- **DCR Phoenix Group of Companies**

Geotechnical Investigation

Type of Document
Final

Project Name
Proposed Residential Development
Fallowfield Road and Cedarview Road, Ottawa, Ontario

Project Number
OTT-00243143-A0

Prepared By: Surinder K. Aggarwal, M.Sc., P.Eng.

Reviewed By: Ismail M. Taki, M.Eng., P.Eng.

EXP Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6
Canada

Date Submitted
June 4, 2018

DCR Phoenix Group of Companies

18A Bentley Avenue
Ottawa, Ontario K2E 6T8

Attention: Mike Boucher

Geotechnical Investigation

Type of Document:
Final

Project Name:
Proposed Residential Development
Fallowfield Road and Cedarview Road, Ottawa, Ontario

Project Number:
OTT-00243143-A0

Prepared By:
EXP Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6
Canada
T: 613-688-1899
F: 613-225-7337
www.exp.com

Surinder K. Aggarwal, M.Sc., P.Eng.
Senior Project Manager, Geotechnical Services
Earth and Environment

Ismail M. Taki, M.Eng. P.Eng.
Manager, Geotechnical Services
Earth and Environment

Date Submitted:
June 4, 2018

Legal Notification

This report was prepared by EXP Services Inc. for the account of **DCR Phoenix Group of Companies.**

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. EXP Services Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this project.

Executive Summary

A geotechnical investigation was undertaken at the site of the proposed residential development to be located at the intersection of Fallowfield Road and Cedarview Road in the City of Ottawa, Ontario. This work was authorized by Mr. Michael Boucher of Phoenix Homes.

It's proposed to construct 14 buildings each containing 12 to 18 apartments, terraced flats or terraced homes.

The investigation comprised of drilling a total of 12 boreholes (including 3 boreholes drilled during the preliminary investigation in 2017) to 1.9 m to 6.3 m depth. These boreholes revealed that beneath some fill and/or silty sand, the predominant soil at the site is compact to very dense silty gravelly sand till, which extends to the refusal depth or to bedrock, i.e. to 1.9 m to 5.5 m, i.e. Elevation 96.9 m to 102.4 m). Washboring and core drilling techniques revealed that the bedrock underlying the is limestone. Groundwater table was established at a depth of 0 m to 3 m below the existing ground surface, i.e. Elevation. 99.1 m to 102.5 m).

Based on the results of the investigation, there are no grade-raise restrictions at the site since cohesive soils were not encountered.

The site has been classified as Class C for seismic site classification in accordance with the requirements of the Ontario Building Code, 2013. The on-site soils are not subject to liquefaction during a seismic event.

The geotechnical conditions at the site are suitable for construction of the proposed residences on spread and strip footing foundations set on engineered fill or compact to dense silty gravelly sand till. These footings may be designed for Serviceability Limit State (SLS) bearing pressure of 150 kPa and factored geotechnical resistance at Ultimate Limit State of 225 kPa. The settlements of the footings properly constructed are expected to be within the normally tolerated limits of 25 mm total and 19 mm differential movements.

The lowest level floors of the proposed buildings may be constructed as slabs-on-grade set on engineered fill or compact to dense silty gravelly sand till. Perimeter and underfloor drains should be provided for structures with basements.

The subsurface walls and the retaining walls may be designed according to the parameters presented in the report.

It is anticipated that the excavations at the site will extend to a depth of 1.6 m to 3.9 m below the existing ground surface. These excavations will extend through the fill to the underlying silty gravelly sand still. They are expected to be partly above the groundwater table and partly below the groundwater table. The excavation at the site should comply with the requirements of the Occupational Health and Safety Act, Ontario, Regulations 213/19. They may be cut back at 45 degrees above the groundwater table. Below the groundwater table, they are expected to slough and may stabilize at in inclination of 2H:1V to 3H:1V.

Base heave of the excavations in the native soil is not expected because of the compact to dense nature of the till.

Engineered fill for placement of foundations and any fill required to raise the grade at the site in the building areas should comply with OPSS 1010 requirements for Granular B, Type II. It should be compacted to 100 percent of SPMDD under the footings and to 98 percent Standard Proctor Maximum Dry Density (SPMDD) under the floor slabs and to 95 percent SPMDD in service trenches located outside the buildings. Trench backfill and subgrade fill in parking areas and access roadways should conform to OPSS 1010 requirement for Select Subgrade Material and compacted to 95 percent of standard Proctor maximum dry density.

The pavement structure for access roads may consist of 90 mm of asphaltic concrete underlain b 150 mm of Granular A base and 450 mm of Granular B sub-base. The pavement structure for parking lots may consist of 65 mm of asphaltic concrete underlain by 150 mm of OPSS 1010 Granular A base and 300 mm of OPSS 1010 Granular B Type II sub-base.

General Use (GU) Portland cement may be used in subsurface concrete at this site. The concrete should be designed in accordance with the requirements of CSA A23.1-14.

Consideration should be given to complete additional probes to collect data on rock elevations throughout the site.

The above and other related considerations are discussed in greater detail in the report.

It is recommended that an additional geotechnical investigation should be undertaken at the site prior to the final design of the structures.

Table of Contents

Page

List of Tables

Page

List of Figures

List of Appendices

1 Introduction

A detailed geotechnical investigation was undertaken by EXP Services Inc. (EXP) on the site located in the southwest quadrant of the intersection of Fallowfield Road and Cedarview Road in the City of Ottawa, Ontario. It is proposed to construct 14 buildings consisting of apartment buildings, terraced homes or flats. Each block would contain 12 to 18 units. Each block will be three-storeys in height with one basement level.

A preliminary investigation was completed by EXP at the subject site in 2017 as part of the due diligence and the results presented under our report OTT-00243143-A0 dated October 30, 2017

The purpose of the additional investigation was completed as part of the final design and site plan submission to the City of Ottawa. The current investigation was completed to:

a) Establish geotechnical and groundwater profile throughout the site;

b) Establish the maximum grade raise permissible at the site;

c) Make recommendations regarding the most suitable type of foundations, founding depth and Serviceability Limit State (SLS) and Ultimate Limit State (ULS) bearing capacities of the founding soil;

d) Determine anticipated settlements;

e) Classify the site for seismic site response in accordance with the requirements of National Building Code (NBC), 2012;

f) Discuss slab-on-grade construction and permanent draining requirements;

g) Comment on excavation conditions and effect of groundwater on the excavations;

h) Discuss backfilling requirements and suitability of on-site soils for backfilling purposes;

i) Recommend pavement structure thickness for access roads and parking areas; and

j) Comment o subsurface concrete requirements.

The comments and recommendations given in this report are preliminary in nature and based on the assumption that the above-described design concept will proceed into construction. If changes are made either in the design phase or during construction, this office must be retained to review these modifications. The result of this review may be a modification of our recommendations or it may require additional field or laboratory work to check whether the changes are acceptable from a geotechnical viewpoint.

2 Procedure

Borehole Nos. 1 to 3 were drilled as part of the preliminary investigation completed in 2017.

The fieldwork for the additional geotechnical investigation was undertaken on March 5 and 6, 2018 and comprised the drilling of nine boreholes (Borehole Nos. 4 to 7, 7A and 8 to 11) to depths ranging between 1.9 m and 6.3 m. The locations of all the boreholes are shown on Borehole Location Plan, Figure 2.

The fieldwork was undertaken with a track-mounted drill rig equipped with continuous flight hollow-stem augers and coring facilities. It was supervised on a full-time basis by a representative of EXP.

Standard penetration tests were performed in all the boreholes at 0.75 m to 1.5 m depth intervals and soil samples retrieved by split barrel sampler. The bedrock in Boreholes 7A and 10 was core drilled using NX-size core barrel. A careful record of any sudden drops of the drill rods, loss of drill water and colour of the wash water was kept when core drilling the bedrock.

Water levels were measured in the open boreholes on completion of drilling. In addition, long-term groundwater monitoring installations consisting of 19 mm diameter PVC (polyvinyl chloride) pipes were placed in Borehole Nos. 1, 3, 4, 7 to 11. The installation configuration is documented on the respective borehole log. All the boreholes were backfilled upon completion of the fieldwork. The initial locations of the boreholes were established by a representative of EXP using GPS technology. The final elevations and locations of the boreholes were determined by a survey crew from EXP. Elevations of the boreholes refer to the Geodetic datum.

All the soil samples were visually examined in the field for textural classification, logged, preserved in plastic bags and identified. The rock cores were placed in core boxes, identified and logged. On completion of the fieldwork, all the soil and rock samples were transported to the EXP laboratory in the City of Ottawa, Ontario.

All the soil samples and rock cores were visually examined in the laboratory by a geotechnical engineer and borehole logs prepared. The engineer also assigned the laboratory testing which consisted of performing natural moisture content, unit weight, grain-size analysis, pH and sulphate content tests on selected soil samples. In addition, two unconfined compressive strength tests were carried out on rock cores.

3 Soil Description

A detailed description of the subsurface soil and groundwater conditions determined from the boreholes are given on the attached borehole logs, Figure Nos. 3 to 14. The borehole logs and related information depict subsurface conditions only at the specific locations and times indicated. Subsurface conditions and water levels at other locations may differ from conditions at the locations where sampling was conducted. The passage of time also may result in changes in the conditions interpreted to exist at the locations where sampling was conducted. Boreholes were drilled to provide representation of subsurface conditions as part of a geotechnical exploration program.

It should be noted that the soil and bedrock boundaries indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect approximate transition zones for the purpose of geotechnical design and should not be interpreted as exact planes of geological change. The “Notes on Sample Descriptions” preceding the borehole logs form an integral part of this report and should be read in conjunction with this report.

A review of the borehole logs indicates the following soil stratigraphy in descending order.

3.1 Topsoil

The thickness of topsoil at the site varies from 50 mm to 300 mm except in the case of Borehole No. 3 where no topsoil was encountered.

3.2 Silty Sand

The topsoil in Borehole Nos. 6 and 9 is underlain by silty sand, which extends to 0.6 m depth (Elev. 102.7 m) in Borehole No. 6 and to 0.9 m depth (Elev. 102.1 m) in Borehole No. 9. The silty sand is loose as indicated by its standard penetration resistance (‘N’ value), which varies from 5 to 6 blows. The moisture content of the silty sand varies from 26 percent to 34 percent.

3.3 Fill

The topsoil in all the boreholes except Borehole Nos. 6, and 8 to 10 is underlain by fill, which extends to 0.6 m depth to 2.5 m depth (Elev. 99.9 to 103.2 m). The fill is a mixture of silty sand and silty clay and contains some gravel, organics and roots. It is loose to compact with standard penetration resistance (‘N’ values) varying from 4 to 16. Its moisture content varies from 10 percent to 57 percent.

3.4 Silty Gravelly Sand Till

The silty sand in Borehole Nos. 6 and 9, the topsoil in Borehole Nos. 8 and 10 and the fill in all the other boreholes is underlain by silty gravelly sand till, which extends to the bedrock surface in Borehole Nos. 3, 7A and 10 and to the auger refusal depth in all the other boreholes, i.e. 1.9 m to 5.5 m depth (Elev. 96.9 m

to 102.4 m). The refusal to augering is considered to have been met on the bedrock surface. The till consists of silty sand with gravel and some bobbles and boulders.

The till is predominantly compact to very dense ('N' values of 13 to 50 blows for 50 mm penetration of the samples) except in Borehole No. 5 where it is loose and in Borehole Nos. 4, 8, 9 and 10, where it is surficially loose ('N' values of 2 to 8 blows). Its moisture content and unit weight vary from 6 to 37 percent and from 18.6 to 23.8 kN/m^3.

Six grain-size analyses performed on the till yielded a composition of 13 to 44 percent clay and silt, 40 to 65 percent sand and 13 to 31 percent gravel (Figures 15 to 20).

3.5 Limestone Bedrock

The bedrock or refusal to augering on assumed bedrock was encountered at a depth of 1.9 m to 5.5 m below the existing ground surface as shown on Table 1 (Elev. 97.8 m to 102.4 m). The bedrock was core drilled in Borehole Nos. 3, 7, and 10 to a depth of 6.2 m to 6.8 m. An examination of the rock cores indicates that the bedrock underlying the site is limestone with shale partings. A Total Core Recovery (TCR) of 80 to 100 percent and Rock Quality Designation (RQD) of 43 to 100 percent was established for the retrieved bedrock. On this basis, the bedrock is considered to be of poor to excellent quality.

Table 1: Anticipated Bedrock Depth and Elevation at Borehole Locations

Borehole No.	Anticipated Bedrock Depth (m)	Bedrock Elevation (m)
1	3.9	99.2
2	3.9	98.4
3	5.3	96.9
4	5.5	99.8
5	1.9	102.4
6	3.7	99.4
7	3.2	99.2
7A	3.3	99.2
8	4.7	97.8
9	2.6	100.4
10	3.3	99.5
11	4.3	97.8

A review of Table 1 indicates that the bedrock at the site is undulating and varies considerably at the site. Its elevation varies from Elevation 96.9 m to 102.4 m.

