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Geotechnical Investigation
Proposed Residential Development

129 Collier Street
Barrie, Ontario
L4M 1H5

Prepared for:

Pinemount Developments Ltd
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Toronto, Ontario
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■ FOUNDATION INVESTIGATIONS ■ ENVIRONMENTAL SITE ASSESSMENTS AND CLEANUP ■ GROUNDWATER STUDIES ■ SLOPE STABILITY STUDIES
■ ASPHALT TECHNOLOGY ■ ASPHALT MIX DESIGNS ■ PAVEMENT PERFORMANCE ANALYSIS ■ CONSTRUCTION MATERIALS TESTING & INSPECTION
■ ANALYSIS OF SOIL CORROSION POTENTIAL ■ PAVEMENT REHABILITATION & TENDER SPECIFICATIONS ■ CONCRETE QUALITY ASSURANCE TESTING
■ ROOF INSPECTIONS ■ INFRASTRUCTURE NEEDS STUDIES ■ FAILURE ANALYSIS AND EXPERT WITNESS SERVICES ■ AGGREGATE EVALUATION

EXECUTIVE SUMMARY

SCOPE OF SERVICES

Proposed Development	Preliminary concept drawings indicate that the proposed development will comprise of two midrise complexes of approximately nine storeys. The development will also include an approximately 3-storey podium. The midrise buildings will include two to three levels of underground parking.
Report Deliverables	The Geotechnical Investigation is required to determine the subsurface conditions underlying the site and to provide design and construction recommendations for the proposed new residential development.

SITE DETAILS AND SETTING

Coordinates	604957, 4916039	**Site Area (approx.)**	6,066 m^2 (1.5 acres)

Site Description	The site is currently undeveloped and is covered predominantly by unmaintained grasses, granular material, and a small number of trees. The site is situated approximately 51 m east of Poyntz Street and 67 m west of Sampson Street, and is bound to the north by Collier Street and to the south by Dunlop Street East. The topography of the land slopes to the south, towards Lake Simcoe, located approximately 70 m south of the site. Commercial premises bound the site to the east and west.
Geology	Topsoil and pavement granular material were encountered at the ground surface. Underlying the surficial material is fill and native sand. The fill extends to depths of between approximately 2.7 m and 4.7 m. Underlying the fill and native sand is silt, gravel, sandy till and clay and extend to the maximum drill depth of approximately 12.6 m below existing ground level. Bedrock was not encountered during this investigation.
Groundwater	Groundwater seepage was encountered at depths of below 6.0 m below existing ground level.

ENGINEERING CONSIDERATIONS

Foundations	It is considered by Landtek that the anticipated moderately loaded foundations for the proposed residential development can be supported by conventional concrete footings seated within the native soils underlying the site. The other feasible option to consider would be a concrete raft foundation, particularly if the proposed condominium structures are of a generally high loading.
Settlements	The general limiting of the total settlement to 25 mm and the differential settlement to 19 mm by the recommended geotechnical reaction at the SLS is considered appropriate for foundations in native soils.
Earthquake Considerations	Based on the soils conditions encountered, and in accordance with Table 4.1.8.4.A. of the current Ontario Building Code (herein "*OBC*"), the site is considered to be a 'D' Site Class.

CONSTRUCTION CONSIDERATIONS

Excavations	The native soils to be encountered during excavation at the site are expected, in general, to behave as Type "3" materials according to the OHSA classification in Part III. Type 3 materials are characteristic of the sand, granular, and silt soils encountered.
Subsurface Concrete	Experience in the area indicates that the native soils generally have a mild sulphate environment and a low chloride concentration. It is recommended that subsurface concrete at the site have the characteristics for an S-3 exposure class. For parking garage decks and ramps, a C-1 exposure class is recommended.
Dewatering	If groundwater dewatering volumes generated during construction are to exceed 50,000 litres per day, but are less than 400,000 litres per day, then the project will require registration online under the Environmental Activity and Sector Registry (*"EASR*"). For amounts greater than 400,000 litres per day a Permit To Take Water ("*PTTW*") will be required.

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1.0 INTRODUCTION

Landtek Limited (herein "*Landtek*") is pleased to submit this geotechnical investigation report for the proposed residential development at the site identified as 129 Collier Street in Barrie. Authorization to proceed with the work was received from Ms. Jacqueline Lee of Pinemount Developments Ltd (herein "*Pinemount*") on August 6, 2019.

Preliminary concept drawings provided to Landtek by Pinemount indicate that the proposed residential development will comprise of two midrise complexes of approximately nine storeys. The development will also include an approximately 3-storey podium. The midrise buildings will include two to three levels of underground parking. No pavement structures are proposed, with access and egress routes from Collier Street and Dunlop Street East leading into the proposed underground parking levels. Significant grade changes are not anticipated.

The primary objectives of this investigation are:

- To confirm the subsurface soil and groundwater conditions for foundation design and construction;
- Provide design and construction recommendations with regards to building foundations, floor slabs, and subsurface drainage and utilities; and,
- Assess the characteristics of the soils to be excavated and their suitability for reuse on site.

This report has been prepared for the Client, the nominated engineers, designers, and project managers pertaining to the proposed residential development at the site identified as 129 Collier Street in Barrie, Ontario. Further dissemination of this report is not permitted without Landtek's prior written approval. Further details of the limitations of this report are presented in Appendix A.

2.0 SITE SETTING

2.1 Site Location and Description

The site is located in Barrie, Ontario, and is centered at approximate grid reference 604957, 4916039 (UTM 17T coordinates). The approximate Geodetic elevation at the site ranges between from 226 m and 235 m.

The site location is shown in Figure 2.1.1 below.

Figure 2.1.1: Area of Proposed Development

The site is an undeveloped land with an area of approximately 6,066.2 m^2 (1.5 acres), and is covered predominantly by unmaintained grasses, granular material, and a small number of trees. The site is situated approximately 51 m east of Poyntz Street and 67 m west of Sampson Street, and is bound to the north by Collier Street and to the south by Dunlop Street East. The topography of the land slopes to the south, towards Lake Simcoe, located approximately 70 m south of the site. Commercial premises bound the site to the east and west.

A selection of site photographs is presented in Appendix E of this report.

2.2 Published Geology

Based on a review of an existing geological publication for the site area, Ontario Geological Survey (OGS) Map 2645: “*Quaternary Geology, eastern half of the Barrie and Elmvale areas*”, the site is underlain by glaciolacustrine gravel, sandy gravel and gravelly sand, and minor silty sand to sand till.

According to the OGS Map M2254 “*Paleozoic Geology of Southern Ontario*”, the superficial geology is underlain by limestone bedrock, identified as the Simcoe Group Member of the Verulam Formation.

Information provided by well records within the vicinity of the site, and held by the Ministry of the Environment, Conservation and Parks (MECP), generally confirms the anticipated geological conditions beneath the site. Based on the data from records for Well ID identified as *“5700288*”, located approximately 250 m southwest of the site, the superficial soil profile confirms the presence gravel, sand, boulders, silt and clay deposits to a depth of silt till and clay till deposits to a depth of 98.1 m. Limestone bedrock was encountered underlying the overburden soils.

2.3 Hydrology and Hydrogeology

The nearest surface water body is the south shore of Lake Simcoe, located approximately 70 m to the south of the site

Static groundwater levels associated with the overburden soils were identified at a depth of approximately 4.5 m below ground level in Well ID identified as *“7191645”,* located approximately 200 m east of the site.

3.0 FIELDWORK AND INVESTIGATION METHODOLOGY

Fieldwork undertaken at the site by Landtek included clearance of underground services, borehole drilling and soil sampling, and field supervision. This geotechnical investigation was undertaken in conjunction with a Phase Two Environmental Site Assessment (ESA) completed by Landtek for the site.

A total of six boreholes (boreholes BH1 to BH6) were drilled between August 12 and 14, 2019. The boreholes were logged using those standard symbols and terms defined in Appendix B. The Borehole Location Plan, Drawing 19280-01, and associated borehole logs are provided in Appendix C.

The boreholes were drilled using a Marl M5T track-mounted drilling rig equipped with continuous flight, hollow stem augers, and were advanced to depths of approximately 12.6 m below existing ground level. Standard Penetration Tests (SPT's) and split spoon samples were taken during drilling at selected depths. Full time supervision of drilling and soil sampling operations was carried out by a representative of Landtek. Three (3) of the boreholes (BH1, BH2 and BH3) were completed as monitoring wells BH/MW1, BH/MW2 and BH/MW3 respectively.

The monitoring wells consisted of new/sealed 50 mm polyvinyl chloride (PVC) screen with No.10 slots threaded onto a matching riser. The screens and riser were pre-threaded including o-ring seals such that no glues or solvents were used to connect the pipe sections. The annular space between the PVC well and the borehole was backfilled to approximately 0.3 m above the top of the screen section with sand pack, and then with bentonite to the existing ground surface. A J-Plug lockable air-tight cap was installed on all the risers. The borehole logs in Appendix C present the monitoring well installation details and the results of subsequent water monitoring visit undertaken on August 29, 2019.

All soil samples were transported to the Landtek's in-house, Canadian Council of Independent Laboratories (CCIL) certified laboratory and visually examined to determine their textural classification. Moisture content testing was carried out on all samples.

Ground surface elevations at the borehole locations were established by Landtek relative to site measurements using the top of a catch basin cover located at the along Dunlop Street East and adjacent to the southeast property boundary, as a Temporary Benchmark (herein *"TBM"*). The elevation at the TBM was assumed as 100 m. The location of the TBM is indicated on Drawing 19280-01 in Appendix C of this report.

4.0 SUBSURFACE CONDITIONS

4.1 Overview

The borehole information is generally consistent with the geological data identified in Sections 2.2, with the predominant native soils comprising of silt, clay, sand and till deposits.

The detailed borehole logs are presented in Appendix C, with the ground conditions encountered by the boreholes discussed in the following sections.

4.1.1 Topsoil

An approximately 100 mm to 150 mm thick layer of topsoil was encountered from ground surface in boreholes BH1, BH3, BH5 and BH6. Topsoil thicknesses may vary across the site, and the topsoil thicknesses measured at the borehole locations may not be representative of the topsoil depth throughout the site.

4.1.2 Granular Material (Sand and Gravel)

Pavement granular material was encountered at the surface of boreholes BH2 and BH4, and consists of approximately 50 mm of sand and gravel.

4.1.3 Fill Material

Fill was encountered in all boreholes BH4 to BH6 underlying the surficial material and extends to depths of between 2.7 m (borehole BH4) and 4.7 m (borehole BH6) below existing ground level. The fill is brown and dark brown in colour, and consists primarily of silty sand with varying proportions of gravel and cobbles and traces of rootlets and brick fragments. SPT ‘‘N’’ values recorded within the fill horizon indicate the fill to be of a good compaction.

4.1.4 Sand

Sand deposits were encountered in boreholes BH1 to BH5 underlying the surface material and fill and interbedded with the silt to sandy silt deposits. The sand was observed to be brown and grey in colour and the sand is generally fine to coarse grained and includes varying proportions of cobbles, gravel, silt and clay.

