Starlight Investments Ltd.

Geotechnical Investigation
37 Johnson Street, Barrie, Ontario

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Final Report

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Geotechnical Investigation, 37 Johnson Street, Barrie, Ontario

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1 Introduction

This report presents the results of a geotechnical investigation carried out at 37 Johnson Street which is located in Barrie, Ontario. The investigation was conducted to assess the subsurface soil conditions in order to provide geotechnical recommendations for the proposed construction of a multi-storey residential building with one level of underground parking on the site. The work was authorized by Ms. Ashley Burke of Starlight Investments Ltd. on October 3, 2016.

The purpose of this investigation was to determine the subsurface soil and groundwater conditions at the site by advancing a limited number of sampled boreholes. Based on the information developed during the on-site investigation, recommendations are provided for the design of the foundation.

2 Site Description

The project site is located at 37 Johnson Street, Barrie, Ontario. The site is located east of Johnson Street, south of Indian Arrow Road and north of Campfire Court. An existing multi-storey residential building and parking facility occupies the southern and western portions portion of the site. The investigation was carried out over the northeast portion of the site, north of the existing Site building and parking facility. The project site increases approximately 5 metres in elevation from the parking facility towards the north corner of the Site property.

3 Procedure

The fieldwork for the geotechnical investigation was carried out on October 26, 27 and 28, 2016. The investigation included six (6) boreholes (numbered BH1 to BH6, inclusive) which were advanced to a depth ranging between 8.1 and 12.5 metres[1] at the locations indicated on the attached Borehole Location Plan (Drawing No. 1) in Appendix A.

The boreholes were advanced using a track mounted drill rig equipped with continuous flight, hollow and solid stem augering equipment and standard soil sampling equipment, owned and operated by a specialist drilling contractor.

The field work was conducted under the supervision of a qualified member of our geotechnical engineering staff. The field engineer examined and classified characteristics of the soils encountered in the boreholes, including the presence of fill materials, made groundwater observations during and upon completion of the drilling, recorded observations of borehole construction, and processed the recovered samples. Representative samples of the overburden were recovered at frequent depth intervals for identification purposes using a conventional split spoon sampler. Standard penetration tests were carried out simultaneously with the sampling operations to assess the strength characteristics of the substrate. Upon completion of drilling, groundwater levels were observed and recorded.

All recovered soil samples were logged in the field, carefully packaged and transported to the laboratory for more detailed examination and classification. In the laboratory, the samples were classified as to their olfactory, visual and textural characteristics.

[1] Unless otherwise indicated all depths are noted as metres below existing grade.

The location and elevation of the explorations were determined by **exp**. The horizontal locations were laid out in the field by **exp** at the time of the drilling operations. The elevations were determined by GPS survey equipment and are referenced to NADS 83 datum.

4 Laboratory Testing

The laboratory-testing program consisted of the following:

- Natural moisture content tests on all recovered samples, with results presented on the Borehole Logs found in Appendix C (Figures 2 to 7, inclusive).
- Three (3) soil samples analyzed (BH2 S3, BH3 S4 and BH4 SA3) for Corrosivity which included Sulfate, pH, Electrical Conductivity, Redox Potential, Resistivity, Chloride and Sulphate. The laboratory Certificates of Analysis is included in Appendix D.
- Standard characterization tests (Sieve Analysis / Hydrometer) were performed on samples:
  - BH1 – SA3
  - BH2 – SA9
  - BH3 – SA9
  - BH4 – SA10
  - BH5 – SA3, SA7 & SA8
  - BH6 – SA4

  The results of these test are presented on the Borehole Logs and the results are presented in Appendix D.
- One (1) standard proctor test was conducted on a combined composite sample of predominant soil stratum from each borehole. The test result is presented in Appendix D.

5 Subsurface Conditions

The detailed soil profile encountered in the boreholes and the results of laboratory moisture content testing are indicated on the attached borehole logs in Appendix C (Figures 2 to 7, inclusive). They include textural descriptions of the subsoil at each location along with the other results of the field-testing program. Two cross-sections are also included in Appendix C.

It should be noted that the soil boundaries indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect transition zones for the purpose of geotechnical design and should not be interpreted as exact planes of geological change. Figures 1A and 1B, "Notes on Sample Descriptions", found in Appendix B, are an integral part of and should be read in conjunction with this report.

The stratigraphy at the site, as revealed in the sampling completed within the boreholes, is generally comprised of an initial layer of topsoil followed by layer of fill overlying varying native till / sand / silty sand / silty clay layers.

A brief description of the soil profile, in general order of depth (listed in metres below grade, unless otherwise noted), follows:

Topsoil / Fill

An initial layer of topsoil was encountered in all boreholes with the exception of Borehole BH6 and was approximately 130 to 250 mm thick.

Fill was encountered in all boreholes, directly below the topsoil layer and at surface in Borehole BH6 and extended to depths ranging between approximately 0.5 to 3.6 metres. The fill is described as silt and sand, contained trace to some gravel, trace clay, with organics, rootlet and wood inclusions and is brown to grey in colour. The fill is generally loose to dense with Standard Penetration Test (SPT) "N" values ranging from 9 to 50 blows for 75 mm of penetration. The moisture conditions encountered were damp to wet with the natural moisture contents of the recovered samples ranging from 7 to 19%.

Please note that the thickness and composition of topsoil/fill can vary greatly across a site. The thicknesses and compactness conditions indicate above and shown on the borehole logs are based on very localized information and should not be used for estimation purposes (i.e. cut/fill quantities, etc.). A test pit investigation is recommended if accurate quantities are required for budgeting purposes.

Till

Till varying in composition from a silt and sand to sand and gravel matrix was encountered in all boreholes directly below the fill layer starting from approximately 0.7 to 3.7 metres. The upper till layer extended to a depths ranging from 1.5 to 10.2 metres in all boreholes. The upper till was found to be loose to very dense with a Standard Penetration Test (SPT) "N" values ranging from 7 to 60 blows. The moisture conditions encountered in this layer were damp to wet with a natural moisture content of the recovered samples ranging from 4 to 21%.

A lower silt and sand till was encountered in Borehole BH3 at approximately 11.0 m and extended to the termination of the borehole at approximately 12.5 metres. The lower till layer contained trace gravel, trace clay and was grey in colour. The lower till was found to be dense to very dense with a Standard Penetration Test (SPT) "N" values ranging from 44 to 90 blows. The moisture conditions encountered in this layer were moist with a natural moisture content of the recovered samples ranging from 8 to 11%.

Sand

A native sand layer was encountered in all boreholes. The sand layers varied in composition and contained with to trace gravel, with to some silt. The varying sand deposits were found to be compact to very dense with a Standard Penetration Test (SPT) "N" values ranging from 26 to 113 blows. The moisture conditions encountered in this layer were moist to wet with a natural moisture content of the recovered samples ranging from 10 to 28%.

Silt / Clayey Silt

Intersecting layers of silt and clayey silt were encountered in Boreholes BH2, BH3 and BH6 beneath the upper till and/or sand layer. The silt was described as trace to some sand, trace to some clay. The silt is grayish brown to brownish grey in colour and is dense to very dense with Standard Penetration Test (SPT) "N" values ranging from 47 to 63. The moisture conditions encountered are wet with the natural moisture contents of the recovered samples ranging from 16 to 22%.

Silty Clay

A thin silty clay layer was encountered in Borehole BH5 approximately 1.5 metres thick at a depth of 5.7 metres below the existing ground surface. The silty clay is grey in colour and hard with Standard Penetration Test (SPT) "N" values of 52.

Groundwater

Groundwater conditions were observed in the open boreholes during the course of the fieldwork. End-of-hole groundwater measurements are included in the attached borehole logs. Upon completion of drilling the boreholes, the end-of-day measurements the boreholes ranged between 3.0 to 9.1 metres below the existing ground surface.

A 51 mm diameter PVC monitoring well was installed in Boreholes BH2, BH4 and BH6. The groundwater table, which was measured on November 21, 2016 ranged between 3.1 to 6.5 metres below the existing ground surface. Seasonal fluctuation of the groundwater levels at the site should also be anticipated.

6 Discussion and Conclusion

6.1 General

The project involves the proposed construction of an eleven storey residential building with one level of underground parking at 37 Johnson Street in Barrie, Ontario. Based on the information provided, we have assumed that the basement/garage floor for the underground parking level will have a surface elevation of approximately 239.0 m.

As identified previously, the soils in this area generally consist of an initial layer of fill overlying a silt and sand till, which is in turn overlying various silt and sand deposits.

The following subsections provide geotechnical engineering guidelines for the design and construction of the proposed development.

6.2 Site Grading

It is understood that some re-grading will be carried out at the site.

The following procedures are recommended for the construction of fill sections for building and pavement areas at the site, where required.

- Site preparation should involve removal of all fill, topsoil, stockpiles, debris and other unsuitable materials down to competent native inorganic soil.

- Following approval of the sub-grade by geotechnical personnel, the site can then be brought up to final sub-grade level with approved on-site or imported material placed in lifts not exceeding 200 mm (loose thickness) and compacted to 100% of its SPMDD within the building area and 98% in pavement or open space areas. The moisture content of the fill to be placed should be at or near its optimum moisture content in order to assure the specified densities can be achieved with reasonable compactive effort.

- Excavated inorganic silty soils from the site are expected to generally be suitable for reuse as fill, subject to effective moisture control; however, they may be difficult to work with. It must be noted that the site soils are moderately to highly sensitive (depending on silt content) and may be easily disturbed if they become wet. It should be noted that the existing moisture contents are typically higher than the optimum moisture content determined by the standard Proctor test performed on the site material (see Section 4.0). In this regard, it is noted that periods of prolonged rainfall would adversely impact the handling and compaction characteristics of the material. As a result, after periods of heavy rainfall, rutting of the sub-grade under heavy repeated traffic can be expected. Construction methods, equipment and schedules must be adopted for these conditions.

- All imported borrow fill material from local sources should be free of organic material and foreign objects (i.e. trees, roots, debris, etc.) and should be approved by **exp** prior to transport to the site. In addition, the chemical quality of the borrow fill material should be assessed by **exp** in accordance with the current applicable Ministry of Environment (MOE) regulations and guidelines.

- All backfilling and compaction operations should be monitored on a full-time basis by **exp** geotechnical staff to approve materials and to ensure the specified degrees of compaction have been obtained.

6.3 Building Construction

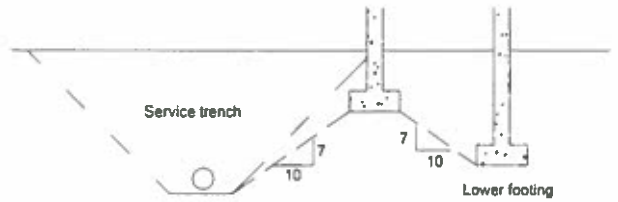
6.3.1 Foundations

Based on the results of the boreholes drilled at the site, the proposed construction may be supported on conventional spread and strip footings as detailed in the following table, subject to inspection by **exp** during construction.

Table 1: Footing Design Parameters

Borehole No.	Depth/Elevation to Founding Soil (m)	SLS Bearing Capacity (kPa)	ULS Bearing Capacity (kPa)
BH1	1.0/243.1	350	525
BH2	3.7/242.4 4.5/241.6	200 350	300 525
BH3	4.0/242.8 6.0/240.8	100 350	150 525
BH4	2.5/240.2 3.8/239.0	150 350	225 525
BH5	1.0/241.8	350	525
BH6	1.0/240.8 2.5/239.3	250 350	375 525

Foundations, which are to be placed at different elevations, should be located such that the higher footings are set below a line drawn up at 10 horizontal to 7 vertical from the near edge of the lower foundation or bottom of the service trench, as indicated on the following sketch:



FOOTINGS NEAR SERVICE TRENCHES OR AT DIFFERENT ELEVATIONS

The native silt and sand till soils are considered to be moderately to highly frost susceptible (increased silt content increases the frost susceptibility). All footings or grade beams exposed to seasonal freezing conditions should be protected from frost action by at least 1.5 m of soil cover or equivalent insulation, depending on the final design requirements.

The total and differential settlements of well designed and constructed footings placed in accordance with the above recommendations are expected to be less than 25 mm and 19 mm, respectively.

It should be noted the recommended bearing capacity has been calculated by **exp** from the borehole information for the design stage only. The investigation and comments are necessarily ongoing as new information on underground conditions become available. For example, it should be appreciated that modifications to bearing levels may be required if unforeseen subsoil conditions are revealed after the excavation is exposed to full view or if final design decisions differ from those assumed in this report. For this reason, this office should be retained to review final foundation drawings and to provide field inspections during the construction stage.

Founding surfaces are subject to softening/loosening when exposed to water and construction activities. In this regard, excess water and/or disturbed soils must be removed prior to placement of concrete. The use of a protective skim coat of lean concrete may be warranted where founding surfaces are to be exposed for an extended period.

