Final Geotechnical Report
Proposed Tower 'B' Multi-Level Building at the Corner of Parkdale Avenue and Bullman Street
Ottawa, ON

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1.0 Introduction

This report presents the results of the Geotechnical Investigation and recommendations carried out for the proposed 28-storey building near the corner of Parkdale Avenue and Bullman Street Ottawa, ON. This building will include six below grade parking levels.

The work was carried out in general accordance with our Proposal Number 1224-B11221, dated March 27, 2013.

This report has been prepared specifically and solely for the project described herein. It presents the factual results of the investigation and provides geotechnical recommendations for the design and construction of the proposed building.

Limitations associated with this report and its contents are provided in the statement of general conditions included in Appendix A.

2.0 Site Description and Background

It is understood that the proposed 28-storey building is to be located at the corner of Parkdale Avenue and Bullman Street west of Parkdale Avenue. The building will be approximately 91 m high with six underground parking levels. The site area is approximately 2382 m^2 and the total gross building floor area (above grade) is approximately 18 702 m^2.

The location of the proposed building is shown on Drawing No. 1 in Appendix B.

Surficial soil maps indicate the soil conditions in the area consist of fill/glacial till over shallow bedrock within 3 m of ground surface.

3.0 Scope of Work

The scope of work for this investigation included the following:

- Advance five boreholes. Two boreholes were cored to the depths of 23 m below ground surface. The remaining boreholes terminated on shallow bedrock confirmed by auger refusal.
- Install two monitoring wells to measure groundwater levels in the two 23 m deep boreholes.
- Survey the ground surface elevations at the borehole locations with reference to a geodetic benchmark.
- Complete a geotechnical laboratory testing program to characterize the soil and rock.

- Prepare a Geotechnical Report outlining the field observations, laboratory results and providing geotechnical recommendations for design and construction of the proposed building including:
  - Geotechnical resistance of rock for foundation design;
  - Lateral earth pressures for shoring systems;
  - Seismic site classification in accordance with 2006 Ontario Building Code;
  - Design recommendations for rock anchors extending to bedrock;
  - Groundwater levels and construction dewatering requirements.

4.0 Method of Investigation

Prior to carrying out the investigation, Stantec Consulting Limited (Stantec) personnel marked out the proposed borehole locations at the site. As a component of our standard procedures and due diligence, Stantec arranged to have the borehole locations cleared of both private and public underground utilities.

The field drilling program was carried out on May 9, 10, and 17, 2013. Four boreholes (13-1, MW13-3, 13-4 and MW 13-5) were advanced at the locations shown on Drawing No. 2 in Appendix B. The fifth borehole (13-2) could not be drilled due to property access issues. Boreholes BH 13-1, MW13-3, and MW13-5 were advanced with a truck mounted CME 55 auger drill rig. The subsurface stratigraphy encountered in each borehole was recorded in the field by Stantec personnel while performing Standard Penetration Tests (SPT). Split spoon samples were collected for surficial soil materials. Bedrock was cored with HQ size coring equipment in Boreholes MW13-3 and BH13-5 to the depths of 22.5 m below ground surface. A 2-man gasoline-powered auger was used to advance BH13-4 due to conflict with overhead power lines. Bulk soil samples were collected from the auger.

Following the investigation, BHs 13-1 and 13-4 were backfilled with augered material. 50 mm diameter monitoring wells were installed at 22.5 and 22.3 m below ground surface in MW13-3 and MW13-5, respectively. The monitoring wells were installed with flush mount well caps and backfilled with silica sand to approximately 0.5 m above screen, then to surface with bentonite hole plug.

Borehole locations were surveyed in the field by Stantec personnel using a Trimble Geo XH GPS. Geodetic ground surface elevations were obtained for all the borehole and are accurate to 0.1 m.

The ground surface elevations at the borehole locations are shown on the Borehole Records included in Appendix C.

Samples were returned to the laboratory and subjected to detailed visual examination and additional classification by a geotechnical engineer. Selected samples were tested for moisture content and intact rock core strength. Groundwater samples collected from the monitoring wells were submitted to Paracel Laboratories Ltd. to measure pH, resistivity, chlorides, and sulphate content. Results of this testing are shown on the Borehole Records in Appendix C and laboratory test results in Appendix D.

Samples will be stored for a period of one (1) month after issuance of this report unless otherwise directed by the client.

5.0 Results of Investigation

5.1 SUBSURFACE INFORMATION

The subsurface conditions observed in the boreholes are presented in detail on the Borehole Records, Field Core Logs, and Bedrock Core Photos in Appendix C. An explanation of the symbols and terms used to describe the Borehole Records is also provided in Appendix C. In general, the observed stratigraphy consisted of fill material underlain by shallow bedrock.

A general overview of the soil, rock and groundwater conditions encountered in the boreholes is provided below.

5.1.1 Surficial Materials

Asphalt was encountered at the surface of BH13-4 and MW13-5. The asphalt varied from 50 to 70 mm in thickness.

Fill materials were observed in all the boreholes and varied from 0.6 m to 0.7 m in thickness. Fill material generally consisted of sandy gravel to gravelly sand, with the exception of a distinct secondary, basal layer of fill observed in BH13-4 consisting of silty sand. The moisture content of fill materials ranged from 3% to 13%.

5.1.2 Bedrock

Bedrock generally consisted of unweathered medium grey crystalline limestone of the Middle Ordovician Bobcaygeon Formation with pervasive dark grey shaley partings. A zone of heavily weathered limestone bedrock was encountered overlying intact, unweathered limestone bedrock in BH13-1, MWs13-3, and 13-5, at depths ranging from 0.7 and 0.8 m below ground surface. The thickness of the heavily weathered layer ranged from 0.3 to 1.0 m. Intact, unweathered limestone bedrock was encountered in all boreholes at depths ranging from 0.8 to 1.7 m below ground surface. The moisture content of the weathered bedrock ranged from 4% to 29%.

Occasional features of the limestone included stylolites, calcite veins and vugs, calcite-healed dipping to subvertical fractures, and shaley partings in sections of bedrock where the partings are not pervasive. A large section of medium grey crystalline limestone without pervasive shaley partings was encountered from 1.7 to 11.9 m below ground surface in MW13-3. A dolomitized bed was encountered in MW13-3 from 13.1 to 13.6 m below ground surface with pyrite and calcite replacement features.

The bedrock had three discontinuity sets; 1 bedding set and two joint sets. The bedding set had a very close to wide spacing and a generally flat orientation. Bedding discontinuity surfaces were generally oxidized to tight, with occasional swelling, soft clay filling. The joint sets were subvertical to dipping and were encountered relatively infrequently in the cored rock samples. One subvertical joint encountered in MW13-5 was infilled with coarse calcite crystals, and had a 7 mm aperture. Due to their infrequent occurrence, the spacing of the dipping and subvertical joint sets is indeterminate.

Generally bedrock quality was good to excellent; however, the top portion (down to 5.9 m and 2.9 m in MWs13-3 and 13-5, respectively) was observed to be of very poor to fair quality. The Rock Quality Designation (RQD) varied from 0% to 100%. The unconfined compressive strength of the rock, which is summarized below in Table 5.1, ranged from 74.6 MPa to 158.2 MPa, indicating a strong to very strong intact rock strength. Rock core logs and photos are shown in Appendix C.

Table 5-1: Unconfined Compressive Strength of Rock Cores

Borehole	Depth (m)	Unconfined Compressive Strength (MPa)
MW13-3	3.3	125.4
	8.1	90.5
	12.6	102.2
	17.6	78.3
	22.1	94.0
MW13-5	2.1	130.3
	6.9	156.3
	11.3	158.2
	16.2	74.6
	23.3	88.4

A ‘double-packer’ test was conducted in MW13-3 on May 9, 2013 following its complete advancement to determine the hydraulic conductivity of the of the limestone rock mass. Hydraulic conductivity values ranged from $1.27\text{x}10^{-7}$ to $2.47\text{x}10^{-6}$ m/s, corresponding to semi-pervious, fractured bedrock. The results are summarized in Table 5-2.

Table 5-2: Packer Test Results Summary

Test No.	Test Interval Depth (m)	Test Interval Elevation (m)	Average hydraulic conductivity, k (m/s)	Minimum k (m/s)	Maximum k (m/s)
1	3.6-7.6	58.3-54.3	$8.39\text{x}10^{-7}$	$4.89\text{x}10^{-7}$	$1.16\text{x}10^{-6}$
2	9.6-11.6	52.3-50.3	$1.52\text{x}10^{-7}$	$1.27\text{x}10^{-7}$	$1.69\text{x}10^{-7}$
3	15.9-19.9	46.0-42.0	$2.10\text{x}10^{-6}$	$1.79\text{x}10^{-6}$	$2.47\text{x}10^{-6}$

5.2 GROUNDWATER

Groundwater was measured by means of monitoring wells installed in MWs 13-3 and 13-5. Groundwater was measured on May 22, 2013. At MW13-3, the groundwater level was measured at 8.5 m (elev. 53.4m) below ground surface. At MW13-5, the groundwater was measured at 8.7 m (elev. 53.4m) below ground surface.

Fluctuation in the groundwater level due to seasonal variations or in response to a particular precipitation event should be anticipated.

6.0 Discussion and Recommendations

The following geotechnical issues should be considered during design activities:

- Conventional spread footings founded on bedrock are appropriate for the design of the multi-storey building at this site.
- Groundwater was encountered at depths within the proposed depth of construction. It is anticipated that surface water run-off and groundwater can be controlled with sump and pump methods during construction.
- The bedrock on this site consists of limestone with a measured unconfined compressive strength ranging between 75 MPa to 158 MPa, which suggests strong to very strong rock.
- The soluble sulphate concentrations show that a low degree of sulphate attack is expected for concrete in contact with soil and groundwater. Type GU Portland Cement should therefore be suitable for use in concrete at this site.
- The recommended Site Classification for Seismic Site Response for the site is Site Class A in accordance with 2006 Ontario Building Code.

6.1 SITE GRADING AND PREPARATION

Restrictions to raising the grades at this site are not anticipated due to the granular nature of the surficial soil and shallow bedrock depth.

6.1.1 Building Footprint

Footings should be founded on sound bedrock. Exposed bedrock surfaces should be free of loose bedrock, soil, water, bedrock irregularities, bedrock pinnacles and sloping surfaces. Hand cleaning and pressure washing of the bearing areas to remove any loose materials will be required to achieve the recommended geotechnical resistance.

Temporary frost protection should be provided for all footings if construction is carried out under winter conditions.

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

Structural Fill should conform to the requirements of Ontario Provincial Standard Specification (OPSS) Granular A. Structural Fill placed beneath building should contain no recycled materials such as concrete or asphalt. It should be compacted in lifts no thicker than 300 mm to at least 100% Standard Proctor Maximum Dry Density (SPMDD). This material should be tested and approved by a Geotechnical Engineer prior to delivery to the site.

Earth removals should be inspected by a geotechnical engineer to ensure that all unsuitable materials are removed prior to placement of fill or concrete. Inspection and testing services will be critical to ensure that all fill and concrete used is suitable and is placed competently.

6.1.2 Paved Areas

All vegetation, topsoil, existing asphalt and other deleterious material should be removed from beneath pavement areas. The subgrade should be proof rolled in the presence of geotechnical personnel. All soft areas revealed during proof rolling or subgrade inspections should be excavated to a maximum depth of 500 mm and replaced with compacted OPSS Granular B Type II.

6.2 FOUNDATIONS

The foundations for the proposed building may be supported on spread footings provided that the foundation preparation work described in Section 6.1 above is carried out. Spread footings should be placed on clean undisturbed sound bedrock.

Table 6-1 provides Geotechnical Resistances for shallow foundations on bedrock.

Table 6-1: Geotechnical Resistance for Foundations on Bedrock

Foundation Type	Footing Width (m)	Geotechnical Resistance, ULS, (kPa)
Strip Footing	1.0 to 3.0	4,500
Square Footing	1.0 to 3.0	5,500

The factored geotechnical bearing resistance at ultimate limit states (ULS) incorporates a resistance factor of 0.5. The settlement of foundations founded on bedrock is expected to be negligible. The factored geotechnical resistance at ULS for footings founded on bedrock will govern, since failure within the bedrock mass is likely to occur before the serviceability limit state (SLS) deformation of 25 mm total settlement is realized.

The design frost depth is 1.8 m. All exterior spread footings and footings for unheated structures should be protected from frost action by a minimum soil cover of 1.8 m or equivalent insulation. Perimeter footings should be protected by a minimum soil cover of 1.5 m or equivalent insulation. Perimeter footings and interior footings within 1.5 m of perimeter walls of heated structures should be protected by a minimum soil cover of 1.5 m or equivalent insulation. Where proposed footings have insufficient soil cover for frost protection, the use of insulation will be required.

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

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

6.3 SEISMIC SITE CLASSIFICATION

Existing V_{S30} measurements around the study site were reviewed to determine the site class according to the 2006 Ontario Building Code. The measurements were obtained from the Geological Survey of Canada Surficial Boreholes for the National Capital Area. The data is accessible through the Carleton University website called the Interactive Surface Geography Map for the City of Ottawa. The selected boreholes are illustrated in Drawing No. 3 in Appendix B and the corresponding shear wave velocity information is shown in Table 6.2. This table provides the average shear wave velocity in top 30 m for the studied sites (V_{s30}).

Based on V_{s30} values, the recommended site classification for seismic site response for the building is Site Class A in accordance with Table 4.1.8.4.A of the 2006 Ontario Building Code.

