Haldimand County

Geotechnical Investigation

Type of Document
Final

Project Name
Proposed Cast Iron Watermain Replacements
Various Streets in Caledonia, Cayuga and Hagersville, Ontario

Project Number
HAM-00801497-A0

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Date Submitted
11.23.2018

Table of Contents

List of Appendices

Appendix

1 Introduction

1.1 Background

EXP Services Inc. (EXP) was retained by Haldimand County (the County) to complete a geotechnical investigation at three (3) sites in Caledonia, Cayuga, and Hagersville as part of the proposed cast iron watermain replacement project. Authorization to proceed with the investigation was provided by Mike King on behalf of the County.

The geotechnical investigation was carried out to establish the subsoil and groundwater conditions at the sites and provide the County with a factual report of the findings.

As requested by the County, the investigation included the advancement of twenty-two (22) boreholes, numbered BH-01 to BH-22, drilled at three (3) sites in Haldimand County as summarized in the following table.

Table 1-1: Site Location Summary

Site No.	Site Location	Relevant Boreholes
1	**Cayuga:** Chippawa Street West, Ouse Street South, Brant Street, Cayuga Street South, Seneca Street, Kerr Street East, Norton Street East, Johnson Street and Ouse Street North	BH-01 to BH-12
2	**Hagersville:** Victoria Street and Foundry Street	BH-13 to BH-14
3	**Caledonia:** Fife Street West, Renfrew Street East, Blair Street, Queen Avenue, Park Lane	BH-15 to BH-22

2 Investigation Program

2.1 General Fieldwork

The number, location, and depth of the boreholes was determined by the County. The approximate borehole locations are shown on Drawings No. 1A to 1E in Appendix A. Prior to the commencement of the drilling operations, the public underground services were located to minimize the risk of contacting any such services during the drilling operations.

The fieldwork for the investigation was carried out on July 16 and 19, 2018. A total of twenty-two (22) boreholes, numbered BH-01 to BH-22, were advanced at the sites by a specialist drilling subcontractor under the full-time supervision of EXP staff. The boreholes were advanced to depths ranging from 0.9 m to 2.7 m below grade using a truck-mounted drill rig equipped with continuous-flight augers. Traffic control procedures in accordance with Book 7 were implemented for the duration of the investigation.

Soil samples were obtained using a 51 mm (2 inch) outside diameter split-spoon sampler in conjunction with Standard Penetration Tests (ASTM D1586) at the depths noted on the borehole logs in Appendix A. The retained 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, respectively.

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. The boreholes were backfilled in accordance with O.Reg. 903 upon completion of drilling and capped with cold patch.

The borehole locations were marked on site by the County and were drilled under the supervision of EXP personnel in accessible locations, free of overhead obstructions and buried utilities. The ground surface elevations at the borehole locations were provided by the County following the investigation.

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 for the soil samples were metals and inorganics. 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.

Twenty–two (22) representative soil samples were submitted, one (1) sample per borehole advanced and submitted to a certified laboratory for analytical testing.

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.

The soil samples were selected for laboratory analysis for metals and inorganics to determine the chemical quality of this material, in the event off-site disposal was required during construction. The samples selected are shown in Section 4 below and were chosen because they represent soils which may be disposed of off-site during construction.

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”), MOECC, 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. 153/04).

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 following SCS tables for each of the three (3) sites:

Table 2-2: Site Condition Standards (SCS) Table Selection by Site

Site No.	Site Location	Site Use	SCS Table	Predominant Soil Type
1	**Cayuga:** Chippawa Street West, Ouse Street South, Brant Street, Cayuga Street South, Seneca Street, Kerr Street East, Norton Street East, Johnston Street South and Ouse Street North	Community	Table 9	Fine Grained
2	**Hagersville:** Victoria Street and Foundry Street	Community	Table 7	Fine Grained
3	**Caledonia:** Fife Street West, Renfrew Street East, Blair Street, Queen Avenue, Park Lane	Community	Table 3	Fine Grained

The selection of the above noted categories is based on the following factors:

- At the time of the field investigation, the sites are not considered sensitive sites
- To the best of EXP's knowledge, all properties within 250 m of the sites are serviced by the municipal water and based on EXP's knowledge of the study area and field observations, groundwater is not used as a potable water source either on or within 250 m of the sites

- The sites are 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 sites
- A waterbody (Grand River) is located within 30 m of Site No. 1
- Bedrock was encountered at less than 2.0 m below grade at Site No. 2

3 Subsurface Conditions

Details of the soil and groundwater conditions encountered during the drilling program are summarized on the attached borehole logs in Appendix A.

The logs include textural descriptions of the subsoil 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

Details of the encountered subsurface conditions at each site are provided in the following sections.

3.1.1 Site No. 1 (Cayuga – Boreholes BH-01 to BH-12)

3.1.1.1 Pavement Structure

The pavement structure at this site consisted of approximately 100 mm to 140 mm of asphalt overlying 160 mm to 280 mm of granular fill.

3.1.1.2 Fill

Fill materials were encountered at all borehole locations, except for Boreholes BH-06 and BH-09, below the pavement structure extending to depths ranging from approximately 0.5 m to 1.8 m below grade. The fill was variable and consisted of silty sand, sandy silt, and silty clay and was noted to be brown and in a moist state.

3.1.1.3 Silty Clay

Native silty clay was encountered below the fill or pavement structure at all borehole locations and extended to 2.3 m below grade at Borehole BH-02 and to the borehole termination depth of 2.7 m below grade at all remaining locations. The silty clay was noted to be brown and in a moist state with moisture contents ranging from 5 to 29 percent of dry mass. SPT N values of the stratum ranged from 7 to 49 blows per 305 mm of penetration. Based on undrained shear strengths from pocket penetrometer readings ranging from 175 kPa to greater than 225 kPa, the silty clay is classified as very stiff to hard in consistency.

3.1.1.4 Sandy Silt

Sandy silt was encountered at BH-02 below the silty clay stratum and extended to the borehole termination depth of 2.7 m below grade. The sandy silt contained trace clay and trace gravel and was noted to be brown and in a moist state with a single moisture content of 9 percent of dry mass. Based on a single SPT N value of 60 blows per 305 mm of penetration, the stratum is classified as very dense.

3.1.2 Site No. 2 (Hagersville – Boreholes BH-13 and BH-14)

3.1.2.1 Pavement Structure

The pavement structure consisted of 120 mm of asphalt overlying 200 mm of granular fill at Borehole BH-13 on Victoria Street and 100 mm of asphalt overlying 250 mm of granular fill at Borehole BH-14 on Foundry Street.

3.1.2.2 Fill

Fill materials were encountered at both boreholes below the pavement structure extending to depth of 0.5 m below grade at BH-13 and 0.8 m below grade at BH-14. The fill materials consisted of brown silty clay with trace gravel and were in a moist state.

3.1.2.3 Silty Clay

Native silty clay was encountered below the fill at both borehole locations and extended to the borehole termination depth of 0.9 m below grade at BH-13 and 1.7 m below grade at BH-14. The silty clay was brown and in a moist state with moisture contents ranging from 15 to 17 percent of dry mass. SPT N values of the stratum ranged from 8 to 15 blows per 305 mm of penetration. Based on undrained shear strengths from pocket penetrometer readings ranging from 200 to greater than 225 kPa, the silty clay is classified as very stiff to hard in consistency.

3.1.2.4 Possible Bedrock

Possible bedrock was encountered at both borehole locations and was inferred based on drilling observations. Based on *Ontario Geological Survey Map 2544, Bedrock Geology of Ontario, Southern Sheet*, the bedrock at Site No. 2 consists of sandstone, dolostone and limestone of the Bois Blanc and Oriskany Formation from the Lower Devonian Period. Hard limestone bedrock can result in contractual problems for excavations. The bedrock surface ranged from approximately 0.9 m to 1.7 m below grade as noted in the following table:

Table 3-3: Depths and Elevations of Bedrock Surface

Borehole No.	Depth of Bedrock Surface (m)	Elevation of Bedrock Surface (m)	Rock Quality Designation (RQD)
BH-13	0.9	222.5	N/A
BH-14	1.7	222.6	N/A

3.1.3 Site No. 3 (Caledonia – Boreholes BH-15 to BH-22)

3.1.3.1 Pavement Structure

The pavement structure at Site No. 3 consisted of approximately 100 mm to 130 mm of asphalt overlying 200 mm to 300 mm of granular fill.

3.1.3.2 Fill

Fill materials were encountered at all borehole locations, except for Borehole BH-22, below the pavement structure extending to depths ranging from 0.8 m below grade to the borehole termination depth of 2.7 m below grade. In general, the fill materials consisted of brown silty clay with trace to some sand, trace gravel. A silty sand fill material was also encountered at Boreholes BH-17 and BH-18. The fill materials were generally in a slightly moist to moist state but were noted to become very moist below 2.6 m at Borehole BH-17. Occasional brick fragments and organic staining was also noted.

3.1.3.3 Silty Clay

Native silty clay was encountered below the fill and pavement structure at Boreholes BH-15, BH-18, BH-21 and BH-22 and extended to the borehole termination depth of 2.7 m below grade. The silty clay was brown and in a moist state with moisture contents ranging from 11 to 27 percent of dry mass. SPT N values of the stratum ranged from 6 to 16 blows per 305 mm of penetration. Based on undrained shear strengths from pocket penetrometer readings ranging from 150 kPa to greater than 225 kPa, the silty clay is classified as very stiff to hard in consistency.

3.1.3.4 Sandy Silt

Native sandy silt was encountered at Boreholes BH-19 and BH-20 below the fill and extended to the borehole termination depth of 2.1 and 2.7 m below grade, respectively. The sandy silt was noted to be brown with trace gravel and silty clay partings and was in a moist to very moist state with moisture contents ranging from 15 to 22 percent of dry mass. Based on SPT N values ranging from 3 to 10 blows per 305 mm of penetration, the stratum is classified as very loose to loose. Borehole BH-19 was terminated at 2.1 m depth due to practical auger refusal on assumed boulder or bedrock.

3.2 Groundwater

Groundwater levels were measured in the open boreholes during and upon completion of drilling operations. The boreholes remained dry upon completion.

Groundwater levels are not anticipated 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 weather conditions.

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 B.

4.2 Soil Analysis

The 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 twenty-one (21) 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.

Twenty–two (22) soil samples were analyzed for metals and inorganics. The results of the metals and inorganics analysis together with the applicable SCS table are summarized in Tables B1 to B3 in Appendix B. As shown in Appendix B, the following exceedances are noted:

- Mercury: BH-11 SS2
- Electrical Conductivity (EC): BH-03 SS2, BH-05 SS1B, BH-06 SS1, BH-10 SS1, BH-12 SS1, BH-13 SS1, BH-15 SS2, BH-16 SS4, BH-19 SS2, BH-20 SS1 and BH-21 SS2
- Sodium Adsorption Ratio (SAR): BH-04 SS2, BH-05 SS1B, BH-10 SS1, BH-13 SS1, BH-18 SS2, BH-19 SS2 and BH-20 SS1

The source of the elevated Mercury level is unknown but likely attributable to poor quality fill material. The elevated EC and SAR levels detected in the soil may be due to the use of fill material exposed to salt for the protection of traffic and public safety. Ontario Regulation 153/04, S. 48 (3), currently prescribes an exemption to exceedances of SCS that are a result of substances used on a highway for the purpose of keeping the highway safe for traffic under conditions of snow or ice. The exemption does not apply to areas not designated as a 'highway' (e.g. sidewalks, parking lots). However, proposed amendments to Ontario Regulation 153/04 (which have not been finalized), would allow for the exemption to extend to private property if it can be demonstrated that the exceedance is solely because a substance has been used for the purpose of traffic and pedestrian safety under conditions of snow/ice. Based on the limited test results, the following options for soil disposal are presented:

Table 4-2: Summary of Soil Samples Submitted for Laboratory Analyses

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 / temporary storage

Option	Description	Advantages	Disadvantages / Considerations
2	Dispose excess soil at 3rd party sites **(applicable only to EC/SAR exceedances)**	• Less expensive than landfill disposal	• Must have Environmental Compliance Approval to accept soils that exceed generic SCS for EC/SAR • Sites sometimes difficult to find at time of construction • Additional testing may be required prior to acceptance
3	Dispose excess soil at licensed landfill facility.	• Landfill sites usually open to accept soils	• Most expensive option • May require additional TCLP tests prior to landfill acceptance • Delineation of exceedances may reduce volume of impacted soil

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"), MOECC, 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 B.

5 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 findings 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 regards to future geotechnical and environmental issues related to this property.

6 Closure

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.

Dilsher Bhangal, M.Eng.
Designer

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Manager, Hamilton Geotechnical Services

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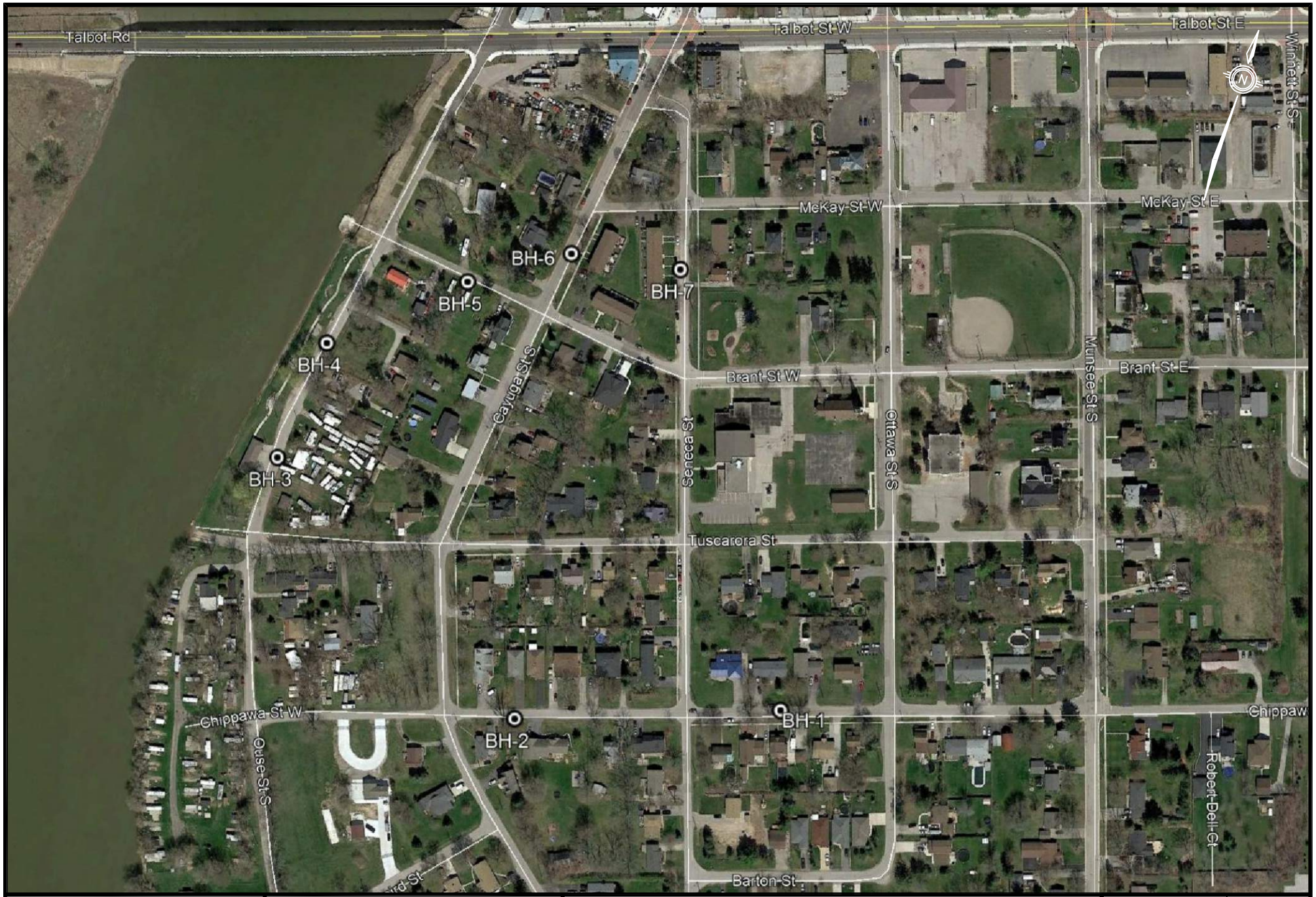
Appendix A – Drawings



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LEGEND:

APPROXIMATE BOREHOLE LOCATION

TITLE AND LOCATION:

BOREHOLE LOCATION PLAN
GEOTECHNICAL INVESTIGATION
PROPOSED CAST IRON WATERMAIN REPLACEMENT
VARIOUS STREETS IN CALEDONIA, CAYUGA AND HAGERSVILLE, ON