6.3.2 Floor Slabs

The borehole data indicate that the lower parking slab will likely be constructed on the dense to very dense silt and sand till and/or sand/silt deposits. Following excavation to the design sub-grade elevation, the area should then be proof-rolled and evaluated by a geotechnical engineer. Any soft spots identified should be sub-excavated. The sub-excavation areas can then be brought up to the design subgrade level using Granular "B" (OPSS 1010) compacted to 100 percent standard Proctor maximum dry density (SPMDD). The parking garage slab can be designed based on a modulus of subgrade reaction of 30 MPa/m on the well-compacted fill materials.

If the garage space is not heated, insulation will need to be provided, both beneath the floor slab and behind the walls to prevent the frost prom penetrating into the surrounding frost susceptible soils and causing vertical or horizontal movement of the concrete structures. For under-slab installations, Styrofoam Highload 40 (or equal) should be used. Styrofoam Ultra SL can be used behind the wall. For design purposes, 25 mm of Styrofoam can be assumed to equal 0.3 m of ground cover.

6.3.3 Excavation and Groundwater Control

Excavations carried out through the existing silt and sand deposits above the prevailing groundwater level may be carried out in open cuts using conventional equipment. Pumping from filtered sumps located outside of the foundation areas may be sufficient to control any potential perched groundwater inflow. Excavations carried out below the prevailing groundwater table may be problematic and could require positive groundwater dewatering methods using well points.

The observed groundwater table depth at the site in the piezometers that were installed on site were checked on November 21, 2016 and the groundwater level was found to range between elevations 238.2 and 239.6 m.

A test dig is recommended to permit prospective contractors an opportunity to view and assess the conditions likely to be encountered and the preferred means of construction cognizant of their own experience and available expertise.

6.3.4 Side Slopes

For preliminary guidance, for this site, the overburden soils encountered in our exploratory explorations consist of fill overlying silt and sand till (within the expected depth of excavation). Under the Occupational Health and Safety Act regulations, these soils should be classified as Type 3 soil requiring a maximum slope inclination of 1 vertical to 1 horizontal extending from the bottom of the excavation, assuming that the groundwater is maintained below the level of the floor of the excavation. The silt and sand deposits below the groundwater table should be classified as Type 4 soil requiring a maximum slope inclination of 1 vertical to 3 horizontal extending from the bottom of the excavation. The need to excavate flatter side slopes if excessively wet or soft/loose materials, or concentrated seepage zones are encountered, should not be overlooked.

The contractor should be aware that slope height, slope inclination, or excavation depths (including utility trench excavations) should in no case exceed those specified in local, provincial or federal safety regulations. Such regulations are strictly enforced and, if not followed, the owner, the contractor or earthwork or utility subcontractor could be liable for substantial penalties.

It is important to note that soils encountered in the construction excavations may vary significantly across the site. Our preliminary soil classifications are based solely on the materials encountered in widely spaced explorations. The contractor should verify that similar conditions exist throughout the proposed area of excavation. If different subsurface conditions are encountered at the time of construction, we recommend that **exp** Services Inc. be contacted immediately to evaluate the conditions encountered.

6.3.5 Dewatering

Based on the findings in the boreholes at the time of the investigation and our understanding of the proposed development, no significant dewatering should be required for the construction of the proposed residential building and below ground parking garage. Depending on the depth of the footings for the parking garage and building, positive dewatering might be required. The native soils are in a dense to very dense condition and would reduce the percolation of groundwater into the excavations. This groundwater seepage might be able to be controlled using filtered pumps, however, if the excavations are left open for longer than 24 hours, then positive dewatering might be required to reduce the groundwater inflow. Any inflow of groundwater into the excavations should be able to be controlled by the use of filtered sumps for excavations that extend up to 0.5 metres below the groundwater table. Excavations that are required to extend beyond 0.5 meters below the groundwater table may require positive dewatering.

Although this investigation has estimated the groundwater level at the time of the field work, and commented on dewatering and general construction problems, the presence of conditions which would be difficult to establish from small diameter boreholes may affect the type and nature of dewatering procedures, which should be used by the contractor in practice. These conditions include

local and seasonal fluctuations in the groundwater table, erratic changes in the soil profile between the tests, thin layers of soil with large or small permeability compared with the general soil mass and possibly sources of relatively large recharge.

6.3.6 Backfill Considerations

Backfill used to satisfy under floor slab requirements, in footing and service trenches, etc., should be compactable fill, i.e. inorganic soil with its moisture content close to its optimum moisture content as determined in the Standard Proctor Maximum Dry Density test.

The excavated on-site material will primarily consist of topsoil, fill and till. The topsoil, fill and till materials are not suitable for use as a drainage medium. Imported granular material conforming to Ontario Provincial Standard Specifications (OPSS) Granular 'B' Type I specifications would be suitable for this purpose. If there are water concerns/problems and imported granular material is required to bring the elevation to the design elevation, then 50 mm crusher run material should be used.

Any shortfall of suitable on-site excavated material can be made up with imported granular material, such as OPSS Granular 'B' Type I or equivalent. The backfill should be placed in lifts not more than 200 mm thick in the loose state with each lift being compacted to 100% of its SPMDD within the building area and 98% elsewhere before subsequent lifts are placed. The degree of compaction achieved in the field should be checked by in-place density tests.

6.3.7 Subsurface Walls

Basement and retaining walls must be designed to resist the unbalanced lateral earth pressure due to the weight of the retained soil. The lateral earth pressure, p, may be computed using the following equation and assuming a triangular pressure distribution:

$$p = k(\gamma h + q)$$

where: p = the pressure in kPa acting against any subsurface wall at depth, h, below the ground surface;

k = the earth pressure coefficient considered to be appropriate for the subsurface walls, see # below for appropriate values;

γ = the bulk unit weight of the retained free draining granular backfill; use 21 kN/m^3;

h = the depth in m below the ground surface at which the pressure, p, is to be computed;

and

q = the value of any adjacent surcharge in kPa, which may be acting close to the wall.

(Note: # k = 0.5 for restrained basement walls; 0.4 for semi flexible walls where some deflection is permitted; 0.35 for flexible cantilever walls).

The above expression assumes an effective perimeter tile drain system will be incorporated to prevent the build-up of hydrostatic pressure behind the wall. All subsurface building walls should be waterproofed and backfilled with free draining granular material. To minimize infiltration of surface water, the upper 600 mm of backfill should comprise compacted relatively impervious material sloped away from the building.

3.2.7 Permanent Drainage

A permanent perimeter tile drainage system should be provided around the parking garage walls and under-floor drains should be installed below the parking garage floor slab on 3 metre centres. The perimeter drains should consist of 100 mm diameter perforated plastic pipe with a filter sock surrounded by at least 150 mm of 19 mm clear stone, all wrapped in a non-woven geotextile (Terrafix 270R or equivalent). For the underfloor drainage, a layer of 19 mm clear stone 300 mm thick should be provided, with the drainage pipes placed at the bottom of the stone layer. Geotextile protection will not be required for the top surface of stone within the building interior, but will be required between the sub-grade and the bottom of the stone layer.

The sub-drains should be carefully installed with a 0.4% to 0.5% slope. Around the perimeter of the building, the ground surface should be sloped on a positive grade away from the structure to promote surface water run-off and to reduce groundwater infiltration adjacent to the foundations. Due to the fluctuating groundwater table, all sub-surface building walls should be waterproofed and backfilled with free draining granular material.

3.2.8 Earthquake Considerations

Subsoil Conditions

The subsoil and groundwater information at this site has been examined in relation to Section 4.1.8.4 of the Ontario Building Code 2006 edition (OBC, 2006). The subsoil generally consisted of silty sand and silty sand till deposits. The foundation system is anticipated to be founded on the compact to very dense silty sand till. The reported "N" values for the soil below the foundation levels ranged from 36 to greater than 50.

As there have been no shear wave velocity measurements carried out at this site, a correlation using the SPT "N" values from the boreholes will have to be used to determine the site classification.

Depths of Boreholes

Table 4.1.8.4.A. Site Classification for Seismic Site Response in OBC 2006 indicated that to determine the site classification, the average properties in the top 30 metres are to be used. The boreholes advanced at this site were terminated at a maximum depth of 12.5 metres. Therefore, the site classification recommendation would be based on the available information as well as our assumption that the soil conditions are similar below the drilled depth.

Site Classification

The soil deposits are generally non-cohesive. Based on the above assumptions and interpretations and the known soil conditions, the Site Class for this site is considered to be "C", as per Table 4.1.8.4.A. Site Classification for Seismic Site Response, OBC, 2006.

6.3.8 Soil Corrosivity

Three (3) split spoon soil samples were submitted to an independent analytical laboratory accredited by the Canadian Association for Laboratory Accreditation (CALA) for chemical analyses consisting of Resistivity, Soluble Chloride, Conductivity, pH, Soluble Sulphate, and Redox Potential. These parameters are used for assessing soil corrosivity according to the 10-point soil evaluation procedure described in American Water Work Association (AWWA) C-105 Standard. It should be noted that the analytical results only provide an indication of the potential for corrosion.

Based on this 10-point evaluation procedure, the severity ranking of the tested sample is tabulated below. The Certificates of Analyses for the corrosivity package are attached in Appendix D.

Table 6: Soil Corrosivity According to AWWA C-105 Standard

Sample Identification	Sample Depth (m)	Material / Soil Type	Severity Ranking
BH2 SA3	1.5 – 2.1	Fill: Silt and Sand, Trace Gravel, Trace Clay	1
BH3 SA4	2.3 – 2.9	Fill: Silt and Sand, Trace to Some Gravel, Trace Clay	1
BH4 SA3	1.5 – 2.1	Fill: Silt and Sand, Trace Gravel, Trace Clay	1

Based on the total points of the soil sample being less than ten, corrosion protective measures are not required for any cast iron alloys that will be exposed to this soil.

The soluble sulphate concentration of the selected sample was also compared to the Canadian Standard CAN3/CSA A23.1 Table 3, Additional Requirements for Concrete Subjected to Sulphate Attack. It is anticipated that these results would be used to determine the type of cementing materials to be used in the manufacture of the concrete foundations. Comparison of the test results indicate that the water soluble sulphate concentration in the tested soil samples is 0.014% or less, and are therefore lower than 0.1%. Based on these results, there is a negligible potential for sulphate attack on concrete exposed to this soil, regardless of the cementing material used.

6.3.9 Hydraulic Conductivity

The site soils above the groundwater table consist of either a silt and sand, trace to some gravel, trace clay material or a silt and sand till. Based on the gradation results discussed in Section 4.0 above, the estimated hydraulic conductivity of these soils ranges from 10^{-4} to 10^{-6}, depending on the silt and clay content of the materials.

Since the anticipated depth of construction will result in the structure being founded at or near the existing groundwater table, infiltration as part of the stormwater management system may not be a desirable design option. If infiltration is used, the groundwater table would rise, resulting in an increase in the volume of water that the drainage system around the parking structure would be required to handle.

6.4 Site Services

6.4.1 Excavations and Side Slopes

For recommendations with respect to excavations and side slopes, see Sections 6.3.3 and 6.3.4 above.

6.4.2 Bedding

The type of material and depth of granular bedding below the pipe will, to some extent, depend on the method of construction used by the contractor.

It is normal procedure to extend the pipe bedding up to the spring line of the pipe where the depth of cover over the pipe is less than 2.1 metres. Where the cover over the pipe is 2.1 metres or more, then it would be prudent to increase the depth of pipe bedding to a level of 300 mm above the obvert of the pipe.

Assuming adequate groundwater control methods are employed, we would suggest that the pipe bedding material consist of a minimum of 150 mm of granular "A" sand and gravel.

In both cases, particular care must be taken to ensure adequate compaction below the haunches of the new pipe.

6.4.2.1 Flexible Pipes

Pipe bedding requirements outlined in the Ontario Provincial Standard Drawing 802.010 (flexible pipe) should be sufficient. Standard granular bedding in accordance with OPSS, compacted to 95% Standard Proctor Maximum Dry Density (SPMDD), should be satisfactory for pipes founded on native soil. For flexible pipes, bedding and cover material should be comprised of OPSS Granular "A".

6.4.2.2 Rigid Pipes

Pipe bedding requirements outlined in the Ontario Provincial Standard Drawing 802.031 and 802.032 (rigid pipe) should be sufficient. Standard granular bedding in accordance with OPSS, compacted to 95% Standard Proctor Maximum Dry Density (SPMDD), should be satisfactory for pipes founded on native soil. For rigid pipes, bedding material (to the pipe spring-line) should be comprised of OPSS Granular "A". Dry native sands should be suitable for cover material, subject to field review.

7 General Comments

Exp Services Inc. should be retained for a general review of the final design and specifications to verify that this report has been properly interpreted and implemented. If not accorded the privilege of making this review, **exp** Services Inc. will assume no responsibility for interpretation of the recommendations in the report.

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

More specific information with respect to the conditions between samples, or the lateral and vertical extent of materials may become apparent during excavation operations. The interpretation of the borehole information must, therefore, be validated during excavation operations. Consequently, during the future development of the property, conditions not observed during this investigation may become apparent; should this occur, **exp** Services Inc. should be contacted to assess the situation and additional testing and reporting may be required.

