Azure Group

A SOIL INVESTIGATION FOR PROPOSED RESIDENTIAL BUILDING

3016-3032 KIRWIN AVENUE & 3031 LITTLE JOHN LANE

MISSISSUGA, ONTARIO

DATE:	**APRIL 27, 2022**
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PREPARED FOR:	**WESTON CONSULTING**
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1.0 INTRODUCTION

Azure Group Inc. was retained by Weston Consulting (the Client) to prepare a geotechnical investigation for the proposed development (high rise residential Building) at 3016-3032 Kirwin Avenue and 3031 Little John Lane in Mississauga, Ontario (hereinafter referred to as the "Site"). The work carried out for this investigation was completed in general accordance with Azure Group's proposal (Azure Group Proposal No. P2201006 dated January 24, 2022). Authorization to proceed with this investigation was received on January 31, 2022 from Mr. Francesco Bertoia of DVB Real Estate Investment Inc. The geotechnical investigation was completed concurrently with hydrogeological investigation. The results of the hydrogeological investigation are provided under a separate cover.

The purpose of the geotechnical investigation was to determine the subsurface conditions at the Site by means of ten (10) boreholes in which three (3) of the ten (10) boreholes will be completed as groundwater monitoring wells, to provide geotechnical parameters and recommendations for the design and construction of the proposed building, underground utilities, driveways and parking areas. The scope of the geotechnical investigation did not include environmental sampling and testing.

This report has been prepared for Weston Consulting specifically and solely for the proposed development of the Site based on the intended layout and the proposed facilities provided at the time of preparing this report. Third party use of this report is prohibited without written consent of Azure Group Inc.

2.0 SITE AND PROJECT DESCRIPTION

The proposed development is located at 3016-3018-3020-3024 and 3031 Little John Lane in Mississauga, Ontario. The Site is approximately 300 m east of Hurontario Street.

Currently the Site is a vacant land covered with trees, bushes and shrubs. Residential and commercial buildings exist in the neighborhood of the property. The existing ground surface elevation at the location of the boreholes varies from 110.8 m at the location of BH6 to 113.4 m at the location of BH1 with average of 112.3 m.

The project considers the construction of eight (8) storey residential building with two (2) underground levels and the associated driveways, parking lots and underground utilities.

The finished floor elevation of the building, structural loads, underground utilities invert depths, etc., are not available at this time. However, we anticipate that the finished floor of the building is ±0.3 m above the existing ground surface. Details of the Site is shown in Figure 1.

3.0 SCOPE OF WORK

The geotechnical investigation was completed in conjunction with a hydrogeological investigation. The results of the hydrologic investigation are provided under separate cover.
The geotechnical and hydrological scope of work included the following:

- Advancing ten (10) boreholes "BH1 to BH10". The location of the boreholes is shown in Figure 1 attached to this report;
- Install 50 mm diameter monitoring wells at the location of BH1, BH2 and BH3;
- It is noted that the boreholes intended to be advanced to a depth of 15 m below the grade encountered virtual refusal on depths ranging between ±8.2 m and of ±11.3 m below grade and as a result was terminated at these depths;
- Conducted field tests during drilling (Standard Penetration Tests "SPT") to obtain the number of blows "N" per 300 mm and pocket penetrometer tests on the extracted soil samples to obtain the undrained shear strength of the soil c_u;
- Conducted a limited laboratory tests on selected soil samples obtained from the boreholes for soil classification, and moisture content;
- Prepared a geotechnical report with comments and recommendations regarding:
  - Site preparation;
  - Appropriate foundation depth, types, bearing capacity, settlement, and seismic classification;
  - Slab on grade;
  - General excavation and backfilling requirements;
  - Lateral earth pressure;
  - Temporary excavations in accordance with latest edition of the Occupational Health and Safety Act (OHSA), and Regulations 213/91,

- Sewer bedding and cover;
- Suitability of the existing materials for backfilling; and,
- Pavement recommendations along the investigated area.

4.0 FIELD WORK

Prior to undertaking the drilling operation, the site was cleared of buried underground utilities at the borehole locations. A private locating contractor was retained to identify the position of any privately owned electrical cables or piping that could be present but not identified by Ontario One Call (Public Utilities Locator).

The field work for this investigation was carried out between March 30 and April 1, 2022. The investigation consisted of drilling ten (10) boreholes "BH1 to BH10" to depths ranging between 8.2 m and 11.3 m.

Three (3) monitoring wells were installed at the location of boreholes BH1, BH2 and BH3 to depths 7.5 m, 8.3 m, and 7.7 m respectively.

The location of the boreholes and monitoring wells is shown on the attached Figure 1.

The ground surface elevation of each borehole was surveyed relative to the elevation of an existing borehole (BH1) which was previously installed by Azure Group. The elevation of BH1 was 113.13 m above sea level (masl).

All boreholes were advanced using a track-mounted CME-55 drilling rig with 100 mm diameter continuous flight open/solid-stem auger under the full-time supervision of a geotechnical engineer from Azure Group.

The subsurface strata were sampled at regular intervals of 0.75 m depth for the first 3 m and at 1.5 m interval for the remaining depth, using a split-spoon sampler while performing the Standard Penetration Test (SPT) as detailed in the ASTM D1586. The number of blows of the 63.4 kg hammer required to drive the spoon 0.3 m (12 inches) into the soil was the SPT "N" value of the soil. The "N" value provides an approximate measure of the consistency of cohesive soils or the relative density in non-cohesive (cohesionless) soils.

The field test results were supplemented by laboratory analysis following completion of the drilling, the soil samples were taken to accredited laboratory for final visual assessment, classification and testing. The soil samples were tested and classified in general accordance with the Unified Soil Classification System (USCS), ASTM 2487, Ontario Ministry of Transportation, Soil Classification System.

The soil samples recovered during the investigation will be stored for a period of 30 days after which they will be discarded unless further instructions are received from Black Creek Group All boreholes were backfilled with soil cuttings and bentonite.

5.0 SUBSURFACE CONDITIONS

The subsurface conditions encountered in the boreholes are shown on the borehole records provided in Figures 2 to 11. The borehole records include soil stratification at the borehole locations with detailed soil descriptions and selected physical properties for each stratum encountered. Variations in the soil stratification may occur and should be expected between borehole locations and elsewhere on the site. Furthermore, since the internal diameter of the Spoon used in the Standard Penetration Test (SPT) is 38 mm which is less than the maximum size of the gravel (75 mm), the grain size test results and soil classification may not reflect the entire gravel size fraction. In general, the subsurface conditions encountered at the borehole locations consisted of topsoil, fill, and native soils. The following sections describe the materials encountered at the location of the boreholes.

5.1 Topsoil

Topsoil was encountered at the location of all boreholes. The approximate average thickness of the topsoil was ±250 mm. However, the thickness of the topsoil at the borehole locations may not represent the entire Site. Therefore, they should not be considered in estimating the total quantity of the topsoil. The topsoil encountered was dark brown in color indicating a considerable amount of roots and humus. Topsoil in general, is unstable and compressive under loads, therefore, it should not be used for engineering purposes.

5.2 Native Sandy and Clayey Soils

Layers of native soft to hard silty clay/clayey silt and loose to very dense sand, silty sand/sandy silt trace gravels, boulders and shale fragments were encountered below the topsoil at the location of all boreholes. The native soils extend to depths ranging between 7.6 m and 10.7 m below grade.

5.3 Shale Bedrock

Shale bedrock was inferred in the boreholes based on auger refusal at depths ranging between 8.2 m and 11.30 m below the existing ground surface.

Given that the bedrock was not cored, and based on our experience and monitoring of the drilling operation, weathered shale exists on top of the sound bedrock. The estimated inferred thickness of the weathered shale ranged between 500 mm and 1000 mm. However, the exact interface depth between the weathered and sound bedrock was not precisely determined. Furthermore, the native soil overlying the weathered or sound shale bedrock may contain boulders which may give a false indication of the shale elevation. Therefore, the exact depth of the bedrock can be different from that recorded in boreholes logs due to possible existence of large pieces of weathered shale.

Summary of the materials encountered at the location of the boreholes is provided in the boring logs drawing 2 to 11.

5.4 Groundwater

Monitoring wells were installed at the location of BH(MW)101, and BH(MW)106. Three Monitoring Wells, BH(MW)1, BH(MW)2 and BH(MW)3 were installed in 2020 investigation. The groundwater table/elevation in the monitoring wells was measured in April 13, 2022 at depth of 4.71/108.68 m and 2.95/107.83 m at the location of BH(MW)101 and BH (MW)106 respectively.

The depth of the groundwater tables in monitoring wells BH(MW)1, BH(MW)2 & BH(MW)3, which were installed in 2020, was also measured in April 13, 2022 at depths of 4.16/108.97 m, 4.21/108.35 m and 4.24/109.97 m respectively.

It should be noted that the natural groundwater table is likely to vary throughout the year, depending on the amount of precipitation, runoff, evaporation, and percolation in the area. Summary of subsurface condition and groundwater table is provided in Table 1.

Table 1: Summary of Subsurface Conditions

BH No.	G.S. E.	BH Depth (mbgs)	Depth Soil Layers		Monitoring Well Depth	G.W. Depth/Elevation April 13, 2022
			Sand/Clay	Shale		
BH(MW)101	113.4	8.2	7.6	8.2	6.27	4.71/108.68
BH102	113.1	9.8	9.2	9.8	-	-
BH103	112.5	9.6	7.6	8.2	-	-
BH104	112.1	9.8	9.2	9.8	-	-
BH105	110.8	9.8	9.2	9.8	-	-
BH(MW)106	110.8	9.8	9.2	9.8	5.50	2.95/107.83
BH107	113.3	10.8	10.7	11.0	-	-
BH108	113.3	10.8	10.7	11.3	-	-
BH109	112.5	9.8	9.2	9.8	-	-
BH110	110.9	9.8	9.2	9.8	-	-
Monitoring Wells installed in 2020						
BH(MW)1	113.13	6.8	-	-	6.8	4.16/109.24
BH(MW)2	112.56	6.1	-	-	6.06	4.21/108.89
BH(MW)3	113.31	6.8	-	-	6.57	4.24/108.26

G.S.E =Ground Surface Elevation
G.W.T = Ground Water Table
Mbgs = meters below ground surface
**Wet soil*
All measurements in meters

6.0 DISCUSSION AND RECOMMENDATIONS

6.1 Introduction

Based on the information obtained from the investigation, the following comments are provided with respect to the proposed scope of development:

- The proposed development considers the construction eight (8) storey building with two (2) underground levels;
- The anticipated depth of the two underground levels ranges between 6 m and 7 m below the grade,
- The topography of the Site is not level, with surface elevation difference of approximately 2.6 m throughout the Site. Earthwork (cut and fill) may be required for the Site to achieve the final grade.

- The finished elevation of slab-on-grade of the building was not available at the time of preparing this report. However, we anticipate that the finished slab on grade elevation of the building will be at ±0.3 m above the existing ground surface;
- Groundwater table was encountered at an average depth of 4.2 (corresponding to elevation of 108.8 m). Dewatering may be required during foundation construction;
- Shallow foundations (spread and continuous footings) may be constructed to support the building loads;
- For frost protection, the recommended minimum depth of the footing should be not less than 1.2 m below the existing grade; and
- Temporary shoring may be required to maintain the stability of the excavation.