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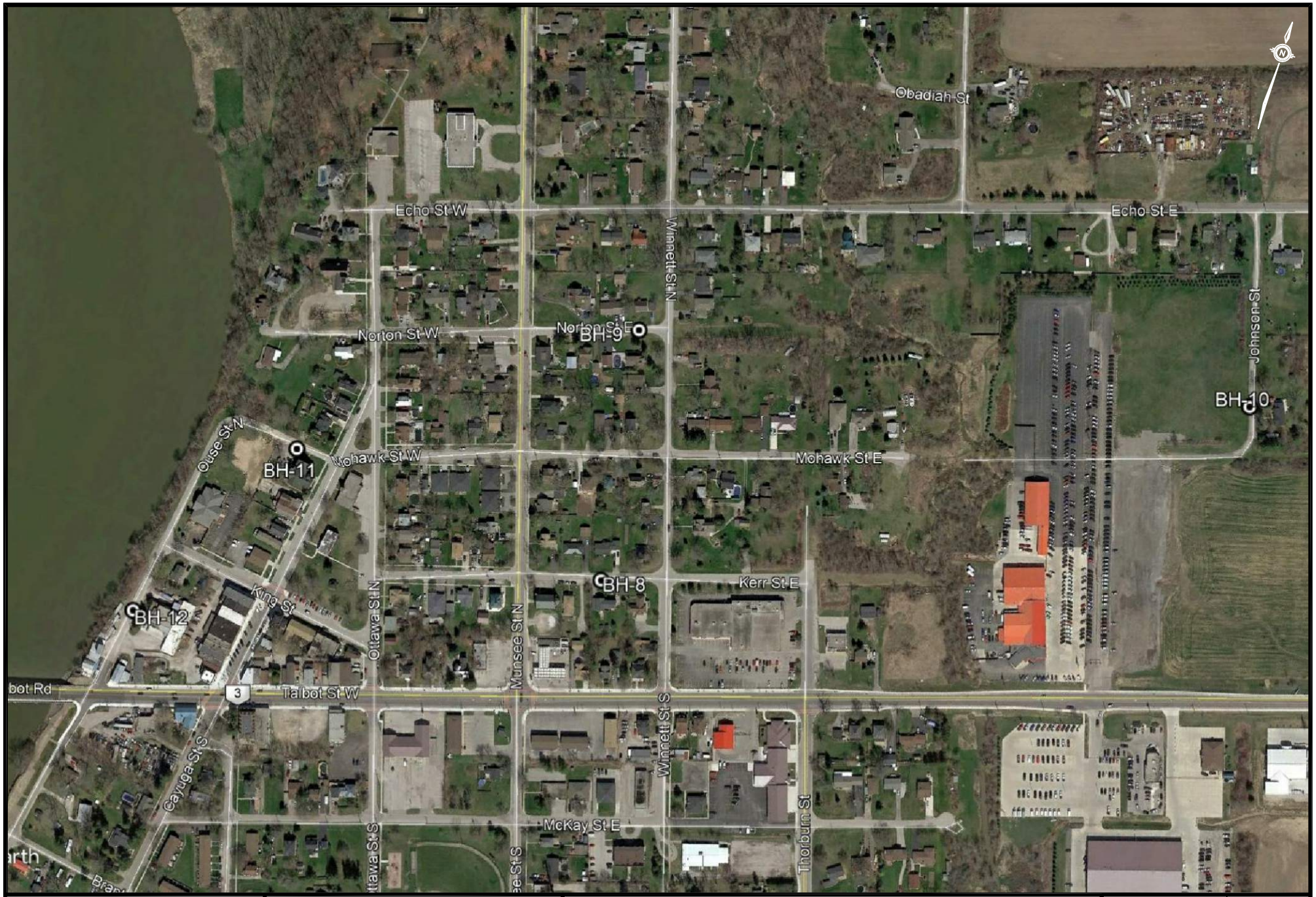
SCALE: NTS	CHECKED BY: JG
DATE: SEPTEMBER 2018	DWG NO.: 1A



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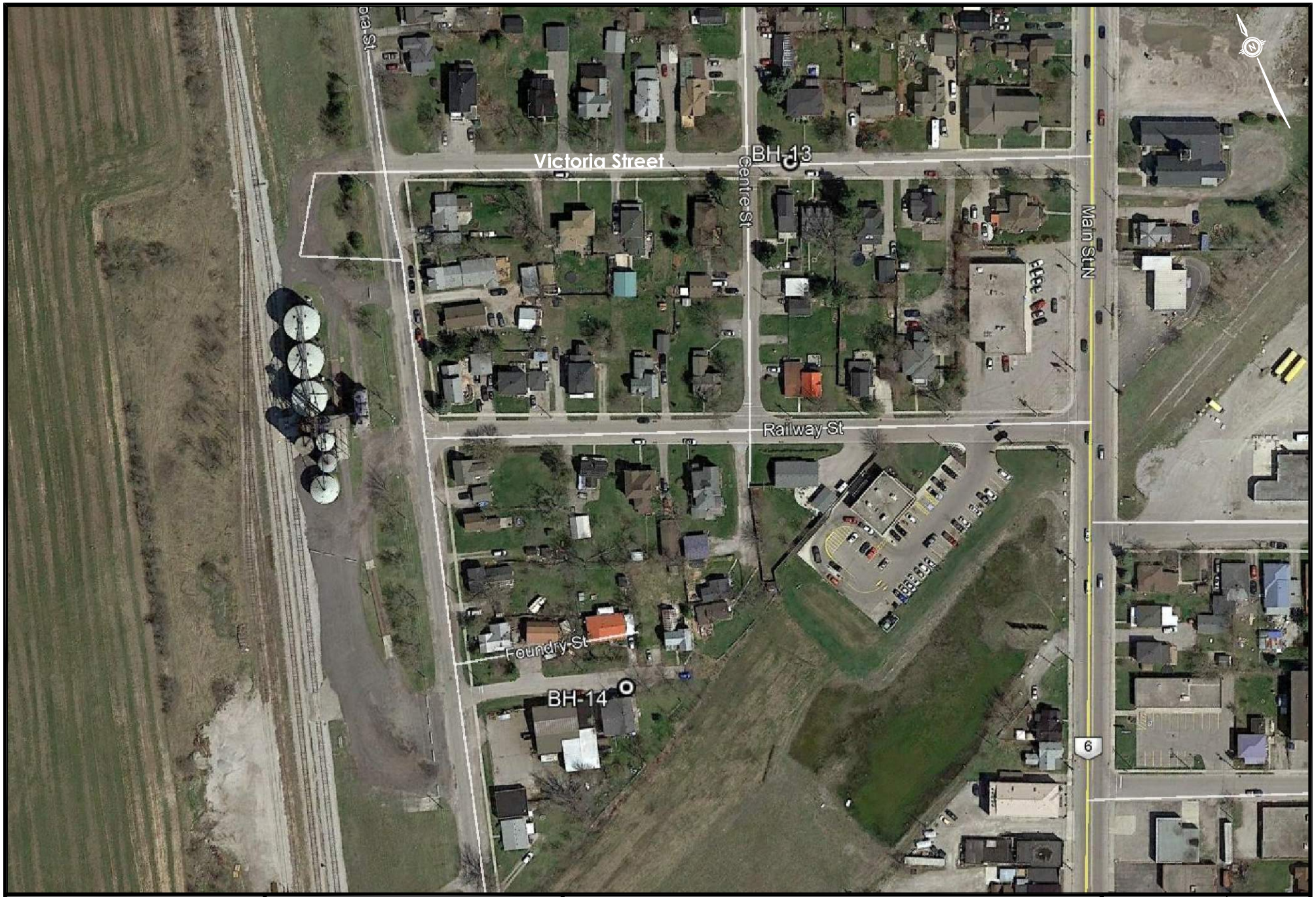

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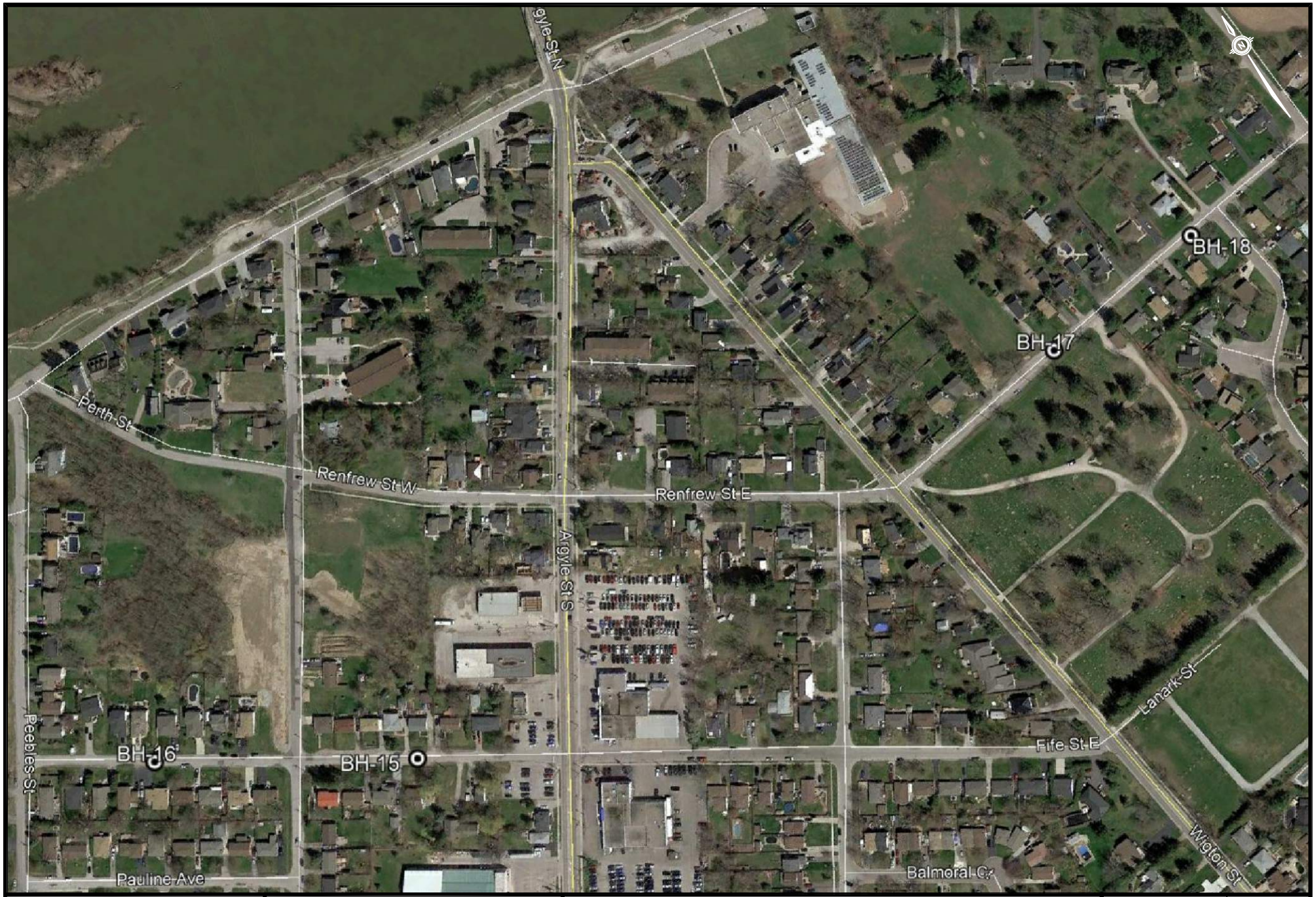

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Notes on Sample Descriptions

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	

0.002	0.006	0.02	0.06	0.2	0.6	2.0	6.0	20	60	200

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-01

Project No. HAM-00801497-A0 | Drawing No. 3

Project: Proposed Cast Iron Watermain Replacements | Sheet No. 1 of 1

Location: Chippawa Street West, Cayuga

Date Drilled: July 16, 2018

Drill Type: CME 75 Truck Mount. Solid Stem.

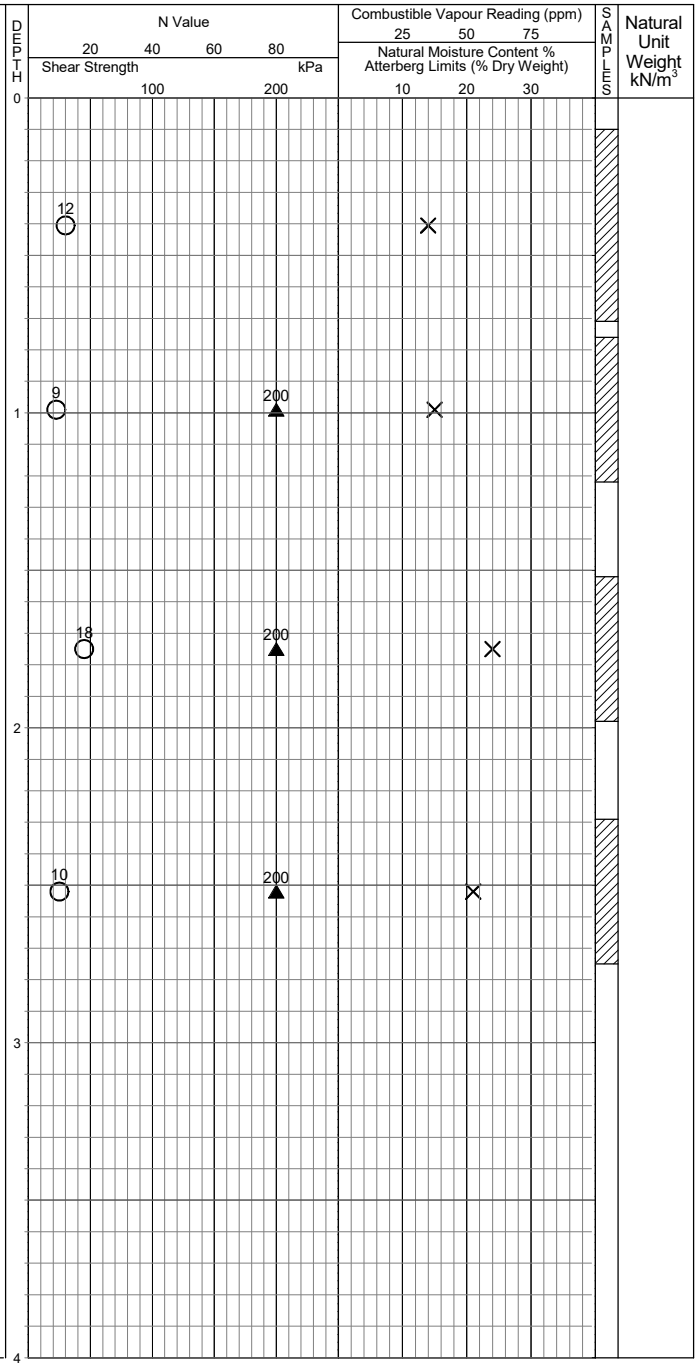
Datum: Geodetic

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
		ASPHALT: (~100 mm thick)	189.80
		GRANULAR FILL: (~200 mm thick)	~189.7
		FILL: silty sand, brown, moist	~189.5
		SILTY CLAY: brown, moist, very stiff	~189.0
		Borehole terminated at 2.7 m depth.	~187.1

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.



Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	2.7

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Log of Borehole BH-02

Project No. HAM-00801497-A0 | Drawing No. 4

Project: Proposed Cast Iron Watermain Replacements | Sheet No. 1 of 1

Location: Chippawa Street West, Cayuga

Date Drilled: July 16, 2018

Drill Type: CME 75 Truck Mount. Solid Stem.

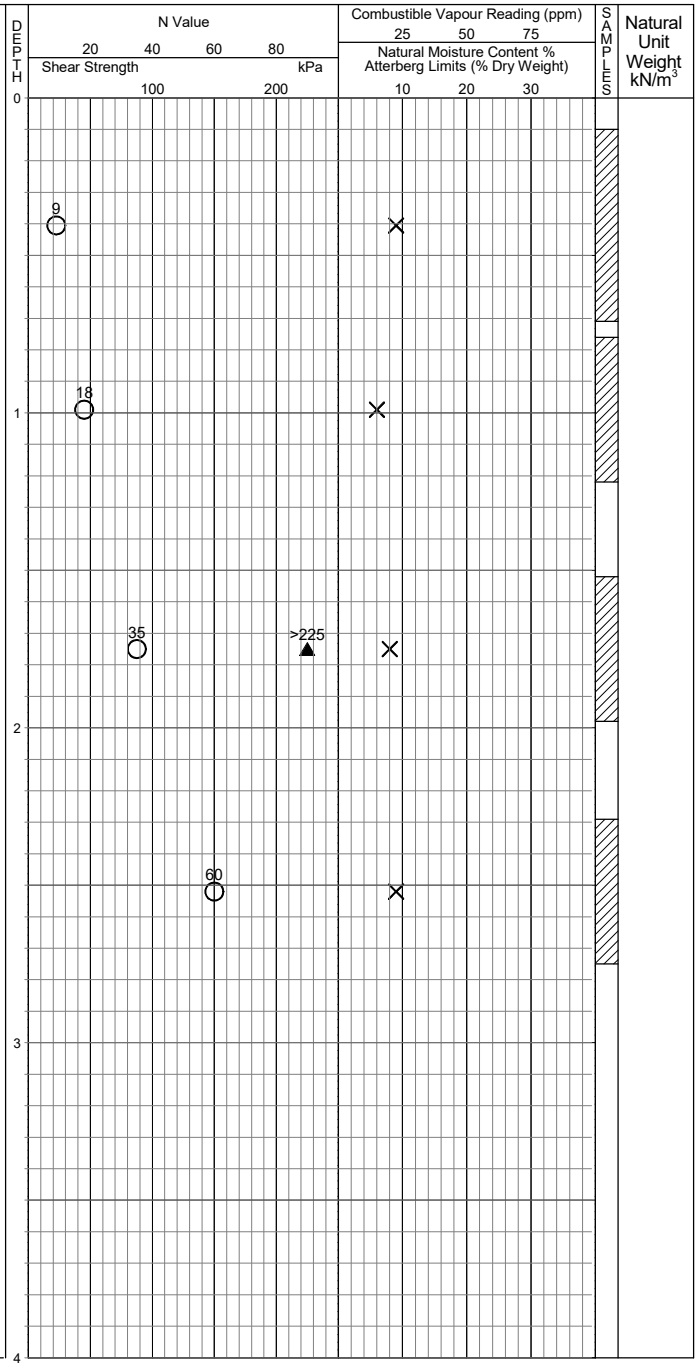
Datum: Geodetic

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
		ASPHALT: (~100 mm thick)	184.36
		GRANULAR FILL: (~200 mm thick)	~184.3
		FILL: silty clay, some sand, trace gravel, brown, moist	~184.1
		SILTY CLAY: some sand, trace gravel, brown, moist, hard	~182.8
		SANDY SILT: trace clay, trace gravel, brown, moist, very dense	~182.1
		Borehole terminated at 2.7 m depth.	~181.6

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.



Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	2.7

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Log of Borehole BH-03

Project No. HAM-00801497-A0 | Drawing No. 5

Project: Proposed Cast Iron Watermain Replacements | Sheet No. 1 of 1

Location: Ouse Street South, Cayuga

Date Drilled: July 16, 2018

Drill Type: CME 75 Truck Mount. Solid Stem.

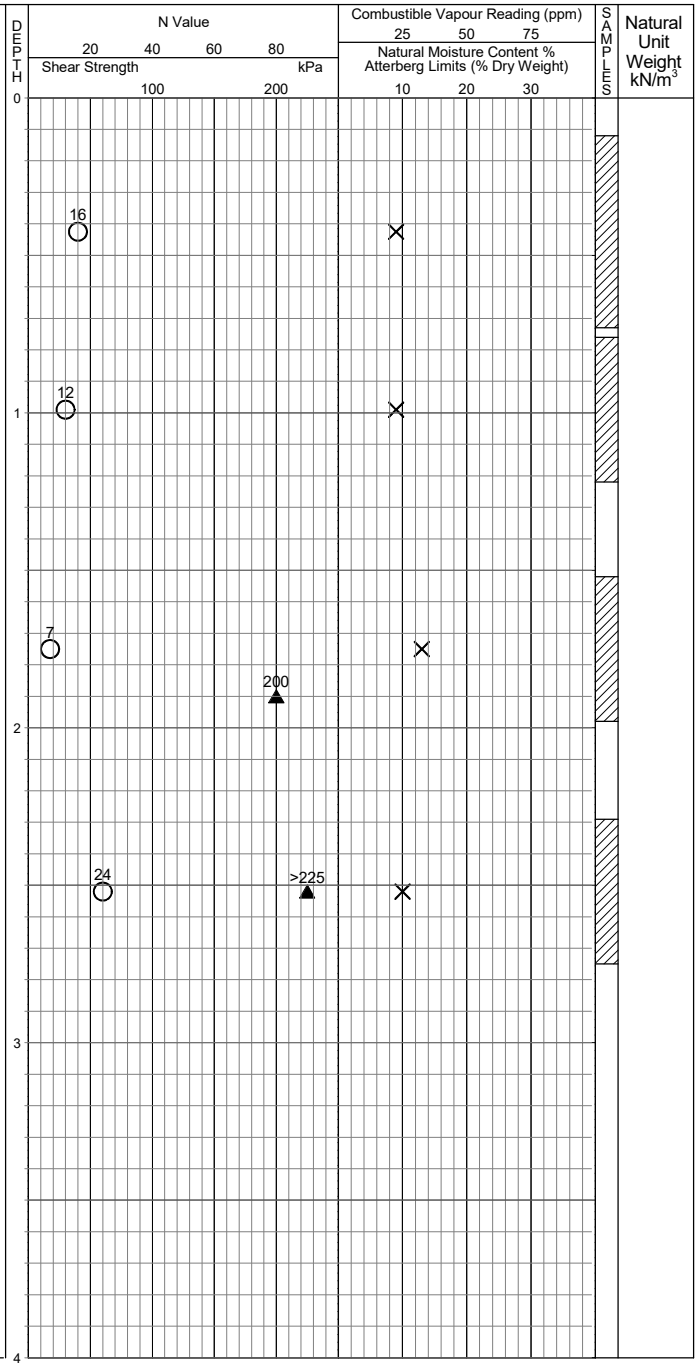
Datum: Geodetic

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
		ASPHALT: (~120 mm thick)	180.08
		GRANULAR FILL: (~220 mm thick)	~180.0
		FILL: sandy silt, trace gravel, brown, moist, brick fragments	~179.7
		rootlets, black organic staining below 1.5 m	
		SILTY CLAY: trace gravel, brown, moist, very stiff to hard	~178.3
		Borehole terminated at 2.7 m depth.	~177.3

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.



Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	2.7

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Log of Borehole BH-04

Project No. HAM-00801497-A0 | Drawing No. 6

Project: Proposed Cast Iron Watermain Replacements | Sheet No. 1 of 1

Location: Ouse Street South, Cayuga

Date Drilled: July 16, 2018

Drill Type: CME 75 Truck Mount. Solid Stem.

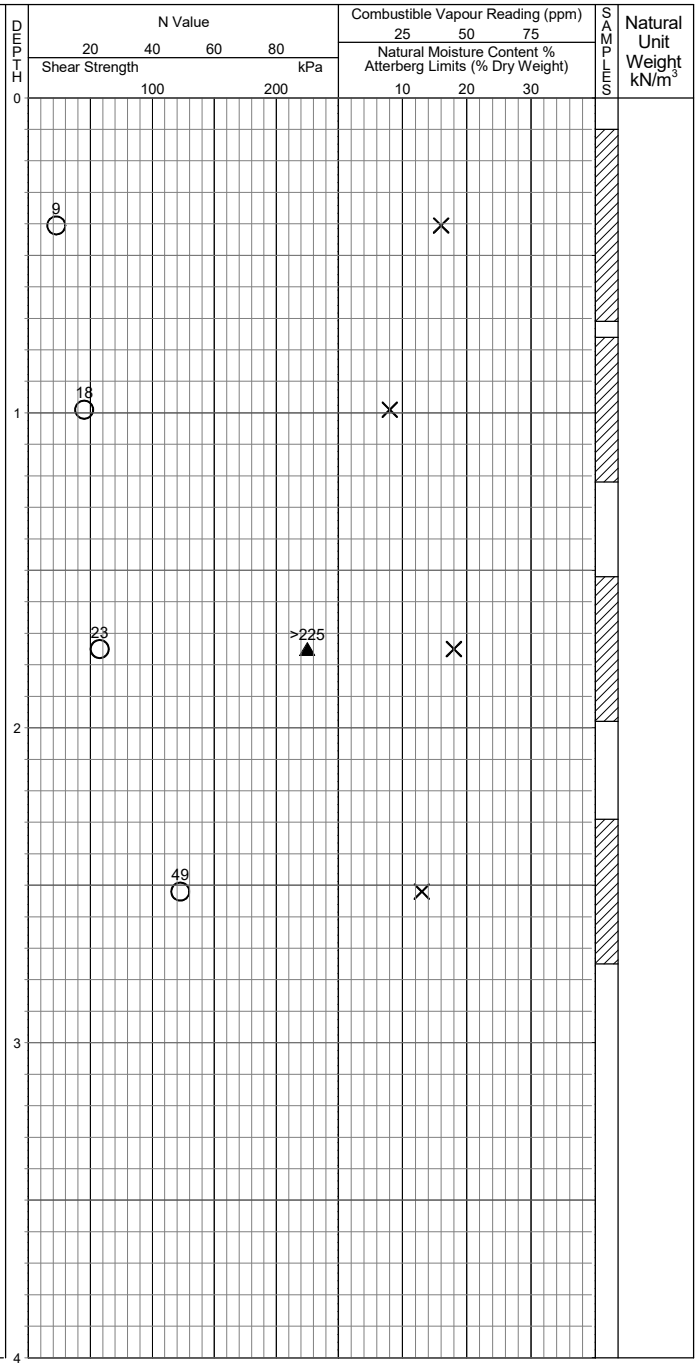
Datum: Geodetic

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
		ASPHALT: (~120 mm thick)	180.06
		GRANULAR FILL: (~160 mm thick)	~179.9
		FILL: silty clay, trace sand, trace gravel, brown, moist	~179.8
		FILL: silty sand, some gravel, brown, moist	~179.3
		SILTY CLAY: brown, moist, hard some sand, trace gravel, hard below 2.3 m	~178.5
		Borehole terminated at 2.7 m depth.	~177.3

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.



Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	2.7

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Log of Borehole BH-05

Project No. HAM-00801497-A0 | Drawing No. 7

Project: Proposed Cast Iron Watermain Replacements | Sheet No. 1 of 1

Location: Brant Street, Cayuga

Date Drilled: July 16, 2018

Drill Type: CME 75 Truck Mount. Solid Stem.

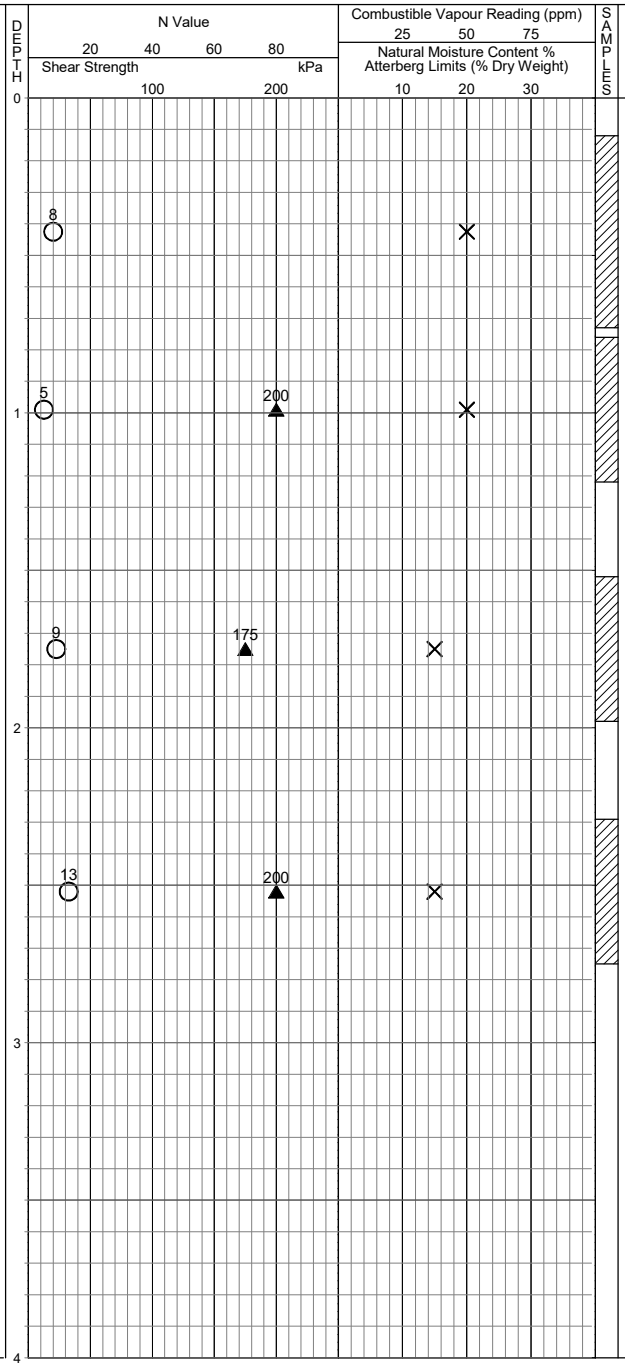
Datum: Geodetic

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
		ASPHALT: (~120 mm thick)	181.38
		GRANULAR FILL: (~270 mm thick)	~181.3
		FILL: silty clay, trace gravel, brown, moist, rootlets, black organic staining	~181.0
		FILL: sandy silt, brown, moist	~180.6
		SILTY CLAY: brown, moist, very stiff	~180.5
		trace sand, trace gravel below 1.5 m	
		Borehole terminated at 2.7 m depth.	~178.6

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.



Natural Unit Weight kN/m³

Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	2.7

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Log of Borehole BH-06

Project No. HAM-00801497-A0 | Drawing No. 8

Project: Proposed Cast Iron Watermain Replacements | Sheet No. 1 of 1

Location: Cayuga Street South, Cayuga

Date Drilled: July 16, 2018

Drill Type: CME 75 Truck Mount. Solid Stem.

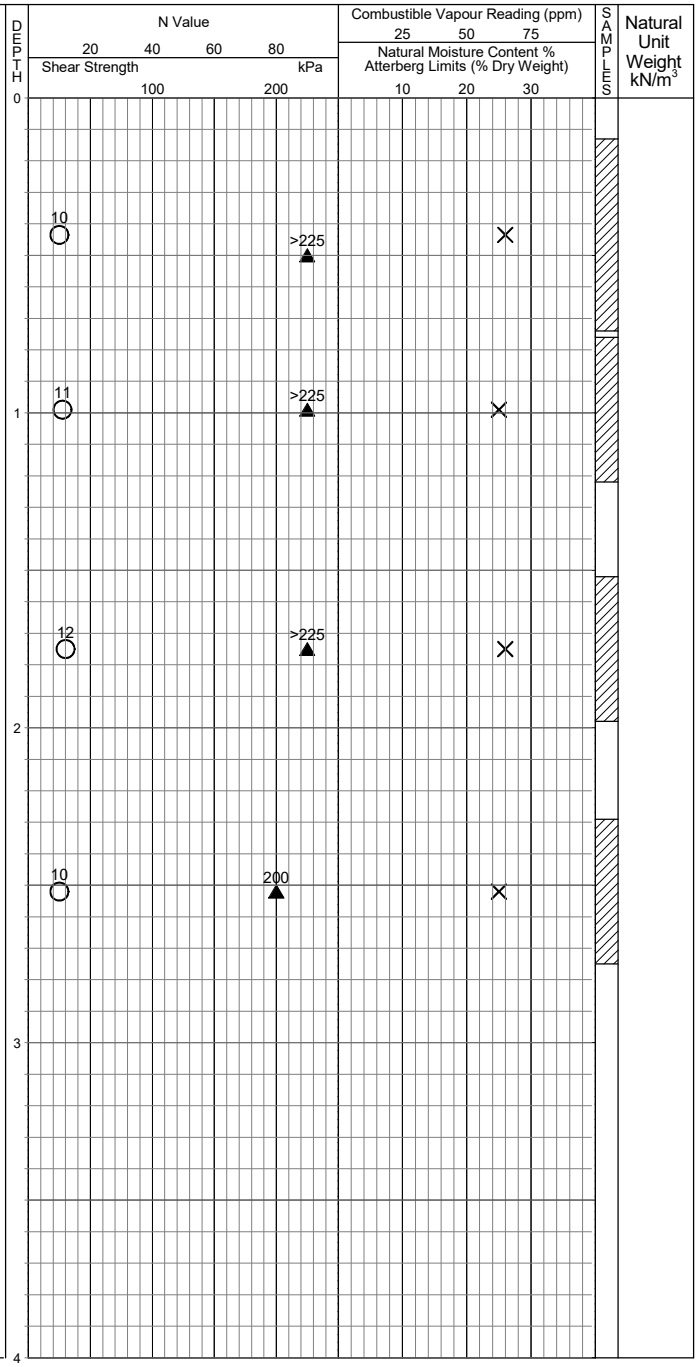
Datum: Geodetic

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
		ASPHALT: (~130 mm thick)	186.19
		GRANULAR FILL: (~270 mm thick)	~186.1
		SILTY CLAY: brown, moist, very stiff to hard, rootlets	~185.8
		Borehole terminated at 2.7 m depth.	~183.5

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.



Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	2.7

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Log of Borehole BH-07

Project No. HAM-00801497-A0 | Drawing No. 9

Project: Proposed Cast Iron Watermain Replacements | Sheet No. 1 of 1

Location: Seneca Street, Cayuga

Date Drilled: July 16, 2018

Drill Type: CME 75 Truck Mount. Solid Stem.

