APPENDIX A

Geotechnical Investigation Report

City of Niagara Falls

Geotechnical Investigation

Type of Document
Final

Project Name
Oakes Park Baseball Diamond Improvements
Niagara Falls, ON

Project Number
HAM-00801777-A0

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1 Introduction

This report presents the results of the geotechnical investigation carried out at the baseball diamond at Oakes Park located at the corner of Morrison Street and Stanley Avenue in Niagara Falls, Ontario. It is understood that the planned project will consist of replacement of both player dugouts, as well as construction of a retaining wall. Authorization to proceed with the geotechnical investigation was provided by Mr. Jeff Claydon on behalf of the City of Niagara Falls (City).

The purpose of this investigation was to determine the general subsoil and groundwater conditions at the site by putting down three (3) boreholes and based on an assessment of the factual borehole data, provide an engineering report containing geotechnical recommendations pertinent to the proposed construction.

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

2 Field Investigation

2.1 General Fieldwork

As requested by the client, a total of three (3) boreholes were advanced at the site. The fieldwork for this investigation was carried out on August 29, 2019 by a combination of auger and split-spoon techniques using track mounted equipment owned and operated by a specialist drilling subcontractor. Prior to the commencement of the drilling operations, private and publicly owned underground services were located to minimize the risk of contacting any such services during the drilling operations.

The boreholes were advanced to a depth of approximately 3.5 m below existing grade. The approximate borehole locations are shown on Drawing No. 1 in Appendix A. Details of the subsurface conditions encountered in the borings are shown on the borehole logs (Drawing No. 3 to 5) in Appendix A.

Soil samples were obtained using a 51 mm (2 inch) outside diameter split-spoon sampler driven in conjunction with Standard Penetration Test procedure (ASTM D1586) at the depths noted graphically on the borehole logs. The retained soil samples were logged in the field and then carefully packaged and transported to our Hamilton laboratory for detailed visual, textural and olfactory classification. The Standard Penetration Test (SPT) N values and pocket penetrometer measurements were recorded and used to provide an assessment of the compactness condition or consistency of the in-situ soils.

Groundwater levels within the boreholes were measured prior to backfilling. Moisture content determinations were carried out on all soil samples and the results are summarized on the borehole logs presented in Appendix A. All boreholes were backfilled in accordance with O.Reg. 903.

The depth and general borehole locations were provided by the City and relocated on site by EXP as required due to buried utilities, overhead obstructions, and other drilling considerations. The ground surface elevations at the borehole locations were surveyed by EXP and referenced to a temporary benchmark (TBM), described as follows:

TBM: Centre of the catch basin lid located in the existing parking lot, approximately 7 m east of the northeast corner of the grandstand structure

Elevation: 190.67 m (geodetic), as per City of Niagara Falls Drawing No. L01, titled *Contract No. 2019-488-18, Oaks Park Ball Diamond #1 Improvements,* dated July 22, 2019

2.2 Environmental Testing

Limited environmental testing was conducted on selected soil samples recovered from the boreholes as part of this geotechnical investigation. Due to limited historical knowledge of the site and surrounding properties, the test parameters selected were metals and inorganics (O.Reg. 153). A total of three (3) samples were submitted from the boreholes to a certified laboratory for analytical testing to determine the chemical quality of the material for off-site disposal during construction. Additional contaminants may be present in the soil from historic site or surrounding property use that were not analyzed. Groundwater was not tested as this was beyond the scope of work.

Dedicated nitrile gloves (i.e. one pair per sample) were used during sample handling. The soil samples were placed in laboratory-supplied glass jars and clean ice-packed coolers prior to and during transportation to the subcontracted laboratory, AGAT Laboratories (AGAT) of Mississauga, Ontario. The samples were transported/submitted under Chain of Custody documentation.

2.3 Site Assessment Criteria

The assessment criteria, Site Condition Standards (SCS), applicable to a given site in Ontario are established under subsection 168.4(1) of the Environmental Protection Act. Tabulated generic criteria are provided in “Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act” (“the SGWS Standards”), MECP, July 2011. These criteria are based on site sensitivity (sensitive or non-sensitive), groundwater use (potable or non-potable), property use (residential, parkland, institutional, commercial, industrial, community and agricultural/other), soil type (coarse or medium to fine textured) and restoration depth (full or stratified restoration). In addition, site specific criteria may be established on the basis of the findings of a risk assessment carried out in accordance with Part IX and Schedule C of Ontario Regulation 153/04 (O. Reg. 153).

The SGWS Standards specify SCS for soil, groundwater and sediment that are tabulated as follows:

Table 1: applicable to sites where background concentrations must be met (full depth) such as sensitive sites where site-specific criteria have not been derived

Table 2: applicable to sites with potable groundwater and full depth restoration

Table 3: applicable to sites with non-potable groundwater and full depth restoration

Table 4: applicable to sites with potable groundwater and stratified restoration

Table 5: applicable to sites with non-potable groundwater and stratified restoration

Table 6: applicable to sites with potable groundwater and less than 2 m of overburden above bedrock

Table 7: applicable to sites with non-potable groundwater and less than 2 m of overburden above bedrock

Table 8: applicable to sites with potable groundwater and less than 30 m from a water body

Table 9: applicable to sites with non-potable groundwater and less than 30 m from a water body

For assessment purposes, EXP selected the Table 3 SCS for Residential/Parkland/Institutional (RPI) Property Use with coarse textured soil. To provide additional options for soil disposal, the analytical results were also compared to the Table 1 Agricultural SCS. The selection of this category is based on the following factors:

- It is understood that the site is not considered a sensitive site
- To the best of EXP's knowledge, all properties within 250 m of the site are serviced by the municipal water supply and groundwater is not used as a potable water source either on or within 250 m of the site
- The site is not located in an area designated in a municipal official plan as a well-head protection area or other designation identified by the municipality for the protection of groundwater
- There is no intention to carry out a stratified restoration at the site
- No waterbodies are located within 30 m of the site
- The property use of the site is parkland
- The predominant soil type on the site is considered to be coarse textured and bedrock was not encountered within the upper 2.0 m
- There is no intention to carry out a stratified restoration at the site

3 Subsurface Conditions

Details of the subsurface conditions encountered during the drilling program are summarized on the borehole logs presented in Appendix A.

The logs include textural descriptions of the subsoil and groundwater conditions and indicate the soil boundaries inferred from non-continuous sampling and observations during drilling. These boundaries reflect approximate transition zones for the purpose of geotechnical design and should not be interpreted as exact planes of geological change. The "Notes on Sample Description" preceding the borehole logs form an integral part of and should be read in conjunction with this report.

3.1 Stratigraphy

All three boreholes encountered surficial topsoil, with native or reworked native silty sand below. The native soils became more clayey below a depth of approximately 2.4 to 2.6 m, and were described as clayey silty sand in Boreholes BH-1 and BH-3. The silty sand or clayey silty sand extended to the termination depth of 3.5 m. Details of the encountered materials are provided in the following sections.