Two unconfined compressive strength tests were performed on the bedrock cores. The results are given on Table 2.

Table 2: Results of Compressive Strength Tests on Rock Cores			
Borehole No.	**Depth (m)**	**Unit Weight (kg/m3)**	**Unconfined Compressive Strength (MPa)**
7A	3.45 – 3.63	2733	178.8
10	4.06 – 4.17	2778	268.8

Based on the unconfined compressive strength of the rock cores, the bedrock may be described as very strong to extremely strong.

3.6 Groundwater

Water level observations were made in the boreholes during drilling and in standpipes installed in some of the boreholes following the completion of drilling. The results of the observations are presented on Table 3.

Table 3: Groundwater Observations at the Site			
Borehole No.	**Observation Date**	**Depth of Groundwater (m)**	**Groundwater Elevation (m)**
1	October 30, 2017 March 27, 2018	1.0 1.3	102.1 101.8
2	October 23, 2017	Dry	--
3	October 30, 2017 March 27, 2018	2.1 2.1	100.1 100.1
4	March 27, 2018	2.8	102.5
5	March 6, 2018	Dry	--
6	March 5, 2018	Dry	--
7	March 6, 2018	At surface	102.4
7A	March 27, 2018	0.4	102.0
8	March 27, 2018	2.8	99.7
9	March 27, 2018	1.5	101.5
10	March 5, 2018	Dry	--
11	March 6, 2018	3.0	99.1

A review of Table 3 indicates that the groundwater table at the site varies from at surface to at 3.0 m depth, i.e. Elev. 99.1 m to Elev. 102.5 m.

The groundwater table at the site is subject to seasonal fluctuations and may be at a higher level during wet weather periods, e.g. spring. Additional groundwater readings will be collected prior to finalizing this report.

4 Grade-Raise Restrictions

Cohesive soils were not encountered at the site. Therefore, there are no grade raise restrictions for the site. However, any existing topsoil, fill and surficially softened till would have to be sub-excavated prior to placing any grade-raise fill.

5 Seismic Site Classification

The geotechnical investigation has revealed that the site contains some surficial fill, which is underlain by compact to very dense silty sand till, which extends to the bedrock surface. The till is surficially loose in some areas, but it has been recommended that all the loose fill should be removed from the building areas. The limestone bedrock at the site is present below 1.9 m to 5.3 m depth.

The site classification was determined by computing the average N_{60} value to 30 m depth. The N_{60} values established in the overburden during the fieldwork were used in the computation. The 'N' value of the bedrock was assumed to be 100. An average 'N' value of 84 was computed. On this basis, the site classification was established to be Class C for seismic site classification in accordance with Section 4.1.7.1(a) of the Ontario Building Code, 2013.

The site contains surficial fill and loose surficial till in some areas. It has been recommended that the fill and the loose till should be sub-excavated from under the buildings. Therefore, the overburden under the buildings will be compact to very dense silty sand till or engineered fill. It is therefore considered that the on-site soil will not be subject to liquefaction during a seismic event.

6 Foundation Considerations

The investigation has revealed that the geotechnical conditions at the site are suitable for construction of the proposed one- to two-storey structures with one level of basement on spread and strip footing foundations. As required by the City of Ottawa, it is recommended that the footings of the proposed structures should be set above the groundwater table.

A preliminary grading plan, Drawing Nos. 113209-GR1 and 113209-GR2 were provided by Novatech Engineers, Planners and Landscape Architects to facilitate preparation of the geotechnical investigation report. A review of these plans revealed that the founding level of the proposed structures at the site would vary from Elevation 101.0 m to Elevation 102.5 m approximately.

Table 4: Footing Design Elevations and Anticipated Founding Soils

Borehole No.	Closest Building	Underside of Footing Elevation (m)	Elevation of Entrance Level (m)	Anticipated Founding Strata
1	6 10	102.05 102.06-101.75	103.75 103.48	Till
2	3, 4	101.70 101.80	103.40 103.50	Engineered Fill Till 0.1 m below
3	13	101.01	102.92	Till
4	8	102.39	104.09	Till
5	7	102.49	104.40	Till and possibly Bedrock
6	9	101.89 -102.20	103.62	Till and/or Engineered Fill
7 and 7A	5	102.00	103.70	Engineered Fill above Till below.
8	11	101.94 101.63	103.36	Till
9	2	101.29	103.20	Till
10	1	101.29	103.20	Till
11	14	101.01	102.92	Till

The founding level at the borehole locations is expected to be in the silty sand gravel till with the following exceptions:

- Borehole No. 2 where the proposed founding level is in the fill approximately 0.2 m above the till.
- Borehole 7 where the proposed founding level will be in the fill. The underlying silty gravelly sand till was encountered approximately 2.1 m below the proposed founding level. Footings near Borehole 7 would require sub-excavation to the underlying till and backfilling with engineered fill.

- Borehole 7A – Foundation level in fill would require sub-excavation of approximately 0.5 m to the underlying till.

It is noted that some adjustments to the proposed founding levels may be required during construction depending on the geotechnical conditions encountered.

Footings founded on the silty gravelly sand till and engineered fill may be designed for Serviceability Limit State (SLS) bearing pressure of 150 kPa and factored geotechnical resistance at Ultimate Limit State (ULS) of 225 kPa. .

The excavation for the placement of the engineered fill should extend a sufficient distance beyond the limits of the footprint of the proposed building to accommodate a 1.0 m wide bench of engineered fill around the perimeter of the structure, which is thereafter sloped at an inclination of 1H :1V down to the compact zone of the native silty sand till. the engineered fill should consist of OPSS Granular B, Type II and it should be placed in lift thicknesses compatible with the compaction equipment and compacted to 100 percent standard Proctor maximum dry density (SPMDD). In-place density tests should be undertaken on each lift to ensure that the specified degree of compaction has been achieved.

The recommended bearing capacities have been calculated by EXP from the borehole information for the preliminary design stage only. The investigation and comments are necessarily on-going as new information of underground conditions becomes available. For example, more specific information is available with respect to conditions between boreholes, when foundation construction is underway. The interpretation between boreholes, and the recommendations of this report must therefore be checked through field monitoring provided by an experienced geotechnical engineer to validate the information for use during the construction stage.

A minimum of 1.5 m of earth cover should be provided to all the exterior footings of heated structures to protect them from damage due to frost penetration. Where earth cover is less than 1.5 m, an equivalent combination of earth fill and rigid polystyrene insulation (i.e. Styrofoam HI-40) should be provided. Footings of unheated structure should be provided with a cover of 2.1 m if snow would not be cleared from their vicinity. If the snow would be cleared from the vicinity of the footings, they should be provided with 2.4 m of earth cover.

All the footing beds should be examined by a geotechnical engineer/geotechnician to ensure that the founding soil is capable of supporting the design bearing pressure and that the footings beds have been prepared satisfactorily.

Settlements of the residences founded on strip and spread footings design according to the above recommendations and properly constructed are expected to be within the normally tolerated limits of 25 mm total and 19 mm differential movements.

7 Floor Slab and Drainage Requirements

The lowest level floors of the proposed buildings may be constructed as slabs-on-grade provided they are set on beds of well compacted 19 mm clear stone at least 200 mm thick placed on the natural soil or on at least 300 mm of compacted OPSS 1010 Granular B Type II. Any fill to be placed under the floor slabs should consist of OPSS Granular B, Type II. It should be placed in maximum of 300 mm lift thicknesses and each lift compacted to 98 percent SPMDD. The clear stone would prevent the capillary rise of moisture from the sub-soil to the floor slab. Adequate saw cuts should be provided in the floor slabs to control cracking.

Perimeter and underfloor drains should be provided for the structures with basements. The underfloor drainage system, may consist of 150 mm diameter perforated pipe or equivalent placed in parallel rows at 5 m to 6 m centres with its invert at least 300 mm below the underside of the floor slab. The drains should be set on 100 mm of pea gravel and covered on top and sides with 150 mm pea gravel. The pea gravel should be surrounded with suitable filter cloth, such as Terrafix 270R or equivalent. The perimeter and underfloor drains should preferably lead to separate positive sumps from where the water can be removed. A schematic illustration of the subsurface drains is presented on Drawing 21.

All subsurface walls should be properly damp-proofed. The exterior grade should be sloped away from the structures at an inclination of at least 1 to 2 percent to prevent the ingress of surface runoff.

8 Lateral Earth Pressure Against Subsurface Walls

The subsurface walls should be backfilled with free draining material, such as OPSS Granular B, Type II and equipped with a perimeter drainage system to prevent the buildup of hydrostatic pressure behind the wall. The walls will be subjected to lateral static and dynamic (seismic) earth forces.

For design purposes, the lateral static earth thrust against the subsurface walls may be computed from the following equations: (ii) and (iii) given below. These equations assume that the finished grade adjacent to the subsurface walls will be level.

$$P = K_0 H (q + \tfrac{1}{2} \gamma H) \text{ ---------- (ii)}$$

where P = lateral earth thrust acting on the subsurface wall; kN/m

K_0 = lateral earth pressure coefficient for 'at rest' condition for Granular B Type II backfill material = 0.5

γ = unit weight of free draining granular backfill; Granular B Type II = 22 kN/m^3

H = Height of backfill adjacent to foundation wall, m

q = surcharge load, kPa

The lateral seismic thrust may be computed from the equation given below:

$$\Delta P_E = 0.3 \gamma H^2 \text{ ---------- (iii)}$$

where ΔP_E = resultant thrust due to seismic activity; kN/m

γ = unit weight of free draining granular backfill; Granular B Type II = 22 kN/m^3

H = height of backfill adjacent to foundation wall, (m)

The ΔP_E value does not take into account the surcharge load. The resultant load should be assumed to act at 0.6 H from the bottom of the wall.

9 Retaining Walls

Preliminary grading plan indicates that 1.2 m to 1.4 m high retaining walls are to be constructed at the end of driveways between Building 7 and 4192 Fallowfield Road, between Buildings 1 and 2 and between Buildings 13 and 14.

The founding level of these retaining walls is expected to be in the silty gravelly sand till. The footings of the retaining walls may be designed using an SLS bearing pressure of 150 kPa and factored geotechnical resistance of 225 kPa.

The footings of the retaining walls should be provided with a minimum earth cover of 2.4 m to prevent frost heave of the footings. Alternatively, the footings may be insulated.

The settlements of the retaining walls are expected to be within the normally tolerated limits of 25 mm total and 19 mm differential movement.

The retaining wall will be subjected to lateral static earth as well as lateral dynamic earth forces during a seismic event. Seismic loading will result in an increase in active lateral earth pressure and a decrease in passive lateral earth pressure on the wall. The seismic lateral earth pressure coefficients given below have been derived based on a design zonal acceleration ratio 0.32 applicable for the Ottawa area.

The dynamic pressure distribution is an inverted triangle with maximum pressure at the top of the wall and a minimum at the bottom of the wall. Therefore, the resultant of earthquake pressure on the retaining wall is assumed to be applied at a height of 0.6 H above the base of the wall where H is the height the wall. The total active pressure distribution can be separated into static component and dynamic components and may be determined as follows (Mononobe and Matsuo, 1929):

$$\sigma_{AE}(z) = k_a \gamma z + (K_{AE} - k_a)\gamma(H - z)$$

Where $\sigma_{AE}(z)$: the total combined active earth pressure (dynamic and static), (kPa).

z : depth below the top of the retaining wall.

K_a : static active earth pressure coefficient

K_{AE} : combined (static and dynamic) active earth pressure coefficient.

γ : unit weight of the backfill soil (KN/m^3).

H : Total height of the wall (m).

The total passive pressure in front of the wall can be similarly separated into static and dynamic components as follows:

$$\sigma_{PE} = k_p \gamma z + (K_{PE} - k_p)\gamma(h - z)$$

Where σ_{PE}: the total combined passive earth pressure (dynamic and static), (kPa).

z : depth below the ground surface in front of the wall.

K_p : static passive earth pressure coefficient

K_{PE} : combined (static and dynamic) passive earth pressure coefficient.

γ : unit weight of the backfill soil (KN/m^3).

h : depth of embedment of the wall (m).

The passive earth pressure resistance of the soil in front of the wall to 2.1 m depth should be ignored due to freeze and thaw action. However, the weight of the soil in front of the retaining wall to 2.1 m depth may be considered to provide passive support. The above earth pressure expression does not take into account any surcharge applied on the wall or on the backfill soil. It also assumes that the backfill against the subsurface walls will be free-draining granular material and drains will be presented at the footing level to prevent building up of hydrostatic pressure against the subsurface walls. The backfill should be compacted to 95 percent SPMDD. The method of compaction of the engineered fill (Granular B Type II) is not known. However, it is recommended that a minimum compaction surcharge of 20 kPa should be taken into account when designing the retaining wall. The lateral earth pressure parameters of the backfill material are given in Table 5.