SPT “N” values for the sand were recorded ranging from 2 to 50 blows for 80 mm of spoon penetration, indicating the sand to be in a very loose to very dense, but generally very dense condition.

Moisture content testing results were recorded between 4% and 16%, which are generally representative of a moist to wet granular soil. The moisture content testing results are presented on the borehole logs in Appendix B.

4.1.5 Silt

Silt deposits were encountered in boreholes BH2 and BH4 interbedded with the sand at depths of between 2.7 m (borehole BH4) and 6.0 m (borehole BH2). The sand was observed to be brown and grey in colour and includes varying proportions of clay and traces of gravel and sand.

An SPT “N” value of 36 was recorded for the silt, indicating the silt to be in a dense condition. A moisture content of 8% was reported.

4.1.6 Sandy Silt

Sandy silt was encountered in boreholes BH4 to BH6 at depths of between 4.5 m (borehole BH5) and 10.6 m (borehole BH4) and extends to depths of between 9.4 m (borehole BH5) and at least 12.6 m (terminus of boreholes BH4 and BH6). The sandy silt is grey in colour and includes traces of clay.

SPT ‘‘N’’ values ranging from 50 to 50 blows for 100 mm of spoon penetration were reported, indicating the sandy silt to be of a very dense condition. Moisture contents in the sandy silt range between 14% and 24% which is indicative of a moist to wet sandy silt soil.

4.1.7 Sandy Silt Till

Sandy silt till was encountered interbedded with the sand deposits in borehole BH3 at a depth of approximately 6.0 m and extends to a depth of 7.6 m below existing ground level. The sandy silt till is brownish grey in colour and includes traces of gravel.

An SPT “N” value of 52 was recorded for the sandy silt till, indicating the till to be in a very dense condition. A moisture content of 7% was reported.

4.1.8 Gravel

Gravel deposits were encountered in borehole BH2 underlying silt at a depth of approximately 6.0 m and extends to a depth of 10.6 m below existing ground level. The gravel is intermixed with sand and silt and includes some cobbles.

SPT “N” values for the gravel were recorded ranging from 57 to 50 blows for 80 mm of spoon penetration, indicating the gravel to be in a very dense condition.

Moisture content testing results were recorded between 4% and 8%.

4.1.9 Clay

Clay deposits were encountered in boreholes BH1, BH2, BH3 and BH5 at depths of between 9.1 (borehole BH1) and 11.4 m (borehole BH3) and extends to at least 12.6 m (terminus of the boreholes) below existing ground level. The clay is grey in colour and includes some silt, traces of gravel and some sand and gravel seams.

SPT ‘‘N’’ values ranging from 17 to 51 were reported, indicating the clay to be of a very stiff to hard consistency. Moisture contents in the clay range between 18 % and 23 %.

4.2 Bedrock

Bedrock was not encountered during this investigation.

4.3 Groundwater

Groundwater was encountered in all the boreholes during the drilling process at depths of between approximately 4.5 m (boreholes BH/MW2) and 7.6 m (borehole BH/MW3). On completion of drilling, monitoring wells were installed in boreholes BH/MW1, BH/MW2, and BH/MW3. Groundwater level measurements were taken on August 29, 2019, by which time the water levels were considered stable. Water level readings recorded in the monitoring wells during the visit are summarized in Table 4.3.1.

Table 4.3.1: Summary of Water Level Measurements

Borehole ID	Well Screen Depth Range	Screened Soil Type	Measured Water Level		
			Depth (mbgl)*	Elevation (m)**	Date
BH/MW1	6.1 m to 9.1 m	Sand	6.16	220.7	Aug. 29, 2019
BH/MW2	6.8 m to 9.8 m	Gravel	6.97	221.1	Aug. 29, 2019
BH/MW3	7.6 m to 10.6 m	Sand	6.85	221.4	Aug. 29, 2019

* mbgl meters below ground level

** Geodetic Elevations are to be considered approximate

It should be noted that groundwater conditions and surface water flow conditions are expected to vary according to the time of the year and seasonal precipitation levels. Water seepage is also expected from soil fissures above the water table.

5.0 FOUNDATION DESIGN CONSIDERATIONS

5.1 Shallow Foundations in Native Soils

The fill encountered in the boreholes BH4 to BH6 is considered unsuitable as a bearing stratum due to the high risk of unacceptable settlements. It should be noted however, that the fill deposits extend to depths of about 4.7 m below the existing ground level, equating to an elevation of 103.8 m (referenced to TBM).

Based on the ground conditions observed at the borehole locations, it is considered by Landtek that the anticipated moderately loaded foundations for the proposed midrise structures can be supported by conventional concrete footings seated within the native soil deposits underlying the site. It is understood that the proposed midrise towers will two to three underground levels of parking.

Table 5.1.1 summarizes the recommended geotechnical reactions at the Serviceability Limit State (herein "*SLS*") and factored geotechnical resistances at the Ultimate Limit State (herein "*ULS*") for the native soils. It should be noted that the design parameters have been determined by Landtek for the design stage only.

In accordance with the Ontario Building Code (herein "OBC"), 9.12.2.2 (5), and based on local experience, the shallowing of exterior and interior footings to 0.9 m and 0.6 m depth below the basement finished floor level respectively, may be adopted for the proposed development. Such shallowing of foundations is to be limited to only those areas where a minimum of one basement level is to be included. Foundations for at-grade structures are to be seated below the frost penetration depth of 1.6 m for the Barrie area, per OBC 9.12.2.2 (1).

Subsurface conditions can vary over relatively short distances and the subsurface conditions revealed at the test locations may not be representative of subsurface conditions across the site. Therefore, a Geotechnical Engineer should be engaged during construction to examine the exposed sub-soil quality and condition, and confirm the subsurface conditions are consistent with design assumptions. This is in compliance with field review requirements in the National Building Code, Volume 1, Clause 4.2.2.3.

Table 5.1.1: Recommended Limit State Foundation Design Values

Founding Depth Range	Founding Stratum	Foundation Design Value	
		SLS [1][2]	ULS [3][4]
5.6 m to 7.6 m	Sand/Gravel/Sandy Silt	320 kPa	480 kPa

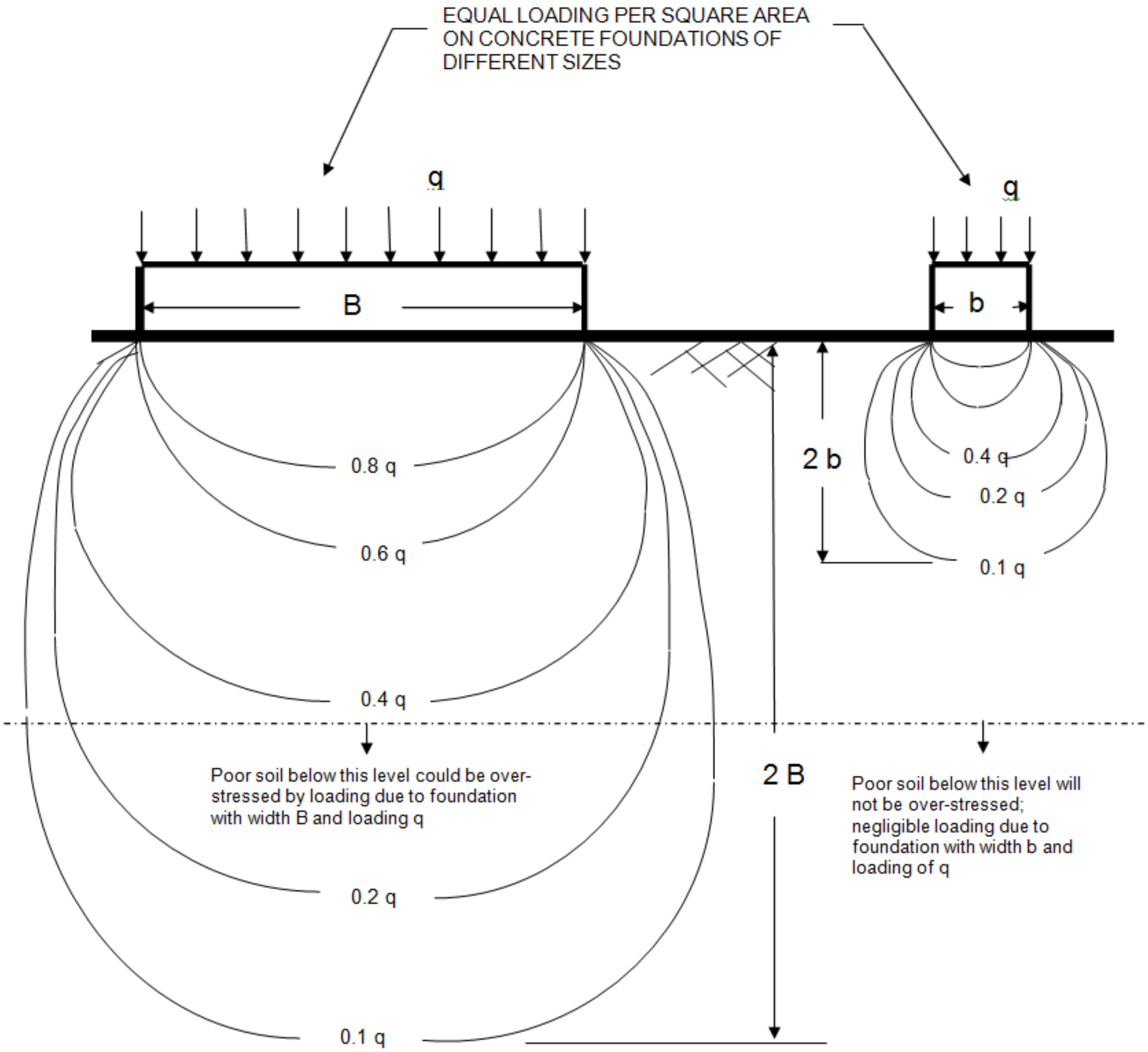
Notes:

1. The National Building Code general safety criterion for the serviceability limit states is: SLS resistance ≥ effect of service loads.
2. Recommended SLS bearing values conform to Estimated Values based on soil types given in Tables K-8 and K-9 of the National Building Codes User's Guide.
3. The ULS resistance factor for shallow foundations is 0.5, as given in Table K-1 of the National Building Code User's Guide.
4. The National Building Code general safety criterion for the ultimate limit states is: factored ULS resistance ≥ effect of factored loads.

Where the bearing levels of the footings are at different design elevations, the footing base levels should be stepped along a line of 7V:10H, drawn upwards from the lowest footing, to avoid overlapping stresses.

Design factors related to structural loads and lowest design floor level will determine the most cost-effective foundation system for the building. The impact on foundation size and soil bearing pressure is illustrated in Figure 5.1.1 and emphasizes that foundation design sizes, bearing pressures, and bearing levels must be taken into account to avoid excessive consolidation settlements.