3.1.1 Topsoil

Surficial topsoil was encountered at all borehole locations and was noted to have a thickness ranging from approximately 200 to 350 mm. It is noted that topsoil thickness can further vary throughout the site.

3.1.2 Silty Sand

Native silty sand was encountered below the topsoil at all borehole locations and extended to depths of 2.4 to 2.6 m below grade in Boreholes BH-1 and BH-3, and to the termination depth of approximately 3.5 m below grade in Borehole BH-2. The silty sand contained trace clay, with occasional clayey seams, was brown, and in a moist state in the upper levels, generally becoming wet below about 1.5 to 2.3 m. Moisture contents of the silty sand ranging from 7 to 29 percent of dry mass. The silty sand was noted to have a reworked appearance within the upper 0.6 m. Based on SPT N values ranging from 3 to 19 blows per 305 mm of penetration, the silty sand is classified as loose to very loose in the upper reworked level, and as loose to compact below.

One (1) grain size analysis was conducted on a select sample of the silty sand stratum, with the results included in Appendix B and summarized in the table below.

Table 3-1: Summary of Grain Size Analyses

Sample	Clay (%)	Silt (%)	Sand (%)	Gravel (%)
BH-1 SS3	8	35	57	0

3.1.3 Clayey Silty Sand

Below a depth of approximately 2.4 to 2.6 m, the soils transitioned to clayey silty sand in Boreholes BH-1 and BH-3. The clayey silty sand was brown and in a wet state, with moisture contents ranging from 18 to 26 percent of dry mass. Based on SPT N values ranging from 17 to 25 blows per 305 mm of penetration, the clayey silty sand is classified as compact.

3.2 Groundwater

Groundwater conditions were monitored in the open boreholes during and upon completion of the drilling operations. Free water was encountered at a depth of 1.2 m in Borehole BH-1 upon completion of drilling. This water was observed to be infiltration from within the upper levels of the silty sand. The other two boreholes were recorded as dry. Groundwater levels are not considered to have stabilized during the short-term of the investigation. Seasonal variations in the water table should be anticipated,

with higher levels occurring during wet weather conditions (spring thaw and late fall) and lower levels occurring during dry periods.

4 Environmental Considerations

4.1 General

In accordance with the scope of work, chemical analyses were performed on selected soil samples recovered from the boreholes. Copies of the laboratory Certificates of Analysis for the tested soil samples are provided in Appendix C.

4.2 Soil Analysis

The Table 3 SCS are applicable if soil pH is in the range of 5 to 9 for surface soil (less than 1.5 m below soil surface) and 5 to 11 for subsurface soil (greater than 1.5 m below soil surface). The Certificates of Analysis include pH measurements taken on two (2) surface soil samples and one (1) subsurface soil sample. The reported pH values obtained from the soil samples were within the acceptable range to enable the use of the generic SCS.

Three (3) soil samples were analyzed for metals and inorganics. The results of the metals and inorganics analysis together with the applicable Table 1 Agricultural and Table 3 RPI SCS are presented below in Table 4-1.

Table 4-1: Analytical Results for Metals and Inorganics in Soil

Parameter	Table 1 SCS	Table 3 SCS	BH-1 SS1 (0.0-0.6 m)	BH-2 SS2 (0.8-1.2 m)	BH-3 SS3 (1.5-2.0 m)
Antimony	1.3	7.5	<0.8	<0.8	<0.8
Arsenic	18	18	3	3	4
Barium	220	390	45	24	60
Beryllium	2.5	4	<0.5	<0.5	<0.5
Boron	36	120	<5	<5	<5
Boron (Hot Water Soluble)	NV	1.5	0.44	0.12	0.1
Cadmium	1.2	1.2	<0.5	<0.5	<0.5
Chromium	70	160	9	7	14
Cobalt	21	22	4	4.2	6.2
Copper	92	140	9	7	13
Lead	120	120	21	5	7
Molybdenum	2	6.9	<0.5	<0.5	<0.5
Nickel	82	100	10	7	13
Selenium	1.5	2.4	0.4	<0.4	<0.4
Silver	0.5	20	<0.2	<0.2	<0.2
Thallium	1	1	<0.4	<0.4	<0.4
Uranium	2.5	23	<0.5	<0.5	<0.5
Vanadium	86	86	15	16	22
Zinc	290	340	63	20	37

Parameter	Table 1 SCS	Table 3 SCS	BH-1 SS1 (0.0-0.6 m)	BH-2 SS2 (0.8-1.2 m)	BH-3 SS3 (1.5-2.0 m)
Chromium VI	0.66	8	<0.2	<0.2	<0.2
Cyanide (free)	0.051	0.051	<0.040	<0.040	<0.040
Mercury	0.27	0.27	<0.10	<0.10	<0.10
Electrical Conductivity (uS/cm)	0.57	0.7	0.35	0.11	0.173
Sodium Adsorption Ratio (unitless)	2.4	5	0.634	0.325	0.369

Note: Concentrations are expressed in µg/g except where noted.
Bold and underline indicates an exceedance of the Table 1 SCS
Bold and shading indicates an exceedance of the Table 3 SCS

As shown in Table 4-1, no exceedances for Table 1 Agricultural or Table 3 RPI SCS were noted. Based on the limited test results, the following options for soil disposal are presented:

Table 4-2: Summary of Disposal Options

Option	Description	Advantages	Disadvantages / Considerations
1	Re-use excess soil on Site	• Cheapest option	• Must be geotechnically suitable for re-use and meet specifications • Potential limitations for stockpiling and temporary storage
2	Dispose excess soil at 3rd party sites	• Less expensive than landfill disposal • Samples meet Table 1 Agricultural and 3 RPI SCS	• Sites sometimes difficult to find at time of construction
3	Dispose excess soil at licensed landfill facility	• Landfill sites usually open to accept soils	• Most expensive option • Requires TCLP sample prior to landfill acceptance • Environmentally unsustainable

4.3 Quality Assurance

Details regarding quality assurance measures taken in the field, including instrument calibration, decontamination procedures, use of dedicated equipment, sample storage and Chain of Custody documentation are provided in Section 2.2.

The subcontract laboratory used during this investigation, AGAT Laboratories, is accredited by the Standards Council of Canada/Canadian Association of Laboratory Accreditation in accordance with ISO/IEC 17025:1999 – "General Requirements for the Competence of Testing and Calibration Laboratories" for the analysis of all parameters for all samples in the scope of work for which SCS have been established under Ontario Regulation 153/04 as amended by Ontario Regulation 511/09 and Ontario Regulation 179/11.

The "Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act" ("the Analytical Protocol"), MECP, July 2011, establishes criteria used in

assessing the performance of analytical laboratories when the data are used in support of the filing of Records of Site Condition.

The laboratory quality assurance program included the analysis of laboratory duplicate (replicate) samples, method blanks, spiked blanks, spiked samples and samples of reference materials in accordance with the Analytical Protocol. These analytical results comprise portions of the Certificates of Analysis in Appendix C.