The following sections contain recommendations for building construction based on the materials encountered in the boreholes:

6.2 Site Preparation (Site Grading, Cut and Fill)

Prior to any construction activities, cut and fill operation may be required to achieve the final grades.

The following recommendations may be considered for the site grading and preparation:

1. The bushes, trees, topsoil, fill and soft/loose soils should be removed from areas of the proposed development,
2. The exposed ground surface should be inspected and thoroughly proof rolled in the presence of a qualified geotechnical engineer. The purpose of the proof-roll is to locate areas of unsuitably loose or soft subgrade and to uniformly compact the surface. In clayey soils, proof-rolling should be performed with a loaded tandem axle dump truck, rubber-tired loader, or other suitable piece of pneumatic-tired construction equipment. In granular soils, proof-rolling should be performed with a heavy (minimum 10 tones) self-propelled vibratory roller. The proof-rolling should consist of a minimum of six passes per unit area and should be tested to ensure that areas exhibiting more than 15 mm deflection or any soft, wet or deleterious materials identified at the time of proof rolling should be sub-excavated and replaced with a suitable and/or approved drier materials. The exposed surface after the proof rolling should be compacted to at least 100% of the materials Standard Proctor Maximum Dry Density (SPMDD),

3. Following the subgrade preparation, fill materials may be placed on the exposed surface
4. Materials placed to raise the final grade or replace the excavated materials during proof rolling should be placed in 150 mm thick lifts in the loose condition and uniformly compacted to minimum of 100% of the materials SPMDD,
5. The filling and compacting should continue until the final elevation of the subgrade and/or foundation level is achieved,
6. During the placement of structural fill, all frozen materials should be removed prior to placing additional layers of materials,
7. Imported fill materials for use in the development on the site must meet all applicable municipal, provincial, and federal guidelines as well as regulations associated with environmental characterization of the materials. The materials should also be examined and approved by a qualified geotechnical engineer,
8. We do not recommend construction to be carried out in wet or inclement weather,
9. Furthermore, the ground surface in the area surrounding the building should be graded to direct run-off water away from the proposed development.

6.3 Foundation Recommendation

Based on the available soil parameters obtained from the boreholes conventional spread and continuous footing foundations supported on the native, the engineered fill and shale bedrock.

6.3.1 Conventional Spread and Strip Footings

6.3.1.1 Footings on Native Soil

Conventional spread or continuous footings may be constructed on the exiting native soils.

For foundations constructed on the existing native soils, the recommended factored Ultimate Limit State (ULS) and the Serviceability Limit State (SLS) to be used for the design of the proposed footings are 600 kPa and 400 kPa respectively,

6.3.1.2 Footing on the Shale Bedrock

Conventional spread or continuous footings may also be constructed on the weathered/sound shale bedrock.

For foundations constructed on the weathered shale, the recommended factored Ultimate Limit State (ULS) and the Serviceability Limit State (SLS) to be used for the design of the proposed footings are 900 kPa and 600 kPa respectively. The footing should penetrate not less than 400 mm the weathered shale.

For foundations constructed on the sound shale bedrock, the recommended factored Ultimate Limit State (ULS) to be used for the design of the proposed footings is 3500 kPa. The ULS will govern the design as the bearing stratum must fail for appreciable settlement to occur. The footing should penetrate not less than 200 mm the sound shale.

6.3.1.3 Footing on the Engineered Fill

Conventional spread or continuous footings may be constructed on the exiting native soils.

For foundations constructed on the existing native soils, the recommended factored Ultimate Limit State (ULS) and the Serviceability Limit State (SLS) to be used for the design of the proposed footings are 225 kPa and 150 kPa respectively.

Summary of the bearing capacities is shown in Table 2.

Table 2- Summary of Bearing Capacities of Foundations

Engineered Fill		Native Soil		Weathered Shale		Sound Shale	
ULS	SLS	ULS	SLS	ULS	SLS	ULS	SLS
225 (kPa)	150 (kPa)	600 (kPa)	400 (kPa)	900 (kPa)	600 (kPa)	3500 (kPa)	

Foundation Notes

The following notes should be considered in the design and construction of the spread and strip footings:

- The above recommendations apply to the actual borehole locations. Variations in soil profile and properties may be present between the borehole locations. Should significant variations evident during construction, it may be necessary to re-evaluate the recommendations of this report,

- Footing excavations should be inspected and approved by **Azure Group geotechnical engineer** during construction. All soft/loose, wet frozen or disturbed material should be removed, and the exposed subgrade should be immediately covered with 50 mm of lean to minimize/eliminate soil disturbance,
- For frost protection, footings should be constructed at a depth of not less than 1.2 m below the grade,
- Surface/rainwater should not be allowed in the excavated footings,
- The above bearing capacities must be reviewed by our office, once the finished floor elevation of the building has been established,
- The total and differential settlement for footings constructed on the native sandy soil and/or the engineered fill are expected to be less than 25 mm and 15 mm respectively,
- The minimum footing size, footing thickness, excavation size and other footing requirements should be designed in accordance with the requirements detailed in the latest edition of the Ontario Building Code "OBC",
- Footings constructed at different levels should be constructed so that the higher foundations are set behind a line sloping at an angle of 7V: 10 H and drawn from the near edge of the lower footing,
- For overturning considerations of spread or continuous foundations, the maximum soil pressure at the toe of the foundations should not exceed the maximum net allowable soil pressure.

6.4 Earthquake Considerations

The 2012 Ontario Building Code (OBC) Subsection 4.1.8 stipulates that a structure should be designed to meet the requirements of the Earthquake Load Effects. The Site Classification for the Seismic Site Response (Table 4.1.8.4. A) is determined from the average Standard Penetration Resistance (N60) and the soil undrained shear strength (Su).

Based on the average soil conditions below the existing ground surface and as per 2012 OBC.

Table 4.1.8.4A, the site classification for seismic site response is considered as **Site Class C.** The site classification is only for design consideration. For the possibility of obtaining higher Site Class, e.g., Site Class **B**, Shear wave tests should be considered.

6.5 Excavation and Groundwater Control

1) It is anticipated that shallow footings will be constructed at depths ranging between 6 m and 7 m below the existing ground surface,
2) Groundwater was encountered at various depths. Therefore, groundwater control will be imperative both during and after construction. Groundwater control is discussed in Section **6.9.**
3) Shallow foundations will most likely be constructed below the encountered groundwater table. For foundations constructed below the groundwater table, groundwater control is recommended. Dewatering the groundwater in sandy soils may be carried out by the installation of caissons/wells in the vicinity of the foundations during construction. The accumulated water may then be pumped out. The wells should be designed and installed by specialized personnel. For foundation constructed on clayey soil, swells along the footing that slope downwards toward a sump may be used. A sump pump may then be used to pump the accumulated,
4) Temporary excavations for footings or underground services must be carried out in accordance with latest edition of the Occupational Health and Safety Act (OHSA), Regulations 213/91,
5) According to OHSA, if excavation is deeper than 1.2 m, the excavated sides should be sloped. The slope of the sides depends on the type of the excavation materials.
6) Table 3 stipulates maximum slope excavation for various soil types,

Table 3- Soil Type and Slope Ratio

Soil Type	**Base of Slope**	**Maximum Slope Identification**
1	Within 1.2 meters of bottom of trench	1H: 1V
2	Within 1.2 meters of bottom of trench	1H: 1V
3	From bottom of trench	1H: 1V
4	From bottom of trench	3H: 1V

7) Fill soil may be classified as Type 4. The native soil may be classified as Type 3. Hard silty clay and weathered shale may be classified as Type 2.

   Excavation in the sound bedrock can be excavated vertically without lateral support. However, the exposed shale deteriorates, flakes and recedes and loses strength with time.

Falling of small shale fragments from the vertical face of the excavation occurs on a continuous basis. The use of draped steel mesh over the excavation faces of the shale is recommended,

8) Excavation of side slopes should be protected from exposure to precipitation and associated ground surface run-off and should be inspected regularly for signs of instability. If localized instability is noted during excavation or if wet conditions are encountered, the side slopes should be flattened as required to maintain safe working conditions,
9) The excavation of the overburden soil and the weathered shale down to the level of the sound bedrock should be relatively straightforward using conventional equipment.
10) The overburden soils may contain larger particles such as boulders that were not encountered during the drilling process,
11) If shale bedrock encounters, the shale can be excavated with conventional excavation equipment once it has been displaced by a ripper tooth, a hoe ram or jackhammer,
12) It should be noted that the above recommendations are based on the actual boreholes locations. Should any contaminated materials be encountered beyond the location of the boreholes, it may be necessary to revise the above recommendations,

6.6 Lateral Earth Pressure

Walls and/or bracing supporting soil should be designed and constructed to resist lateral earth pressure imposed by the soil and hydrostatic pressure. For wall that are designed to allow rotation, active earth pressure may be used for design. For rigidly tied walls, the at-test earth pressure should be used for design. The lateral earth pressure, p, in kPa, acting on a unit element of the shoring system at any depth h, in meters, below the surface of the retained soil, may be estimated from the following equation:

$P = K [\gamma (h - h_w) + \gamma' h_w + q] + \gamma_w h_w$

The above equation considers the hydrostatic pressure in determining the lateral pressure on the wall if continuous wall drains are not provided.

A perimeter drainage system may be constructed to prevent the build-up of any hydrostatic pressure behind the wall. In this case, the following equation is recommended:

$Pa = K (\gamma h + q)$

Where:

γ = the soil unit weight

K = Lateral earth pressure coefficient

K_o = earth pressure coefficient at rest, if wall movement cannot be permitted

K_a = active earth pressure coefficient, if moderate wall movement can be permitted,

K_p = passive earth pressure coefficient

q = is the surcharge load adjacent to the shoring wall

ϕ = is the angle of internal friction of the soil

A summary of the soil parameters is provided in the following Table 4.

Table 4 – Recommended Soil Parameters

Soil Parameters	**ϕ**	**γ(kN/m3)**	**K_a**	**K_o**	**K_p**
Compact sand/silty sand	30	19	0.33	0.5	3.0
Dense sand/silty sand	33	21	0.30	0.45	3.33

6.7 Shoring the Excavated Walls

If the underground excavation extends to the property boundaries, temporary shoring will be required. The following provides our recommendation for the design and construction of the temporary shoring:

1) The shoring system should be designed in accordance with the latest edition of the Canadian Foundation Engineering Manual (CFEM),
2) The design of the temporary shoring system must take into account the presence of underground utilities and services below the adjacent streets as well as proximity of the foundations of the existing structures of adjacent sites, both of which must be protected against lateral or downward movement. If services and/or foundations of adjacent structures are present within the active zone behind the shoring system, appropriate parameters must be considered to avoid any harmful movements,
3) Monitoring the horizontal movement at the top of the shoring is recommended. Monitoring recommendation is discussed in Section 6.7.5.
4) The temporary shoring may consist of caisson walls or soldier piles and a wooden lagging system. The latter is recommended for this project,

5) Groundwater and boulders may encounter during caisson and/or solider pile installation.