Table 6-2: Shear Wave Velocity Information of Selected Boreholes

Borehole Name	Borehole ID	Bedrock Depth (m)	V_{s30} (m/sec)	Bedrock Velocity Range (m/sec)
a	UGE05646	1.25	1944	1549-2333
b	UGE00166	1.68	1878	1486-2262
c	UGE00704	1.19	1954	1558 - 2343

The location of the proposed building and known faults were evaluated. The location of the nearest faults are shown in Drawing No. 4 in Appendix B. The drawing indicates that the proposed building is not located on a fault.

6.4 GROUNDWATER CONTROL

The groundwater level was measured at elevation 53.4 m within both monitoring wells, MWs 13-3 and 13-5. The proposed below grade parking levels will be below the groundwater level.

The design of the below grade parking levels should consider the groundwater level. The below grade levels could be designed as a waterproof structure designed to resist the build up of hydrostatic pressure. Alternatively, a drainage system (perforated pipe) could be provided around the exterior perimeter of the building and the foundation walls backfilled with free draining granular material such as OPSS Granular B Type II. A second alternative includes the use of a proprietary drainage board in conjunction with the perimeter drainage system with the walls backfilled with OPSS Select Subgrade Material (SSM). The drainage system should be connected to a frost free outlet.

An underfloor drainage should also be provided. The subdrains should be founded at least 400 mm below the underside of the floor slab and should be connected to a frost free outlet. If subdrains are proposed, the floor slab should be supported on a 400 mm thick layer of clear stone for drainage. The underfloor drainage system and perimeter drainage system should be connected to separate outlets.

6.5 PIPE BEDDING AND BACKFILL

Bedding for utilities should be placed in accordance with the pipe design requirements. It is recommended that a minimum of 150 mm to 200 mm of OPSS Granular A be placed below the pipe invert as bedding material. Granular pipe backfill placed above the invert should consist of Granular A material. A minimum of 300 mm vertical and side cover should be provided. These materials should be compacted to at least 95% of SPMDD.

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

Excavations for catch basins and manholes should be backfilled with compacted granular material. A 3 horizontal to 1 vertical frost taper should be built within the upper 1.2 m. The joints between catch basin or manhole sections must be wrapped with non-woven geotextile.

It should be noted that reuse of the site generated material will be highly dependent on the material’s moisture content at time of placement.

Backfill should be compacted in lifts not exceeding 300 mm.

6.6 TEMPORARY EXCAVATIONS AND BACKFILLING

6.6.1 Excavations in Soil

The shallow sandy gravel to gravelly sand, and silty sand fill (maximum encountered thickness of 0.7 m) present at the site is considered Type 3 soil in accordance with the Occupational Health and Safety Act (OHSA) and Regulations for Construction Projects. Temporary excavations in the overburden may be supported or should be sloped at 1 horizontal to 1 vertical from the base of the excavation and as per the requirements of OHSA. Alternatively, sheet piling or other support methods will be required. Excavations should be inspected regularly for signs of instability and flattened as required. The excavation support system should be designed to resist loads from traffic and foundations from adjacent structures.

6.6.2 Excavations in Bedrock

Drilling and blasting and hoe ramming techniques will be required to excavate bedrock. Temporary excavation in bedrock may be carried out at near vertical slopes, provided the trench sides are cleared of loose rock prior to workers entering the trench. If the bedrock is overly fractured such that the loose rock cannot be entirely removed, a temporary rock catchment system such as a wire mesh system should be used. The catchment system should be designed to contain and/or prevent loose rock particles from falling on workers within the excavation.

Bedrock excavation sidewalls adjacent to existing building foundations should be supported to ensure the stability of the existing buildings.

6.6.3 Groundwater

Groundwater was encountered during this geotechnical investigation within the depths of the anticipated excavations.

Packer tests were conducted to determine the hydraulic conductivity of the limestone bedrock. Hydraulic conductivity values ranged from 1.27×10^{-7} to 2.47×10^{-6} m/s, corresponding to semi-pervious, fractured bedrock. It is expected that dewatering of the excavations will be possible using conventional sump and pump techniques. It should be noted that groundwater elevations fluctuate seasonally. Dewatering of the excavation is not anticipated to cause settlement of soils due to groundwater lowering in the vicinity of the site.

6.7 LATERAL EARTH PRESSURES ON SHORING SYSTEMS AND BASEMENT WALLS

Earth pressures will need to be considered in the design of shoring systems for temporary excavations during construction and for basement walls. Table 6-3 gives the coefficients of lateral earth pressure for shoring systems and basement walls. These values are based on the assumption that a horizontal back slope will be utilized behind the shoring system and wall.

Static Lateral Earth Pressures

For walls that are designed to allow rotation, active earth pressure may be used for design. For rigidly tied and unyielding structures, the at-rest earth pressure should be used for design. The unfactored soil parameters provided in Table 6-3 may be used for design of walls with a horizontal backfill. The effects of compaction should be accounted for by applying a compaction surcharge.

The total active (P_A), passive (P_P) and at-rest (P_O) thrusts can be calculated using the following equations

$P_A = ½ K_a \gamma H^2$
$P_P = ½ K_p \gamma H^2$
$P_O = ½ K_o \gamma H^2$

where H is the height of the wall and γ is the unit weight of the backfill soil. Preliminary values for K_a, K_p, K_o and γ are provided below. The thrust acts at a point one third up the height of the wall.

Table 6-3: Lateral Earth Pressure Parameters

Parameter	On Site Fill	OPSS Granular A	OPSS Granular B Type II
Unit Weight (kN/m^3)	19.0	22.0	22.0
Angle of Internal Friction, Φ	32°	35°	32°
Coefficient of Passive Earth Pressure, K_p	3.25	3.69	3.25
Coefficient of at Rest Earth Pressure, K_o	0.47	0.43	0.47
Coefficient of Active Earth Pressure, K_a	0.31	0.27	0.31

Seismic Lateral Earth Pressures

Seismic earth pressures may be calculated using the parameters detailed in Table 6-4 below.

The total active and passive thrusts under seismic loading conditions can be calculated using the following equations:

- $P_{AE} = ½ K_{AE} \gamma H^2 (1 - k_V)$
- $P_{PE} = ½ K_{PE} \gamma H^2 (1 - k_V)$

where:

K_{AE} = active earth pressure coefficient (combined static and seismic)
K_{PE} = passive earth pressure coefficient (combined static and seismic)
H = height of wall
k_h = horizontal acceleration coefficient
k_v = vertical acceleration coefficient
γ = total unit weight of soil

For this site, the following design parameters were used to develop the recommended K_{AE} and K_{PE} values. A yielding wall was assumed.

Zonal Acceleration Ratio, A or PGA	0.42
Horizontal Acceleration Coefficient, k_h	0.21
Vertical Acceleration Coefficient, k_v	0.14
Horizontal Backslope to Wall	0°
Vertical Back of Wall	0°

The k_h value above corresponds to half of the A value for yielding walls. The k_v value corresponds to 0.67 of the k_h value. The angle of friction between the soil and the wall has been set at 0° to provide a conservative estimate.

Table 6-4: Seismic Lateral Earth Pressure Parameters (Yielding Wall)

Material	K_{AE}	Height of Application of P_{AE} from base as a ratio of wall height, (H)	K_{PE}	Height of Application of P_{PE} from base as a ratio of wall height, (H)	ϕ (friction angle)	Unit Weight (kN/m^3)
OPSS Granular A	0.43	0.40	3.19	0.24	35°	22
OPSS Granular B Type II	0.48	0.40	2.78	0.24	32°	22
In-Situ Fills	0.48	0.40	2.78	0.24	32°	19

If the wall is designed as a non-yielding wall it could be designed based on values obtained from the Wood (1973) method;

$$\Delta P_{eq} = \gamma H^2 \frac{a_h}{g} F_p$$

ΔP_{eq} : Steady state dynamic trust

γ : Bulk unit weight of soil

H : Height of wall (m)

g : Gravity (m/s^2)

a_h : Amplitude of harmonic base acceleration

F_p : Dimensionless trust factor at ν=0.5

$$h_{eq} = \frac{\Delta M_{eq}}{\Delta P_{eq}} \approx 0.63H$$

6.8 SLIDING RESISTANCE

Sliding resistance can be calculated using the following unfactored friction coefficients, outlined in Table 6-5.

Table 6-5: Unfactored Friction Coefficients

Condition	Unfactored Friction Coefficient
Between Concrete and Structural Fill	0.55
Between Concrete and Clean Bedrock	0.60

6.9 ROCK ANCHORS

Rock anchors could be used to ensure stability of temporary shoring system and resist uplift forces. For the design of rock anchors extending into bedrock, the following design parameters may be considered for the rock mass.

- A rock to grout working bond stress of 1000 kPa may be used for holes grouted with non-shrink grout having a minimum compressive strength of 30 MPa.
- The minimum fixed anchor length (i.e. the length over which the rock to grout bond stress is developed) should be no less than 3 m.
- The unbonded length of anchor should be equal to the height of the rock cone and less half the bonded length.

To ensure against the possibility of a rock mass failure, the following design parameters should be used:

- Submerged unit weight of rock = 16 kN/m^3
- A 90° (apex angle) failure cone with the apex located at the midpoint of the bonded length as shown on the sheet titled “Rock Anchor: Resistance to Rock Mass Failure” in Appendix E.

The bond stress used by the contractor for design should be confirmed by full scale testing of anchors.

6.10 FOUNDATION BACKFILL

Backfill within the footprint of the proposed buildings should consist of OPSS Granular A compacted to 100% SPMDD. Exterior foundation backfill should consist of a material meeting the requirements of OPSS Select Subgrade Material (SSM). Reference is made to Section 6.4 regarding additional comments for foundation wall backfill.

Exterior foundation backfill shall be placed in lifts no thicker than 300 mm and compacted using suitable compaction equipment to at least 95% of SPMDD. Care should be taken immediately adjacent to the foundation walls to avoid over-compaction of the soil which could result in damage to the walls.

6.11 CEMENT TYPE AND CORROSION POTENTIAL

Two representative groundwater samples were submitted to Paracel Laboratories Ltd. in Ottawa, Ontario, for pH, chloride, sulphate and resistivity testing. The test results are summarized in Table 6-6.

Table 6-6: pH, Sulphate, Chloride and Resistivity Analysis Results

Borehole No.	pH	Sulphate (µg/g)	Resistivity (0.01 ohm.m)	Chloride (µg/g)
MW13-3	7.2	78	9.43	205
MW13-5	8.6	28	45.6	29

The soluble sulphate ranges from 28-78 µg/g. Soluble sulphate concentrations less than 1000 µg/g generally indicate that a low degree of sulphate attack is expected for concrete in contact with soil and groundwater. Type GU Portland Cement should therefore be suitable for use in concrete at this site.

The pH, resistivity and chloride concentration provide an indication of the degree of corrosiveness of the sub-surface environment. The soil pH was 7.2-8.6 which is within what is considered the normal range for soil pH of 5.5 to 9.0. The pH levels of the tested soil do not indicate a highly corrosive environment. The test results provided in the Table 6.5 can be used to aid in the selection of coatings and corrosion protection systems for buried steel objects.

6.12 PAVEMENT STRUCTURE RECOMMENDATIONS

It has been assumed that the parking areas will be used mostly by passenger vehicles and the access roads will be used by delivery trucks and fire vehicles.

The subgrade in paved areas should be prepared as described in Section 6.1 above. The following minimum pavement structures are recommended:

Table 6-7: Recommended Pavement Design

Material	Heavy Duty Parking Access Roads	Standard Duty Parking Area
SP 12.5 Asphaltic Concrete	40 mm	50 mm
SP 19 Asphaltic Concrete	50 mm	-
Granular Base Course, OPSS Granular A	150 mm	150 mm
Granular Subbase Course, OPSS Granular B Type II	400 mm	300 mm

It is estimated that the service life prior to major rehabilitation for the above pavement structures is 20 years provided they are properly maintained. The pavement surface and the underlying subgrade should be graded to direct runoff water towards suitable drainage.

All granular materials should be tested and approved by a geotechnical engineer prior to delivery to the site. Both base and subbase materials should be compacted to at least 100% SPMDD. Asphalt should be compacted to at least 97% Marshal bulk density.

It is recommended that the lateral extent of the subbase and base layers not be terminated in a vertical fashion immediately behind the curb line. A taper with a grade of 5 horizontal to 1 vertical is recommended in the subgrade line to minimize differential frost heave problems under sidewalks.

6.13 VIBRATIONS MONITORING AND PRE-CONSTRUCTION SURVEYS

The required construction activities for the proposed building will generate some vibrations that will be perceptible to nearby residents. The vibrations are expected to be greatest during bedrock excavation by blasting/mechanical methods. It is recommended that pre-construction surveys of all structures be carried out in accordance with OPSS 120 “General Specifications for the Use of Explosives”.

It is recommended that construction vibrations generally be limited to a maximum peak particle velocity as outlined in OPSS 120. Should there be structures in the area sensitive to vibrations, more stringent specifications should be developed by a vibration specialist. For instance, the particle velocity should be limited to 10 mm/sec if there is any historic building in the area. Vibration monitoring should be carried out prior to and throughout the construction period.

No blasting should be carried out within a distance of 200 m from any water storage reservoir, pumping station, water works transformer station or water storage tank without prior approval by the owner of the facility.

7.0 Closure

Use of this report is subject to the Statement of General Conditions provided in Appendix A. It is the responsibility of Richcraft, who is identified as "the Client" within the Statement of General Conditions, and its agents to review the conditions and to notify Stantec should any of these note be satisfied. The Statement of General Conditions addresses the following:

- Use of the report
- Basis of the report
- Standard of care
- Interpretation of site conditions
- Varying of unexpected site conditions
- Planning, design or construction

This report has been prepared by Simon Harvey and reviewed by Susan Potyondy.