5 Engineering Discussion & Recommendations

It is understood that the planned project will consist of replacement of both player dugouts, as well as construction of a retaining wall. We offer the following comments and recommendations for the proposed construction.

5.1 Foundation Recommendations

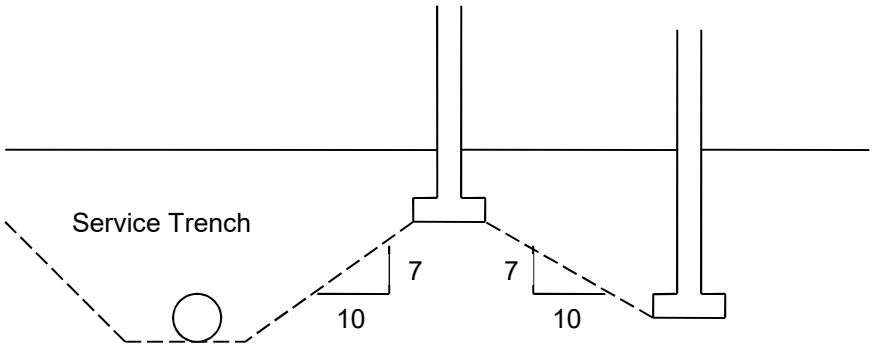
Based on the subsurface conditions encountered at the site, spread or strip footings for the proposed dugouts and retaining wall may be founded on the undisturbed native silty sand or clayey silty sand, below any reworked or disturbed material. Conventional footings constructed on the undisturbed native soils below the depths specified in the table below can be designed using a geotechnical resistance of 75 to 100 kPa at Serviceability Limit State (SLS) and 125 to 150 kPa at Ultimate Limit State (ULS), subject to inspection by EXP during construction.

Table 5-1: Available Geotechnical Resistance

Borehole No.	Available Geotechnical Resistance (kPa)	Founding Soils	Recommended Minimum Founding Elevation / Depth (m)
BH-1	100 SLS / 150 ULS	silty sand	Below 0.8 / 188.9
BH-2	75 SLS / 125 ULS	silty sand	Below 0.8 / 190.5
BH-3	75 SLS / 125 ULS	silty sand	Below 0.8 / 189.8

5.1.1 General Foundation Recommendations

Foundations at different elevations should be located such that higher footings are set below a line drawn up at 10 horizontal to 7 vertical from the near edge of the lower footing. This concept should also be applied to excavations for new foundations in relation to existing footings or underground services.



FOOTINGS NEAR SERVICE TRENCHES OR AT DIFFERENT ELEVATIONS

All footings exposed to freezing conditions should be provided with a minimum of 1.2 m of earth cover or equivalent insulation for frost protection, depending on the final grade requirements.

Provided that the soil is not disturbed due to groundwater, precipitation, traffic, etc., and the aforementioned bearing pressure is not exceeded, then total and differential settlements should be small and within the normally tolerated limits of 25 mm and 19 mm, respectively.

The recommended bearing capacities have been calculated by EXP from the borehole information for the design stage only. The investigation and comments are necessarily on-going as new information of underground conditions becomes 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 reviews during the construction stage.

5.2 Concrete Slab-on-Grade and Permanent Drainage

The dugout slabs-on-grade can be supported on the native silty sand. The exposed native subgrade surface should be examined by a geotechnical engineer. Any soft or loose areas detected during the review process should be sub-excavated and replaced with approved material compacted to 100 percent Standard Proctor Maximum Dry Density (SPMDD).

A 200 mm thick layer of 19 mm clear crushed stone material should be placed between the prepared subgrade and the floor slab to serve as a moisture barrier. As the exterior grade is expected to be well above the finished floor elevation, perimeter drainage is required.

5.3 Excavations

Excavations for the dugouts and retaining wall are expected to extend to depths of 2 m below grade or less. In reference to the borehole data, the excavations will typically be carried out in the native silty

sand. Excavations within the encountered soils may be undertaken with a sufficiently sized hydraulic excavator.

The contractor should be aware that the slope height, slope inclination, or excavation depths should in no case exceed those specified in local, provincial, or federal safety regulations. Installation of the proposed dug outs by open-cut excavations is considered feasible. Should open-cut excavations not be feasible, e.g. due to adjacent structures etc., a properly designed shoring system or a trench box can be used. Side slopes of the temporary excavations must conform to the most recent Occupational Health and Safety Act (OHSA) and local regulations.

For guidance, the encountered soils can generally be considered Type 3 soil above the groundwater level. Locally, where loose/soft materials are encountered, or within zones of persistent seepage at depth, it may be necessary to flatten the slopes. All excavations must be completed in accordance with the most recent regulations of the Ontario Occupation Health and Safety Act (OHSA). The OHSA requires that excavation slopes be cut at predetermined inclinations, based on the soil types encountered. The need to excavate flatter side slopes if excessively wet or soft/loose materials, or concentrated seepage zones are encountered, should not be overlooked. Water (i.e. surface water runoff) should not be permitted to enter and/or pond within the construction area.

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 the boreholes advanced at the site. 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 be contacted immediately to evaluate the conditions encountered.

5.4 Groundwater Control

Free water was encountered at a depth of 1.2 m in Borehole BH-1 upon completion of drilling, from infiltration within the upper levels of the native soils. The other two boreholes were recorded as dry. The retrieved samples were noted to become wet below depths ranging from 1.5 to 2.4 m below grade.

As such some groundwater may be encountered within the native soil, as well as near the transition to clayey silty sand, at depths of approximately 2.4 to 2.6 m. However, based on the anticipated excavation depths, any encountered groundwater should be possible to remove using conventional construction dewatering techniques, i.e. pumping from sumps in conjunction with oversized excavations, as required. Seasonal variations in the water table should be anticipated, with higher levels occurring during wet weather conditions (spring thaw and late fall) and lower levels occurring during dry weather.

5.5 Lateral Earth Pressure

The lateral earth pressure acting on the foundation walls of the dugouts or the retaining wall may be calculated using the following equation:

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

where p = Lateral earth pressure (kPa)

K = Coefficient of earth pressure (assume 0.40)

γ = Unit weight of supported soil (assume 21.0 kN/m^3)

h = Depth to point of interest (m)

q = Surcharge load acting adjacent to the wall at the ground surface (kPa)

The above expression assumes that the drainage system prevents the build-up of hydrostatic pressure behind the wall and free-draining granular material will be used for backfilling adjacent to the wall.

5.6 Backfill

Backfill used against foundations, the retaining wall, etc., should be compactable fill, i.e. inorganic soil with its moisture content close to its optimum moisture content as determined by a Standard Proctor Test. The excavated soils, which are not mixed with organics or other obviously unsuitable materials, may be re-used as backfill. Materials found to be wet should be allowed to drain and dry out before re-using. Any shortfall of suitable on-site excavated material can be made up with imported and approved materials.

Imported granular material conforming to OPSS Granular B Type I is preferable for use in confined areas and where free-draining characteristics are required. Backfill should be placed in lifts not exceeding 200 mm and compacted to at least 98 percent Standard Proctor Maximum Dry Density (SPMDD) in pavement areas.