We trust this report is complete within our terms of reference, and the information presented is sufficient for your present purposes. If you have any questions, or when we may be of further assistance, please do not hesitate to contact our office.

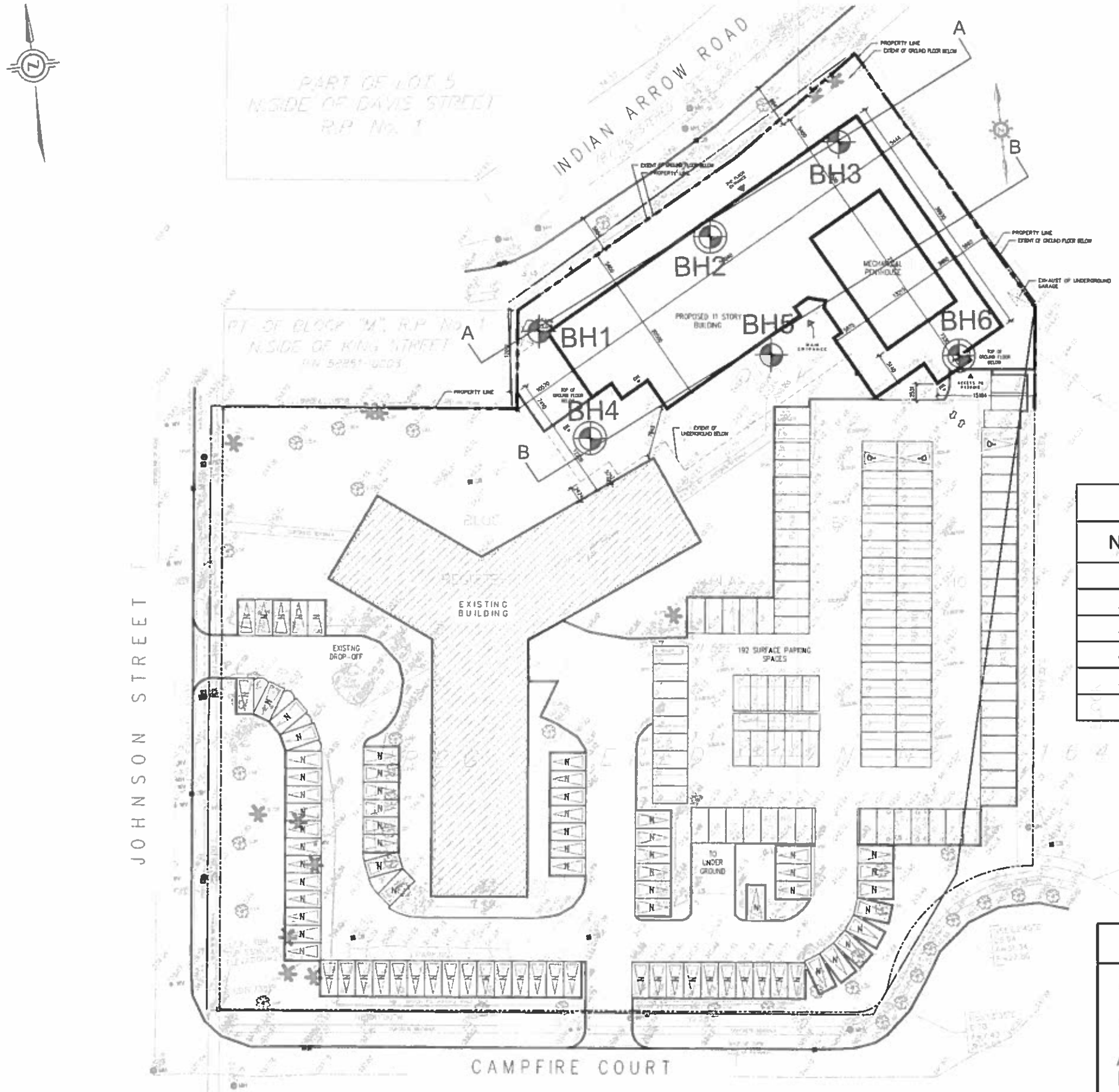
Yours truly,

exp. Services Inc.

FOR:
Leigh H. Knegt, P. Eng.
Manager, Geotechnical Services
Barrie Office

Alexander Winkelmann, P. Eng.
Geotechnical Engineer
Barrie Office

Appendix A – Borehole Location Plan



Borehole Location Data		
No.	Elevation (m)	Depth (m)
1	244.12	10.7
2	246.14	11.3
3	246.82	12.2
4	242.68	9.1
5	242.85	8.2
6	241.85	10.7

LEGEND

- Borehole Location
- Borehole + Monitoring Well Location
- A — Cross Section View

base map prepared by "architectureunfolded"

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CLIENT: Starlight Investments Ltd.

PROJECT: 37 JOHNSON STREET, BARRIE, ONTARIO

TITLE: BOREHOLE LOCATION PLAN

scale	NTS
date	NOV. 2016
drawn by	JF
project no.	BAR-00042830-A0

DRAWING 1

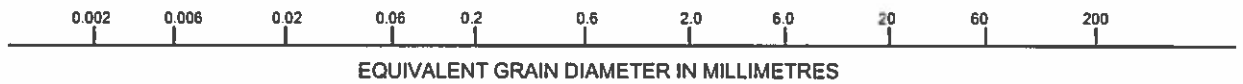
Appendix B –
Notes on Soil Description

Notes On Sample Descriptions

1. All sample descriptions included in this report follow the Unified Soil Classification System (USCS) as outlined by the Ministry of Transportation. Different classification systems may be used by others; one such system is the International Society for Soil Mechanics and Foundation Engineering (ISSMFE), as outlined in the Canadian Foundation Engineering Manual. Please note that, with the exception of those samples where a grain size analysis has been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.

UNIFIED SOIL CLASSIFICATION

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



EQUIVALENT GRAIN DIAMETER IN MILLIMETRES

ISSMFE SOIL CLASSIFICATION

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

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

3. Till: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (75 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

Notes On Sample Descriptions

4. The following table gives a description of the soil based on particle sizes. With the exception of those samples where grain size analyses have been performed, all samples are classified visually. The accuracy of visual examination is not sufficient to differentiate between this classification system or exact grain size.

Soil Classification		Terminology	Proportion
Clay and Silt	<0.075 mm		
Sand	0.075 to 4.75 mm	"trace" (e.g. Trace sand)	0% to 10%
Gravel	4.75 to 75 mm	"some" (e.g. Some sand)	10% to 20%
Cobbles	75 to 200 mm	with (e.g. with sand)	20% to 35%
Boulders	>200 mm	and (e.g. and sand)	35% to 50%

For a given material listed as an adjective (e.g. silty sand) means the predominant grain size is sand sized with 30 to 40% silt sized particles.

The compactness of Cohesionless soils and the consistency of the cohesive soils are defined by the following:

Cohesionless Soil		Cohesive Soil		
Compactness	**Standard Penetration Resistance "N" value Blows/ 0.3 m**	**Consistency**	**Undrained Shear Strength (kPa)**	**'N' Values**
Very Loose	0 to 4	Very soft	<12	<2
Loose	4 to 10	Soft	12 to 25	2 to 4
Compact	10 to 30	Firm	25 to 50	4 to 8
Dense	30 to 50	Stiff	50 to 100	8 to 15
Very Dense	Over 50	Very Stiff	100 to 200	15 to 30
		Hard	>200	>30

5. **ROCK CORING**

Where rock drilling was carried out, the term RQD (Rock Quality Designation) is used. The RQD is an indirect measure of the number of fractures and soundless of the rock mass. It is obtained from the rock cores by summing the length of the core covered, counting only those pieces of sound core that are 100 mm or more length. The RQD value is expressed as a percentage and is the ratio of the summed core lengths to the total length of core run. The classification based on the RQD value is given below.

RQD Classification	RQD (%)
Very Poor Quality	<25
Poor Quality	25 to 50
Fair Quality	50 to 75
Good Quality	75 to 90
Excellent Quality	90 to 100

Recovery Designation: $$\% \text{ Recovery} = \frac{\text{Length of Core Per Run}}{\text{Total Length of Run}} \times 100$$

Appendix C – Borehole Logs

Log of Borehole BH1

Project No. BAR-00042830-A0 — Figure No. 2

Project: 37 Johnson Street - Condominium Development — Sheet No. 1 of 1

City/ Municipality: Barrie, Ontario

Location: 37 Johnson Street

Date Drilled: October 28, 2016

Drill Type: Solid Stem Augers

Datum: Geodetic

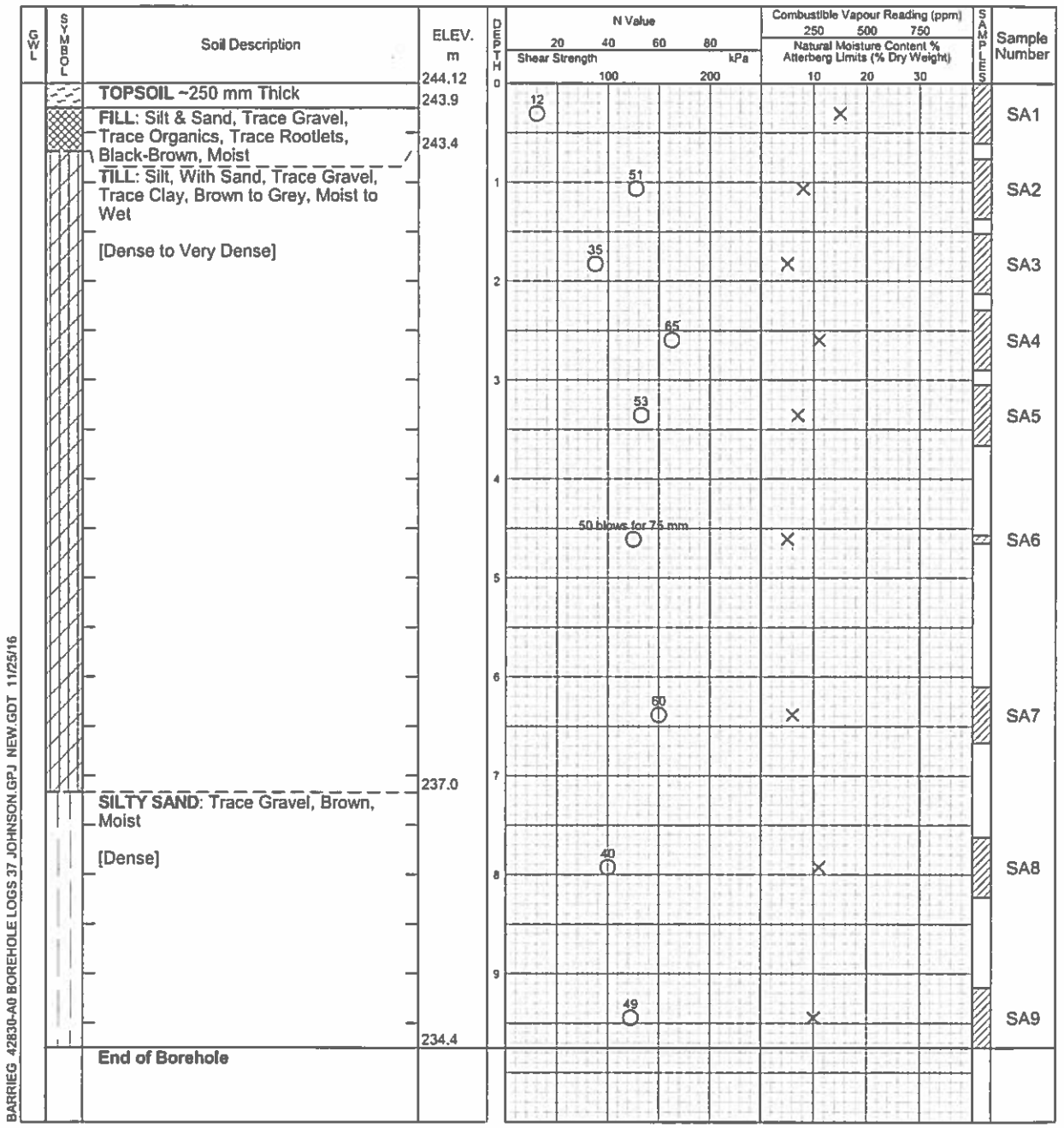
Auger Sample ☒ — Combustible Vapour Reading □

SPT (N) Value ○ ▨ — Natural Moisture ×

Dynamic Cone Test ——— — Plastic and Liquid Limit |—○

Shelby Tube ■ — Undrained Triaxial at % Strain at Failure ⊕

Field Vane Test S — Penetrometer ▲



BARRIEG 42830-A0 BOREHOLE LOGS 37 JOHNSON.GPJ NEW.GDT 11/25/16

exp. Services Inc.
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Borehole data requires interpretation assistance from **Exp** before use by others.