Respectfully submitted,

STANTEC CONSULTING LTD.

Simon Harvey, B.Sc.(Eng.)
Engineering Intern - Geotechnical Engineering

Susan Potyondy, P.Eng.
Senior Geotechnical Engineer

LICENSED PROFESSIONAL ENGINEER
19/06/13
S.M. POTYONDY
37232568
PROVINCE OF ONTARIO

APPENDIX A

Statement of General Conditions

STATEMENT OF GENERAL CONDITIONS

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

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

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

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

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

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

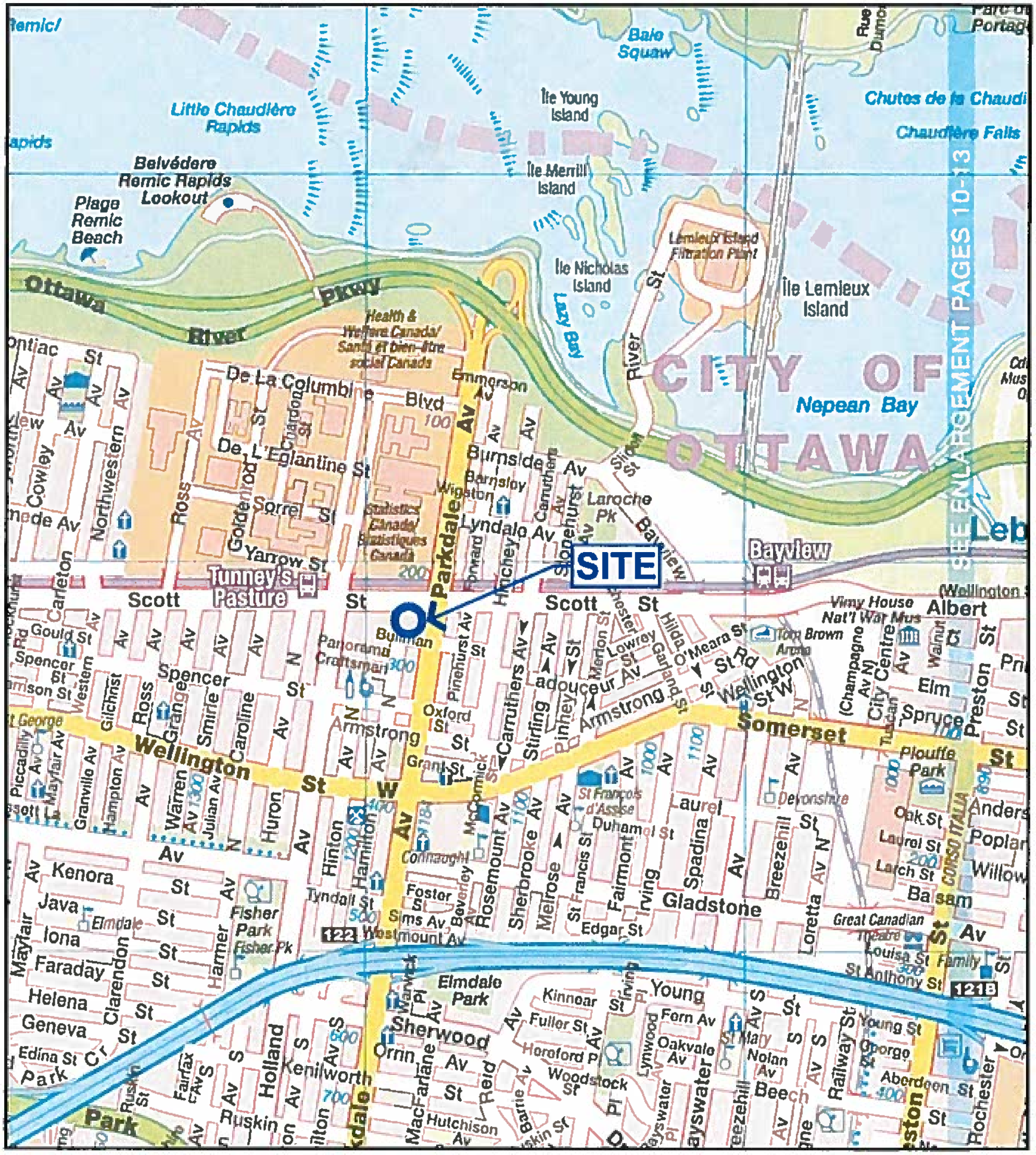
APPENDIX B

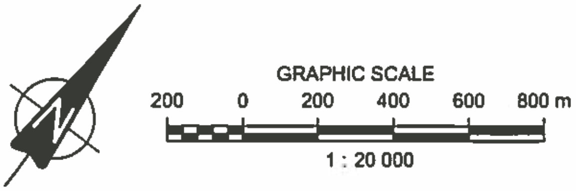
Key Plan

Borehole Location Plan

V_{S30} Measurement Location Plan

Fault Location Plan





REFERENCE: MAPART

NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

KEY PLAN

GEOTECHNICAL INVESTIGATION
WEST PARKDALE AVE. AND NORTH BULLMAN ST., OTTAWA, ON.

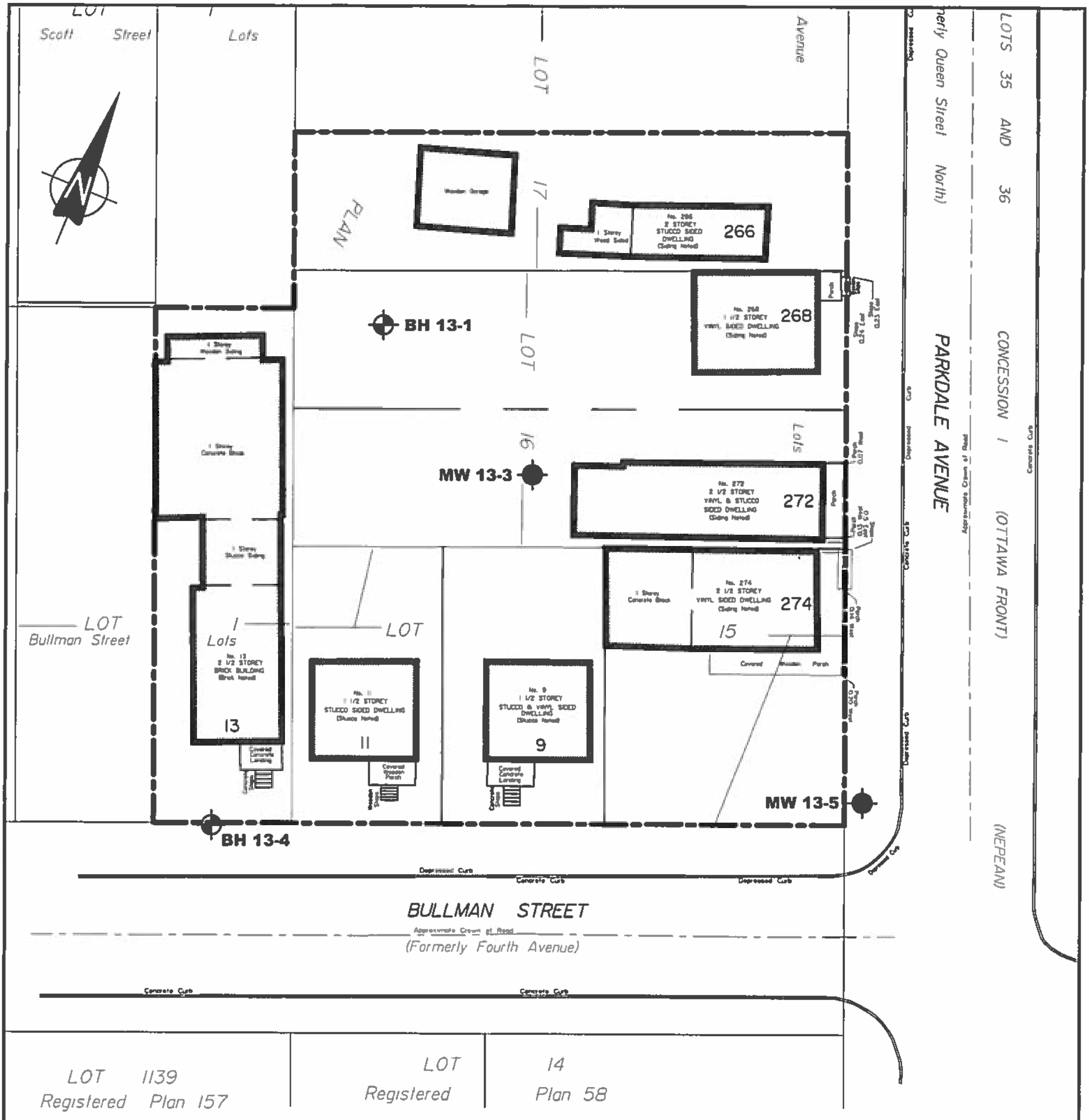
Client: RICHCRAFT GROUP OF COMPANIES

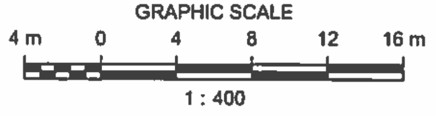
Job No.: 122410780
Scale: 1 : 20 000
Date: 13/05/29
Dwn. By: GBB
App'd By:

Dwg. No.: 1

Stantec

T:\Autocad\Drawings\Project Drawings\2013\122410780\268 Parkdale\122410780-1&4 (268).dwg PRINTED: May 30, 2013





LEGEND:

BASEPLAN PROVIDED BY ANNIS, O'SULLIVAN, VOLLEBEKK LTD.
FILENAME: 13688-13 Richcraft Lts 1 15 to 17 PL 58 T F.DWG, DATED AUGUST 4, 2011.

LEGEND:

- PROPERTY BOUNDARY
- BOREHOLE
- MONITORING WELL

NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

BOREHOLE & MONITORING WELL LOCATION PLAN

GEOTECHNICAL INVESTIGATION
WEST PARKDALE AVE. AND NORTH BULLMAN ST., OTTAWA, ON.

Client: RICHCRAFT GROUP OF COMPANIES

Job No.:	122410780
Scale:	1 : 400
Date:	13/05/29
Dwn. By:	GBB
App'd By:	

Dwg. No.: 2

Stantec

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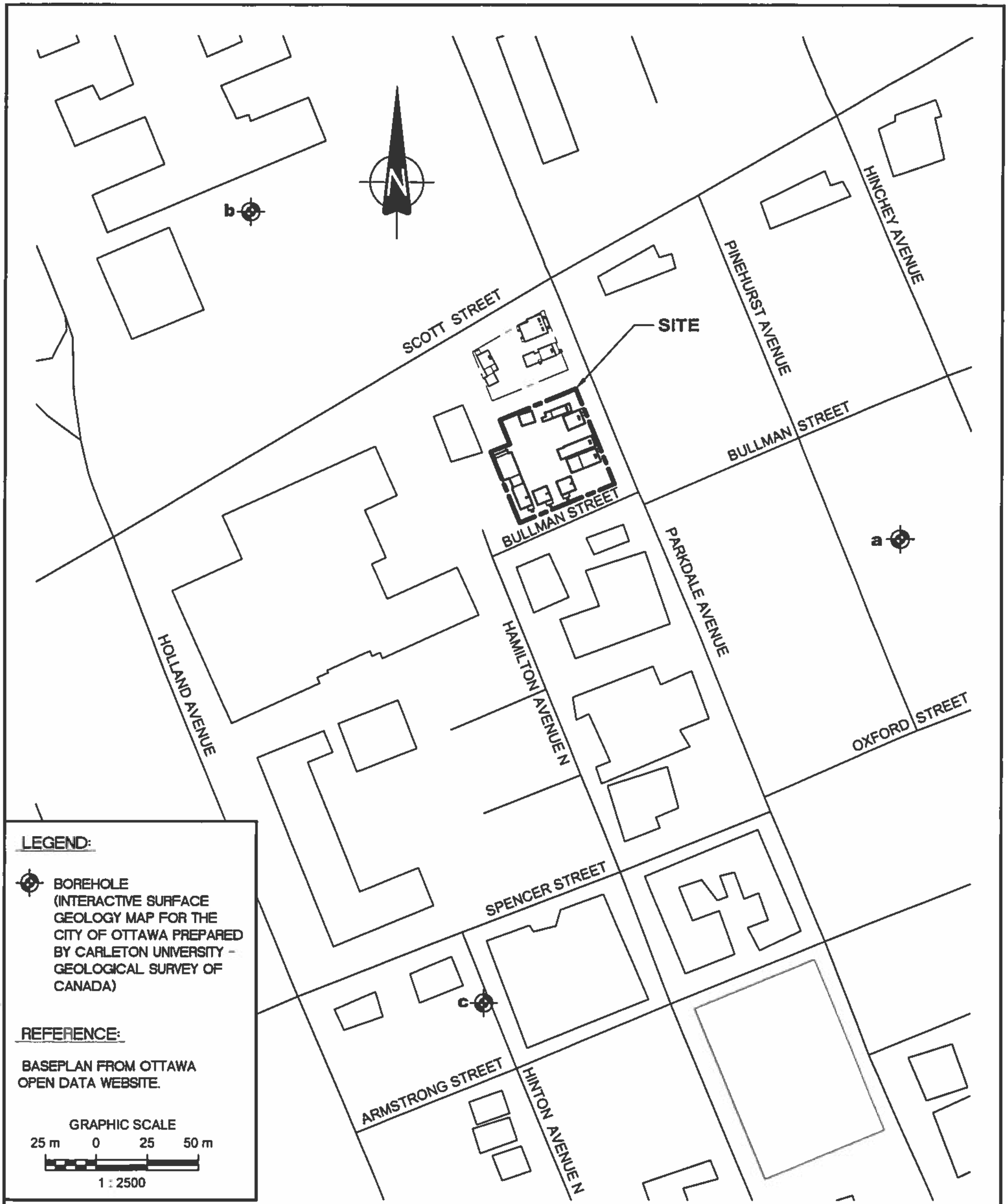

LEGEND:

⌖ BOREHOLE (INTERACTIVE SURFACE GEOLOGY MAP FOR THE CITY OF OTTAWA PREPARED BY CARLETON UNIVERSITY – GEOLOGICAL SURVEY OF CANADA)

REFERENCE:

BASEPLAN FROM OTTAWA OPEN DATA WEBSITE.