Figure 5.1.1: Illustration of Load Distribution below Variable Size Foundations with the Same Applied Loading



EQUAL LOADING PER SQUARE AREA ON CONCRETE FOUNDATIONS OF DIFFERENT SIZES

Poor soil below this level could be over-stressed by loading due to foundation with width B and loading q

Poor soil below this level will not be over-stressed; negligible loading due to foundation with width b and loading of q

5.2 Raft Foundations

Standard strip or spread foundations may be considered an appropriate option for the condominium towers, though the acceptability of footings will depend upon design issues such as the elevation of the lowest floor level and the structural loading. If the footing design criteria provided in this report cannot be satisfied or footings are not a cost-effective alternative, a feasible alternative option to consider would be a concrete raft foundation, particularly if the proposed condominium structures are of a generally high loading.

The soil parameters to be used in the raft foundation design process include the modulus of subgrade reaction, corrected for the building footprint size, and the limiting average pressure at the underside of the raft foundation. The limiting average bearing pressure on the underside of the raft should be taken as 300 kPa.

Design values for the modulus of subgrade reaction generally decrease when the size of the loaded plate (or footing) is larger than 0.3 m by 0.3 m. For granular soils, if the loaded area on the soil is a width of b, the modulus of subgrade reaction can be taken as:

$$k_{vb} = k_{v1}\left[\frac{b+0.3}{2b}\right]^2$$

where:

k_{v1} = modulus of subgrade reaction for a loaded plate of dimensions 0.3 m x 0.3 m;
= 120 MPa/m, considered representative of the predominant soil bearing conditions at depth across the site;
b = raft foundation width in metres;
k_{vb} = modulus of subgrade reaction in MPa/m for actual foundation dimension b

For preliminary considerations, based on an example with a raft foundation of 48 m width (i.e. b = 48), the design modulus of subgrade reaction (k_{vb}) is therefore calculated to be 30.4 MPa/m.

The recommended limit state bearing capacities provided in this report are based on the available borehole data, knowledge of the geotechnical and geological history of the area, and the condition that construction quality assurance inspection will be carried out by Landtek. Construction quality assurance is considered essential to confirm that the bearing stratum and bearing levels are consistent with the findings of this report, and the foundation installations are in accordance with accepted best practices.

5.3 Frost Susceptibility

The very fine silty sand encountered at shallow depths across the site are considered sensitive to water and frost, and their physical and mechanical properties are dependent on in-situ moisture content. As such, the founding soils at the site are considered to have a moderate to high frost susceptibility, being classified as Frost Group "*F4*" (Table 13.1 of the "*Canadian Foundation Engineering Manual*", 4th Edition). However, the identified depths for foundations, as given in Section 5.1.1 are considered to be below the maximum extents of influence from frost penetration in the Barrie area.

Should any re-grading be required as part of the proposed development and adjacent to the new structures, it will be important to ensure that the associated exterior footings will have a minimum of 1.6 m of soil cover, or equivalent suitable insulation, for frost protection.

5.4 Settlement Considerations

Based on the outline information provided for the nature of the proposed redevelopment of the site, it is anticipated that the loads to be applied to the ground by any such structure will be generally moderate intensity. As such, associated settlements are not expected to be large. Therefore, the general limiting of the total settlement to 25 mm and the differential settlement to 19 mm by the recommended geotechnical reaction at the SLS is considered appropriate.

5.5 Seismic Design Considerations

Based on the soils conditions encountered, and in accordance with Table 4.1.8.4.A. of the current Ontario Building Code (herein "*OBC*"), the site is considered to be a 'D' Site Class. The acceleration and velocity-based site coefficients, F_a and F_v, should be determined from Tables 4.1.8.4.B. and 4.1.8.4.C. respectively of the OBC for the above recommended Site Class. The seismic design data given in Table 1.2 of Supplementary Standard SB-1 in Volume 2 of the OBC, for selected Municipal locations, should be used to complete the seismic analysis.

Should a higher classification be required, then Shear Wave Velocity Testing should be undertaken using Multichannel Analysis of Surface Waves (MASW) methodologies. However, this assessment will not necessarily guarantee a change of classification, as it is wholly dependent on the ground conditions beneath the site.

5.6 Damp Proofing and Waterproofing Considerations

The subsurface areas should be damp proofed and comply with the OBC requirements. As a minimum it is recommended that the damp proofing system include a Delta Drainage Board or MiraDrain 2000 series product, or an approved alternative, along with an asphalt based spray-on wall coating.

It is recommended that all subsurface structures and areas (i.e. basement walls, floor slabs etc.) are appropriately waterproofed below the stabilized groundwater levels identified (i.e. 6.0 m depth at its shallowest) plus the required buffer zone (nominally 1.0 m to 1.5 m above the stabilized groundwater level).

6.0 FLOOR SLAB AND PERIMETER DRAINAGE CONSIDERATIONS

Based on the borehole soil conditions and preliminary design information provided to Landtek, it should be possible to construct the lowest (i.e. basement) floor slab level using slab-on-grade methods. The subgrade support conditions are anticipated to be native sand, gravel, and silt, which should provide competent conditions for placing the vapour barrier material. However, after the subgrade has been prepared to the underfloor design elevation it is recommended that the area be assessed by Landtek to determine if there is a need for any remedial work.

It is recommended that a minimum 200 mm layer of clear 19 mm crushed quarried stone be used as the vapour barrier under the floor slab. The vapour barrier stone should meet the requirements of Ontario Provincial Standard Specifications (herein "*OPSS*") 1004 for 19 mm Type II clear stone. If a graded crushed stone is substituted for clear stone, the material should be limited to a maximum of 5 % fines (passing the 0.075 mm sieve). The floor slab thickness should meet the specifications of the project based on anticipated floor loadings.

The finished exterior ground surface should be sloped away from the buildings at a grade in the order of 2 %.

The concrete properties should meet the requirements of OPSS 1350. Contraction and isolation jointing practices should be in accordance with current Portland Cement Association recommendations, as given in the engineering bulletin "*Concrete Floors on Ground*", second edition, by R. E. Spears, and W. C. Panarese.

In the event that the subsurface foundations are not to be waterproofed as detailed in Section 5.6, perimeter drainage should be provided around all subsurface floor areas where water may accumulate. It is recommended that underfloor drains be provided at all deep foundation locations. The drainage system should comply with the OBC and associated amendments. Further details pertaining to perimeter and underfloor drainage systems are provided in Drawings 19280-02 and 19280-03 respectively, in Appendix D.

After the subgrade has been prepared to the underfloor design elevation it is recommended that the area be proof-rolled with a loaded tandem axle dump truck to delineate if there are soft or unstable ground conditions that require repair. This operation should be completed before the underfloor vapour barrier granular material is placed.

7.0 EARTH PRESSURE CONSIDERATIONS ON SUBSURFACE WALLS

The earth pressure, p, acting on subsurface walls at any depth, h, in metres below the ground surface assumes an equivalent triangular fluid pressure distribution and may be calculated using expression (1) below. It is assumed that granular material is used as backfill. Allowances for pressure due to compaction operations should be included in the earth pressure determinations and a value of 12 kPa is applicable for a vibratory compactor and granular material.

If the structure retaining soil can move slightly, the active earth pressure case can be used in determining the lateral earth pressure. For restrained structures and no yielding an “at rest” earth pressure condition should be used. The determination of the earth pressures should be based on the following expression:

$$p = K\,(\delta\ h + q) \qquad (1)$$

where:

p = the pressure in kPa acting against any subsurface wall at depth, h, in metres (feet) below the ground surface;

K = the at rest earth pressure coefficient considered appropriate for subsurface walls; OPSS 1010 Granular B Type 1 (pit-run sand and gravel) material has an effective angle of friction estimated to be 32° with a corresponding at rest earth pressure coefficient, K_o, of 0.45; and,

δ = the moist bulk unit weight of the retained backfill; 21.5 kN/m^3.

and,

q = the value for any adjacent surcharge in kPa, which may be acting close to the wall; and,

h = the depth, in m, at which the pressure is calculated

Granular B backfill should meet OPSS 1010 Type I or Type II material specifications. The granular fill should be compacted to a minimum of 97 % SPMDD, or to the levels and backfilling procedures specified.

8.0 SUBSURFACE CONCRETE

8.1 Concrete Class Considerations

The requirements for subsurface concrete subject to a sulphate and chloride environment are presented in Canadian Standards Association specification, CSA A23.1-14 *"Concrete Materials and Methods of Concrete Construction, Tables 1-4"*. Experience in the area indicates that the native soils generally have a mild sulphate environment and a low chloride concentration. It is recommended that subsurface concrete at the site have the following characteristics for an S-3 exposure class:

- minimum 56-day strength = 30 MPa;
- maximum water to cement ratio = 0.50;
- cementing materials:
  MS hydraulic cement or MSb; as per tables 3 and 4 respectively in CSA A23.1-14; and,
- air content:
  4 – 7 % for 14 mm to 20 mm nominal size coarse aggregate
  3 – 6 % for 28 mm to 40 mm nominal size coarse aggregate

For the parking garage decks and ramps it is recommended that the concrete exposure class be C-1 and the concrete have the following minimum properties:

- minimum 56-day compressive strength = 35 MPa;
- maximum water to cementing materials ratio = 0.40;
- chloride ion penetrability requirement = < 1500 coulombs within 91 days)
- cementing materials; GU (general use hydraulic cement) or GUb (blended general use)
- air content; as per CSA A23.1-14 Table 4, air content category 1 (freeze-thaw environment)

The concrete should be placed without segregation and should be consolidated to achieve a uniform dense mass.

8.2 Methods for Specifying Concrete

Alternative methods of specifying concrete for a project are outlined in CSA A23.1-14 and allow for "*Performance*" or "*Prescription*" based methods. Each method attaches different levels of responsibility to the owner, the contractor, and the concrete supplier. The pros and cons of each method should be examined prior to completion of the specifications for the project.

9.0 EXCAVATION AND BACKFILL CONSIDERATIONS

9.1 General Excavation Considerations

All temporary excavations and unbraced side slopes in the soils should conform to standards set out in the Occupational Health and Safety Act, Ontario Regulation 213/91 "*Construction Projects*" (herein "*OHSA*"). The native soils to be encountered during excavation at the site are expected, in general, to behave as *"Type 3"* materials according to the OHSA classification in Part III. Type 3 materials include are characteristic of the sand, granular and silt soils encountered.

It should be possible to excavate the overburden soils with a hydraulic backhoe. Moist Type 3 soils are expected to be stable for short construction periods at slopes of approximately 45° to the horizontal (i.e. 1V:1H).

Saturated sand layers and pockets may be encountered below depths of approximately 5.0 m and could result in progressive sloughing to slopes flatter than 45° to the horizontal. In this regard saturated "running" soils would be classified as a Type 4 soil. According to the OHSA the excavation slope should be cut and shaped to meet the OHSA requirements for the soil with the highest classification number.

Consideration should be given to any existing trench excavations and associated backfill that may be present directly behind cut slopes within the native soils that may appear to be stable on first excavation. In these circumstances, slopes can suddenly slough or collapse due to the effects of the adjacent backfill. Consequently, for excavation conditions that cannot satisfy the OHSA requirements for unbraced 1H:1V side slopes, a trench box system should be used, or temporary shoring should be installed to maintain safe working conditions. This may be more applicable to service trench excavations, though may also apply to basement excavations etc., particularly where in close proximity to new road pavements or associated infrastructure.