See Figures 1A and 1B for Notes on Sample Descriptions.

Time	Water Level (m)	Depth to Cave (m)
Upon Completion	5.5	3.7

Log of Borehole BH2

Project No. BAR-00042830-A0 — Figure No. 3

Project: 37 Johnson Street - Condominium Development — Sheet No. 1 of 2

City/ Municipality: Barrie, Ontario

Location: 37 Johnson Street

Date Drilled: October 27, 2016

Drill Type: Hollow Stem Augers

Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer

GWL	SYMBOL	Soil Description	ELEV. m	DEPTH
		TOPSOIL: ~130 mm Thick	246.14	0
		FILL: Silt & Sand to Sandy Silt, Trace Gravel, Trace Clay, Trace Rootlets and Organics Inclusions, Brown, Damp to Moist [Loose to Dense]	245.9	
		TILL: Silt & Sand, Trace Gravel, Trace Clay, Brown, Moist [Compact to Dense]	242.4	
		TILL: Sand & Gravel , Some Silt, Trace Clay, Brownish Grey, Moist [Dense to Very Dense]	240.5	
		SAND: Some Silt, Trace Gravel,	235.9	

N Value (20 40 60 80) — Shear Strength (100 200 kPa)

Combustible Vapour Reading (ppm) (250 500 750) — Natural Moisture Content % Atterberg Limits (% Dry Weight) (10 20 30)

Sample Number	N Value
SA1	4
SA2	15
SA3	16
SA4	9
SA5	39
SA6	21
SA7	41
SA8	58
SA9	38
SA10	54

Continued Next Page

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Borehole data requires interpretation assistance from Exp before use by others.

See Figures 1A and 1B for Notes on Sample Descriptions.

Time	Water Level (m)	Depth to Cave (m)
Upon Completion	6.4	
November 21, 2016	6.51	

Log of Borehole BH2

Project No. BAR-00042830-A0 Figure No. 3

Project: 37 Johnson Street - Condominium Development Sheet No. 2 of 2

GWL	SYMBOL	Soil Description	ELEV. m	DEPTH	N Value / Shear Strength (kPa)	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLE	Sample Number
		Brown, Moist	235.64		20 40 60 80 / 100 200	250 500 750 / 10 20 30		
		[Very Dense]	235.2	11	13	×		SA11A SA11B
		SILT: Some Sand, Brownish Grey, Moist [Very Dense]	235.0					
		End of Borehole						

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Borehole data requires interpretation assistance from Exp before use by others.

See Figures 1A and 1B for Notes on Sample Descriptions.

Time	Water Level (m)	Depth to Cave (m)
Upon Completion	6.4	
November 21, 2016	6.51	

Log of Borehole BH3

Project No. BAR-00042830-A0 Figure No. 4

Project: 37 Johnson Street - Condominium Development Sheet No. 1 of 2

City/ Municipality: Barrie, Ontario

Location: 37 Johnson Street

Date Drilled: October 27, 2016

Drill Type: Hollow Stem Augers

Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer

GWL	SYMBOL	Soil Description	ELEV. m	DEPTH	N Value: Shear Strength kPa (20 40 60 80 / 100 200)	Combustible Vapour Reading (ppm) (250 500 750) / Natural Moisture Content % Atterberg Limits (% Dry Weight) (10 20 30)	SAMPLES	Sample Number
		TOPSOIL: ~130 mm Thick	246.82	0	7			SA1
		FILL: Silt & Sand, Trace to Some Gravel, Trace Clay, With Organics and Rootlets, Wood Fragment Inclusions, Dark Brown, Moist to Wet	246.7					
		[Compact]		1	14			SA2
				2	16			SA3
					11			SA4
				3	15			SA5
			243.1					
		TILL: Silt & Sand, Trace Gravel, Trace Clay, Greyish Brown,		4	7			SA6
		[Loose to Compact]		5	11			SA7
		Becoming Very Dense at approximately 6.1 m depth		6	64			SA8
			239.7	7				
		SILT: Some Sand, Trace Clay, Greyish Brown, Wet						
		[Very Dense]		8	82			SA9
			238.1					
		GRAVELLY SAND: Some Silt, Trace Clay, Brownish Grey, Wet		9				SA10A
		[Dense]	237.6		47			SA10B
		SILT: Some Sand, Trace Clay, Brownish Grey, Wet						
		[Dense]	236.6	10				
		GRAVELLY SAND: Some Silt, Trace						

Continued Next Page

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Borehole data requires interpretation assistance from **Exp** before use by others.

See Figures 1A and 1B for Notes on Sample Descriptions.

Time	Water Level (m)	Depth to Cave (m)
Upon Completion	3.0	7.6

Log of Borehole BH3

Project No. BAR-00042830-A0 Figure No. 4

Project: 37 Johnson Street - Condominium Development Sheet No. 2 of 2

GWL	SYMBOL	Soil Description	ELEV. m	DEPTH	N Value / Shear Strength (kPa)	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLE	Sample Number
			236.32		20 40 60 80 / 100 200	250 500 750 / 10 20 30		
		Clay, Grey, Moist			44	×		SA11A
		[Dense]	235.8	11				SA11B
		SILT & SAND TILL: Trace Gravel, Trace Clay, Grey, Moist						
		[Dense to Very Dense]		12				
			234.3		90	×		SA12
		End of Borehole						

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Borehole data requires interpretation assistance from Exp before use by others.

See Figures 1A and 1B for Notes on Sample Descriptions.

Time	Water Level (m)	Depth to Cave (m)
Upon Completion	3.0	7.6

Log of Borehole BH4

Project No. BAR-00042830-A0 Figure No. 5

Project: 37 Johnson Street - Condominium Development Sheet No. 1 of 1

City/ Municipality: Barrie, Ontario

Location: 37 Johnson Street

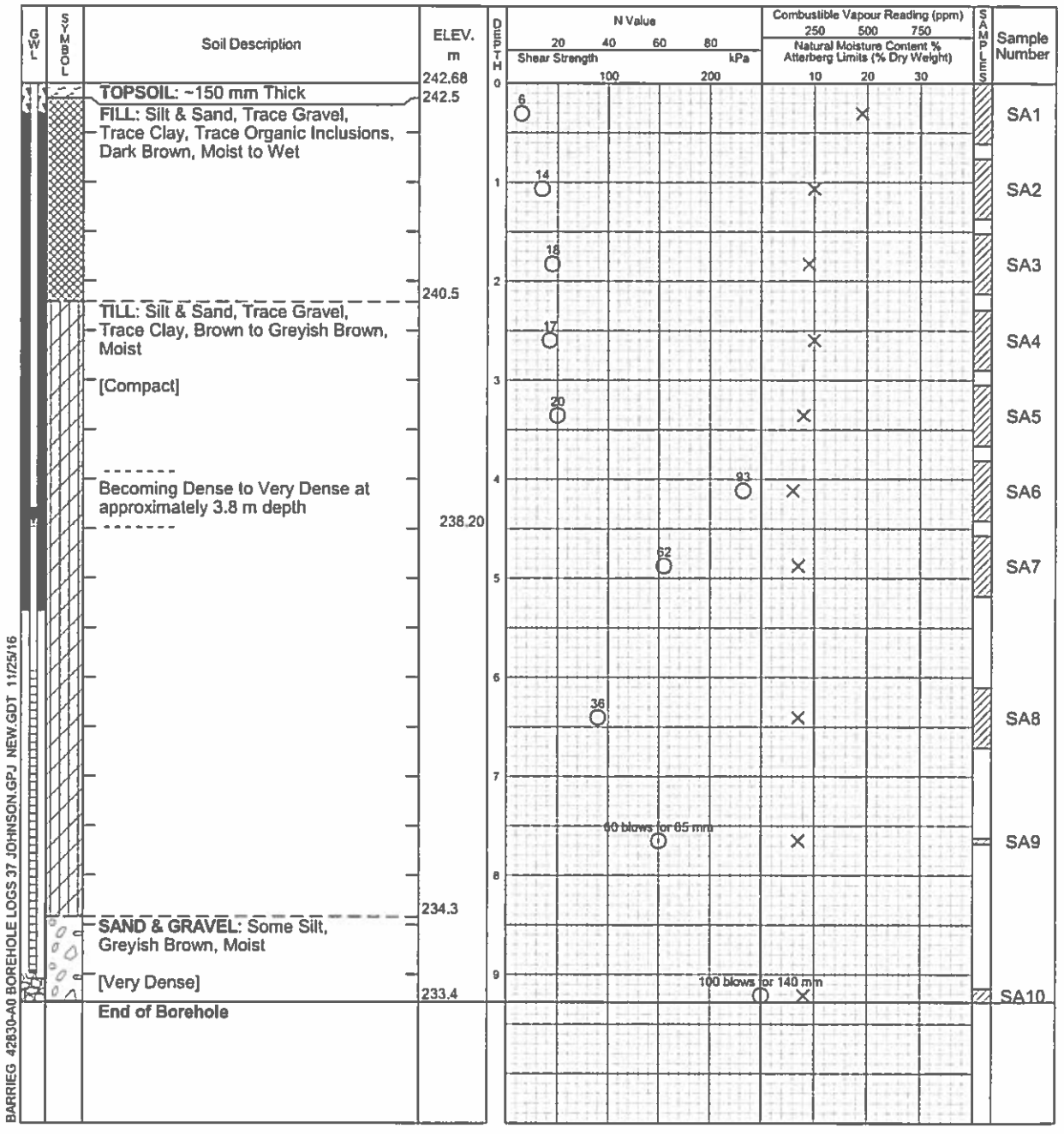
Date Drilled: October 28, 2016

Drill Type: Hollow Stem Augers

Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer



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Borehole data requires interpretation assistance from Exp before use by others.

See Figures 1A and 1B for Notes on Sample Descriptions.

Time	Water Level (m)	Depth to Cave (m)
Upon Completion	4.6	
November 21, 2016	4.48	

Log of Borehole BH5

Project No. BAR-00042830-A0 — Figure No. 6

Project: 37 Johnson Street - Condominium Development — Sheet No. 1 of 1

City/ Municipality: Barrie, Ontario

Location: 37 Johnson Street

Date Drilled: October 26, 2016

Drill Type: Solid Stem Augers

Datum: Geodetic

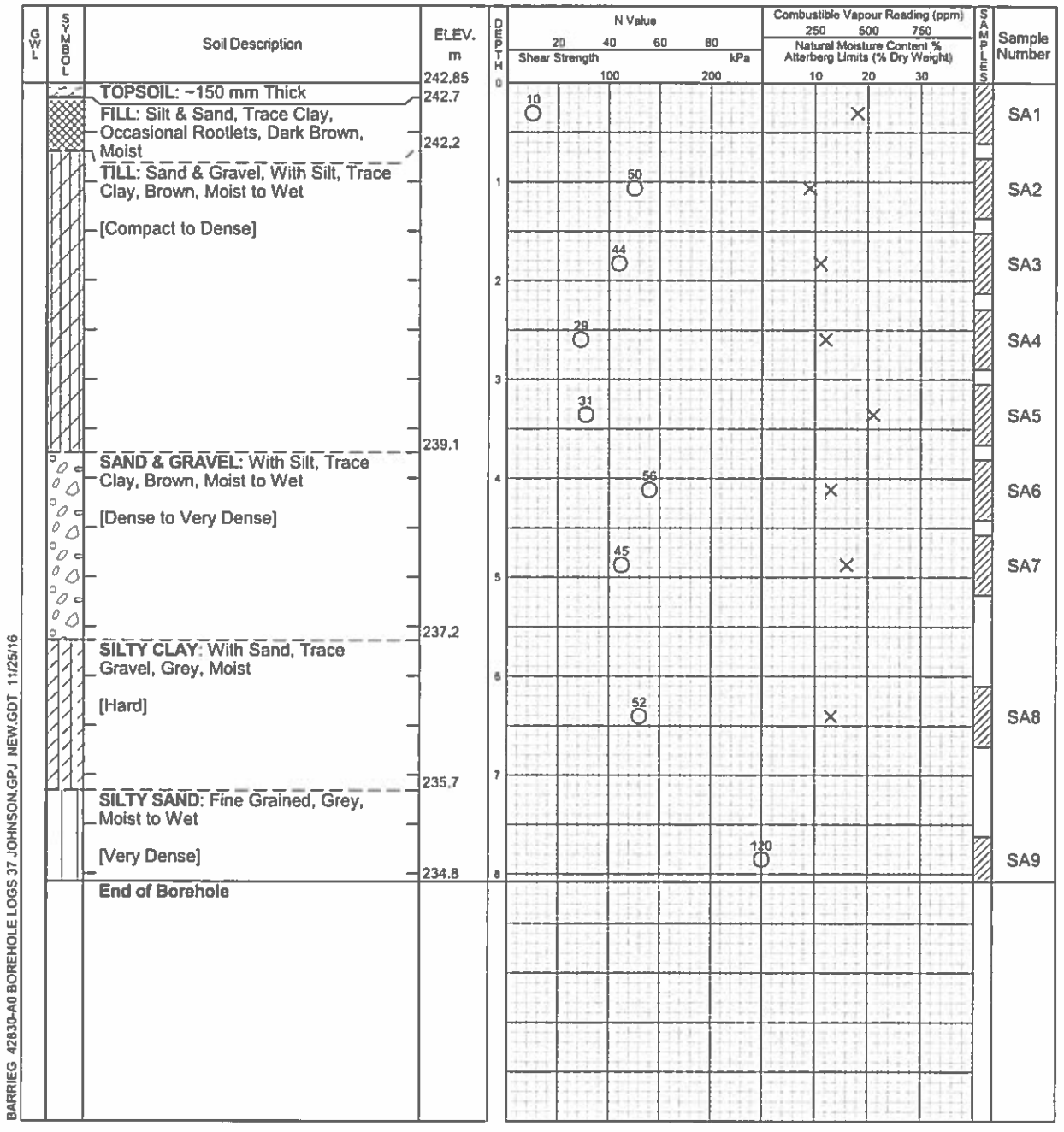
Auger Sample ☒ — Combustible Vapour Reading □

SPT (N) Value ○ ▨ — Natural Moisture ×

Dynamic Cone Test ——— — Plastic and Liquid Limit |—○

Shelby Tube ■ — Undrained Triaxial at % Strain at Failure ⊕

Field Vane Test S — Penetrometer ▲



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Borehole data requires interpretation assistance from Exp before use by others.

