAC shot records using the SeisImagerSW™ software. The data inversions were realized with a non-linear least square method, and a genetic algorithm, considering the fundamental mode. In theory, all the shot records for a given spread should produce a similar shear-wave velocity profile. In practice, however, differences can arise due to energy dissipation, localized surface seismic velocities variations, and/or dipping of overburden layers or rock.

As the MASW method is usually not robust enough for adequately resolve shallow rock and/or very high gradient of seismic impedance in shallow environments, the seismic refraction method was used to identify the V_S value for the upper portion of the rock. With such combination of methods, the MASW model, prior to the inversions, can consider the seismic refraction results for realistic results.

Interpretation Method for the Seismic Refraction surveys

The considered seismic wave's arrival times are identified for each geophone. The General Reciprocal Method was used, with shot points at both ends of the seismic spread, in order to consider seismic wave propagation in two opposite directions. The measurements were not realized to calculate the rock depth, but rather for its seismic velocity. Conversely to the MASW method, the seismic rock velocity measured by seismic refraction is only representative of its superior part, due to the evanescent nature of the refracted wave. The rock seismic velocities were calculated using two methods: the reduced travel times and the opposite apparent velocities. The first one allows independence from the surface and rock topography effect, as well as the overburden lateral variation of the seismic velocity, but remains limited to common geophones. The second one can use longer segments of opposite direction signals, improving the regressions accuracy, but remains affected by the surface and rock topography effect, as well as the overburden lateral variation of the seismic velocity.

Survey Design

The main seismic spread was aligned on the monitoring wells # 3 and 7, using geophones spacing of 3.0 meters, which means that the total length of a 24 geophones spread was 69 meters. It was used for the MASW as well as for the seismic refraction surveys. A second shorter seismic spread, with geophone spacing of 1 meter, was dedicated to the near surface details.

The seismic records counted 4096 data, sampled at 1 ms for the MASW, and 40 µs for the seismic refraction method. Records triggering were realized with electrical close-contact.

Unlike the refraction method, which produces a data point beneath each geophone, the shear wave depth sounding can be considered as the average of the bulk area within the geophone spread, especially for its central half-length. The seismic records were realized with a seismograph Terraloc PRO (from ABEM Instrument), and the geophones were 4.5 Hz. A 20 pounds sledgehammer was used as the primary energy source with impacts being recorded off both ends of the seismic spread.

RESULTS

As the rock was very close to the surface, the MASW method was not an optimal one to solve the complete column. It can therefore be used to identify the surface seismic velocities, considering the shorter seismic spread. For the rock seismic velocity, a first evaluation has been realized through the seismic refraction V_S calculations.

The first seismic arrivals are related to the compressional seismic wave (P). Figure 5 presents the picked arrival times, as well as the calculated velocities. Depending of the calculation method, the V_P value could be between 3126 and 3257 m/s. The same seismic refraction results can be used to identify the seismic shear wave arrivals. They appear in later time, but with higher amplitudes. The seismic signal train of the P wave can sometime interfere with the arrivals of the S waves, especially at short distances from the signal point source. Figure 6 shows the picked S arrivals, and their calculated velocities. Depending of the calculation method, the V_S value varies between 1752 and 1784. Rough sound rock depths estimations from critical distances suggested a relatively sound rock around 5 meters deep (using the S waves), and around 7 meters deep (using the P waves).

The calculated V_{S30} value for the actual site is 745.7 m/s (cf. Table 1), corresponding to a Site Class “C”.

CONCLUSION

Seismic surveys were realized with the MASW/ESPAC and seismic refraction methods, to calculate the V_{S30} value for the Site Class determination. The site is located south- west of the intersection of the Highway 417 and the St Laurent Boulevard, Ottawa. The V_{S30} calculation is presented in Table 1.

The calculated V_{S30} value is 746 m/s. Based on this value (as determined through the MASW/ESPAC and seismic refraction methods), Table 4.1.8.4.A of the NBC and the Building Code, O. Reg. 350/06, the investigated actual site presents a Class “C” ($360 < V_{S30} \leq 760$ m/s).