GRAPHIC SCALE
25 m 0 25 50 m
1 : 2500

NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

Vs30 MEASUREMENT LOCATION PLAN

GEOTECHNICAL INVESTIGATION

WEST PARKDALE AVE. AND NORTH BULLMAN ST., OTTAWA, ON.

Client: RICHCRAFT GROUP OF COMPANIES

Job No.:	122410780
Scale:	1 : 2500 (Approx.)
Date:	13/05/29
Dwn. By:	GBB
App'd By:	

Dwg. No.: 3

Stantec

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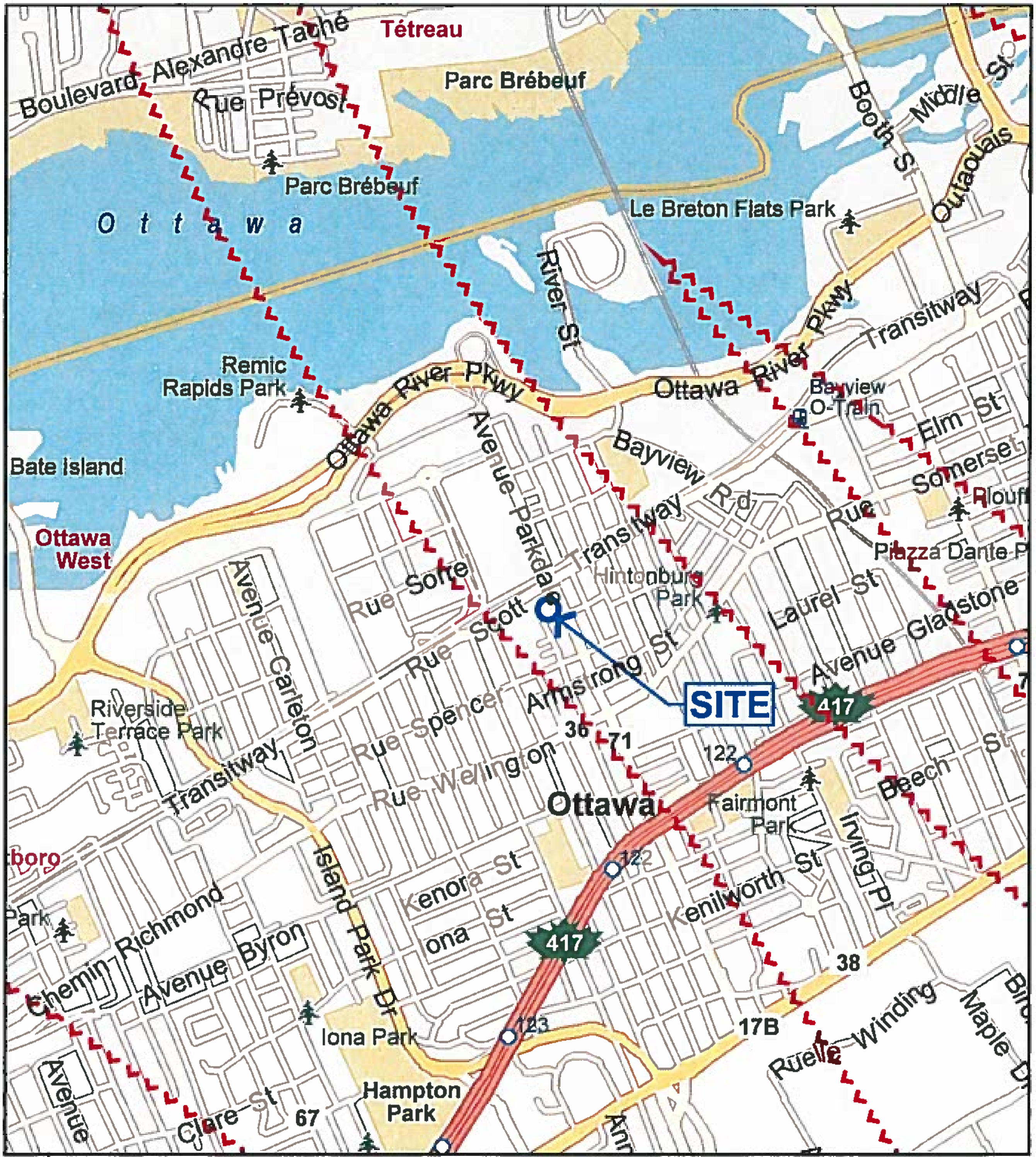

REFERENCE: 2011 MICROSOFT STREETS AND TRIPS.

GRAPHIC SCALE

200 0 200 400 600 800 m

1 : 20 000

LEGEND:

FAULT LOCATION

NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

FAULT LOCATION PLAN

GEOTECHNICAL INVESTIGATION
WEST PARKDALE AVE. AND NORTH BULLMAN ST., OTTAWA, ON.

Client: RICHCRAFT GROUP OF COMPANIES

Job No.:	122410780
Scale:	1 : 20 000
Date:	13/05/29
Dwn. By:	GBB
App'd By:	

Dwg. No.: 4

Stantec

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APPENDIX C

Symbols and Terms Used on Borehole Records

Borehole Records

Field Core Logs

Bedrock Core Photos

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

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

Terminology describing soil structure:

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

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

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

Trace, or occasional	Less than 10%
Some	10-20%
Frequent	> 20%

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

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

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

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

ROCK DESCRIPTION

Terminology describing rock quality:

RQD	Rock Mass Quality
0-25	*Very Poor*
25-50	*Poor*
50-75	*Fair*
75-90	*Good*
90-100	*Excellent*

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

Terminology describing rock mass:

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

Terminology describing rock strength:

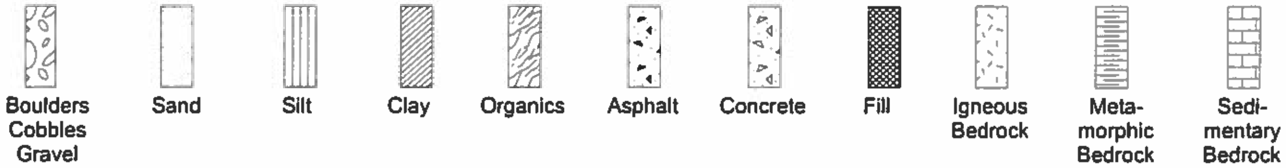
Strength Classification	Unconfined Compressive Strength (MPa)
Extremely Weak	< 1
Very Weak	1 – 5
Weak	5 – 25
Medium Strong	25 – 50
Strong	50 – 100
Very Strong	100 – 250
Extremely Strong	> 250

Terminology describing rock weathering:

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

STRATA PLOT

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



SAMPLE TYPE

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

WATER LEVEL MEASUREMENT

▼	measured in standpipe, piezometer, or well
▽	inferred

RECOVERY

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

N-VALUE

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

DYNAMIC CONE PENETRATION TEST (DCPT)

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

OTHER TESTS

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

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

Stantec

BOREHOLE RECORD

N: 5 028 111 E: 442 731

BH13-1

1 of 1

CLIENT Richcraft Group of Companies

LOCATION Ottawa, ON

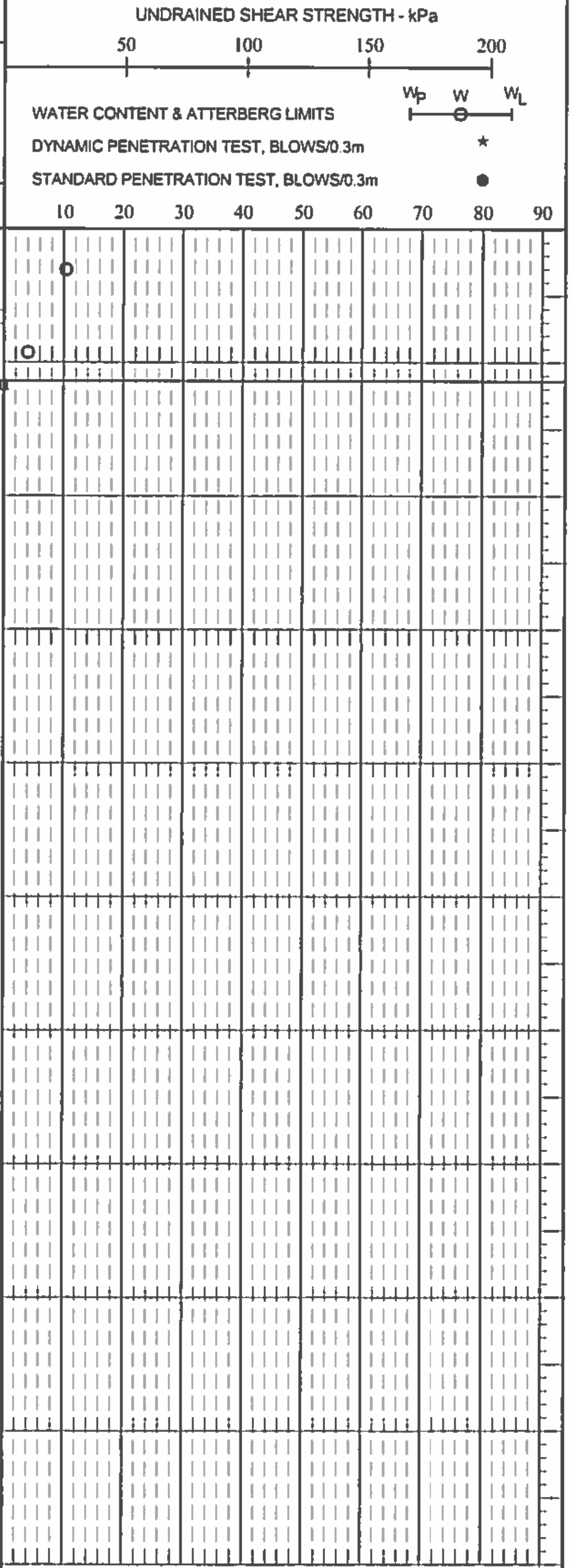
DATES: BORING May 10, 2013 WATER LEVEL

BOREHOLE No. BH13-1

PROJECT No. 122410780

DATUM

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	61.96	FILL: Brown gravelly sand	▨		BS	1	-	-
	61.3	Weathered LIMESTONE fragments with clay			SS	2	100	50 /125 mm
1	60.8	End of Borehole						
2								
3								
4								
5								
6								
7								
8								
9								
10								



▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

☐ Field Vane Test, kPa

☐ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

Stantec

MONITORING WELL RECORD

N: 5 028 105 E: 442 745

MW13-3

CLIENT Richcraft Group of Companies

LOCATION Ottawa, ON

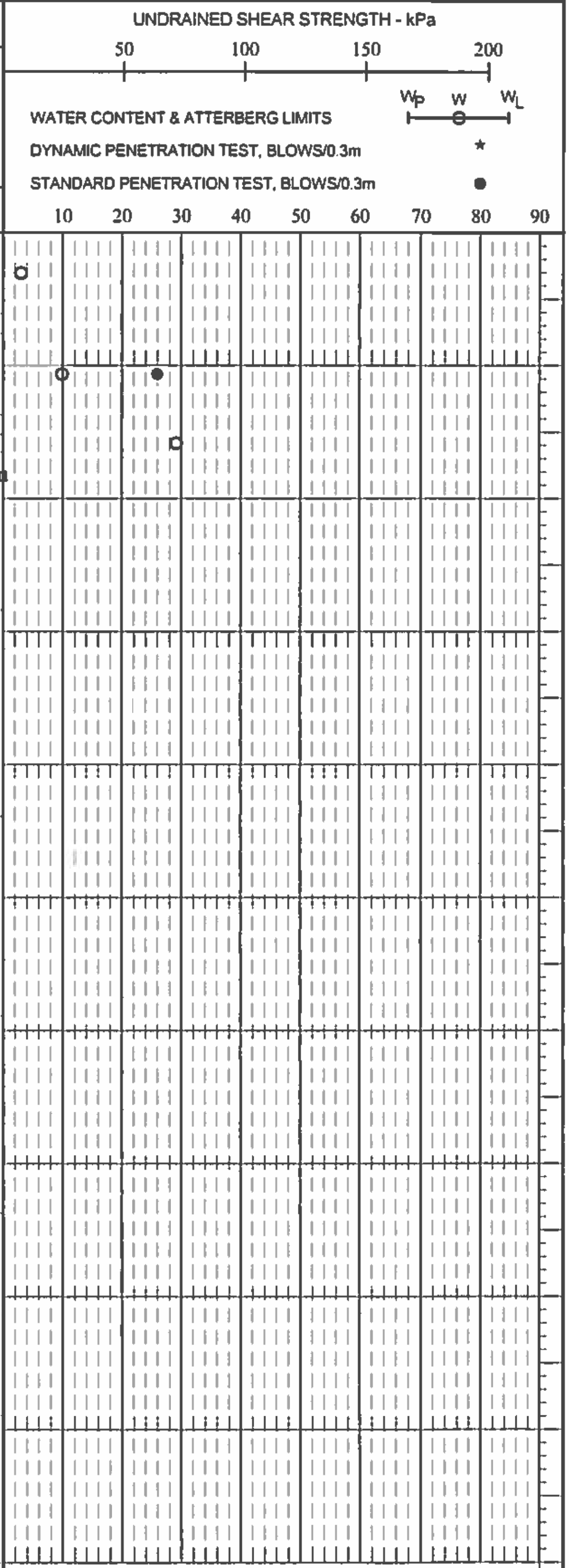
DATES: BORING May 8/9, 2013 WATER LEVEL May 22, 2013