See Figures 1A and 1B for Notes on Sample Descriptions.

Time	Water Level (m)	Depth to Cave (m)
Upon Completion	4.1	4.3

Log of Borehole BH6

Project No. BAR-00042830-A0 — Figure No. 7

Project: 37 Johnson Street - Condominium Development — Sheet No. 1 of 2

City/ Municipality: Barrie, Ontario

Location: 37 Johnson Street

Date Drilled: October 26, 2016

Drill Type: Hollow Stem Augers

Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer

GWL	SYMBOL	Soil Description	ELEV. m	DEPTH
		FILL: Silt & Sand, Trace Gravel, Trace Clay, Trace Organic Inclusions, Brown, Moist	241.85	0
		TILL: Silt & Sand, Trace Gravel, Trace Clay, Brown, Moist [Compact]	241.2	1
		SAND: With Gravel, Some to With Silt, Brown to Grey, Damp to Moist [Compact to Very Dense]	240.4	2
			238.72	3
		Becoming Wet at approximately 7.6 m depth		4
			232.4	5
		CLAYEY SILT: Grey, Wet [Hard]	231.6	6
		SILT: Trace to Some Sand, Trace		7
				8
				9
				10

N Value: 20 40 60 80 — Shear Strength: 100 200 kPa

Combustible Vapour Reading (ppm): 250 500 750 — Natural Moisture Content % Atterberg Limits (% Dry Weight): 10 20 30

SAMPLES	Sample Number	N Value	Combustible Vapour Reading (ppm)	Natural Moisture Content %
	SA1	7		
	SA2	25		
	SA3	26		
	SA4	44		
	SA5	62		
	SA6	48		
	SA7	57		
	SA8	99		
	SA9	74		
	SA10A	63		
	SA10B			

Continued Next Page

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Borehole data requires interpretation assistance from Exp before use by others.

See Figures 1A and 1B for Notes on Sample Descriptions.

Time	Water Level (m)	Depth to Cave (m)
Upon Completion	9.1	
November 21, 2016	3.13	

Log of Borehole BH6

Project No. BAR-00042830-A0 Figure No. 7

Project: 37 Johnson Street - Condominium Development Sheet No. 2 of 2

GWL	SYMBOL	Soil Description	ELEV. m	DEPTH	N Value / Shear Strength (20 40 60 80 kPa; 100 200)	Combustible Vapour Reading (ppm) 250 500 750 / Natural Moisture Content % Atterberg Limits (% Dry Weight) 10 20 30	SAMPLE TYPE	Sample Number
		Clay, Grey, Wet	231.35					
		[Very Dense]	230.9	11	53			SA11A
		CLAYEY SILT: Grey, Moist	230.6					SA11B
		[Very Dense]						
		End of Borehole						

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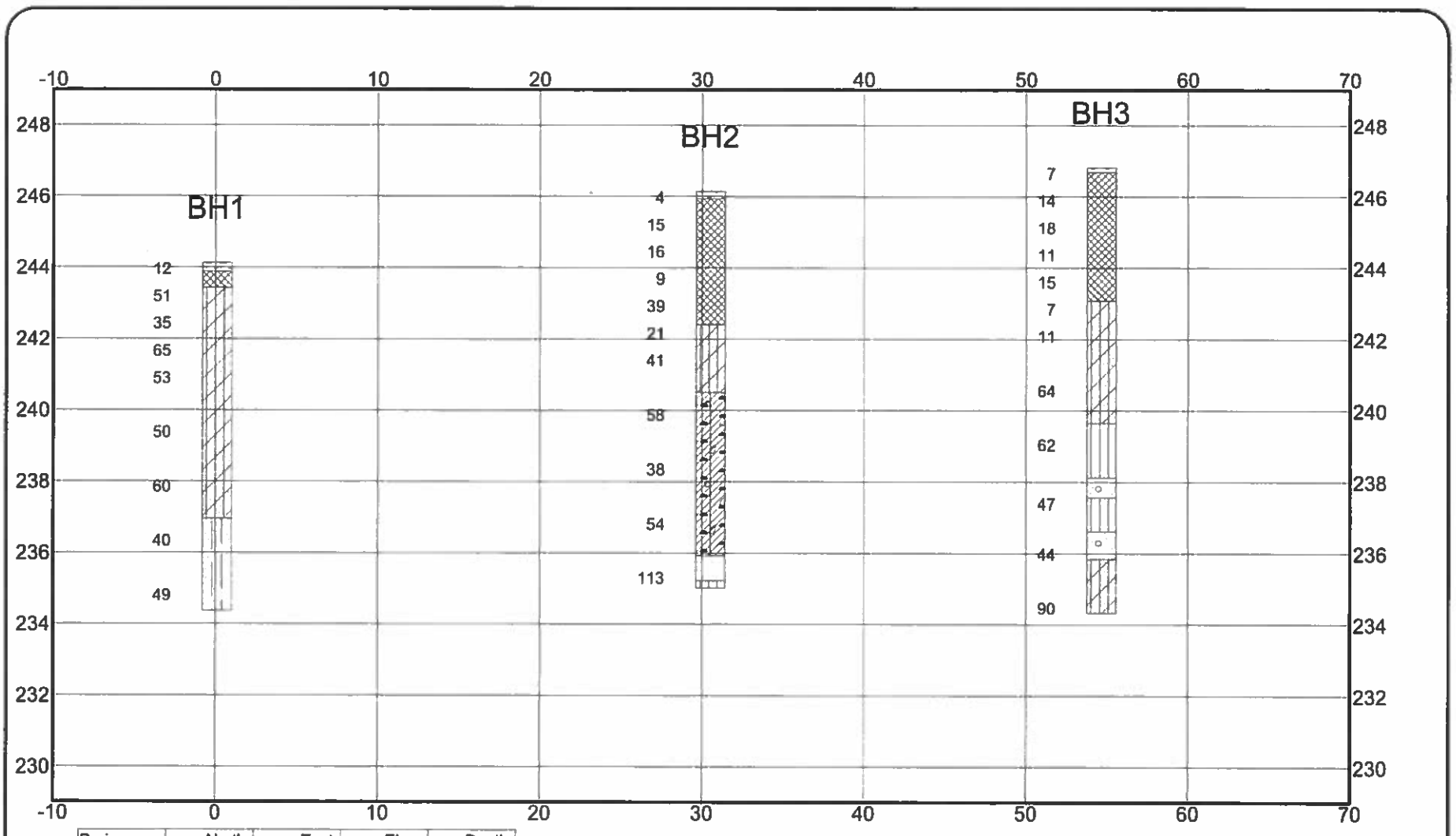
Borehole data requires interpretation assistance from **Exp** before use by others.

See Figures 1A and 1B for Notes on Sample Descriptions.

Time	Water Level (m)	Depth to Cave (m)
Upon Completion	9.1	
November 21, 2016	3.13	



Boring	North	East	Elev.	Depth
BH1	4916754	607034	244.1	9.8
BH2	4916766	607062	246.1	11.1
BH3	4916778	607083	246.8	12.5

DISTANCES:

Beginning	-10
Ending	70

VIEWING ANGLES (degrees):

Horizontal	0.0
Vertical	0.0

Position	North	East
Left, Front	4916749	607025
Right, Front	4916784	607097
Left, Back	4916749	607025
Right, Back	4916784	607097

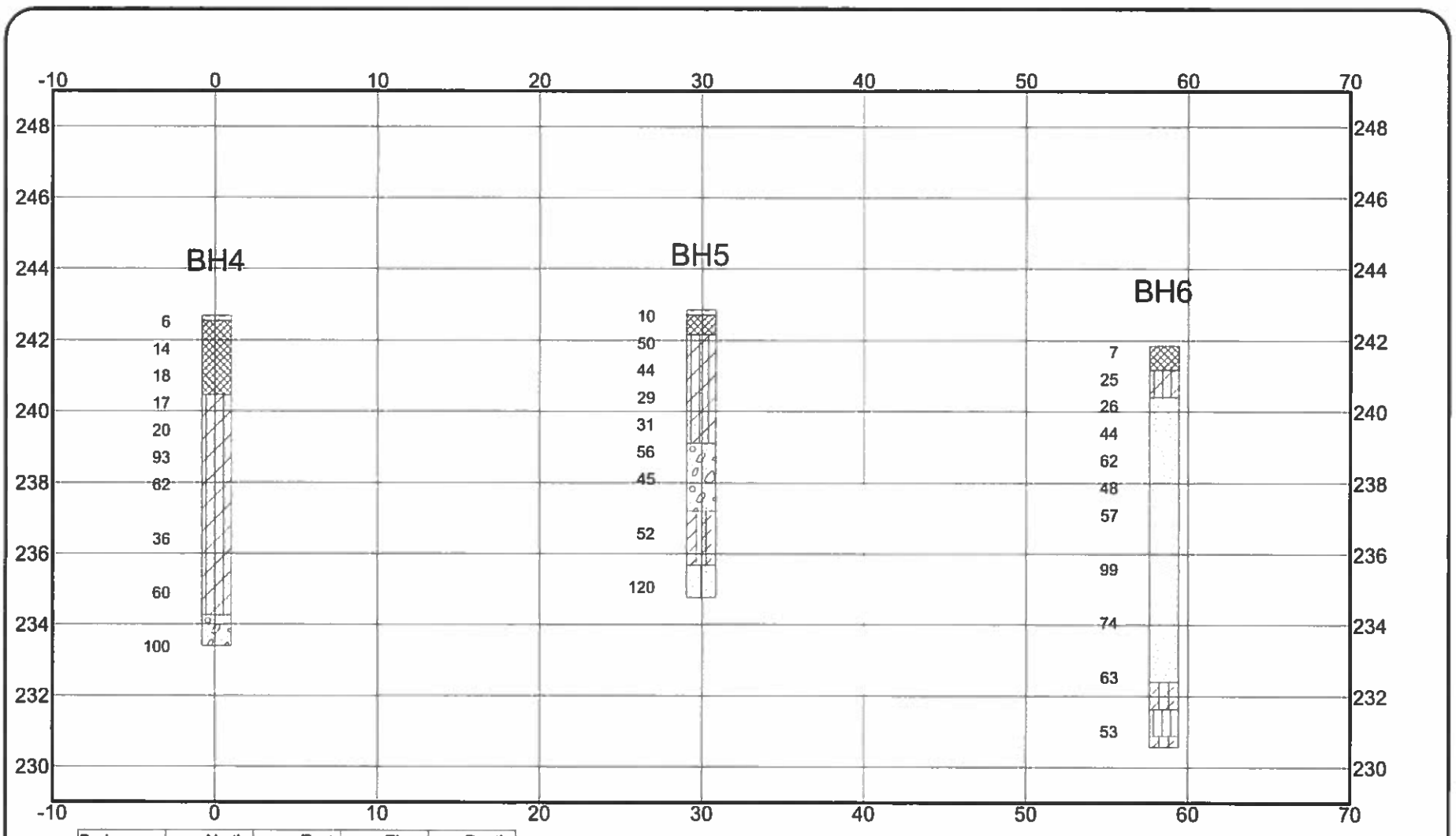
SUBSURFACE FENCE DIAGRAM

Cross-Section A-A

37 Johnson Street - Condominium Development

Barrie, Ontario

PROJECT #	DATE	PLATE
BAR-00042830-A0	Nov 2016	1



Boring	North	East	Elev.	Depth
BH4	4916737	607040	242.7	9.3
BH5	4916747	607069	242.9	8.1
BH6	4916744	607098	241.9	11.3

DISTANCES:

Beginning	-10
Ending	70

VIEWING ANGLES (degrees):