The following sections discuss the type of applicable shoring system:

6.7.1 Caisson Wall

1) A caisson wall may be constructed to minimize the underground water seeping into the excavated area,
2) The caisson wall may be constructed by drilling individual caissons along all the excavated sides,
3) We recommend that liners be used in sandy soil below the groundwater table and the caissons be advanced without removal of the soil for several meters below the groundwater table,
4) Soldier piles may be installed in some of the drilled holes as recommended by the shoring engineer,
5) The holes should be filled with concrete using Tremie pipe or equivalent method. The concrete strength must be specified by the shoring designer,
6) The walls of the excavation should be supported by either post-tensioned anchors or tiebacks drilled and grouted into the soil around the excavation by struts. Tiebacks and/or anchors are discussed in section 6.7.3 of this report,
7) If permission to extend anchors into the adjacent properties subsoil is not granted, internal bracing, such as using struts and/or rakers, are other options for supporting the shoring,
8) If rakers are to be used to support the shoring system, they should be designed by the shoring consultant. The raker footings should be designed in accordance with the design principles for foundations subject to inclined loading. Raker foundation should be constructed at depth of not less than 0.50 m below the excavated surface of the underground level. The allowable bearing capacity of the raker foundation should be not more than 150 kPa at the depth of the building foundations. Footings and the foundation material of the rakers should be protected from freezing or deterioration. The rakers should be installed in trenches such that the lateral movement of the retaining wall is limited to an acceptable amount,
9) Similar lateral earth pressure and soil parameters recommended in Section 6.6, may be used for the design of the shoring system,

10) For the design of shoring system, a triangular pressure distribution envelope may be considered for the top third of the shoring system and rectangular pressure distribution envelope may be assumed for the lower two third,
11) The shoring system should be designed by a local design professional experienced in the type of system being proposed,
12) It should be noted that the caisson wall may not provide permanent waterproofing for the underground levels below the groundwater table. Furthermore, the wall should not be considered as a permanent basement wall unless special consideration was considered prior to its construction,
13) Permanent basement walls abutting the caissons wall and incorporating drainage measures should be considered in the construction to obtain relatively dry underground parking below the groundwater table, and
14) The underground wall and the drainage system should be constructed independent of the caisson walls. The underground parking wall and drainage system will be discussed in this report.

6.7.2 Soldier Piles and Wooden Lagging

1) Temporary shoring may also consist of soldier piles and wooden lagging,
2) The soldier piles should be installed in pre-augured holes extended below the deepest excavation. The depth below the deepest excavation must be specified by a shoring designer,
3) If the soldier piles of the shoring system coincide with the line of excavation in the bedrock, the pile should penetrate the bedrock below the bottom of excavation,
4) The shoring system should be supported by anchors, tie back, or rakers as discussed in the construction of the caisson walls **(Section 6.7.1),**
5) The soil parameters recommended in the design of the soldier piles and wooden lagging system can be found in Section 6.6 of this report,
6) The backfilled materials between the shoring system and the excavated sides should be free draining materials, in order to minimize the effect of hydrostatic pressure on the shoring system. Otherwise, the hydrostatic pressure should be added to the lateral earth pressure acting on the system,

7) We recommend the use of geotextile filter cloth on the exposed surface of the lagging boards to prevent/minimize the loss of the soil through the spaces between the boards.

6.7.3 Tiebacks or Anchors

1) The walls of the excavation should be supported by either post-tensioned anchors or tiebacks drilled and grouted into the soil around the excavation,
2) Liners should be used in constructing the anchors or tie backs in sandy soils,
3) The anchors/tie backs may extend to the adjacent properties and roads subsoil,
4) Permission will be required from the owners of the adjacent properties to install the anchors/tie backs,
5) The anchors/tie backs must extend to a length in the soil recommended by Canadian Foundation Manual. A minimum length of 2.5 m beyond the line of 45^{o} drawn from the base of the excavation is recommended,
6) The anchors/tie backs bond depends on the soil property, installation method and grouting properties. For gravity poured concrete, an allowable bond pressure of 40 kPa to 50 kPa is suggested for the compact to dense silty sand/sandy silt soils. An allowable bond pressure of 100 kPa and 250 kPa may be considered for anchors installed in weathered and sound shale respectively. A higher bond pressure may be obtained if a pressurized method of grout installation is used,
7) All anchors should be tested as indicated in Canadian Foundation Engineering Manual (CFEM). At least two (2) anchors in each level should be tested to 200% of the design load in accordance with the current edition of the CFEM in order to verify the capacity of the anchors/tie backs. The design of the working anchors/tie backs should then be modified based on the test results, where necessary. All remaining anchors should be installed following similar procedures and proof tested to 1.33 times the design load.

6.7.4 Lateral Earth Pressure on the Shoring

The recommendations and soil parameters provided in Section 6.6 of this report may be adopted in estimating the lateral earth pressure "P" acting on a unit element of the shoring system at any depth below the surface of the retained.

For the design of the shoring system, a rectangular pressure distribution envelope may be considered, and The shoring system should be designed by a local design professional experienced in the type of system being proposed.

6.7.5 Shoring System Movement (Vertical and Horizontal)

Vertical and horizontal movement of the shoring system are inevitable. The vertical movement will result from the vertical component of the inclined anchor or tie back and surface settlement. The horizontal movement will result from the lateral earth pressure and water pressure. The magnitude of these movements may be minimized/eliminated by proper construction practices. The vertical and horizontal movement will be in the range of 0.1H% to 0.25%H%. However, the actual shoring movement should be determined by the shoring consultant.

Monitoring the vertical and horizontal movement of the shoring system using inclinometer incorporated in the solider piles and/or using total station with targets attached on the soldier piles are recommended to ensure that the movements are within the acceptable range.

Initial readings of these devices should be conducted prior to any excavation activities.

Based on our experience of monitoring the movement using either inclinometer and/or total station with targets, we recommend the measurements be carried out on weekly basis on the early stages of underground construction and then every other week until the completion of the underground levels and backfilling beyond the underground wall.

Monitoring records should be provided continuously to Azure Team and shoring consultant.

We should also be informed immediately for any movement exceeding the recommended limit.

6.8 Elevator Pit

The elevator pit below the slab-on-grade of the underground parking will be constructed in the native soil, weathered shale and/or shale bedrock below the existing groundwater table. We recommend that the pit be designed and constructed as a water-tight structure. The design of the elevator pit should consider the hydrostatic pressure on the pit walls and the uplift pressure acting at the bottom of the pit.

6.9 Underground Retaining Wall

To obtain dry underground parking below the permanent groundwater table and resist the lateral earth and hydrostatic pressure the walls should be designed and constructed abutting the shoring wall and incorporate the drainage system. The permanent drainage will be discussed separately in this report. The lateral earth pressure on the wall may be calculated using the same principle and formula in estimating the lateral earth pressure on the shoring system.

The recommended formula assumes that the perimeter drainage system prevents the buildup of any hydrostatic pressure behind the wall. However, hydrostatic pressure must be considered in determining the lateral pressure on the wall, if continuous wall drains are not provided.

6.10 Lowering the Groundwater Table

Groundwater was encountered at depths ranging between 4.16 m and 4.24 m below the existing ground surface (corresponding to elevations 109.24 m and 108.26 m respectively). The two underground level will extend to an approximate depths of ±6.0 m to ±7 m. Therefore, control of groundwater will be imperative, both during and after construction.

Dewatering the groundwater in sandy soils may be carried out by the installation of caissons/wells in the vicinity of the foundations during construction. The accumulated water may then be pumped out. The wells should be designed and installed by specialized personnel. For foundation constructed on clayey soil, swells along the footing that slope downwards toward a sump may be used. A sump pump may then be used to pump the accumulated water.

If the excavation extends to the bedrock, groundwater entering the excavation through the shoring system may be controlled by constructing ditches to which water can be channeled to sump pits. The accumulated water may then be pumped out using sump pump.

Lowering the groundwater table should be designed by specialized consultant and executed by specialized dewatering contractor. Lowering the groundwater table during underground construction should only be carried to a depth that will not adversely affect the adjacent structure.

6.11 Floor Slab on the Existing Grade

A floor slab on the existing ground surface may be required for development. The ground surface preparation is discussed in Section 6.2. The following is recommended for slab on grade construction:

- The floor slab of the building will mainly be constructed as a conventional slab-on-grade on the native soil, or prepared engineered fill. preparation of the engineered fill is discussed in section 6.2,
- The soils below the existing ground surface are expected to include existing silty sand, sandy silt, clay silt or a mixture of these materials which are considered susceptible to frost. The effect of frost heave is anticipated to be more significant in areas where water is not allowed to drain freely either due to subsoil conditions, site grade, or other factors. A provision for a draining system connected to catch basin should be considered to enhance drainage conditions, and to reduce the effect of frost heave.
- Prior to any slab on grade construction, we recommend the stripping of the top 500 mm of the site soil,
- The subsurface of the exposed subgrade after the removal of the top 500 mm layer should be inspected and compacted to at least 98% of the material standard Proctor Maximum Dry Density “SPMDD”, and proof rolled with a loaded tandem truck. Proof rolling is discussed in Section 6.2.
- Materials placed to raise the final grade and compaction is discussed in Section 6.2,
- A moisture barrier (capillary moisture barrier) should be placed between the underside of the floor slab and exposed soil. It is recommended that the moisture barrier consist of a minimum 200 mm thick layer of Ontario Provincial Standard Specification (OPSS) Granular “A” or 19 mm clear crushed stone compacted to a minimum of 98% of the Standard Proctor Maximum Dry Density (SPMDD),
- Subfloor drainage are not required provided that the building’s slab-on-grade is constructed above the outside grade. Furthermore, the outside ground surface should be graded to direct run-off water away from the building.

6.12 Permanent Drainage for Underground Slab

The underground floor slab will mainly be constructed as a conventional slab-on-grade on the existing native soil and/or weathered/sound shale. The following is recommended for the slab-on-grade construction:

1) A moisture barrier should be placed between the underside of the floor slab and exposed native soil. It is recommended that the moisture barrier consist of a minimum 200 mm thick

layer of Ontario Provincial Standard Specification (OPSS) Granular "A" or 19 mm clear crushed stone compacted to a minimum of 98% of the Standard Proctor Maximum Dry Density (SPMDD),

2) An underfloor and perimeter drainage system should be installed below the slab on-grade to relieve the uplift hydrostatic pressure,
3) The underfloor and perimeter drainage drains should consist of 100 mm diameter perforated "PVC" or weeping tiles surrounded by 150 mm of 19 mm clear stone, having less than 8% passing the 75 micron (No. 200) sieve size. The pipes and the crushed stone should be wrapped with geotextile filter fabric sheets having a filtering opening size (FOS) of 60 microns,
4) We recommend that the under floor drain pipes should be placed parallel to each other with spacing in the range of ±2.5 m. We recommend constructing several sumps distributed along the edges of the underground level. The spacing of the drain pipes and the number and location of the sumps should be determined by dewatering consultant.
5) We recommend to install perimeter pipes with 1 m of the exterior wall to collect water flowing from the wall drain,
6) The underfloor and perimeter drainage should be sloped in one direction toward a frost-free sump/sumps,
7) The accumulated water should be pumped frequently using a sump pumps,
8) If the exposed subgrade below the groundwater table consist of sand, silt or a mixture of these materials, we recommend covering the ground surface below the slab-on-grade with a filter fabric. Class II non-woven textile with filtration opening size of 50 μm to 100 μm is recommended. We further recommend spreading 80 mm medium to coarse sand on top of the filter fabric to prevent the loss of the fines through the filter fabric,
9) The floor slab should be constructed independently of any structural members; e.g., load bearing walls and/or columns,
10) The drainage system should be independent of any storm water piping,
11) Saw cuts should be provided along column lines and closer centers as required, and
12) Pressure relief ports (valves) are recommended for the slab on grade of the underground level. The ports may be constructed by installing trapezoidal shape concrete plug (300 mm

x 300 mm, or other sizes) in the slab on grade. Other materials may also be considered. The recommended spacing between the relief ports is 10 m on-center. However, dewatering and/or hydrologist should determine the spacing of the ports.