Groundwater seepage is expected to be variable and will depend upon the depth of the excavations, the time of year, and precipitation levels preceding construction. The site information indicates that groundwater may be expected at depths of below 6.0 m below existing ground level.

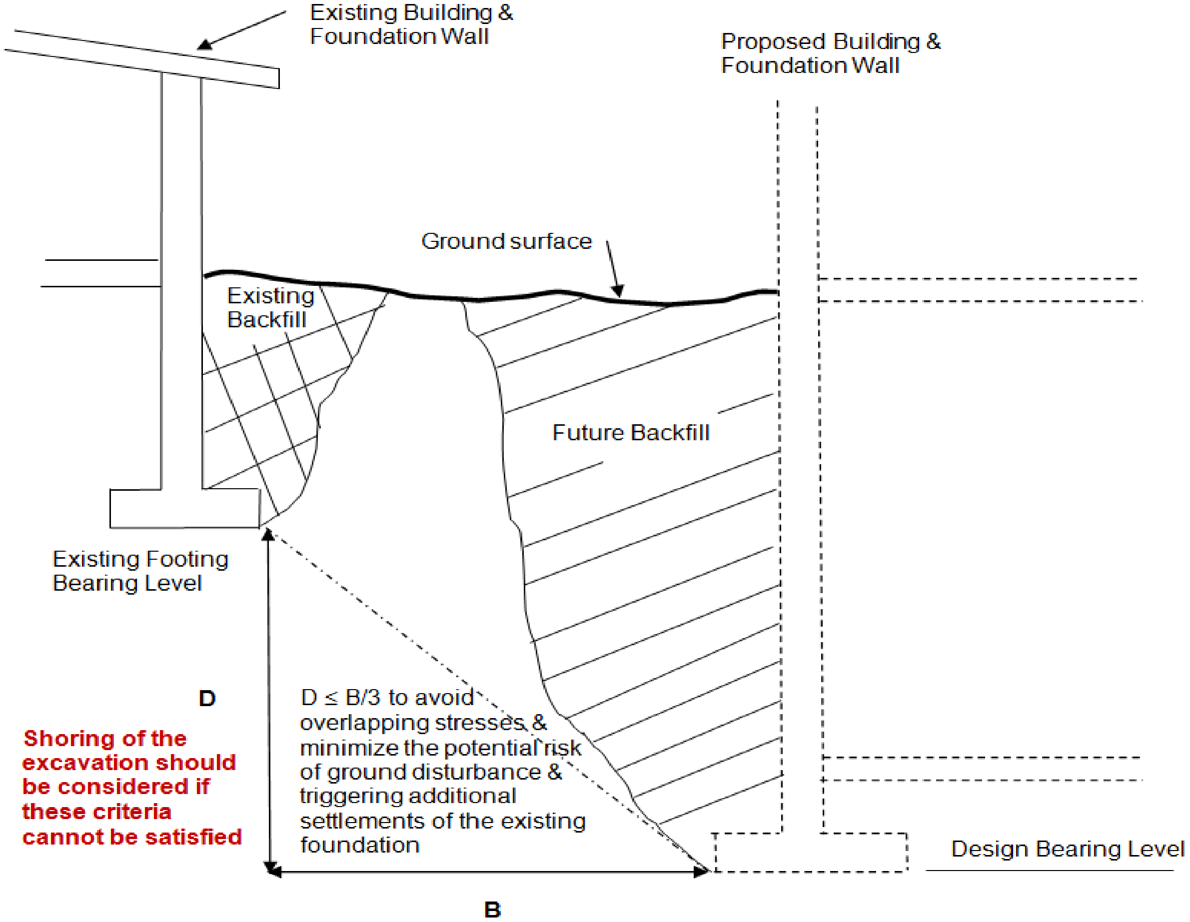
It has been assumed that the proposed structures will include two to three levels of underground parking. Therefore, it is anticipated that excavation at the site will not be greater than 5.6 m below existing ground level and will likely encounter significant groundwater seepage.

Should significant excavation be proposed below the reported water levels, then a hydrogeological investigation may be required for the proposed development to provide recommendations for dewatering.

If groundwater dewatering volumes generated during construction are to exceed 50,000 litres per day, but are less than 400,000 litres per day, then the project will require registration online under the Environmental Activity and Sector Registry (herein *"EASR*"). For amounts greater than 400,000 litres per day a Permit To Take Water (herein "*PTTW*") will be required.

Excavations for new foundations should satisfy the criteria given in the example shown in Figure 9.1.1 to avoid overlapping stresses and minimize the risk of undermining existing adjacent structures, including utilities, and/or triggering additional settlements of the existing structures due to soil disturbance.

Figure 9.1.1: Criteria for Assessing Excavation Shoring Requirements (Not to Scale)



Example: If the separation between existing and new proposed footings is 2 m the difference in bearing elevation should not exceed 0.67 m.

9.2 General Backfill Considerations

Backfill next to foundation walls and within service trenches should be selected to be compactable in narrow trench conditions. The fill and native soils are expected to be reusable as trench backfill and backfill around the proposed structures on the site. Any variation in the moisture contents of the soils encountered may require selective separation of material to avoid the use of wet soil.

Site servicing trench backfill should be uniformly compacted to a density that minimizes the risk of long-term settlements. It is recommended that the target compaction specification for trench backfill be 97 % SPMDD with no individual test below 95 % SPMDD.

During inclement weather the soils may become too wet to achieve satisfactory compaction. If construction is proposed for late in the year, a reduced level of trench compaction with a higher risk of future settlements is to be anticipated, and it is recommended that provisional contract quantities be established for the supply and placement of imported granular fill under such circumstances. The imported granular should meet the requirements of OPSS 1010 for Granular B Type I material as a minimum requirement.

10.0 TEMPORARY SHORING CONSIDERATIONS

Excavations should satisfy the criteria given in the previous Figure 9.1.1 to avoid overlapping stresses and minimize the risk of undermining existing adjacent foundations/utilities and/or triggering additional settlements of the existing foundations/utilities due to soil disturbance. In most instances, it is anticipated that excavations will be within an area where excavation walls can be battered back at a 45° angle (i.e. 1V:1H), in accordance with the OHSA. As such, the requirement and application of shoring will be dependent on the required excavation depth and the proximity of existing or newly constructed infrastructure adjacent to the excavation.

The requirement and application of shoring to support excavation side slopes will be dependent on the required excavation depth and the proximity of existing or newly constructed infrastructure adjacent to the excavation. Soldier piles and timber lagging may be considered as an option for a shoring system, though this type of system may require measures to prevent the loss of soil between the spaces of lagging boards where a wet or flowing soil layer may be present.

If required, the preferred temporary trench support for utility installations, where permissible under the OHSA, is generally in the form of trench boxes. Consideration should be given to the time taken between completing the excavation section and installing the trench boxes; trench boxes are to be installed quickly and efficiently. Once the service pipes have been installed and the required bedding cover placed, the trench box will require repositioning to enable the continuation of the service pipe installation. When the trench box is to be moved, the void space between the trench box's outer walls and the trench is to be backfilled and the backfill compacted, which may require the trench box to be raised sequentially prior to sliding it laterally into its new position.

It is also important to ensure that the trench is not over-excavated so that there is a suitably tight fit between the trench box and the excavated trench walls. Post-construction ground settlements may occur along the line of the trench walls, or adjacent the excavated trench area, if the excavation is not adequately supported throughout the entire service installation procedure.

The earth pressure acting on trench box bracing may be evaluated using apparent earth pressure diagrams presented in Canadian Foundation Engineering Manual 4th Edition, Chapter 26.

It should be noted that the design of any temporary shoring system is the responsibility of the Contractor. Therefore, a specialist shoring contractor should be consulted to provide the most appropriate shoring type method and associated installation procedures. In any event, the shoring design should be based on the procedures outlined in the latest edition of the Canadian Foundation Engineering Manual. It is also recommended that lateral and vertical movement of the shoring system be monitored during construction to ensure that movements are within the acceptable range.

11.0 SITE SERVICING CONSIDERATIONS

There is no indication that special pipe bedding materials or procedures are required for the installation of services. All bedding cover and backfill materials should be selected in accordance with OPSS 1010 Aggregates – Base, Subbase, Select Subgrade, and Backfill Material.

The pipes should be placed with a minimum bedding thickness in conformance of OPSD 802.010 series (typical 150 mm for flexible pipes, OPSD 802.010, 802.013 and 802.014). The use of normal Class B type bedding is applicable for the pipe.

Bedding material shall be placed in layers not exceeding 300 mm in thickness, loose measurement, and compacted to 95 % of the SPMDD before a subsequent layer is placed. Site servicing trench backfill should be uniformly compacted to a density that minimizes the risk of long-term settlements. Bedding on each side of the pipe shall be completed simultaneously. At no time shall the levels on each side differ by more than the 300 mm uncompacted layer. The remainder of the trench should be backfilled as per the requirements defined in Sections 9.0 and 12.0.

It is assumed all services will have a minimum of 1.6 m of soil cover for frost protection. For services installed at shallower depths, suitable insulation for frost protection is recommended.

12.0 SOIL MANAGEMENT CONSIDERATIONS

Construction for the proposed development may involve cut and fill operations. From a geotechnical perspective, and in order to optimize the use of the on-site soils, a Soil Management Plan should be established. The plan objective should be to achieve a self-sustainable development with respect to excavated materials, and control the placement of organic soils so that there is negligible impact on the settlement performance of the compacted fill material.

The soil management criteria should be as follows:

- Surface vegetation, topsoil and organic soils should not be placed within the proposed roadways, below finished subgrade level for pavement construction or building limits. These materials should be placed in landscaped areas where settlements are not critical;

- Excavated soils for structural fill in pavement areas and building floor slab areas, which does not have topsoil or organic matter and are compactable with moisture contents within 2 % to 3 % of the optimum value, should be placed and compacted to a target density of 97 % of the SPMDD with no individual test result below 95 % SPMDD; and,

- Soils to be placed in landscaped areas where settlements are not critical should receive nominal compaction effort in order to achieve at least 90 % of the SPMDD.

13.0 DECK PAVEMENT CONSIDERATIONS

13.1 Deck Pavement Design Considerations

Any proposed deck pavement should comprise a minimum 50 mm cover of OPSS HL 3 asphalt. The bedding or grading material to be placed between the concrete deck and the asphalt pavement surface should comprise either blinding sand or OPSS Granular A material, depending on the thickness of the layer required.

13.2 Pavement Materials

Granular Base Course

If the option with granular base material is used, the granular base course material should meet OPSS Granular “A” specifications. Quarried 20 mm limestone crushed to Granular "A" gradation specifications is recommended.

Hot Mix Asphalt

The surface course asphalt should meet current specifications for HL 3, as prescribed by the City of Barrie or, alternatively, OPSS 1150.

Compaction

Granular base course fill material should be compacted to 100 % SPMDD.

14.0 CLOSURE

The Limitations of Report, as stated in Appendix A, are an integral part of this report.