Heavy compactors, which generate large lateral stress, should be kept at a safe distance from walls to avoid structural damage. All backfill and compaction operations should be monitored by qualified geotechnical personnel to approve material, evaluate placement operations, and verify that the specified degree of compaction is being achieved throughout the fill.

5.7 General Comments on Permeability

It is understood that the design is considering solutions to promote ground recharge, such as using the bullpen areas for exfiltration. As noted above, the encountered native subgrade soil was predominantly silty sand, becoming clayey with depth. Based on the grain size analysis completed, the native silty sand would be estimated to have an approximate percolation rate (T-time) of 15 to 20 mins/cm. This would correspond to an estimated infiltration rate of 30 to 40 mm/hr, which would generally be considered moderately permeable. It is noted the above rates are based on a single grain size analysis and are for the purpose of aiding in the preliminary design only. It is further noted that the soils would generally become less permeable with depth, as the clay content increases. In areas

where the design requires an infiltration rate, the final design rate used should be based on in-situ testing.

6 General Comments

The information presented in this report is based on a limited investigation designed to provide information to support an overall assessment of the current geotechnical conditions of the subject property. The conclusions presented in this report reflect site conditions existing at the time of the investigation.

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 design engineers. The number of boreholes required to determine the localized underground conditions between boreholes affecting construction costs, techniques, sequencing, equipment, scheduling, etc., would be much greater than has been carried out for 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. 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. EXP Services Inc. has qualified personnel to provide assistance in regard to future geotechnical and environmental issues related to this property.

We trust this report is satisfactory for your purposes. Should you have any questions, please do not hesitate to contact this office.

EXP Services Inc.

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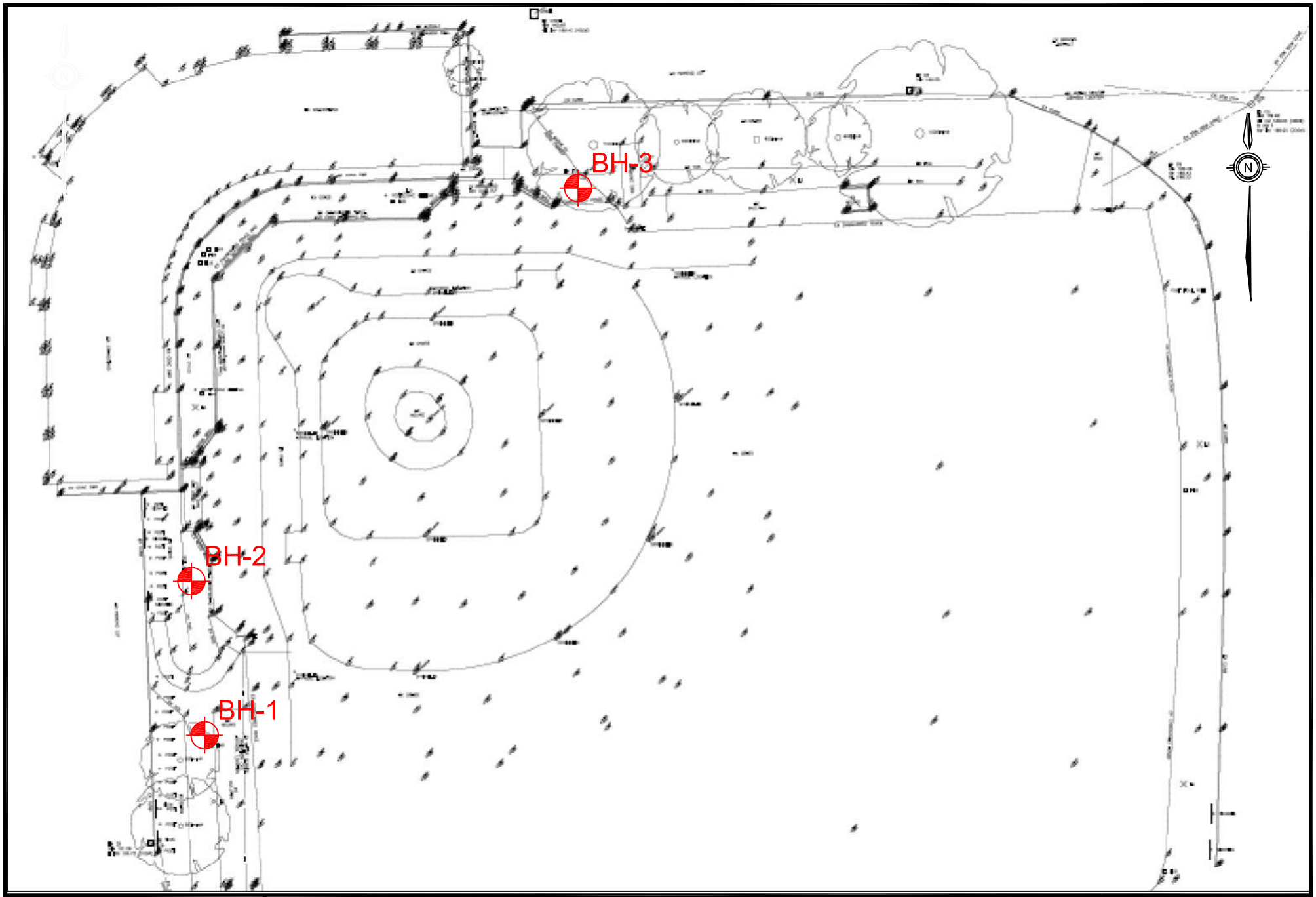
Appendix A – Drawings



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LEGEND:

APPROXIMATE BOREHOLE LOCATION

TITLE AND LOCATION:

BOREHOLE LOCATION PLAN
GEOTECHNICAL INVESTIGATION
OAKES PARK BASEBALL DIAMOND IMPROVEMENTS
NIAGARA FALLS, ON

JOB NO.: HAM-00801777-A0	DRAWN BY: ML
SCALE: NTS	CHECKED BY: JG
DATE: September 2019	DWG NO.: 1

Notes on Sample Descriptions

1. All sample descriptions included in this report follow the International Society for Soil Mechanics and Foundation Engineering (ISSMFE), as outlined in the Canadian Foundation Engineering Manual. Note, however, that behavioral properties (i.e. plasticity, permeability) take precedence over particle gradation when classifying soil. 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 Soil 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	<0.060 mm	"trace" (e.g. Trace sand)	1% to 10%
Sand	0.060 to 2.0 mm	"some" (e.g. Some sand)	10% to 20%
Gravel	2.0 to 75 mm	adjective (e.g. sandy, silty)	20% to 35%
Cobbles	75 to 200 mm	"and" (e.g. and sand)	35% to 50%
Boulders	>200 mm		

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" Blows / 0.3 m**	**Consistency**	**Undrained Shear Strength (kPa)**	**Standard Penetration Resistance "N" Blows / 0.3 m**
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

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

Log of Borehole BH-1

Project No. HAM-00801777-A0 Drawing No. 3

Project: Oakes Park Baseball Diamond Improvements Sheet No. 1 of 1

Location: Niagara Falls, ON

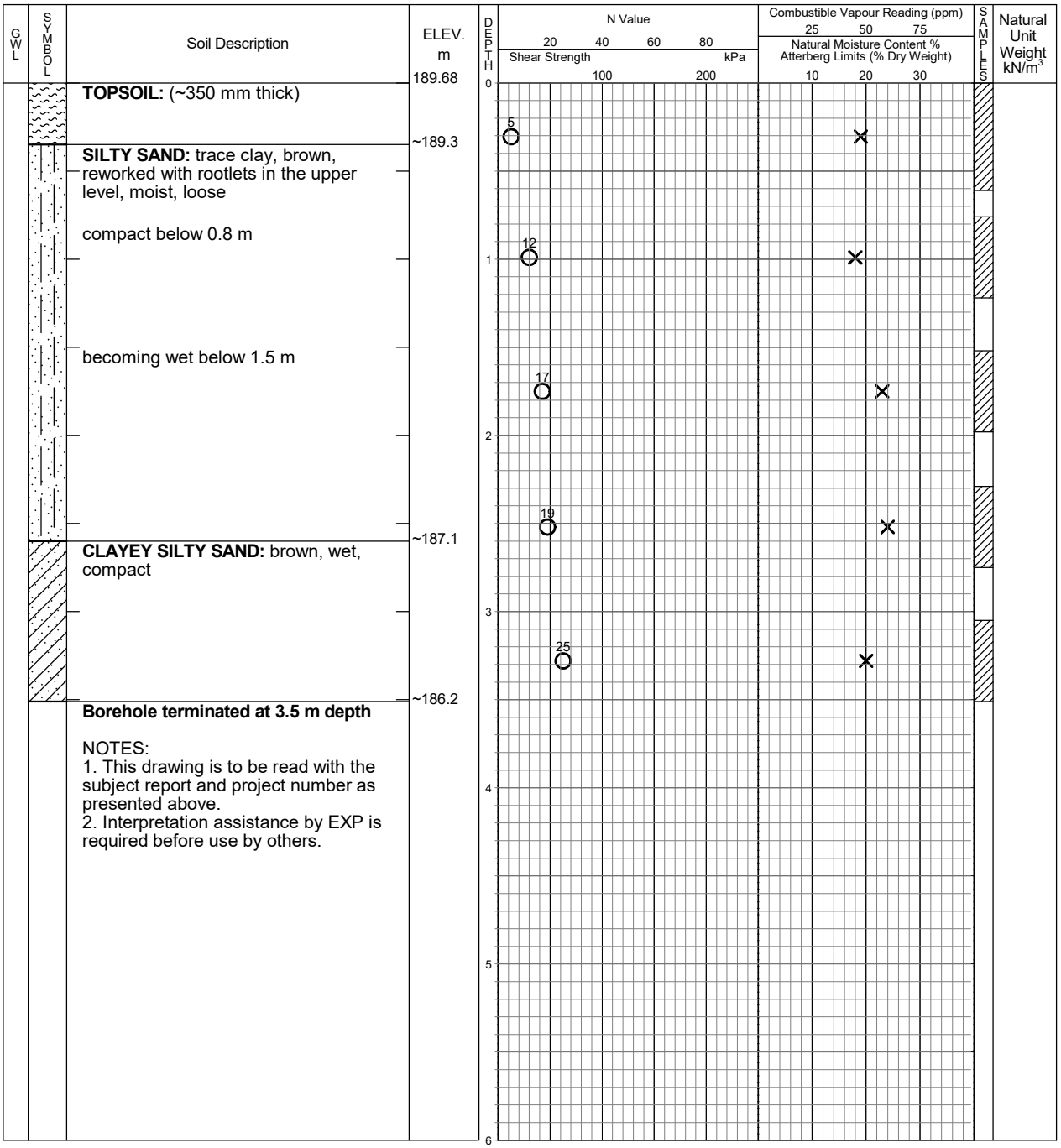
Date Drilled: August 29, 2019

Drill Type: D-50 Track Mount. Solid Stem.

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



LAGWGLJFHAM-EXP BHLOGS.GPJ NEW.GDT 9/13/19

EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	1.2	1.2

Log of Borehole BH-2

Project No. HAM-00801777-A0 Drawing No. 4

Project: Oakes Park Baseball Diamond Improvements Sheet No. 1 of 1

Location: Niagara Falls, ON

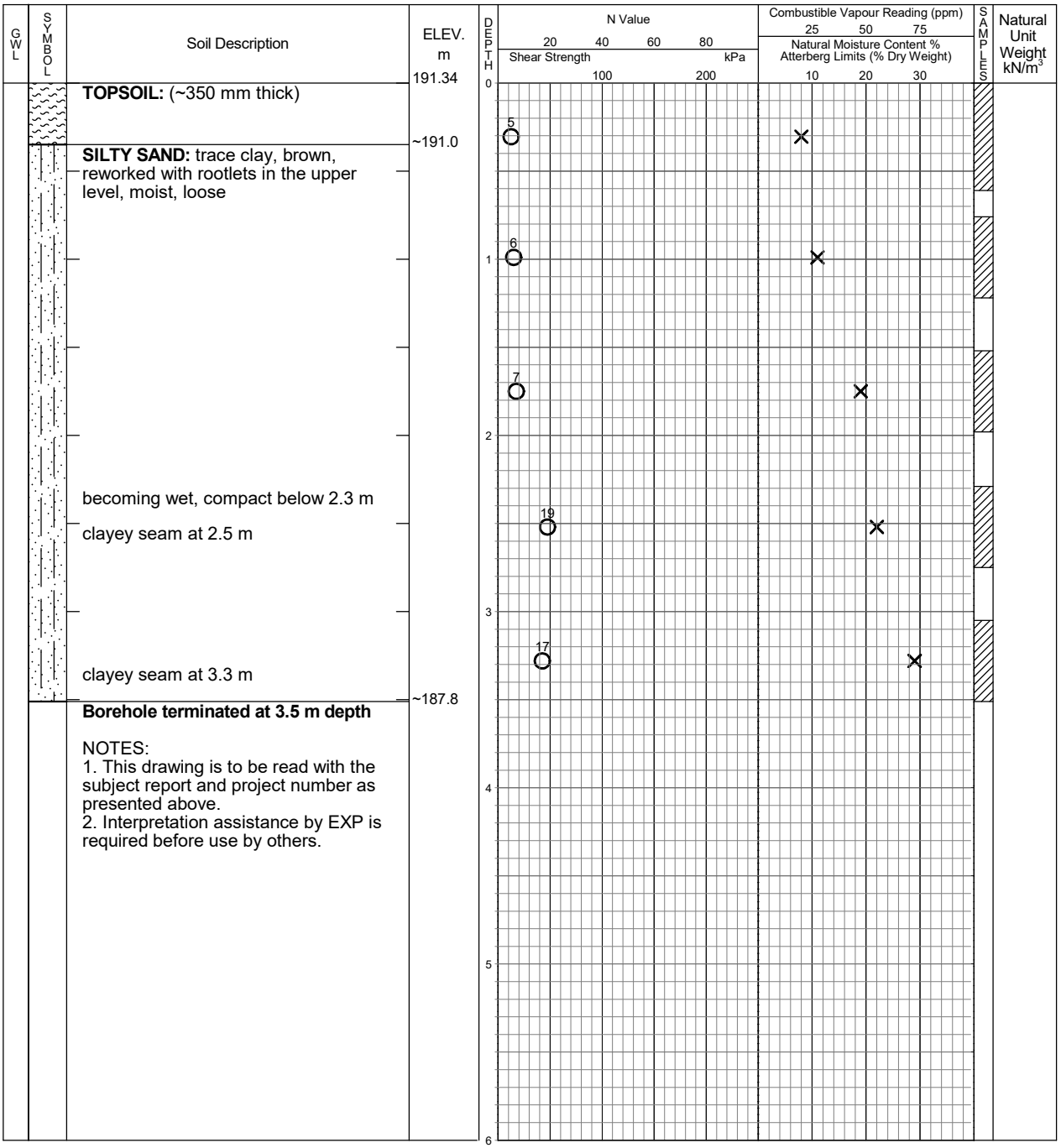
Date Drilled: August 29, 2019

Drill Type: D-50 Track Mount. Solid Stem.

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



NOTES:
1. This drawing is to be read with the subject report and project number as presented above.
2. Interpretation assistance by EXP is required before use by others.

LAGWGLJFHAM-EXP BHLOGS.GPJ NEW.GDT 9/13/19

EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	dry	no cave

Log of Borehole BH-3

Project No. HAM-00801777-A0 Drawing No. 5

Project: Oakes Park Baseball Diamond Improvements Sheet No. 1 of 1

Location: Niagara Falls, ON

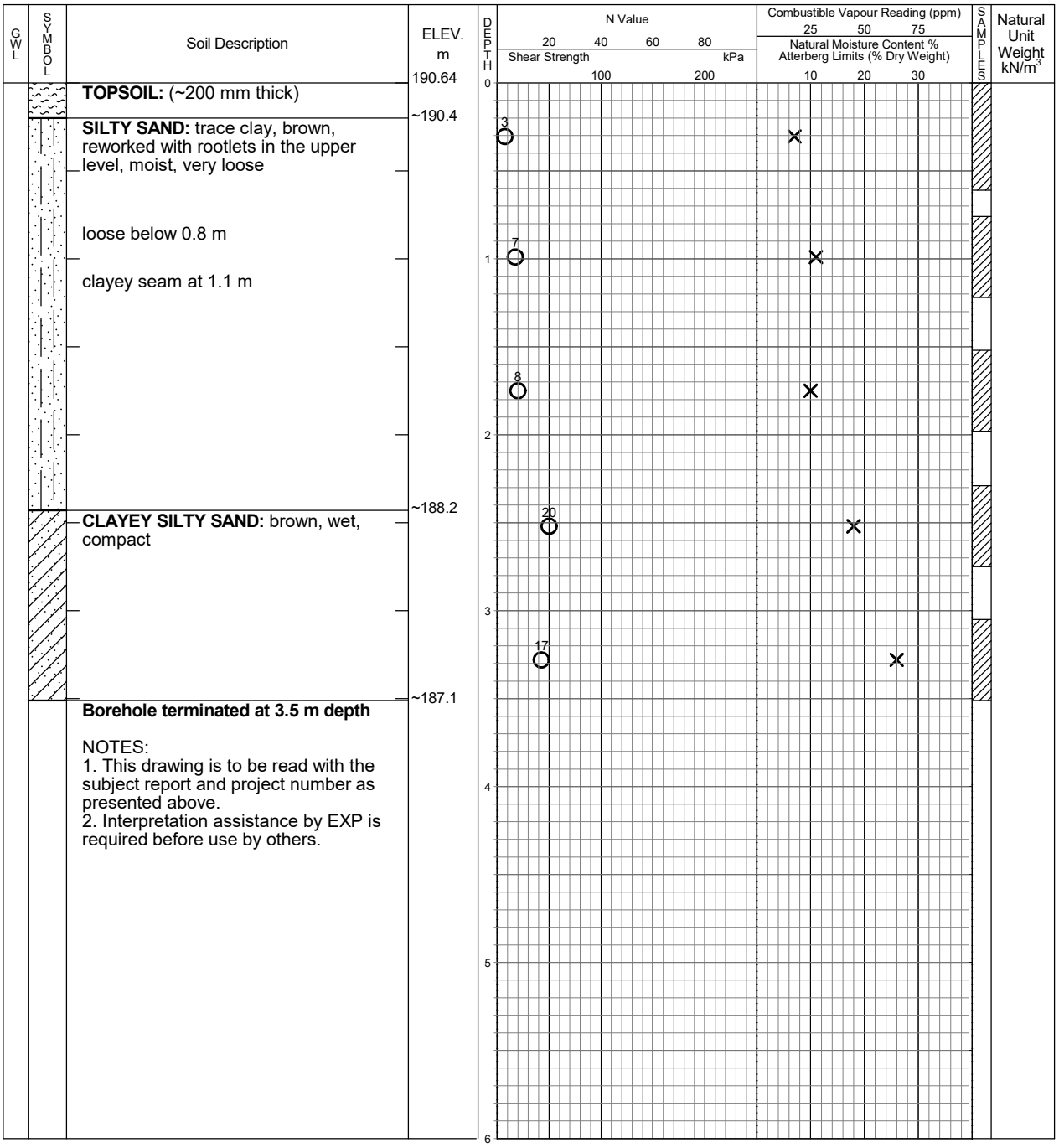
Date Drilled: August 29, 2019

Drill Type: D-50 Track Mount. Solid Stem.

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



NOTES:
1. This drawing is to be read with the subject report and project number as presented above.
2. Interpretation assistance by EXP is required before use by others.

LAGWGLJFHAM-EXP BHLOGS.GPJ NEW.GDT 9/13/19

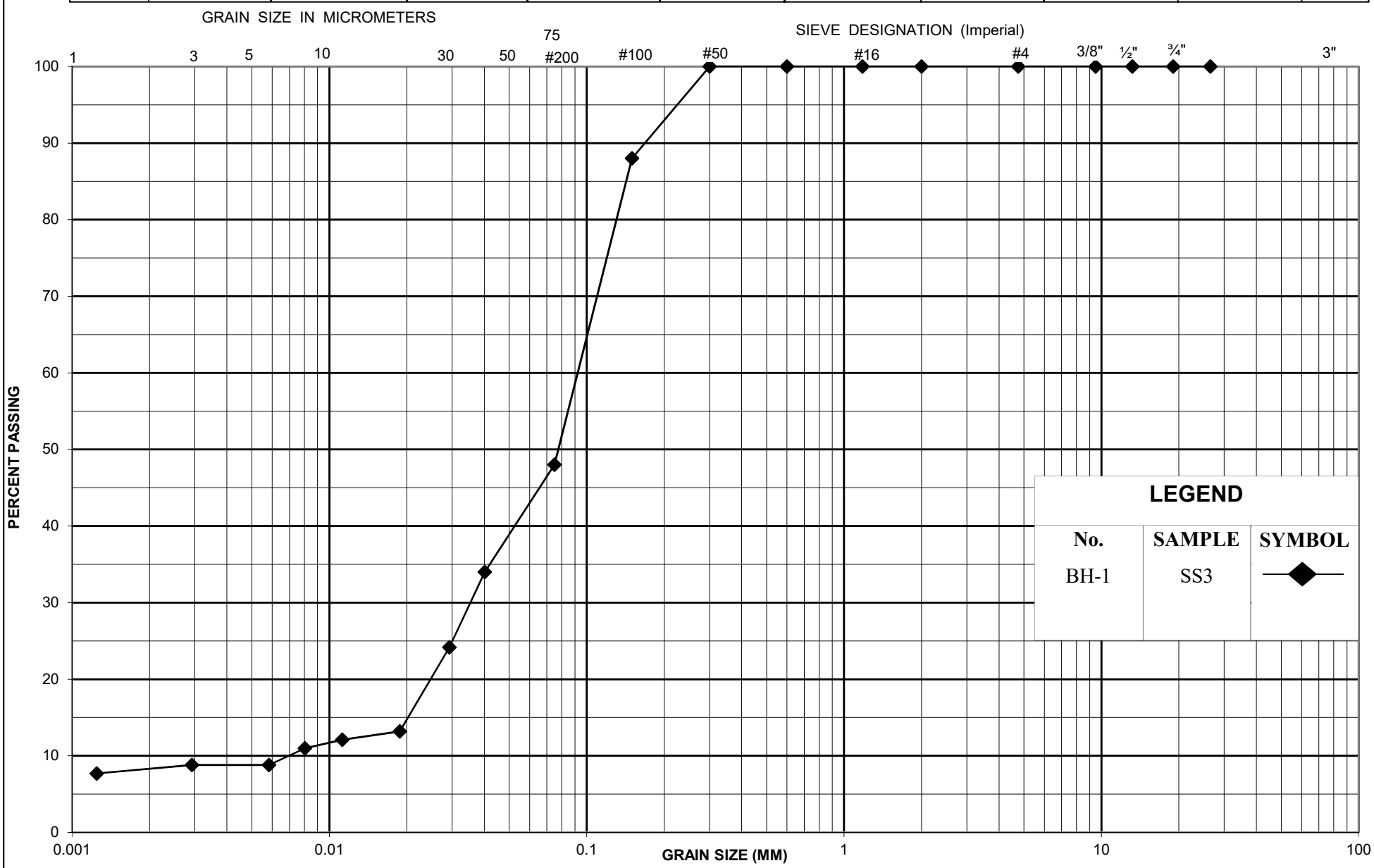
EXP Services Inc.
Hamilton, Ontario
Telephone: 905.573.4000
Facsimile: 905.573.9693

Time	Water Level (m)	Depth to Cave (m)
on completion	dry	no cave

Appendix B –
Laboratory Test Results

ISSMFE SOIL CLASSIFICATION SYSTEM

CLAY	SILT			SAND			GRAVEL			Cobbles
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	



GRAIN SIZE DISTRIBUTION

DRAWING NO.:	B1
PROJECT NO.:	HAM 00801777-A0
DATE:	September 2019

Appendix C – Certificate of Analysis

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.
80 BANCROFT STREET
HAMILTON, ON L8E2W5
(905) 573-4000

ATTENTION TO: Jeff Golder

PROJECT: HAM-00801777-A0

AGAT WORK ORDER: 19T513227

SOIL ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Supervisor

DATE REPORTED: Sep 10, 2019

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
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FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 19T513227

PROJECT: HAM-00801777-A0

CLIENT NAME: EXP. SERVICES INC.

ATTENTION TO: Jeff Golder

SAMPLING SITE:

SAMPLED BY:

O. Reg. 153(511) - Metals & Inorganics (Soil)

DATE RECEIVED: 2019-09-03

DATE REPORTED: 2019-09-10

		SAMPLE DESCRIPTION:		BH1 SS1	BH2 SS2	BH3 SS3
		SAMPLE TYPE:		Soil	Soil	Soil
		DATE SAMPLED:		2019-08-29	2019-08-29	2019-08-29
Parameter	Unit	G / S	RDL	494436	494437	494438
Antimony	µg/g	1	0.8	<0.8	<0.8	<0.8
Arsenic	µg/g	11	1	3	3	4
Barium	µg/g	210	2	45	24	60
Beryllium	µg/g	2.5	0.5	<0.5	<0.5	<0.5
Boron	µg/g	36	5	<5	<5	<5
Boron (Hot Water Soluble)	µg/g	NA	0.10	0.44	0.12	0.10
Cadmium	µg/g	1	0.5	<0.5	<0.5	<0.5
Chromium	µg/g	67	2	9	7	14
Cobalt	µg/g	19	0.5	4.0	4.2	6.2
Copper	µg/g	62	1	9	7	13
Lead	µg/g	45	1	21	5	7
Molybdenum	µg/g	2	0.5	<0.5	<0.5	<0.5
Nickel	µg/g	37	1	10	7	13
Selenium	µg/g	1.2	0.4	0.4	<0.4	<0.4
Silver	µg/g	0.5	0.2	<0.2	<0.2	<0.2
Thallium	µg/g	1	0.4	<0.4	<0.4	<0.4
Uranium	µg/g	1.9	0.5	<0.5	<0.5	<0.5
Vanadium	µg/g	86	1	15	16	22
Zinc	µg/g	290	5	63	20	37
Chromium VI	µg/g	0.66	0.2	<0.2	<0.2	<0.2
Cyanide	µg/g	0.051	0.040	<0.040	<0.040	<0.040
Mercury	µg/g	0.16	0.10	<0.10	<0.10	<0.10
Electrical Conductivity	mS/cm	0.47	0.005	0.350	0.110	0.173
Sodium Adsorption Ratio	NA	1	NA	0.634	0.325	0.369
pH, 2:1 CaCl2 Extraction	pH Units		NA	7.02	7.17	7.07

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Agricultural or Other Property Use
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

494436-494438 EC was determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil). pH was determined on the 0.01M CaCl2 extract prepared at 2:1 ratio. SAR is a calculated parameter.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

AGAT Laboratories

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

Quality Assurance

CLIENT NAME: EXP. SERVICES INC.

AGAT WORK ORDER: 19T513227

PROJECT: HAM-00801777-A0

ATTENTION TO: Jeff Golder

SAMPLING SITE:

SAMPLED BY:

Soil Analysis

RPT Date: Sep 10, 2019			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
O. Reg. 153(511) - Metals & Inorganics (Soil)															
Antimony	494436	494436	<0.8	<0.8	NA	< 0.8	100%	70%	130%	95%	80%	120%	84%	70%	130%
Arsenic	494436	494436	3	3	NA	< 1	109%	70%	130%	102%	80%	120%	100%	70%	130%
Barium	494436	494436	45	44	2.2%	< 2	104%	70%	130%	101%	80%	120%	96%	70%	130%
Beryllium	494436	494436	<0.5	<0.5	NA	< 0.5	74%	70%	130%	116%	80%	120%	124%	70%	130%
Boron	494436	494436	<5	<5	NA	< 5	76%	70%	130%	114%	80%	120%	106%	70%	130%
Boron (Hot Water Soluble)	494436	494436	0.44	0.43	NA	< 0.10	112%	60%	140%	103%	70%	130%	101%	60%	140%
Cadmium	494436	494436	<0.5	<0.5	NA	< 0.5	106%	70%	130%	101%	80%	120%	99%	70%	130%
Chromium	494436	494436	9	10	NA	< 2	92%	70%	130%	99%	80%	120%	99%	70%	130%
Cobalt	494436	494436	4.0	4.1	2.5%	< 0.5	90%	70%	130%	98%	80%	120%	97%	70%	130%
Copper	494436	494436	9	10	10.5%	< 1	87%	70%	130%	97%	80%	120%	92%	70%	130%
Lead	494436	494436	21	21	0.0%	< 1	103%	70%	130%	98%	80%	120%	91%	70%	130%
Molybdenum	494436	494436	<0.5	<0.5	NA	< 0.5	108%	70%	130%	101%	80%	120%	99%	70%	130%
Nickel	494436	494436	10	11	9.5%	< 1	93%	70%	130%	101%	80%	120%	99%	70%	130%
Selenium	494436	494436	0.4	<0.4	NA	< 0.4	101%	70%	130%	100%	80%	120%	97%	70%	130%
Silver	494436	494436	<0.2	<0.2	NA	< 0.2	111%	70%	130%	99%	80%	120%	94%	70%	130%
Thallium	494436	494436	<0.4	<0.4	NA	< 0.4	93%	70%	130%	102%	80%	120%	97%	70%	130%
Uranium	494436	494436	<0.5	<0.5	NA	< 0.5	101%	70%	130%	98%	80%	120%	88%	70%	130%
Vanadium	494436	494436	15	15	0.0%	< 1	90%	70%	130%	98%	80%	120%	98%	70%	130%
Zinc	494436	494436	63	64	1.6%	< 5	100%	70%	130%	104%	80%	120%	108%	70%	130%
Chromium VI	484978	494436	<0.2	<0.2	NA	< 0.2	104%	70%	130%	105%	80%	120%	97%	70%	130%
Cyanide	484978		<0.040	<0.040	NA	< 0.040	96%	70%	130%	92%	80%	120%	82%	70%	130%
Mercury	494436	494436	<0.10	<0.10	NA	< 0.10	95%	70%	130%	100%	80%	120%	101%	70%	130%
Electrical Conductivity	494436	494436	0.350	0.345	1.4%	< 0.005	100%	90%	110%	NA			NA		
Sodium Adsorption Ratio	494436	494436	0.634	0.627	1.1%	NA	NA			NA			NA		
pH, 2:1 CaCl2 Extraction	495724		7.03	7.04	0.1%	NA	100%	80%	120%	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
pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.

Certified By:

AGAT Laboratories

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

Method Summary

CLIENT NAME: EXP. SERVICES INC.

AGAT WORK ORDER: 19T513227

PROJECT: HAM-00801777-A0

ATTENTION TO: Jeff Golder

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Antimony	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Arsenic	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Barium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Beryllium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Boron	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Boron (Hot Water Soluble)	MET-93-6104	EPA SW 846 6010C; MSA, Part 3, Ch.21	ICP/OES
Cadmium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Chromium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Cobalt	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Copper	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Lead	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Molybdenum	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Nickel	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Selenium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Silver	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Thallium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Uranium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Vanadium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Zinc	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Chromium VI	INOR-93-6029	SM 3500 B; MSA Part 3, Ch. 25	SPECTROPHOTOMETER
Cyanide	INOR-93-6052	MOE CN-3015 & E 3009 A;SM 4500 CN	TECHNICON AUTO ANALYZER
Mercury	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Electrical Conductivity	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Sodium Adsorption Ratio	INOR-93-6007	McKeague 4.12 & 3.26 & EPA SW-846 6010C	ICP/OES
pH, 2:1 CaCl2 Extraction	INOR-93-6031	MSA part 3 & SM 4500-H+ B	PH METER

AGAT Laboratories

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 #: 19T513227
Cooler Quantity: 1 SM
Arrival Temperatures: 17 17.2 17.3
Custody Seal Intact: ☐Yes ☐No ☐N/A
Notes: Dico

Report Information:
Company: exp Services Inc
Contact: Jeffrey Golder
Address: 80 Bancroft Street
Hamilton, ON L8E 2W5
Phone: 905 573 4000 x5013 Fax:
Reports to be sent to:
1. Email: matt.livecchi@exp.com
2. Email:

Regulatory Requirements: ☐ No Regulatory Requirement
(Please check all applicable boxes)

☑ Regulation 153/04
Table 1 (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 ☐ 1 Business Day
OR Date Required (Rush Surcharges May Apply):
Please provide prior notification for rush TAT
**TAT is exclusive of weekends and statutory holidays*

Project Information:
Project: HAM-00801777-A0
Site Location: Oakes Park
Sampled By:
AGAT Quote #: 159061 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

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI (Please Circle) Y / N	Metals and Inorganics	Metal Scan	Hydride Forming Metals	Client Custom Metals	(Check Applicable) ORPs: ☐B-HWS ☐Cl ☐CN ☐EC ☐FOC ☐NO_3/NO_2 ☐Cr^{6+} ☐Hg ☐pH ☐SAR ☐Total N	Nutrients: ☐TP ☐NH_3 ☐TKN ☐NO_3 ☐NO_2 ☐NO_3/NO_2	Volatiles: ☐VOC ☐BTEX ☐THM	CCME Fractions 1 to 4	ABNs	PAHs	Chlorophenols	PCBs	Organochlorine Pesticides	TCLP Metals/Inorganics	Sewer Use
BH1 SS1	Aug29	AM	1	S			X														
BH2 SS2	↓	AM	1	S			X														
BH3 SS3		AM	1	S			X														

Samples Relinquished By (Print Name and Sign)	Date	Time	Samples Received By (Print Name and Sign)	Date	Time
Matt Livecchi			John Chyppyha	Sept 3	1:40
Samples Relinquished By (Print Name and Sign)	Date	Time	Samples Received By (Print Name and Sign)	Date	Time
			John Chyppyha	Sept 3	
Samples Relinquished By (Print Name and Sign)	Date	Time			

Page 1 of 1
N°:

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