BOREHOLE No. MW13-3

PROJECT No. 122410780

DATUM

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	61.92	FILL: brown gravelly sand	▨		BS	1	-	-
1	61.2	Weathered LIMESTONE fragments with clay			SS	2	100	26
	60.3	Medium grey crystalline LIMESTONE -Fair to excellent rock mass quality -Strong to very strong intact rock strength -Unweathered -Discontinuities: 1 bedding set and 2 joint sets (Refer to Field Bedrock Core Log)			SS	3	75	50 /125 mm
2					HQ	4	100%	79%
3 4					HQ	5	100%	69%
5					HQ	6	98%	69%
6 7					HQ	7	100%	100%
8				▼	HQ	8	100%	100%
9 10				▽	HQ	9	100%	90%



▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

◘ Field Vane Test, kPa

☐ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd ________

Date ________

Stantec

MONITORING WELL RECORD

N: 5 028 105 E: 442 745

MW13-3

CLIENT Richcraft Group of Companies

LOCATION Ottawa, ON

DATES: BORING May 8/9, 2013 WATER LEVEL May 22, 2013

BOREHOLE No. MW13-3

PROJECT No. 122410780

DATUM

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
10		*(Cont.)* Medium grey crystalline LIMESTONE (Refer to Field Bedrock Core Log)				
11			HQ	10	100%	93%
12	50.0	Medium grey crystalline LIMESTONE with shaley partings -Good to excellent rock mass quality -Strong to very strong intact rock strength -Unweathered -Discontinuities: 1 bedding set and 2 joint sets (Refer to Field Bedrock Core Log)	HQ	11	100%	92%
14			HQ	12	100%	80%
15			HQ	13	100%	93%
17			HQ	14	100%	87%
19			HQ	15	100%	91%
20						

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

□ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

Stantec

MONITORING WELL RECORD

N: 5 028 105 E: 442 745

MW13-3

CLIENT Richcraft Group of Companies
LOCATION Ottawa, ON
DATES: BORING May 8/9, 2013 WATER LEVEL May 22, 2013
BOREHOLE No. MW13-3
PROJECT No. 122410780
DATUM

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
DYNAMIC PENETRATION TEST, BLOWS/0.3m *
STANDARD PENETRATION TEST, BLOWS/0.3m ●
10 20 30 40 50 60 70 80 90

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
20		*(Cont.)* Medium grey crystalline LIMESTONE with shaley partings (Refer to Field Bedrock Core Log)			HQ	16	100%	87%
21								
					HQ	17	97%	81%
22								
	39.4	End of Borehole Monitoring Well Installed						
23								
24								
25								
26								
27								
28								
29								
30								

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

□ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd ____
Date ____

Stantec

BOREHOLE RECORD

N: 5 028 072 E: 442 733

BH13-4

CLIENT Richcraft Group of Companies

LOCATION Ottawa, ON

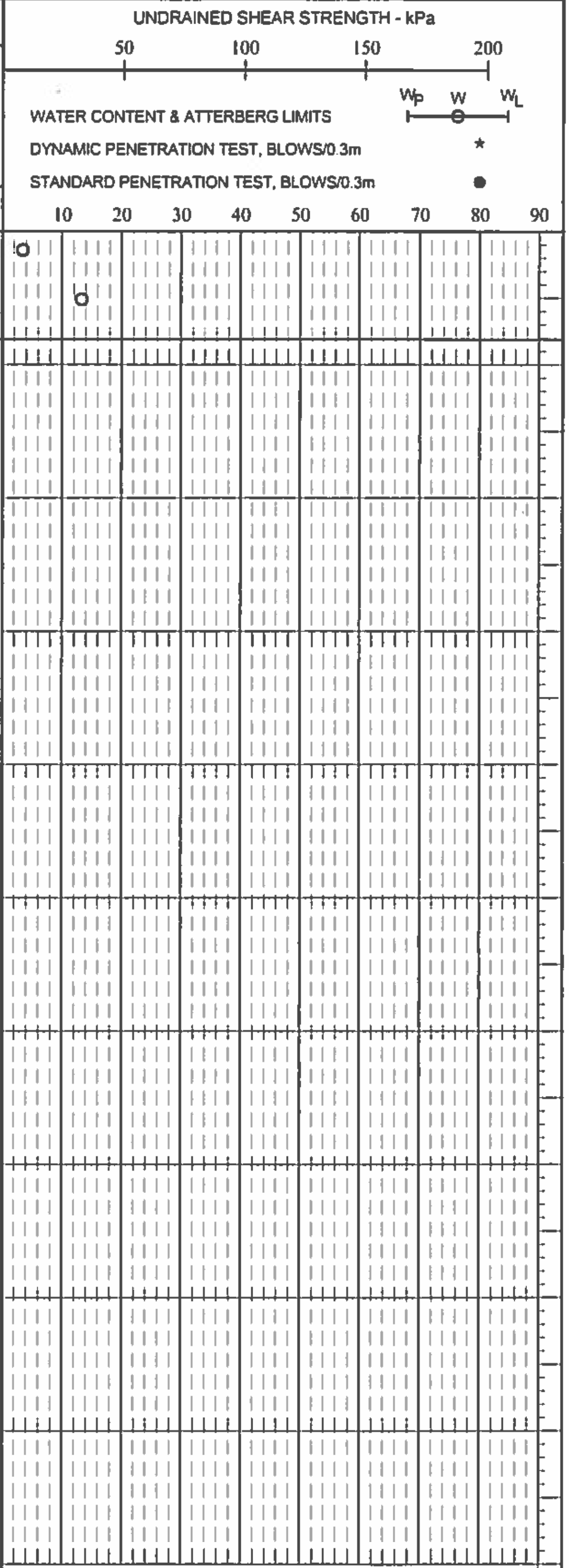
DATES: BORING May 17, 2013 WATER LEVEL

BOREHOLE No. BH13-4

PROJECT No. 122410780

DATUM

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	62.24							
	62.2	70 mm ASPHALT						
	62.0	FILL: grey sandy gravel			BS	1	-	-
	61.4	FILL: brown silty sand -trace gravel						
		End of Borehole Refusal on Inferred Bedrock						



DEPTH (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

□ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

Stantec

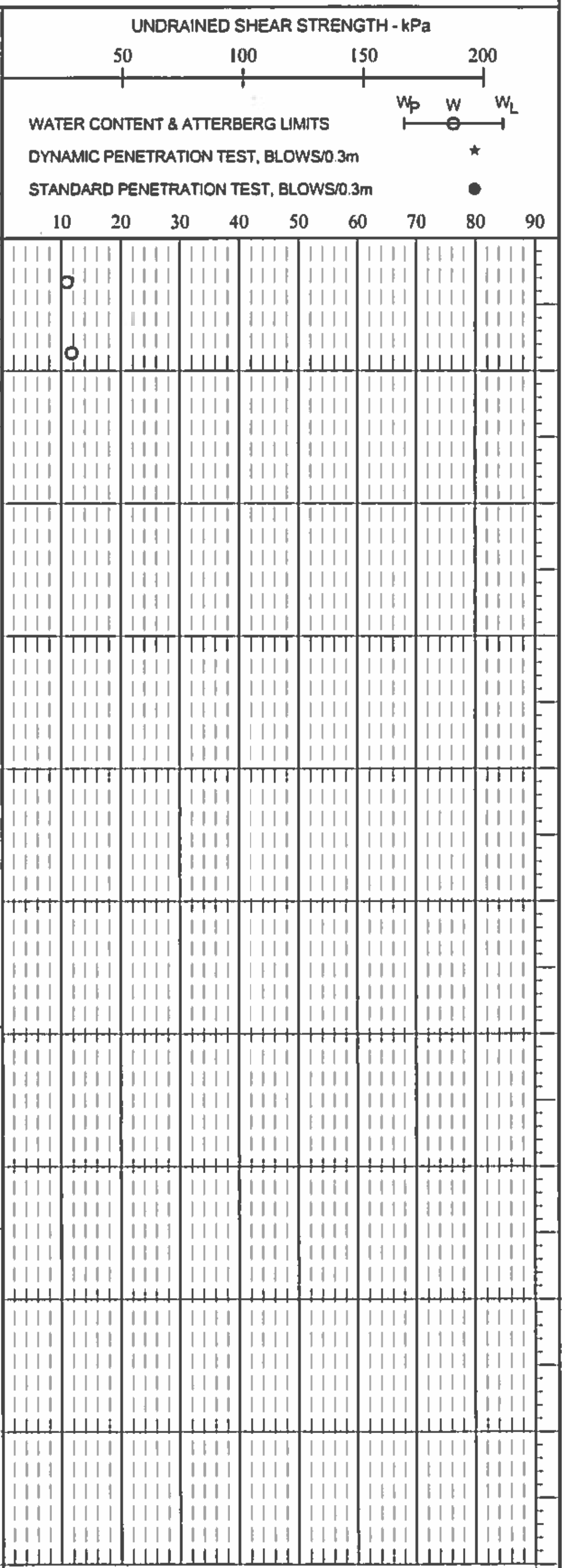
MONITORING WELL RECORD

N: 5 028 092 E: 442 776

MW13-5

CLIENT Richcraft Group of Companies
LOCATION Ottawa, ON
DATES: BORING May 10, 2013 WATER LEVEL May 22, 2013
BOREHOLE No. MW13-5
PROJECT No. 122410780
DATUM

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	62.15							
	62.1	50 mm ASPHALT						
	61.5	FILL: brown gravelly sand with clay			BS	1	-	-
1	61.2	Weathered LIMESTONE fragments with clay			SS	2	100	50
		Medium grey crystalline LIMESTONE with shaley partings -Very poor to excellent rock mass quality -Strong to very strong intact rock strength -Slightly weathered to unweathered -Discontinuities: 1 bedding set and 1 joint set (Refer to Field Bedrock Core Log)			HQ	3	100%	/50 mm 0%
2					HQ	4	98%	59%
3					HQ	5	100%	88%
4, 5					HQ	6	100%	83%
6, 7					HQ	7	100%	78%
8				▼	HQ	8	100%	82%
9, 10					HQ	9	100%	88%



▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

□ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Stantec

MONITORING WELL RECORD

N: 5 028 092 E: 442 776

MW13-5

2 of 3

CLIENT Richcraft Group of Companies
LOCATION Ottawa, ON
DATES: BORING May 10, 2013 WATER LEVEL May 22, 2013
BOREHOLE No. MW13-5
PROJECT No. 122410780
DATUM

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
10		*(Cont.)* Medium grey crystalline LIMESTONE with shaley partings (Refer to Field Bedrock Core Log)						
11					HQ	10	100%	98%
12					HQ	11	100%	98%
13								
14					HQ	12	100%	97%
15					HQ	13	100%	100%
16								
17					HQ	14	98%	98%
18					HQ	15	95%	93%
19								
20								

UNDRAINED SHEAR STRENGTH - kPa
50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L
DYNAMIC PENETRATION TEST, BLOWS/0.3m *
STANDARD PENETRATION TEST, BLOWS/0.3m ●
10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

□ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Stantec

MONITORING WELL RECORD

N: 5 028 092 E: 442 776

MW13-5

CLIENT Richcraft Group of Companies

BOREHOLE No. MW13-5

LOCATION Ottawa, ON

PROJECT No. 122410780

DATES: BORING May 10, 2013 WATER LEVEL May 22, 2013

DATUM

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m *

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
20		*(Cont.)* Medium grey crystalline LIMESTONE with shaley partings			HQ	16	100%	92%
21		(Refer to Field Bedrock Core Log)			HQ	17	98%	75%
22	39.6							
		End of Borehole Monitoring Well Installed						
23								
24								
25								
26								
27								
28								
29								
30								

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

□ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

Stantec

Field Bedrock Core Log

Client: Richcraft Group of Companies
Project: Parkdale Development
Contractor: Downing Estate Drilling Ltd.

Project No.: 122410780
Date: May 8, 2013
Borehole No.: MW13-3 (Page 1 of 4)
Logger: SH

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
1.65	HQ-4	100%	79%	2.84	Medium grey crystalline limestone - syenite cobble at top of run		U	2	B	F	C-M	RU	-	T	stylolites / dipping calcite healed fracture / calcite infilling dipping joint	Mohs Hardness: H=3-5.5
									J	D	C-M	RP	-	T		
2.84	HQ-5	100%	69%	4.39	Medium grey crystalline limestone	VS	U	1	B	F	VC-M	RU-RP	-	T	stylolites	Mohs Hardness: H=3-5.5
4.39	HQ-6	98%	69%	5.89	Medium grey crystalline limestone		U	3	B	F	VC-M	RU-SP	-	T	stylolites / shaley partings 1 mm thick / calcite infilling dipping joint	Mohs Hardness: H=3-5.5
									J	V	-	RP	-	T		
									J	D	W	RP	-	S		
5.89	HQ-7	100%	100%	7.37	Medium grey crystalline limestone		U	3	B	F	C-M	RU-RP	-	T	stylolites / calcite infilling vertical and dipping joints	Mohs Hardness: H=3-5.5
									J	D	-	RP	-	T		
									J	V	-	RP	-	T		

STRENGTH (MPa)
EH = Extremely Strong = > 250
VS = Very Strong = 100-250
S = Strong = 50-100
MS = Medium Strong = 25-50
W = Weak = 5 - 25
VW = Very Weak = 1-5
EW = Extremely Weak = < 1

WEATHERING
U = Unweathered = No Signs
S = Slightly = Oxidized
M = Moderately = Discoloured
H = Highly = Friable
C = Completely = Soil-like

DISCONTINUITY TYPE
B = Bedding Joint
J = Cross Joint
F = Fault
S = Shear Plane

SPACING
VW = Very Wide = >3m
W = Wide = 1-3 m
M = Moderate = 0.3-1 m
C = Close = 5-30 cm
VC = Very Close = <5 cm

ORIENTATION
F = Flat = 0-20^{0}
D = Dipping = 20-50^{0}
V = n-Vertical = >50^{0}

ROUGHNESS
RU = Rough Undulating
RP = Rough Planar
SU = Smooth Undulating
SP = Smooth Planar
LU = Slickensided Undulating
LP = Slickensided Planar

FILLING
T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

Field Bedrock Core Log

Client: Richcraft Group of Companies
Project: Parkdale Development
Contractor: Downing Estate Drilling Ltd.

Project No.: 122410780
Date: May 8, 2013
Borehole No.: MW13-3 (Page 2 of 4)
Logger: SH

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
7.37	HQ-8	100%	100%	8.89	Medium grey crystalline limestone	S	U	1	B	F	C-M	RU	-	T	stylolites / dipping calcite healed vein / shaley partings 1 mm thick	Mohs Hardness: H=3-5.5
8.89	HQ-9	100%	90%	10.41	Medium grey crystalline limestone		U	2	B	F	C-M	RU-SU	-	T	stylolites / dipping healed calcite vein / calcite vugs / calcite infilling dipping joint	Mohs Hardness: H=3-5.5
									J	D	-	RP	-	T		
10.41	HQ-10	100%	93%	11.91	Medium grey crystalline limestone		U	1	B	F	VC-M	RU-RP	-	T	calcite vugs + lenses / healed vertical vein / stylolites / shaley partings 1 mm thick	Mohs Hardness: H=3-5.5
11.91	HQ-11	100%	92%	13.44	11.91-13.11 m: Medium grey crystalline limestone with shaley partings 13.11 - 13.44 m: dark grey crystalline dolomite	VS	U	3	B	F	M	RU	-	T	calcite vugs + lenses / dipping pyrite and calcite lenses	Mohs Hardness: H=3-5.5
									J	D	-	SU	-	T		
									J	V	M	RP	-	SC		

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EH = Extremely Strong = > 250
VS = Very Strong = 100-250
S = Strong = 50-100
MS = Medium Strong = 25-50
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Stantec

Field Bedrock Core Log

Client: Richcraft Group of Companies
Project: Parkdale Development
Contractor: Downing Estate Drilling Ltd.
Project No.: 122410780
Date: May 8, 2013
Borehole No.: MW13-3 (Page 3 of 4)
Logger: SH

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
13.44	HQ-12	100%	80%	14.94	13.44 - 13.64 m : Dark grey crystalline dolomite 13.64 - 14.94 m: medium grey crystalline limestone with shaley partings 1-3 mm thick		U	3	B	F	M	RU	-	T	calcite veins + vugs / calcite and pyrite replacement features	Mohs Hardness: H=3-5.5
									J	D	-	RP	-	T		
									J	V	-	RP	-	SC		
14.94	HQ-13	100%	93%	16.48	Medium grey crystalline limestone with shaley partings		U	1	B	F	VC-M	RP-RU	-	T	dipping calcite veins	Mohs Hardness: H=3-5.5
16.48	HQ-14	100%	87%	18.01	Medium grey crystalline limestone with shaley partings	S	U	2	B	F	C-M	RU	-	T	dipping joint infilled with calcite / calcite vugs + dipping veins	Mohs Hardness: H=3-5.5
									J	D	-	RP	-	T		
18.01	HQ-15	100%	91%	19.48	Medium grey crystalline limestone		U	1	B	F	C-M	RU-RP	-	T	calcite vugs / shaley partings	Mohs Hardness: H=3-5.5

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ORIENTATION
F = Flat = $0-20^0$
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Field Bedrock Core Log

Stantec

Client: Richcraft Group of Companies
Project: Parkdale Development
Contractor: Downing Estate Drilling Ltd.

Project No.: 122410780
Date: May 8, 2013
Borehole No.: MW13-3 (Page 4 of 4)
Logger: SH

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
19.48	HQ-16	100%	87%	21.00	Medium grey crystalline limestone with interbeds of dark grey shale 1 - 20 mm thick		U	1	B	F	C-M	RU-SU	-	T	calcite vugs	Mohs Hardness : H=3-5.5
21.00	HQ-17	97%	81%	22.50	Medium grey crystalline limestone with interbeds of dark grey shale 1 - 20 mm thick	S	U	1	B	F	VC-M	RU-SU	-	T	-	Mohs Hardness : H=3-5.5

STRENGTH (MPa)
EH = Extremely Strong = > 250
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VW = Very Wide = >3m
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F = Flat = 0-20^0
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V = n-Vertical = >50^0

ROUGHNESS
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Field Bedrock Core Log

Client: Richcraft Group of Companies
Project: Parkdale Development
Contractor: Downing Estate Drilling Ltd.

Project No.: 122410780
Date: May 10, 2013
Borehole No.: MW13-5 (Page 1 of 4)
Logger: SH

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING	OCCASIONAL FEATURES	DRILLING OBSERVATIONS
0.97	HQ-3	100%	0%	1.42	Medium grey crystalline limestone		S	2	B	F	C	RU	-	T	coarse calcite infilling vertical joint	Mohs Hardness: H=3-5.5
									J	V	-	RP	7mm	O		
1.42	HQ-4	98%	59%	2.92	Medium grey crystalline limestone	VS	U	2	B	F	VC-M	RU	-	T-O	coarse calcite infilling vertical joint / shaley partings 1-30 mm thick	Mohs Hardness: H=3-5.5
									J	V	-	RP	7mm	O		
2.92	HQ-5	100%	88%	4.45	Medium grey crystalline limestone with black shaley partings 10-30 mm thick		U	1	B	F	VC-M	RU-SU	-	T	shaley partings <1 mm thick	Mohs Hardness: H=3-5.5
4.45	HQ-6	100%	83%	5.94	Medium grey crystalline limestone with black shaley partings 5-10 mm thick		U	1	B	F	VC-M	RU-SP	-	T-SC	subvertical calcite veins 1 mm thick / shaley partings <1 mm thick	Mohs Hardness: H=3-5.5

STRENGTH (MPa)
EH = Extremely Strong = > 250
VS = Very Strong = 100-250
S = Strong = 50-100
MS = Medium Strong = 25-50
W = Weak = 5 - 25
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WEATHERING
U = Unweathered = No Signs
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DISCONTINUITY TYPE
B = Bedding Joint
J = Cross Joint
F = Fault
S = Shear Plane

SPACING
VW = Very Wide = >3m
W = Wide = 1-3 m
M = Moderate = 0.3-1 m
C = Close = 5-30 cm
VC = Very Close = <5 cm

ORIENTATION
F = Flat = 0-20^{0}
D = Dipping = 20-50^{0}
V = n-Vertical = >50^{0}

ROUGHNESS
RU = Rough Undulating
RP = Rough Planar
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SP = Smooth Planar
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FILLING
T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
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Field Bedrock Core Log

Stantec

Client: Richcraft Group of Companies
Project: Parkdale Development
Contractor: Downing Estate Drilling Ltd.

Project No.: 122410780
Date: May 10, 2013
Borehole No.: MW13-5 (Page 2 of 4)
Logger: SH

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
5.94	HQ-7	100%	78%	7.47	Medium grey crystalline limestone shaley partings 1 - 20 mm thick	VS	U	1	B	F	VC-M	RU-SU	-	T	subvertical calcite veins	Mohs Hardness: H=3-5.5
7.47	HQ-8	100%	82%	8.99	Medium grey crystalline limestone with shaley partings 1 - 25 mm thick		U	1	B	F	VC-M	RU-SU	-	T	subvertical calcite veins	Mohs Hardness: H=3-5.5
8.99	HQ-9	100%	88%	10.49	Medium grey crystalline limestone		U	1	B	F	C-M	RU-SU	-	T	shaley partings 1 - 10 mm thick / subvertical calcite veins 1 mm thick	Mohs Hardness: H=3-5.5
10.49	HQ-10	100%	98%	11.99	Medium grey crystalline limestone with black shaley partings 1-50 mm thick	VS	U	1	B	F	VC-M	RU	-	T	subvertical calcite veins / calcite vugs	Mohs Hardness: H=3-5.5

STRENGTH (MPa)
EH = Extremely Strong = > 250
VS = Very Strong = 100-250
S = Strong = 50-100
MS = Medium Strong = 25-50
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FILLING
T = Tight, Hard
O = Oxidized
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Field Bedrock Core Log

Client: Richcraft Group of Companies
Project: Parkdale Development
Contractor: Downing Estate Drilling Ltd.

Project No.: 122410780
Date: May 10, 2013
Borehole No.: MW13-5 (Page 3 of 4)
Logger: SH

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
11.99	HQ-11	100%	98%	13.49	Medium grey crystalline limestone with black shaley partings 1-40 mm thick		U	1	B	F	VC-W	SP-RP	-	T	subvertical calcite veins 1 mm thick	Mohs Hardness: H=3-5.5
13.49	HQ-12	100%	97%	14.99	Medium grey crystalline limestone with black shaley partings 1-20 mm thick		U	1	B	F	C-M	SU-SP	-	T	-	Mohs Hardness: H=3-5.5
14.99	HQ-13	100%	100%	16.51	Medium grey to dark grey crystalline limestone	S	U	1	B	F	C-M	SP-RP	-	T	shaley partings 1 mm thick	Mohs Hardness: H=3-5.5
16.51	HQ-14	98%	98%	18.01	Medium grey crystalline limestone with black shaley partings 10-20 mm thick		U	1	B	F	C-M	SP-SU	-	T	subvertical calcite veins 1 mm thick	Mohs Hardness: H=3-5.5

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Stantec

Field Bedrock Core Log

Client: Richcraft Group of Companies
Project: Parkdale Development
Contractor: Downing Estate Drilling Ltd.

Project No.: 122410780
Date: May 10, 2013
Borehole No.: MW13-5 (Page 4 of 4)
Logger: SH

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
18.01	HQ-15	95%	93%	19.51	Medium grey crystalline limestone		U	1	B	F	C-M	RU-SU	-	T	shaley partings 1 mm thick / subvertical calcite veins 1 mm thick	Mohs Hardness: H=3-5.5
19.51	HQ-16	100%	92%	21.00	Medium grey crystalline limestone with shaley partings 1-10 mm thick	S	U	1	B	F	VC-M	SP-RU	-	T	subvertical calcite veins 1 mm thick	Mohs Hardness: H=3-5.5
21.00	HQ-17	98%	75%	22.50	Medium grey crystalline limestone with black shaley partings 1-20 mm		U	1	B	F	C-M	RP-RU	-	T	subvertical calcite veins 1-3 mm thick	Mohs Hardness: H=3-5.5

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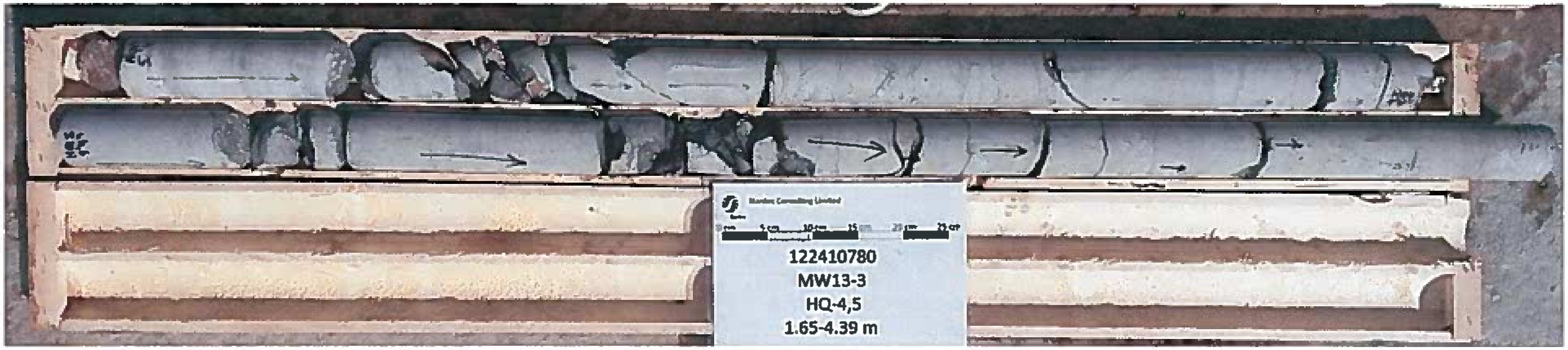
Stantec	Project No.: 122410780	Rock Core Photographs
	Project Name: Parkdale Development	