Soil samples will be retained and stored by Landtek for a period of three months after the report is issued. The samples will be disposed of at the end of the three-month period unless a written request from the client to extend the storage period is received.

We trust this report will be of assistance with the design and construction of the proposed development. Should you have any questions, please do not hesitate to contact our office.

Yours sincerely,

LANDTEK LIMITED

Isaac Asonya, EIT
Author

LICENSED PROFESSIONAL ENGINEER
R. DI CIENZO
Sep 25/19
PROVINCE OF ONTARIO

James Dann, B.Eng. (Hons)
Manager, Geotechnical Projects

Ralph Di Cienzo, P. Eng.
Consulting Engineer

APPENDIX A
LIMITATIONS OF REPORT

The conclusions and recommendations given in this report are based on information determined at the borehole locations. Subsurface and ground water conditions between and beyond the Boreholes may be different from those encountered at the borehole locations, and conditions may become apparent during construction that could not be detected or anticipated at the time of the geotechnical investigation. It is recommended practice that Landtek be retained during construction to confirm that the subsurface conditions throughout the site are consistent with the conditions encountered in the Boreholes.

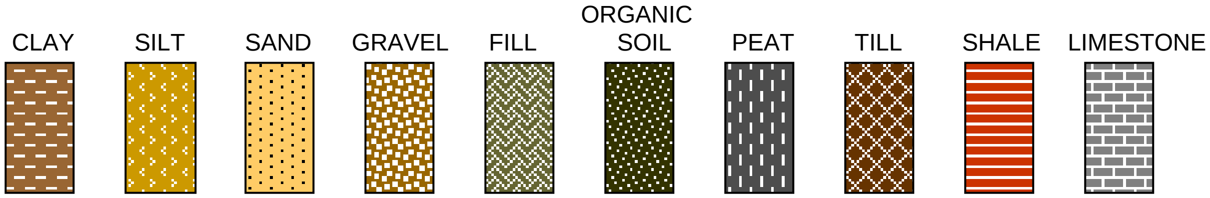
The comments made in this report on potential construction problems and possible remedial methods are intended only for the guidance of the designer. The number of Boreholes may not be sufficient to determine all the factors that may influence construction methods and costs. For example, the thickness and quality of surficial topsoil or fill layers may vary markedly and unpredictably. Additionally, bedrock contact depths throughout the site may vary significantly from what was encountered at the exact borehole locations. Contractors bidding on the project, or undertaking construction on the site should make their own interpretation of the factual borehole information, and establish their own conclusions as to how the subsurface conditions may affect their work.

The survey elevations in the report were obtained by Landtek Limited or others, and are strictly for use by Landtek in the preparation of the geotechnical report. The elevations should not be used by any other parties for any other purpose.

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. Landtek Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

This report does not reflect environmental issues or concerns related to the property unless otherwise stated in the report. The design recommendations given in the report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, it is recommended that Landtek Limited be retained during the final design stage to verify that the design is consistent with the report recommendations, and that the assumptions made in the report are still valid.

APPENDIX B
SYMBOLS AND TERMS USED IN THE REPORT



RELATIVE PROPORTIONS

Term	Range
Trace	0 - 5%
A Little	5 – 15%
Some	15 – 30%
With	30 – 50%

CLASSIFICATION BY PARTICLE SIZE

Boulder	> 200 mm
Cobble	80 mm – 200 mm
Gravel -	
Coarse	19 mm – 80 mm
Fine	4.75 mm – 19 mm
Sand -	
Coarse	4.75 mm – 2 mm
Medium	2 mm – 0.425 mm
Fine	0.425 mm – 0.75 mm
Silt	0.075 mm – 0.002 mm
Clay	< 0.002 mm

DENSITY OF NON-COHESIVE SOILS

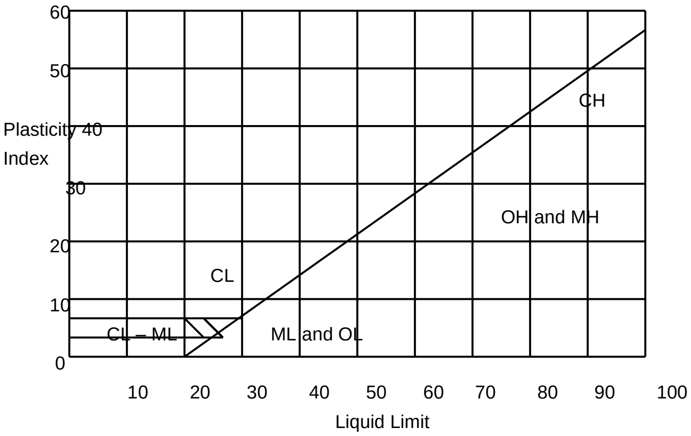
Descriptive Term	Relative Density	Standard Penetration Test
Very Loose	0 – 15%	0 – 4 Blows Per 300 mm Penetration
Loose	15 – 35%	4 – 10 Blows Per 300 mm Penetration
Compact	35 – 65%	10 – 30 Blows Per 300 mm Penetration
Dense	65 – 85%	30 – 50 Blows Per 300 mm Penetration
Very Dense	85 – 100%	Over 50 Blows Per 300 mm Penetration

CONSISTENCY OF COHESIVE SOILS

Descriptive Term	Undrained Shear Strength kPa (psf)	N Value Standard Penetration Test	Remarks
Very Soft	< 12 (< 250)	< 2	Can penetrate with fist
Soft	12 – 25 (250 – 500)	2 – 4	Can indent with fist
Firm	25 – 50 (500 –1000)	4 – 8	Can penetrate with thumb
Stiff	50 – 100 (1000 – 2000)	8 – 15	Can indent with thumb
Very Stiff	100 – 200 (2000 – 4000)	15 – 30	Can indent with thumb-nail
Hard	> 200 (> 4000)	> 30	Can indent with thumb-nail

Notes: 1. Relative density determined by standard laboratory tests.
2. N value – blows/300 mm penetration of a 623 N (140 Lb.) hammer falling 760 mm (30 in.) on a 50 mm O.D. split spoon soil sampler. The split spoon sampler is driven 450 mm (18 in.) or 610 mm (24 in.). The “N” value is the Standard Penetration Test (SPT) value and is normally taken as the number of blows to advance the sampler the last 300 mm.

APPENDIX B CONTINUED
CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES
ASTM Designation: D 2487 - 69 AND D 2488 – 69
(Unified Soil Classification System)

Major Divisions			Group Symbols	Typical Names	Classification Criteria		
Coarse-grained soils More than 50% retained on No. 200 sieve *	Gravels 50% or more of coarse fraction retained on No. 4 sieve	Clean gravels	**GW**	Well-graded gravels and gravel-sand mixtures, little or no fines	Classification on basis of percentage of fines Less than 5% pass No. 200 sieve . . . . . . GW, GP, SW, SP More than 12% pass No. 200 sieve . . . . . GM, GC, SM, SC 5 to 12% pass No.200 sieve . . . . Borderline classifications requiring use of dual symbols	C_u=D60/D10 greater than 4; C_z = $(D30)^2/(D10xD60)$ between 1 and 3	
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines		Not meeting both criteria for GW	
		Gravels with fines	**GM**	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
	Sands More than 50% of coarse fraction passes No. 4 sieve	Clean Sands	**SW**	Well-graded sands and gravelly sands, little or no fines		C_u=D60/D10 greater than 6; C_z = $(D30)^2/$ (D10xD60) between 1 and 3	
			SP	Poorly graded sands and gravelly sands, little or no fines		Not meeting both criteria for SW	
		Sands with fines	**SM**	Silty sands, sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
Fine-grained soils 50% or more passes No. 200 sieve *	Silts and clays Liquid limit 50% or less		**ML**	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands	Plasticity Chart For classification of fine-grained soils and fine fraction of coarse-grained soils. Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols. Equation of A-line: PI=0.73 (LL-20) 		
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silts			
			OL	Organic silts and organic silts of low plasticity			
	Silts and clays Liquid limit greater than 50%		**MH**	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts			
			CH	Inorganic clays of high plasticity, fat clays			
			OH	Organic clays of medium to high plasticity			
	Highly organic soils		**Pt**	Peat, much and other highly organic soils	* Based on the material passing the 3 in. (76mm) sieve.		

APPENDIX C

DRAWING 19280-01 – BOREHOLE LOCATION PLAN
BOREHOLE LOGS

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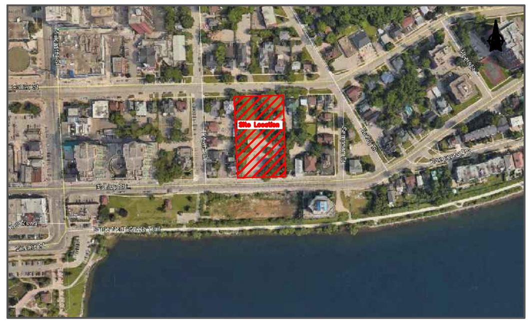
project location



● Approximate location of boreholes as drilled by Landtek Limited between August 12 and 14, 2019.

● Approximate location of monitoring well installed by Landtek Limited between August 12 and 14, 2019.

▲ Temporary Benchmark (TBM): Top of existing catch basin cover.

Borehole and monitoring well locations are considered approximate.

Base plan provided by Turner Fleischer Architects Inc.

Key plan provided by google maps.

revisions/ submissions

#	date	description
1	September 24, 2019	Issued for report

client
Pinemount Developments Ltd

municipality
The Corporation of The City of Barrie

project
Geotechnical Investigation
129 Collier Street

sheet
Borehole Location Plan

date: September 24, 2019
drawn: MD
checked: IA
project #: 19280
scale: NOT TO SCALE