Horizontal	0.0
Vertical	0.0

Position	North	East
Left, Front	4916739	607030
Right, Front	4916747	607109
Left, Back	4916739	607030
Right, Back	4916747	607109

SUBSURFACE FENCE DIAGRAM

Cross-Section B-B

37 Johnson Street - Condominium Development

Barrie, Ontario

PROJECT #	DATE	PLATE
BAR-00042830-A0	Nov 2016	1

Appendix D – Lab Testing

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14 Cedar Pointe Dr., Unit 1510
Barrie, Ontario
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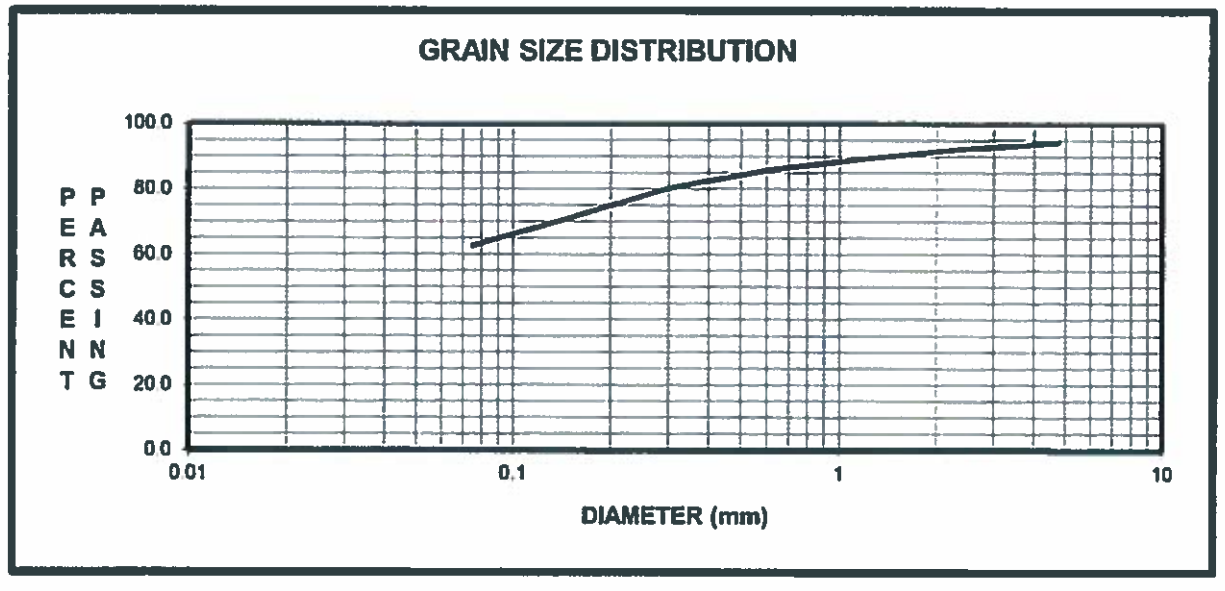
Grain Size Analysis Report

Project Name: 37 Johnson St
Project No.: BAR-0042830-A0
Material: Native Till
Sample Location: BH1 SA3

Client: Starlight Investments
Dated Tested: Nov 22 2016
Date Sampled: Oct 26 2016
Supplier: N/A

SAMPLE DATA

Sieve Diameter (mm)	Percent Retained (%)	Percent Passing (%)	Spec (%)
150			
75			
53			
37.5			
26.5			
19			
13.2	1.2	98.8	
9.5	3.2	96.8	
4.75	5.6	94.4	
2.36	7.8	92.2	
1.18	10.6	89.4	
0.6	14.3	85.7	
0.3	19.8	80.2	
0.15	28.8	71.2	
0.075	37.4	62.6	



Distribution:	Prepared By:	Checked By:
Starlight Investments	Levi Pottage	Leigh Knegt P. Eng.

Report No. _____

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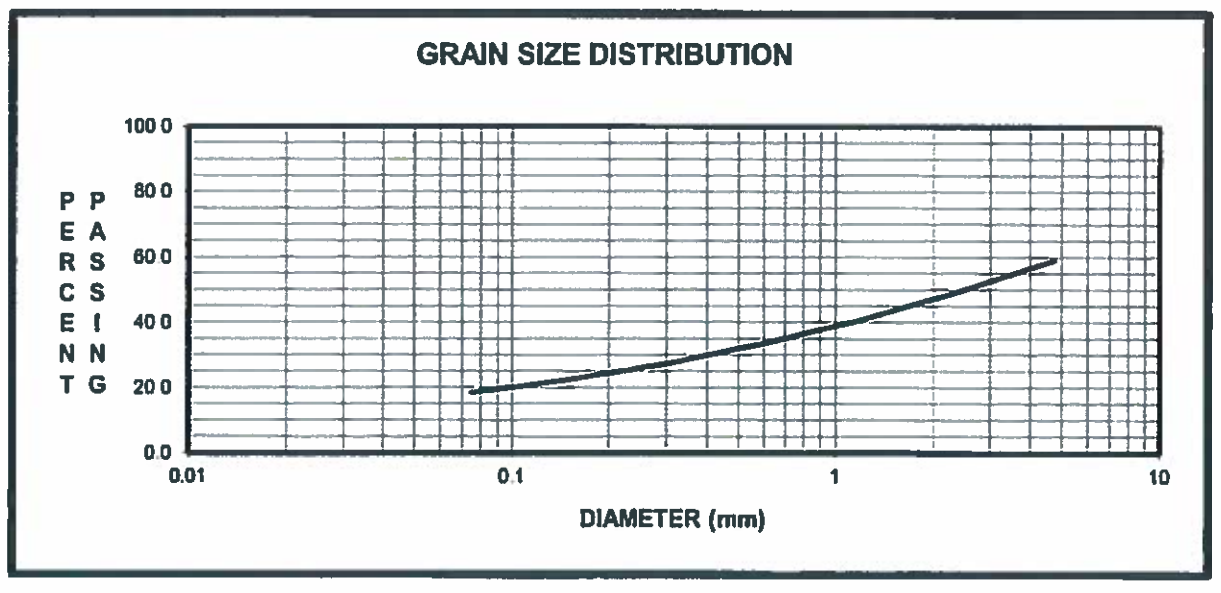
Grain Size Analysis Report

Project Name: 37 Johnson St
Project No.: BAR-0042830-A0
Material: Native Till
Sample Location: BH2 SA9

Client: Stalight Investments
Dated Tested: Nov 22 2016
Date Sampled: Oct 26 2016
Supplier: N/A

SAMPLE DATA

Sieve Diameter (mm)	Percent Retained (%)	Percent Passing (%)	Spec (%)
150			
75			
53			
37.5			
26.5	5.6	94.4	
19	18.2	81.8	
13.2	25.7	74.3	
9.5	31.9	68.1	
4.75	40.9	59.1	
2.36	50.7	49.3	
1.18	59.5	40.5	
0.6	66.4	33.6	
0.3	72.7	27.3	
0.15	77.6	22.4	
0.075	81.5	18.5	



Distribution:	Prepared By:	Checked By:
Stalight Investments	Levi Potiage	Leigh Knegt P. Eng.

Report No. _____

t: 1.705.719.1100
f: 1.705.719.1109
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www.exp.com

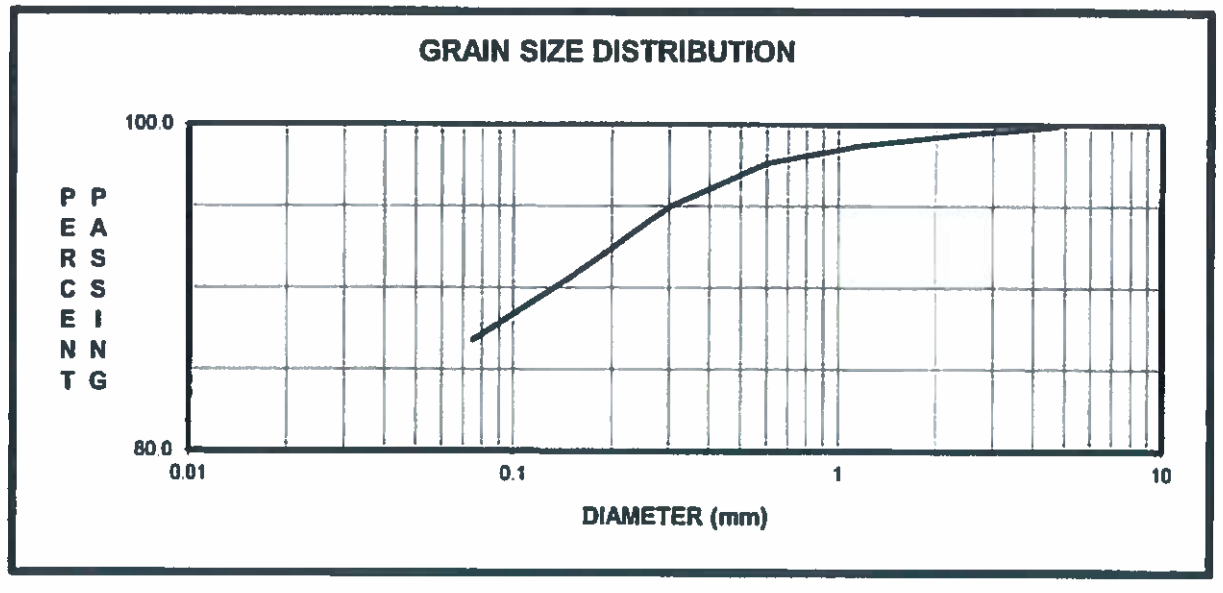
Grain Size Analysis Report

Project Name: 37 Johnson St
Project No.: BAR-00042830-A0
Material: Silt
Sample Location: BH3 SA9

Client: Starlight Investments
Dated Tested: Nov 22 2016
Date Sampled: Oct 26 2016
Supplier: N/A

SAMPLE DATA

Sieve Diameter (mm)	Percent Retained (%)	Percent Passing (%)	Spec (%)
150			
75			
53			
37.5			
26.5			
19			
13.2			
9.5	1.2	98.8	
4.75	0.1	99.9	
2.36	0.6	99.4	
1.18	1.3	98.7	
0.6	2.4	97.6	
0.3	5.1	94.9	
0.15	9.3	90.7	
0.075	13.2	86.8	



Distribution:
Starlight Investments

Prepared By:
For Alex Griffin

Checked By:
For Leigh Knegt P. Eng.

Report No. _____

t: 1.705.719.1100
f: 1.705.719.1109
14 Cedar Pointe Dr., Unit 1510
Barrie, Ontario
L4N 5R7
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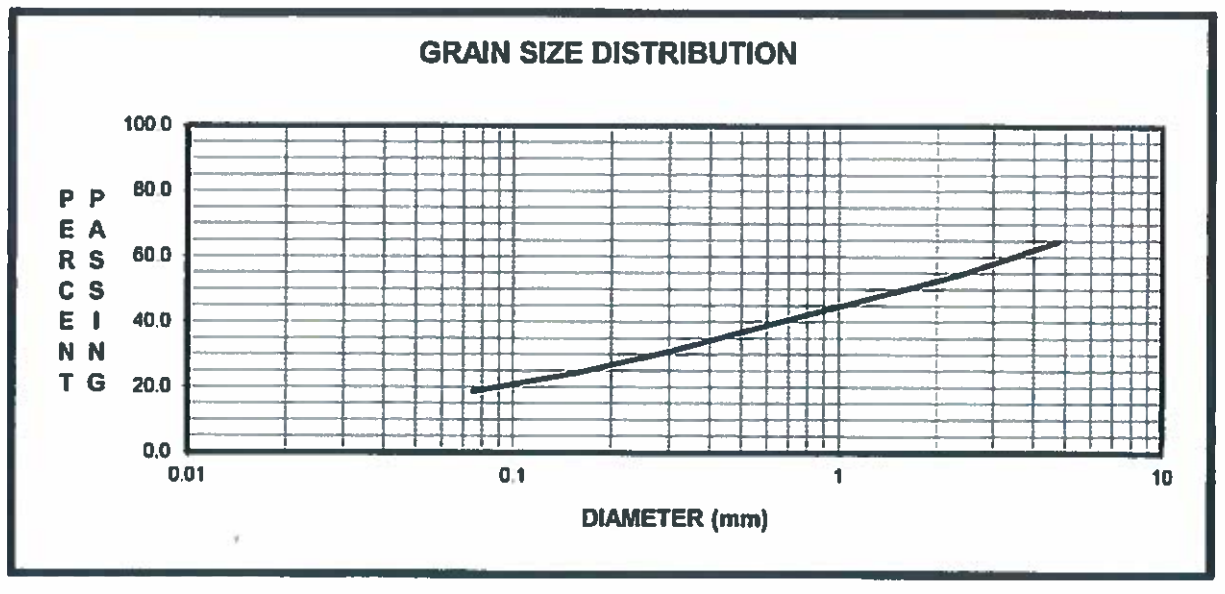
Grain Size Analysis Report

Project Name: 37 Johnson St.
Project No.: BAR-00042830-A0
Material: Gravelly Sand
Sample Location: BH4 SA10

Client: Starlight Investments
Dated Tested: Nov 22 2016
Date Sampled: Oct 25 2016
Supplier: N/A

SAMPLE DATA

Sieve Diameter (mm)	Percent Retained (%)	Percent Passing (%)	Spec (%)
150			
75			
53			
37.5			
26.5			
19	9.3	90.7	
13.2	16.0	84.0	
9.5	22.2	77.8	
4.75	35.3	64.7	
2.36	45.4	54.6	
1.18	53.4	46.6	
0.6	61.0	39.0	
0.3	69.1	30.9	
0.15	76.1	23.9	
0.075	81.3	18.7	



Distribution:	Prepared By:	Checked By:
Starlight Investments	for Alex Griffin	Leigh Knegt P. Eng.

Report No. _____

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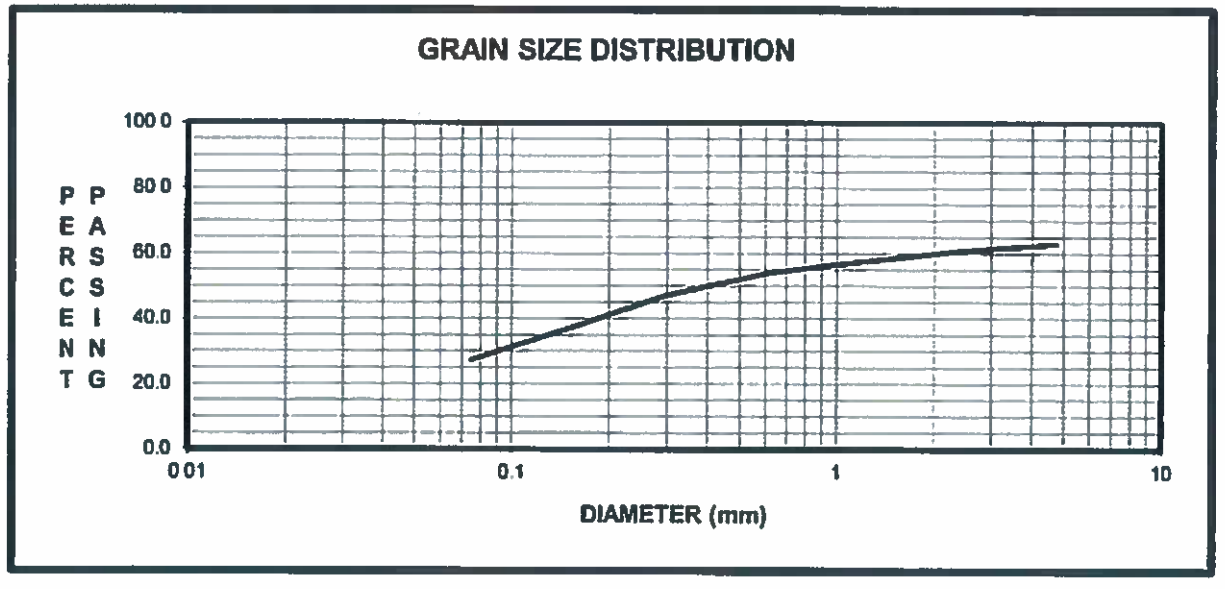
Grain Size Analysis Report

Project Name: 37 Johnson St
Project No.: BAR-00042830-A0
Material: Silt and Sand Till
Sample Location: BH5 SA3

Client: Starlight Investments
Dated Tested: Nov 22 2016
Date Sampled: Oct 26 2016
Supplier: N/A

SAMPLE DATA

Sieve Diameter (mm)	Percent Retained (%)	Percent Passing (%)	Spec (%)
150			
75			
53			
37.5			
26.5	11.8	88.2	
19	27.7	72.3	
13.2	30.7	69.3	
9.5	34.0	66.0	
4.75	37.1	62.9	
2.36	39.3	60.7	
1.18	42.5	57.5	
0.6	46.2	53.8	
0.3	52.8	47.2	
0.15	63.0	37.0	
0.075	72.7	27.3	



Distribution:	Prepared By:	Checked By:
Starlight Investments	Jodi Fountain	Leigh Knegt P. Eng.

Report No. _____

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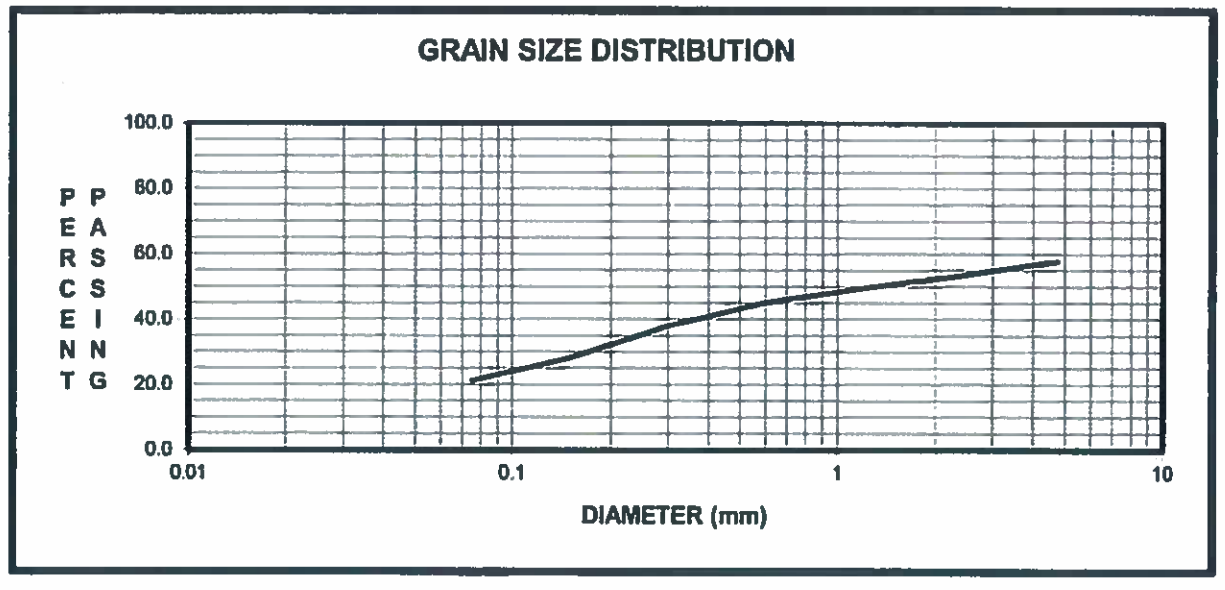
Grain Size Analysis Report

Project Name: 37 Johnson St
Project No.: BAR-00042830-A0
Material: Sand
Sample Location: BH5 SA7

Client: Starlight Investments
Dated Tested: Nov 22 2016
Date Sampled: Oct 26 2016
Supplier: N/A

SAMPLE DATA

Sieve Diameter (mm)	Percent Retained (%)	Percent Passing (%)	Spec (%)
150			
75			
53			
37.5			
26.5	17.9	82.1	
19	24.8	75.2	
13.2	32.3	67.7	
9.5	37.6	62.4	
4.75	42.1	57.9	
2.36	46.6	53.4	
1.18	50.5	49.5	
0.6	54.9	45.1	
0.3	62.0	38.0	
0.15	71.8	28.2	
0.075	78.8	21.2	



Distribution:	Prepared By:	Checked By:
Starlight Investments	Jodi Fountain	Leigh Knegt P. Eng.

Report No. _____

exp Services Inc.
14 Cedar Pointe Drive, Unit 1510
Barrie, Ontario, L4N 5R7
tel. 705.719.1100 fax 705.719.1109
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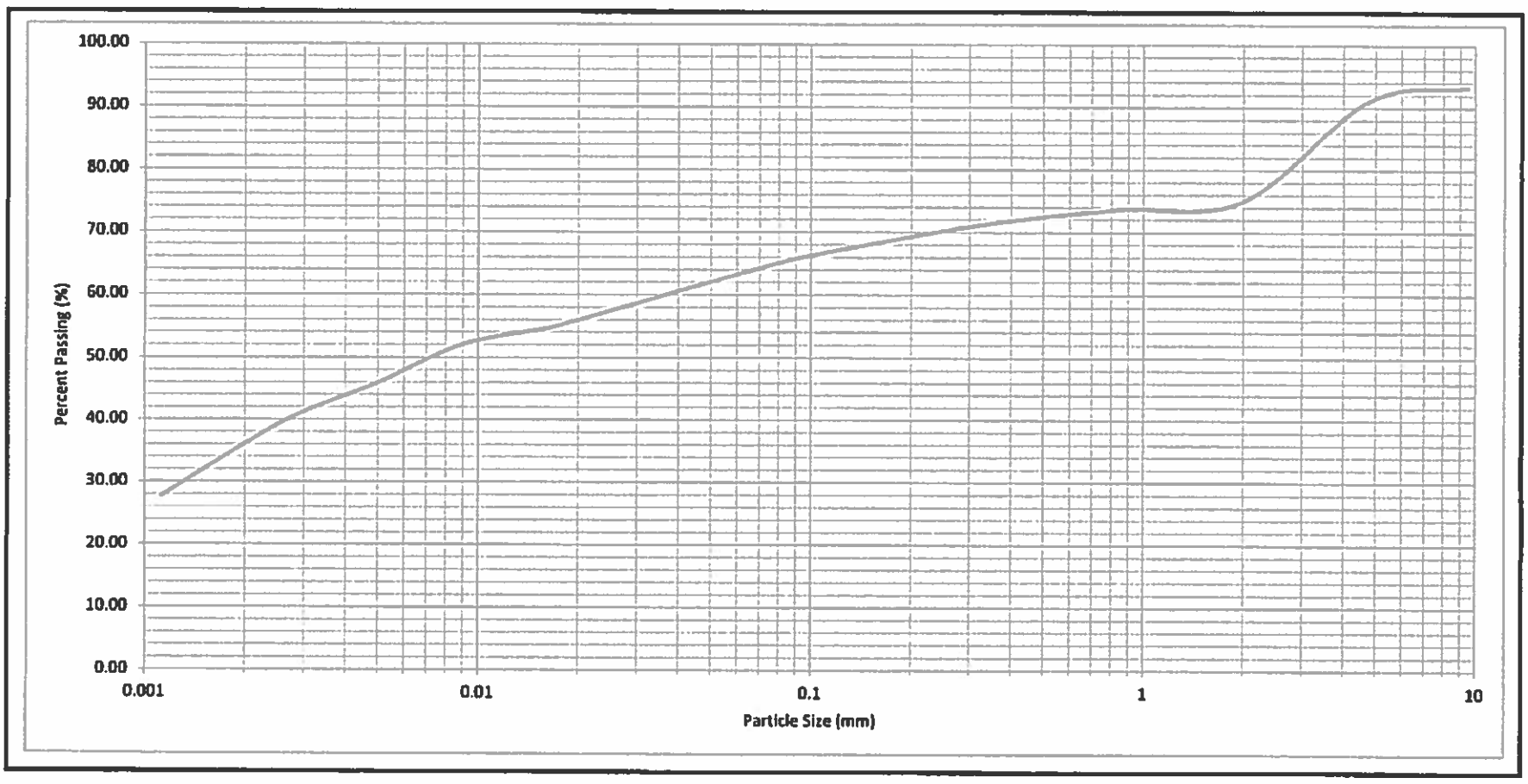
GRAIN SIZE ANALYSIS



Project Name:	37 Johnson St.	Sample Location:	BH5 SA8
Sample Date:	Oct. 26, 2016	Project Number:	BAR-00042830-A0
Client:	Starlight Investments		

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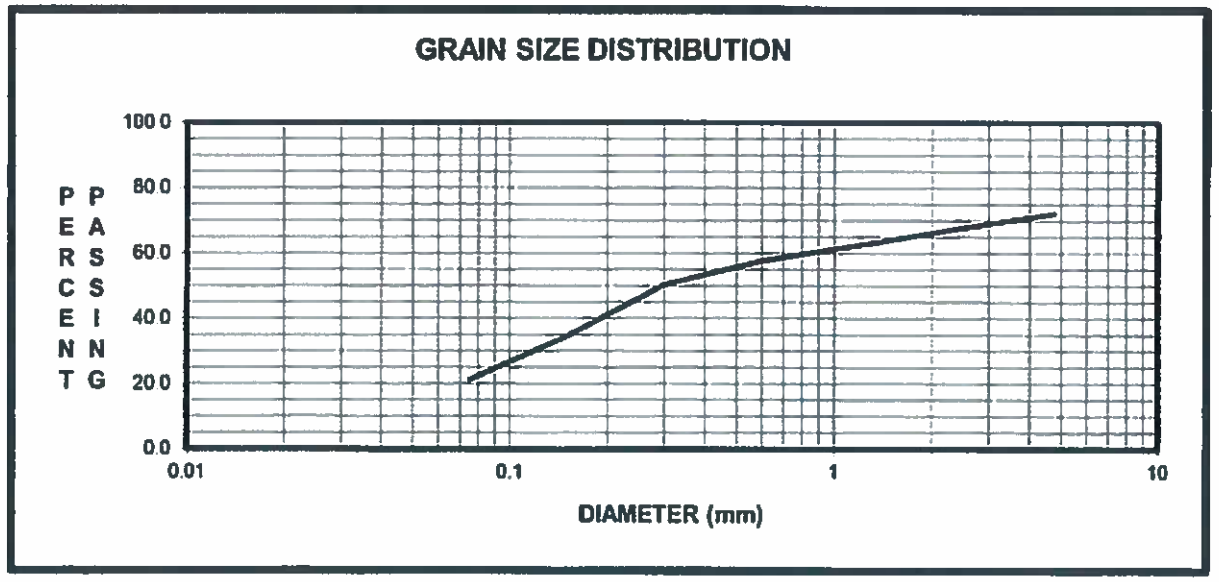
Grain Size Analysis Report

Project Name: 37 Johnson St
Project No.: BAR-00042830-A0
Material: Silty Sand
Sample Location: BH6 SA4

Client: Starlight Investments
Dated Tested: Nov 22 2016
Date Sampled: Oct 26 2016
Supplier: N/A

SAMPLE DATA

Sieve Diameter (mm)	Percent Retained (%)	Percent Passing (%)	Spec (%)
150			
75			
53			
37.5			
26.5	12.0	88.0	
19	15.4	84.6	
13.2	20.1	79.9	
9.5	21.6	78.4	
4.75	27.8	72.2	
2.36	32.6	67.4	
1.18	37.6	62.4	
0.6	42.3	57.7	
0.3	49.6	50.4	
0.15	65.4	34.6	
0.075	78.9	21.1	



Distribution:	Prepared By:	Checked By:
Starlight Investments	Kole Petronis	Leigh Knegt P. Eng.

Report No. _____

t: 1.705.719.1100
f: 1.705.719.1109
14 Cedar Pointe Dr.
Barrie, Ontario
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Standard Proctor Test Report

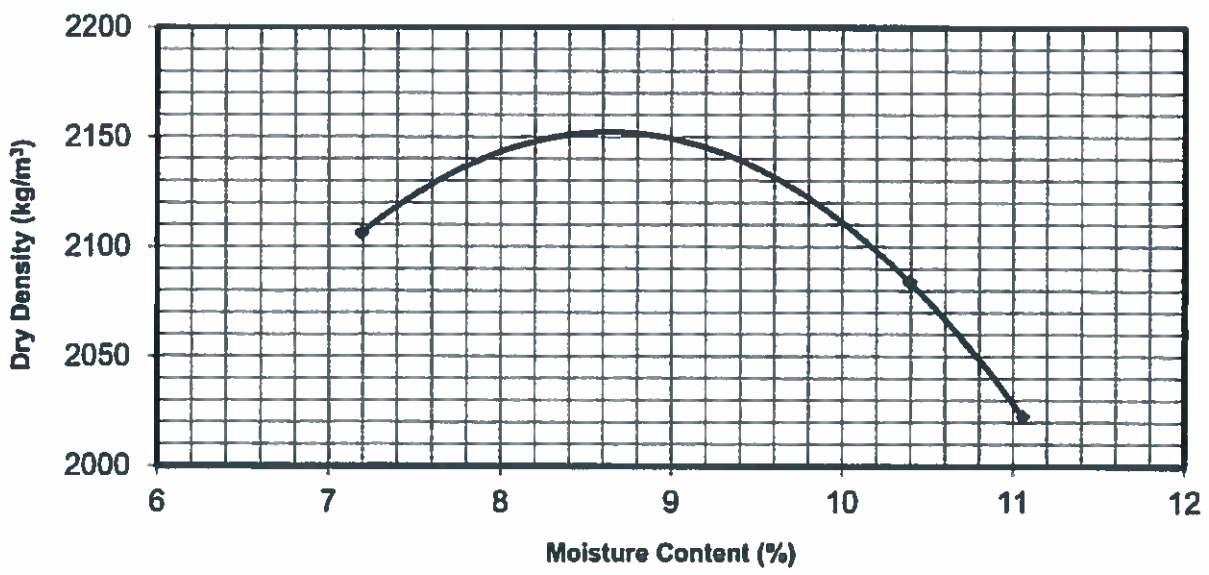
Project Name:	37 Johnson St	**Client:**	Starlight Investments
Project No.:	BAR-00042830-A0	**Dated Tested:**	October 22, 2016
Material:	Upper Till Mix	**Date Sampled:**	Oct. 26-28 2016
Lab No.:	N/A	**Sample Location:**	All Boreholes
		Supplier:	N/A

LAB DATA

Density	Test Points						
	1	2	3	4	5	6	7
Mass of Soil + Mould (g)	11480.0	11600.0	11490.0				
Mass of Mould (g)	6640.0	6640.0	6640.0				
Mass of Soil (g)	4840.0	4960.0	4850.0				
Volume of Mould (m^3)	0.002133	0.002133	0.002133				
Bulk Density (kg/m^3)	2269	2326	2274				
Dry Density (kg/m^3)	2106	2084	2023				
Moisture							
Mass of Tin (g)	128.2	129.7	131.3				
Mass of Tin + Wet Soil (g)	542.4	675.7	687.8				
Mass of Tin + Dry Soil (g)	514.6	624.3	632.4				
Mass of Soil (g)	386.4	494.6	501.1				
Moisture (g)	27.8	51.4	55.4				
Moisture Content (%)	7.2	10.4	11.1				

Maximum Dry Density = 2152 kg/m^3 **Optimum Moisture Content =** 8.6 %

Moisture/Density Relationship



Distribution:	Prepared By:	Checked By:
Starlight Investments	Jodi Fountain	Leigh Knegt, P. Eng.

Report No._____

AGAT Laboratories

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

CLIENT NAME: EXP. SERVICES INC.
14 CEDAR POINTE DRIVE UNIT 1510,
BARRIE, ON L4N5R7
(705) 734-6222

ATTENTION TO: Rebecca Moser

PROJECT: BAR-00042830-A0

AGAT WORK ORDER: 16T156640

SOIL ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Coordinator

DATE REPORTED: Nov 10, 2016

PAGES (INCLUDING COVER): 5

VERSION*: 1

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

***NOTES**

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

AGAT Laboratories

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

Certificate of Analysis

AGAT WORK ORDER: 16T156640

PROJECT: BAR-00042830-A0

CLIENT NAME: EXP. SERVICES INC.

SAMPLING SITE:

ATTENTION TO: Rebecca Moser

SAMPLED BY:CF

Corrosivity Package

DATE RECEIVED: 2016-11-04

DATE REPORTED: 2016-11-10

		SAMPLE DESCRIPTION:		BH2/S3	BH3/S4	BH4/S3
		SAMPLE TYPE:		Soil	Soil	Soil
		DATE SAMPLED:		2016-11-01	2016-11-01	2016-11-01
Parameter	Unit	G / S	RDL	7986150	7986151	7986152
Sulphide	%		0.05	<0.05	<0.05	<0.05
Chloride (2:1)	µg/g		2	7	4	9
Sulphate (2:1)	µg/g		2	139	23	18
pH (2:1)	pH Units		NA	8.14	8.08	8.01
Electrical Conductivity (2:1)	mS/cm		0.005	0.258	0.159	0.166
Resistivity (2:1)	ohm.cm		1	3880	6290	6020
Redox Potential (2:1)	mV		5	269	264	266

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

7986150-7986152 EC/Resistivity, pH, Chloride, Sulphate and Redox Potential were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil).

Certified By: Amanjot Bhela

AGAT Laboratories

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CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: EXP. SERVICES INC.

PROJECT: BAR-00042830-A0

SAMPLING SITE:

AGAT WORK ORDER: 16T156640

ATTENTION TO: Rebecca Moser

SAMPLED BY:CF

Soil Analysis

RPT Date: Nov 10, 2016			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Corrosivity Package															
Sulphide	7986152	7986152	<0.05	<0.05	NA	< 0.05	98%	80%	120%	NA			NA		
Chloride (2:1)	7986145		281	284	1.1%	< 2	102%	80%	120%	104%	80%	120%	104%	70%	130%
Sulphate (2:1)	7986145		129	130	0.8%	< 2	91%	80%	120%	100%	80%	120%	101%	70%	130%
pH (2:1)	7986145		9.39	9.35	0.4%	NA	100%	90%	110%	NA			NA		
Electrical Conductivity (2:1)	7989762		0.111	0.108	2.7%	< 0.005	100%	90%	110%	NA			NA		
Redox Potential (2:1)	7986145		233	233	0.0%	< 5	101%	70%	130%	NA			NA		

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

Certified By: Amanjot Bhela

AGAT Laboratories

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MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
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FAX (905)712-5122
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Method Summary

CLIENT NAME: EXP. SERVICES INC.

AGAT WORK ORDER: 16T156640

PROJECT: BAR-00042830-A0

ATTENTION TO: Rebecca Moser

SAMPLING SITE:

SAMPLED BY:CF

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Sulphide	MIN-200-12025	ASTM E1915-09	GRAVIMETRIC
Chloride (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Electrical Conductivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Resistivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B,SSA #5 Part 3	CALCULATION
Redox Potential (2:1)		McKeague 4.12 & SM 2510 B	REDOX POTENTIAL ELECTRODE

AGAT Laboratories

small reel

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

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water intended for human consumption)

Laboratory Use Only

Work Order #: 16T156640

Cooler Quantity:

Arrival Temperatures: 4.9 | 4.8 | 5.8

Custody Seal Intact: ☐ Yes ☐ No ☑ N/A

Notes:

Report Information:

Company: EXP GLOBAL

Contact: REBECCA MOSER

Address: 14 Cedar Pointe Dr. Barrie ON L4N 5R7.

Phone: 705-719-1100 Fax:

Reports to be sent to:

1. Email: rebecca.moser@exp.com
2. Email: jodi.fountain@exp.com

Regulatory Requirements: ☑ No Regulatory Requirement

(Please check all applicable boxes)

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

☐ Sewer Use: ☐ Sanitary ☐ Storm; Region (Indicate One)

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

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

Report Guideline on Certificate of Analysis ☐ Yes ☐ No

Turnaround Time (TAT) Required:

Regular TAT ☑ 5 to 7 Business Days

Rush TAT (Rush Surcharges Apply): ☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day

OR Date Required (Rush Surcharges May Apply):

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

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

Project Information:

Project: BAR-00042830-A0

Site Location: 37 JOHNSON STREET

Sampled By: CF

AGAT Quote #: PO:

Please note: If quotation number is not provided, client will be billed full price for analysis.

Invoice Information: Bill To Same: Yes ☑ No ☐

Company:

Contact:

Address:

Email:

Sample Matrix Legend

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

Analysis columns: Field Filtered - Metals, Hg, CrVI (Y/N); O. Reg 153: Metals and Inorganics; ☐ All Metals ☐ 153 Metals (excl. Hydrides) ☐ Hydride Metals; ORPs: ☐ B-HWS ☐ Cl ☐ CN ☐ Cr6+ ☐ EC ☐ FOC ☐ Hg ☐ pH ☐ SAR; Full Metals Scan; Regulation/Custom Metals; Nutrients: ☐ TP ☐ NH₃ ☐ TKN ☐ NO₃ ☐ NO₂ ☐ NO₃+NO₂; Volatiles: ☐ VOC ☐ BTEX ☐ THM; CCME Fractions 1 to 4; ABNs; PAHs; PCBs: ☐ Total ☐ Aroclors; Organochlorine Pesticides; TCLP ☐ M&I ☐ VOCs ☐ ABNs ☐ B(a)P ☐ PCBs; Sewer Use; Corrosivity pkg (pH, sulfate, resistivity)

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Corrosivity pkg (pH, sulfate, resistivity)
BH2/S3	Oct.27	2:15PM	1	S		X
BH3/S4	Oct.27	9:45AM	1	S		X
BH4/S3	Oct.28	9:30AM	1	S		X

Samples Relinquished By (Print Name and Sign)	Date	Time	Samples Received By (Print Name and Sign)	Date	Time
J. Fountain (signature)	Nov 3/16	4:00pm	Shannon (signature) Nov 4/16		10:10am

Page 1 of 1

Nº T 038917

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

Appendix E – Site Photographs

Photograph No. 1 – Borehole BH6 Location, Northeast View

Photograph No. 2 – Borehole BH5 Location, Northwest View

Photograph No. 3 – Borehole BH4 on the left and Borehole BH1 on the right, West View

Photograph No. 4 – Borehole BH2 Location, West View

Photograph No. 5 – Borehole BH3 Location, Northeast View

Photograph No. 6 – Monitoring well at BH4, Southwest View

Photograph No. 7 – Drilling at Borehole BH5 Location, West View

Photograph No. 8 – Monitoring well at Borehole BH2, West View