Rock Core Photo No.: 1	Borehole: MW13-3	Depth: 1.65-4.39 m

Rock Core Photo No.: 2	Borehole: MW13-3	Depth: 4.39-7.37 m

Project No.: 122410780

Project Name: Parkdale Development

Rock Core Photographs

Rock Core Photo No.: 3

Borehole: MW13-3

Depth: 7.37-10.41 m

Rock Core Photo No.: 4

Borehole: MW13-3

Depth: 10.41-13.44 m

Stantec

Project No.: 122410780

Project Name: Parkdale Development

Rock Core Photographs

Rock Core Photo No.: 5 | Borehole: MW13-3 | Depth: 13.44-16.48 m

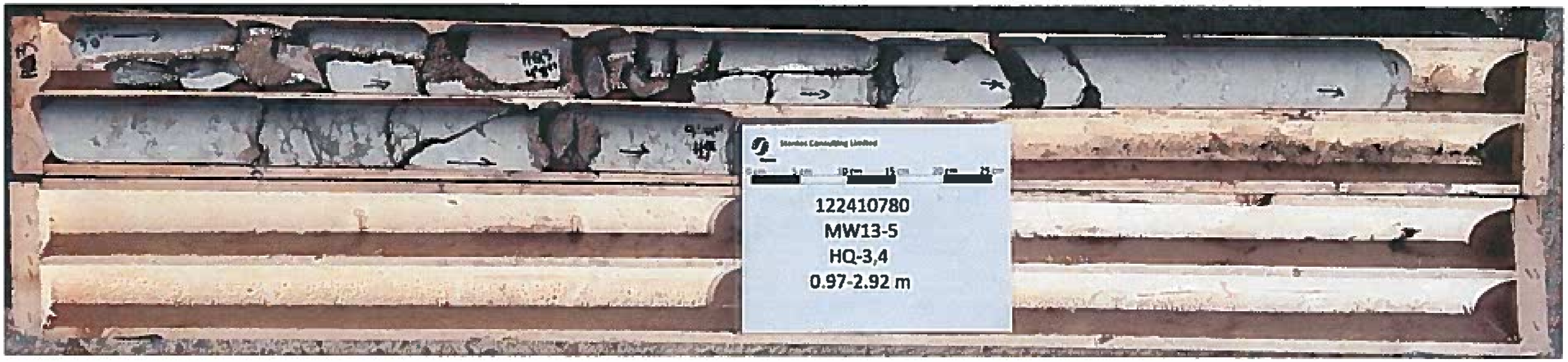
Rock Core Photo No.: 6 | Borehole: MW13-3 | Depth: 16.48-19.48 m

Project No.: 122410780

Project Name: Parkdale Development

Rock Core Photographs

Rock Core Photo No.: 7 | Borehole: MW13-3 | Depth: 19.48-22.50 m



Rock Core Photo No.: 8 | Borehole: MW13-5 | Depth: 0.97-2.92 m

Stantec

Project No.: 122410780

Project Name: Parkdale Development

Rock Core Photographs

Rock Core Photo No.: 9 | Borehole: MW13-5 | Depth: 2.92-5.94 m

Rock Core Photo No.: 10 | Borehole: MW13-5 | Depth: 5.94-8.99 m

Stantec	Project No.: 122410780 Project Name: Parkdale Development	Rock Core Photographs

Rock Core Photo No.: 11	Borehole: MW13-5	Depth: 8.99-11.99 m

Rock Core Photo No.: 12	Borehole: MW13-5	Depth: 11.99-14.99 m

Stantec	Project No.: 122410780	Rock Core Photographs
	Project Name: Parkdale Development	

Rock Core Photo No.: 13	Borehole: MW13-5	Depth: 14.99-18.01 m

Rock Core Photo No.: 14	Borehole: MW13-5	Depth: 18.01-21.00 m

Stantec

Project No.: 122410780

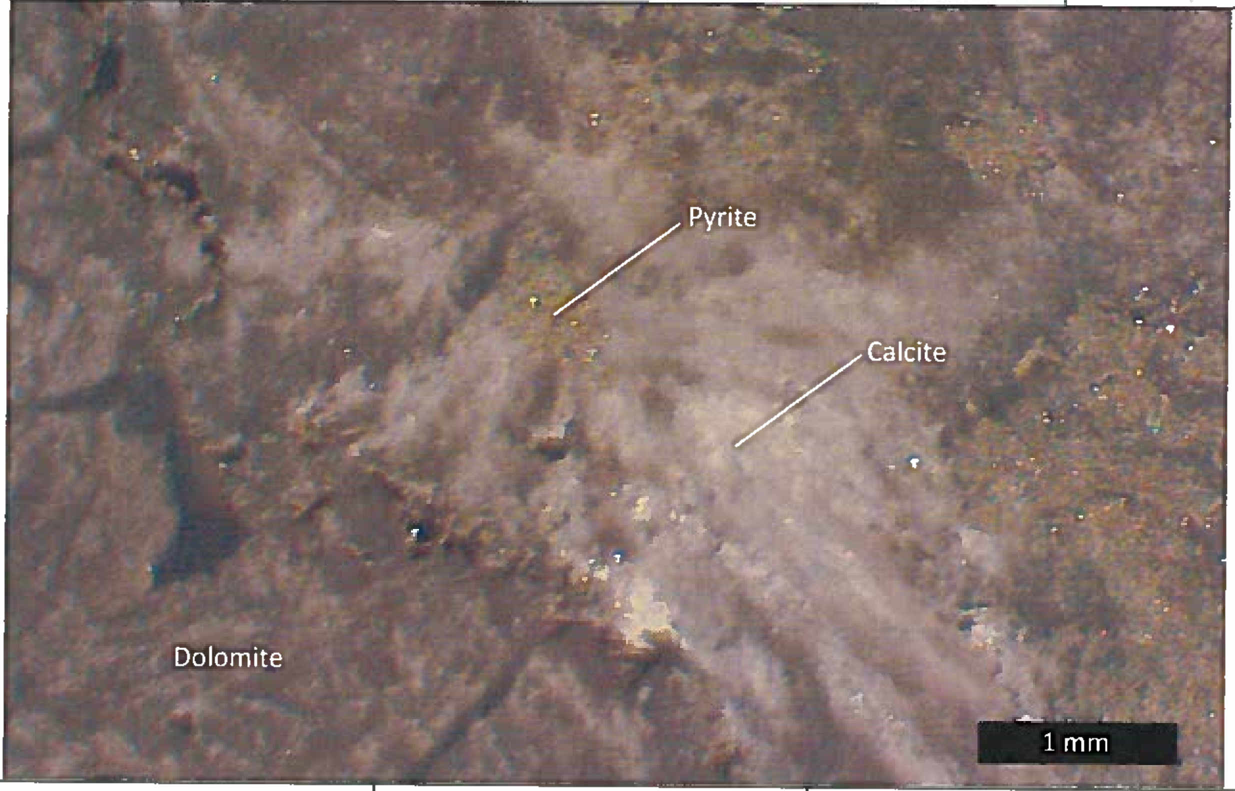
Project Name: Parkdale Development

Rock Core Photographs

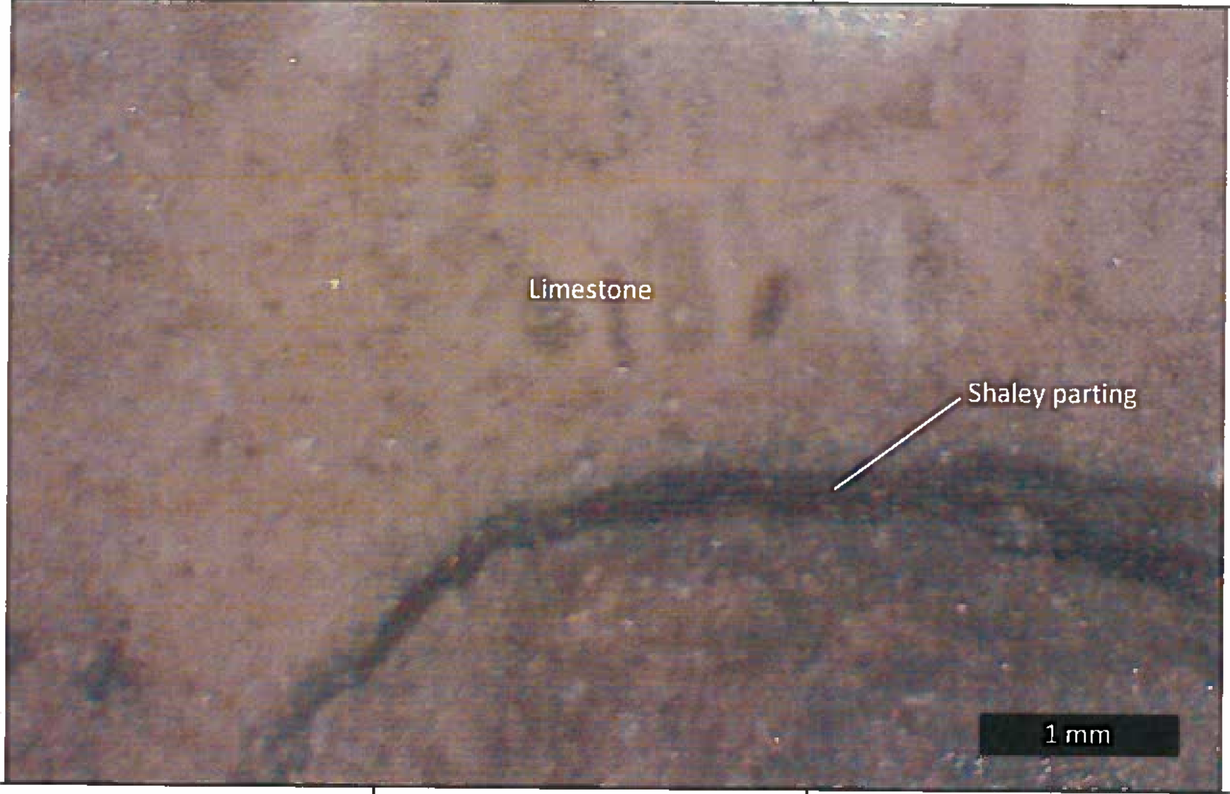
Rock Core Photo No.: 15

Borehole: MW13-5

Depth: 21.00-22.50 m

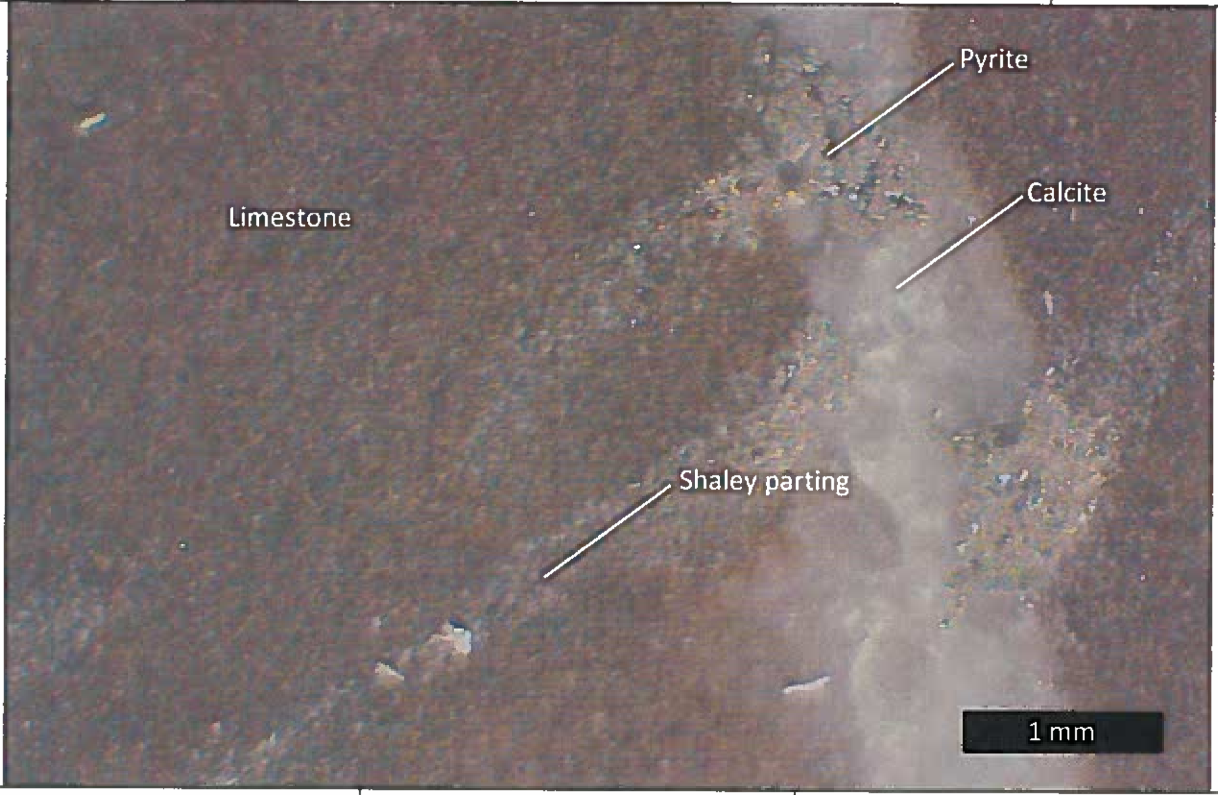


Rock Core Photo No.: 16	Borehole: MW13-3	Depth: 13.26 m



Rock Core Photo No.: 17	Borehole: MW13-3	Depth: 18.62 m

Stantec	Project No.: 122410780	Rock Core Photographs
	Project Name: Parkdale Development	