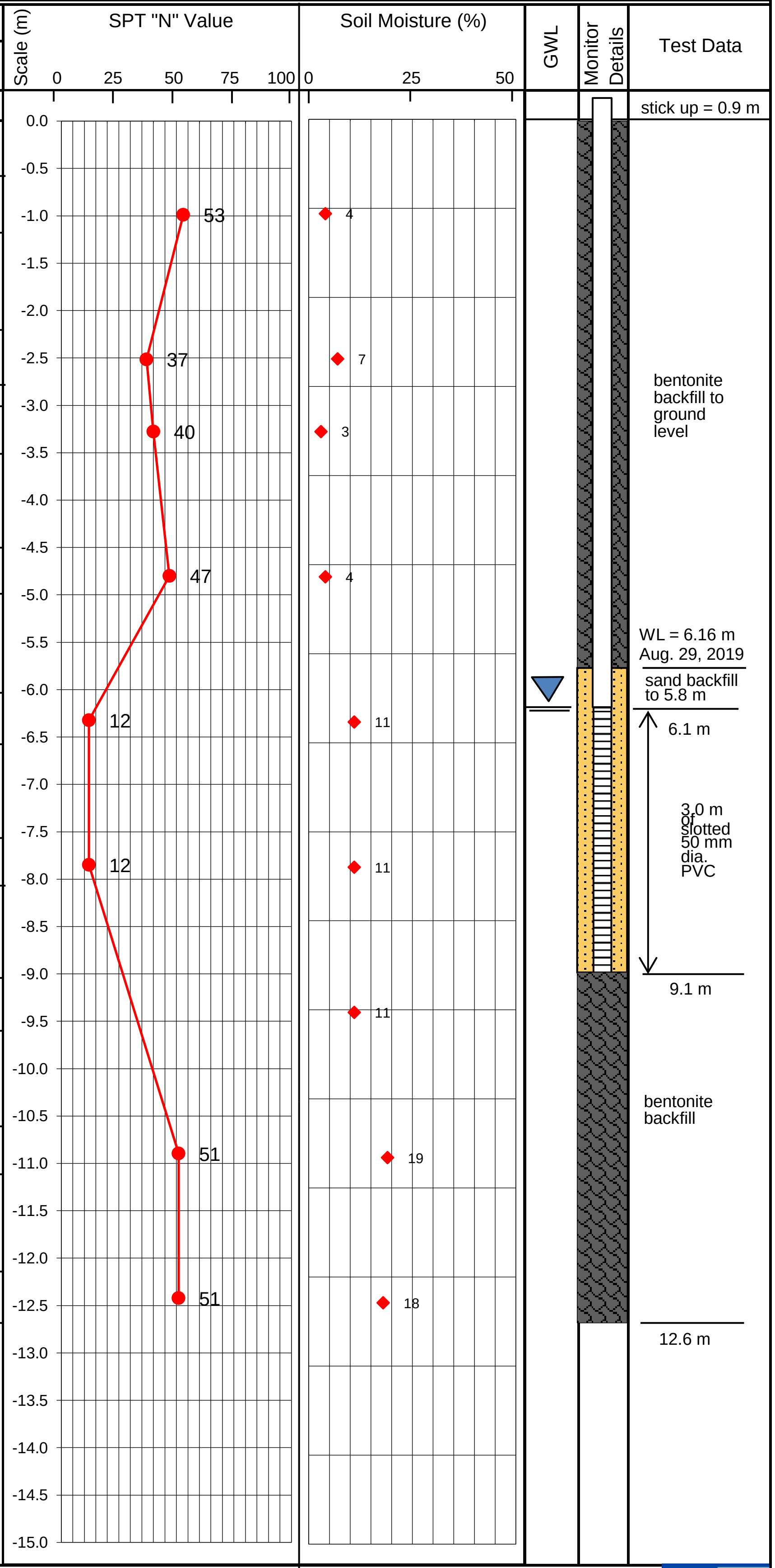
19280-01

LANDTEK LIMITED

BH/MW 1

Project No.:	19280	Drill Date:	August 12, 2019
Project:	Geotechnical Investigation	Drill Method:	[ ] solid stem [x] hollow stem [ ] vibratory
Location:	129 Collier Street, Barrie, Ontario	Datum:	TBM: Assumed elevation = 100 m

Material Description	Elev. Depth	Samples No.	Type
Ground Surface	100.6		
±150 mm of topsoil	0.0		
SAND: medium grained, gravelly, some silt, trace cobbles, dark brown, very dense, moist	0.15	1	SS
2.3 m to 6.0 m: brownish grey, dense		2	SS
		3	SS
		4	SS
6.0 m to 9.1 m: clayey, grey, wet		5	SS
		6	SS
	91.5		
CLAY: some silt, trace gravel, grey, hard**,** medium plastic, wet 9.1 m to 9.6 m: some sand and gravel seams	9.1	7	AUG
		8	SS
	88.0	9	SS
END OF BOREHOLE AT TARGET DEPTH	12.6		



Notes:
1. On completion, borehole open to 12.2 m
2. Groundwater encountered below 6.0 m
3. Water level reading: WL at 6.16 m depth on August 29, 2019

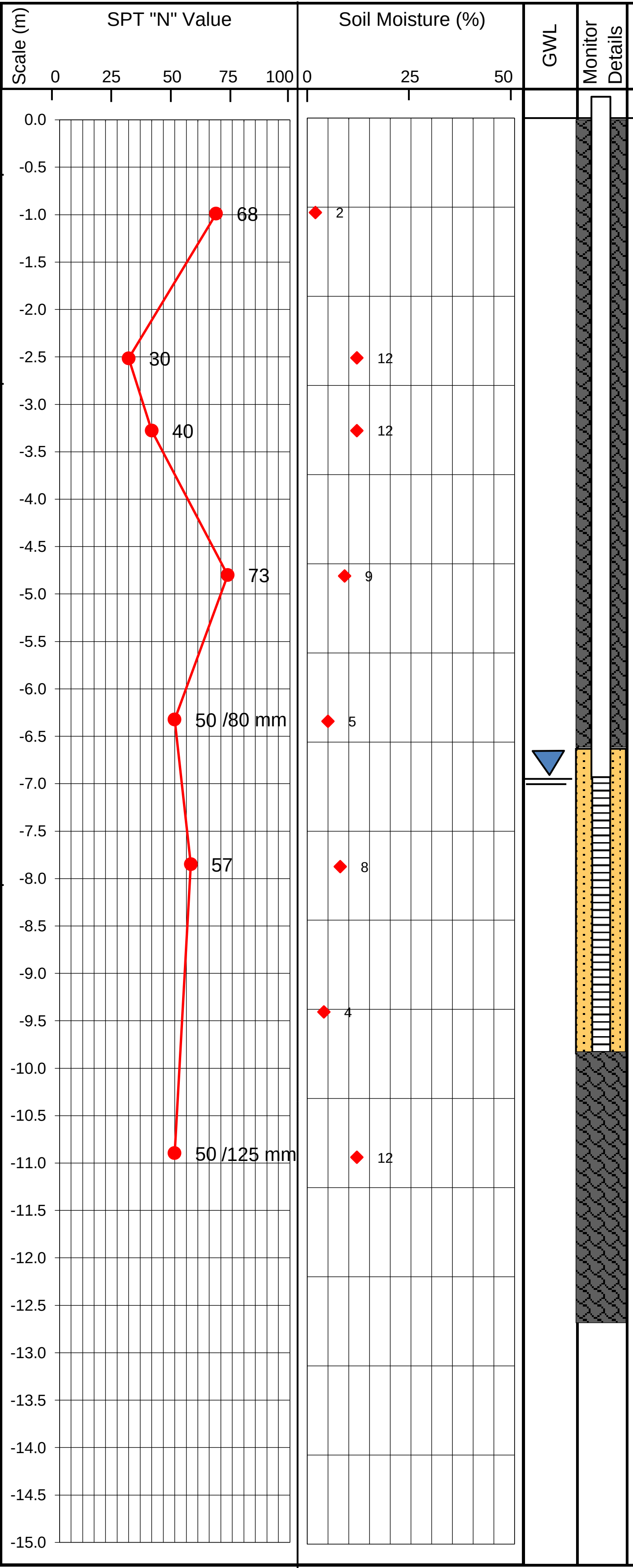
PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

LANDTEK LIMITED

BH/MW 2

Project No.:	19280	Drill Date:	August 12, 2019
Project:	Geotechnical Investigation	Drill Method:	[ ] solid stem [x] hollow stem [ ] vibratory
Location:	129 Collier Street, Barrie, Ontario	Datum:	TBM: Assumed elevation = 100 m

Material Description	Elev. Depth	Samples No.	Samples Type
Ground Surface	102.0		
±50 mm of granular (sand and gravel)	0.0		
SAND: fine to medium grained, gravelly, some silt, trace cobbles, brownish grey, very dense, damp		1	SS
2.3 m to 5.0 m: clayey, silty, trace gravel, trace cobbles, dense to very dense		2	SS
		3	SS
at 4.5 m: wet	97.0	4	SS
SILT: trace clay, brown, very dense, wet	5.0 96.0		
GRAVEL: sandy, silty, some cobbles, grey, and brown, very dense, wet	6.0	5	SS
		6	SS
	91.4	7	AUG
CLAY: some silt, grey, very stiff, medium plastic, wet	10.6	8	SS
	89.4	9	AUG
END OF BOREHOLE AT TARGET DEPTH	12.6		



Test Data

stick up = 0.82 m

bentonite backfill to ground level

WL = 6.97 m
Aug. 29, 2019

sand backfill to 6.5 m

6.8 m

3.0 m of slotted 50 mm dia. PVC

9.8 m

bentonite backfill

12.6 m

Notes:
1. On completion, borehole open to 12.2 m
2. Groundwater encountered below 4.5 m
3. Water level reading: WL at 6.97 m depth on August 29, 2019

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

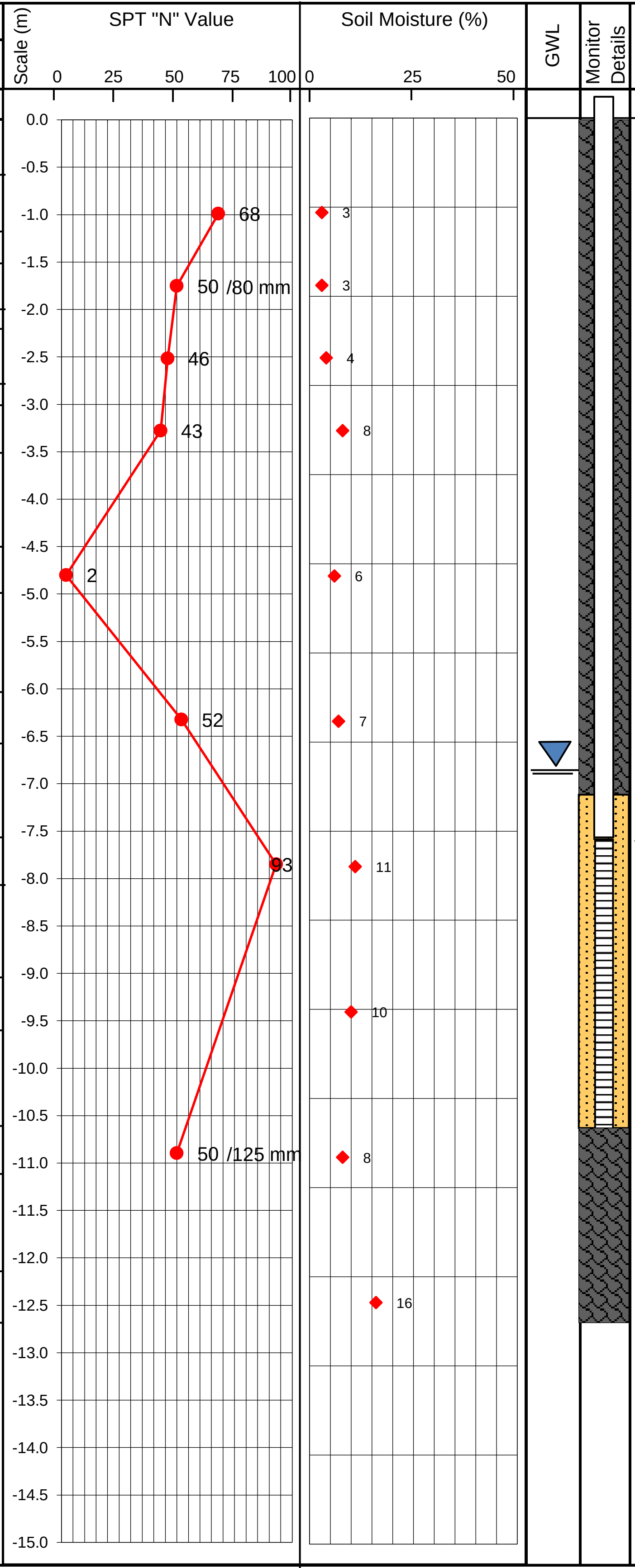
LANDTEK LIMITED

BH/MW 3

Project No.:	19280	Drill Date:	August 13, 2019
Project:	Geotechnical Investigation	Drill Method:	[ ] solid stem [x] hollow stem [ ] vibratory
Location:	129 Collier Street, Barrie, Ontario	Datum:	TBM: Assumed elevation = 100 m