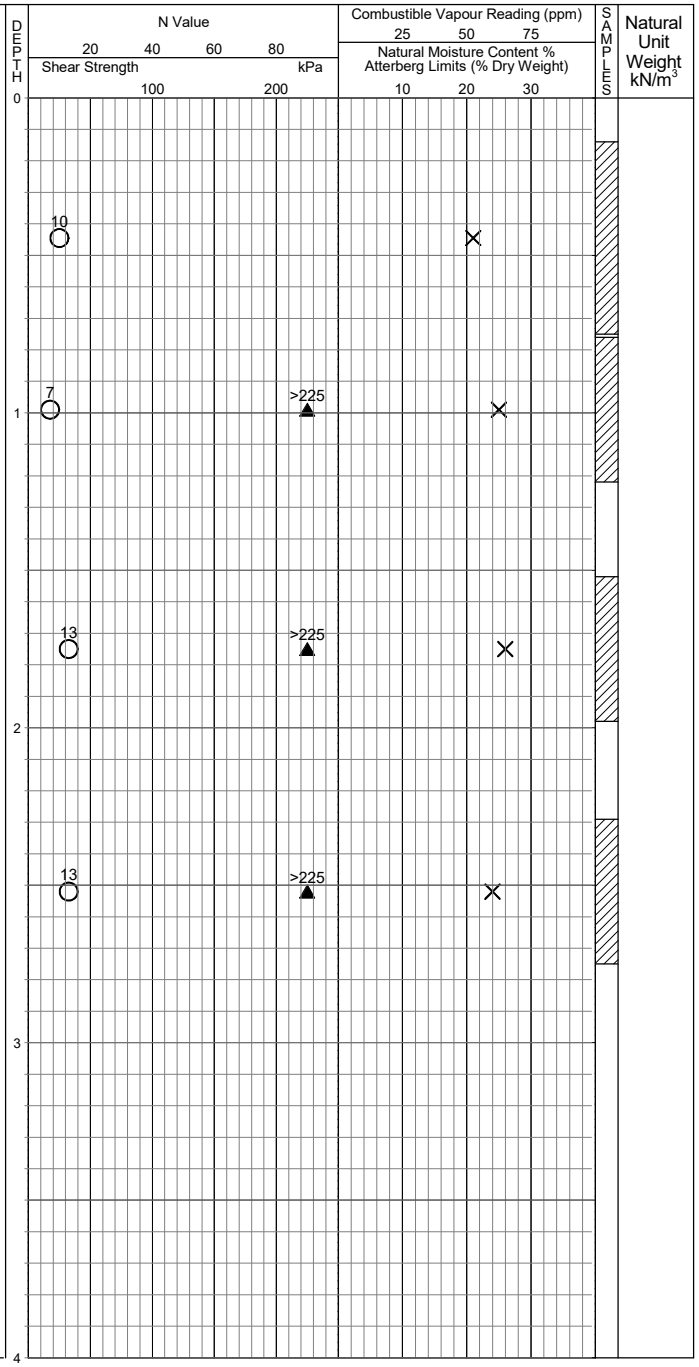
Datum: Geodetic

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
		ASPHALT: (~140 mm thick)	186.91
		GRANULAR FILL: (~270 mm thick)	~186.8
		FILL: silty clay, trace sand, trace gravel, brown, moist, black organic staining	~186.5
		SILTY CLAY: brown, moist, hard	~186.2
		Borehole terminated at 2.7 m depth.	~184.2

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.



Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	2.7

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Log of Borehole BH-08

Project No. HAM-00801497-A0 | Drawing No. 10

Project: Proposed Cast Iron Watermain Replacements | Sheet No. 1 of 1

Location: Kerr Street East, Cayuga

Date Drilled: July 16, 2018

Drill Type: CME 75 Truck Mount. Solid Stem.

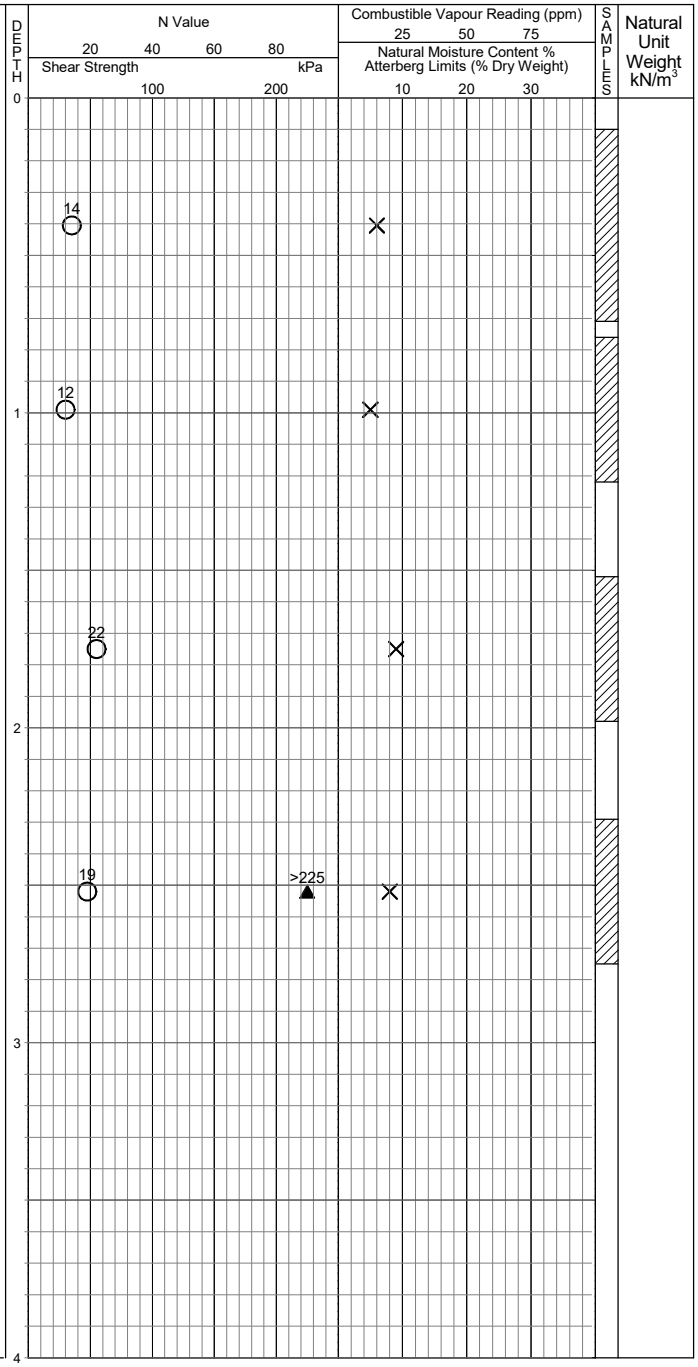
Datum: Geodetic

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
		ASPHALT: (~100 mm thick)	191.38
		GRANULAR FILL: (~200 mm thick)	~191.3
		FILL: silty sand, brown, moist	~191.1
		SILTY CLAY: trace sand, trace gravel, brown, moist, very stiff to hard	~190.6
		Borehole terminated at 2.7 m depth.	~188.6

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.



Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	2.7

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Log of Borehole BH-09

Project No. HAM-00801497-A0 | Drawing No. 11

Project: Proposed Cast Iron Watermain Replacements | Sheet No. 1 of 1

Location: Norton Street East, Cayuga

Date Drilled: July 16, 2018

Drill Type: CME 75 Truck Mount. Solid Stem.

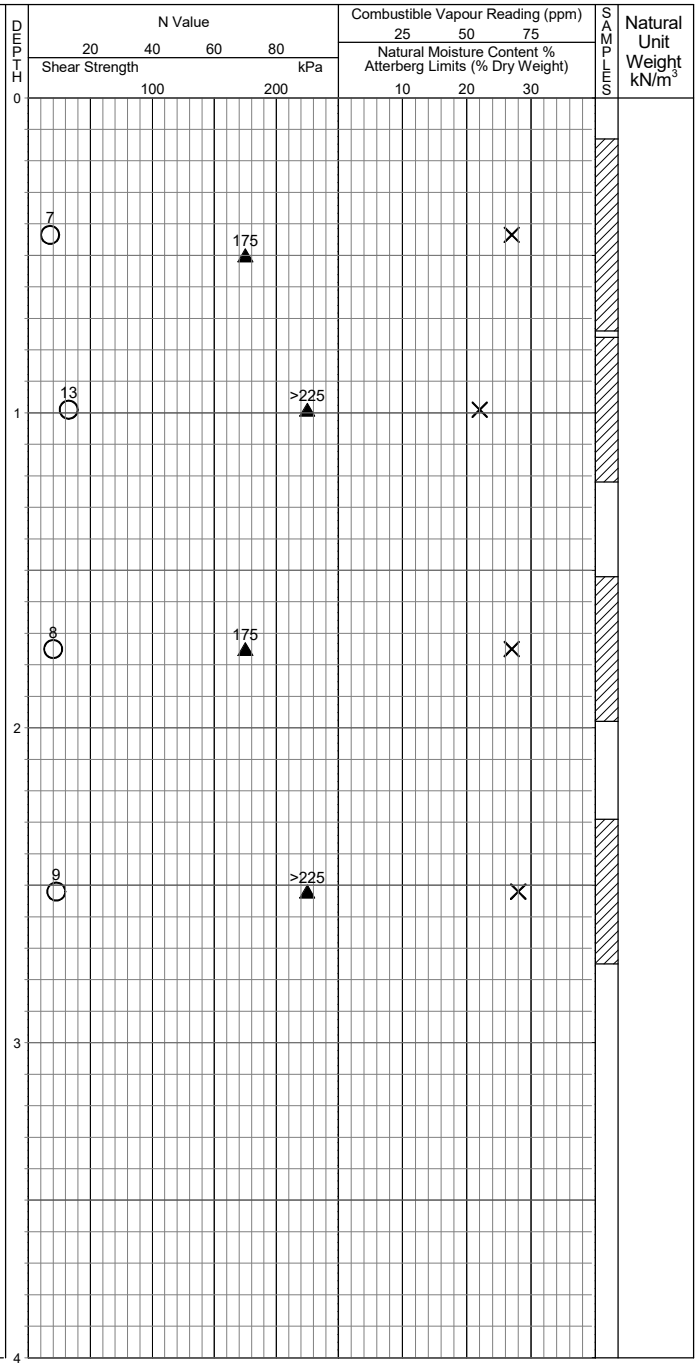
Datum: Geodetic

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
		ASPHALT: (~130 mm thick)	189.43
		GRANULAR FILL: (~280 mm thick)	~189.3
		SILTY CLAY: brown, moist, very stiff to hard, black organic staining	~189.0
		Borehole terminated at 2.7 m depth.	~186.7

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.



Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	2.7

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Log of Borehole BH-10

Project No. HAM-00801497-A0 | Drawing No. 12

Project: Proposed Cast Iron Watermain Replacements | Sheet No. 1 of 1

Location: Johnson Street, Cayuga

Date Drilled: July 16, 2018

Drill Type: CME 75 Truck Mount. Solid Stem.

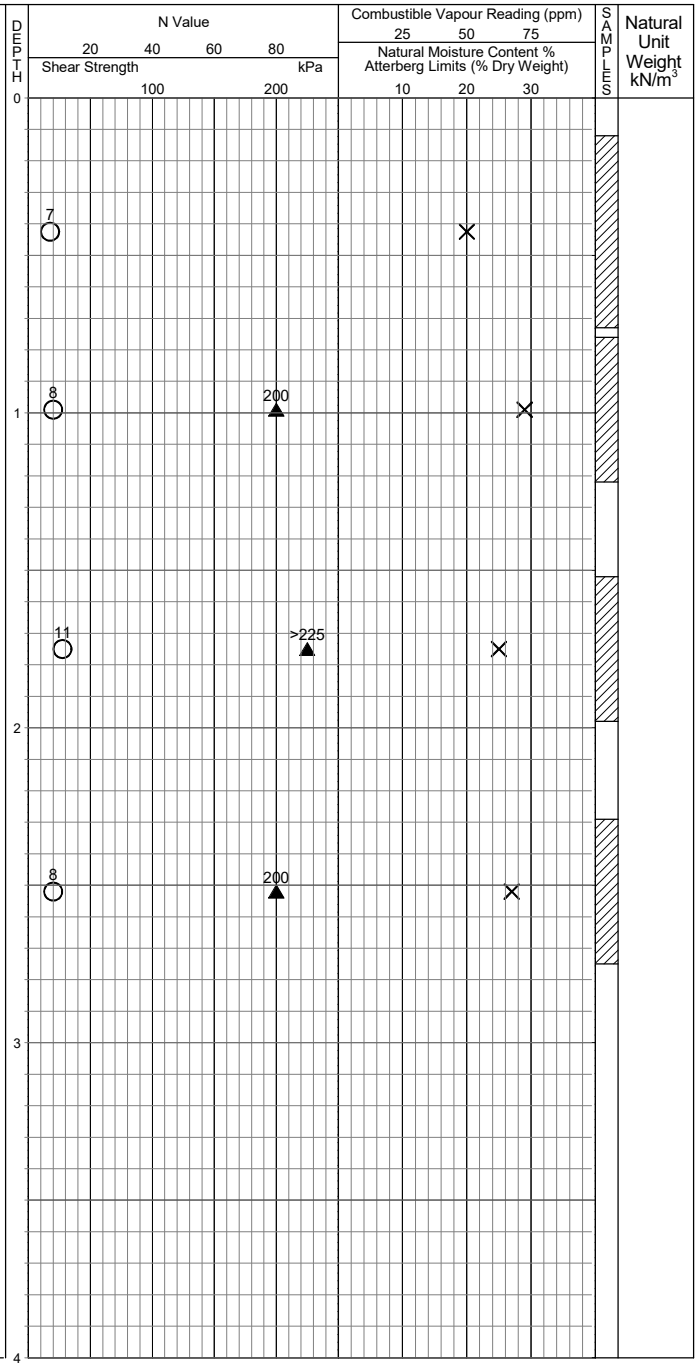
Datum: Geodetic

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
		ASPHALT: (~120 mm thick)	190.24
		GRANULAR FILL: (~280 mm thick)	~190.1
		FILL: silty clay, brown, moist, black organic staining	~189.8
		SILTY CLAY: brown, moist, very stiff to hard	~189.5
		Borehole terminated at 2.7 m depth.	~187.5

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.



Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	2.7

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Log of Borehole BH-11

Project No. HAM-00801497-A0 | Drawing No. 13

Project: Proposed Cast Iron Watermain Replacements | Sheet No. 1 of 1

Location: Ouse Street North, Cayuga

Date Drilled: July 16, 2018

Drill Type: CME 75 Truck Mount. Solid Stem.

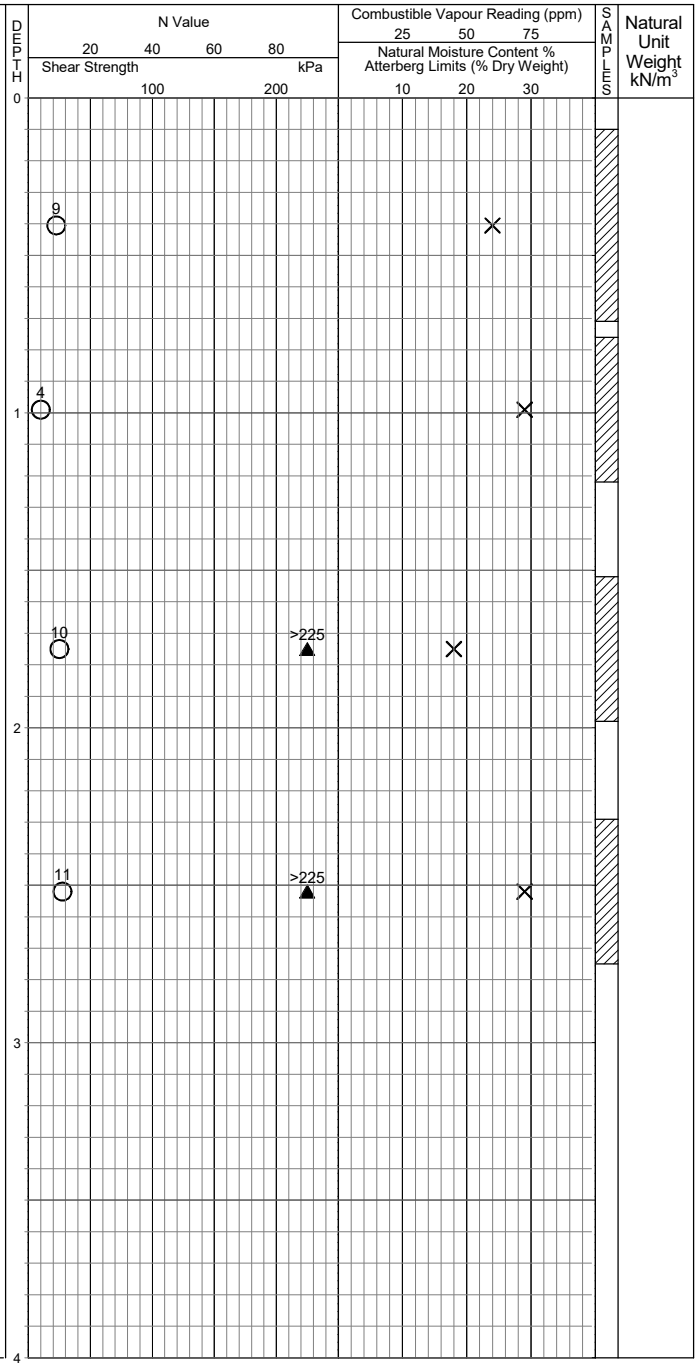
Datum: Geodetic

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
		ASPHALT: (~100 mm thick)	184.27
		GRANULAR FILL: (~200 mm thick)	~184.2
		FILL: silty clay, trace gravel, brown, moist, organic odour	~184.0
		SILTY CLAY: brown, moist, hard	~182.8
		Borehole terminated at 2.7 m depth.	~181.5

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.



Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	2.7

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Log of Borehole BH-12

Project No. HAM-00801497-A0 | Drawing No. 14

Project: Proposed Cast Iron Watermain Replacements | Sheet No. 1 of 1

Location: Ouse Street North, Cayuga

Date Drilled: July 16, 2018

Drill Type: CME 75 Truck Mount. Solid Stem.