Rock Core Photo No.: 18	Borehole: MW13-5	Depth: 17.37 m

APPENDIX D

Laboratory Test Results

Stantec

2781 Lancaster Rd. Suite 200
Ottawa, Ontario K1J 1A7
Tel: (613) 738-0708
Fax: (613) 738-0721

ASTM-D7012
Compressive Strength and Elastic Moduli of Intact Rock Core Speciments under Varying States of Stress and Temperatures. Method C: Unconfined Compressive of Intact Rock Core Speciments.
D4543/ Preparation

Client: Richcraft Group of Companies Inc.
Project No.: 122410780
Project: Parkdale Development
Date Rec'd: May 14,2013
Date Drilled: May 8-10, 2113
Date Tested: 16-May-13
Cored By: Simon Harvey
Tested By: Athir Nader

Sample Location	BH13-3 HQ5 10'9"	BH13-3 HQ8 26'7"	BH13-3 HQ11 41'5"	
Physical Description	As per Geo-tech Report	As per Geo-tech Report	As per Geo-tech Report	
Average Diameter (mm) (≥47.0)	62.00	62.00	62.00	
Specimen Length (mm)	149.00	150.00	151.00	
L/D Ratio (2.0-2.5)	2.40	2.42	2.44	
Failure Load (lbs)	85135	61456	69356	
Compressive Strength (Mpa)	**125.4**	**90.5**	**102.2**	
Straightness by Procedure S1 (≤0.02inch)	<0.02	<0.02	<0.02	
Flatness by Procedure FP2 (≤0.001inch)	<0.001	<0.001	<0.001	
Parallelism by Procedure FP2 (≤0.25°)	-0.079	-0.062	-0.046	
Perpendicularity by Procedure P2 (≤0.0043)	<0.0043	<0.0043	<0.0043	
Moisture Condition	As-Received	As-Received	As-Received	
Description of Break D7012/11.1.13	Reasonable well formed cones on both ends	Well formed cone on one end, vertical cracks running through	Well formed cone on one end, vertical cracks running through	
Note				

Reviewed by: ______________________

Date: ____________

Stantec

2781 Lancaster Rd. Suite 200
Ottawa, Ontario K1J 1A7
Tel: (613) 738-0708
Fax: (613) 738-0721

ASTM-D7012
Compressive Strength and Elastic Moduli of Intact Rock Core Speciments under Varying States of Stress and Temperatures. Method C: Unconfined Compressive of Intact Rock Core Speciments.
D4543/ Preparation

Client: Richcraft Group of Companies Inc.

Project No.: 122410780

Project: Parkdale Development

Date Rec'd: May 14,2013

Date Drilled: May 8-10, 2113

Date Tested: 16-May-13

Cored By: Simon Harvey

Tested By: Athir Nader

Sample Location	BH13-3 HQ14 57'7"	BH13-3 HQ17 72'4"		
Physical Description	As per Geo-tech Report	As per Geo-tech Report		
Average Diameter (mm) (≥47.0)	62.00	62.00		
Specimen Length (mm)	146.00	137.00		
L/D Ratio (2.0-2.5)	2.35	2.21		
Failure Load (lbs)	53136	63778		
Compressive Strength (Mpa)	78.3	**94.0**		
Straightness by Procedure S1 (≤0.02inch)	<0.02	<0.02		
Flatness by Procedure FP2 (≤0.001inch)	<0.001	<0.001		
Parallelism by Procedure FP2 (≤0.25°)	-0.119	-0.087		
Perpendicularity by Procedure P2 (≤0.0043)	<0.0043	<0.0043		
Moisture Condition	As-Received	As-Received		
Description of Break D7012/11.1.13	Diagonal fracture with cracks through one end	Well formed cone on one end, vertical cracks through caps		
Note				

Reviewed by: ____________________

Date: __________

Stantec

2781 Lancaster Rd. Suite 200
Ottawa, Ontario K1J 1A7
Tel: (613) 738-0708
Fax: (613) 738-0721

ASTM-D7012

Compressive Strength and Elastic Moduli of Intact Rock Core Speciments under Varying States of Stress and Temperatures. Method C: Unconfined Compressive of Intact Rock Core Speciments.

D4543/ Preparation

Client: Richcraft Group of Companies Inc.
Project No.: 122410780
Project: Parkdale Development
Date Rec'd: May 14,2013
Date Drilled: May 8-10, 2113
Date Tested: 16-May-13
Cored By: Simon Harvey
Tested By: Athir Nader

Sample Location	BH13-5 HQ4 6'9"	BH13-5 HQ7 22'9"	BH13-5 HQ10 37'1"	0
Physical Description	As per Geo-tech Report	As per Geo-tech Report	As per Geo-tech Report	
Average Diameter (mm) (≥47.0)	62.00	62.00	62.00	
Specimen Length (mm)	151.00	150.00	148.00	
L/D Ratio (2.0-2.5)	2.44	2.42	2.39	
Failure Load (lbs)	88413	106101	107351	
Compressive Strength (Mpa)	**130.3**	**156.3**	**158.2**	
Straightness by Procedure S1 (≤0.02inch)	<0.02	<0.02	<0.02	
Flatness by Procedure FP2 (≤0.001inch)	<0.001	<0.001	<0.001	
Parallelism by Procedure FP2 (≤0.25°)	-0.078	-0.109	-0.089	
Perpendicularity by Procedure P2 (≤0.0043)	<0.0043	<0.0043	<0.0043	
Moisture Condition	As-Received	As-Received	As-Received	
Description of Break D7012/11.1.13	Well formed cone on one end, vertical cracks running through	Well formed cone on one end, vertical cracks running through	Well formed cone on one end, vertical cracks running through	
Note				

Reviewed by: __________

Date: __________

Stantec

2781 Lancaster Rd. Suite 200
Ottawa, Ontario K1J 1A7
Tel: (613) 738-0708
Fax: (613) 738-0721

ASTM-D7012
Compressive Strength and Elastic Moduli of Intact Rock Core Speciments under Varying States of Stress and Temperatures. Method C: Unconfined Compressive of Intact Rock Core Speciments.
D4543/ Preparation

Client: Richcraft Group of Companies Inc.

Project No.: 122410780

Project: Parkdale Development

Date Rec'd: May 14,2013

Date Drilled: May 8-10, 2113

Date Tested: 16-May-13

Cored By: Simon Harvey

Tested By: Athir Nader

Sample Location	BH13-5 HQ13 53'1"	BH13-5 HQ16 67'0"		
Physical Description	As per Geo-tech Report	As per Geo-tech Report		
Average Diameter (mm) (≥47.0)	62.00	62.00		
Specimen Length (mm)	151.00	149.00		
L/D Ratio (2.0-2.5)	2.44	2.40		
Failure Load (lbs)	50658	59993		
Compressive Strength (Mpa)	74.6	88.4		
Straightness by Procedure S1 (≤0.02inch)	<0.02	<0.02		
Flatness by Procedure FP2 (≤0.001inch)	<0.001	<0.001		
Parallelism by Procedure FP2 (≤0.25°)	-0.159	-0.092		
Perpendicularity by Procedure P2 (≤0.0043)	<0.0043	<0.0043		
Moisture Condition	As-Received	As-Received		
Description of Break D7012/11.1.13	Well formed cone on one end, vertical cracks running through	Columnar vertical cracking through both ends, no well formed cone		
Note				

Reviewed by: ______________________

Date: ____________

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www.paracellabs.com

Certificate of Analysis

Stantec Consulting Ltd. (Ottawa)
1331 Clyde Avenue Suite 400
Ottawa, ON K2C 3G4
Attn: Simon Harvey

Phone: (613) 722-4420
Fax: (613) 738-0721

Client PO: Parkdale Development
Project: 122410780.200
Custody: 8942

Report Date: 6-Jun-2013
Order Date: 3-Jun-2013
Order #: 1323037

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	**Client ID**
1323037-01	MW13-3
1323037-02	MW13-5

Approved By: Mark Foto

Mark Foto, M.Sc. For Dale Robertson, BSc
Laboratory Director

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC	3-Jun-13	3-Jun-13
pH	EPA 150.1 - pH probe @25 °C	6-Jun-13	6-Jun-13
Resistivity	EPA 120.1 - probe	6-Jun-13	6-Jun-13

Certificate of Analysis

Report Date: 06-Jun-2013
Client: **Stantec Consulting Ltd. (Ottawa)**
Order Date:3-Jun-2013
Client PO: Parkdale Development
Project Description: 122410780.200

	Client ID:	MW13-3	MW13-5	-	-
	Sample Date:	03-Jun-13	03-Jun-13	-	-
	Sample ID:	1323037-01	1323037-02	-	-
	MDL/Units	Water	Water	-	-
General Inorganics					
pH	0.1 pH Units	7.2	8.6	-	-
Resistivity	0.01 Ohm.m	9.43	45.6	-	-
Anions					
Chloride	1 mg/L	205	29	-	-
Sulphate	1 mg/L	78	28	-	-

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	ND	1	mg/L						
Sulphate	ND	1	mg/L						
General Inorganics									
Resistivity	ND	0.01	Ohm.m						

Certificate of Analysis

Report Date: 06-Jun-2013
Order Date:3-Jun-2013

Client: **Stantec Consulting Ltd. (Ottawa)**
Client PO: Parkdale Development
Project Description: 122410780.200

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	281	1	mg/L	282			0.3	10	
Sulphate	45.6	1	mg/L	45.8			0.3	10	
General Inorganics									
pH	6.3	0.1	pH Units	6.3			0.5	10	
Resistivity	9.42	0.01	Ohm.m	9.43			0.2	20	

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	10.7		mg/L	0.92	97.4	78-112			
Sulphate	55.1		mg/L	45.8	93.0	75-111			

Qualifier Notes:

None

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.

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№ 8942

Page 1 of 1

Client Name: Stantec Consulting Ltd.
Contact Name: Simon Harvey
Address: 1331 Clyde Ave.
Telephone: 613-722-4420

Project Reference: Parkdale Development
Quote #: 122410780
PO #: 200
Email Address: simon.harvey@stantec.com

TAT: [✓ Regular] [ ] 3 Day [ ] 2 Day [ ] 1 Day
Date Required: ______

Criteria: [✓] O. Reg. 153/04 Table __ [ ] O. Reg 153/11 (Current) Table __ [ ] RSC Filing [ ] O. Reg. 558/00 [ ] PWQO [ ] CCME [ ] SUB (Storm) [ ] SUB (Sanitary) Municipality ______ [ ] Other: ______

Matrix Type: S (Soil/Sed) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)

Paracel Order Number: 1323037

Required Analyses

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken Date	Sample Taken Time	pH	resistivity	sulphate	chlorides							
1	MW13-3			1	June 3, 2013		✓	✓	✓	✓							
2	MW13-5			1	June 3, 2013		✓	✓	✓	✓							
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	

Comments:

Method of Delivery: Walk in

Relinquished By (Print & Sign): Simon Harvey
Date/Time: June 3, 2013 2:36 pm

Received by Driver/Depot:
Date/Time:
Temperature: ____ °C

Received at Lab:
Date/Time: June 3/13 2:36 pm
Temperature: 14.0

Verified By: MJC
Date/Time: June 3/13 3:03
pH Verified [ ] By: N/A

APPENDIX E

Rock Anchor: Resistance to Rock Mass Failure

Rock Anchor

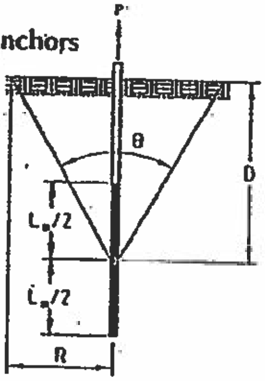
Resistance to Rock Mass Failure

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

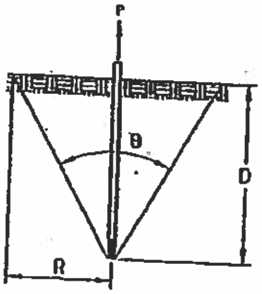
Design Considerations:

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

Vertical Anchors

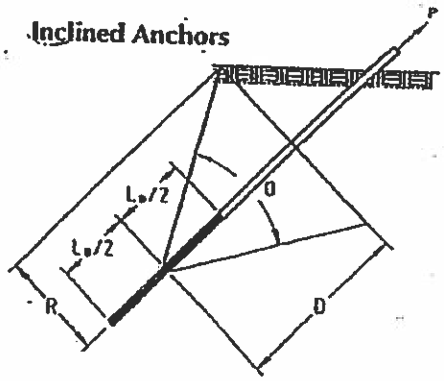


Grouted Rock Anchors

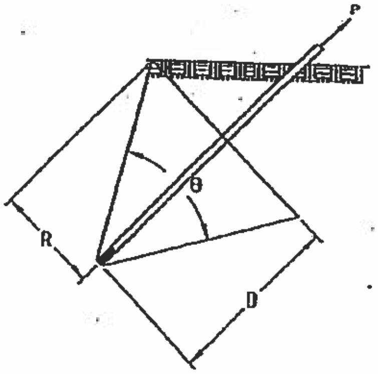


Mechanical Rock Anchors

Inclined Anchors



Grouted Rock Anchors



Mechanical Rock Anchors

P = Resultant of maximum axial anchor forces
D = Height of rock cone
R = Radius of rock cone
θ = Appex angle
L_B = Bond length
γ_R = Submerged unit weight of bedrock
W_R = Weight of rock cone ($W_R = \frac{1}{3}\pi R^2 D \gamma_R$)