Material Description	Elev. Depth
Ground Surface	102.2
±150 mm of topsoil	0.0
SAND: medium grained, gravelly, some cobbles, some silt, brown, dense to very dense, damp 2.3 m to 4.5 m: fine to medium grained, trace gravel 3.0 m to 11.4 m: brownish grey 4.5 m to 5.0 m: trace clay,	96.2
SANDY SILT TILL: trace gravel, brownish grey,very dense, moist	6.0 94.6
SAND: fine to medium grained, some silt, trace gravel, grey, very dense, wet 9.1 m to 11.4 m: medium to coarse grained, gravelly, some silt	7.6 90.8
CLAY: some silt, grey, very stiff, medium plastic, wet	11.4 89.6
END OF BOREHOLE AT TARGET DEPTH	12.6

Samples No.	Type
1	SS
2	SS
3	SS
4	SS
5	SS
6	SS
7	SS
8	AUG
9	SS
10	AUG



Test Data

stick up = 0.93 m

bentonite backfill to ground level

WL = 6.85 m
Aug. 29, 2019

sand backfill to 7.3 m

7.6 m

3.0 m of slotted 50 mm dia. PVC

10.6 m

bentonite backfill

12.6 m

Notes:
1. On completion, borehole open to 12.2 m
2. Groundwater encountered below 7.6 m
3. Water level reading: WL at 6.85 m depth on August 29, 2019

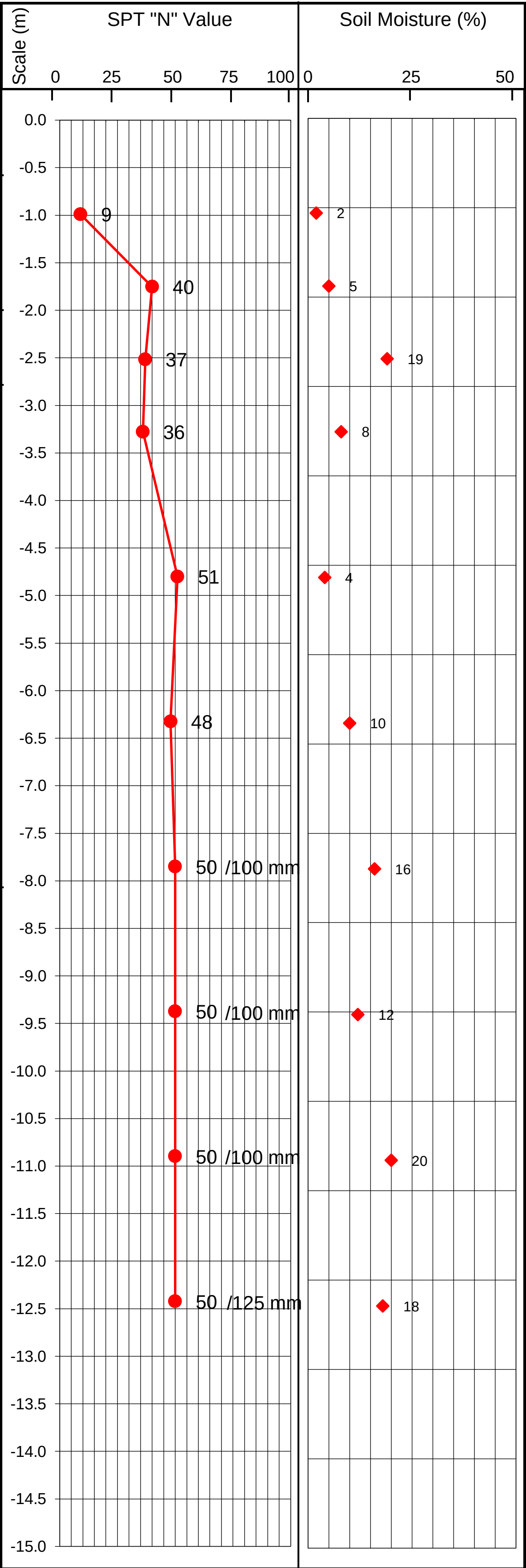
PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

LANDTEK LIMITED

BH 4

Project No.:	19280	Drill Date:	August 13, 2019
Project:	Geotechnical Investigation	Drill Method:	[ ] solid stem [x] hollow stem [ ] vibratory
Location:	129 Collier Street, Barrie, Ontario	Datum:	TBM: Assumed elevation = 100 m

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type	GWL	Monitor Details	Test Data
Ground Surface		106.0					
±50 mm of granular (sand and gravel)	▨	0.0					
SILTY SAND: trace to some gravel, trace rootlets, brown, loose, damp 1.5 m to 2.7 m: dense 2.3 m to 2.7 m: trace brick fragments, moist	▨	103.3	1 2 3	SS SS SS			
SILT: some clay, trace gravel, trace sand, brown and grey, dense, moist	▨	2.7 101.5	4	SS			
SAND: medium grained, some gravel, grey, dense to very dense, moist 6.0 m to 10.6 m: wet 6.0 m to 6.6 m: some iron staining, reddish brown	▨	4.5 95.4	5 6 7 8	SS SS SS SS			
SANDY SILT: trace clay, grey, very dense, wet	▨	10.6 93.4	9 10	SS SS			
END OF BOREHOLE AT TARGET DEPTH		12.6					



Notes:
1. On completion, borehole open to 12.2 m
2. Groundwater encountered below 6.0 m

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

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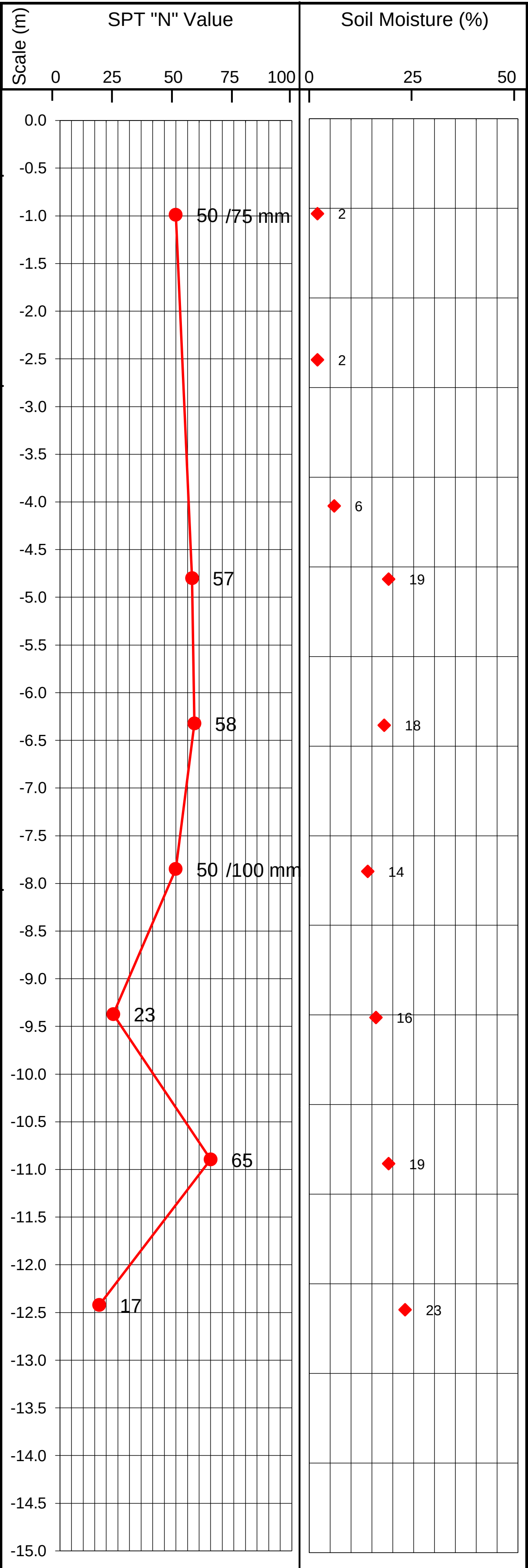
LANDTEK LIMITED

BH 5

Project No.:	19280	Drill Date:	August 14, 2019
Project:	Geotechnical Investigation	Drill Method:	[ ] solid stem [x] hollow stem [ ] vibratory
Location:	129 Collier Street, Barrie, Ontario	Datum:	TBM: Assumed elevation = 100 m

Material Description	Symbol	Elev. Depth
Ground Surface		107.1
±100 mm of topsoil		0.0
FILL: silty sand, fine grained, gravelly, trace cobble, brown, very dense, damp		103.3 3.8
SAND: gravelly, trace cobble, trace silt, brown, dense, moist		102.6 4.5
SANDY SILT: fine grained sand, grey, very dense, moist 6.0 m to 9.4 m: wet		97.7 9.4
CLAY: some silt, grey, very stiff, moist 10.5 m to 11.5 m: hard 12.0 m to 12.6 m: wet		94.5 12.6
END OF BOREHOLE AT TARGET DEPTH		

Samples No.	Type
1	SS
2	AUG
3	AUG
4	SS
5	SS
6	SS
7	SS
8	SS
9	SS



GWL	Monitor Details	Test Data

Notes:
1. On completion, borehole open to 12.2 m
2. Groundwater encountered below 6.0 m