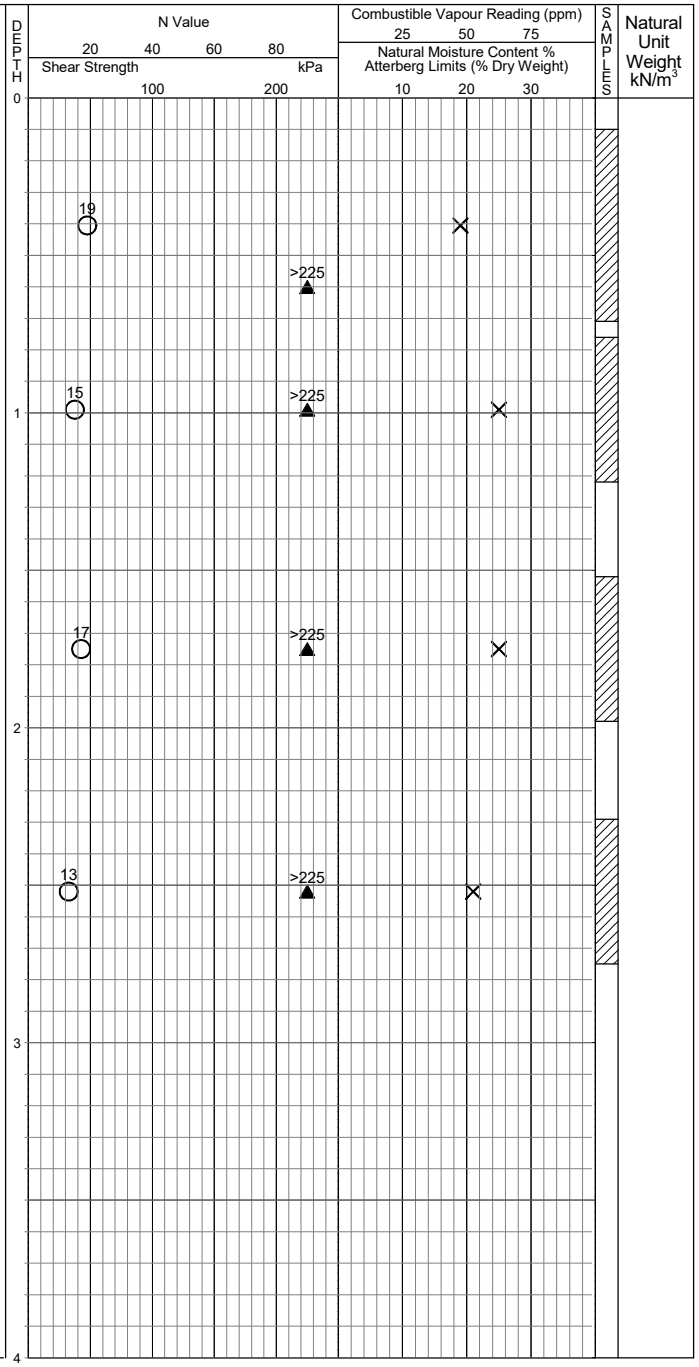
Datum: Geodetic

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
		ASPHALT: (~100 mm thick)	182.42
		GRANULAR FILL: (~200 mm thick)	~182.3
		FILL: silty clay, trace gravel, brown, moist, black organic staining	~182.1
		SILTY CLAY: brown, moist, hard	~182.0
		Borehole terminated at 2.7 m depth.	~179.7

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.



Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	2.7

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Log of Borehole BH-13

Project No. HAM-00801497-A0 | Drawing No. 15

Project: Proposed Cast Iron Watermain Replacements | Sheet No. 1 of 1

Location: Victoria Street, Hagersville

Date Drilled: July 19, 2018

Drill Type: CME 75 Truck Mount. Solid Stem.

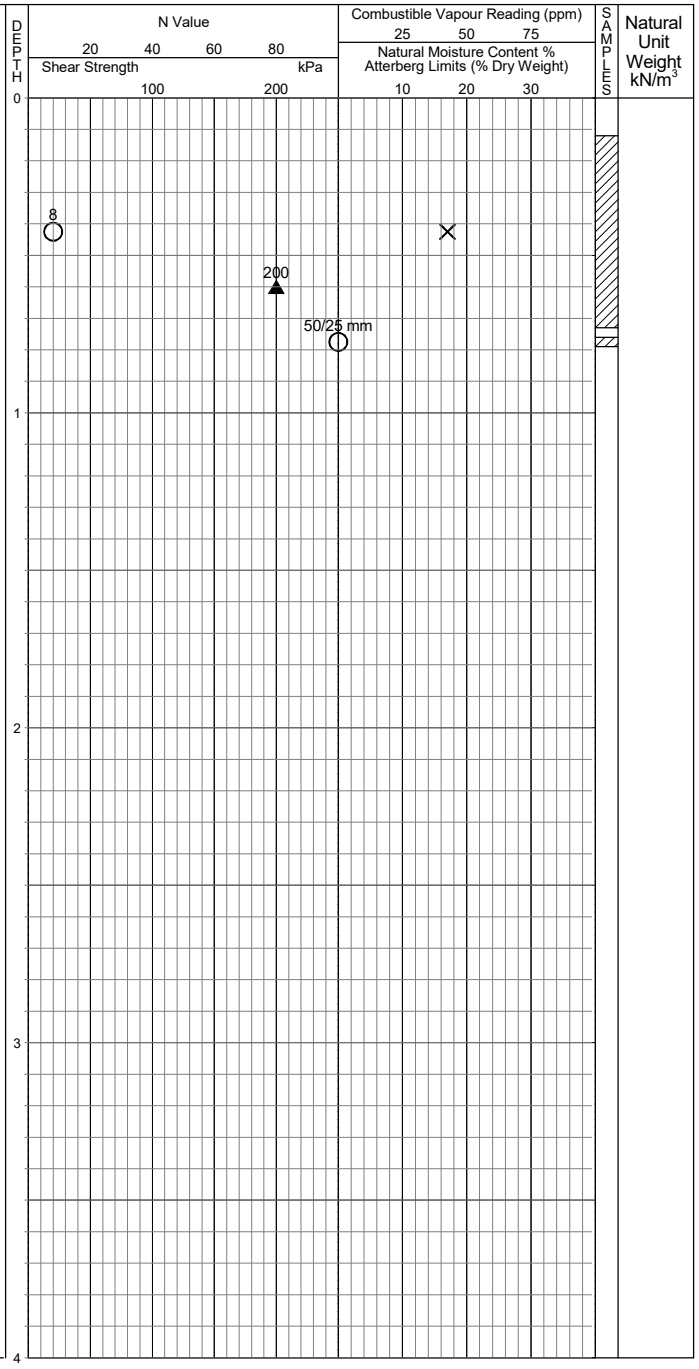
Datum: Geodetic

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
		ASPHALT: (~120 mm thick)	223.38
		GRANULAR FILL: (~200 mm thick)	~223.3
		FILL: silty clay, trace sand, trace gravel, brown, moist, black organic staining	~223.1
		SILTY CLAY: brown, moist, very stiff	~222.9
		Borehole terminated at 0.9 m depth due to practical auger refusal on assumed bedrock.	~222.5

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.



Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	0.9

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Log of Borehole BH-14

Project No. HAM-00801497-A0 | Drawing No. 16

Project: Proposed Cast Iron Watermain Replacements | Sheet No. 1 of 1

Location: Foundry Street, Hagersville

Date Drilled: July 19, 2018

Drill Type: CME 75 Truck Mount. Solid Stem.

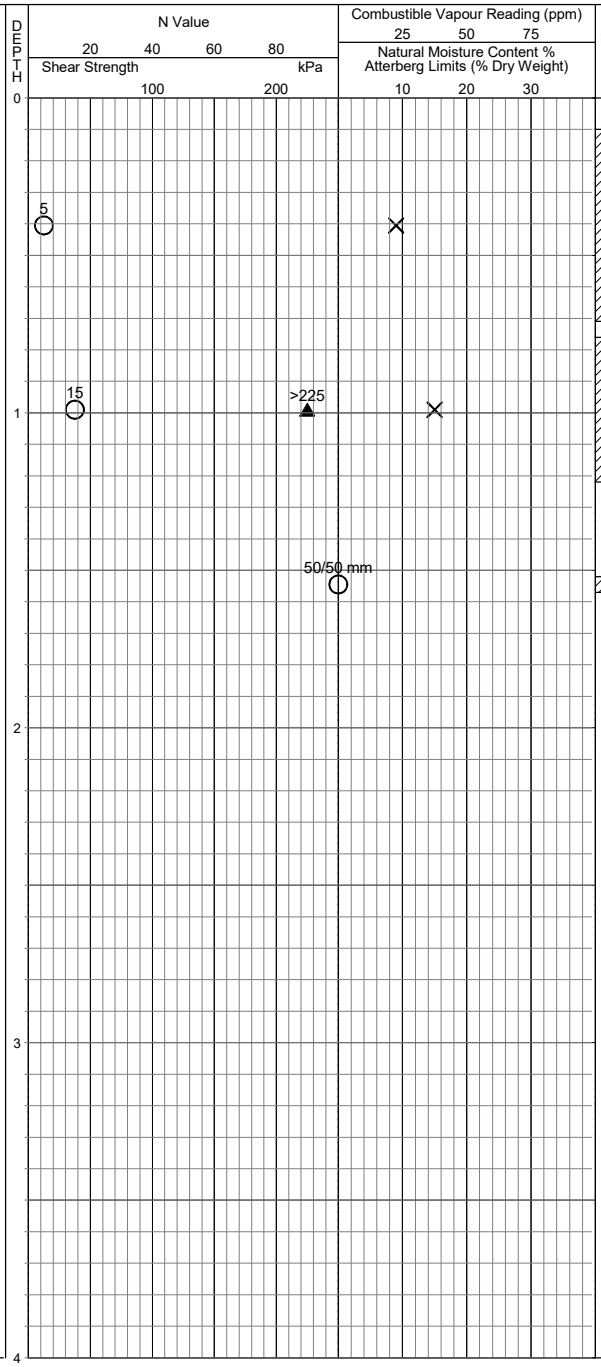
Datum: Geodetic

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
		ASPHALT: (~100 mm thick)	224.31
		GRANULAR FILL: (~250 mm thick)	~224.2
		FILL: silty clay, trace gravel, brown, moist	~224.0
		SILTY CLAY: trace gravel, brown, moist, hard	~223.6
		Borehole terminated at 1.7 m depth due to practical auger refusal on assumed bedrock.	~222.6

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



Natural Unit Weight kN/m³

Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	1.7

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Log of Borehole BH-15

Project No. HAM-00801497-A0 | Drawing No. 17

Project: Proposed Cast Iron Watermain Replacements | Sheet No. 1 of 1

Location: Fife Street West, Caledonia

Date Drilled: July 19, 2018

Drill Type: CME 75 Truck Mount. Solid Stem.

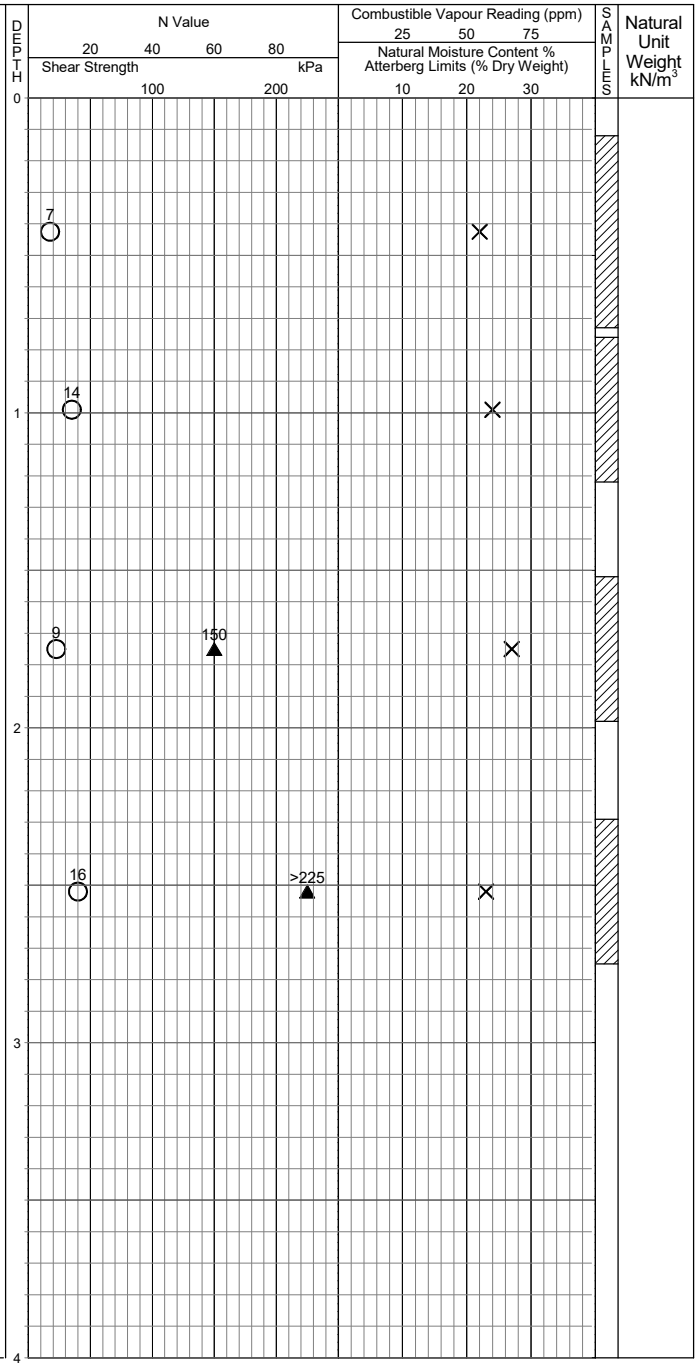
Datum: Geodetic

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
		ASPHALT: (~120 mm thick)	199.30
		GRANULAR FILL: (~200 mm thick)	~199.2
		FILL: silty clay, trace gravel, brown, moist, black organic staining	~199.0
		SILTY CLAY: brown, moist, very stiff to hard	~197.8
		Borehole terminated at 2.7 m depth.	~196.6

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.



Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	2.7

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Log of Borehole BH-16

Project No. HAM-00801497-A0 | Drawing No. 18

Project: Proposed Cast Iron Watermain Replacements | Sheet No. 1 of 1

Location: Fife Street West, Caledonia

Date Drilled: July 19, 2018

Drill Type: CME 75 Truck Mount. Solid Stem.

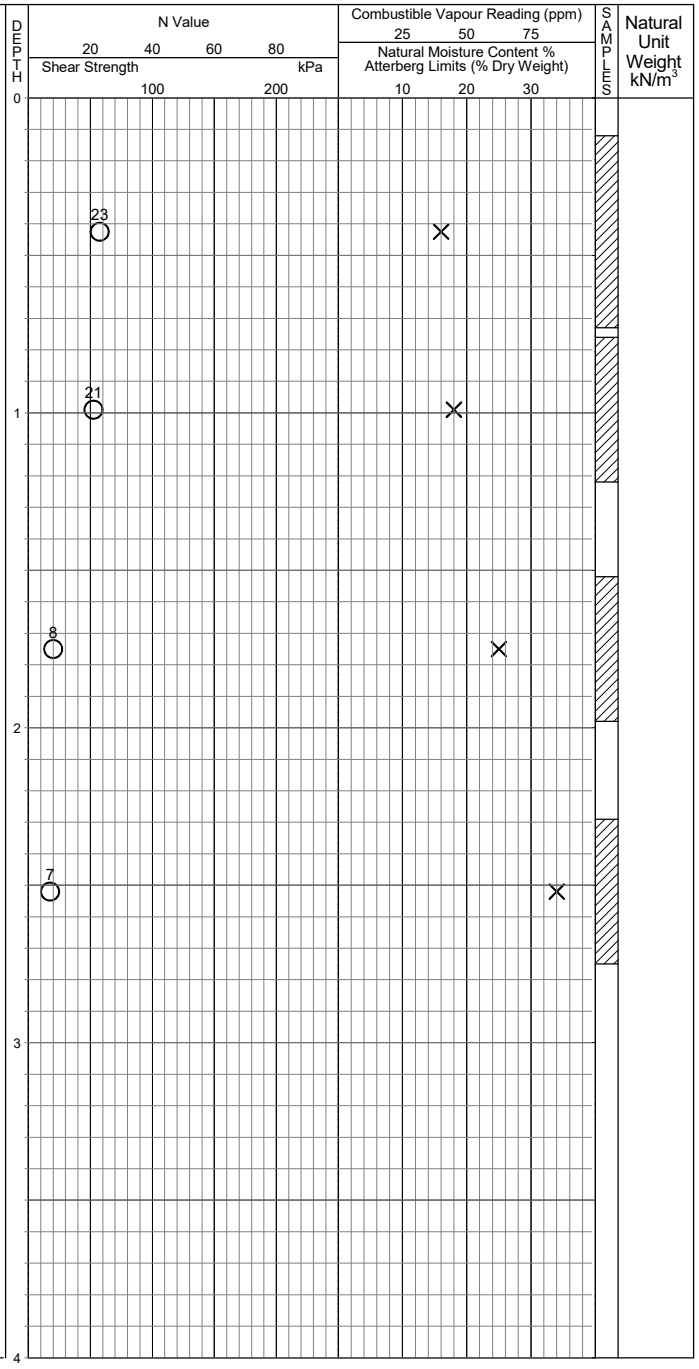
Datum: Geodetic

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
		ASPHALT: (~120 mm thick)	200.25
		GRANULAR FILL: (~300 mm thick)	~200.1
		FILL: silty clay, trace gravel, brown, moist, black organic staining	~199.8
		Borehole terminated at 2.7 m depth.	~197.5

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.



Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	2.7

EXP Services Inc.
Hamilton, ON
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Log of Borehole BH-17

Project No. HAM-00801497-A0 | Drawing No. 19

Project: Proposed Cast Iron Watermain Replacements | Sheet No. 1 of 1

Location: Renfrew Street East, Caledonia

Date Drilled: July 19, 2018

Drill Type: CME 75 Truck Mount. Solid Stem.

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
		ASPHALT: (~100 mm thick)	192.64
		GRANULAR FILL: (~200 mm thick)	~192.5
		FILL: silty clay, some sand, trace gravel, brown, moist	~192.3
		FILL: silty sand, trace gravel, brown, very moist	~190.1
		Borehole terminated at 2.7 m depth.	~189.9

NOTES:
1. This drawing is to be read with the subject report and project number as presented above.
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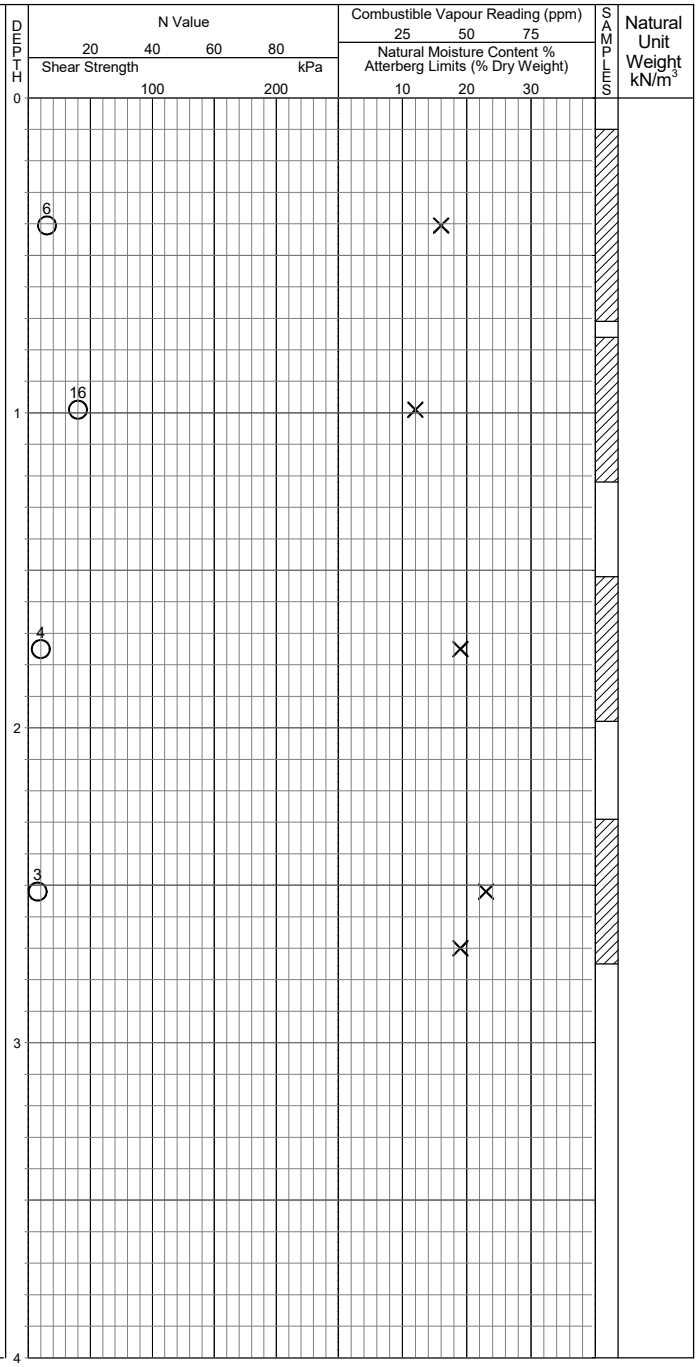

Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	2.7

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Log of Borehole BH-18

Project No. HAM-00801497-A0 | Drawing No. 20

Project: Proposed Cast Iron Watermain Replacements | Sheet No. 1 of 1

Location: Renfrew Street East, Caledonia

Date Drilled: July 19, 2018

Drill Type: CME 75 Truck Mount. Solid Stem.

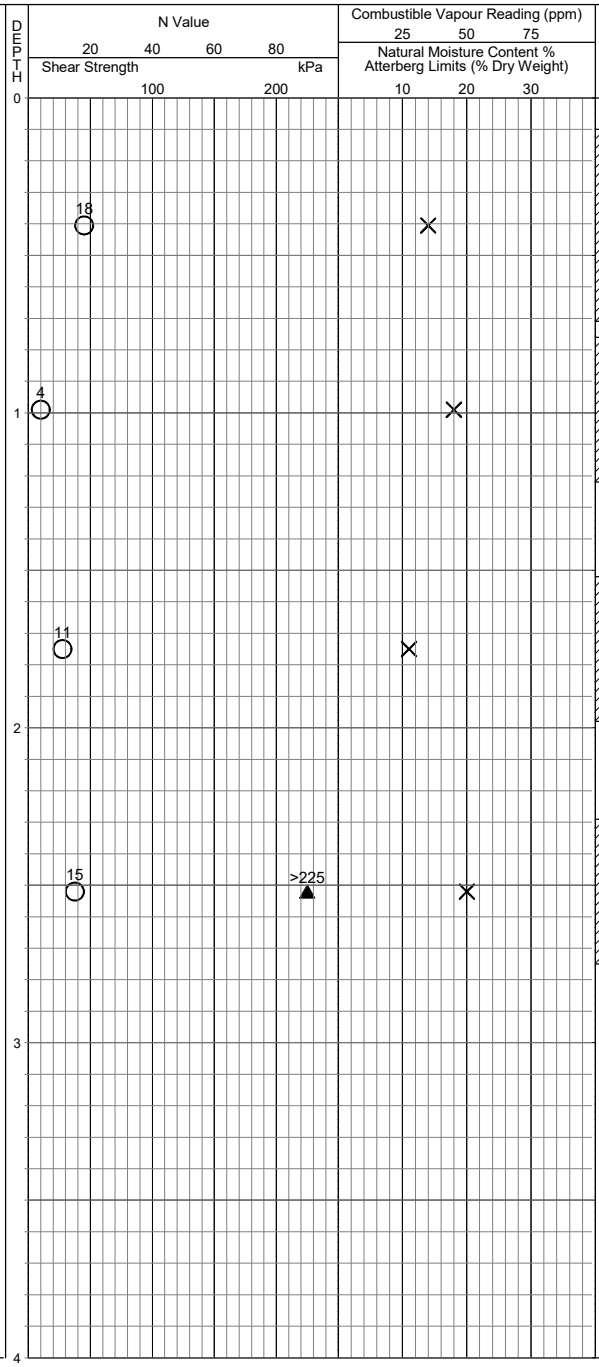
Datum: Geodetic

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
		ASPHALT: (~100 mm thick)	189.14
		GRANULAR FILL: (~270 mm thick)	~189.0
		FILL: silty clay, some sand, brown, moist	~188.8
		FILL: silty sand, trace clay, some gravel, brown, moist	~187.6
		SILTY CLAY: brown, moist, hard	~186.9
		Borehole terminated at 2.7 m depth.	~186.4

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.



Natural Unit Weight kN/m³

Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	2.7

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Log of Borehole BH-19

Project No. HAM-00801497-A0 | Drawing No. 21

Project: Proposed Cast Iron Watermain Replacements | Sheet No. 1 of 1

Location: Blair Street, Caledonia

Date Drilled: July 19, 2018

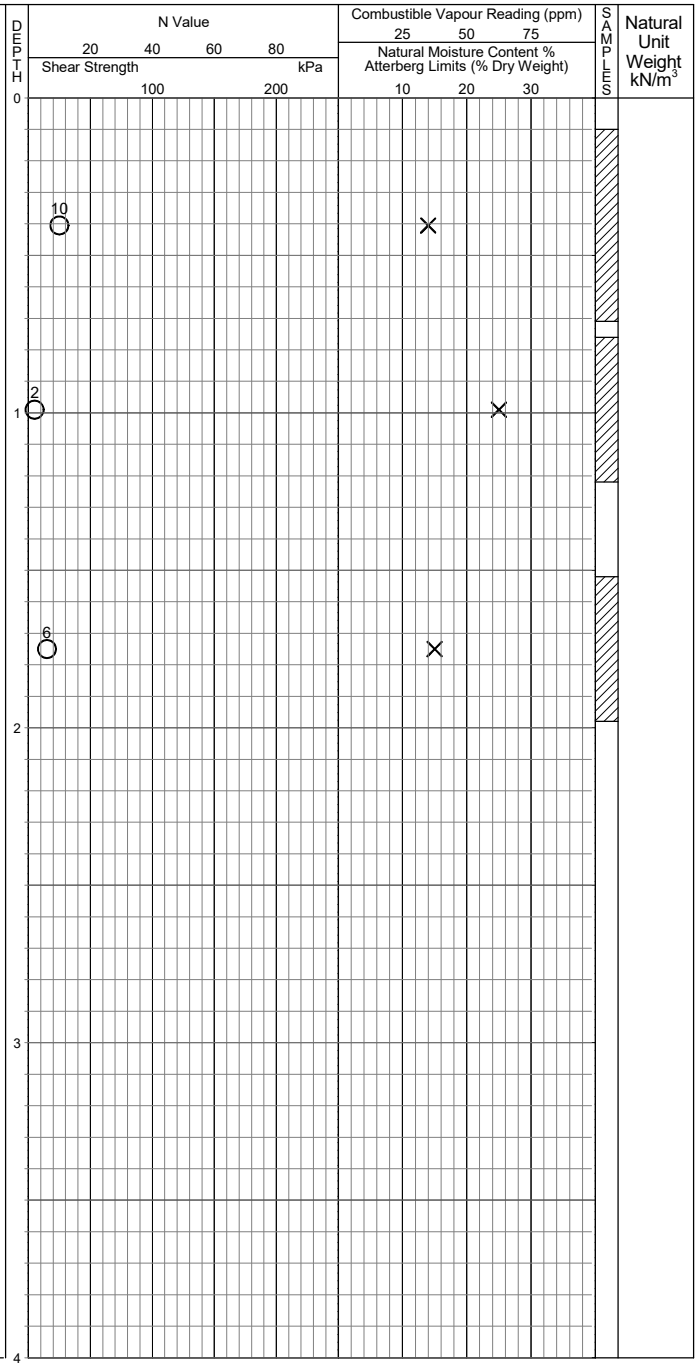
Drill Type: CME 75 Truck Mount. Solid Stem.

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
		ASPHALT: (~100 mm thick)	189.75
		GRANULAR FILL: (~270 mm thick)	~189.7
		FILL: silty clay, trace gravel, trace sand, brown, moist, black organic staining brick fragments below 0.8 m	~189.4
		SANDY SILT: trace clay, trace gravel, brown, moist, loose	~188.2
		Borehole terminated at 2.1 m depth due to practical auger refusal on assumed boulder or bedrock. 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.	~187.6



Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	2.1

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Log of Borehole BH-20

Project No. HAM-00801497-A0 | Drawing No. 22

Project: Proposed Cast Iron Watermain Replacements | Sheet No. 1 of 1

Location: Queen Avenue, Caledonia

Date Drilled: July 19, 2018

Drill Type: CME 75 Truck Mount. Solid Stem.

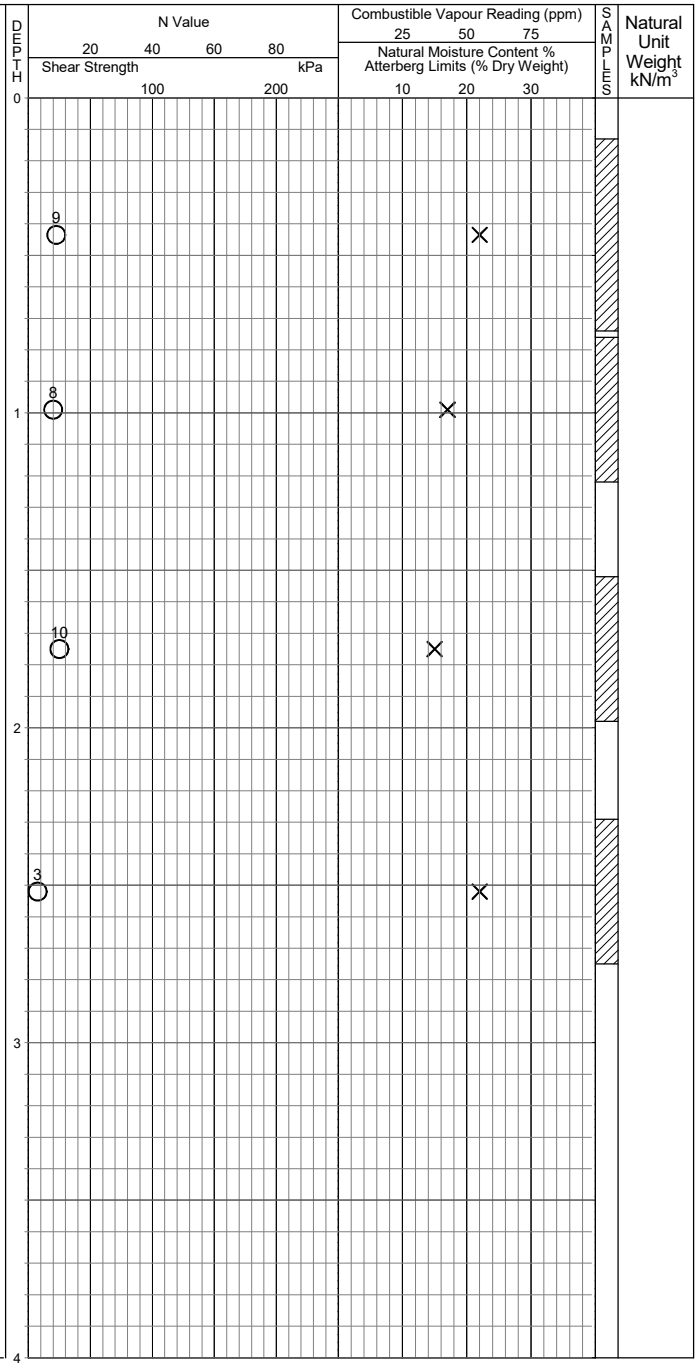
Datum: Geodetic

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
		ASPHALT: (~130 mm thick)	190.11
		GRANULAR FILL: (~270 mm thick)	~190.0
		FILL: silty clay, brown, moist, black organic staining	~189.7
		SANDY SILT: trace gravel, brown, moist, loose, silty clay partings	~189.4
		very moist, very loose below 2.3 m	
		Borehole terminated at 2.7 m depth.	~187.4

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.



Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	2.7

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Log of Borehole BH-21

Project No. HAM-00801497-A0 | Drawing No. 23

Project: Proposed Cast Iron Watermain Replacements | Sheet No. 1 of 1

Location: Park Lane, Caledonia

Date Drilled: July 19, 2018

Drill Type: CME 75 Truck Mount. Solid Stem.

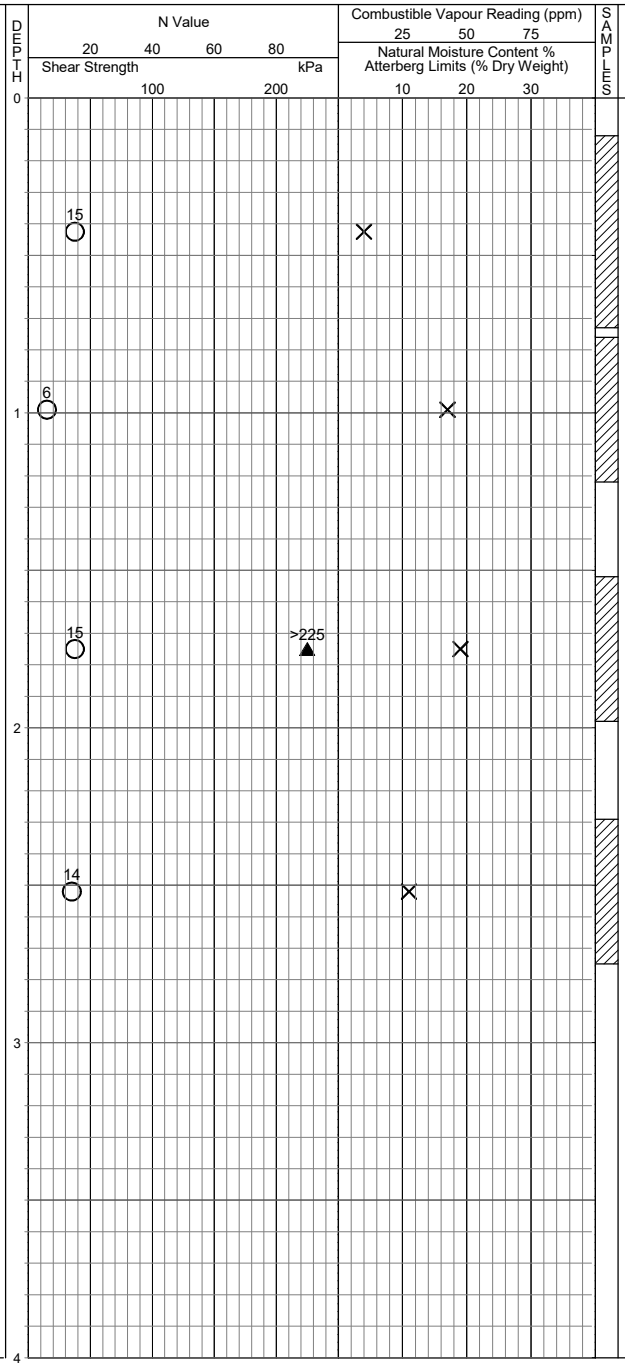
Datum: Geodetic

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
		ASPHALT: (~120 mm thick)	192.96
		GRANULAR FILL: (~280 mm thick)	~192.8
		FILL: silty clay, trace gravel, brown, slightly moist moist below 0.8 m	~192.6
		SILTY CLAY: trace sand, trace gravel, brown, moist, hard	~191.4
		Borehole terminated at 2.7 m depth.	~190.2

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.