As the rock V_S was clearly identified higher than 1500 m/s (around 1730 m/s), the Site Class “A” could be considered in the case the foundations would be on the rock, or close to. Further evaluation could be realized if such case should be considered.

It must be noted that other geotechnical information gleaned onsite; including the presence of liquefiable soils, soft clays, high moisture content etc. can supersede the site classification provided in this report based on the V_{S30} value.

The V_S values calculated are representative of the in situ materials, and were not corrected for the total and effective stress.

This report has been written by Jean-Luc Arsenault, M.A.Sc., P.Eng.

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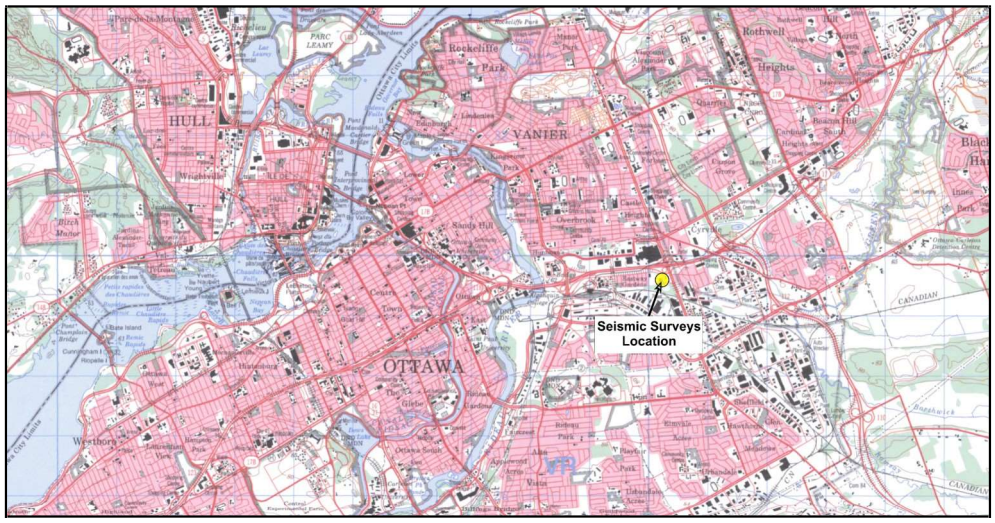


Figure 1: Regional location of the Site
(extract from the topographic map 031 G/05)

Figure 2: Location of the seismic spread
(source : geoOttawa)

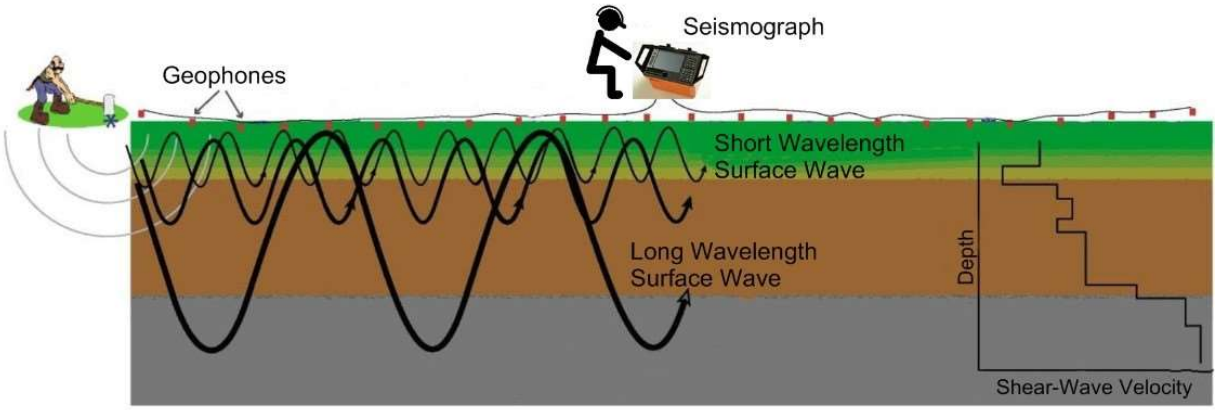


Figure 3: MASW Operating Principle

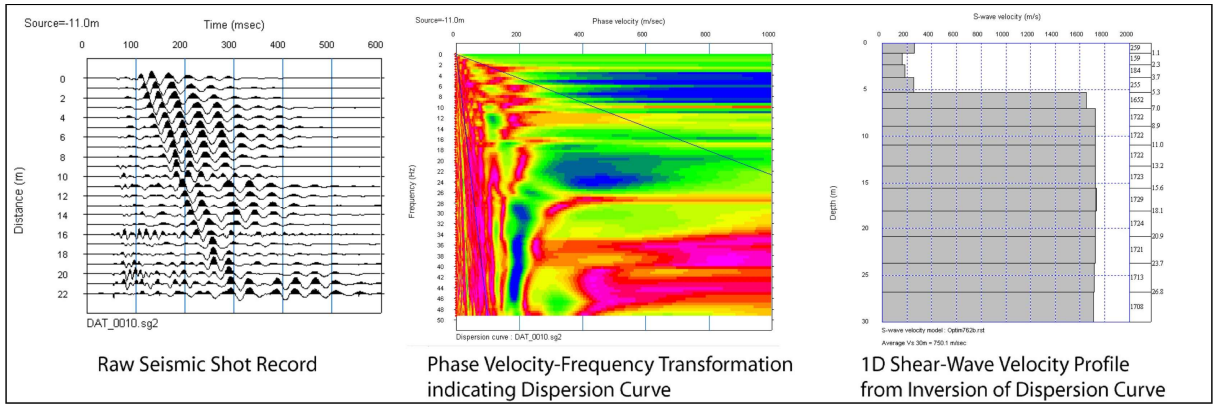
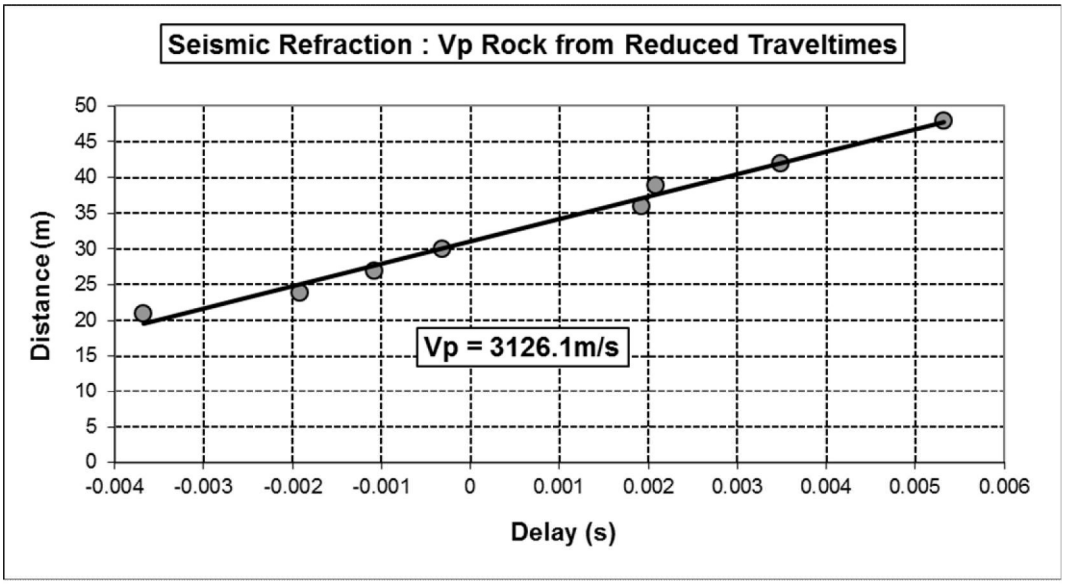


Figure 4: Example of a typical MASW shot record, phase velocity/frequency curve and resulting 1D shear wave velocity model



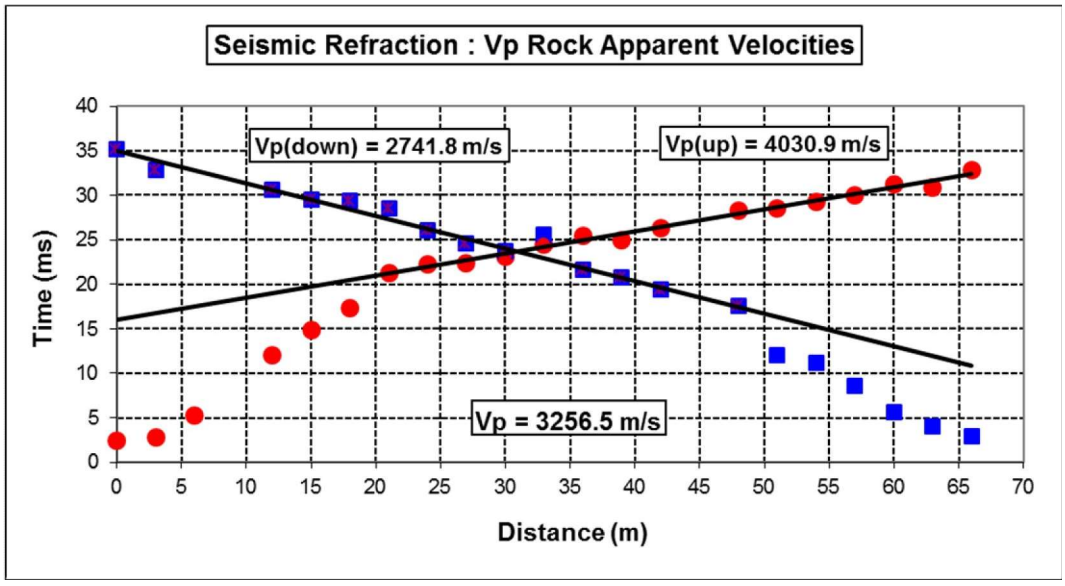


Figure 5: V_P from Seismic Refraction

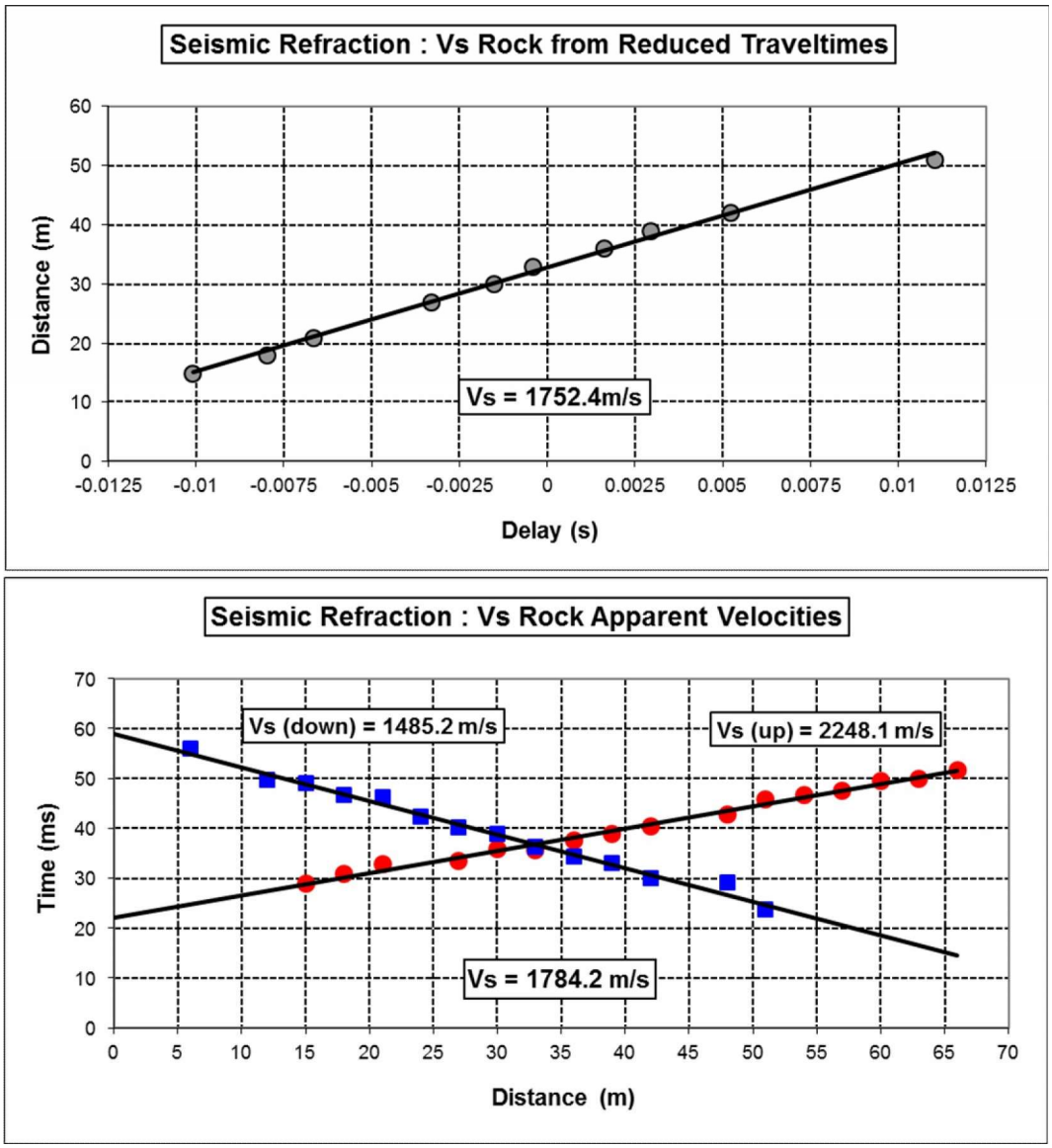


Figure 6: V_S from Seismic Refraction

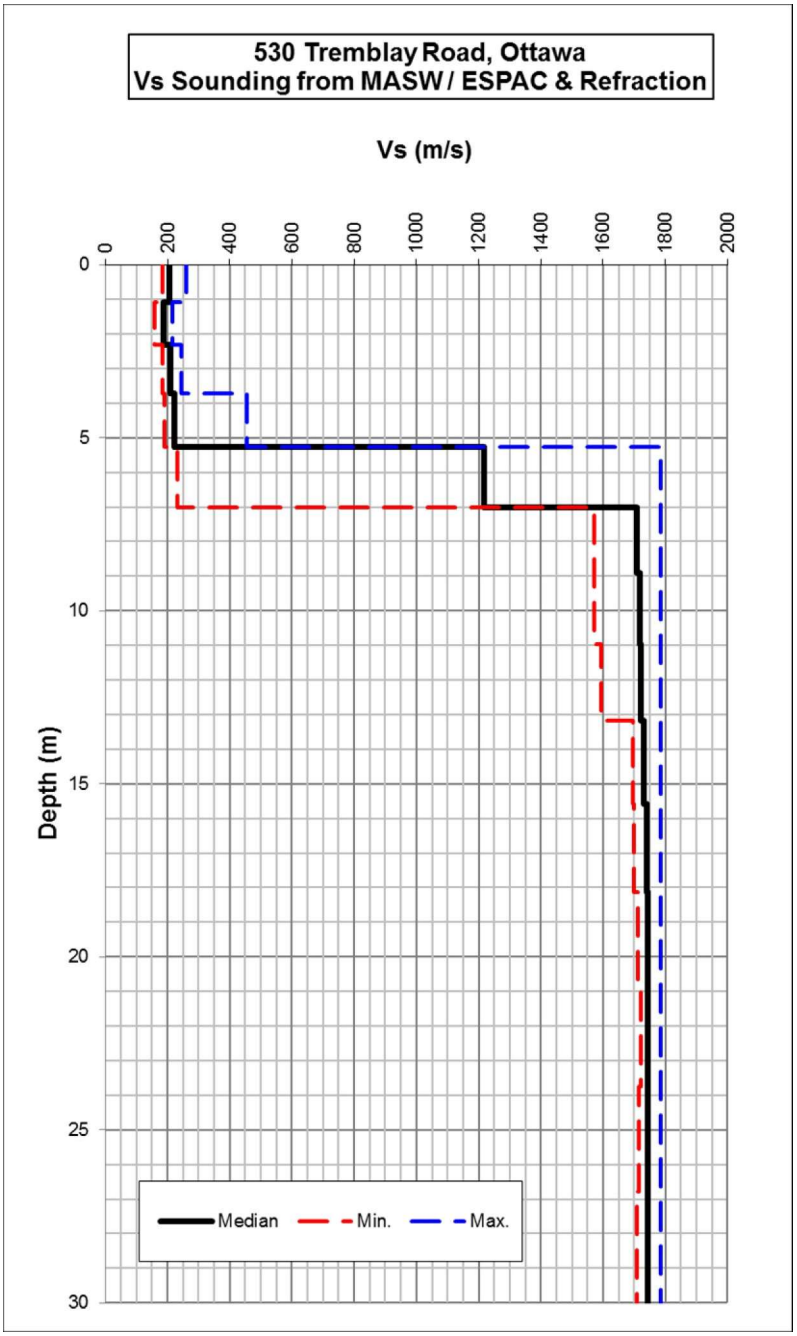


Figure 7: MASW Shear-wave Velocity Sounding with Refraction

TABLE 1

V_{S30} Calculation from MASW / ESPAC and Seismic Refraction (actual site)

Depth	Vs			Thickness	Cumulated Thickness	Delay for med. Vs	Cumulated Delay	Average Vs for given Depth
	Min.	Median	Max.					
(m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(s)	(s)	(m/s)
0.00	185.0	205.0	259.4					
1.07	157.1	185.7	215.9	1.07	1.07	0.005227	0.005227	205.0
2.31	184.5	210.3	244.6	1.24	2.31	0.006657	0.011885	194.2
3.71	188.6	223.5	454.8	1.40	3.71	0.006662	0.018547	200.0
5.27	232.8	1216.0	1784.2	1.57	5.27	0.007008	0.025555	206.4
7.01	1571.9	1709.0	1784.2	1.73	7.01	0.001423	0.026978	259.7
8.90	1571.9	1718.9	1784.2	1.90	8.90	0.001109	0.028087	316.9
10.96	1592.8	1722.2	1784.2	2.06	10.96	0.001198	0.029285	374.3
13.19	1695.9	1731.3	1784.2	2.23	13.19	0.001292	0.030577	431.2
15.58	1700.0	1742.0	1784.2	2.39	15.58	0.001381	0.031958	487.4
18.13	1710.9	1743.1	1784.2	2.56	18.13	0.001467	0.033425	542.4
20.85	1721.1	1742.6	1784.2	2.72	20.85	0.001560	0.034985	596.0
23.74	1713.7	1742.9	1784.2	2.89	23.74	0.001656	0.036641	647.8
26.79	1708.5	1744.0	1784.2	3.05	26.79	0.001749	0.038390	697.7
30.00				3.21	30.00	0.001843	0.040233	745.7

V_{S30} (m/s) =	**745.7**
Site Class :	**C**