13) The City of Mississauga regulations for pumping the water should be followed, and
14) To protect unheated areas and the entrance of the underground parking against frost heave, we recommend the installation of 50 mm thick Styrofoam or equivalent below the slab on grade.

6.13 Permanent Drainage for Underground Wall

The lower portion of the underground wall and floor slab-on-grade will most likely lie below the permanent ground water table. Therefore, to avoid the buildup of hydrostatic pressure on the underground wall and keep the floor slab dry, the following is recommended:

1) The exterior underground walls should be positively water-proofed with a perimeter and vertical drainage system,
2) The exterior underground wall drain may be accomplished with the installation of dimpled core membrane sheets between the shoring system and the underground wall. The drainage membrane sheets are installed vertically and nailed to the shoring walls (caissons or the wood lagging walls). Since groundwater table fluctuates, it is recommended that the drainage membranes are installed continuously over the shoring walls extending down from at least 2 m above the stabilized groundwater table,
3) Additional waterproofing layer between the core drainage membraned and the underground wall is recommended as an extra protection,
4) Drainage ports or "PVC" pipes through the walls should be installed at the base of the drainage strip, to allow drainage to under floor weeping tile located on interior side of the wall. The recommended spacing of the drainage ports/PVC pipes is 2.4 m,
5) The ends of the PVC pipes should be covered by textile or polyethylene sheeting, to prevent ingress of concrete during placing the concrete,
6) The underfloor drain was discussed in section 6.12,

6.14 Suitability of Site Material for Reuse

The fill and native soils are considered suitable for backfilling the trenches provided that the moisture content is within the optimum content of 2%, and these activities are not undertaken in wet or freezing conditions. However, these materials are not suitable for reuse as new base/subbase materials below the pavement. Deleterious material, if any, should be removed prior to reuse on site. The use of these materials is subject to a geotechnical engineer approval.

6.15 Recommendation for Sewer Bedding and Trench Backfilling

- Pipe bedding and backfill material specifications and compaction criteria for water and sewer services should be in accordance with the pipe designer's recommendations and/or local municipal requirements,
- The subgrade of the sewer should consist of sound native soil, or properly compacted fill materials free of organic and/or deleterious materials. If the bottom of the trench at the required pipe grade is found to be unstable or include organics materials, the unsuitable materials should be removed and replaced with approved materials prior to any pipe installation,
- The exposed trench bottom shall be compacted to a minimum of 95% of the materials Standard Proctor Maximum Dry Density (SPMDD). OPSS Granular B is recommended for the backfilling the excavated trench. The backfilling operation should be carried out in lifts not exceeding 150 mm in the loose state compacted to 98% of the materials SPMDD,
- Sandy layer of minimum thickness of 50 mm should be placed below the sewers as a leveling pad. The leveling pad will make the pipe foundation more rigid, reduce the detrimental effect of differential settlement and provide working platform to facilitate the construction off the sewers. The levelling pad should spread the full width of the trench bottom,
- After preparation of the trench base, a pipe bedding of a minimum thickness of 150 mm shall be placed using crushed stone or crushed gravel, meeting OPSS Granular "A" material compacted to 98% of the materials SPMDD,
- All trench excavations shall be backfilled immediately after the sewers are laid. The backfilling operation should be carried out on both sides of the sewer and shall be manually compacted simultaneously. At no time shall the levels of each side differ by more than 100 mm un-compacted. Approved granular materials should be used for backfilling. The granular materials should extend to a minimum of 300 mm above the top of pipe. Backfill materials shall be placed in uniform layers not exceeding 150 mm in thickness for the full width of the trench and compacted manually,

- Backfilling above the 300 mm should be placed in uniform thickness of 150 mm compacted to 98% of the materials SPMDD to eliminate the possibility of settlement, pipe misalignment, or damage to the joints,
- In the event that the sewer and/or water main are located below the groundwater, the excavated trench should be dewatered and any loose/soft, saturated soil that exist at the bottom of the trench should be removed. From 300 mm above the pipe crest to the surface, granular materials may be used as backfill materials. The site materials encountered below the topsoil or the ground surface may also be used provided that the materials are free from organics and other deleterious materials,
- Backfill materials shall be placed to a minimum of 900 mm above the crown of the sewer before any power operated tractor or rolling equipment are used for compaction.
- To eliminate pipe floatation when the trench is deluged with water, we recommend to backfill the trench to a thickness of not less than 1.2 m immediately after pipe insallation.
- Water lines installed outside of heated areas should be provided with a minimum of 1.5-meter soil cover or equivalent for frost protection,
- In normal sewer construction, the problem of road settlement largely occurs adjacent to manholes or catch basin. In areas which are inaccessible to heavy compaction equipment, additional compactive effort with smaller equipment is warranted,
- Fill materials imported to the site must meet all applicable municipal, provincial, and federal guidelines and regulations associated with environmental characterization of the material. The materials preparation and compaction of bedding layer, the pipe installation should be in accordance with the current revision of OPSS 1010, OPSS 401, OPSS 501, OPSS410, OPSD 902.032, OPSD 803.030 and OPSD 803.031.

6.16 Foundation Walls Backfilling

All foundations and foundations trenches should be backfilled with granular materials. The backfilled materials should be compacted in 150 mm thick loose lifts to a minimum pf 98% of the materials SPMDD using plate vibrator compactor. The backfilling process should be carried out on both sides of the walls simultaneously.

6.17 Winter Construction

When construction is undertaken during periods of inclement weather, or when freeze-thaw affects are a concern, the backfilling procedures should consider the following comments:

- The preferred backfill material during periods of inclement weather is OPPS Granular B Type 1,
- Areas of intended backfill should be clearly identified in the field prior to commencing the work,
- Fill placement should be inspected by qualified field personnel under the supervision of a geotechnical engineer,
- Imported materials that contain ice, snow, or any frozen materials should not be accepted for use,
- Overnight frost penetration into the existing subgrade or the fill layer should be prevented by using insulation blankets. Alternatively, the frozen fill can be removed prior to placing subsequent lifts. Approaches such as breaking the frost in-situ is not considered acceptable, and
- During periods of cold, where ambient temperature is -5° or less, placement of engineered fill should stop and the existing fill materials should be protected from freezing.

6.18 Pavement Design for Asphalt Concrete

Flexible asphalt pavement is recommended for the parking areas and site access roads. Flexible pavement consists of a prepared roadbed (subgrade) underlying layers of subbase, base, and surface courses (pavement structure).

Prior to pavement structure construction, we recommend the pavement subgrade should be prepared as noted below:

Pavement Subgrade: pavement subgrade can consist of the engineered fill or the native soils encountered at the site. The topsoil and the underlying fill soil to a depth of not less than 500 mm below the existing ground surface should be removed. Any soft, lose or unstable materials should also be removed. The exposed surface should be compacted to at least 98% of the SPMDD and proof-rolled with a loaded tandem truck as discussed in section 6.2.

Sub-grade up-fill should be compacted to at least 98% of the SPMDD, at or below the optimum moisture content (OMC) in lifts not exceeding 150 mm in thickness. Any materials that has moisture content higher than 3% of its OMC should be dried out.

The granular sub-base: the granular sub-base is the portion of the flexible pavement structure between the roadbed (subgrade) and the base course, and is used to increase the structural capacity, raise pavement layers above the frost line, or provide a levelling course for the placement of base layers. Granular "B" may be used for sub-base construction. The sub-base layer should be placed on prepared subgrade.

Granular Base: the granular base is the portion of the pavement structure immediately beneath the surface course. It is constructed with high quality aggregates. The base materials consist of 100% aggregate materials. These materials consist of durable particles of gravel and sand or crushed rock, crushed gravel and sand. Recycled aggregates may also be used for base construction. Geotechnical engineer should be consulted prior the use of the recycled materials.

The production, gradation and placement of granular materials (base and sub-base) shall be in accordance with applicable OPSS requirements. The granular base and sub-base layers should be compacted to at least 100% of the SPMDD.

In the extreme cases, such as during the wet season, the top 600 mm of the subgrade may have to be replaced by compacted granular material in order to compensate for the inadequate strength of the wet sub-grade.

Pavement Surface: the surface course of a flexible pavement structure consists of a mixture of mineral aggregates and bituminous materials placed as the upper course and usually constructed on a base course. The pavement surface must be constructed to a higher standard than other layers in the pavement structure. The materials most commonly used for pavement surfacing are the asphalt/bituminous mixtures.

Based on City of Mississauga pavement design standards, following heavy duty minimum asphalt pavement structure is recommended for the proposed developments in Table 5.

Table 5: Pavement Structure for the Driveways and Parking Areas

Description	Heavy duty	Materials
Asphalt Surface Course (HL3)	40 mm	Hot Mix Asphalt
Asphalt Base Course (HL8)	65 mm	Hot Mix Asphalt
Granular Base	200 mm	19 mm CRL or Granular A
Granular Sub-Base Course	250 mm	50 mm Crushed Limestone or Granular B Type II

CRL = Crusher Run Limestone

The recommended compaction level for each layer is provided in Table 6.

Table 6: Compaction Recommendation for Pavement Layers

Pavement Layer	Compaction Level
Asphalt Surface Course (HL3)	92.0 -96.5% MRD
Asphalt Base Course (HL8)	92.0 – 96.5% MRD
OPSS Granular “A” or 20 mm CRL (Granular Base)	100% SPMDD
OPSS Granular “B” Type II or 50 mm CRL (Granular Sub-base)	100% SPMDD

MRD = Marshall Relative Density

SPMDD = Standard Proctor Maximum Dry Density

Notes

1. The pavement surface and subgrade should be graded to direct run-off water away from the roadway, parking areas and associated infrastructure.
2. We recommend the installation of sub-drains pipes along the perimeter of the pavement and throughout low areas to prevent infiltration and accumulation of surface run-off water in the pavement structure. The sub-drain pipes should be placed parallel to each other and sloped downward toward the adjacent areas or swells,
3. Construction trucks and equipment should be kept off the newly constructed parking area and driveways before the placement of asphalt layer.

The discussion and recommendations as presented represent the best judgment of the inspector based on the visual observations of the accessible property elements of the Site and adjacent properties observed. Should additional information become available, Azure Group Inc. requests that this information be brought to our attention so that we may reassess the conclusions presented herein.

Respectfully Submitted,

AZURE GROUP INC.

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7.0 LIMITATIONS OF REPORT

This report was prepared by Azure Group Inc. for the account of Mr. Francesco Bertoia of DVB Real Estate Investment Inc. and for review by its designated agents and financial institutions and government agencies. The material in it reflects the judgement of Mr. Ahmed Al-Temimi, M.Sc., P.Eng. QP(ESA), in light of the information available to it at the time of preparation.

The report may not be relied upon by any other person or entity without the express written consent of Azure Group Inc. and the Client. Any use that a third party makes of this report, or any reliance on decisions made based on it, is the responsibility of such third parties. Azure Group Inc. accepts no responsibility for damages, if any, suffered by any party as a result of decisions made or actions based on this report.

One must understand that the mandate of Azure Group Inc. is to obtain readily available past and present information pertinent to the subject site for a Geotechnical Investigation only. No other warranty or representation, expressed or implied, as to the accuracy of the information is included or intended by this investigation. Azure Group Inc. makes no other representation whatsoever, including those concerning the legal significance of its findings or as to the other legal matters addressed incidentally in this report, including but not limited to, ownership of any property, or the application of any law to the facts set forth herein. With respect to regulatory compliance issues, regulatory statutes are subject to interpretation. These interpretations may change over time; thus the Client should review such issues with appropriate legal counsel.

It should be noted that the information supplied in this report is not be sufficient to obtain approval for disposal of excess soil or materials generated during construction. The geotechnical site characterization is a limited sampling of a site and it does not include any chemical testing. Some of the information presented in this report was provided through existing documents and by third parties. Although attempts were made, whenever possible, to obtain a minimum of two confirmatory sources of information, Azure Group Inc. in certain instances has been required to assume that this information provided is accurate. Due to the nature of the investigation and the limited data available, Azure Group Inc. cannot warrant against undiscovered geotechnical liabilities. No other warranty or representation, either expressed or implied, is included or intended in this report.

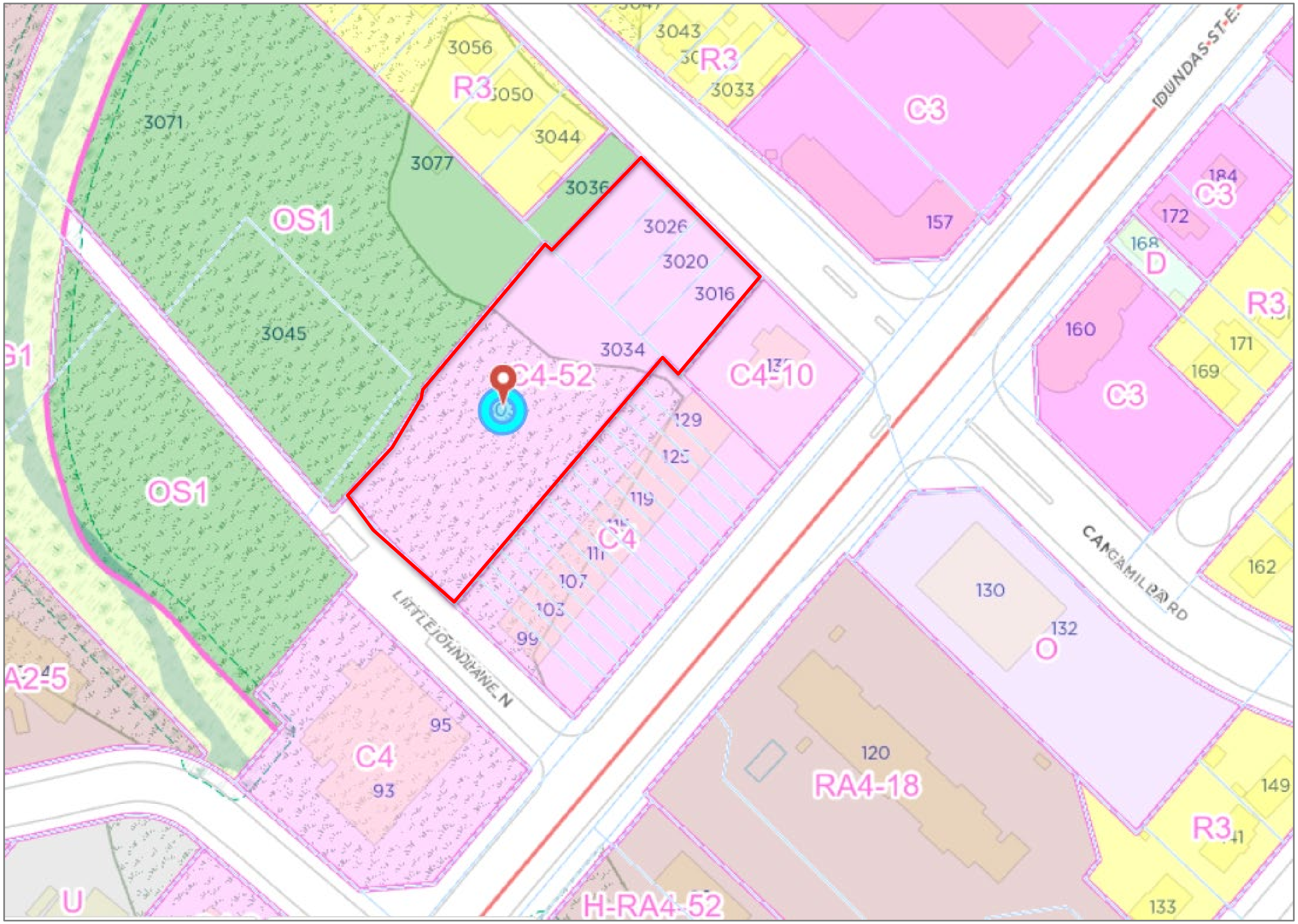
APPENDIX A

FIGURES

0 20 40m

Subject Property

Title	Project:	Project No.	Scale:	Date:	Figure No.
Site Location Plan	3016, 3020, 3026 & 3032 Kirwin Avenue and 3031 Littlejohn Lane City of Mississauga, Ontario	2202-001	As drawn	April, 2022	1

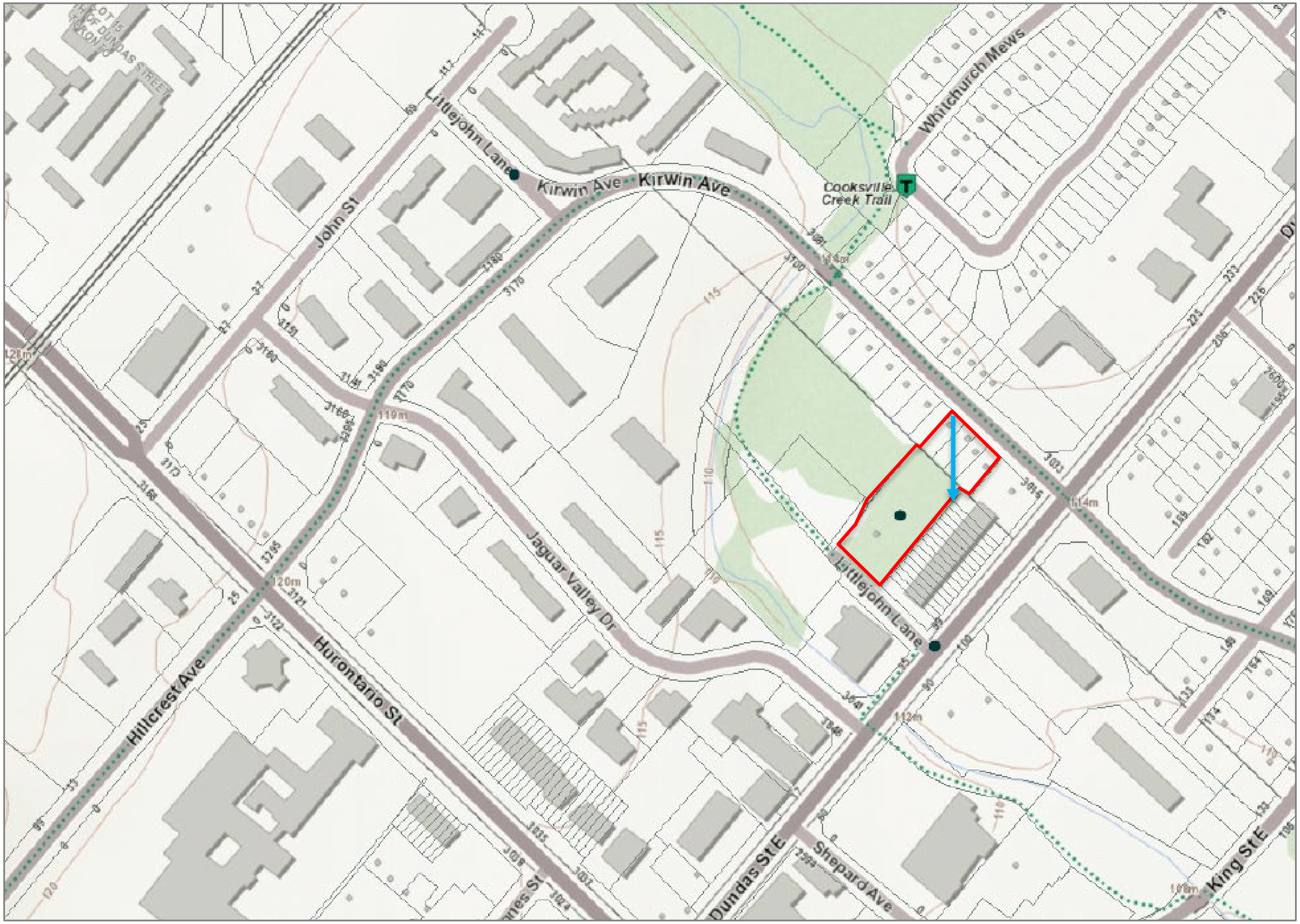


Subject Property

0 20 40m

Source: City of Mississauga Interactive Zoning Map

Title	Project:	Project No.	Scale:	Date:	Figure No.
Zoning Map	3016, 3020, 3026 & 3032 Kirwin Avenue and 3031 Littlejohn Lane City of Mississauga, Ontario	2202-001	As drawn	April, 2022	2



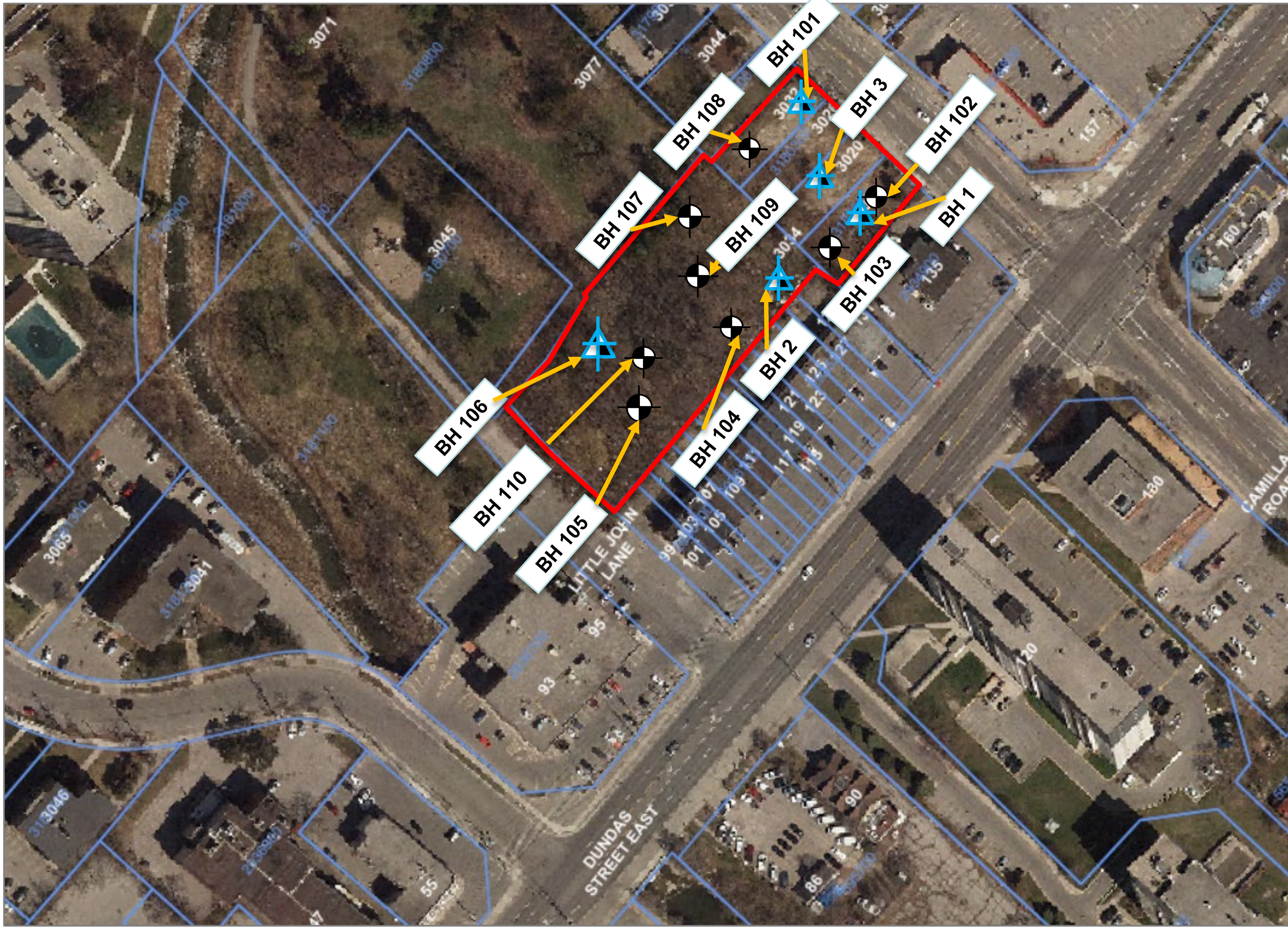
Subject Property

Inferred Groundwater Flow Direction

0 50 100m

Source: Ontario Make a Topographic Map
© 2020 Ontario Ministry of Natural Resources and Forestry

Title	Project:	Project No.	Scale:	Date:	Figure No.
Topographic Map	3016, 3020, 3026 & 3032 Kirwin Avenue and 3031 Littlejohn Lane City of Mississauga, Ontario	2202-001	As drawn	April, 2022	3



Approximate location Subject Property

Approximate Location of Monitoring Well

0 20 40m

Approximate location of Boreholes

Source: City of Mississauga Interactive Maps
© 2022 City of Mississauga

Title	Project:	Project No.	Scale:	Date:	Figure No.
Borehole Location Plan	3016, 3020, 3026 & 3032 Kirwin Avenue and 3031 Littlejohn Lane City of Mississauga, Ontario	2202-001	As drawn	April, 2022	4

APPENDIX B

BOREHOLE LOG

AZURE GROUP **DRAWING NO. 2**

JOB NUMBER 2202-001 **BH(MW)101**

PROJECT LOCATION: 3016 – 3032 Kirwin Avenue & 3031 Little John Lane, Mississauga, Ontario

Client: Black Creek Group

C_u = Shear Strength (kPa) | *G%= Gravel, S% = Sand, F% = Fines (Silt and Clay), M = Moisture Content*

Temperature: 5°C

Started/Date April 1, 2022 Time: 8.55 am Sheet 1 of 1

Finished/Date April 1, 2022 Time: 5:30 pm

Azure Rep: Amit Pal Auger Type: 150 mm Open

G. S. El: 113.399 m G.W. Depth: 5.4 m G.W. Elevation: 107.13 m April 13, 2022 Time: 1 pm

Depth/Elev. (m)		Soil Description	Type/No		N	C_u (kPa)	G.W.T	Remark
0	113.4	250 mm Topsoil Soft to firm dark brown silty clay/clayey silt trace sand, gravel, and organics	SS	1	6			
.75	112.7		SS	2	5			
1.5	111.9		SS	3	5			
2.25	111.2	Compact SILTY SAND/SANDY SILT trace gravel, moist below 2.2 m	SS	4	37			
3.0	110.4	Loose below 3.0 m, wet	SS	5	36			
4.6	108.8	Stiff to very grayish brown stiff SILTY CLAY/CLAYEY SILT trace sand and gravel, wet below 4.0 m	SS	6	19		4.71m	
6.1	107.9	Hard grey CLAYEY SILT trace to some shale fragments below 6.0 m	SS	7	55			
7.6	105.8		SS	8	>80			
8.2	105.2	Refusal at 8.2 m			>80			

EOB

AZURE GROUP **DRAWING NO. 3**

JOB NUMBER 2202-001 **BH102**

PROJECT LOCATION: 3016 – 3032 Kirwin Avenue & 3031 Little John Lane, Mississauga, Ontario

Client: Black Creek Group

C_u = Shear Strength (kPa)	***G%= Gravel, S% = Sand, F% = Fines (Silt and Clay), M = Moisture Content***

Temperature: 5°C

Started/Date	**April 8, 2022**	**Time: 8.55 am**	**Sheet 1**	**of 1**
Finished/Date	**April 8, 2022**	**Time: 5:30 pm**		
Azure Rep: Amit Pal		**Auger Type: 150 mm Open**		
G. S. El: 113.094 m	**G.W. Depth:**	**G.W. Elevation:**	**Time:**	

Depth/Elev. (m)		Soil Description	Type/No		N	C_u (kPa)	G.W.T	Remark
0	113.1	250 mm Topsoil Soft to firm dark brown silty clay/clayey silt trace sand, gravel, and organics, moist	SS	1	8			
.75	112.4	Trace gravel, possible cobbles, moist below 0.7 m	SS	2	8			
1.5	111.6	Compact SILTY SAND/SANDY SILT trace gravel, moist below 1.8 m	SS	3	15			
2.25	110.9	Very dense SAND & GRAVEL below 2.2 m, moist (possible boulder)	SS	4	>80			
3.0	110.1	Very dense SAND & GRAVEL, moist below 3.0 m, possible cobbles	SS	5	66			
4.6	108.5	Compact SAND & GRAVEL trace clay, wet below 4.0 m	SS	6	22			
6.1	105.5	Hard grey SILTY CLAY/CLAYEY SILT trace shale fragments, wet below 6.0 m	SS	7	52			
7.6	105.5	Hard grey SILTY CLAY/CLAYEY SILT with SHALE fragments below 7.0 m Hard weathered shale Below 9.0 M	SS	8	>80			
9.8	103.3	Refusal at 9.8 m	SS	9.8	>80			

EOB

AZURE GROUP

DRAWING NO. 4

JOB NUMBER 2202-001

BH103

PROJECT LOCATION: 3016 – 3032 Kirwin Avenue & 3031 Little John Lane, Mississauga, Ontario

Client: Black Creek Group

C_u = Shear Strength (kPa) | *G%= Gravel, S% = Sand, F% = Fines (Silt and Clay), M = Moisture Content*

Temperature: 5°C

Started/Date April 8, 2022 Time: 4.45 am Sheet 1 of 1
Finished/Date April 8, 2022 Time: 6:30 pm
Azure Rep: Amit Pal Auger Type: 150 mm Open
G. S. El: 112.5 m G.W. Depth: G.W. Elevation: Time:

Depth (m)	Elev. (m)	Soil Description	Type	No	N	C_u (kPa)	G.W.T	Remark
0	112.5	250 mm Topsoil Dark brown silty clay/clayey silt trace sand, gravel, and organics	AS	1				
.75	111.8		AS	2				
1.5	111.0		AS	3				
2.25	110.3	SILTY SAND/SANDY SILT trace gravel, moist below 2.2 m	AS	4				
3.0	109.5		AS	5				
4.6	107.9	Stiff to very stiff SILTY CLAY/CLAYEY SILT trace sand and gravel, wet below 4.0 m	SS	6				
6.1	106.4	Hard CLAYEY SILT/SILTY CLAY trace gravel, wet below 6.0 m	SS	7	50			
7.6	104.9	Hard CLAYEY SILT/SILT below 7.0 m	SS	8	>80			
9.2	103.3	Refusal at 8.2 m	SS	9	>80			

EOB

AZURE GROUP

DRAWING NO. 5

JOB NUMBER 2202-001

BH104

PROJECT LOCATION: 3016 – 3032 Kirwin Avenue & 3031 Little John Lane, Mississauga, Ontario

Client: Black Creek Group

C_u = Shear Strength (kPa) | *G%= Gravel, S% = Sand, F% = Fines (Silt and Clay), M = Moisture Content*

Temperature: 5°C

Started/Date April 7, 2022 **Time: 3.10 am** **Sheet 1 of 1**
Finished/Date April 7, 2022 **Time: 6:30 pm**
Azure Rep: Amit Pal **Auger Type: 150 mm Open**
G. S. El: 112.1 m **G.W. Depth:** **G.W. Elevation:** **Time:**

Depth/Elev. (m)		Soil Description	Type/No		N	C_u (kPa)	G.W.T	Remark
0	112.1	250 mm Topsoil Dark brown silty sand/sandy silt trace clay, gravel, and organics	AS	1				
.75	111.4	Dark brown SILTY CLAY trace gravel and organics below 0.7 m	AS	2				
1.5	110.6	Light brown CLAYEY SILT trace gravel below 1.5 m	AS	3				
2.25	109.9	SILTY CLAY/CLAYEY SILT, trace gravel, wet below 2.2 m	AS	4				
3.0	109.1	Hard CLAYEY SILT/SILTY CLAY below 3.0 m	AS	5				
4.6	107.5		AS	6				
6.1	106.0	Hard grey CLAYEY SILT/SILTY trace sand and gravel, wet below 6.0 m	SS	7	>80			
7.6	104.5		SS	7	>80			
9.2	102.9		SS	8	>80			
9.8	102.3	Hard CLAYEY SILT with SHALE trace gravel below 9. M Refusal at 9.8 m	SS	9	>80			

EOB

AZURE GROUP **DRAWING NO. 6**

JOB NUMBER 2202-001 **BH105**

PROJECT LOCATION: 3016 – 3032 Kirwin Avenue & 3031 Little John Lane, Mississauga, Ontario

Client: Black Creek Group

C_u = Shear Strength (kPa) | *G%= Gravel, S% = Sand, F% = Fines (Silt and Clay), M = Moisture Content*

Temperature: 5°C

Started/Date April 8, 2022 Time: Sheet 1 of 1
Finished/Date April 8, 2022 Time:
Azure Rep: Amit Pal Auger Type: 150 mm Open
G. S. El: 110.8 m G.W. Depth: G.W. Elevation: Time:

Depth/Elev. (m)		Soil Description	Type/No			C_u (kPa)	G.W.T	Remark
0	110.8	250 mm Topsoil Dark brown silty sand/sandy silt trace clay, gravel, and organics	AS	1				
.75	110.1	Sand trace clay and gravel below 0.75 m, moist to wet	AS	2				
1.5	109.3	SAND/SILTY SAND trace clay & GRAVEL, Wet below 1.5 m	AS	3				
2.25	108.6		AS	4				
3.0	107.8		AS	5				
4.6	106.2	Grey CLAYEY SILT, SILT trace sands below 4.6 m, wet	AS	6				
6.1	104.7	Very dense SILTY SAND/SANDY SILT trace Gravel and clay, wet below 6.0 m	SS	7	>80			
7.6	103.2		SS	8	>80			
9.2	101.6	Hard CLAYEY SILT with weathered SHALE below 9.0 m	SS	9	>80			
9.8	101.0	Refusal at 9.8 m	SS	10	>80			

EOB

AZURE GROUP

DRAWING NO. 7

JOB NUMBER 2202-001

BH(MW)106

PROJECT LOCATION: 3016 – 3032 Kirwin Avenue & 3031 Little John Lane, Mississauga, Ontario

Client: Black Creek Group

C_u = Shear Strength (kPa)	G%= Gravel, S% = Sand, F% = Fines (Silt and Clay), M = Moisture Content

Temperature: 5°C

Started/Date	April 8, 2022	Time:		Sheet 1	of 1
Finished/Date	April 8, 2022	Time:			
Azure Rep: Amit Pal		Auger Type: 150 mm Open			
G. S. El: 110.78 m	G.W. Depth: 2.69 m	G.W. Elevation: 108.09 m		Time:	

Depth/Elev. (m)		Soil Description	Type/No		N	C_u (kPa)	G.W.T	Remark
0	110.8	250 mm Topsoil Dark brown SILTY SAND/SANDY SILT trace clay, gravel, and organics	SS	1				
.75	110.1		SS	2				
1.5	109.3	CLAYEY SILT trace clay & GRAVEL, Wet below 1.5 m	SS	3				
2.25	108.6		SS	4				
							2.95m	
3.0	107.8		SS	5				
4.6	106.2	Grey CLAYEY SILT trace gravel below, wet below 4.6 m	SS	6		225.0		
6.1	104.7	Hard grey CLAYEY SILT trace to some shale fragments, wet below 6.0 m	SS	7	>80	225.0		
7.6	103.2		SS	8	>80	225.0		
9.2	101.6	Hard grey CLAYEY SILT with weathered SHALE below 9.0 m, wet	SS	9	>80			
9.8	101.0	Refusal at 9.8 m	SS	10	>80			

EOB

AZURE GROUP **DRAWING NO. 8**

JOB NUMBER 2202-001 **BH(MW)107**

PROJECT LOCATION: 3016 – 3032 Kirwin Avenue & 3031 Little John Lane, Mississauga, Ontario

Client: Black Creek Group

C_u = Shear Strength (kPa)	*G%= Gravel, S% = Sand, F% = Fines (Silt and Clay), M = Moisture Content*

Temperature: 5°C

Started/Date	April 8, 2022	Time: 11:45	Sheet 1 of 1
Finished/Date	April 8, 2022	Time:	
Azure Rep: Amit Pal		Auger Type: 150 mm Open	
G. S. El: 113.26 m	G.W. Depth:	G.W. Elevation:	Time:

Depth/Elev. (m)		Soil Description	Type/No		N	C_u (kPa)	G.W.T	Remark
0	113.3	50 mm Asphalt Loose to very loose dark brown silty sand/sandy silt trace to some organics, gravel, and clay, moist	SS	1	5			
.75	112.6		SS	2	7			
1.5	111.8	Compact below 1.5 m	SS	3	18			
2.25	111.1	Very dense below 2.2 m , possible boulders	SS	4	80			
3.0	110.3	Dense below 3.0 m, wet	SS	5	43			
4.6	108.7	Dense SILTY SAND/SAND possible boulders, wet below 4.0 m	SS	6	47			
6.1	107.2	Hard grey SILTY CLAY/CLAYEY SILT trace gravel, wet below 5.0 m	SS	7	47			
7.6	105.7	Hard grey weathered SHALE with hard SILTY CLAY	SS	8	>80			
9.2	104.1	Grey Weathered SHALE below 9.2 m	SS	9	>80			
10.7	102.6		SS	10	>80			
11.0	102.3	Refusal at 7.8 m	SS	11	>80			

EOB

AZURE GROUP

DRAWING NO. 9

JOB NUMBER 2202-001

BH108

PROJECT LOCATION: 3016 – 3032 Kirwin Avenue & 3031 Little John Lane, Mississauga, Ontario

Client: Black Creek Group

C_u = Shear Strength (kPa) | ***G%= Gravel, S% = Sand, F% = Fines (Silt and Clay), M = Moisture Content***

Temperature: 5°C

Started/Date April 8, 2022 **Time:** 8:00 am **Sheet 1 of 1**
Finished/Date April 8, 2022 **Time:**
Azure Rep: Amit Pal **Auger Type:** 150 mm Open
G. S. El: 113.28 m **G.W. Depth:** **G.W. Elevation:** **Time:**

Depth/Elev. (m)		Soil Description	Type/No		N	C_u (kPa)	G.W.T	Remark
0	113.3	250 mm Topsoil Dark brown SILTY SAND/SANDY SILT trace clay, gravel, and organics	AS	1				
.75	112.6		AS	2				
1.5	111.8	Light brown SILTY SAND, trace clay and gravel, moist below 1.5 m,	AS	3	7			
2.25	111.1		AS	4				
3.0	110.3	Brown SILTY SAND with GRAVEL, moist below 3.0 m	AS	5	28			
4.6	108.7	Light brown SILTY SANDY/SANDY SILT trace to some clay and gravel, moist below 4.0 m	AS	6	25			
6.1	107.2	Hard CLAYEY SILTSILTY CLAY trace to some shale fragments, wet below 6.0 m	SS	7	45			
7.6	105.7	Grey weathered SHALE with SILTY CLAY trace gravel, moist below 7.0 m	SS	8	75			
9.2	104.1	Grey weathered SHALE with SILTY CLAY trace gravel, moist below 9.0 m	SS	9	>80			
10.7	102.6		SS	10	>80			
11.3	102.0	Refusal at 11.3 m	SS	11	>80			

EOB

AZURE GROUP **DRAWING NO. 10**

JOB NUMBER 2202-001 **BH109**

PROJECT LOCATION: 3016 – 3032 Kirwin Avenue & 3031 Little John Lane, Mississauga, Ontario

Client: Black Creek Group

C_u = Shear Strength (kPa) | *G%= Gravel, S% = Sand, F% = Fines (Silt and Clay), M = Moisture Content*

Temperature: 5°C

Started/Date	April 8, 2022	Time: 8:50 am	Sheet 1 of 1
Finished/Date	April 8, 2022	Time:	
Azure Rep: Amit Pal		Auger Type: 150 mm Open	
G. S. El: 112.5 m	G.W. Depth:	G.W. Elevation:	Time:

Depth/Elev. (m)		Soil Description	Type/No		N	C_u (kPa)	G.W.T	Remark
0	112.5	250 mm Topsoil Dark brown SILTY SAND/SANDY SILT trace clay, gravel, and organics	AS					
.75	111.8		AS					
1.5	111.0	CLAYEY SILT trace clay & gravel, wet below 1.5 m	AS					
2.25	110.3		AS					
3.0	109.5		AS					
4.6	109.5	Grey CLAYEY SILT trace gravel below 4.6 m, wet below 4.0 m	AS					
6.1	106.4	Hard CLAYEY SILT/SILTY CLAY trace shale fragments, wet below 6.0 m	SS		>80			
7.6	104.9		SS		>80			
9.2	103.3	Hard CLAYEY SILT with weathered SHALE below 9.0 m, wet	SS		>80			
9.8	102.7	Refusal at 9.8 m	SS		>80			

EOB

AZURE GROUP **DRAWING NO. 11**

JOB NUMBER 2202-001 **BH110**

PROJECT LOCATION: 3016 – 3032 Kirwin Avenue & 3031 Little John Lane, Mississauga, Ontario

Client: Black Creek Group

C_u = Shear Strength (kPa) | *G%= Gravel, S% = Sand, F% = Fines (Silt and Clay), M = Moisture Content*

Temperature: 5°C

Started/Date	April 8, 2022	Time:	Sheet 1 of 1
Finished/Date	April 8, 2022	Time:	
Azure Rep: Amit Pal		Auger Type: 150 mm Open	
G. S. El: 110.88 m	G.W. Depth:	G.W. Elevation:	Time:

Depth (m)	Elev. (m)	Soil Description	Type	No	N	C_u (kPa)	G.W.T	Remark
0	110.9	250 mm Topsoil Dark brown SILTY SAND/SANDY SILT trace clay, gravel, and organics	AS	1				
.75	110.2		AS	2				
1.5	109.4	CLAYEY SILT trace sand & gravel, wet below 1.5 m	AS	3				
2.25	108.7		AS	4				
3.0	107.9	SILTY SAND/SANDY SILT, wet below 3.0 m	AS	5				
4.6	106.3	Grey CLAYEY SILT trace gravel below 4.6 m, wet below 4.0 m	AS	6		225.0		
6.1	104.8	Hard CLAYEY SILT trace to some gravels, wet below 6.0 m	SS	7	>80	225.0		
7.6	103.3	Hard grey CLAYEY SILT trace shale fragments below 7.5 m	SS	8	>80			
9.2	101.7	Hard grey CLAYEY SILT with weathered SHALE below 9.0 m, wet	SS	9	>80			
9.8	101.1	Refusal at 9.8 m	SS	10	>80			

EOB

APPENDIX C

GRAIN SIZE DISTRIBUTION GRAPHS

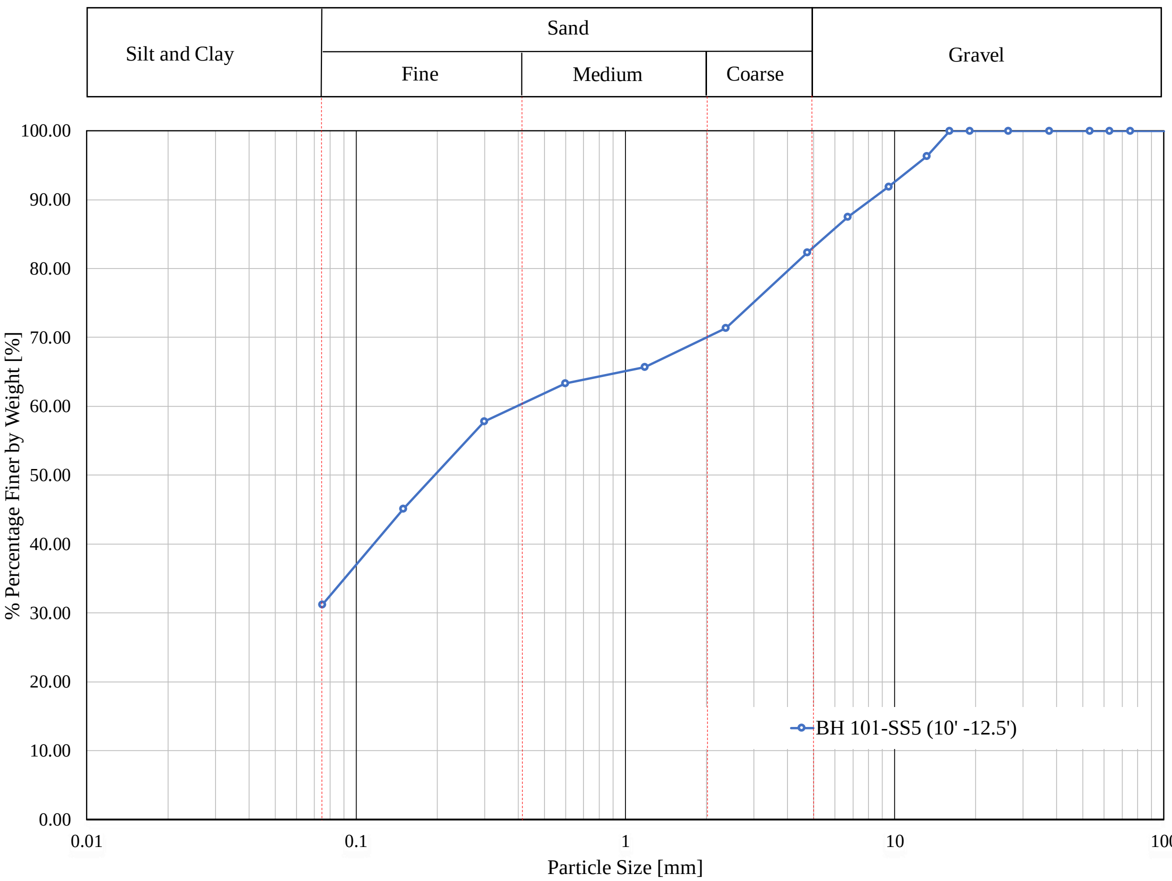
McINTOSH PERRY

JOB NO.	2202-001 (CCC-213999-00)
DRAWING NO.	

CLIENT : Azure Group

LOCATION : 3034 Kirwin Ave., Mississauga

DATE : May 4, 2022



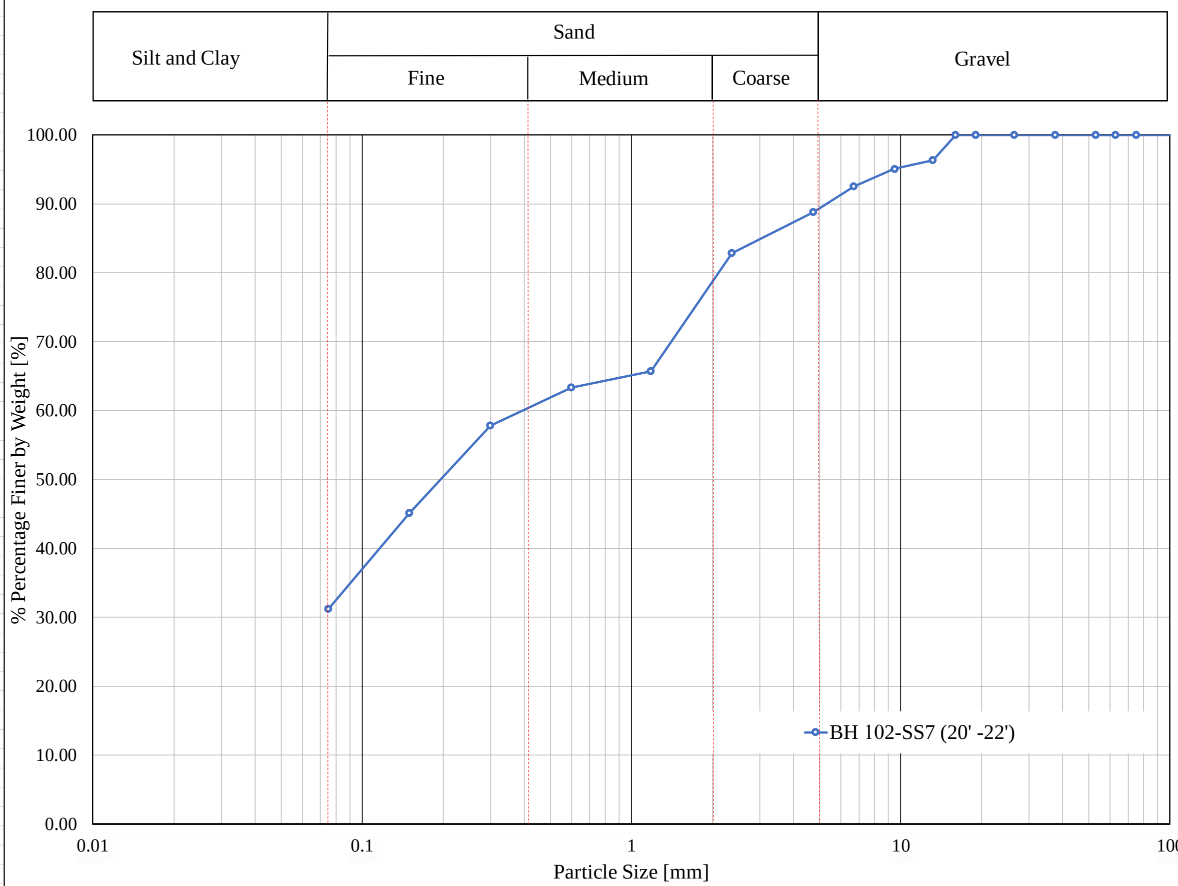
Sample	Percent Gravel [%]	Percent sand [%]	Percent Silt and Clay [%]	Moisture Content [%]
BH 101-SS5 (10' -12.5') Brown Gravelly Silty Sand	17.63%	63.36%	19.01%	5.92%

McINTOSH PERRY

McINTOSH PERRY

JOB NO.	2202-001 (CCC-213999-00)
DRAWING NO.	

CLIENT :	Azure Group
LOCATION :	3034 Kirwin Ave., Mississauga
DATE :	May 4, 2022

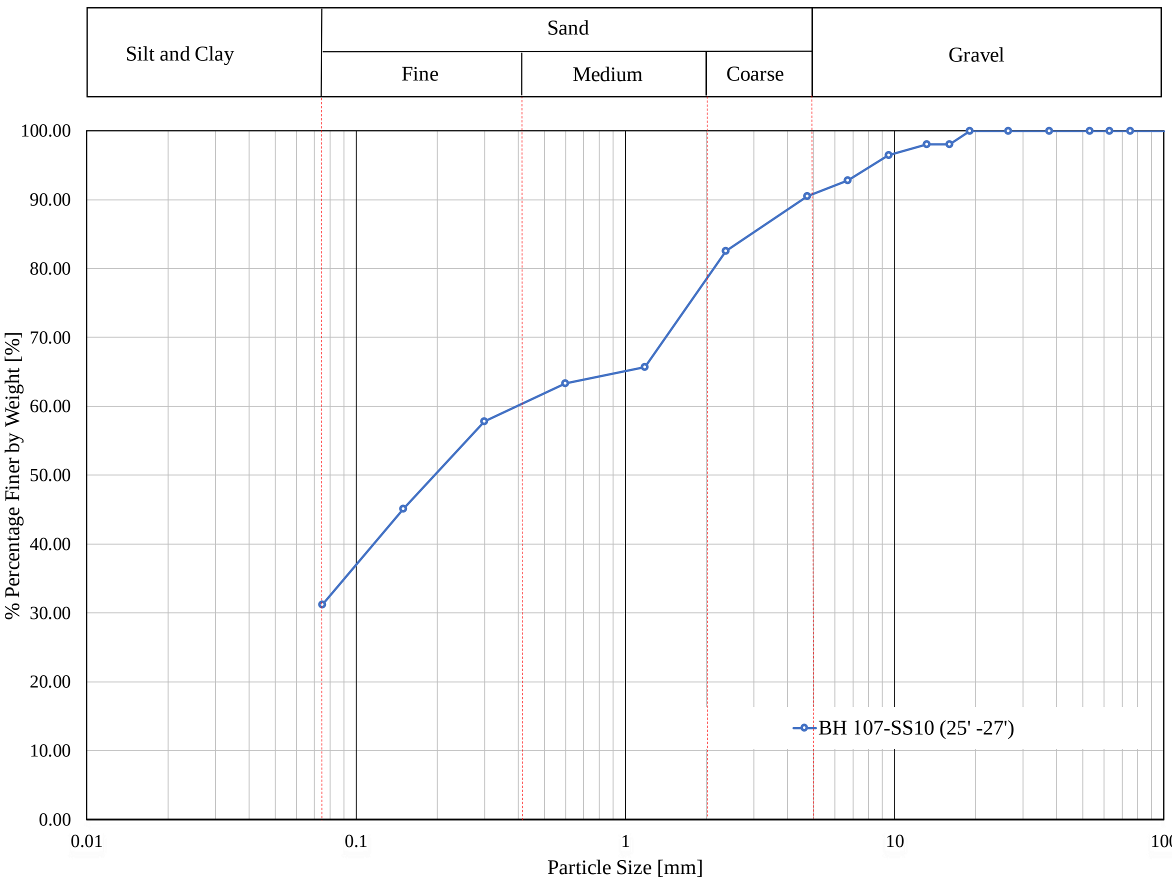


Sample	Percent Gravel [%]	Percent sand [%]	Percent Silt and Clay [%]	Moisture Content [%]
BH 102-SS7 (20' -22') Grey weathered shale	11.19%	30.89%	57.92%	8.39%

McINTOSH PERRY

McINTOSH PERRY	JOB NO.	2202-001 (CCC-213999-00)
	DRAWING NO.	

CLIENT	:	Azure Group
LOCATION	:	3034 Kirwin Ave., Mississauga
DATE	:	May 4, 2022



Sample	Percent Gravel [%]	Percent sand [%]	Percent Silt and Clay [%]	Moisture Content [%]
BH 107-SS10 (25' -27') Grey weathered shale	9.47%	34.04%	56.48%	6.94%

McINTOSH PERRY