Natural Unit Weight kN/m³

Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	2.7

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Log of Borehole BH-22

Project No. HAM-00801497-A0 | Drawing No. 24

Project: Proposed Cast Iron Watermain Replacements | Sheet No. 1 of 1

Location: Queen Avenue, Caledonia

Date Drilled: July 19, 2018

Drill Type: CME 75 Truck Mount. Solid Stem.

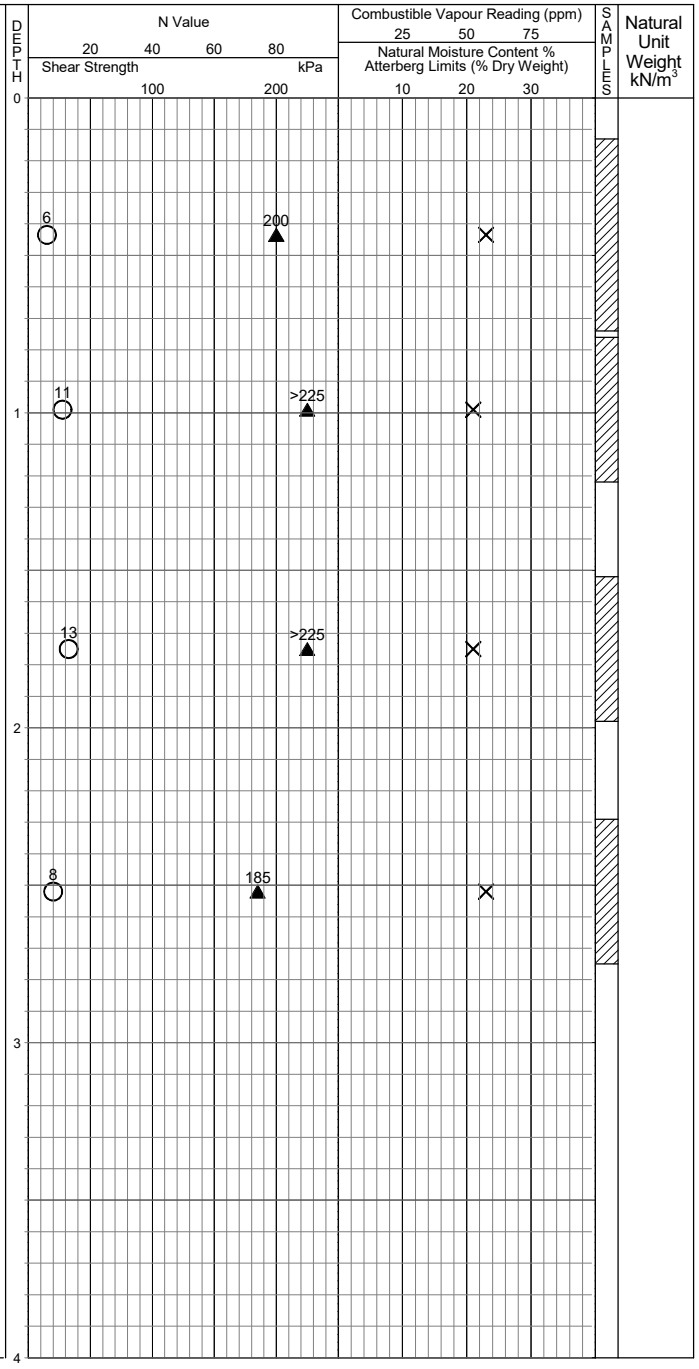
Datum: Geodetic

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
		ASPHALT: (~130 mm thick)	197.80
		GRANULAR FILL: (~300 mm thick)	~197.7
		SILTY CLAY: brown, moist, very stiff to hard	~197.4
		Borehole terminated at 2.7 m depth.	~195.1

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.



Time	Water Level (m)	Depth to Cave (m)
on completion	no free water	2.7

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Appendix B – Certificate of Analysis

EXP. SERVICES INC.
PROJECT NO: HAM-801497-A0

TABLE NO. B1

Table 9 - Generic Non-Potable	Soil µg/g	Detection Limit µg/g	BH1 SS1 9535708 Soil 6-Sep-18	BH2 SS2 9535710 Soil 6-Sep-18	BH3 SS2 9535711 Soil 6-Sep-18	BH4 SS2 9535712 Soil 6-Sep-18	BH5 SS1B 9535713 Soil 6-Sep-18	BH6 SS1 9535714 Soil 6-Sep-18	BH7 SS1 9535715 Soil 6-Sep-18
Antimony	1.3	0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Arsenic	18	1	2	5	4	5	2	5	5
Barium	220	2	16	61	74	32	41	161	204
Beryllium	2.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.3	1.7
Boron	36	5	<5	13	8	11	<5	19	13
Boron (Hot Water Soluble)	1.5	0.1	<0.10	0.14	0.42	0.14	0.24	0.22	0.32
Cadmium	1.2	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	70	2	5	14	12	11	16	32	40
Cobalt	22	0.5	1.7	7	6.3	4.3	7.2	16.2	18.7
Copper	92	1	5	29	16	16	10	25	31
Lead	120	1	4	13	17	11	9	13	25
Molybdenum	2	0.5	<0.5	<0.5	0.8	1.1	<0.5	<0.5	<0.5
Nickel	82	1	3	14	12	10	13	34	40
Selenium	1.5	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	0.4
Silver	0.5	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Thallium	1	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Uranium	2.5	0.5	<0.5	0.5	0.7	0.8	<0.5	0.6	0.6
Vanadium	86	1	10	21	21	18	28	44	52
Zinc	290	5	19	54	45	32	39	74	98
Chromium VI	0.66	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cyanide	0.051	0.04	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
Mercury	0.27	0.1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Electrical Conductivity	0.7	0.005	0.121	0.368	**0.719**	0.67	**0.729**	**1.62**	0.624
Sodium Adsorption Ratio	5	NA	1.33	4.48	2.8	**9.99**	**13.8**	4.64	1.42
pH, 2:1 CaCl2 Extraction	NV	NA	7.58	7.8	7.79	7.98	7.49	7.75	7.51

EXP. SERVICES INC.
PROJECT NO: HAM-801497-A0

TABLE NO. B1

Table 9 - Generic Non-Potable	Soil µg/g	Detection Limit µg/g	BH8 SS1 9535716 Soil 6-Sep-18	BH9 SS1 9535717 Soil 6-Sep-18	BH10 SS1 9535718 Soil 6-Sep-18	BH11 SS2 9535719 Soil 6-Sep-18	BH12 SS1 9535730 Soil 6-Sep-18
Antimony	1.3	0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Arsenic	18	1	1	5	8	4	4
Barium	220	2	20	219	164	147	128
Beryllium	2.5	0.5	<0.5	1.9	1.7	1.1	0.8
Boron	36	5	<5	11	8	14	13
Boron (Hot Water Soluble)	1.5	0.1	0.13	0.35	0.12	0.34	0.46
Cadmium	1.2	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	70	2	7	41	36	32	22
Cobalt	22	0.5	2.1	21.6	21.8	16.5	9.9
Copper	92	1	5	33	40	24	19
Lead	120	1	5	21	15	35	25
Molybdenum	2	0.5	<0.5	<0.5	<0.5	<0.5	0.6
Nickel	82	1	4	46	40	30	21
Selenium	1.5	0.4	<0.4	0.7	0.7	<0.4	<0.4
Silver	0.5	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Thallium	1	0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Uranium	2.5	0.5	<0.5	0.6	0.7	0.6	0.9
Vanadium	86	1	16	51	45	42	31
Zinc	290	5	22	105	88	84	53
Chromium VI	0.66	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cyanide	0.051	0.04	<0.040	<0.040	<0.040	<0.040	<0.040
Mercury	0.27	0.1	<0.10	<0.10	<0.10	**0.8**	<0.10
Electrical Conductivity	0.7	0.005	0.218	0.677	**1.6**	0.632	**0.771**
Sodium Adsorption Ratio	5	NA	2.46	4.03	**8.25**	2.07	2.57
pH, 2:1 CaCl2 Extraction	NV	NA	7.8	7.46	7.25	7.66	7.77

EXP. SERVICES INC.
PROJECT NO: HAM-801497-A0

TABLE NO. B2

Table 7 - Shallow Soils Non-Potable	Soil µg/g		Detection Limit	BH13 SS1	BH14 SS2
	Residential	Industrial		9535720	9535721
				Soil	Soil
			µg/g	**6-Sep-18**	**6-Sep-18**
Antimony	7.5	(50) 40	0.8	<0.8	<0.8
Arsenic	18	18	1	5	4
Barium	390	670	2	119	114
Beryllium	(5) 4	(10) 8	0.5	1	0.7
Boron	120	120	5	11	13
Boron (Hot Water Soluble)	1.5	2	0.1	1.18	0.14
Cadmium	1.2	1.9	0.5	<0.5	<0.5
Chromium	160	160	2	27	23
Cobalt	22	(100) 80	0.5	11.3	10.7
Copper	(180) 140	(300) 230	1	24	19
Lead	120	120	1	62	10
Molybdenum	6.9	40	0.5	<0.5	<0.5
Nickel	(130) 100	(340) 270	1	23	22
Selenium	2.4	5.5	0.4	0.7	<0.4
Silver	(25) 20	(50) 40	0.2	<0.2	<0.2
Thallium	1	3.3	0.4	<0.4	<0.4
Uranium	23	33	0.5	0.7	0.6
Vanadium	86	86	1	37	32
Zinc	340	340	5	149	49
Chromium VI	(10) 8	(10) 8	0.2	<0.2	<0.2
Cyanide	0.051	0.051	0.04	<0.040	<0.040
Mercury	(1.8) 0.27	(20) 3.9	0.1	0.12	<0.10
Electrical Conductivity	0.7	1.4	0.005	**3.46**	0.521
Sodium Adsorption Ratio	5	12	NA	**16.3**	3.16
pH, 2:1 CaCl2 Extraction	NV	NV	NA	7.38	7.95

EXP. SERVICES INC.
PROJECT NO: HAM-801497-A0

TABLE NO. B3

Table 3 - Full Depth Non-Potable	Soil µg/g		Detection Limit	BH15 SS2	BH16 SS4	BH17 SS2	BH18 SS2	BH19 SS2	BH20 SS1
	Residential	Industrial		9535722	9535723	9535724	9535725	9535726	9535727
				Soil	Soil	Soil	Soil	Soil	Soil
			µg/g	**6-Sep-18**	**6-Sep-18**	**6-Sep-18**	**6-Sep-18**	**6-Sep-18**	**6-Sep-18**
Antimony	7.5	(50) 40	0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Arsenic	18	18	1	4	4	3	4	10	5
Barium	390	670	2	121	153	57	31	83	121
Beryllium	(5) 4	(10) 8	0.5	1.2	1.2	0.7	<0.5	0.9	1
Boron	120	120	5	7	7	5	16	19	14
Boron (Hot Water Soluble)	1.5	2	0.1	0.58	0.93	0.29	<0.10	0.45	0.94
Cadmium	1.2	1.9	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	160	160	2	29	30	19	15	25	26
Cobalt	22	(100) 80	0.5	16.7	17.8	9.7	5.7	13	13.1
Copper	(180) 140	(300) 230	1	24	21	18	17	28	25
Lead	120	120	1	24	19	12	11	33	56
Molybdenum	6.9	40	0.5	0.5	<0.5	<0.5	0.9	2.4	1.1
Nickel	(130) 100	(340) 270	1	27	30	18	14	27	27
Selenium	2.4	5.5	0.4	0.5	0.7	<0.4	<0.4	<0.4	0.5
Silver	(25) 20	(50) 40	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Thallium	1	3.3	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Uranium	23	33	0.5	0.7	0.6	<0.5	1	0.8	0.9
Vanadium	86	86	1	38	38	28	26	44	32
Zinc	340	340	5	88	98	53	38	65	107
Chromium VI	(10) 8	(10) 8	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cyanide	0.051	0.051	0.04	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
Mercury	(1.8) 0.27	(20) 3.9	0.1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Electrical Conductivity	0.7	1.4	0.005	0.922	0.82	0.596	0.414	**2.73**	**3**
Sodium Adsorption Ratio	5	12	NA	0.87	0.416	1.85	8.74	**43.1**	**33.9**
pH, 2:1 CaCl2 Extraction	NV	NV	NA	7.01	6.75	7.11	7.73	7.89	7.61

EXP. SERVICES INC.
PROJECT NO: HAM-801497-A0

TABLE NO. B3

Table 3 - Full Depth Non-Potable	Soil µg/g		Detection Limit	BH21 SS2	BH22 SS1
	Residential	Industrial		9535728	9535729
				Soil	Soil
			µg/g	6-Sep-18	6-Sep-18
Antimony	7.5	(50) 40	0.8	<0.8	<0.8
Arsenic	18	18	1	5	5
Barium	390	670	2	134	137
Beryllium	(5) 4	(10) 8	0.5	1.3	1.4
Boron	120	120	5	11	15
Boron (Hot Water Soluble)	1.5	2	0.1	0.37	0.15
Cadmium	1.2	1.9	0.5	<0.5	<0.5
Chromium	160	160	2	34	34
Cobalt	22	(100) 80	0.5	16.7	16.6
Copper	(180) 140	(300) 230	1	29	28
Lead	120	120	1	20	14
Molybdenum	6.9	40	0.5	<0.5	<0.5
Nickel	(130) 100	(340) 270	1	34	37
Selenium	2.4	5.5	0.4	0.5	<0.4
Silver	(25) 20	(50) 40	0.2	<0.2	<0.2
Thallium	1	3.3	0.4	<0.4	<0.4
Uranium	23	33	0.5	0.5	0.5
Vanadium	86	86	1	44	43
Zinc	340	340	5	89	82
Chromium VI	(10) 8	(10) 8	0.2	<0.2	<0.2
Cyanide	0.051	0.051	0.04	<0.040	<0.040
Mercury	(1.8) 0.27	(20) 3.9	0.1	<0.10	<0.10
Electrical Conductivity	0.7	1.4	0.005	**3.64**	1.36
Sodium Adsorption Ratio	5	12	NA	7.32	3.82
pH, 2:1 CaCl2 Extraction	NV	NV	NA	7.61	7.75

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
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FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: **EXP. SERVICES INC.**
80 BANCROFT STREET
HAMILTON, ON L8E2W5
(905) 573-4000

ATTENTION TO: **Jeffrey Golder**

PROJECT: **HAM-801497-A0**

AGAT WORK ORDER: **18T383508**

SOIL ANALYSIS REVIEWED BY: **Amanjot Bhela, Inorganic Supervisor**

DATE REPORTED: **Sep 14, 2018**

PAGES (INCLUDING COVER): **9**

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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Certificate of Analysis

AGAT WORK ORDER: 18T383508

PROJECT: HAM-801497-A0

CLIENT NAME: EXP. SERVICES INC.

ATTENTION TO: Jeffrey Golder

SAMPLING SITE:

SAMPLED BY:

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

DATE RECEIVED: 2018-09-10 **DATE REPORTED: 2018-09-14**

		SAMPLE DESCRIPTION:		BH1 SS1	BH2 SS2	BH3 SS2	BH4 SS2	BH5 SS1B	BH6 SS1	BH7 SS1	BH8 SS1
		SAMPLE TYPE:		Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
		DATE SAMPLED:		2018-09-06	2018-09-06	2018-09-06	2018-09-06	2018-09-06	2018-09-06	2018-09-06	2018-09-06
Parameter	**Unit**	**G / S**	**RDL**	**9535708**	**9535710**	**9535711**	**9535712**	**9535713**	**9535714**	**9535715**	**9535716**
Antimony	µg/g		0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Arsenic	µg/g		1	2	5	4	5	2	5	5	1
Barium	µg/g		2	16	61	74	32	41	161	204	20
Beryllium	µg/g		0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.3	1.7	<0.5
Boron	µg/g		5	<5	13	8	11	<5	19	13	<5
Boron (Hot Water Soluble)	µg/g		0.10	<0.10	0.14	0.42	0.14	0.24	0.22	0.32	0.13
Cadmium	µg/g		0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	µg/g		2	5	14	12	11	16	32	40	7
Cobalt	µg/g		0.5	1.7	7.0	6.3	4.3	7.2	16.2	18.7	2.1
Copper	µg/g		1	5	29	16	16	10	25	31	5
Lead	µg/g		1	4	13	17	11	9	13	25	5
Molybdenum	µg/g		0.5	<0.5	<0.5	0.8	1.1	<0.5	<0.5	<0.5	<0.5
Nickel	µg/g		1	3	14	12	10	13	34	40	4
Selenium	µg/g		0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	0.4	<0.4
Silver	µg/g		0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Thallium	µg/g		0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Uranium	µg/g		0.5	<0.5	0.5	0.7	0.8	<0.5	0.6	0.6	<0.5
Vanadium	µg/g		1	10	21	21	18	28	44	52	16
Zinc	µg/g		5	19	54	45	32	39	74	98	22
Chromium VI	µg/g		0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cyanide	µg/g		0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
Mercury	µg/g		0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Electrical Conductivity	mS/cm		0.005	0.121	0.368	0.719	0.670	0.729	1.62	0.624	0.218
Sodium Adsorption Ratio	NA		NA	1.33	4.48	2.80	9.99	13.8	4.64	1.42	2.46
pH, 2:1 CaCl2 Extraction	pH Units		NA	7.58	7.80	7.79	7.98	7.49	7.75	7.51	7.80

Certified By:

Amanjot Bhela

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AGAT WORK ORDER: 18T383508

PROJECT: HAM-801497-A0

CLIENT NAME: EXP. SERVICES INC.