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

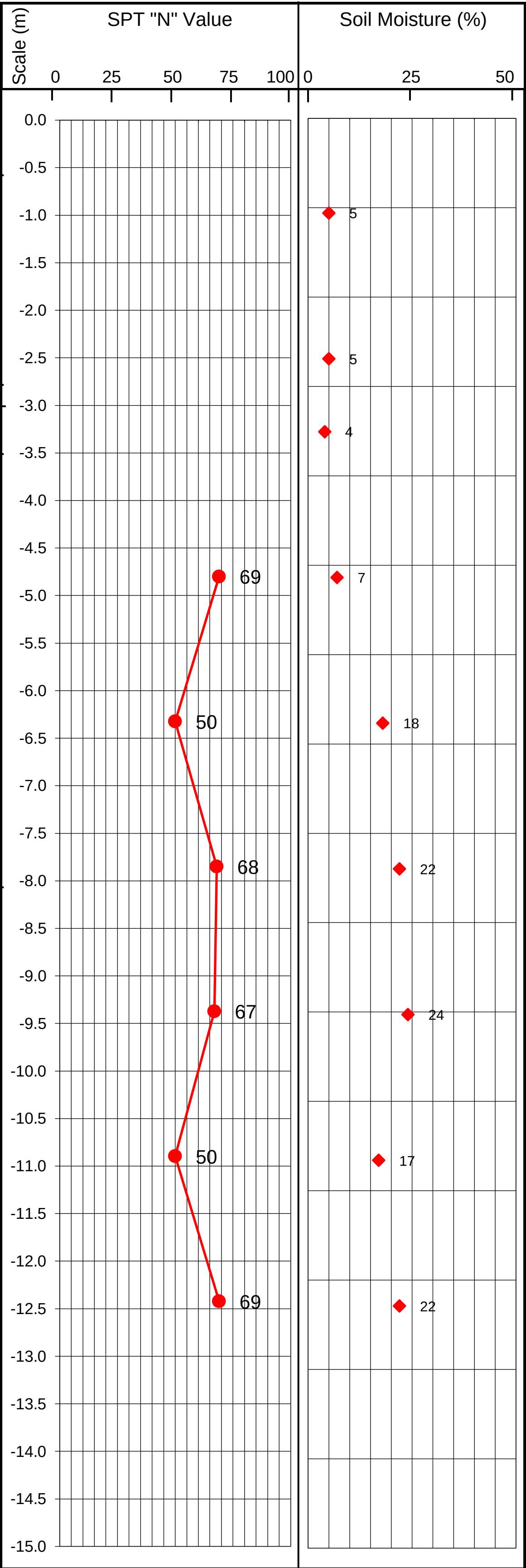
LANDTEK LIMITED **BH 6**

Project No.:	19280	Drill Date:	August 14, 2019
Project:	Geotechnical Investigation	Drill Method:	[ ] solid stem [x] hollow stem [ ] vibratory
Location:	129 Collier Street, Barrie, Ontario	Datum:	TBM: Assumed elevation = 100 m

Material Description	Symbol	Elev. Depth	GWL	Monitor Details	Test Data
Ground Surface		108.5			
±100 mm of topsoil	▨	0.0			
FILL: silty sand, fine grained, gravelly, some cobble, dark brown, compact to dense, damp	▨				
SANDY SILT: fine grained sand, grey, very dense, moist 6.0 m to 12.6 m: wet	▨	103.8 4.7			
END OF BOREHOLE AT TARGET DEPTH		95.9 12.6			

Samples

No.	Type
1	AUG
2	AUG
3	AUG
4	SS
5	SS
6	SS
7	SS
8	SS
9	SS



Notes:
1. On completion, borehole open to 12.2 m
2. Groundwater encountered below 6.0 m

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

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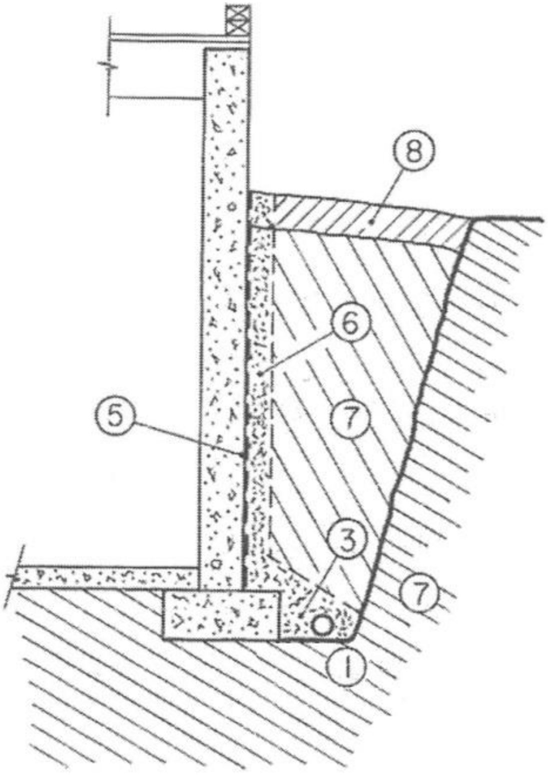
APPENDIX D

DRAWING 19280-02 – ENGINEERING COMMENTARIES – GENERAL REQUIREMENTS FOR DRAINAGE TO BASEMENT STRUCTURES

DRAWING 19280-03 – ENGINEERING COMMENTARIES – GENERAL REQUIREMENTS FOR UNDERFLOOR DRAINAGE SYSTEMS



① 100 mm, perforated or slotted pipe placed below the upper level of the floor slab.;

③ Filter material that is compatible with the grain size characteristics of the fine grained foundation and backfill soils, as well as with the perforations of the pipe;

④ Filter material continuously or intermittently placed next to the foundation wall to intercept water draining from window wells, down exterior walls and from low areas near the building;

⑤ Damp-proofing on wall – optional depending on the quality of the concrete wall;

⑥ Optional use of sheet drain, or synthetic fire blanket, next to the foundation wall to replace the soil filter according to ④;

⑦ Foundation and backfill soils, which may contain fine grained and erosion-susceptible materials;

⑧ "*Topping off*" material is to be graded such that it slopes outwards to lead surface water away from the building. It is usually desirable to use low permeability topsoil to reduce the risk of overloading the drainage pipe.

Based on Figure 12.1, Canadian Foundation Engineers Manual, Fourth Edition, 2006.

Additional Notes:

1. The perforated or slotted drainage pipe is to lead to a positive drainage sump or outlet. The invert of the pipe is to be a minimum of 150 mm below the underside of the proposed floor slab.
2. Backfill materials to the interior of the foundation walls may be clean, organic-free soils that can be compacted to the specified density within in a confined space.
3. Heavy, vibratory compaction equipment should not be used within 450 mm of the foundation wall. Fill is not to be placed or compacted within 1.8 m of the wall unless fill is being placed simultaneously on both sides of the wall.
4. The moisture barrier beneath the floor slab is to comprise at least 200 mm of compacted19mm clear stone or an equivalent free-draining material.
5. Should the 19 mm clear stone require surface blinding then 6mm stone chips are to be used.
6. The slab on grade should not be structurally connected to the foundation wall or footing.

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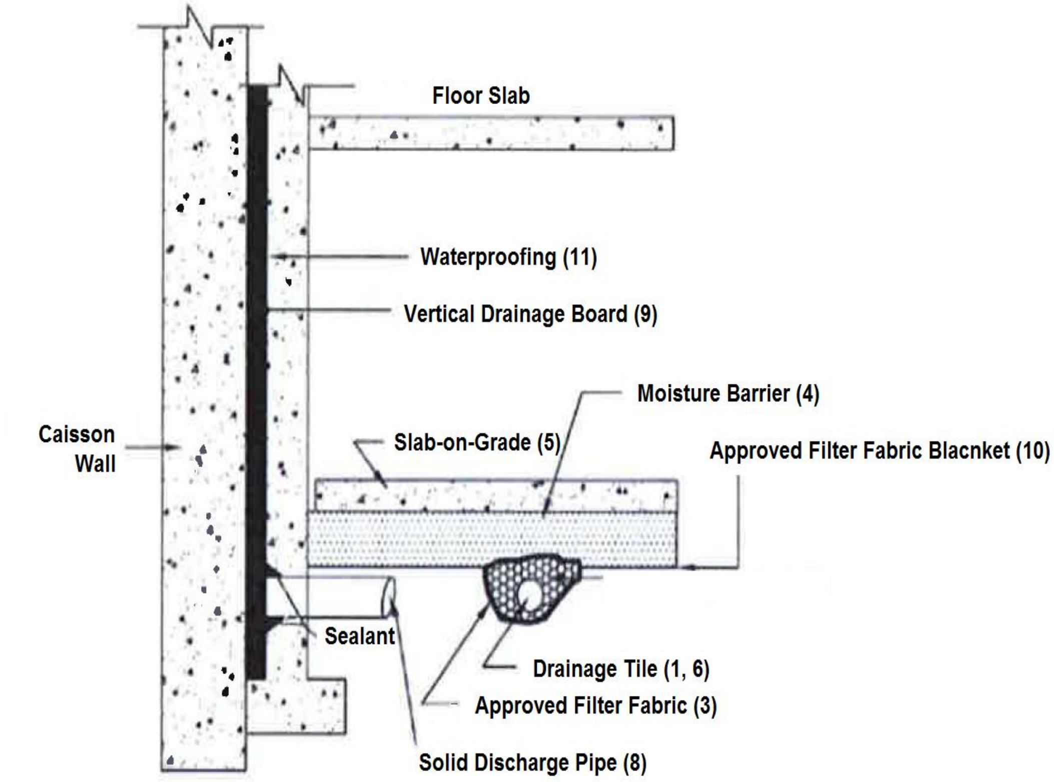
General Requirements for Drainage to Basement Structures

client Pinemount Developments Ltd

project 129 Collier Street, Barrie, Ontario

project # 19280

drawing # 2



Notes:

1. Drainage tile to consist of 100 mm diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet, spaced between columns;
2. 19 mm clear stone – 150 mm top and side of drain. If the drain is not on the footing then place 100 mm of 19 mm clear stone below the drain;
3. Wrap the clear stone with an approved filter fabric (e.g. Terrafix 270R or equivalent);
4. Moisture barrier to be at least 200 mm of compacted, 19 mm clear stone or equivalent (and approved), free-draining material. A vapour barrier may be required for specialty floor coverings;
5. Typically, the slab-on-grade is not structurally connected to the wall or footing. However, if it is connected to the walls it should be designed accordingly;
6. Underfloor drain invert to be at least 300 mm below underside of floor slab. Drainage tile should be placed in parallel rows 6 m to 8 m centres one way. Place drains on 100 mm of 19 mm clear stone and 150 mm of 19 mm clear stone on top and sides. Enclose clear stone with filter fabric as prescribed in Note (3);
7. Do not connect underfloor drainage to perimeter drainage. The two systems are to remain separate.
8. Locate solid discharge at the middle of each bay between soldier piles;
9. Vertical drainage board (e.g. MiraDrain 6000 or equivalent) with filter cloth should be continuous from bottom to 1.2 m below exterior finished grade;
10. The entire subgrade is to be sealed with an approved filter fabric as in Note (3) where non-cohesive (silty/sandy/granular) soils are encountered below the groundwater table;
11. The basement walls must be waterproofed using bentonite or an equivalent waterproofing system;
12. The Geotechnical Report should be reviewed for site-specific details. Final detail must be approved before system is considered acceptable.

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General Requirements for Underfloor Drainage Systems

client Pinemount Developments Ltd

project 129 Collier Street, Barrie, Ontario

project # 19280

drawing # 3

APPENDIX E

SITE PHOTOGRAPHS

Photograph #1
View of site, facing west

Photograph #2
View of site, facing north

LANDTEK LIMITED

Project No.	19280	Date: September 2019

Geotechnical Investigation Report
129 Collier Street, Barrie, Ontario

Title:	Photographs of Site Conditions

Photograph #3
View of site, facing east

Photograph #4
View of site, facing south towards Lake Simcoe

LANDTEK LIMITED

Project No.	19280	Date: September 2019

Geotechnical Investigation Report
129 Collier Street, Barrie, Ontario

Title:	Photographs of Site Conditions