Table 5: Lateral Earth Pressure Parameters

Soil layer				**Granular B Type II**
Wet Unit Weight of Soil (γ) , kN/m^3				22
Angle of Internal Friction (ϕ') (^{o})				30 ^{o}
Coefficient of Earth Pressure at Rest (k_0)				0.5
Retained Slope Angle	**Static (k_a)**	**Static (k_p) ****	**Dynamic (k_a)**	**Dynamic ** (k_p)**
0 ^{o}	0.33	3.0	0.12	-0.33

** : Peak Ground Acceleration in Ottawa, a=0.32.*

***: Ground surface in front of the wall is assumed horizontal.*

It is imperative that once the design of the retaining walls has been completed, it should be checked for global slope stability. A factor of safety of 1.5 should be incorporated in the design for static slope stability analysis and 1.1 for seismic slope stability analysis.

The final design of the retaining walls should be reviewed by this office.

10 Excavations

All the excavations at the site should comply with the latest requirements of the Occupational Health and Safety Act, Ontario Regulation 213/91.

Excavations at the site will be undertaken to a depth of 0.6 m to 2.9 m below the existing ground surface for construction of the foundations. The depth to which the utilities will be installed is not known. It has been assumed that the utilities will be located approximately 1 m below the proposed founding levels. Therefore, the excavations are expected to extend to a maximum depth of 1.6 m to 3.9 m. These excavations will extend through the fill into the underlying silty gravelly sand till. They will vary from above the groundwater table to 2.5 m below the groundwater table. A base heave of these excavations is not anticipated due to the compact to dense nature of the silty gravelly sand till.

The excavations at the site may be undertaken as open-cut provided that they are cutback at 45 degrees above the groundwater table. Below the groundwater table, the excavations may slough and are expected to stabilize at a slope of 2H:1V to 3H:1V. Excavations for installation of the utilities may be undertaken within the confines of a trench box designed to the requirements of the Occupational Health and Safety Act.

It is noted that the excavations for construction of the foundations and utilities may in some areas extend into the bedrock, e.g. in the vicinity of Borehole Nos. 5, 9 and 10. Any excavation of the bedrock would require the use of hoe ramming or line drilling and blasting. The sides of the excavations in the bedrock may be undertaken at new vertical sides.

Seepage of the surface and subsurface water into the excavations is anticipated. However, it should be possible to collect any water entering the excavations in perimeter ditches and to remove it by pumping from sumps. Although this investigation has estimated the groundwater levels at the time of the field work, and commented on dewatering and general construction problems, conditions may be present which are difficult to establish from standard boring techniques and which may affect the type and nature of dewatering procedures used by the contractor in practice. These conditions include local and seasonal fluctuations in the groundwater table, erratic changes in the soil profile, thin layers of soil with large or small permeabilities compared with the soil mass, etc. Only carefully controlled tests using pumped wells and observation wells will yield the quantitative data on groundwater volumes and pressures that are necessary to adequately engineer construction dewatering systems.

Many geologic materials deteriorate rapidly upon exposure to meteorological elements. Unless otherwise specifically indicated in this report, walls and floors of excavations must be protected from moisture, desiccation, and frost action throughout the course of construction.

11 Backfilling Requirements and Suitability of On-site Soils for Backfilling Purposes

The backfill against subsurface walls and in footing and service trenches inside the structures should consist of free draining material preferably conforming to OPSS for Granular B, Type II. It should be compacted to 98 percent of SPMDD in the interior of the building and to 95 percent SPMDD outside the building.

The backfill in service trenches outside the buildings should be compactable, i.e. free of organics and debris and with natural moisture content which is within 2 percent of the optimum moisture content. It also should be compacted to 95 percent SPMDD.

The material to be excavated during construction of the footings and installation of services is expected to be existing fill and some glacial till, which primarily comprises of silty sand and gravel with occasional cobbles and boulders. It may be possible to use some of this material as subgrade fill, depending on its assessment during construction. This material however may be used for general grading purposes in the landscaped areas.

It is anticipated that any fill required to backfill the blocks would have to be imported and should comply to the requirement listed below;

- Engineered fill under footings and floor slabs and behind subsurface walls, OPSS 1010 Granular B, Type II placed and compacted to 98 to 100 percent of the Standard Proctor Maximum Dry Density (SPMDD) in the interior of the buildings and to 95 % SPMDD in the exterior of the buildings;
- Trench backfill and subgrade fill in parking area and access roadways – OPSS 1010 Select Subgrade Material (SSM), placed in 300 mm thick lifts and each lift compacted to 95 percent of the SPMDD. To minimize settlement of the pavement structure over services trenches, the trench backfill material within the frost zone should match the existing material along the trench walls to minimize differential frost heaving of the subgrade soil, provided this material is compactible. Otherwise, frost tapers may be required.

If the backfill in the service trenches will consist of granular fill and silty gravelly sand till. Therefore, clay seals should be installed in the service trenches at select intervals as per City of Ottawa Drawing No. S8. The seals should be 1 m wide, extend over the entire trench from the bottom of the trench to the underside of the pavement structure. The clay should be compacted to 95% SPMDD. The purpose of the clay seals is to minimize the permanent lowering of the groundwater level.

12 Access Roads and Driveways

Pavement structure thicknesses required for the access roads and driveways to be used by light automobile traffic and heavy traffic (fire and garbage trucks) were computed. The pavement structures are shown on Table 6 and are based upon an estimate of the subgrade soil properties determined from visual examination and textural classification of the soil samples and functional design life of 15 to 18 years. The proposed functional design life represents the number of years to the first rehabilitation, assuming regular maintenance is carried out.

Table 6: Recommended Pavement Structure Thicknesses

Pavement Layer	Compaction Requirements	Parking Areas	Subdivision Roadway
Asphaltic Concrete – PG 58-34	92-97% Maximum Relative Density	65 mm SP12.5-Cat B	40 mm – SP12.5-Cat B 50 mm - SP19.0-Cat B
OPSS Granular A Base (crushed limestone)	100% SPMDD*	150 mm	150 mm
OPSS Granular B Sub-Base, Type II	100% SPMDD*	300 mm	450 mm

* *Denotes standard Proctor maximum dry density (SPMDD), ASTM-D698.*
Any subgrade fill must be compacted to 98% SPMDD for at least the upper 300 mm.

Construction procedures for the pavement structure are discussed below.

After all the underground services have been installed, backfilled and satisfactorily compacted, the entire road should be excavated to the subgrade level. The subgrade should be crowned with a centre edge to edge slope of at least 2 percent. It should then be proof rolled with a heavy roller. Any soft areas which become evident should be sub-excavated and replaced with approved native fill or free draining granular material. All subgrade fill should be placed in maximum 300 mm lifts and compacted to 98 percent of SPMDD. In-place density tests should be performed at regular intervals to ensure that the specified degree of compaction is being achieved.

1. It is stressed that the overall satisfactory performance of the recommended pavement structures is contingent upon the provisions of good drainage. Subsurface drains should be provided on both sides of the access roads. In parking areas, the drains should be located at low points and should be continuous between catch basins. The drains should be located with their invert approximately 300 mm below the subgrade level and may consist of 150 mm diameter perforated pipe set on 100 mm bed of 19 mm clear stone and covered top and sides with 150 mm of 19 mm stone. The stone should be surrounded with a suitable filter cloth, such as Terrafix 270 R or equivalent. The remainder of the trench should be backfilled with well compacted, free draining granular material.
2. To minimize the problems of differential movement between the pavement and catchbasins/manholes due to frost action, the backfill around the structures should consist of free-draining granular material preferably conforming to OPSS Granular B Type II. Weep holes should

be provided in the catchbasins and screened with filter cloth to facilitate drainage of any water which may accumulate in the granular fill around the catchbasins/manholes.

3. Relatively weaker subgrade may develop over service trenches at subgrade level due to soil disturbance. If this is the case, it is recommended that additional 150 mm of granular sub-base Granular B should be provided in these areas.
4. The finished pavement surface should be free of depressions and should be sloped (preferably at a minimum cross fall of 2 percent) to provide effective surface drainage towards catch basins. Surface water should not be allowed to pond adjacent to the outside edges of paved areas.
5. The granular materials used for pavement construction should conform to OPSS 1010 for Granular A and Granular B, Type II and should be compacted to 100 percent SPMDD. The asphaltic concrete used and its placement should meet OPSS 1151 requirements. It should be placed and compacted to OPSS 310 and 313 requirements.

It is recommended that EXP be retained to review the final pavement structure design and drainage plans prior to construction to ensure that they are consistent with the recommendations of this report.

13 Subsurface Concrete Requirements

Chemical tests limited to pH, sulphate tests and chemical resistivity was performed on seven groundwater samples obtained from the boreholes. The test results are given on Table 7.

Table 7: Results of Chemical Tests on Groundwater Samples

Parameter	Borehole No. 4	Borehole No. 8	Borehole No. 9	Borehole No. 11	Threshold Values
pH	8.03	7.75	8.05	8.34	<5
Sulphates (%)	0.0005	0.0004	0.0014	0.002	>0.10%
Electrical Resistivity Ohm/cm	9900	6623	5952	9434	<700 ohm.cm

The test results indicate that the groundwater contains a sulphate content of 0.0005 percent to 0.002 percent. This concentration of sulphates is considered to have a negligible potential of attach on subsurface concrete. Therefore, General Use (GU) Portland cement may be used in the subsurface concrete at this site. The concrete should be designed in accordance with the requirements of CSA A23.1-14. It should be dense, well compacted and cured.

The resistivity results indicate that the groundwater is mildly corrosive to buried steel. It is therefore recommended that a corrosion specialist should be consulted if subsurface steel is to be buried in the ground at this site.

14 General Comments

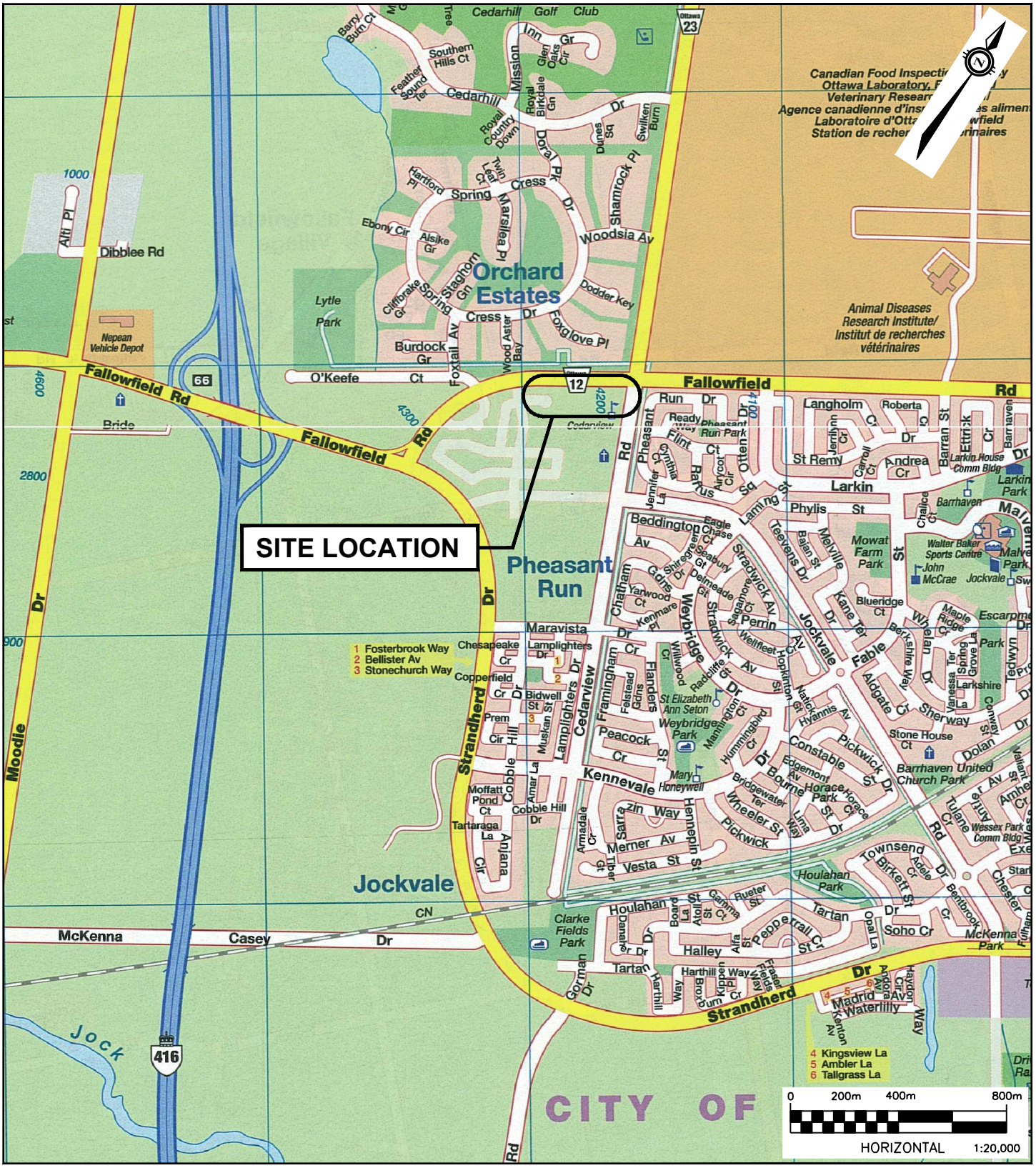
The investigation has indicated that the site topography and geotechnical conditions vary considerably across the site. It is therefore feasible that the depth of fill encountered between boreholes may vary considerably from the depths established at borehole locations. Also, bedrock may be encountered in some areas during installation of the foundations and utilities. Therefore, additional investigation, i.e. test pits or probes are recommended at the site prior to ten during of the project.

The comments given in this report are intended only for the guidance of design engineers. The number of boreholes required to determine the localized underground conditions between boreholes affecting construction costs, techniques, sequencing, equipment, scheduling, etc., would be much greater than has been carried out for the design purposes. Contractors bidding on or undertaking the works should, in this light, decide on their own investigations, as well as their own interpretations of the factual borehole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

The information contained in this report is not intended to reflect on environmental aspects of the soils. The reader should refer to a separate report prepared by EXP for environmental conditions.

We trust that the information contained in this report will be satisfactory for your purposes. Should you have any questions, please do not hesitate to contact this office.

Figures

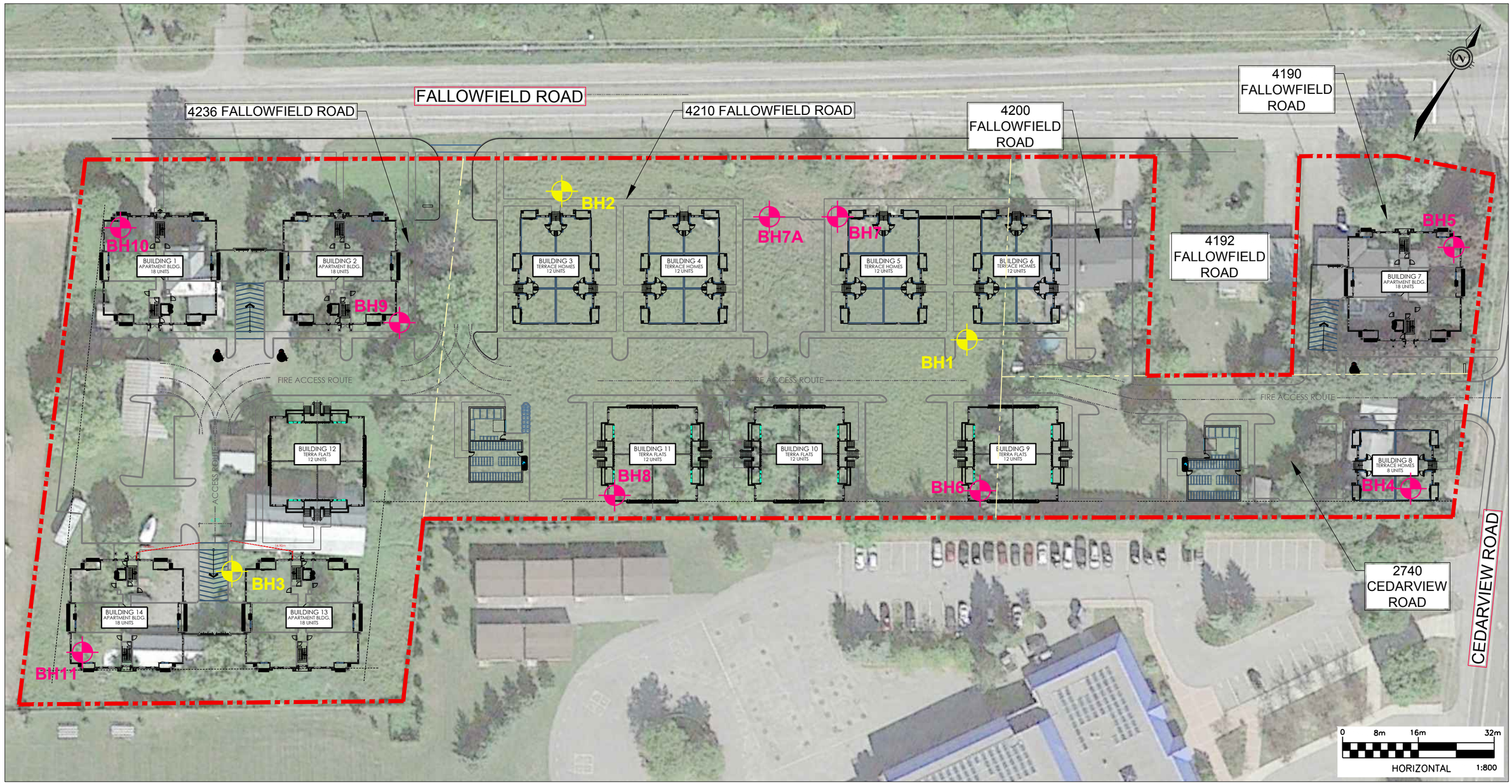


exp Services Inc.
t: +1.613.688.1899 | f: +1.613.225.7337
2650 Queensview Drive, Suite 100
Ottawa, ON K2B 8H6
Canada
www.exp.com

• BUILDINGS • EARTH & ENVIRONMENT • ENERGY •
• INDUSTRIAL • INFRASTRUCTURE • SUSTAINABILITY •

scale: 1:20 000	CLIENT: DCR PHOENIX GROUP OF COMPANIES PROPOSED RESIDENTIAL DEVELOPMENT	project no.: OTT-00243143-A0
date: MAY 2017	TITLE: SITE LOCATION PLAN 4190, 4200, 4210, 4236 FALLOWFIELD ROAD & 2740 CEDARVIEW ROAD, NEPEAN, ON	FIG 1
drawn by: J.R.		

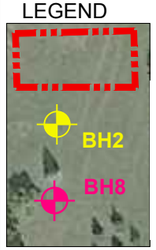
Filename: r:\240000\243000\243143-a0 4190-4236 fallowfield, 2740 cedarview\243143-a0-ge-sr.dwg
Last Saved: 2/27/2018 11:31:44 AM
Last Plotted: 5/3/2018 9:49:59 AM Plotted by: RevelIJ Pen Table:: trow standard, july 01, 2004.ctb



NOTES :

1. THE BOUNDARIES AND SOIL TYPES HAVE BEEN ESTABLISHED ONLY AT BOREHOLE LOCATIONS. BETWEEN BOREHOLES THEY ARE ASSUMED AND MAY BE SUBJECT TO CONSIDERABLE ERROR.
2. SOIL SAMPLES AND ROCK WILL BE RETAINED IN STORAGE FOR THREE MONTHS AND THEN DESTROYED UNLESS THE CLIENT ADVISES THAT AN EXTENDED TIME PERIOD IS REQUIRED.
3. TOPSOIL QUANTITIES SHOULD NOT BE ESTABLISHED FROM THE INFORMATION PROVIDED AT THE BOREHOLE LOCATIONS.
4. BOREHOLE ELEVATIONS SHOULD NOT BE USED TO DESIGN BUILDING(S) OR FLOOR SLABS OR PARKING LOT(S) GRADES.
5. THIS DRAWING FORMS PART OF THE REPORT PROJECT NUMBER AS REFERENCED AND SHOULD BE USED ONLY IN CONJUNCTION WITH THIS REPORT.
6. BASE PLAN OBTAINED FROM exp SERVICES INC, SITE BUILDING LAYOUT COURTESY OF NOVATECH

LEGEND



APPROXIMATE PROPERTY LIMITS

Boreholes drilled in 2017

Boreholes drilled in 2018

exp Services Inc.
t: +1.613.688.1899 | f: +1.613.225.7337
2650 Queensview Drive, Suite 100
Ottawa, ON K2B 8H6
Canada
www.exp.com
• BUILDINGS • EARTH & ENVIRONMENT • ENERGY •
• INDUSTRIAL • INFRASTRUCTURE • SUSTAINABILITY •

scale 1:800	CLIENT: DCR PHOENIX GROUP OF COMPANIES PROPOSED RESIDENTIAL DEVELOPMENT	project no. OTT-00243143-A0
date MAY 2018	TITLE: BOREHOLE LOCATION PLAN 4190, 4200, 4210, 4236 FALLOWFIELD ROAD & 2740 CEDARVIEW ROAD, NEPEAN, ON	FIG 2
drawn by J.R.		

Filename: r:\24000\0243000\243143-a0 4190-4236 fallowfield, 2740 cedarview\243143-a0-ge-sr.dwg
Last Saved: 2/27/2018 11:31:44 AM
Last Plotted:5/3/2018 9:49:39 AM Plotted by: RevellJ Pen Table:: trow standard, july 01, 2004.ctb

Notes On Sample Descriptions

1. All sample descriptions included in this report follow the Canadian Foundations Engineering Manual soil classification system. This system follows the standard proposed by the International Societv for Soil Mechanics and Foundation Engineering. Laboratory grain size analyses provided by **exp** Services Inc. also follow the same system. Different classification systems may be used by others; one such system is the Unified Soil Classification. Please note that, with the exception of those samples where a grain size analysis has been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.

ISSMFE SOIL CLASSIFICATION

CLAY	SILT			SAND			GRAVEL			COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE		

0.002 0.006 0.02 0.06 0.2 0.6 2.0 6.0 20 60 200

EQUIVALENT GRAIN DIAMETER IN MILLIMETRES

CLAY (PLASTIC) TO	FINE	MEDIUM	CRS.	FINE	COARSE
SILT (NONPLASTIC)	SAND			GRAVEL	

UNIFIED SOIL CLASSIFICATION

2. Fill: Where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc., none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional geotechnical site investigation.

3. Till: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

Log of Borehole BH-1

Project No: OTT-00243143-A0

Project: Geotechnical Investigation. Proposed Residential Development

Location: 4190, 4200, 4210, 4236 Fallowfield Rd and 2740 Cedarview Rd, Ottawa

Figure No. 3

Page. 1 of 1

Date Drilled: 'October 23, 2017

Drill Type: CME-55 Trackmount

Datum: Geodetic

Logged by: M.L. Checked by: I.T.

Split Spoon Sample ☒ | Auger Sample ◧ | SPT (N) Value ○ | Dynamic Cone Test ——— | Shelby Tube ■ | Shear Strength by Vane Test +S

Combustible Vapour Reading □ | Natural Moisture Content × | Atterberg Limits |—○—| | Undrained Triaxial at % Strain at Failure ⊕ | Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~100 mm	103.1	0				
		FILL Mixture of silty sand and silty clay, some gravel, grey and brown, moist, (compact)	103.0		10	×		
			102.4	1	25	×		23.1
		SILTY GRAVELLY SAND TILL Trace clay, occasional boulders and cobbles, brownish grey to grey, moist to wet (compact)		2	31	×		23.3
					29	×		
				3	15	×		
			99.2		50 for 100 mm	×		
		Borehole Terminated at 3.9 m Depth Upon Auger Refusal						

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. 19 mm standpipe installed upon completion
3. Field work supervised by an **exp** representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00243143-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
Completion	Dry	4.0
Oct 30, 2017	1.0	
Mar 27, 2018	1.3	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE BH LOGS - 243143 - FALLOWFIELD CEDARVIEW.GPJ TROW OTTAWA.GDT 5/4/18

Log of Borehole BH-2

Project No: OTT-00243143-A0

Project: Geotechnical Investigation. Proposed Residential Development

Location: 4190, 4200, 4210, 4236 Fallowfield Rd and 2740 Cedarview Rd, Ottawa

Figure No. 4

Page. 1 of 1

Date Drilled: 'October 23, 2017

Drill Type: CME-55 Trackmount

Datum: Geodetic

Logged by: M.L. Checked by: I.T.

Split Spoon Sample ☒ | Auger Sample ◧ | SPT (N) Value ○ | Dynamic Cone Test ——— | Shelby Tube ■ | Shear Strength by Vane Test +S

Combustible Vapour Reading □ | Natural Moisture Content × | Atterberg Limits ⊢○ | Undrained Triaxial at % Strain at Failure ⊕ | Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic m	Depth
		TOPSOIL ~100 mm	102.3	0
		FILL Mixture of silty sand and silty clay, trace gravel, grey and brown, moist, (loose)	102.2	
		SILTY GRAVELLY SAND TILL Trace clay, cobbles and boulders throughout, grey-brown to grey, moist to wet (compact to very dense)	101.6	1
				2
				3
			98.4	
		Borehole Terminated at 3.9 m Depth Upon Auger Refusal		

Standard Penetration Test N Value: 20 40 60 80

Shear Strength kPa: 50 100 150 200

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % Atterberg Limits (% Dry Weight): 20 40 60

SAMPLES

Natural Unit Wt. kN/m³

8 | 28 | 31 | 66 | 50 for 100 mm

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled with cuttings upon completion
3. Field work supervised by an **exp** representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00243143-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
Completion	Dry	3.4

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE BH LOGS - 243143 - FALLOWFIELD CEDARVIEW.GPJ TROW OTTAWA.GDT 5/4/18

Log of Borehole BH-3

Project No: OTT-00243143-A0

Project: Geotechnical Investigation. Proposed Residential Development

Location: 4190, 4200, 4210, 4236 Fallowfield Rd and 2740 Cedarview Rd, Ottawa

Figure No. 5

Page. 1 of 1

Date Drilled: 'October 23, 2017

Drill Type: CME-55 Trackmount

Datum: Geodetic

Logged by: M.L. Checked by: I.T.

Split Spoon Sample ☒ | Auger Sample ◧ | SPT (N) Value ○ | Dynamic Cone Test ——— | Shelby Tube ■ | Shear Strength by Vane Test +S

Combustible Vapour Reading □ | Natural Moisture Content × | Atterberg Limits ⊢○ | Undrained Triaxial at % Strain at Failure ⊕ | Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic m	Depth	Standard Penetration Test N Value (20 40 60 80) / Shear Strength kPa (50 100 150 200)	Combustible Vapour Reading (ppm) (250 500 750) / Natural Moisture Content % Atterberg Limits (% Dry Weight) (20 40 60)	SAMPLES	Natural Unit Wt. kN/m³
		FILL Mixture of sand and gravel, trace silt, brown, moist, (compact)	102.2	0	18	×		
		SILTY GRAVELLY SAND TILL Trace clay, cobbles and boulders throughout, brown to grey, moist to wet (compact to very dense)	101.5	1	19	×		
				2	34	×		22.2
				3	49	×		23.5
					50 for 75 mm	×		
				4	58	×		
				5	75	×		
		LIMESTONE BEDROCK Thin shale partings, grey (excellent quality)	96.9	6				Run 1
		Borehole Terminated at 6.8 m Depth	95.4					

LOG OF BOREHOLE BH LOGS - 243143 - FALLOWFIELD CEDARVIEW.GPJ TROW OTTAWA.GDT 5/4/18

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. 19 mm standpipe installed upon completion
3. Field work supervised by an **exp** representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00243143-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
Completion	Core Water	6.8
Oct 30, 2017	2.1	
Mar 27, 2018	2.1	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	5.3 - 6.8	100	94

Log of Borehole BH-4

Project No: OTT-00243143-A0

Project: Geotechnical Investigation. Proposed Residential Development

Location: 4190, 4200, 4210, 4236 Fallowfield Rd and 2740 Cedarview Rd, Ottawa

Figure No. 6

Page. 1 of 1

Date Drilled: 'March 6, 2018

Drill Type: CME-55 Trackmount

Datum: Geodetic

Logged by: A.N. Checked by: I.T.

Split Spoon Sample ☒ | Auger Sample ◧ | SPT (N) Value ○ | Dynamic Cone Test ——— | Shelby Tube ■ | Shear Strength by Vane Test +S

Combustible Vapour Reading □ | Natural Moisture Content × | Atterberg Limits ⊢○ | Undrained Triaxial at % Strain at Failure ⊕ | Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic m	Depth	Standard Penetration Test N Value / Shear Strength (kPa)	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~ 200 mm	105.3	0	12	×		
		FILL Mixture of sand and gravel, trace silt, some organics, brown, moist, (compact to loose)	105.1					
				1	5	×		18.6
		SILTY GRAVELLY SAND TILL Trace clay, cobbles and boulders throughout, brown to grey, moist, (compact to very dense)	104.1					
				2	15	×		23.8
					75	×		
				3	60/100 mm	×		
				4	50/75 mm	×		
					63	×		
				5				
		Borehole Terminated at 5.5 m Depth Upon Auger Refusal	99.8					

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. 19 mm standpipe installed upon completion
3. Field work supervised by an **exp** representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00243143-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
Completion	Dry	5.5
Mar 27, 2018	2.8	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE BH LOGS - 243143 - FALLOWFIELD CEDARVIEW.GPJ TROW OTTAWA.GDT 5/4/18

Log of Borehole BH-5

Project No: OTT-00243143-A0

Project: Geotechnical Investigation. Proposed Residential Development

Location: 4190, 4200, 4210, 4236 Fallowfield Rd and 2740 Cedarview Rd, Ottawa

Figure No. 7

Page. 1 of 1

Date Drilled: 'March 6, 2018

Drill Type: CME-55 Trackmount

Datum: Geodetic

Logged by: A.N. Checked by: I.T.

Split Spoon Sample ☒ | Auger Sample ◧ | SPT (N) Value ○ | Dynamic Cone Test ——— | Shelby Tube ■ | Shear Strength by Vane Test +S

Combustible Vapour Reading □ | Natural Moisture Content × | Atterberg Limits ⊢○ | Undrained Triaxial at % Strain at Failure ⊕ | Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
			104.3	0	20 40 60 80 / 50 100 150 200 kPa	250 500 750 / 20 40 60		
		TOPSOIL ~ 150 mm	104.2					
		FILL Mixture of sand and gravel, brown, moist, (loose)			6 ○	×		
				1	7 ○	×		19.8
		SILTY GRAVELLY SAND TILL With cobbles and boulders, (loose)	103.2		8 ○	×		22.3
			102.4					
		Borehole Terminated at 1.9 m Depth Upon Auger Refusal						

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled with cuttings upon completion
3. Field work supervised by an **exp** representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00243143-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
Completion	Dry	1.9

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE BH LOGS - 243143 - FALLOWFIELD CEDARVIEW.GPJ TROW OTTAWA.GDT 5/4/18

Log of Borehole BH-6

Project No: OTT-00243143-A0

Project: Geotechnical Investigation. Proposed Residential Development

Location: 4190, 4200, 4210, 4236 Fallowfield Rd and 2740 Cedarview Rd, Ottawa

Figure No. 8

Page. 1 of 1

Date Drilled: 'March 5, 2018

Drill Type: CME-55 Trackmount

Datum: Geodetic

Logged by: A.N. Checked by: I.T.

Split Spoon Sample ☒
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits |—○
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~200 mm	103.1	0				
		SILTY SAND Brown, moist, (loose)	102.9		5			
		SILTY GRAVELLY SAND TILL Trace clay, possible cobbles and boulders, brown to grey, moist to wet, (compact to dense)	102.5	1	13			
				2	25			23.5
				3	23			23.6
					36			
			99.4					
		Borehole Terminated at 3.7 m Depth Upon Auger Refusal						

Standard Penetration Test N Value: 20 40 60 80
Shear Strength: 50 100 150 200 kPa
Combustible Vapour Reading (ppm): 250 500 750
Natural Moisture Content % Atterberg Limits (% Dry Weight): 20 40 60

LOG OF BOREHOLE BH LOGS - 243143 - FALLOWFIELD CEDARVIEW.GPJ TROW OTTAWA.GDT 5/4/18

NOTES:
1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled with cuttings upon completion
3. Field work supervised by an **exp** representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00243143-A0

WATER LEVEL RECORDS		
Elapsed Time	Water Level (m)	Hole Open To (m)
Completion	Dry	3.7

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

Log of Borehole BH-7

Project No: OTT-00243143-A0

Project: Geotechnical Investigation. Proposed Residential Development

Location: 4190, 4200, 4210, 4236 Fallowfield Rd and 2740 Cedarview Rd, Ottawa

Figure No. 9

Page. 1 of 1

Date Drilled: 'March 5, 2018

Drill Type: CME-55 Trackmount

Datum: Geodetic

Logged by: A.N. Checked by: I.T.

Split Spoon Sample ☒ | Auger Sample ◧ | SPT (N) Value ○ | Dynamic Cone Test ——— | Shelby Tube ■ | Shear Strength by Vane Test +S

Combustible Vapour Reading □ | Natural Moisture Content × | Atterberg Limits ⊢○ | Undrained Triaxial at % Strain at Failure ⊕ | Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~200 mm	102.4	0				
		FILL Mixture of sand and gravel, some organics, grey, moist to wet, (loose)	102.2		4			
				1	4			18.5
				2	4			
		SILTY GRAVELLY SAND TILL Trace silt and clay, brown, wet, (compact to very dense)	99.9		12			
				3	50/50 mm			
			99.2					
		Borehole Terminated at 3.2 m Depth Upon Auger Refusal						

Standard Penetration Test N Value: 20 40 60 80

Shear Strength kPa: 50 100 150 200

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % Atterberg Limits (% Dry Weight): 20 40 60

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. 19 mm standpipe installed upon completion
3. Field work supervised by an **exp** representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00243143-A0

WATER LEVEL RECORDS		
Elapsed Time	Water Level (m)	Hole Open To (m)
Completion	At surface	3.2

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

LOG OF BOREHOLE BH LOGS - 243143 - FALLOWFIELD CEDARVIEW.GPJ TROW OTTAWA.GDT 5/4/18

Log of Borehole BH-7A

Project No: OTT-00243143-A0

Project: Geotechnical Investigation. Proposed Residential Development

Location: 4190, 4200, 4210, 4236 Fallowfield Rd and 2740 Cedarview Rd, Ottawa

Figure No. 10

Page. 1 of 1

Date Drilled: 'March 6, 2018

Drill Type: CME-55 Trackmount

Datum: Geodetic

Logged by: A.N. Checked by: I.T.

Split Spoon Sample ☒
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits ⊢○
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~250 mm	102.4	0	4			
		FILL Mixture of sand and gravel, some organics, moist, (loose)	102.2					
		SILTY GRAVELLY SAND TILL Trace clay, cobbles and boulders throughout, brown to grey, moist, (very dense)	101.6	1	60/100 mm			22.8
				2	60/100 mm			
					47			23.8
▼			99.4	3	50/75 mm			
		LIMESTONE BEDROCK Thin shale partings, some calcite veins, grey (excellent quality)	99.2	4				Run 1
				5				Run 2
			96.2	6				
		Borehole Terminated at 6.2 m Depth						

LOG OF BOREHOLE BH LOGS - 243143 - FALLOWFIELD CEDARVIEW.GPJ TROW OTTAWA.GDT 5/4/18

NOTES:
1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled with cuttings upon completion
3. Field work supervised by an **exp** representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00243143-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
Completion	3.0	6.2
Mar 27, 2018	0.4	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	3.2 - 4.7	100	100
2	4.7 - 6.2	100	100

Log of Borehole BH-8

Project No: OTT-00243143-A0

Project: Geotechnical Investigation. Proposed Residential Development

Location: 4190, 4200, 4210, 4236 Fallowfield Rd and 2740 Cedarview Rd, Ottawa

Figure No. 11

Page. 1 of 1

Date Drilled: 'March 5, 2018

Drill Type: CME-55 Trackmount

Datum: Geodetic

Logged by: A.N. Checked by: I.T.

Split Spoon Sample ☒ | Auger Sample ◧ | SPT (N) Value ○ | Dynamic Cone Test ——— | Shelby Tube ■ | Shear Strength by Vane Test +S

Combustible Vapour Reading □ | Natural Moisture Content × | Atterberg Limits ⊢○ | Undrained Triaxial at % Strain at Failure ⊕ | Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~200 mm	102.5	0				
		GRAVELLY SAND TILL Some silt trace clay, cobbles and boulders throughout, brown to grey, moist, (loose to very dense)	102.3		6, 17, 41, 22, 75, 91, 66/75 mm			22.6, 23.5
		Borehole Terminated at 4.7 m Depth Upon Auger Refusal	97.8	4				

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. 19 mm standpipe installed upon completion
3. Field work supervised by an **exp** representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00243143-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
Completion	Dry	4.7
Mar 27, 2018	2.8	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE BH LOGS - 243143 - FALLOWFIELD CEDARVIEW.GPJ TROW OTTAWA.GDT 5/4/18

Log of Borehole BH-9

Project No: OTT-00243143-A0

Project: Geotechnical Investigation. Proposed Residential Development

Location: 4190, 4200, 4210, 4236 Fallowfield Rd and 2740 Cedarview Rd, Ottawa

Figure No. 12

Page. 1 of 1

Date Drilled: 'March 5, 2018

Drill Type: CME-55 Trackmount

Datum: Geodetic

Logged by: A.N. Checked by: I.T.

Split Spoon Sample ☒ | Auger Sample ◧ | SPT (N) Value ○ | Dynamic Cone Test ——— | Shelby Tube ■ | Shear Strength by Vane Test +S

Combustible Vapour Reading □ | Natural Moisture Content × | Atterberg Limits ⊢○ | Undrained Triaxial at % Strain at Failure ⊕ | Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~200 mm	103.1	0				
		SILTY SAND Grey, moist to wet, rootlets present, (loose)	102.9		6			
		SILTY GRAVELLY BOULDERLY TILL Brown-grey to brown, wet to moist, (very loose to very dense)	102.2	1	2			
				2	39			23.3
					50/75 mm			
		Borehole Terminated at 2.6 m Depth Upon Auger Refusal	100.5					

Standard Penetration Test N Value: 20 40 60 80

Shear Strength kPa: 50 100 150 200

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % Atterberg Limits (% Dry Weight): 20 40 60

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. 19 mm standpipe installed upon completion
3. Field work supervised by an **exp** representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00243143-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
Completion	2.6	2.6
Mar 27, 2018	1.5	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE BH LOGS - 243143 - FALLOWFIELD CEDARVIEW.GPJ TROW OTTAWA.GDT 5/4/18

Log of Borehole BH-10

Project No: OTT-00243143-A0

Project: Geotechnical Investigation. Proposed Residential Development

Location: 4190, 4200, 4210, 4236 Fallowfield Rd and 2740 Cedarview Rd, Ottawa

Figure No. 13

Page. 1 of 1

Date Drilled: 'March 5, 2018

Drill Type: CME-55 Trackmount

Datum: Geodetic

Logged by: A.N. Checked by: I.T.

Split Spoon Sample ⊠ | Auger Sample ◧ | SPT (N) Value ○ | Dynamic Cone Test ——— | Shelby Tube ■ | Shear Strength by Vane Test +S

Combustible Vapour Reading □ | Natural Moisture Content × | Atterberg Limits ⊣○⊢ | Undrained Triaxial at % Strain at Failure ⊕ | Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic m	Depth
		TOPSOIL ~300 mm	102.8	0
		SILTY GRAVELLY TILL With boulders and cobbles, grey, moist, (loose to very dense)	102.5	
			100.6	2
		WEATHERED TO BOULDERLY TILL Boulders and cobbles in silty sand matrix, grey	99.5	3
		LIMESTONE BEDROCK Horizontal and vertical fractures, thin shale partings, grey (poor to fair quality)		4
			96.5	6
		Borehole Terminated at 6.3 m Depth		

Standard Penetration Test N Value: 20 40 60 80

Shear Strength: 50 100 150 200 kPa

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % Atterberg Limits (% Dry Weight): 20 40 60

SAMPLES

Natural Unit Wt. kN/m³

5 (0 m)

23 (1 m)

54 (2 m)

84 (3 m)

21.2 (1 m)

22.9 (2 m)

Run 1 (4 m)

Run 1 (6 m)

LOG OF BOREHOLE BH LOGS - 243143 - FALLOWFIELD CEDARVIEW.GPJ TROW OTTAWA.GDT 5/4/18

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. 19 mm standpipe installed upon completion
3. Field work supervised by an **exp** representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00243143-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
Completion	Dry	2.2
Mar 27, 2018	dry	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	3.3 - 4.8	80	43
2	4.8 - 6.3	94	63

Log of Borehole BH-11

Project No: OTT-00243143-A0

Project: Geotechnical Investigation. Proposed Residential Development

Location: 4190, 4200, 4210, 4236 Fallowfield Rd and 2740 Cedarview Rd, Ottawa

Figure No. 14

Page. 1 of 1

Date Drilled: 'March 5, 2018

Drill Type: CME-55 Trackmount

Datum: Geodetic

Logged by: A.N. Checked by: I.T.

Split Spoon Sample ☒ | Auger Sample ◧ | SPT (N) Value ○ | Dynamic Cone Test ——— | Shelby Tube ■ | Shear Strength by Vane Test +S

Combustible Vapour Reading □ | Natural Moisture Content × | Atterberg Limits |—○—| | Undrained Triaxial at % Strain at Failure ⊕ | Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic m	Depth	Standard Penetration Test N Value / Shear Strength kPa (20 40 60 80 / 50 100 150 200)	Combustible Vapour Reading (ppm) 250 500 750 / Natural Moisture Content % Atterberg Limits (% Dry Weight) 20 40 60	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~50 mm	102.06	0				
		FILL Mixture of sand and gravel, pieces of concrete and asphalt, moist, (compact)	102.0					
		GRAVELLY SAND TILL Some silt, trace clay, cobbles and boulders throughout, brown to grey, moist to wet, (compact to very dense)	101.5	1	16, 11	×		21.9
				2	58	×		22.0
			99.36	3	56, 40	×		
				4	60/125 mm	×		
			97.8					
		Borehole Terminated at 4.3 m Depth Upon Auger Refusal						

LOG OF BOREHOLE BH LOGS - 243143 - FALLOWFIELD CEDARVIEW.GPJ TROW OTTAWA.GDT 5/4/18

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. 19 mm standpipe installed upon completion
3. Field work supervised by an **exp** representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00243143-A0

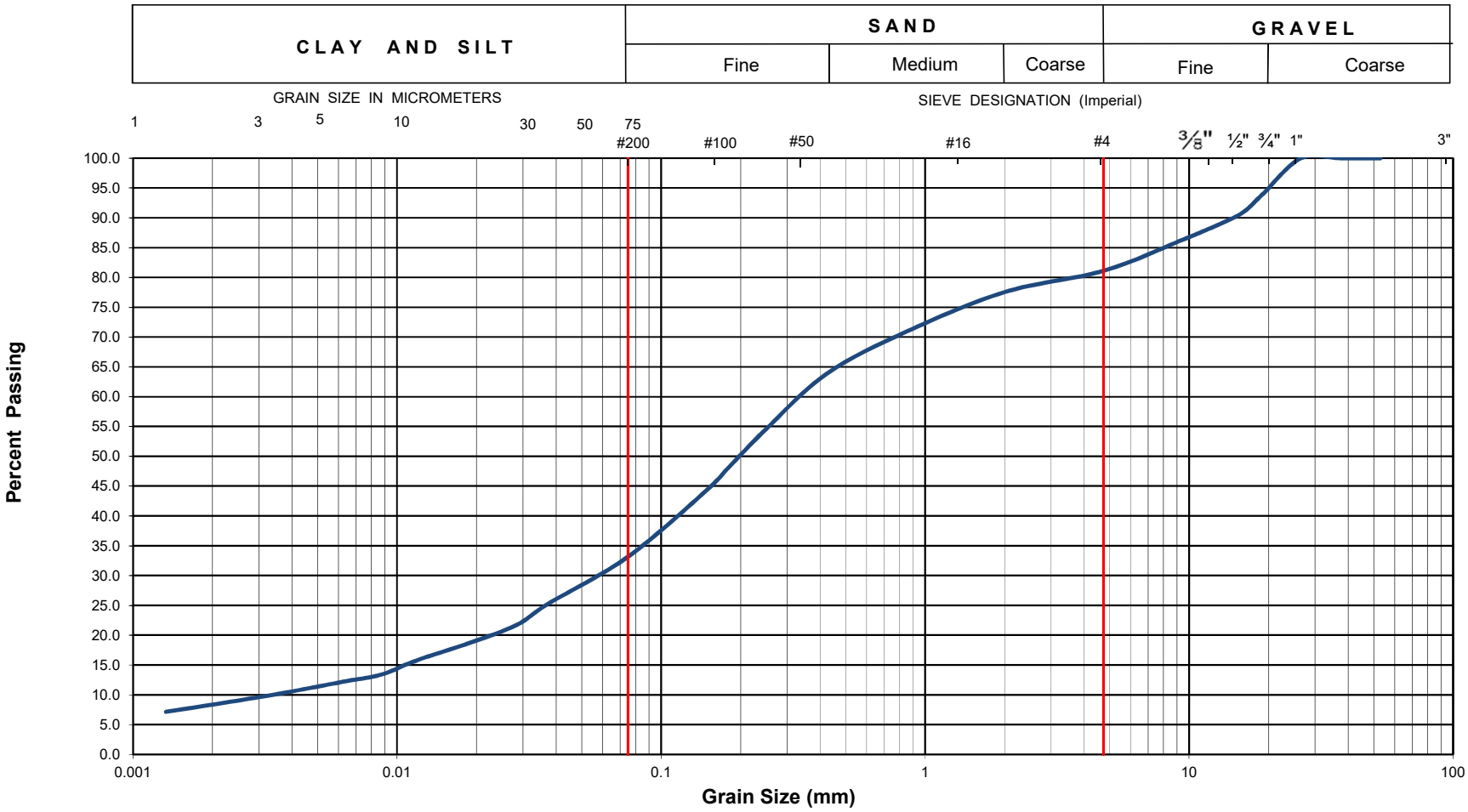
WATER LEVEL RECORDS		
Elapsed Time	Water Level (m)	Hole Open To (m)
Completion	3.0	4.3

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

EXP Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6

Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422

Unified Soil Classification System

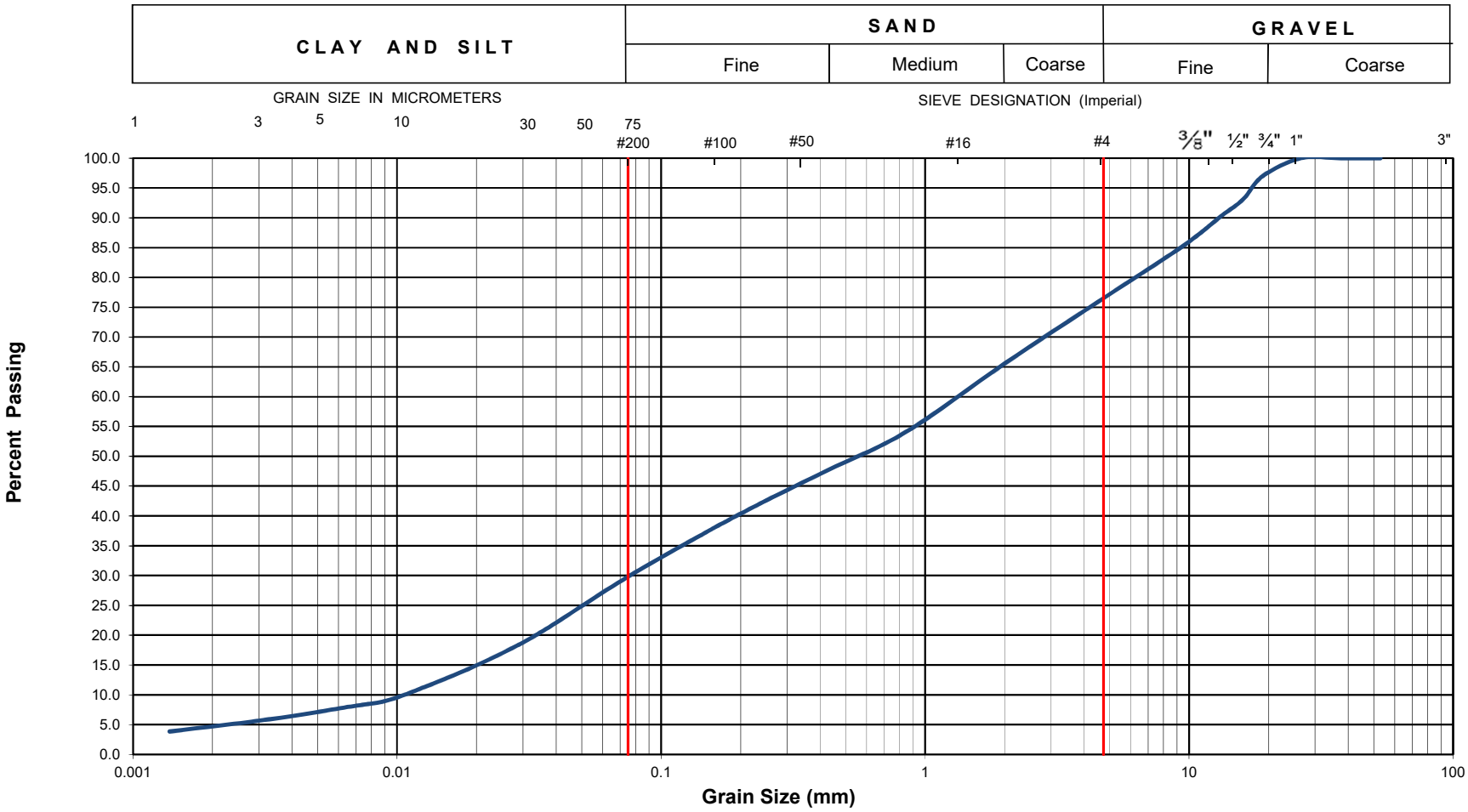


EXP Project No.:	**OTT-00243143-AO**	**Project Name :**	**Geotechnical Investigation. Proposed Residential Development**						
Client :	**DCR Phoenix Group of Companies**	**Project Location :**	**4190, 4200, 4210, 4236 Fallowfield Rd and 2740 Cedarview Rd, Otttawa, ON**						
Date Sampled :	**October 23, 2017**	**Borehole No:**	**1**		**Sample No.:**	**SS4**		**Depth (m) :**	**2.3-2.9**
Sample Description :		**% Silt and Clay**	**33**	**% Sand**	**48**	**% Gravel**	**19**	**Figure :**	**15**
Sample Description :		**Silty Sand with Gravel (SM)**							

EXP Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6

Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422

Unified Soil Classification System

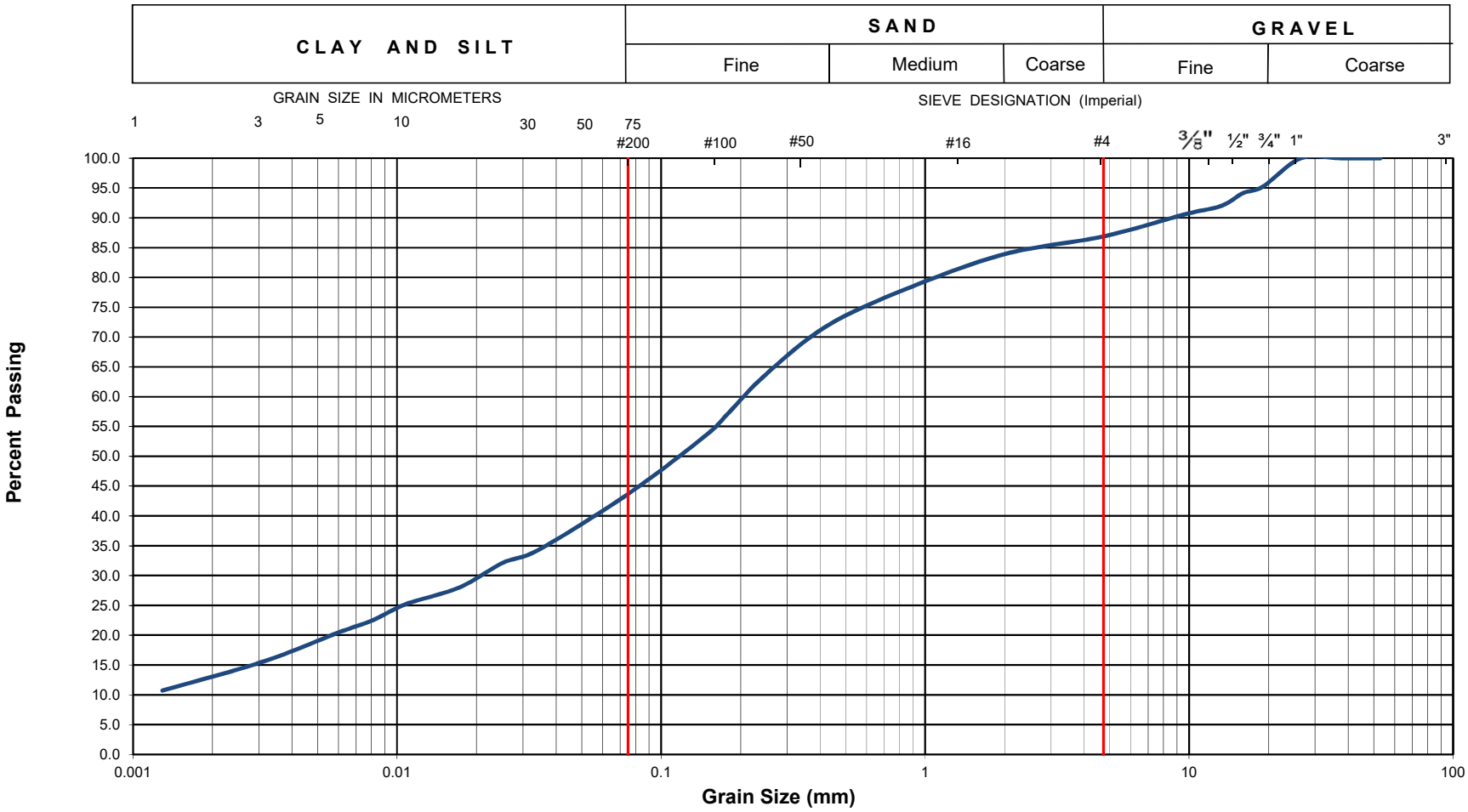


EXP Project No.:	**OTT-00243143-AO**	**Project Name :**	**Geotechnical Investigation. Proposed Residential Development**						
Client :	**DCR Phoenix Group of Companies**	**Project Location :**	**4190, 4200, 4210, 4236 Fallowfield Rd and 2740 Cedarview Rd, Otttawa, ON**						
Date Sampled :	**October 23, 2017**	**Borehole No:**	**3**		**Sample No.:**	**SS6**		**Depth (m) :**	**3.8-4.4**
Sample Description :		**% Silt and Clay**	**30**	**% Sand**	**47**	**% Gravel**	**23**	**Figure :**	**16**
Sample Description :		**Silty Sand with Gravel (SM)**							

EXP Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6

Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422

Unified Soil Classification System

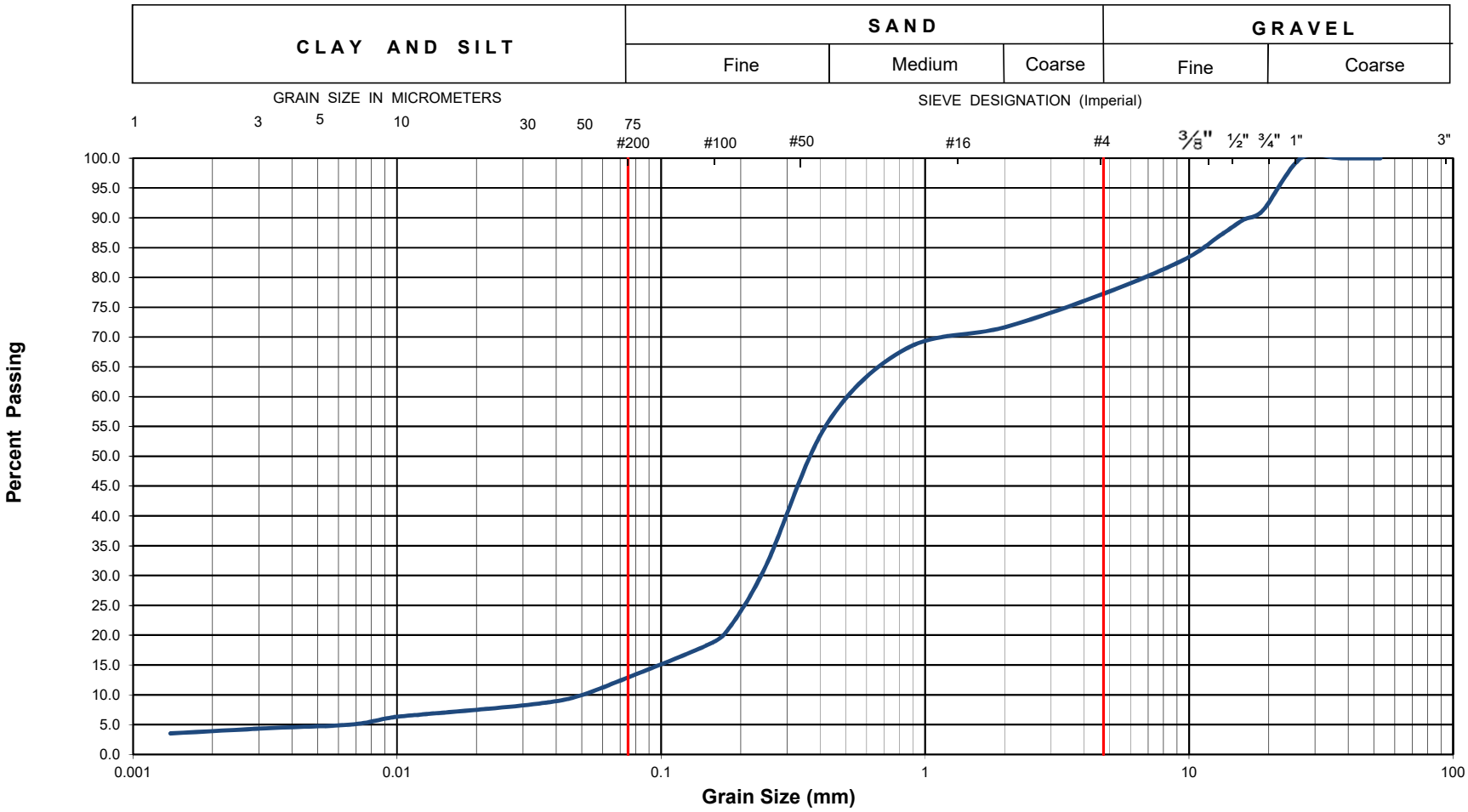


EXP Project No.:	**OTT-00243143-AO**	**Project Name :**	**Geotechnical Investigation. Proposed Residential Development**						
Client :	**DCR Phoenix Group of Companies**	**Project Location :**	**4190, 4200, 4210, 4236 Fallowfield Rd and 2740 Cedarview Rd, Otttawa, ON**						
Date Sampled :	**March 6, 2018**	**Borehole No:**	**4**		**Sample No.:**	**SS3**		**Depth (m) :**	**1.4-2.0**
Sample Description :		**% Silt and Clay**	**44**	**% Sand**	**43**	**% Gravel**	**13**	**Figure :**	**17**
Sample Description :		**Silty Sand with Gravel (SM)**							

EXP Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6

Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422

Unified Soil Classification System

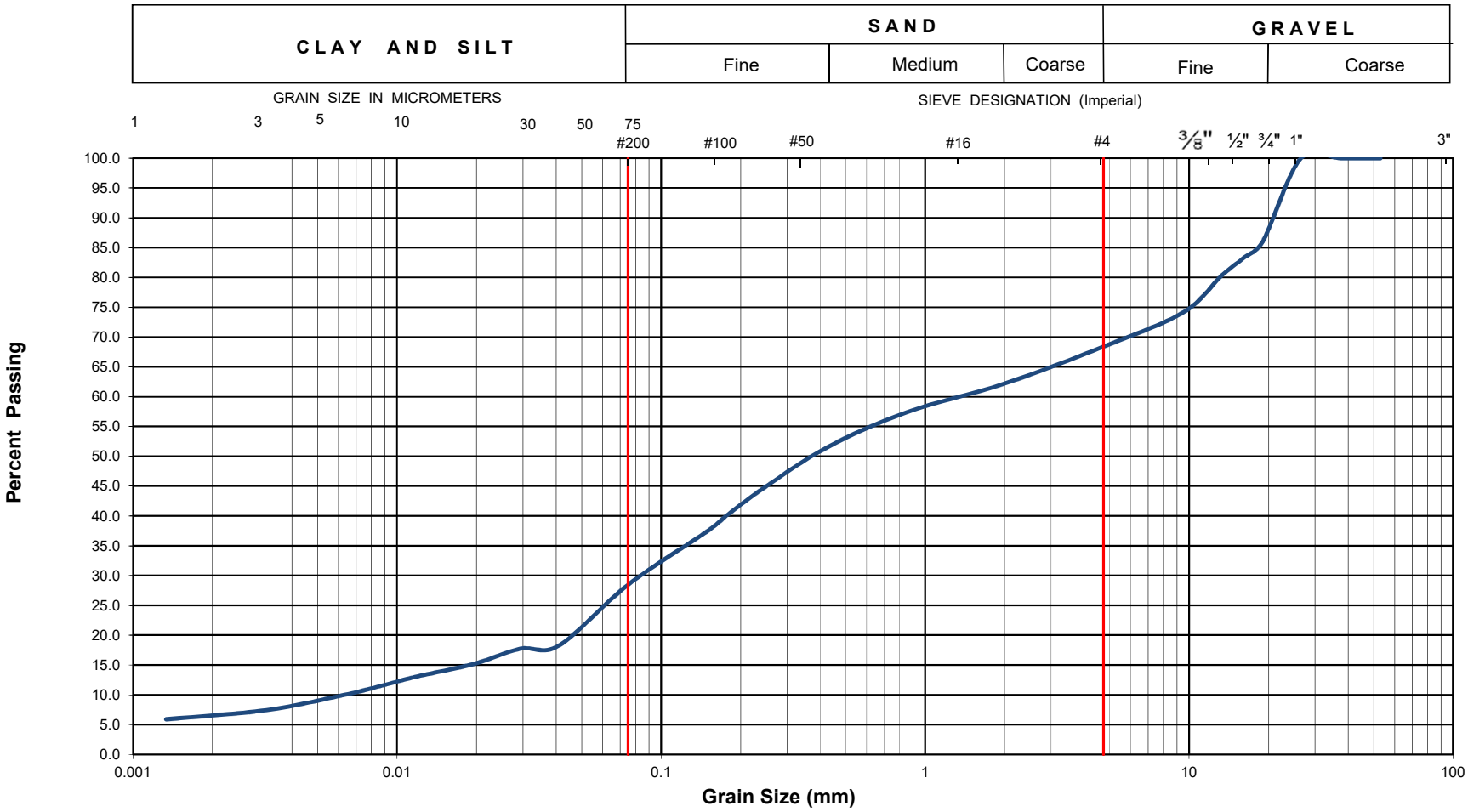


EXP Project No.:	**OTT-00243143-AO**	**Project Name :**	**Geotechnical Investigation. Proposed Residential Development**						
Client :	**DCR Phoenix Group of Companies**	**Project Location :**	**4190, 4200, 4210, 4236 Fallowfield Rd and 2740 Cedarview Rd, Otttawa, ON**						
Date Sampled :	**March 6, 2018**	**Borehole No:**	**7**		**Sample No.:**	**SS4**		**Depth (m) :**	**2.3-2.9**
Sample Description :		**% Silt and Clay**	**13**	**% Sand**	**65**	**% Gravel**	**22**	**Figure :**	**18**
Sample Description :		**Gravelly Sand, little Fines (SW)**							

EXP Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6

Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422

Unified Soil Classification System

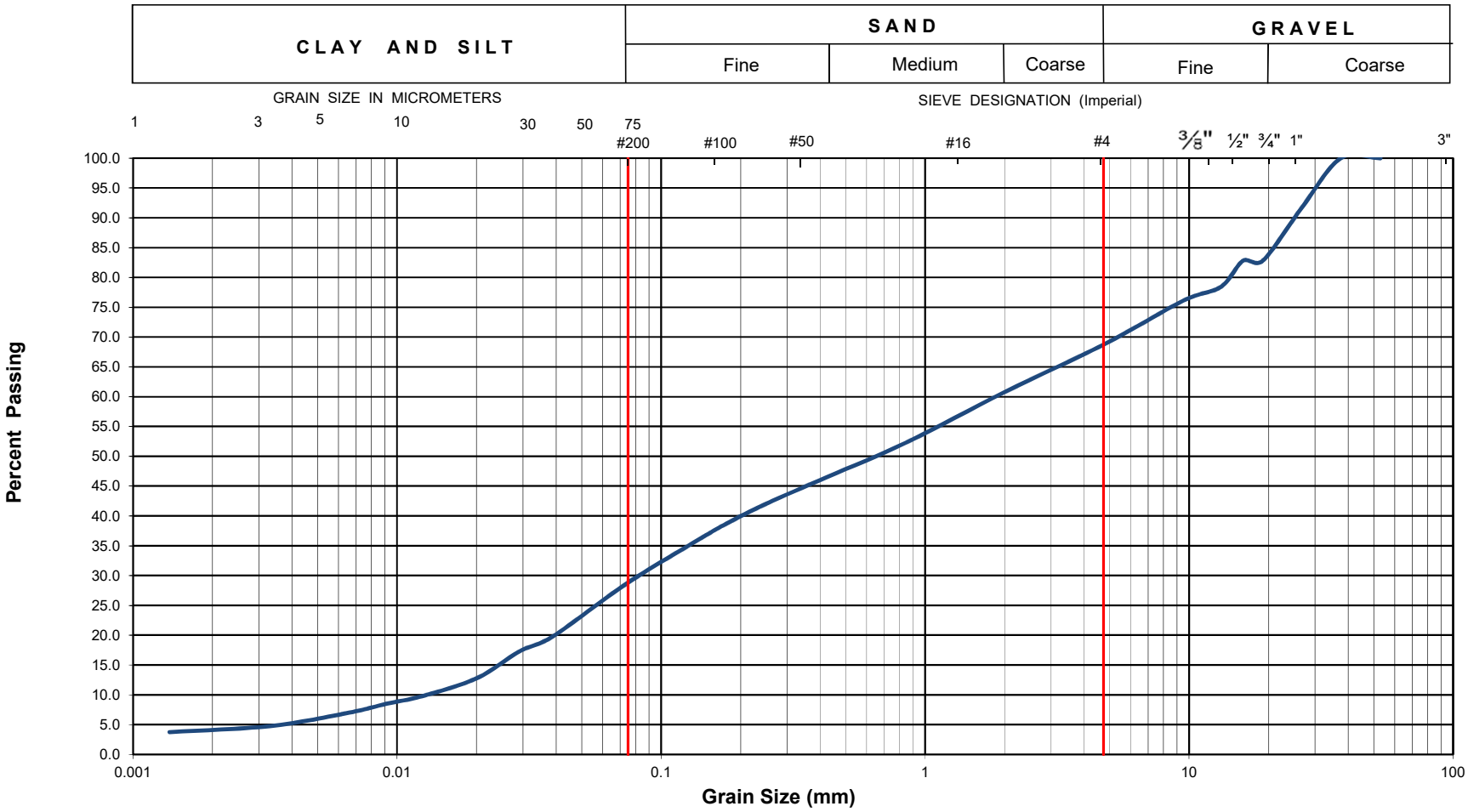


EXP Project No.:	**OTT-00243143-AO**	**Project Name :**	**Geotechnical Investigation. Proposed Residential Development**						
Client :	**DCR Phoenix Group of Companies**	**Project Location :**	**4190, 4200, 4210, 4236 Fallowfield Rd and 2740 Cedarview Rd, Otttawa, ON**						
Date Sampled :	**March 6, 2018**	**Borehole No:**	**8**		**Sample No.:**	**SS5**		**Depth (m) :**	**3.0-3.7**
Sample Description :		**% Silt and Clay**	**13**	**% Sand**	**65**	**% Gravel**	**22**	**Figure :**	**19**
Sample Description :		**Silty Sand with Gravel (SM)**							

EXP Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6

Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422

Unified Soil Classification System



EXP Project No.:	**OTT-00243143-AO**	**Project Name :**	**Geotechnical Investigation. Proposed Residential Development**						
Client :	**DCR Phoenix Group of Companies**	**Project Location :**	**4190, 4200, 4210, 4236 Fallowfield Rd and 2740 Cedarview Rd, Otttawa, ON**						
Date Sampled :	**March 6, 2018**	**Borehole No:**	**11**		**Sample No.:**	**SS6**		**Depth (m) :**	**3.8-4.4**
Sample Description :		**% Silt and Clay**	**29**	**% Sand**	**40**	**% Gravel**	**31**	**Figure :**	**20**
Sample Description :		**Silty Sand with Gravel (SM)**							

Appendix A: AGAT Laboratory Certificate

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: EXP SERVICES INC
2650 QUEENSVIEW DRIVE, UNIT 100
OTTAWA, ON K2B8H6
(613) 688-1899

ATTENTION TO: Ismail M. Taki

PROJECT: OTT-243143-AO

AGAT WORK ORDER: 18Z319208

SOIL ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Coordinator

DATE REPORTED: Mar 16, 2018

PAGES (INCLUDING COVER): 5

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

Member of: Association of Professional Engineers and Geoscientists of Alberta (APEGA)
Western Enviro-Agricultural Laboratory Association (WEALA)
Environmental Services Association of Alberta (ESAA)

AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation.

Results relate only to the items tested and to all the items tested
All reportable information as specified by ISO 17025:2005 is available from AGAT Laboratories upon request

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 18Z319208

PROJECT: OTT-243143-AO

CLIENT NAME: EXP SERVICES INC

ATTENTION TO: Ismail M. Taki

SAMPLING SITE:Fallowfield Rd.

SAMPLED BY:exp

Inorganic Chemistry (Soil)

DATE RECEIVED: 2018-03-12 **DATE REPORTED: 2018-03-16**

Parameter	Unit	G / S	RDL	SAMPLE DESCRIPTION: BH4 SS4 7. 5'-9.5'	SAMPLE DESCRIPTION: BH8 SS4 7. 5'-9.5'	SAMPLE DESCRIPTION: BH9 SS3 5'-7'	SAMPLE DESCRIPTION: BH11 SS3 5'-7'
SAMPLE TYPE:				Water	Water	Water	Water
DATE SAMPLED:				2018-03-06	2018-03-06	2018-03-06	2018-03-06
				9118773	9118774	9118775	9118776
pH (2:1)	pH Units		N/A	8.03	7.75	8.05	8.34
Sulphate (2:1)	µg/g		2	5	4	14	20
Electrical Conductivity (2:1)	mS/cm		0.005	0.101	0.151	0.168	0.106

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

9118773-9118776 EC, Sulphate and pH were determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil).

Certified By: Amanjot Bhela

Results relate only to the items tested and to all the items tested

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: EXP SERVICES INC

AGAT WORK ORDER: 18Z319208

PROJECT: OTT-243143-AO

ATTENTION TO: Ismail M. Taki

SAMPLING SITE:Fallowfield Rd.

SAMPLED BY:exp

Soil Analysis

RPT Date: Mar 16, 2018			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Inorganic Chemistry (Soil)															
pH (2:1)	9118773	9118773	8.03	8.10	0.9%	N/A	99%	90%	110%	NA			NA		
Sulphate (2:1)	9118773	9118773	5	5	NA	< 2	104%	70%	130%	105%	70%	130%	94%	70%	130%
Electrical Conductivity (2:1)	9118773	9118773	0.101	0.102	1.0%	< 0.005	97%	90%	110%	NA			NA		

Comments: NA signifies Not Applicable.
Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Certified By: Amanjot Bhela

AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation.

Results relate only to the items tested and to all the items tested

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Method Summary

CLIENT NAME: EXP SERVICES INC

AGAT WORK ORDER: 18Z319208

PROJECT: OTT-243143-AO

ATTENTION TO: Ismail M. Taki

SAMPLING SITE:Fallowfield Rd.

SAMPLED BY:exp

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
pH (2:1)	INOR 93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Sulphate (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
Electrical Conductivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER

Results relate only to the items tested and to all the items tested

AGAT Laboratories

1 small blue

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
webearth.agatlabs.com

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Report Information:

Company: Exp
Contact: Ismail Tak
Address: 100-2650 Queensview Drive
Ottawa Ont K2B 8H6
Phone: 613-688-1899 Fax:
Reports to be sent to:
1. Email: Ismail.Tak@exp.com
2. Email:

Project Information:

Project: OTT-243143-A0
Site Location: Fallowfield Rd
Sampled By: exp
AGAT Quote #: PO:
Please note: If quotation number is not provided, client will be billed full price for analysis.

Invoice Information:

Bill To Same: Yes ☒ No ☐
Company:
Contact:
Address:
Email:

Regulatory Requirements:

☐ No Regulatory Requirement
(Please check all applicable boxes)

☐ Regulation 153/04
Table (Indicate One) ☐ Ind/Com ☐ Res/Park ☐ Agriculture
Soil Texture (Check One) ☐ Coarse ☐ Fine

☐ Sewer Use ☐ Sanitary ☐ Storm
Region (Indicate One) ☐ MISA

☐ Regulation 558
☐ CCME
☐ Prov. Water Quality Objectives (PWQO)
☐ Other (Indicate One)

Is this submission for a **Record of Site Condition?** ☐ Yes ☐ No

Report Guideline on *Certificate of Analysis* ☐ Yes ☐ No

Sample Matrix Legend

B	Biota
GW	Ground Water
O	Oil
P	Paint
S	Soil
SD	Sediment
SW	Surface Water

Laboratory Use Only

Work Order #: 18231920 8
Cooler Quantity: one on ice
Arrival Temperatures: 15.3 | 15.3 | 15.4
CT- 6.9 | 7.4 | 7.7
Custody Seal Intact: ☐ Yes ☐ No ☐ N/A
Notes:

Turnaround Time (TAT) Required:

Regular TAT ☒ 5 to 7 Business Days

Rush TAT (Rush Surcharges Apply)

☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day

OR Date Required (Rush Surcharges May Apply):

Please provide prior notification for rush TAT
**TAT is exclusive of weekends and statutory holidays*

For 'Same Day' analysis, please contact your AGAT CPM

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI (Y/N)	O. Reg 153: Metals and Inorganics (☐ All Metals ☐ 153 Metals (excl. Hydrides) ☐ Hydride Metals ☐ 153 Metals (Incl. Hydrides))	ORPs: ☐ B-HWS ☐ Cl ☐ CN ☐ Cr^{6+} ☐ EC ☐ FOC ☐ Hg ☐ pH ☐ SAR	Full Metals Scan	Regulation/Custom Metals	Nutrients: ☐ TP ☐ NH_3 ☐ TKN ☐ NO_3 ☐ NO_2 ☐ NO_3+NO_2	Volatiles: ☐ VOC ☐ BTEX ☐ THM	PHCs F1 - F4	ABNs	PAHs	PCBs: ☐ Total ☐ Aroclors	Organochlorine Pesticides	TCLP: ☐ M&I ☐ VOCs ☐ ABNs ☐ B(a)P ☐ PCBs	Sewer Use	pH	Sulphide	Electro Conductivity
BH4 SS4 7.5'-9.5'	Mar6/18																			✓	✓	✓
BH8 SS4 7.5'-9.5'	Mar5/18																			✓	✓	✓
BH9 SS3 5'-7'	Mar5/18																			✓	✓	✓
BH11 SS3 5'-7'	Mar5/18																			✓	✓	✓

Samples Relinquished By (Print Name and Sign): Ryan DiGiuseppe	Date: Mar 9/18	Time: 6:30pm	Samples Received By (Print Name and Sign): Linda Bethel	Date: 12-Mar-18	Time: 8h06
Samples Relinquished By (Print Name and Sign): FedEx	Date: 12-Mar-18	Time: 16h00	Samples Received By (Print Name and Sign):	Date:	Time:
Samples Relinquished By (Print Name and Sign):	Date:	Time:	Samples Received By (Print Name and Sign): Shawnna Mar 13/18	Date: 8:50am	Time:

Page 1 of 1

Nº: T 063373

Document ID: DIV-78-1511-014

Pink Copy - Client | Yellow Copy - AGAT | White Copy- AGAT

Date Issued: February 22, 2017

List of Distribution

Report Distributed To:

Mike Boucher – DCR Phoenix Group of Companies - mboucher@phoenixhomes.ca

Mark Bissett – Novatech Engineering -m.bissett@novatech-eng.com>

Greg Winters – Novatech Engineering - G.Winters@novatech-eng.com