ATTENTION TO: Jeffrey Golder

SAMPLING SITE:

SAMPLED BY:

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

DATE RECEIVED: 2018-09-10 **DATE REPORTED: 2018-09-14**

		SAMPLE DESCRIPTION:		BH9 SS1	BH10 SS1	BH11 SS2	BH13 SS1	BH14 SS2	BH15 SS2	BH16 SS4	BH17 SS2
		SAMPLE TYPE:		Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
		DATE SAMPLED:		2018-09-06	2018-09-06	2018-09-06	2018-09-06	2018-09-06	2018-09-06	2018-09-06	2018-09-06
Parameter	**Unit**	**G / S**	**RDL**	**9535717**	**9535718**	**9535719**	**9535720**	**9535721**	**9535722**	**9535723**	**9535724**
Antimony	µg/g		0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Arsenic	µg/g		1	5	8	4	5	4	4	4	3
Barium	µg/g		2	219	164	147	119	114	121	153	57
Beryllium	µg/g		0.5	1.9	1.7	1.1	1.0	0.7	1.2	1.2	0.7
Boron	µg/g		5	11	8	14	11	13	7	7	5
Boron (Hot Water Soluble)	µg/g		0.10	0.35	0.12	0.34	1.18	0.14	0.58	0.93	0.29
Cadmium	µg/g		0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	µg/g		2	41	36	32	27	23	29	30	19
Cobalt	µg/g		0.5	21.6	21.8	16.5	11.3	10.7	16.7	17.8	9.7
Copper	µg/g		1	33	40	24	24	19	24	21	18
Lead	µg/g		1	21	15	35	62	10	24	19	12
Molybdenum	µg/g		0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	<0.5	<0.5
Nickel	µg/g		1	46	40	30	23	22	27	30	18
Selenium	µg/g		0.4	0.7	0.7	<0.4	0.7	<0.4	0.5	0.7	<0.4
Silver	µg/g		0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Thallium	µg/g		0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Uranium	µg/g		0.5	0.6	0.7	0.6	0.7	0.6	0.7	0.6	<0.5
Vanadium	µg/g		1	51	45	42	37	32	38	38	28
Zinc	µg/g		5	105	88	84	149	49	88	98	53
Chromium VI	µg/g		0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cyanide	µg/g		0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
Mercury	µg/g		0.10	<0.10	<0.10	0.80	0.12	<0.10	<0.10	<0.10	<0.10
Electrical Conductivity	mS/cm		0.005	0.677	1.60	0.632	3.46	0.521	0.922	0.820	0.596
Sodium Adsorption Ratio	NA		NA	4.03	8.25	2.07	16.3	3.16	0.870	0.416	1.85
pH, 2:1 CaCl2 Extraction	pH Units		NA	7.46	7.25	7.66	7.38	7.95	7.01	6.75	7.11

Certified By:

Amanjot Bhela

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Certificate of Analysis

AGAT WORK ORDER: 18T383508

PROJECT: HAM-801497-A0

CLIENT NAME: EXP. SERVICES INC.

ATTENTION TO: Jeffrey Golder

SAMPLING SITE:

SAMPLED BY:

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

DATE RECEIVED: 2018-09-10 **DATE REPORTED: 2018-09-14**

		SAMPLE DESCRIPTION:		BH18 SS2	BH19 SS2	BH20 SS1	BH21 SS2	BH22 SS1	BH12 SS1
		SAMPLE TYPE:		Soil	Soil	Soil	Soil	Soil	Soil
		DATE SAMPLED:		2018-09-06	2018-09-06	2018-09-06	2018-09-06	2018-09-06	2018-09-06
Parameter	Unit	G / S	RDL	9535725	9535726	9535727	9535728	9535729	9535730
Antimony	µg/g		0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Arsenic	µg/g		1	4	10	5	5	5	4
Barium	µg/g		2	31	83	121	134	137	128
Beryllium	µg/g		0.5	<0.5	0.9	1.0	1.3	1.4	0.8
Boron	µg/g		5	16	19	14	11	15	13
Boron (Hot Water Soluble)	µg/g		0.10	<0.10	0.45	0.94	0.37	0.15	0.46
Cadmium	µg/g		0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	µg/g		2	15	25	26	34	34	22
Cobalt	µg/g		0.5	5.7	13.0	13.1	16.7	16.6	9.9
Copper	µg/g		1	17	28	25	29	28	19
Lead	µg/g		1	11	33	56	20	14	25
Molybdenum	µg/g		0.5	0.9	2.4	1.1	<0.5	<0.5	0.6
Nickel	µg/g		1	14	27	27	34	37	21
Selenium	µg/g		0.4	<0.4	<0.4	0.5	0.5	<0.4	<0.4
Silver	µg/g		0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Thallium	µg/g		0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Uranium	µg/g		0.5	1.0	0.8	0.9	0.5	0.5	0.9
Vanadium	µg/g		1	26	44	32	44	43	31
Zinc	µg/g		5	38	65	107	89	82	53
Chromium VI	µg/g		0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cyanide	µg/g		0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
Mercury	µg/g		0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Electrical Conductivity	mS/cm		0.005	0.414	2.73	3.00	3.64	1.36	0.771
Sodium Adsorption Ratio	NA		NA	8.74	43.1	33.9	7.32	3.82	2.57
pH, 2:1 CaCl2 Extraction	pH Units		NA	7.73	7.89	7.61	7.61	7.75	7.77

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

9535708-9535730 EC & SAR were 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.

Certified By:

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Quality Assurance

CLIENT NAME: EXP. SERVICES INC.

PROJECT: HAM-801497-A0

SAMPLING SITE:

AGAT WORK ORDER: 18T383508

ATTENTION TO: Jeffrey Golder

SAMPLED BY:

Soil Analysis

RPT Date: Sep 14, 2018			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
O. Reg. 153(511) - Metals & Inorganics (Soil)															
Antimony	9535708	9535708	<0.8	<0.8	NA	< 0.8	97%	70%	130%	90%	80%	120%	88%	70%	130%
Arsenic	9535708	9535708	2	2	NA	< 1	107%	70%	130%	87%	80%	120%	95%	70%	130%
Barium	9535708	9535708	16	16	0.0%	< 2	99%	70%	130%	86%	80%	120%	104%	70%	130%
Beryllium	9535708	9535708	<0.5	<0.5	NA	< 0.5	114%	70%	130%	110%	80%	120%	100%	70%	130%
Boron	9535708	9535708	<5	<5	NA	< 5	87%	70%	130%	108%	80%	120%	102%	70%	130%
Boron (Hot Water Soluble)	9535708	9535708	<0.10	<0.10	NA	< 0.10	117%	60%	140%	97%	70%	130%	94%	60%	140%
Cadmium	9535708	9535708	<0.5	<0.5	NA	< 0.5	103%	70%	130%	96%	80%	120%	110%	70%	130%
Chromium	9535708	9535708	5	6	NA	< 2	93%	70%	130%	94%	80%	120%	100%	70%	130%
Cobalt	9535708	9535708	1.7	1.7	NA	< 0.5	97%	70%	130%	97%	80%	120%	100%	70%	130%
Copper	9535708	9535708	5	5	0.0%	< 1	94%	70%	130%	104%	80%	120%	97%	70%	130%
Lead	9535708	9535708	4	4	NA	< 1	105%	70%	130%	96%	80%	120%	95%	70%	130%
Molybdenum	9535708	9535708	<0.5	<0.5	NA	< 0.5	99%	70%	130%	104%	80%	120%	114%	70%	130%
Nickel	9535708	9535708	3	4	NA	< 1	97%	70%	130%	96%	80%	120%	96%	70%	130%
Selenium	9535708	9535708	<0.4	<0.4	NA	< 0.4	104%	70%	130%	89%	80%	120%	100%	70%	130%
Silver	9535708	9535708	<0.2	<0.2	NA	< 0.2	106%	70%	130%	96%	80%	120%	105%	70%	130%
Thallium	9535708	9535708	<0.4	<0.4	NA	< 0.4	101%	70%	130%	91%	80%	120%	93%	70%	130%
Uranium	9535708	9535708	<0.5	<0.5	NA	< 0.5	102%	70%	130%	104%	80%	120%	100%	70%	130%
Vanadium	9535708	9535708	10	10	0.0%	< 1	93%	70%	130%	92%	80%	120%	98%	70%	130%
Zinc	9535708	9535708	19	18	NA	< 5	98%	70%	130%	104%	80%	120%	107%	70%	130%
Chromium VI	9535724	9535724	<0.2	<0.2	NA	< 0.2	75%	70%	130%	90%	80%	120%	79%	70%	130%
Cyanide	9535708	9535708	<0.040	<0.040	NA	< 0.040	108%	70%	130%	109%	80%	120%	95%	70%	130%
Mercury	9535708	9535708	<0.10	<0.10	NA	< 0.10	94%	70%	130%	92%	80%	120%	87%	70%	130%
Electrical Conductivity	9535708	9535708	0.121	0.122	0.8%	< 0.005	94%	90%	110%	NA			NA		
Sodium Adsorption Ratio	9535708	9535708	1.33	1.34	0.7%	NA	NA			NA			NA		
pH, 2:1 CaCl2 Extraction	9535724	9535724	7.11	7.18	1.0%	NA	101%	80%	120%	NA			NA		
O. Reg. 153(511) - Metals & Inorganics (Soil)															
Antimony	9536158		<0.8	<0.8	NA	< 0.8	111%	70%	130%	97%	80%	120%	79%	70%	130%
Arsenic	9536158		7	7	0.0%	< 1	108%	70%	130%	96%	80%	120%	98%	70%	130%
Barium	9536158		87	92	5.6%	< 2	99%	70%	130%	89%	80%	120%	91%	70%	130%
Beryllium	9536158		1.0	0.9	NA	< 0.5	116%	70%	130%	112%	80%	120%	111%	70%	130%
Boron	9536158		15	16	NA	< 5	87%	70%	130%	107%	80%	120%	106%	70%	130%
Boron (Hot Water Soluble)	9536158		0.90	0.91	1.1%	< 0.10	113%	60%	140%	96%	70%	130%	100%	60%	140%
Cadmium	9536158		<0.5	<0.5	NA	< 0.5	103%	70%	130%	99%	80%	120%	100%	70%	130%
Chromium	9536158		29	31	6.7%	< 2	92%	70%	130%	96%	80%	120%	106%	70%	130%
Cobalt	9536158		13.9	14.3	2.8%	< 0.5	99%	70%	130%	99%	80%	120%	97%	70%	130%
Copper	9536158		121	124	2.4%	< 1	97%	70%	130%	105%	80%	120%	99%	70%	130%
Lead	9536158		10	10	0.0%	< 1	105%	70%	130%	98%	80%	120%	98%	70%	130%
Molybdenum	9536158		1.2	1.3	NA	< 0.5	106%	70%	130%	108%	80%	120%	105%	70%	130%
Nickel	9536158		28	29	3.5%	< 1	98%	70%	130%	98%	80%	120%	95%	70%	130%

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Quality Assurance

CLIENT NAME: EXP. SERVICES INC.

AGAT WORK ORDER: 18T383508

PROJECT: HAM-801497-A0

ATTENTION TO: Jeffrey Golder

SAMPLING SITE:

SAMPLED BY:

Soil Analysis (Continued)

RPT Date: Sep 14, 2018			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Selenium	9536158		<0.4	<0.4	NA	< 0.4	101%	70%	130%	92%	80%	120%	95%	70%	130%
Silver	9536158		<0.2	<0.2	NA	< 0.2	115%	70%	130%	100%	80%	120%	97%	70%	130%
Thallium	9536158		<0.4	<0.4	NA	< 0.4	95%	70%	130%	93%	80%	120%	95%	70%	130%
Uranium	9536158		0.8	0.8	NA	< 0.5	103%	70%	130%	105%	80%	120%	108%	70%	130%
Vanadium	9536158		29	31	6.7%	< 1	96%	70%	130%	93%	80%	120%	98%	70%	130%
Zinc	9536158		69	73	5.6%	< 5	98%	70%	130%	104%	80%	120%	109%	70%	130%
Chromium VI	9535722	9535722	<0.2	<0.2	NA	< 0.2	74%	70%	130%	97%	80%	120%	100%	70%	130%
Cyanide	9535729	9535729	< 0.040	< 0.040	NA	< 0.040	94%	70%	130%	108%	80%	120%	94%	70%	130%
Mercury	9536158		<0.10	<0.10	NA	< 0.10	97%	70%	130%	93%	80%	120%	96%	70%	130%
Electrical Conductivity	9536158		0.766	0.770	0.5%	< 0.005	94%	90%	110%	NA			NA		
Sodium Adsorption Ratio	9536158		2.07	2.06	0.5%	NA	NA			NA			NA		
pH, 2:1 CaCl2 Extraction	9534284		7.57	7.62	0.7%	NA	101%	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

Certified By:

Amanjot Bhela

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Method Summary

CLIENT NAME: EXP. SERVICES INC.

AGAT WORK ORDER: 18T383508

PROJECT: HAM-801497-A0

ATTENTION TO: Jeffrey 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 #: 18T383508

Cooler Quantity:

Arrival Temperatures: 9.1 | 9.2 | 9.2 / 8.1 | 8.2 | 8.2

Custody Seal Intact: ☐ Yes ☐ No ☐ N/A

Notes:

Report Information:

Company: exp Services Inc.
Contact: Jeffrey Golder
Address: 80 Bancroft Street
Hamilton, ON L8E 2W5
Phone: 905.573.4000 x5022 Fax:
Reports to be sent to:
1. Email: jeffrey.golder@exp.com
2. Email: dilsher.bhangal@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 ☐ 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 801497-A0
Site Location: Caledonia, Cayuga, Haldimand, ON
Sampled By: DB
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	ORPs: ☐ B-HWS ☐ Cl⁻ ☐ CN⁻ ☐ Cr⁶⁺ ☐ EC ☐ FOC ☐ NO_3/NO_2 ☐ Total N ☐ Hg ☐ pH ☐ SAR (Check Applicable)	Nutrients: ☐ TP ☐ NH_3 ☐ TKN ☐ NO_3 ☐ NO_2 ☐ NO_3/NO_2 (Check Applicable)	Volatiles: ☐ VOC ☐ BTEX ☐ THM (Check Applicable)	CCME Fractions 1 to 4	ABNs	PAHs	Chlorophenols	PCBs	Organochlorine Pesticides	TCLP Metals/Inorganics	Sewer Use
BH1	SS1	6/9/18	4:30 PM	1				✓													
BH2	SS2	↓	↓	↓				✓													
BH3	SS2							✓													
BH4	SS2							✓													
BH5	SS1B							✓													
BH6	SS1							✓													
BH7	SS1							✓													
BH8	SS1							✓													
BH9	SS1							✓													
BH10	SS1							✓													
BH11	SS2							✓													

Samples Relinquished By (Print Name and Sign):	Date	Time	Samples Received By (Print Name and Sign):	Date	Time
Dilsher Bhangal	6/9/18		20180910		1:15
20180910		4:20			

Page ____ of ____

N°:

AGAT Laboratories

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Mississauga, Ontario L4Z 1Y2
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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 #: 18T383508

Cooler Quantity:

Arrival Temperatures: 9.1 | 9.2 | 9.2 | 8.1 | 8.2 | 8.2

Custody Seal Intact: ☐ Yes ☐ No ☐ N/A

Notes:

Report Information:

Company: exp Services Inc.

Contact: Jeffrey Golder

Address: 80 Bancroft Street
Hamilton, ON L8E 2W5

Phone: 905.573.4000 x5022 Fax:

Reports to be sent to:

1. Email: jeffrey.golder@exp.com
2. Email: dilsher.bhangal@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)

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 801497-AD

Site Location: Caledonia, Onyuga, Hagersville, ON

Sampled By: DB

AGAT Quote #: 159061 PO:

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

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

Report Guideline on Certificate of Analysis ☐ Yes ☑ No

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	ORPs: ☐ B-HWS ☐ Cl⁻ ☐ CN⁻ ☐ Cr6+ ☐ EC ☐ FOC ☐ NO_3/NO_2 ☐ Total N ☐ Hg ☐ pH ☐ SAR (Check Applicable)	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
BH13 SS1	6/9/18	4:00PM	1				✓														
BH14 SS2	↓	↓	↓				✓														
BH15 SS2							✓														
BH16 SS4							✓														
BH17 SS2							✓														
BH18 SS2							✓														
BH19 SS2							✓														
BH20 SS1							✓														
BH21 SS2							✓														
BH22 SS1							✓														
BH12 SS1							✓														

Samples Relinquished By (Print Name and Sign):	Date	Time	Samples Received By (Print Name and Sign):	Date	Time
Dilsher Bhangal	7/9/18		2018/09/10		1:15
2018/09/10		4:20			

Page ____ of ____

N°: