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Fidelity Engineering and Construction Inc.

Final Foundation Report

MTO Grafton Patrol Yard

Geocres No: 31C-306

Latitude: 44.003101

Longitude: -78.024064

April 21, 2021

AG File No: 20582-1

Submitted To:

Fidelity Engineering Inc.
Robert Walker, General Manager
512 Purdy Road,
Colborne, ON



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Figure No. 1 - Development Preferred Option

Figure No. 1 - Site Strata and Borehole Location Plan

Appendix A - Borehole Logs

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PART A

Foundation Investigation Report

MTO Grafton Patrol Yard

Geocres No.: 31C-306

PART A – FACTUAL INFORMATION

1.0 INTRODUCTION

Ainley Group (Ainley) was retained by Fidelity Engineering and Construction Inc. to carry out geotechnical consulting services for the proposed MTO Grafton Patrol Yard upgrades located in Grafton, Ontario.

The objectives of the assignment were:

- To conduct a geotechnical site investigation, soil sampling and testing within the subject site in accordance with the received agreement.
- To prepare a foundation report and recommendations based on the information obtained during the site investigation completed in order to advance the design and construction of the proposed building.

Based on the information provided to our office it is understood that the proposed redevelopment is to consist of the following key components:

- Maintenance Work Garage
- Lean On Structure
- Cold Storage Building
- New parking and site access

2.0 SITE DESCRIPTION

The Grafton Patrol Yard is located at 425 Lyle Street North in Grafton, Ontario. The site is bound by Highway 401 to the north, Lyle Street North to the west, a treed area to the south and agricultural land to the east. The property is approximately 9.9 hectares. The site currently has a large multi bay garage, new rectangular salt storage building, fueling station/area and multiple scrap metal and dumping piles. The main access road and area around the existing garage is paved with the remaining areas beside and behind the salt storage building, fueling station and scrap pile is gravel. The overall existing site is relatively flat and generally slopes toward the south. The site is currently serviced by hydro, cable, gas and water, however, sanitary flows to a septic system. Site elevations range from 164.5 m to 168.04 m.

3.0 FIELDWORK / METHODOLOGY

The field program consisted of the advancement of a total of eight (8) boreholes throughout the proposed project area. Four boreholes (BH1 to BH4) were advanced in the location of the proposed new building to determine the underlying subsoil conditions and are utilized in this report to develop the foundation recommendations. The remaining boreholes were advanced to

shallower depths and were utilized to develop pavement design recommendations to be submitted under a separate report.

The northing, easting and elevation of the boreholes are shown on the Borehole Location and Soil Strata Drawing attached to this report as **Figure No. 1**. The site is located within MTM Zone 10.

Borehole Summary

Borehole No.	Location	Northing (Latitude)	Easting (Longitude)	Ground Surface Elevation (m)
BH1	Proposed Garage	4874736.101 (44.003081)	423137.270 (-78.024369)	167.05
BH2	Proposed Garage	4874752.280 (44.003219)	423179.113 (-78.023844)	167.25
BH3	Proposed Garage	4874714.905 (44.002890)	423144.079 (-78.024289)	166.69
BH4	Proposed Garage	4874722.724 (44.002956)	423180.799 (-78.023829)	166.12

The boreholes were advanced by means of a truck mounted CME-55 drill rig equipped for soil sampling supplied and operated by GET Drilling Ltd. The foundation boreholes were advanced to a depth of 6.0 m below existing site grades where sound founding soil was encountered. The borehole depth was established after reviewing a previous foundation investigation completed on the site where very dense material was encountered within this depth.

The boreholes were advanced on December 11, 2020 under the constant supervision of Josh Charlton, a member of Ainley Group's geotechnical team. Upon completion, all borehole locations were reinstated to match existing grade by backfilling with native soils as required. Prior to commencing the geotechnical investigation program, Ainley Group contacted local utility companies to obtain clearances for all underground services in the immediate area of the proposed field program.

Split spoon sampling procedures were performed following the methods described in ASTM D1586-11 at foundation borehole locations (BH1 to 4) to determine the penetration resistance (in terms of N values, Standard Penetration Index) of the existing subsoils. The values obtained may be correlated to the relative density of non-cohesive materials and consistency of cohesive soils.

Representative samples of the subsoil materials encountered were secured within each borehole for further review and selection for laboratory analysis. All laboratory testing was completed by SNC Lavalin in their Kingston laboratory to MTO and/or ASTM standards as appropriate. Copies of the laboratory testing results are included in **Appendix B**.

Groundwater infiltration was monitored during the borehole program however long-term monitoring of the groundwater conditions was outside the scope of the assignment.

The location and ground surface elevations at each respective borehole was surveyed using a Sokkia GSR 2700 ISX GPS with real time sub-centimeter accuracy, and referenced to the UTM geodetic coordinate system.

The borehole program was established to supplement a previous foundation investigation completed by Thurber Engineering Ltd. completed in February 2020 (Agreement No. 4017-E-0021, Assignment No. 6, Geocres No. 31C-287). A copy of the report is enclosed in **Appendix C** for reference purposes. Ainley utilized the subsoil and groundwater findings to prepare our reports for the site.

4.0 SITE GEOLOGY AND STRATIGRAPHY

4.1 Physiographic Region

The project lies within the physiographic region known as the Iroquois Plain. The unconsolidated surface deposits in Northumberland County are of glacial origin and are the parent material from which soils have developed. The area overburden generally consists of sands, silts and clays with occasional drumlins.

4.2 Site Stratigraphy

Full details of the subsurface conditions encountered at the borehole locations are presented on the individual borehole logs included in **Appendix A**. It is emphasized however, that the soil types, their sequence, thickness and physical properties may vary between borehole locations and samples both vertically and horizontally.

In general, the subsurface conditions encountered in the boreholes consist of 2.1 m to 3.5 m of fill consisting of sand to silty sand with varying amounts of gravel. The fill is underlain by a sand with silt to sandy silt deposit extending to depths of 3.0 m to 6.0 m below grade where a dense glacial till was encountered. A 100 mm thick layer of coarse fibrous wood was encountered beneath the fill in BH1 at a depth of 2.1 m below grade. Representative samples of the subsoil materials encountered within the boreholes were collected and returned to our office for further visual review by an engineer having experience with soil classification and identification.

The subsoil conditions encountered throughout the proposed development site generally consisted of the following:

Fill

A fill layer consisting of sand to silty sand with varying amounts of gravel was encountered in all boreholes at the ground surface. The fill extended to depths ranging from 2.1 m to 3.5 m (Elevation 164.95 m to 162.62 m) below existing site grades. Trace of organics within the fill matrix was identified in BH2 and BH3 at depths of 1.8 m to 2.4 m and extended to depths of 3.3 m to 3.0 m.

SPT testing produced N values ranging from 4 to 48 blows, indicating a loose to dense state.

Grain size distribution and moisture content analysis was performed on one (1) sample of fill material encountered in BH3 between 1.5 m and 2.1 m below existing site grades revealed a moisture content of 7.8%. Grain size distribution indicated 92.4% passing the 4.75 mm sieve and 35.5% passing the 75 μ m classifying the material as silty sand, trace of gravel.

Wood

A 100 mm thick layer of coarse fibrous wood was encountered immediately beneath the fill layer in BH1 at a depth of 2.1 m (Elevation 164.95 m).

Sand (SP-SM) with Silt

Brown to grey sand with silt was encountered beneath the fill and organic deposits at depths ranging from 2.2 m to 3.5 m (Elevation 164.85 m to 162.62 m). The sand deposit extended to depths ranging from 3.0 m to 6.0 m (Elevation 164.25 to 160.69 m).

SPT testing produced N values ranging from 3 to 50 blows, indicating a loose to dense state.

Grain size distribution and moisture content analysis was performed on two (2) samples of sand obtained from BH1. Moisture content was determined to be 13.2% and 16.4 %. Grain size distribution performed on a sample obtained between 2.25 m and 3.6 m below existing grades indicated 98.9% passing the 4.75 mm sieve and 28.8% passing the 75 μ m classifying the material as sand with silt, trace of gravel. Grain size distribution performed on a sample obtained between 3.75 m and 4.35 m below existing grades indicated 100% passing the 4.75 mm sieve and 35% passing the 75 μ m with a 26% silt content and a 9% clay content. The material may be classified as sand with silt, trace of clay.

Sandy Silt (ML)

A grey sandy silt deposit was encountered in BH2 beneath the sand deposit at a depth of 3.0 m (Elevation 164.25 m) below existing grade. The deposit extended to a depth of 6.0 m (Elevation 161.25 m) where the borehole was terminated.

SPT testing produced N values ranging from 26 to over 50 blows, indicating a compact to very dense state.

Grain size distribution and moisture content analysis was performed on one (1) sample of material encountered in BH2 between 3.0 m and 3.6 m. Moisture content was determined to be 18.9%. Grain size distribution indicated 100% passing the 4.75 mm sieve and 64% passing the 75 µm with a 59% silt content and a 5% clay content. The material may be classified as sandy silt, trace of clay.

Glacial Till

A brown to grey glacial till deposit was encountered beneath the sand with silt deposit in BH Nos. 1 and 4. The glacial till was encountered at depths ranging from 4.7 m to 5.1 m (Elevation 162.35 m to 161.02 m) and extended to borehole termination at 6.0 m (Elevation 161.05 m to 160.12 m).

SPT testing produced N values were recorded over 50 blows, indicating a very dense state.

Grain size distribution testing was not completed, however, the soil sample matrix consisted of a mix of sand, silt and gravel.

Groundwater

Groundwater infiltration was encountered at all foundation borehole locations Nos. 1 to 4 during the borehole investigation. Groundwater water was encountered at depths (elevations) ranging between 2.25 m – 3.68 m (163.45 m – 164.44 m) however groundwater piezometers were not installed in the boreholes. To establish the stable groundwater level on the site at Elevation 163.0 m, the information contained in the Thurber Engineering Ltd. foundation investigation report (Feb 2020) was utilized since their study utilized the installation of piezometers and is considered a more accurate representation of groundwater elevations.

5.0 CLOSURE

We trust this report meets the Terms of Reference for this assignment.

Sincerely,

AINLEY GRAHAM & ASSOCIATES LIMITED



Bill McLatchie, P.Eng.
Sr. Geotechnical Engineer



Lois-Ann L. Hayes, P.Eng.
MTO Designated Principal Contact



PART B

Foundation Design Report

Grafton Patrol Yard

Geocres No.: 31C-306

PART B – FOUNDATION DESIGN REPORT

6.0 DISCUSSION AND RECOMMENDATIONS

This section provides foundation design recommendations for the design-build assignment for the proposed construction of a new maintenance building at the Grafton Patrol Yard. The recommendations are based on interpretation of the factual data obtained from the borehole investigation program and the Thurber Engineering Ltd. Investigation report.

6.1 Foundations

Based on the subsoil and groundwater conditions encountered at the test locations and considering them to be generally representative of the subsoil and groundwater conditions across the site, the following recommendations and comments are offered to advance the detail design of the maintenance garage and cold storage buildings. It is noted, the Thurber Engineering Ltd report was utilized to develop recommendations with respect to the cold storage building.

The results of the investigation program revealed that there is one predominate founding layer across the site suitable for the placement of the proposed foundations; namely the compact to dense sand with silt encountered in all foundation boreholes at depths (elevations) ranging from 2.4 m to 3.6 m (164.85 to 162.62 m) below existing site grades.

Conventional strip and spread footings may be designed to bear directly on the compact to dense sand using the bearing capacity values of 75 KPa (SLS) or 125 KPa (ULS) with a geotechnical resistance factor of 0.5 (National Building Code of Canada). A consequence factor of 1 was utilized.

Alternatively, foundations may be placed on properly constructed engineered fill built up from the approved founding surface. Engineered fill as proposed by Fidelity Engineering and Construction for this project is considered acceptable (meeting OPSS 1010 requirements for Granular B, Type I) and should be compacted to 100% Standard Proctor Maximum Dry Density (SPMDD). See **Appendix D** for grain size distribution of material to be supplied by Fidelity. The engineered fill material should be placed in maximum 300 mm lifts and topped with a minimum 200 mm layer of OPSS 1010 Granular A over a 600 mm layer of OPSS 1010 Granular B, Type II compacted to 100% SPMDD.

A quality control technician should monitor the placement of the engineered fill material and the compaction densities for each lift to ensure that proper compaction efforts have been achieved. Foundations placed on properly constructed engineered fill built up from the approved compact to dense sand with varying amounts of silt surface may be designed using the bearing capacity

values of 75 kPa (SLS) or 125 kPa (ULS) with a geotechnical resistance factor of 0.5. A consequence factor of 1 was utilized.

The bearing capacities noted are valid provided the footings are placed on undisturbed soils, free of frost, topsoil and organic materials. Total and differential settlements for foundations placed on the approved native soil or engineered fill under SLS pressure conditions should not exceed 25 mm and 19 mm respectively.

The geotechnical resistance values provided above are for loads applied perpendicular to the surface of the footings. Where applicable, the structural designer should take into account any inclination of the load in accordance with the OBC. The geotechnical resistance values have been established for spread footing widths of 1.0 m to 3.0 m and strip footings ranging in width between 0.45 m and 2.0 m. The geotechnical resistance analysis assumes a founding level for the engineered fill placement on native subsoil above elevation 162.5 m.

The unfactored horizontal resistance of spread footings may be calculated using an unfactored coefficient of friction between the cast-in-place concrete and Granular A as 0.55. A resistance factor of 0.8 against sliding should be utilized to obtain the resistance at ULS.

All exterior footings for unheated structures must be protected by a minimum of 1.5 m of earth cover or equivalent, and 1.2 m for heated structures in order to provide protection against detrimental frost action (per OPSD 3090.101). Alternatively, using insulation material placed over the concrete foundation wall and below the slab base course could also be considered.

As the existing patrol yard garage is to be removed in its entirety and the site regraded, for the purpose of estimating it may be assumed that the existing building foundation is at least 1.2 m below existing site grades. It should be noted however that this is based on frost protection only neither an intrusive investigation nor As-Constructed information were available for review to establish the existing foundation depth.

6.2 Slabs-on-Grade

Normal slab-on-grade construction can be carried out as follows:

- a) Remove all overburden fill materials and surficial topsoil to expose the underlying compact to dense sand with varying amounts of silt.
- b) Build up granular fill materials from the approved soil surface by placing approved engineered fill in lifts suitable with the compaction equipment used to achieve a minimum of 100% SPDMM.
- c) A minimum 600 mm thick layer of Granular 'B' Type II compacted to achieve a minimum of 100% SPMDD is recommended overlying the engineered fill.

-
- d) A capillary moisture barrier consisting of either 19 mm clear crushed stone or Granular 'A' is recommended at least 200 mm thick immediately underlying the slab. The 200 mm thick Granular 'A' is also recommended for fine grading purposes and to provide a uniform bearing surface for the concrete slab.

Under floor drains are not considered necessary due to the depth of engineered fill to be placed beneath the structure.

6.3 Groundwater Control/Subsurface Drainage

Based on the observations made during the field investigation and our knowledge of the local geologic conditions, groundwater infiltrations may be encountered within excavations, however it should be noted that groundwater levels will fluctuate seasonally and also during periods of drought and precipitation. Development areas within the site should be graded in the early stages of construction to provide for positive runoff of all surface water. The pumping of groundwater will be required during excavation of the overburden.

The contractor should review the groundwater levels at the time of construction to ensure suitable dewatering operations are in place to keep the groundwater level below the excavation during the construction period. Normal pumps should suffice but sand filters may be required to prevent clogging of the pumps. Dewatering should be in accordance with OPSS 517.

It is not anticipated a PTTW will be required as the volume of groundwater to be removed from the excavation is expected to be under the 50 m³ per day threshold. Groundwater taking analysis was performed by Ainley Group's environmental staff (Report: Site Information Summary and Groundwater Calculations Summary) and determined that the dewatering would be less than 25m³ per day.

6.4 Excavations

All excavations should be carried out in accordance with the provisions in the Occupational Health and Safety Act. At the time of the field investigations the sub-soil materials encountered across the site can be classified as follows:

- The fill materials encountered may be classified as Type 4 soil.
- The glacial till and sand with silt may be classified as Type 2 soil.

Excavations into the native soils are considered straightforward and conventional excavation techniques and equipment appropriate. Care to minimize disturbance to the founding soil subgrade surface should be taken by the contractor during construction.

Excavations for the new cold storage building foundations and placement of engineered fill will be completed to a maximum depth of 3.0 m or so. A separation of 4 m is proposed between the

two structures to allow for suitably sloped excavations in accordance with the OHS. Should temporary shoring be necessary, it should be designed in accordance with OPSS 539.

It is recommended that during construction of the new cold storage building, the existing building should be monitored on a daily basis for signs of ground movement. A pre and post structural inspection should be completed and documented.

To ensure a suitably stable slope around the stormwater management pond, it is recommended that all side slopes be no greater than 4H:1V. Ditching side slopes should not be greater than 3H:1V throughout.

No subgrade instability associated with construction staging or groundwater dewatering are anticipated during construction. No additional limitations with respect to construction staging is considered necessary.

6.5 Seismic Classification

Based upon the subsoil information obtained during the field program (very dense soil), assuming the depth to 30 m remains consistent and our local knowledge of the subsoil conditions in the region, the proposed development site may be graded as Site Classification 'C' with respect to Table 4.1.8.4.A of the Ontario Building Code.

Seismic hazard data was obtained from the NRCan database. The PGA for 2% chance of exceedance in 50 years is 0.110. Detailed seismic hazard values are included in **Appendix E**. Liquefaction is not considered an issue with the subsoils on the site.

6.6 Corrosion Potential and Cement Type

Based on chemical analysis completed by Thurber Engineering Ltd. In their investigation report, the native subsoil tested for sulphate gave an average percentage sulphate less than 0.02. The National Research Council of Canada (NRC) characterizes the potential of sulphate attack on buried concrete for sulphate percentages less than 0.10 as negligible. Therefore, a conventional GU or MS Portland cement may be used for construction of the concrete elements.

The pH values ranged from 7.7 to 7.8 indicating a durable condition against corrosion and the concrete will not be exposed to attack from acids.

The resistivity values of the soil samples ranged from 1640 Ohm-cm to 4590 ohm-cm. Resistivity values ranging between 3000 and 7500 Ohm-cm is considered slightly aggressive to reinforcement steel corrosion. Normal protection of the steel in the form of concrete air entrainment and adequate concrete cover will suffice.

6.7 Suitability of Material

The non-organic fill materials encountered across the site may be reused for grading operations outside the building envelope and foundation walls. A maximum particle size of 100 mm is recommended for backfill against the foundation walls. The subsoils are considered suitable for reuse as subgrade material below exterior paved areas for fill materials throughout the site to meet grading or in utility trenches.

It is cautioned that the silt content within the soil matrix makes it susceptible to strength loss when wet. It is recommended that moisture contents in these soils be closely monitored when it is to be used as select subgrade fill or as a founding soil during construction. Wet soils should not be placed as backfill, subgrade fill or utilized as a founding material under any circumstances.

6.8 Construction Considerations

6.8.1 Drainage

Control of surface water during construction will be necessary for construction of the new buildings to be carried out in dry conditions. Surface water during construction should be directed away from the excavation areas to prevent water ponding that could result in weakening of the foundation subgrade.

6.8.2 Erosion Control

To prevent potential for erosion of the foundations placed on engineered fill, the foundation walls should be backfilled as soon as possible after construction. Newly constructed earth ditches and slopes should be monitored and vegetative growth established as soon as weather permits. The use of rip rap at the outlet and inlet to the concrete weir should be considered to prevent scour and erosion of the weir structure.

6.9 Site Inspections

It is recommended that all foundation and subgrade materials be inspected by qualified geotechnical personnel prior to the placement of concrete for footings, in order to ensure that the materials and founding elevations are consistent with the recommendations of this report. It is also recommended that the placement and compaction of all fill soils be monitored and tested by qualified geotechnical personnel to ensure that the appropriate materials and compaction densities are achieved and placed in accordance with OPSS 501.

7.0 CLOSURE

The Limitations of Report attached, form an integral part of this report. We trust this report provides sufficient information for your present requirements in accordance with our agreement. We trust this report is to your satisfaction. Should you have any questions concerning the above, please feel free to contact our office.

Sincerely,

Sincerely,

AINLEY GRAHAM & ASSOCIATES LIMITED



Bill McLatchie, P.Eng.
Sr. Geotechnical Engineer



Lois-Ann L. Hayes, P.Eng.
MTO Designated Principal Contact



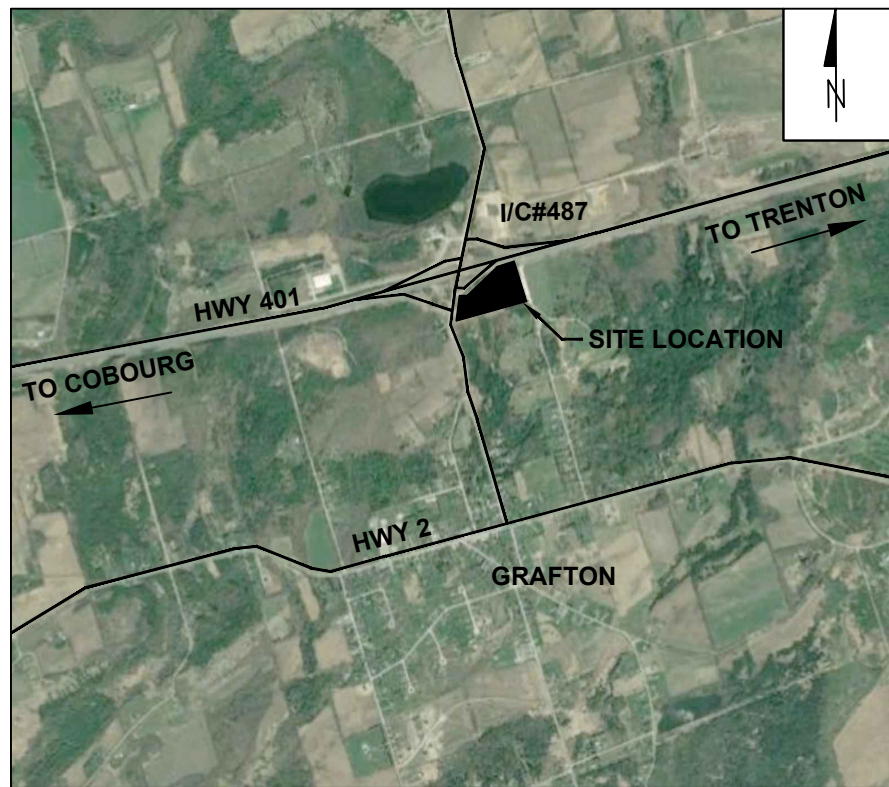
Limitations of Report

The conclusions and recommendations given in this report are based on information determined at the borehole locations. Subsurface and groundwater conditions between and beyond the test holes may differ from those encountered at the test locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the Soils Engineer be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in the boreholes.

The comments made in this report are intended only for the guidance of the designer. The number of test holes may not be sufficient to determine all factors that may affect construction methods and costs. The contractors bidding on this project or undertaking the construction should therefore make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work.

This report has been prepared for design purposes, for the sole use of Fidelity Engineering and Construction Inc. Any uses, which a Third Party makes of this report, or any reliance or decisions to be made based on it, are the responsibilities of said Third Parties. Ainley Group accepts no responsibility for damages if any, suffered by any Third Party as a result of decisions made or actions based on this report.

Figure No.1
Site Strata and Borehole Location Plan



KEY MAP
N.T.S.

BOREHOLE DATA							
ID	NORTHING	EASTING	LATITUDE	LONGITUDE	TOP OF GRADE ELEVATION (masl)	BEDROCK ELEVATION (masl)	ENCOUNTERED GROUNDWATER ELEVATION (masl)
	MTM ZONE 10						
BH1	4874736.101	423137.270	44.003081	-78.024369	167.05	NE	163.45
BH2	4874752.280	423179.113	44.003219	-78.023844	167.25	NE	163.57
BH3	4874714.905	423144.079	44.002890	-78.024289	166.69	NE	164.44
BH4	4874722.724	423180.799	44.002956	-78.023829	166.12	NE	163.72



LEGEND
 ⊕ = BOREHOLE LOCATION
 NE = FEATURE NOT ENCOUNTERED

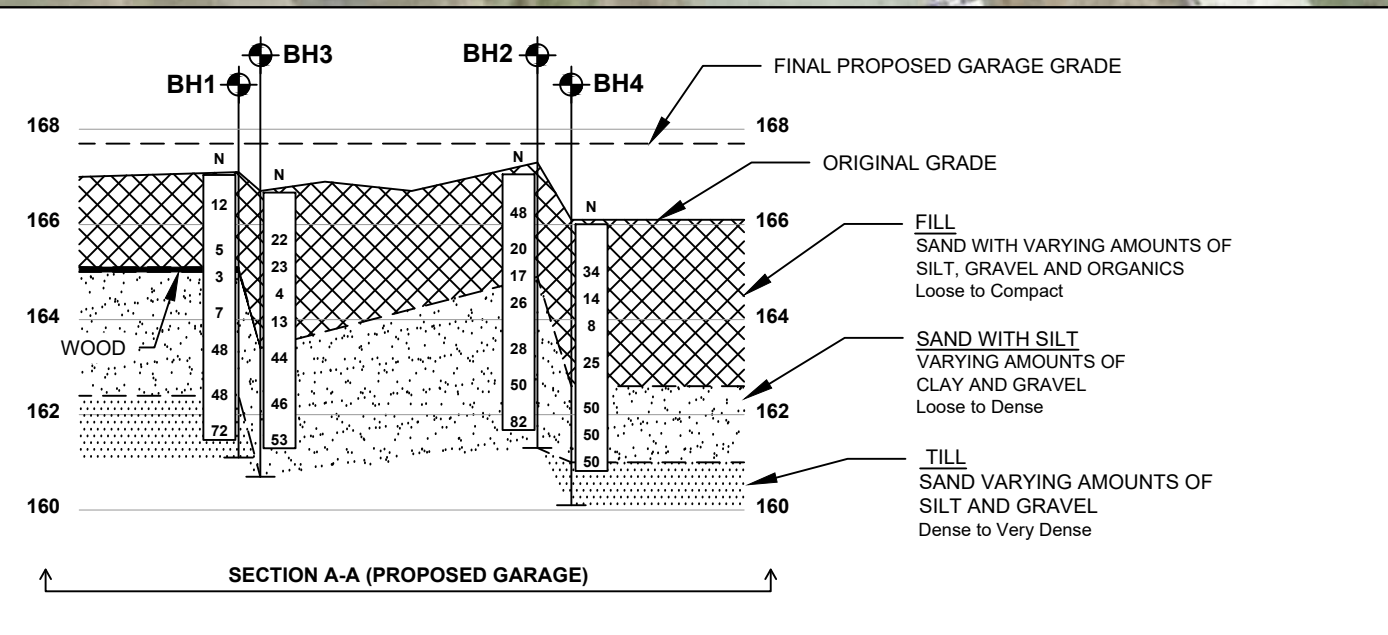
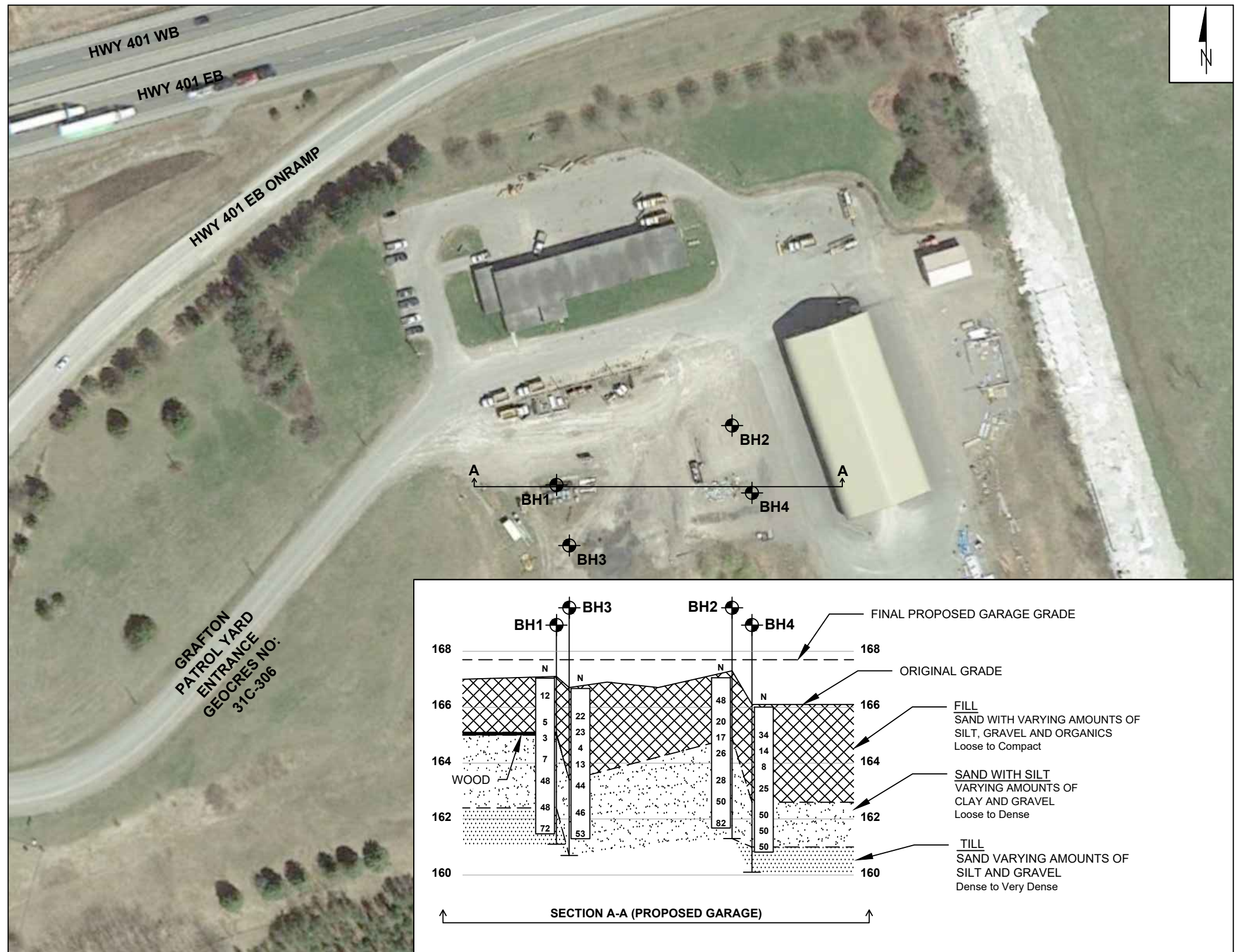


FIGURE NO. 1
 SITE STRATA AND BOREHOLE LOCATION PLAN
 GRAFTON PATROL YARD, GEOCRE NO. 31C-306

Appendix A
Borehole Logs

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. _____ LOCATION Geocres No: 31C-306 Grafton Patrol Yard, MTM z10: N4874736.101 E423137.27 ORIGINATED BY JRC
 DIST _____ HWY 401 BOREHOLE TYPE CME 55 Truck Mounted COMPILED BY JRC
 DATUM GEODETIC DATE 2020.12.11 - 2020.12.11 LATITUDE 44.003081 LONGITUDE -78.024369 CHECKED BY LAH

SOIL PROFILE		STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION		NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
167.1	Fill																
169.0	Sand with gravel, compact, brown, fill.																
0.1	Sand, some gravel, compact, brown, fill.																
166.5	Silty sand, some gravel, compact, brown, fill.																
0.6																	
165.9	Sand, trace of gravel loose, brown, fill.																
1.2																	
165.1	Coarse fibrous wood.																
168.0	Sand (SP-SM) with silt, trace of gravel, loose, brown.																
2.1																	
165.1			13	SS	12												
168.0			14	SS	5												
165.1			15	SS	3												
168.0			15	SS	7												
163.5	Sand (SP-SM) with silt, trace of clay, dense, moist, grey.		16	SS	48												
3.6			17	SS	48												
162.4	Till, sand (SP-SM), some silt, and gravel, dense becoming very dense, wet, grey.		17	SS	72												
4.7																	
161.1	End of Borehole at 6.0 m below existing site grades.																
6.0																	

ONTARIO MTO 20582-1 GRAFTON PATROL YARD.GPJ ONTARIO MTO.GDT 4/21/21

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. _____ LOCATION Geocres No: 31C-306 Grafton Patrol Yard, MTM z10: N4874752.28 E423179.113 ORIGINATED BY JRC
 DIST _____ HWY 401 BOREHOLE TYPE CME 55 Truck Mounted COMPILED BY JRC
 DATUM GEODETIC DATE 2020.12.11 - 2020.12.11 LATITUDE 44.003219 LONGITUDE -78.023844 CHECKED BY LAH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20
167.3	Fill																	
169.2	Sand with gravel, compact, brown, fill.																	
0.1	Sand, some gravel, compact, brown, fill.																	
166.7	Sand, some gravel and cobbles, dense, brown, fill.																	
0.6			18	SS	48													
165.5	Silty sand, trace of gravel and amorphous organics, loose, black, fill.																	
1.8			19	SS	20													
164.9	Sand (SP-SM) with silt, trace of gravel, compact, brown.																	
2.4			20	SS	17													
164.3	Sandy silt (ML), trace of clay, compact becoming very dense, moist becoming wet, grey.																	
3.0			20	SS	26													
164.3			21	SS	28													
164.3			21	SS	50													0 77 18 5
164.3			21	SS	82													
161.3	End of Borehole at 6.0 m below existing site grades.																	
6.0																		

ONTARIO MTO 20582-1 GRAFTON PATROL YARD.GPJ ONTARIO MTO.GDT 4/21/21

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. _____ LOCATION Geocres No: 31C-306 Grafton Patrol Yard, MTM z10: N4874714.905 E423144.079 ORIGINATED BY JRC
 DIST _____ HWY 401 BOREHOLE TYPE CME 55 Truck Mounted COMPILED BY JRC
 DATUM GEODETIC DATE 2020.12.11 - 2020.12.11 LATITUDE 44.00289 LONGITUDE -78.024289 CHECKED BY LAH

SOIL PROFILE		STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION		NUMBER	TYPE	"N" VALUES			20	40					
166.7	Fill													
160.0	Sand with gravel, compact, brown, fill.													
0.1	Sand with gravel, trace of cobbles, compact, brown, fill.													
165.5	Silty sand, trace of gravel, compact, grey, fill.													
1.2			27	SS	22									
164.3	Silty sand, trace of gravel and coarse fibrous organics, loose, black, fill.													
2.4			28	SS	23									8 57 (36)
163.4	Sand (SP-SM) with silt, trace of gravel, compact becoming dense, wet, brown.													
3.3			30	SS	13									
162.2	Sand (SP-SM) with silt, trace of clay, dense becoming very dense, wet, grey.													
4.5			32	SS	46									
160.7	End of Borehole at 6.0 m below existing site grades.													
6.0			33	SS	53									

ONTARIO MTO 20582-1 GRAFTON PATROL YARD.GPJ ONTARIO MTO.GDT 4/21/21

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. _____ LOCATION Geocres No: 31C-306 Grafton Patrol Yard, MTM z10: N4874722.724 E423180.799 ORIGINATED BY JRC
 DIST _____ HWY 401 BOREHOLE TYPE CME 55 Truck Mounted COMPILED BY JRC
 DATUM GEODETIC DATE 2020.12.11 - 2020.12.11 LATITUDE 44.002956 LONGITUDE -78.023829 CHECKED BY LAH

SOIL PROFILE		STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION		NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20
166.1 0.0	Fill Sand with gravel, compact, brown, fill.																	
165.7 0.4	Sand with gravel, trace of cobbles, compact, loose at times, brown, fill.		22	SS	34													
			22	SS	14													
164.0 2.1	Sand, loose becoming compact and wet, brown, fill.		23	SS	8													
			23	SS	25													
162.6 3.5	Sand (SP-SM) with silt, trace of clay, dense, wet, grey.		24	SS	50													
		25	SS	50														
161.0 5.1	Till, sand (SP-SM) with silt and gravel, dense, grey.	26	SS	50														
160.1 6.0	End of Borehole at 6.0 m below existing site grades.																	

ONTARIO MTO 20582-1 GRAFTON PATROL YARD.GPJ ONTARIO MTO.GDT 4/21/21

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

Appendix B
Soil Reports



SNC · LAVALIN

Lab # 20506 Client: Ainley

Project Name:205826-1 Grafton Patrol Yard Date: December 11,2020

SAMPLE INFORMATION	SAMPLE	MASS OF SAMPLE WET & TARE (g)	MASS OF SAMPLE DRY & TARE (g)	MASS OF WATER (g)	MASS OF DRY SOIL (g)	MASS OF TARE (g)	MOISTURE CONTENT (%)
JC015	A	407.1	374.5	32.6	247.9	126.6	13.2
JC016	B	533	477.1	55.9	340.5	136.6	16.4
JC004	C	677.3	602.7	74.6	522.7	80	14.3
JC001	D	581.6	535.4	46.2	460	75.4	10.0
JC028	E	606.4	572	34.4	438.8	133.2	7.8
JC010	F	768.3	743.6	24.7	665.3	78.3	3.7
JC021	G	682.8	596.3	86.5	457.3	139	18.9
JC006	H	667	656.8	10.2	579.2	77.6	1.8



Grain Size Analysis Test Report

Project No.: 20-1690-01 Project Description: Lab Testing

Date: Dec 17, 2020

Project Location:

Contract No.:

SAMPLE DATA

Material: Subsoil
 Date Sampled: Dec 11, 2020
 Time Sampled:
 Sample Type: Borehole
 Sample Location: JC015 BH#1 2.25-3.60M 20582-1 Grafton Patrol Yard
 Lot: Sublot:
 Source: Ainley
 Sampled By: Client

Grain Size Analysis		
Sieve Sizes (mm)	Percent Passing	
	Sample	Specification
150.0		
100.0		
75.0		
53.0		
50.0		
37.5		
26.5		
25.0		
19.0		
16.0		
13.2		
9.5		
6.7	100	
4.75	98.9	
2.36	98.3	
2.00		
1.18	97.6	
0.600	96.6	
0.425		
0.300	92.8	
0.150	67.4	
0.075	28.8	

LAB DATA

Lab No.: 20506-A Date Tested: Dec 17, 2020

Specification:

PARTICLE ANALYSIS

TEST	Sample	Specification
Percent Crushed:		
% Asphalt Coated:		
% Flat and Elongated		

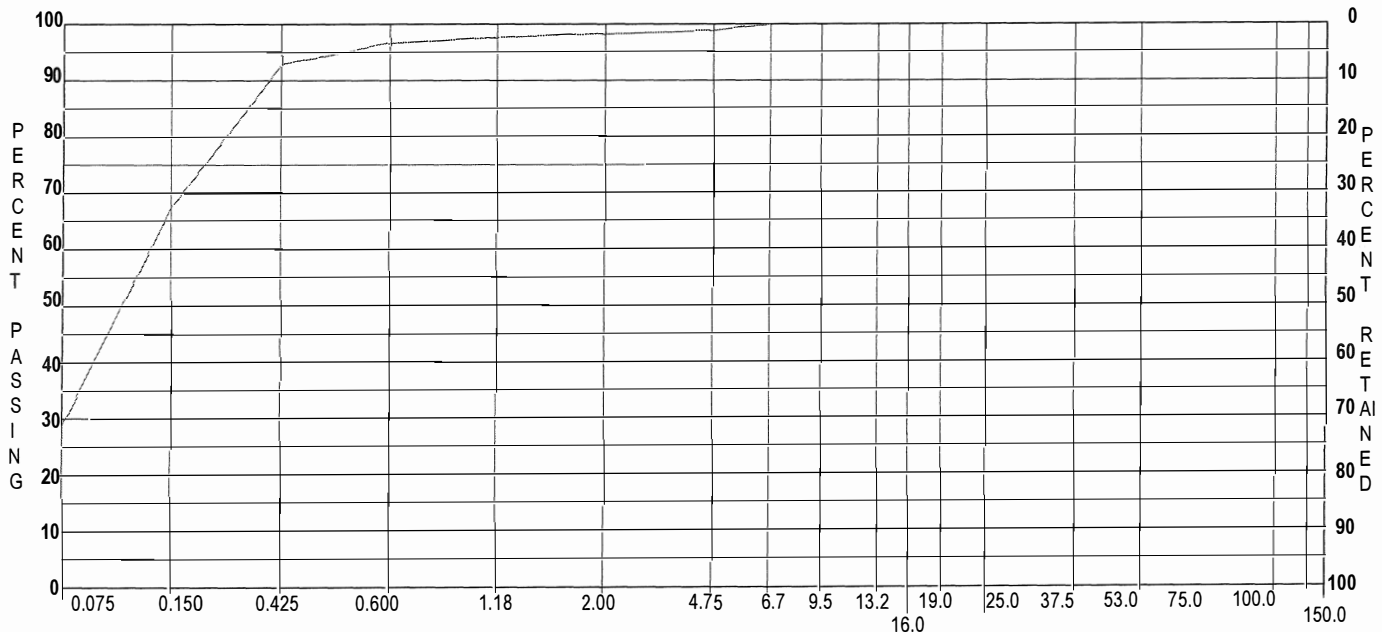
WASH PASS 0.075mm

TEST	Sample	Specs
Wash Pass 0.075 mm:		
FINENESS MODULUS	0.47	

Comments: Moisture Content is 13.2%

* Indicates Out of Specification

Sample: _____ Specs: _____



Data presented hereon is for the sole use of the stipulated client. SNCL is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of SNCL. The testing services reported herein have been performed by a SNCL technician to recognized industry standards, unless otherwise noted. No other warranty is made. This data does not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, SNCL will provide it upon written request.

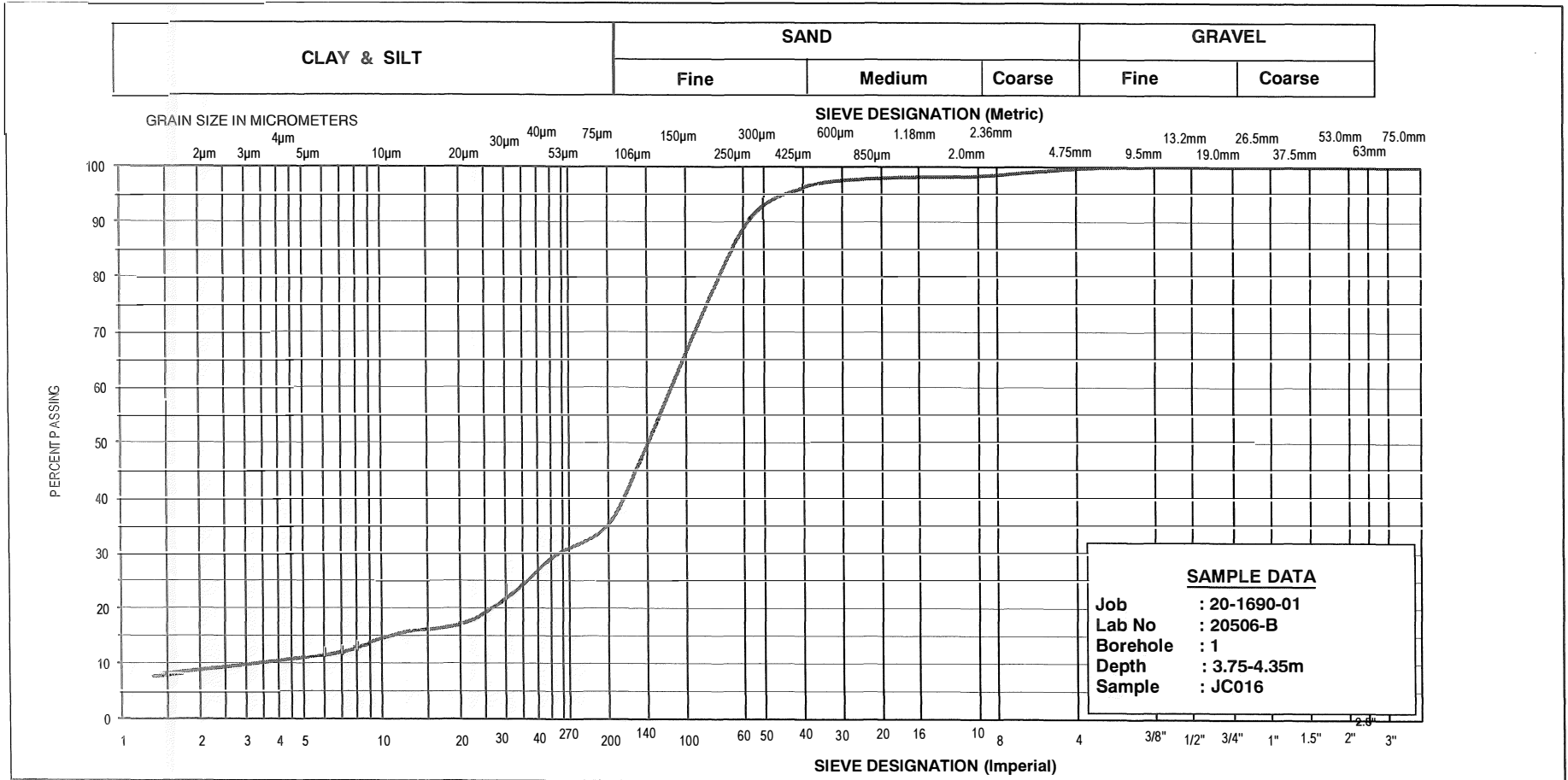
Project Manager: Mark McClelland, C.E.T.





SNC-LAVALIN

UNIFIED SOIL CLASSIFICATION SYSTEM



% +3"	% Gravel		% Sand			% Fines	
	Course	Fine	Coarse	Medium	Fine	Silt	Clay
	0	0	1	2	61	26	9

SNC-LAVALIN 1164 Clyde Court Kingston, Ontario K7P 2E4	GRAIN SIZE DISTRIBUTION	Client: Ainley	
	SAND	Project: 20-1690-01	
	With Silt, Trace Clay	20582-1 Grafton Patrol Yard	
		Date: December 12, 2020	Moisture Content is 16.4



Grain Size Analysis Test Report

Project No.: 20-1690-01 Project Description: Lab Testing

Date: Dec 17, 2020

Project Location:

Contract No.:

SAMPLE DATA

Material: Subsoil
Date Sampled: Dec 11, 2020
Time Sampled:
Sample Type: Borehole
Sample Location: JC028 BH#3 1.5-2.1M 20582-1 Grafton Patrol Yard
Lot: Sublot:
Source: Ainley
Sampled By: Client

Grain Size Analysis

Table with columns: Sieve Sizes (mm), Percent Passing (Sample, Specification). Rows include sieve sizes from 150.0 to 0.075 mm and corresponding percent passing values.

LAB DATA

Lab No.: 20506-E Date Tested: Dec 17, 2020

Specification:

PARTICLE ANALYSIS

Table with columns: TEST, Sample, Specification. Rows include Percent Crushed, % Asphalt Coated, % Flat and Elongated.

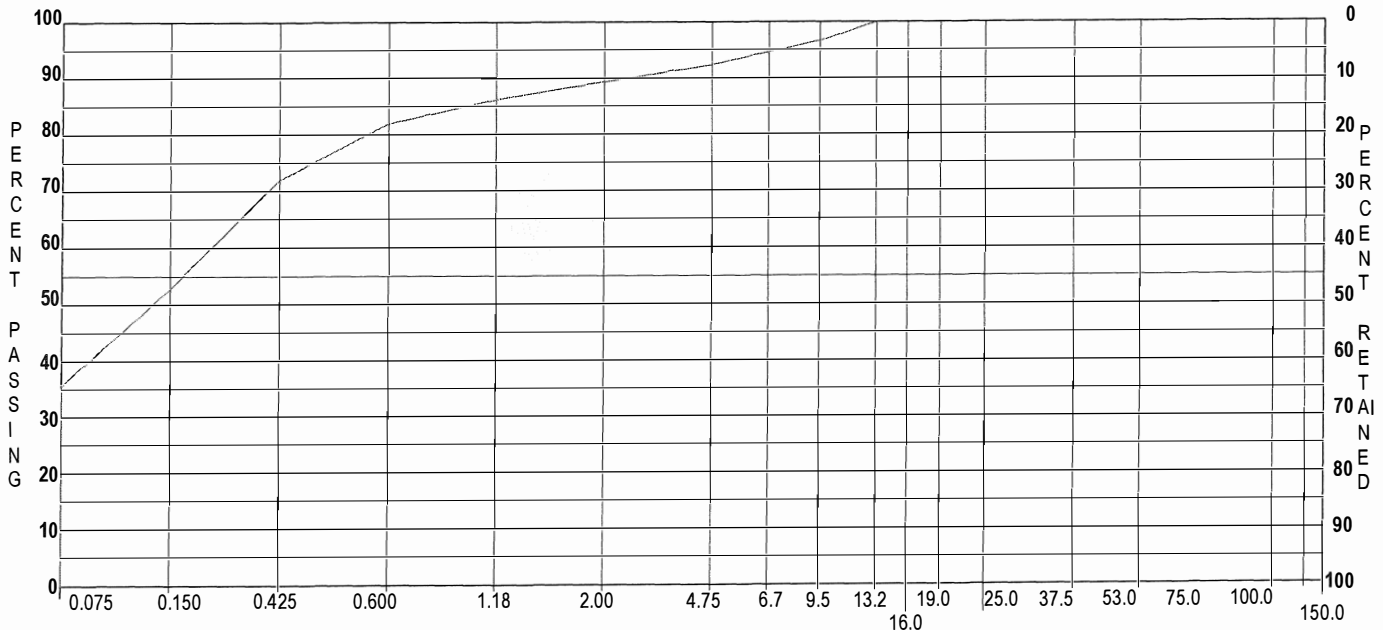
WASH PASS 0.075mm

Table with columns: TEST, Sample, Specs. Rows include Wash Pass 0.075 mm, FINENESS MODULUS (1.18).

Comments: Moisture Content is 7.8%

* Indicates Out of Specification

Sample: Specs:



Data presented hereon is for the sole use of the stipulated client. SNCL is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of SNCL.

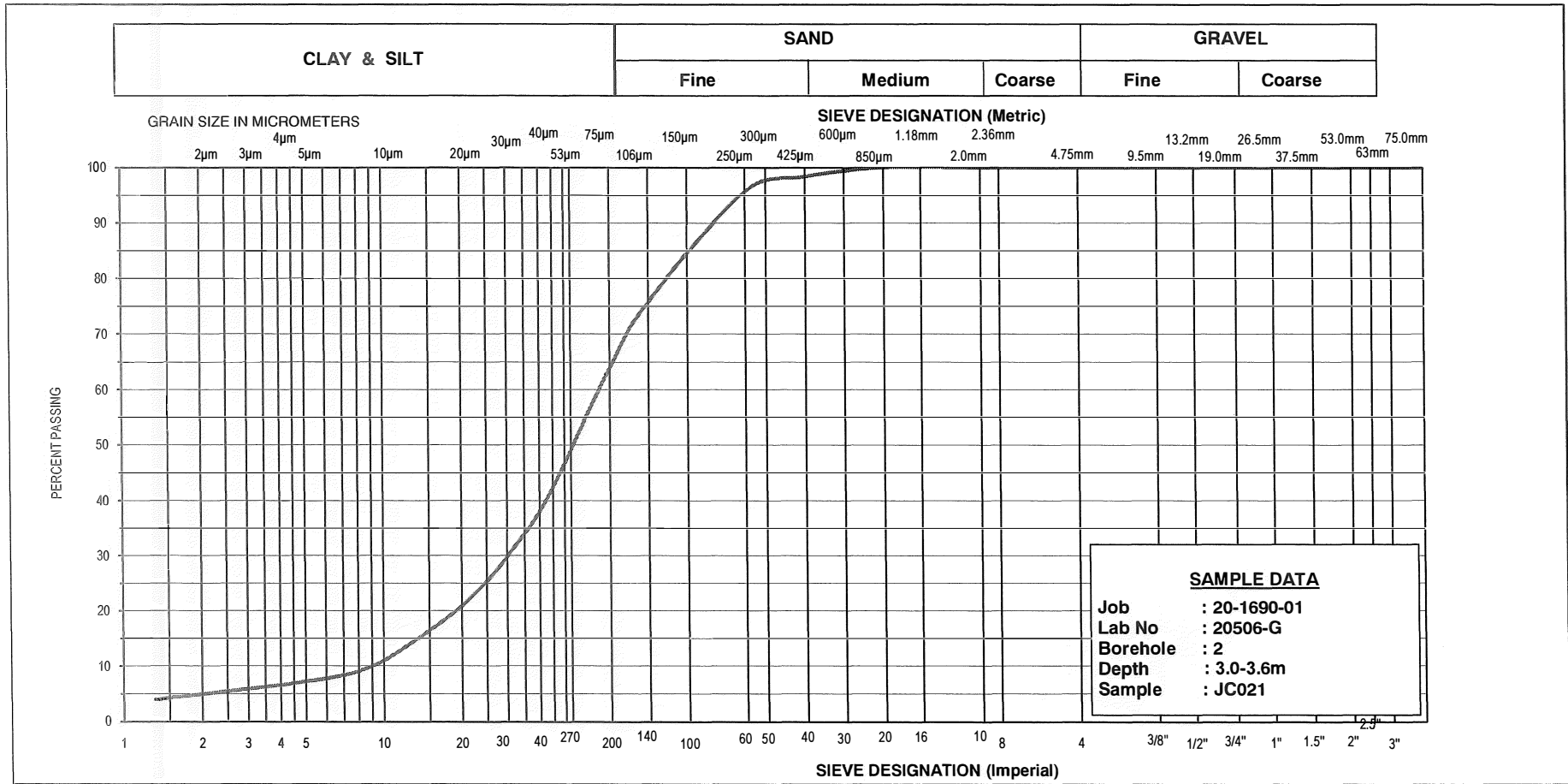
Project Manager: Mark McClelland, C.E.T.





SNC-LAVALIN

UNIFIED SOIL CLASSIFICATION SYSTEM



SAMPLE DATA	
Job	: 20-1690-01
Lab No	: 20506-G
Borehole	: 2
Depth	: 3.0-3.6m
Sample	: JC021

% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
	0	0	0	2	35	59	5

SNC-LAVALIN 1164 Clyde Court Kingston, Ontario K7P 2E4	GRAIN SIZE DISTRIBUTION	Client: Ainley	
	SANDY SILT	Project: 20-1690-01	
	Trace Clay	20582-1 Grafton Patrol Yard	
		Date: December 12, 2020	Moisture Content is 18.9%

Appendix C
Thurber Foundation Investigation Report



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION REPORT
MTO PATROL YARD IN GRAFTON, ONTARIO
AGREEMENT NO. 4017-E-0021, ASSIGNMENT NO. 6**

Geocres No.: 31C-287

Report to:

McIntosh Perry Consulting Engineers

Latitude: 44.003101°
Longitude: -78.024064°

February 2020
Thurber File No.: 25964



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2	SITE DESCRIPTION	1
3	SITE INVESTIGATION AND FIELD TESTING.....	2
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APPENDICES

Appendix A.	Borehole Location Plan and Stratigraphic Drawings
Appendix B.	Field Investigation and Testing
Appendix C.	Laboratory Testing
Appendix D.	Site Photographs



**FOUNDATION INVESTIGATION REPORT
MTO PATROL YARD IN GRAFTON, ONTARIO
AGREEMENT NO. 4017-E-0021, ASSIGNMENT NO. 6**

Geocres No.: 31C-287

PART 1. FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual data obtained from a foundation investigation conducted by Thurber Engineering Ltd. (Thurber) for the MTO Patrol Yard located south east of the Lyle Street / County Road 23 / Highway 401 Interchange in Grafton, Ontario. Thurber carried out the investigation as a subconsultant to McIntosh Perry Consulting Engineers (MPCE), under MTO Retainer Agreement Number 4017-E-0021, Assignment #06.

A preliminary general arrangement (GA) drawing and base plan mapping were provided by MPCE for the preparation of this report.

The purpose of this investigation was to explore the subsurface conditions at the site and, based on this data, provide a borehole location plan, record of boreholes, a stratigraphic profile, laboratory test results and a written description of the subsurface conditions.

2 SITE DESCRIPTION

The existing Grafton Patrol Yard configuration consists of a garage, salt shed and storage building. Paved access roads and parking areas are present as are grassed landscape areas and gravel surfaced outside storage areas. The land adjacent to the site is relatively flat and typically consists of forests and agricultural fields. The site is bordered to the north by Highway 401 and by Lyle Street / County Road 23 to the west. Drainage is generally overland leading to ditches on the north and east sides of this relatively flat site.

Based on published geological information in *The Physiography of Southern Ontario* by Chapman and Putnam (1984), the site lies within the physiographic region known as the Iroquois Plain. The Iroquois Plain is characterized primarily by a band of beach deposits formed at the shoreline of an ancestral lake and a lacustrine plain extending to Lake Ontario that represent lake bottom deposits smoothed by wave action.

Photographs showing the existing conditions at the time of the field investigation are included in Appendix D for reference.



3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field-testing program was carried out between December 10th and 13th, 2019. The field investigation consisted of advancing eight boreholes identified as Boreholes 19-1 through 19-8. Prior to commencement of drilling, utility clearances were obtained in the vicinity of the borehole locations.

The northing, easting and elevation of the boreholes are shown on the Borehole Location and Soil Strata Drawing No. 1 in Appendix A, the individual Record of Borehole sheets in Appendix B, and in Table 3-1 below. The site is located within MTM Zone 10.

Table 3-1: Borehole Summary

Borehole No.	Drilled Location	Northing (Latitude)	Easting (Longitude)	Ground Surface Elevation (m)	Termination Depth (m)
19-1	Proposed Garage	4 874 728.8 (44.003018)	423 126.5 (-78.024505)	166.9	9.4
19-2	Proposed Garage	4 874 699.5 (44.002752)	423 136.7 (-78.024384)	166.4	13.2
19-3	Proposed Garage	4 874 725.5 (44.002983)	423 159.7 (-78.024092)	166.8	10.9
19-4	Proposed Garage	4 874 750.8 (44.003206)	423 183.0 (-78.023795)	167.3	10.7
19-5	Proposed Garage	4 874 719.9 (44.002927)	423 194.7 (-78.023656)	166.3	8.2
19-6	Proposed Garage	4 874 740.0 (44.003106)	423 203.2 (-78.023546)	167.3	11.2
19-7	Proposed Cold Storage	4 874 774.2 (44.003406)	423 249.6 (-78.02296)	167.3	8.0
19-8	Proposed Cold Storage	4 874 786.9 (44.003519)	423 259.6 (-78.022832)	167.6	9.3

The investigation was carried out using a truck-mounted CME 75 drill rig equipped with hollow-stem augers.

The subsurface stratigraphy encountered in the boreholes was recorded in the field by Thurber personnel. Split spoon samples were collected at regular depth intervals in the boreholes during the completion of Standard Penetration Tests (SPT) following the methods described in ASTM Standard D1586-11. All soil samples recovered from the boreholes were placed in moisture-proof



containers and the samples were transported to Thurber's Ottawa geotechnical laboratory for further examination and testing.

A 50 mm diameter monitoring well was installed in Borehole 19-2 on completion of drilling to allow for pump testing and measurements of the groundwater level. The well installation details are illustrated on the Record of Borehole sheets for Borehole 19-2 provided in Appendix B. The well was decommissioned in accordance with Ontario MOE Regulation 903 on December 13th, 2019.

The boreholes without well installations were backfilled with a low-permeability combination of auger cuttings and bentonite pellets in accordance with Ontario MOE Regulation 903.

The as-drilled locations of the boreholes and ground surface elevations at the borehole locations were surveyed by Thurber on December 13th, 2019 using a Trimble Catalyst DA1 antenna with centimeter accuracy. The benchmarks used were site benchmarks provided by MPCE labeled 300 and 301 with geodetic elevations of 167.848 m and 168.024 m, respectively.

4 LABORATORY TESTING

Geotechnical laboratory testing consisted of natural moisture content determination and visual identification of all soil samples in accordance with the current MTO standards. Grain size distribution analyses, Atterberg Limits testing and organic content testing were carried out on selected samples to MTO and ASTM standards.

The results of the geotechnical tests are summarized on the Record of Borehole sheets included in Appendix B and all laboratory results are presented on the figures included in Appendix C.

Chemical analysis for determination of pH, resistivity, conductivity, soluble sulphate, sulfide and chloride concentrations was carried out on three soil samples. A copy of the chemical analysis results is provided in Appendix C.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

5.1 Overview / General

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendix B. Stratigraphic profiles for the site are presented on the drawing in Appendix A for illustrative purposes. An overall description of the stratigraphy is given in the following paragraphs; however, the factual data presented in the Record of Boreholes governs any interpretation of the site conditions. It must be recognized that the soil and groundwater conditions may vary between and beyond borehole locations. Soil classification is in accordance with ASTM D2487.

For reference, the stratigraphy encountered in the boreholes at this site is characterized by fill, overlying a native sand to silt deposit over glacial till. Bedrock was not confirmed during the course of this investigation.



More detailed descriptions of the individual strata are presented below.

5.2 Fill

A fill layer ranging in composition from silty sand with gravel to gravel with silt and sand was encountered from surface in all boreholes. Trace to some organics was observed in the fill from a depth of 0.8 to 3.0 m in Borehole 19-1. The fill extended to depths ranging from 1.5 m to 3.0 m (Elevation 163.3 m to 166.1 m) below ground surface.

SPT tests conducted in this layer gave N-values ranging from 3 to greater than 100 blows, indicating a very loose to very dense relative density.

The moisture content of the fill samples tested ranged from 3 to 35%. An organic content test performed on a sample of fill material from Borehole 19-1 indicated an organic content of 13.7%. The results of grain size analysis tests conducted on seven samples of the fill material are summarized below in Table 5-1 and are illustrated on Figures C1 and C2 in Appendix C.

Table 5-1: Summary of Grain Size Distribution Testing – Fill

Soil Particle	Percentage (%)
Gravel	1 – 46
Sand	46 – 82
Silt & Clay	6 – 22

5.3 Silty Sand to Sand (SP-SM)

A native deposit ranging in composition from silty sand to sand with silt some gravel, trace organics was encountered below the fill in Boreholes 19-1, 19-2, 19-5 and 19-6. This layer ranged in thickness from 0.9 m to 3.8 m with an underside depth ranging from 3.0 to 6.1 m below ground surface (base elevation 160.2 m to 163.4 m).

SPT tests conducted within this layer gave N-values ranging from 3 to greater than 100 blows, indicating a very loose to very dense relative density; but typically, compact to dense.

The moisture content of the samples tested ranged from 8 to 19%. An organic content test performed on a sample near the surface of this deposit in Borehole 19-6 indicated an organic content of 1.3%. The results of three grain size analysis tests conducted on samples of this material are summarized below in Table 5-2 and are illustrated on Figure C3 in Appendix C.



Table 5-2: Summary of Grain Size Distribution Testing – Silty Sand to Sand

Soil Particle	Percentage (%)	
Gravel	10 – 18	
Sand	46 – 80	
Silt	33	10 – 42
Clay	9	

Atterberg Limits testing was completed on the fines fraction (minus the gravel and coarse sand fraction) of one sample of this deposit. The sample was found to be non-plastic.

5.4 Sandy Silt to Silt (ML)

A native deposit ranging in composition from sandy silt to silt some sand was encountered below the silty sand layer in Borehole 19-2 and beneath the fill material in Boreholes 19-3, 19-4, 19-7 and 19-8. This layer ranged in thickness from 1.5 m to 4.6 m with an underside depth ranging from 3.0 m to 7.6 m below ground surface (base elevation ranging from 159.2 m to 164.6 m).

SPT tests conducted within this layer gave N-values ranging from 8 to 99 blows indicating a loose to very dense state; but typically, compact to dense.

The moisture content of the samples tested ranged from 8 to 24%. The results of four gradation tests on samples of this material are summarized below in Table 5-3 and are illustrated on Figure C4 in Appendix C.

Table 5-3: Summary of Grain Size Distribution Testing – Sandy Silt to Silt

Soil Particle	Percentage (%)	
Gravel	0 – 3	
Sand	10 – 46	
Silt	57 – 85	51 – 90
Clay	4 – 7	

Atterberg Limits testing on three samples of the sandy silt to silt indicated the samples to be non-plastic.

5.5 Glacial Till

A glacial till deposit consisting of a heterogeneous mixture of gravel, sand, silt and clay was encountered beneath the native silty sand to sand in Boreholes 19-1, 19-5 and 19-6 and below the native sandy silt to silt deposit in all other boreholes. The till is generally classified as silty



sand with to some gravel. It is noted that, although not observed in the boreholes, glacial till typically contains cobbles and boulders.

Sampling in all of the boreholes was terminated within this deposit at depths ranging from 8.0 to 11.3 m (Elevation 155.1 m to 159.3 m). Borehole 19-2 was continued with a dynamic cone penetration test to a refusal depth of 13.2 m (elevation 153.2 m). The SPT 'N' values ranged from 14 to greater than 100 indicating a compact to very dense condition; but typically, dense. The higher blow counts could also be due to the presence of cobbles or a boulder within the deposit rather than the relative density of the soil matrix.

The moisture content of the glacial till ranged from 6 to 15%. The results of grain size distribution testing carried out on nine samples of the glacial till are summarized in Table 5-4 below and are illustrated on Figures C5 and C6 in Appendix C.

Table 5-4: Summary of Grain Size Distribution Testing – Glacial Till

Soil Particle	Percentage (%)	
Gravel	11 – 24	
Sand	40 – 66	
Silt	27 – 33	17 – 33
Clay	5 – 12	

Atterberg Limits testing was completed on the fines fraction (minus the gravel and coarse sand fraction) of seven samples of the glacial till. Six of the fines portion samples were found to be non-plastic; the remaining sample had a liquid limit of 11, a plastic limit of 10 and a plasticity index of 1, indicating a silt of low plasticity (ML). The results of this Atterberg Limits analysis are illustrated on Figure C7 in Appendix C.

5.6 Groundwater

The groundwater level was measured in the monitoring well installed in Borehole 19-2. The measurements are presented on the Record Borehole sheets in Appendix B and in Table 5-5 below:

Table 5-5: Summary of Groundwater Levels

Borehole No.	Bottom of Screen Elevation (m)	Depth (mbgs)	Groundwater Elevation (m)	Date of Measurement
19-2	158.8	4.1	162.3	2019.12.10
		3.4	163.0	2019.12.11
		3.4	163.0	2019.12.12
		3.4	163.0	2019.12.13



These observations are considered short term and it should be noted that the groundwater level at the time of construction may be different and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after periods of significant and/or prolonged precipitation.

A pump test was performed within the monitoring well installed in Borehole 19-2; this test indicates an estimated hydraulic conductivity using Hvorslev of 1.9×10^{-6} m/s at the well screen level.

5.7 Analytical Testing

Three samples of the native soils were submitted to Paracel Laboratories in Ottawa, Ontario for analysis of pH, water soluble sulphate, sulphide and chloride concentrations, resistivity and conductivity. The analysis results are summarized in Table 5-6. Copies of the test results are provided in Appendix C.

Table 5-6: Results of Chemical Analysis

Borehole	19-2	19-4	19-7
Sample	SS5	SS4	SS4
Depth (m)	3.0 – 3.6	2.3 – 2.9	2.3 – 2.9
Chloride ($\mu\text{g/g}$)	222	257	82
Sulphate ($\mu\text{g/g}$)	15	12	8
Sulphide (%)	< 0.02	< 0.02	< 0.02
pH (-)	7.7	7.8	7.8
Resistivity (Ohm-cm)	2,330	1,640	4,590
Conductivity ($\mu\text{S/cm}$)	429	611	218



6 MISCELLANEOUS

Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to drilling. The as-drilled locations and ground surface elevation were measured by Thurber following completion of the field program.

Downing Drilling of Hawkesbury, Ontario supplied and operated the drilling equipment and carried out the drilling, soil sampling, in-situ testing, well installation and borehole decommissioning. The field investigation was supervised on a full-time basis by Mr. Jamil Pirani of Thurber. Overall supervision of the investigation program was provided by Mr. Christopher Murray, P.Eng.

Routine geotechnical laboratory testing was completed by Thurber's laboratory in Ottawa, Ontario. Analytical testing was completed by Paracel Laboratories in Ottawa, Ontario. Organic content testing was carried out by Stantec Consulting Ltd. in its MTO-approved laboratory in Ottawa.

Overall project management was provided by Mr. Stephen Peters, P.Eng. Interpretation of the factual data and preparation of this report were carried out by Mr. Christopher Murray, P.Eng.. The report was reviewed by Dr. Fred Griffiths, P.Eng., a Designated Principal Contact for MTO Foundations Projects.



Christopher Murray, M.A.Sc., P.Eng.
Geotechnical Engineer

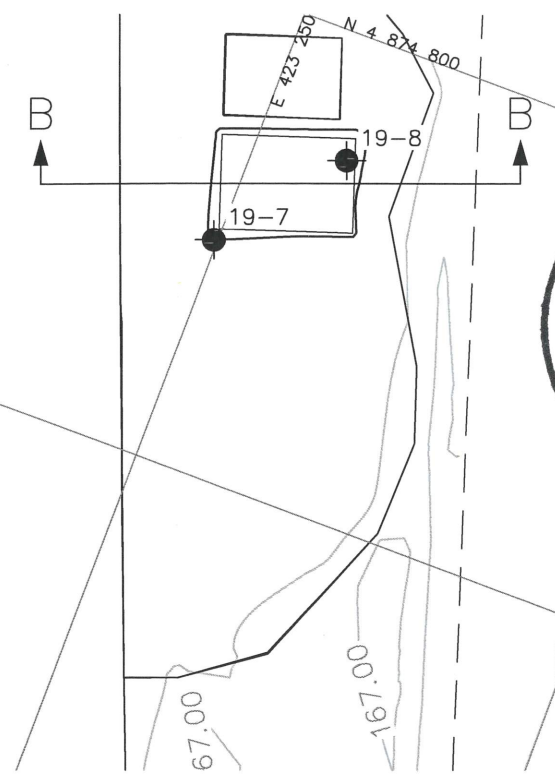
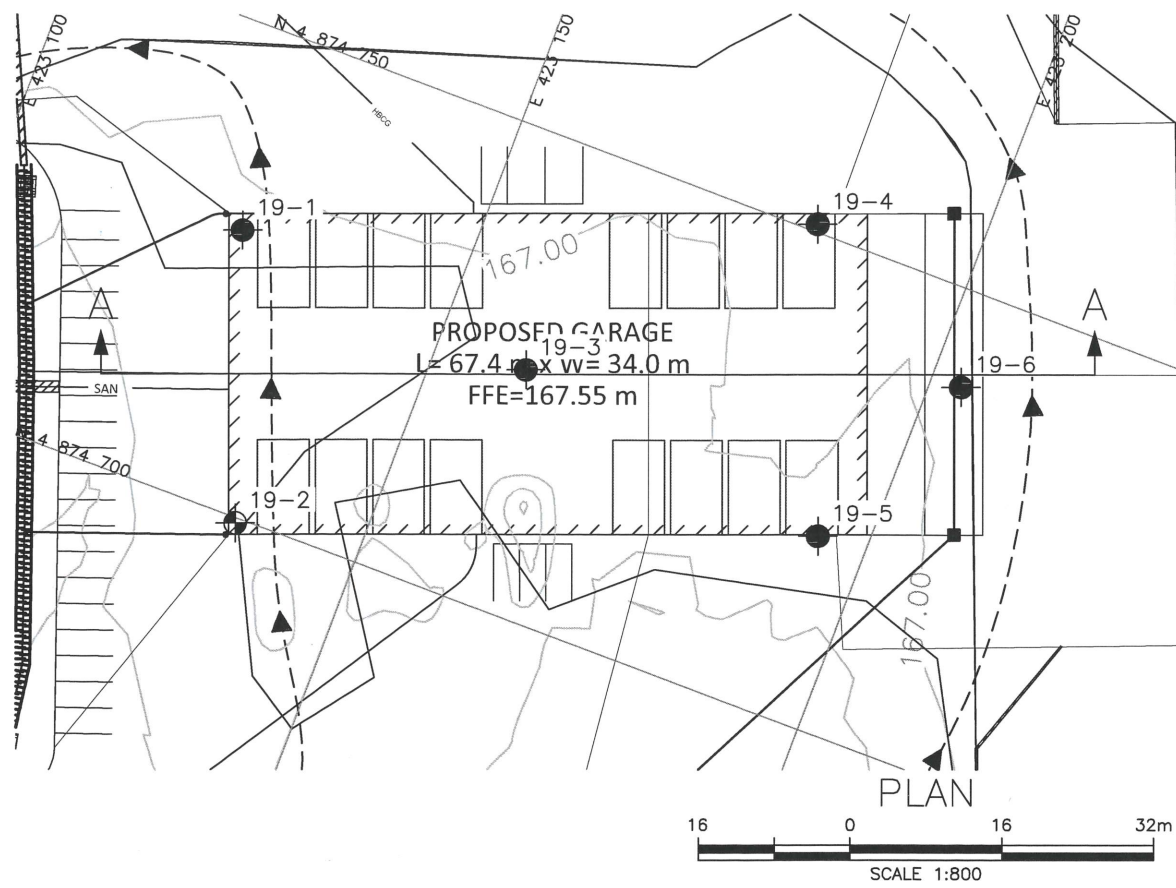


Dr. Fred Griffiths, P.Eng.
MTO Review Principal,
Senior Geotechnical Engineer



Appendix A.

Borehole Location Plan and Stratigraphic Drawings



METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
C. A. Murray
C. A. MURRAY
100206832
Feb 21/2020
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
F. J. Griffiths
F. J. GRIFFITHS
90360280
Feb 21/20
PROVINCE OF ONTARIO

CONT No
WP No

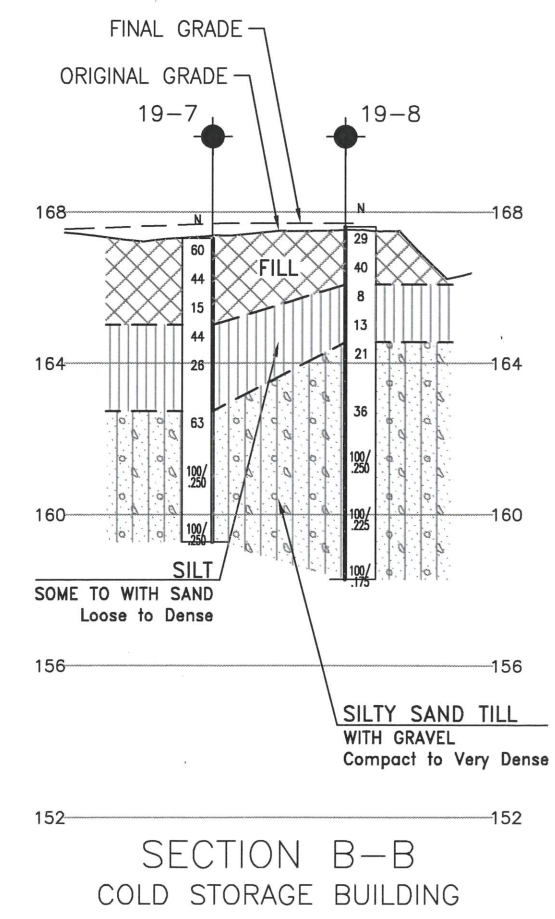
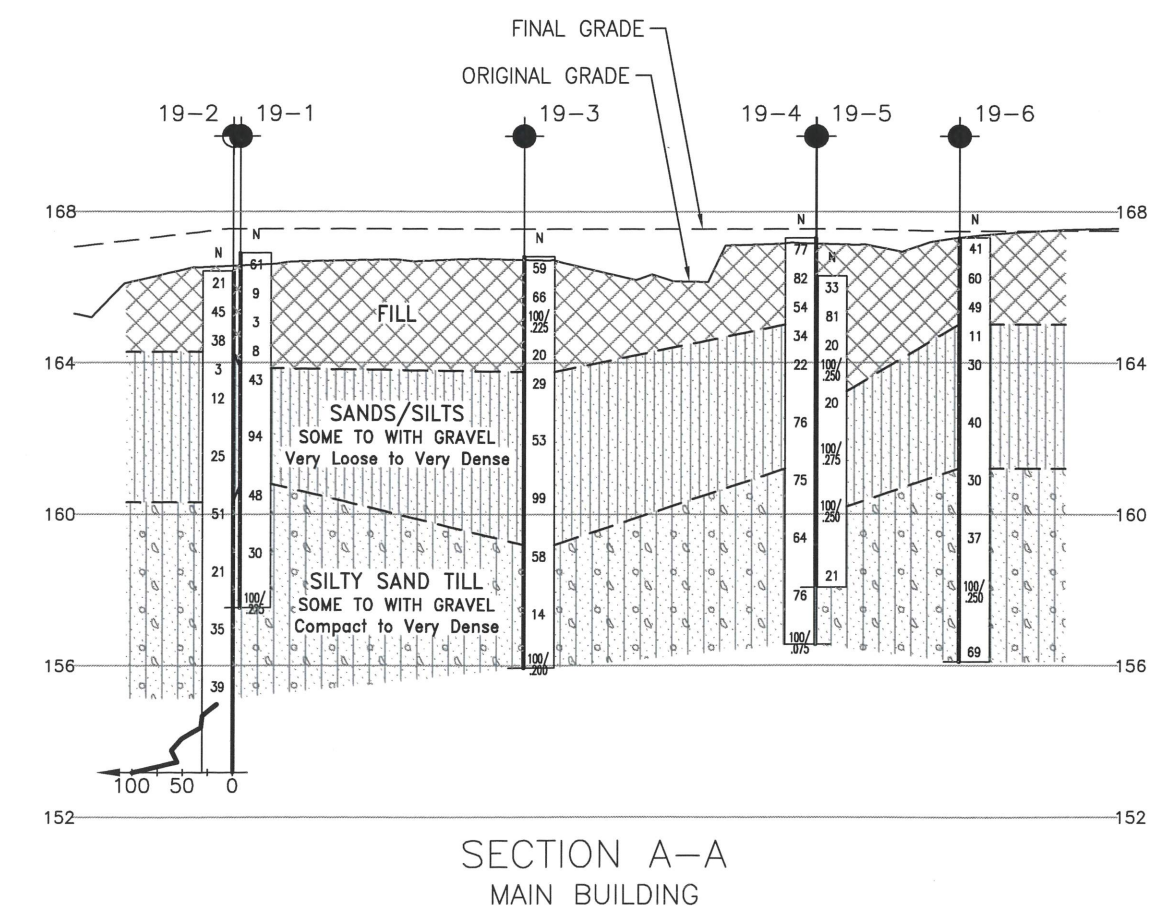
HIGHWAY 401
GRAFTON PATROL YARD

BOREHOLE LOCATIONS AND SOIL STRATA

THURBER ENGINEERING LTD.

KEYPLAN

© 2020 Microsoft Corporation © 2019 HERE bing



LEGEND

- ◆ Borehole
- ◆ Borehole and Cone
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- ▽ Water Level
- ▽ Head Artesian Water
- ⊥ Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
19-1	166.9	4 874 728.8	423 126.5
19-2	166.4	4 874 699.5	423 136.7
19-3	166.8	4 874 725.5	423 159.7
19-4	167.3	4 874 750.8	423 183.0
19-5	166.3	4 874 719.9	423 194.7
19-6	167.3	4 874 740.0	423 203.2
19-7	167.3	4 874 774.2	423 249.6
19-8	167.6	4 874 786.9	423 259.6

- NOTES-**
- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
 - This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
 - Coordinate system is MTM NAD 83 Zone 10.
- GEOCREs No. 31C-287**

DATE	BY	DESCRIPTION
DESIGN	CM	CHK - CODE
DRAWN	MFA	CHK CM SITE

LOAD DATE FEB 2020
STRUCT DWG 1



Appendix B.
Field Investigation and Testing



SYMBOLS, ABBREVIATIONS AND TERMS USED ON TEST HOLE RECORDS

TERMINOLOGY DESCRIBING COMMON SOIL GENESIS

Topsoil	mixture of soil and humus capable of supporting vegetative growth
Peat	mixture of fragments of decayed organic matter
Till	unstratified glacial deposit which may include particles ranging in sizes from clay to boulder
Fill	material below the surface identified as placed by humans (excluding buried services)

TERMINOLOGY DESCRIBING SOIL STRUCTURE:

Desiccated	having visible signs of weathering by oxidization of clay materials, shrinkage cracks, etc.
Fissured	having cracks, and hence a blocky structure
Varved	composed of alternating layers of silt and clay
Stratified	composed of alternating successions of different soil types, e.g. silt and sand
Layer	> 75 mm in thickness
Seam	2 mm to 75 mm in thickness
Parting	< 2 mm in thickness

RECOVERY:

For soil samples, the recovery is recorded as the length of the soil sample recovered.

N-VALUE:

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 63.5 kg hammer falling 0.76 m, required to drive a 50 mm O.D. split spoon sampler 0.3 m into undisturbed soil. For samples where insufficient penetration was achieved and N-value cannot be presented, the number of blows are reported over the sampler penetration in millimetres (e.g. 50/75).

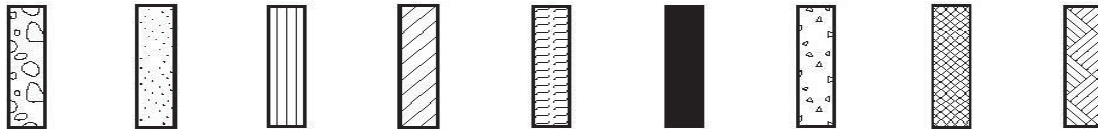
DYNAMIC CONE PENETRATION TEST (DCPT):

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to an "A" size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone 0.3 m into the soil. The DCPT is used as a probe to assess soil variability.



STRATA PLOT:

Strata plots symbolize the soil and bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders
Cobbles
Gravel Sand Silt Clay Organics Asphalt Concrete Fill Bedrock

TEXTURING CLASSIFICATION OF SOILS

Classification	Particle Size
Boulders	Greater than 200 mm
Cobbles	75 – 200 mm
Gravel	4.75 – 75 mm
Sand	0.075 – 4.75 mm
Silt	0.002 – 0.075 mm
Clay	Less than 0.002 mm

TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

Descriptive Term	Undrained Shear Strength (kPa)
Very Soft	12 or less
Soft	12 – 25
Firm	25 – 50
Stiff	50 – 100
Very Stiff	100 – 200
Hard	Greater than 200

NOTE: Clay sensitivity is defined as the ratio of the undisturbed strength over the remolded strength.

SAMPLE TYPES

SS	Split spoon samples
ST	Shelby tube or thin wall tube
DP	Direct push sample
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ etc.	Rock core sample obtained with the use of standard size diamond coring equipment

TERMS DESCRIBING CONSISTENCY (COHESIONLESS SOILS ONLY)

Descriptive Term	SPT "N" Value
Very Loose	Less than 4
Loose	4 – 10
Compact	10 – 30
Dense	30 – 50
Very Dense	Greater than 50



MODIFIED UNIFIED SOIL CLASSIFICATION

Major Divisions		Group Symbol	Typical Description
COARSE GRAINED SOIL	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILT AND CLAY SOILS $W_L < 35\%$	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		OL	Organic silts and organic silty-clays of low plasticity.
	SILT AND CLAY SOILS $35\% < W_L < 50\%$	MI	Inorganic compressible fine sandy silt with clay of medium plasticity, clayey silts.
		CI	Inorganic clays of medium plasticity, silty clays.
		OI	Organic silty clays of medium plasticity.
	SILT AND CLAY SOILS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other organic soils.

Note - W_L = Liquid Limit



EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock materials.
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structures are preserved.

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1 m in length or larger, as a percentage of total core length
Unconfined Compressive Strength: (UCS)	Axial stress required to break the specimen.
Fracture Index: (FI)	Frequency of natural fractures per 0.3 m of core run.

DISCONTINUITY SPACING

Bedding	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 to 2 m
Medium bedded	0.2 to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 to 60 mm
Laminated	6 to 20 mm
Thinly laminated	Less than 6 mm

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)
Extremely Strong	Greater than 250
Very Strong	100 – 250
Strong	50 – 100
Medium Strong	25 – 50
Weak	5 – 25
Very Weak	1 – 5
Extremely Weak	0.25 – 1

RECORD OF BOREHOLE No 19-1

1 OF 1

METRIC

Lat: 44.003018°, Long: -78.024505°
Grafton Patrol Yard, MTM z10: N 4 874 728.8 E 423 126.5

WP# _____	LOCATION _____	ORIGINATED BY <u>JP</u>
HWY <u>401</u>	BOREHOLE TYPE <u>CME 75 Truckmount, HSA</u>	COMPILED BY <u>JP</u>
DATUM <u>Geodetic</u>	DATE <u>2019.12.12 - 2019.12.12</u>	CHECKED BY <u>CM</u>

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W		
166.9	Ground Surface											
0.0	SILTY SAND, with gravel Very Dense Brown FILL		1	SS	61							
166.1												
0.8	SILTY SAND, trace to some organics Very Loose to Loose Dark Brown to Brown FILL		2	SS	9							
			3	SS	3							
			4	SS	8							Org Content = 13.7%
163.9												1 82 17 (SI+CL)
3.0	SILTY SAND (SP-SM), with gravel Dense to Very Dense Grey-Brown to Brown		5	SS	43							18 65 17 (SI+CL)
			6	SS	94							
160.8												
6.1	SILTY SAND (SM) some gravel Dense to Very Dense Grey-Brown TILL		7	SS	48							13 48 30 9 non-plastic
			8	SS	30							
157.5			9	SS	100/							
9.4	End of Borehole					225mm						

DOUBLE LINE 25964 GRAFTON PATROL YARD.GPJ 2012TEMPLATE(MTO) GDT 20/2/20

+³, ×³: Numbers refer to Sensitivity
20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 19-2

1 OF 2

METRIC

WP# _____ LOCATION Lat: 44.002752°, Long: -78.024384°
Grafton Patrol Yard, MTM z10: N 4 874 699.5 E 423 136.7 ORIGINATED BY JP
 HWY 401 BOREHOLE TYPE CME 75 Truckmount, HSA COMPILED BY JP
 DATUM Geodetic DATE 2019.12.10 - 2019.12.10 CHECKED BY CM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80						100	W _p
166.4	Ground Surface																	
0.0	SILTY SAND, with gravel Compact to Dense Brown to Grey-Brown FILL	[Cross-hatched pattern]	1	SS	21													
			2	SS	45													27 55 18 (SI+CL)
			3	SS	38													
164.3	SILTY SAND (SM) some gravel Very Loose Grey	[Dotted pattern]	4	SS	3													12 46 33 9 non-plastic
163.4	SANDY SILT (ML) Compact Grey to Brown	[Vertical line pattern]	5	SS	12													
			6	SS	25													
160.3	SILTY SAND (SM) some gravel Compact to Very Dense Grey to Grey-Brown TILL	[Dotted pattern]	7	SS	51													11 56 33 (SI+CL)
			8	SS	21													
			9	SS	35													

DOUBLE LINE 25964 GRAFTON PATROL YARD.GPJ 2012TEMPLATE(MTO).GDT 20/2/20

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
 20
 15
 10
 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 19-2

2 OF 2

METRIC

WP# _____ LOCATION Lat: 44.002752°, Long: -78.024384°
Grafton Patrol Yard, MTM z10: N 4 874 699.5 E 423 136.7 ORIGINATED BY JP
 HWY 401 BOREHOLE TYPE CME 75 Truckmount, HSA COMPILED BY JP
 DATUM Geodetic DATE 2019.12.10 - 2019.12.10 CHECKED BY CM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
155.1	Continued From Previous Page SILTY SAND (SM) some gravel Compact to Very Dense Grey to Grey-Brown TILL		10	SS	39										
11.3	End of Borehole - Continue with DCPT														
153.2	End of DCPT 50 mm diameter monitoring well installed on completion of DCPT WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2019.12.10 4.1 162.3 2019.12.11 3.4 163.0 2019.12.12 3.4 163.0 2019.12.13 3.4 163.0														

DOUBLE LINE 25964 GRAFTON PATROL YARD.GPJ 2012TEMPLATE(MTO).GDT 20/2/20

RECORD OF BOREHOLE No 19-3

2 OF 2

METRIC

WP# _____ LOCATION Lat: 44.002983°, Long: -78.024092°
Grafton Patrol Yard, MTM z10: N 4 874 725.5 E 423 159.7 ORIGINATED BY JP
 HWY 401 BOREHOLE TYPE CME 75 Truckmount, HSA COMPILED BY JP
 DATUM Geodetic DATE 2019.12.11 - 2019.12.11 CHECKED BY CM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa						
						20 40 60 80 100	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	W _p	W	W _L		
							WATER CONTENT (%)							
							20 40 60							
	Continued From Previous Page													
155.9	SILTY SAND (SM) with gravel Compact to Very Dense Grey TILL		10	SS	100/									
10.9	End of Borehole				200mm									

DOUBLE LINE 25964 GRAFTON PATROL YARD.GPJ 2012TEMPLATE(MTO).GDT 20/2/20

RECORD OF BOREHOLE No 19-4

1 OF 2

METRIC

WP# _____ LOCATION Lat: 44.003206°, Long: -78.023795°
Grafton Patrol Yard, MTM z10: N 4 874 750.8 E 423 183.0 ORIGINATED BY JP
 HWY 401 BOREHOLE TYPE CME 75 Truckmount, HSA COMPILED BY JP
 DATUM Geodetic DATE 2019.12.12 - 2019.12.12 CHECKED BY CM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
167.3	Ground Surface														
0.0	SAND with silt and gravel Very Dense Brown FILL		1	SS	77										33 61 6 (SI+CL)
			2	SS	82										
			3	SS	54										
165.0	SANDY SILT (ML) Compact to Very Dense Brown to Grey-Brown		4	SS	34										
2.3			5	SS	22										
			6	SS	76										1 38 57 4 non-plastic
161.2	SILTY SAND (SM) with gravel Very Dense Grey to Grey-Brown TILL		7	SS	75										
6.1			8	SS	64										
			9	SS	76										16 66 18 (SI+CL)

DOUBLE LINE 25964 GRAFTON PATROL YARD.GPJ 2012TEMPLATE(MTO).GDT 20/2/20

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
 20
 15
 10
 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 19-4

2 OF 2

METRIC

WP# _____ LOCATION Lat: 44.003206°, Long: -78.023795°
Grafton Patrol Yard, MTM z10: N 4 874 750.8 E 423 183.0 ORIGINATED BY JP
 HWY 401 BOREHOLE TYPE CME 75 Truckmount, HSA COMPILED BY JP
 DATUM Geodetic DATE 2019.12.12 - 2019.12.12 CHECKED BY CM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
	Continued From Previous Page						20	40	60	80	100	W _p	W	W _L		
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
156.6	SILTY SAND (SM) with gravel Very Dense Grey to Grey-Brown TILL		10	SS	100/											
10.7	End of Borehole				75mm											

DOUBLE LINE 25964 GRAFTON PATROL YARD.GPJ 2012TEMPLATE(MTO).GDT 20/2/20

RECORD OF BOREHOLE No 19-5

1 OF 1

METRIC

WP# _____ LOCATION Lat: 44.002927°, Long: -78.023656°
Grafton Patrol Yard, MTM z10: N 4 874 719.9 E 423 194.7 ORIGINATED BY JP
 HWY 401 BOREHOLE TYPE CME 75 Truckmount, HSA COMPILED BY JP
 DATUM Geodetic DATE 2019.12.11 - 2019.12.11 CHECKED BY CM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
166.3	Ground Surface														
0.0	SILTY SAND with gravel Compact to Very Dense Brown to Grey-Brown FILL		1	SS	33										
			2	SS	81										
			3	SS	20										
			4	SS	100/ 250mm										
163.3	SAND (SP-SM) with silt, some gravel Compact to Very Dense Brown		5	SS	20										10 80 10 (SI+CL)
			6	SS	100/ 275mm										
160.2	SILTY SAND (SM) some gravel Compact to Very Dense Grey-Brown TILL		7	SS	100/ 250mm										
			8	SS	21										12 49 32 7 non-plastic
158.1	End of Borehole														
8.2	End of Borehole														

DOUBLE LINE 25964 GRAFTON PATROL YARD.GPJ 2012TEMPLATE(MTO).GDT 20/2/20

+³, ×³: Numbers refer to Sensitivity
 20
 15
 10
 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 19-6

1 OF 2

METRIC

WP# _____ LOCATION Lat: 44.003106°, Long: -78.023546°
Grafton Patrol Yard, MTM z10: N 4 874 740.0 E 423 203.2 ORIGINATED BY JP
 HWY 401 BOREHOLE TYPE CME 75 Truckmount, HSA COMPILED BY JP
 DATUM Geodetic DATE 2019.12.11 - 2019.12.11 CHECKED BY CM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)			
						20 40 60 80 100		20 40 60					
						○ UNCONFINED + FIELD VANE		W P W W L					
						● QUICK TRIAXIAL × LAB VANE							
167.3	Ground Surface												
0.0	SAND with silt and gravel to GRAVEL with silt and sand Dense to Very Dense Brown FILL		1	SS	41								
			2	SS	60								
			3	SS	49							46 46 8 (SI+CL)	
165.0													
2.3	SAND (SP-SM) with silt, some gravel - trace organics in SS4 Compact to Dense Brown-Black to Brown		4	SS	11							Org Content = 1.3%	
			5	SS	30								
			6	SS	40								
161.2													
6.1	SILTY SAND (SM) some to with gravel Compact to Very Dense Grey to Grey-Brown TILL		7	SS	30							14 44 33 9 non-plastic	
			8	SS	37								
			9	SS	100/250mm								

DOUBLE LINE 25964 GRAFTON PATROL YARD.GPJ 2012TEMPLATE(MTO).GDT 20/2/20

Continued Next Page

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 19-6

2 OF 2

METRIC

WP# _____ LOCATION Lat: 44.003106°, Long: -78.023546°
Grafton Patrol Yard, MTM z10: N 4 874 740.0 E 423 203.2 ORIGINATED BY JP
 HWY 401 BOREHOLE TYPE CME 75 Truckmount, HSA COMPILED BY JP
 DATUM Geodetic DATE 2019.12.11 - 2019.12.11 CHECKED BY CM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80						100	W _p	W
156.1	Continued From Previous Page SILTY SAND (SM) some to with gravel Compact to Very Dense Grey to Grey-Brown TILL		10	SS	69		157												16 40 32 12
11.2	End of Borehole																		

DOUBLE LINE 25964 GRAFTON PATROL YARD.GPJ 2012TEMPLATE(MTO).GDT 20/2/20

RECORD OF BOREHOLE No 19-7

1 OF 1

METRIC

WP# _____ LOCATION Lat: 44.003406°, Long: -78.02296°
Grafton Patrol Yard, MTM z10: N 4 874 774.2 E 423 249.6 ORIGINATED BY JP
 HWY 401 BOREHOLE TYPE CME 75 Truckmount, HSA COMPILED BY JP
 DATUM Geodetic DATE 2019.12.12 - 2019.12.13 CHECKED BY CM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
167.3	Ground Surface														
0.0	SAND with silt and gravel Compact to Very Dense Brown to Grey-Brown FILL		1	SS	60										32 59 9 (SI+CL)
			2	SS	44										
			3	SS	15										
165.0															
2.3	SILT (ML) with sand Compact to Dense Brown		4	SS	44										2 27 64 7 non-plastic
			5	SS	26										
162.7															
4.6	SILTY SAND (SM) with gravel Very Dense Brown TILL		6	SS	63										
			7	SS	100/ 250mm										
159.3															
8.0	End of Borehole		8	SS	100/ 250mm										17 40 32 11 non-plastic

DOUBLE LINE 25964 GRAFTON PATROL YARD.GPJ 2012TEMPLATE(MTO).GDT 20/2/20

+³, ×³: Numbers refer to Sensitivity
 20
 15
 10
 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 19-8

1 OF 1

METRIC

WP# _____ LOCATION Lat: 44.003519°, Long: -78.022832°
Grafton Patrol Yard, MTM z10: N 4 874 786.9 E 423 259.6 ORIGINATED BY JP
 HWY 401 BOREHOLE TYPE CME 75 Truckmount, HSA COMPILED BY JP
 DATUM Geodetic DATE 2019.12.13 - 2019.12.13 CHECKED BY CM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80			100
167.6	Ground Surface													
0.0	SAND with silt and gravel Compact to Dense Brown FILL		1	SS	29						o			
			2	SS	40						o			25 67 8 (SI+CL)
166.1	SILT (ML) some sand trace organics Loose to Compact Brown to Brown-Black		3	SS	8						o			
1.5			4	SS	13						o			0 10 85 5 non-plastic
164.6	SILTY SAND (SM) with gravel Compact to Very Dense Brown TILL		5	SS	21						o			
3.0			6	SS	36						o			24 44 27 5 non-plastic
			7	SS	100/ 250mm						o			
			8	SS	100/ 225mm						o			
			9	SS	100/ 175mm						o			
158.3	End of Borehole													
9.3														

DOUBLE LINE 25964 GRAFTON PATROL YARD.GPJ 2012TEMPLATE(MTO).GDT 20/2/20

+³, ×³: Numbers refer to Sensitivity
 20
 15
 10
 (%) STRAIN AT FAILURE



Slug Test Analysis Report

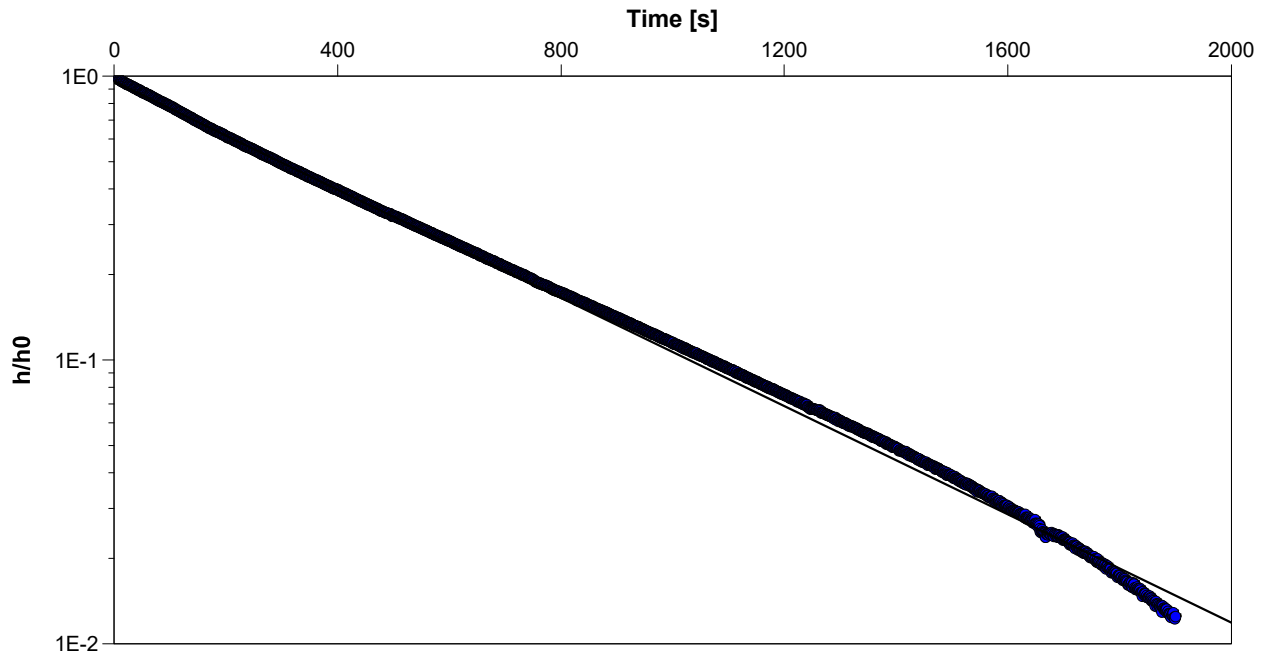
Project: Hwy 401 - Grafton Patrol Yard

Number: 25964

Client: McIntosh Perry

Location: Grafton Patrol Yard	Slug Test: BH19-2	Test Well: BH19-02
Test Conducted by: J.P.		Test Date: 2019-12-12
Analysis Performed by: Y.C.	Checked by: D.H.	Analysis Date: 2019-12-17

Aquifer Thickness:



Calculation using Hvorslev

Observation Well	Hydraulic Conductivity [m/s]
BH19-02	1.9×10^{-6}



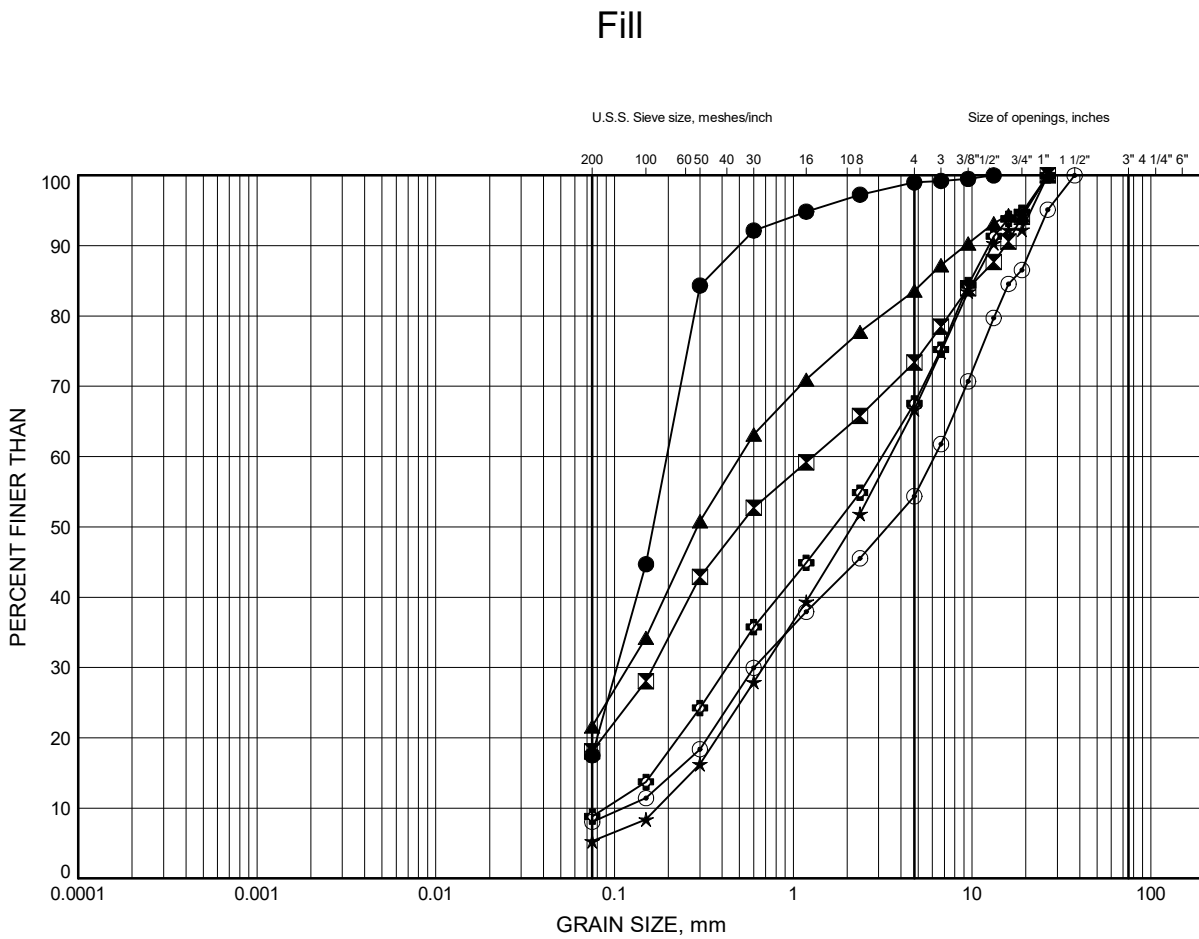
Appendix C.
Laboratory Testing



Appendix C.1
Particle Size Analysis Figures
Atterberg Limit Test Results

Hwy 401 Grafton Patrol Yard GRAIN SIZE DISTRIBUTION

FIGURE C1



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	19-1	2.6	164.3
⊠	19-2	1.1	165.4
▲	19-3	1.1	165.8
★	19-4	0.3	167.0
⊙	19-6	1.8	165.5
⊕	19-7	0.3	167.0

Date January 2020
WP#

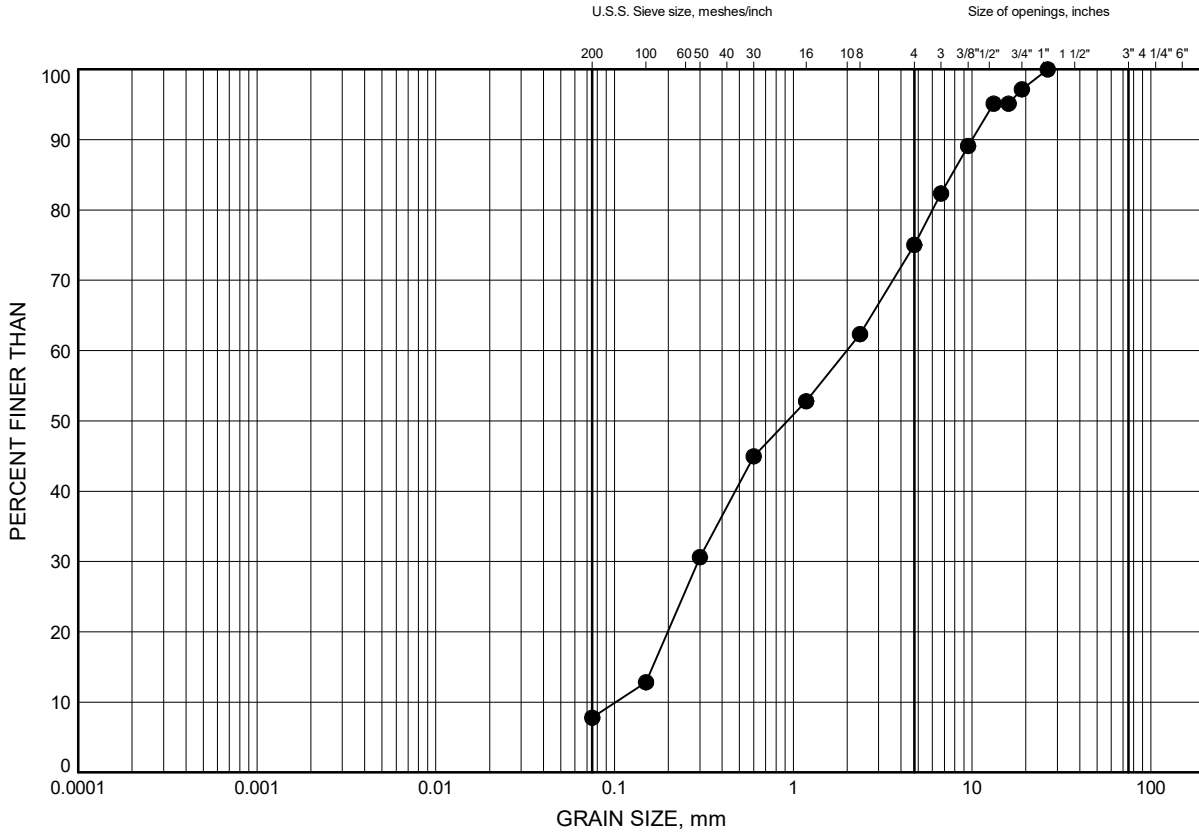


Prep'd CM
Chkd. FJG

Hwy 401 Grafton Patrol Yard
GRAIN SIZE DISTRIBUTION

FIGURE C2

Fill



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	19-8	1.1	166.5

Date January 2020
 WP#



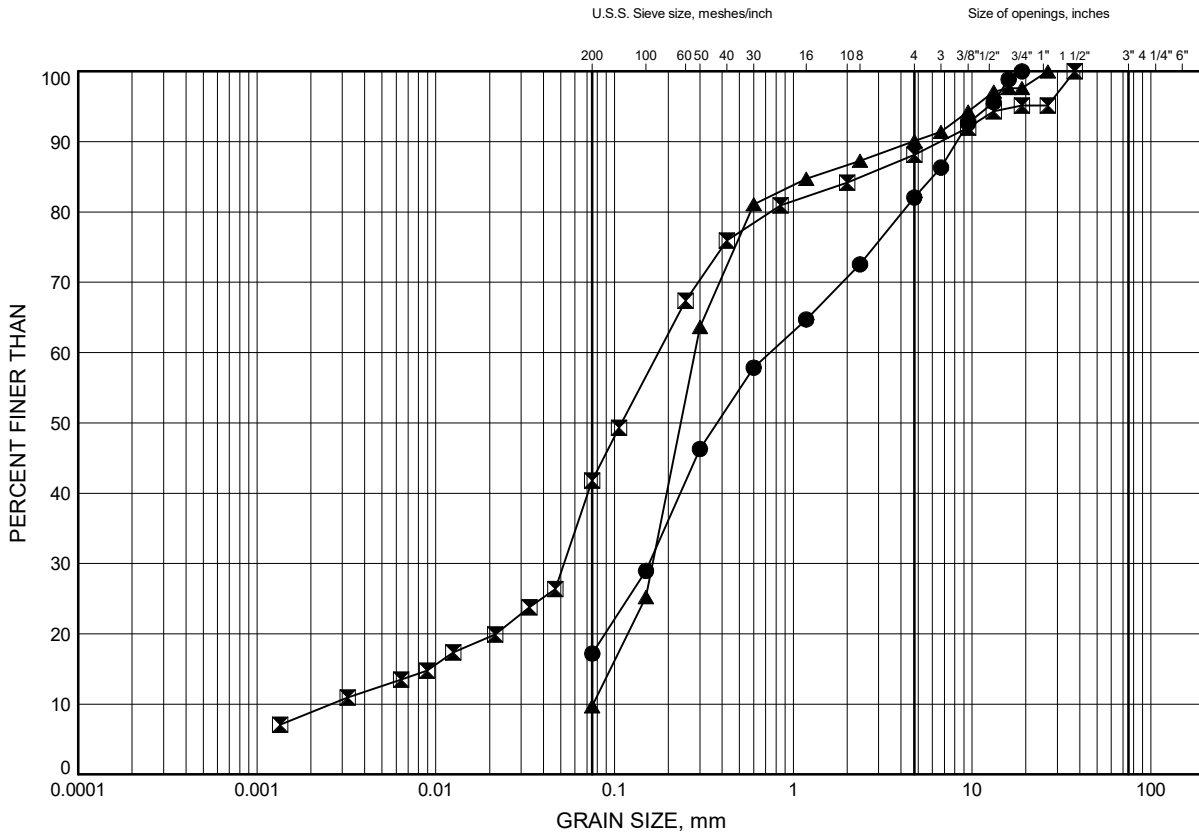
Prep'd CM
 Chkd. FJG

GRAIN SIZE DISTRIBUTION - THURBER 25964 GRAFTON PATROL YARD.GPJ 22/1/20

Hwy 401 Grafton Patrol Yard
GRAIN SIZE DISTRIBUTION

FIGURE C3

Silty Sand to Sand



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	19-1	3.4	163.6
☒	19-2	2.6	163.8
▲	19-5	3.4	162.9

Date January 2020
 WP#



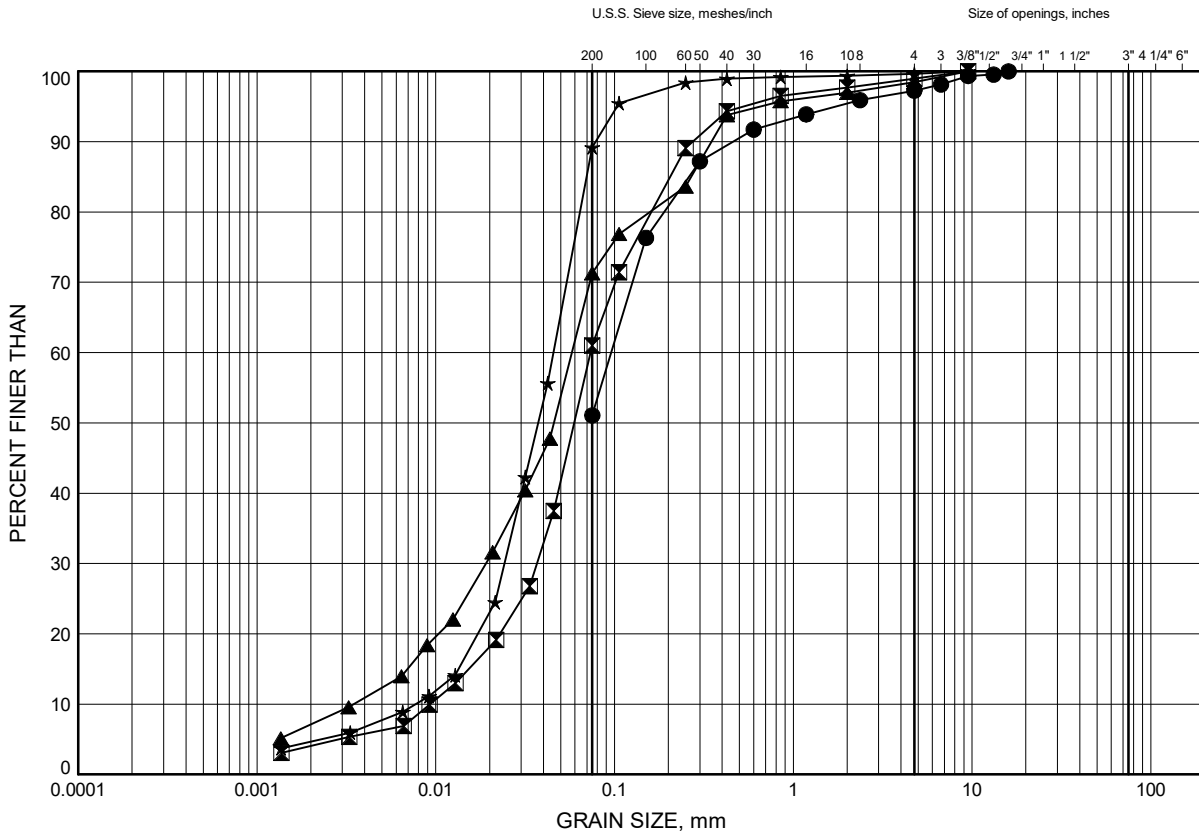
Prep'd CM
 Chkd. FJG

GRAIN SIZE DISTRIBUTION - THURBER 25964 GRAFTON PATROL YARD.GPJ 24/1/20

Hwy 401 Grafton Patrol Yard
GRAIN SIZE DISTRIBUTION

FIGURE C4

Sandy Silt to Silt



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	19-3	4.9	162.0
⊠	19-4	4.9	162.4
▲	19-7	3.4	164.0
★	19-8	2.6	165.0

Date January 2020
 WP#

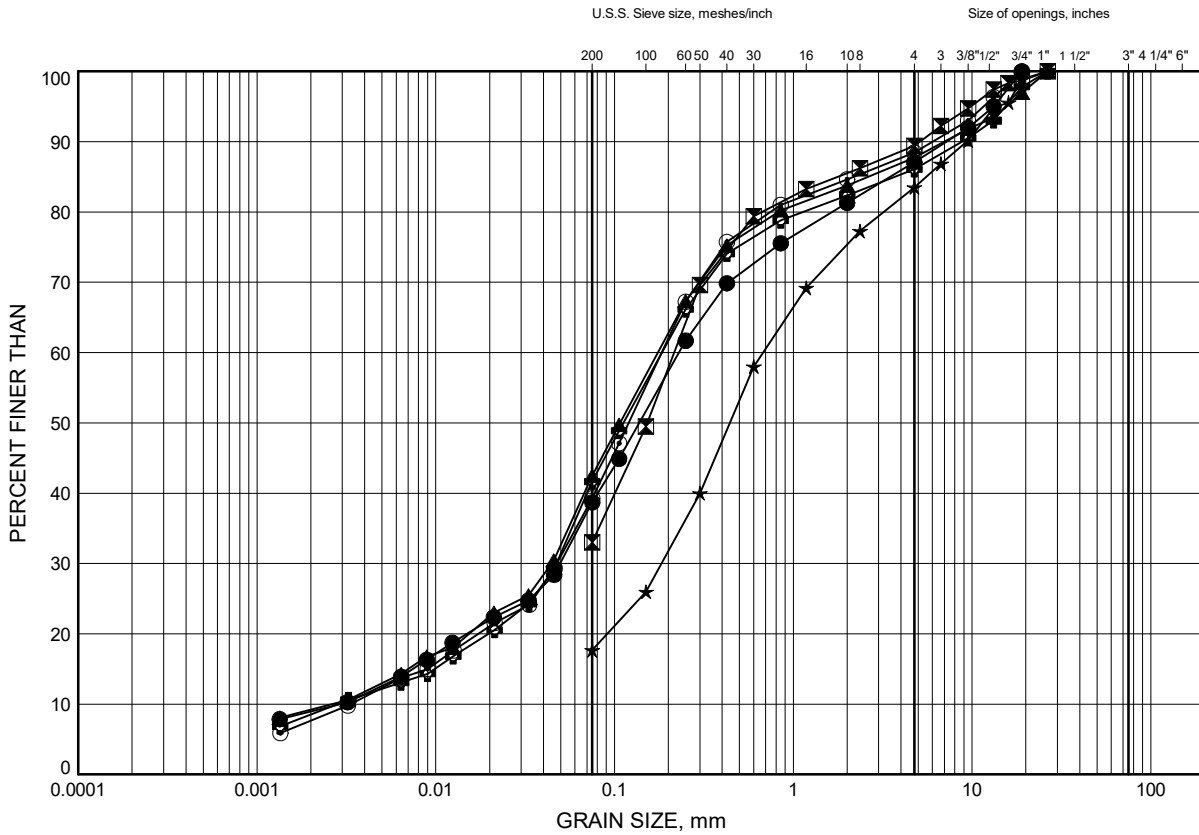


Prep'd CM
 Chkd. FJG

Hwy 401 Grafton Patrol Yard
GRAIN SIZE DISTRIBUTION

FIGURE C5

Glacial Till



SILT and CLAY		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED		SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	19-1	6.4	160.5
⊠	19-2	6.4	160.0
▲	19-3	9.4	157.4
★	19-4	9.4	157.9
⊙	19-5	7.9	158.4
⊕	19-6	6.4	160.9

Date January 2020
 WP#



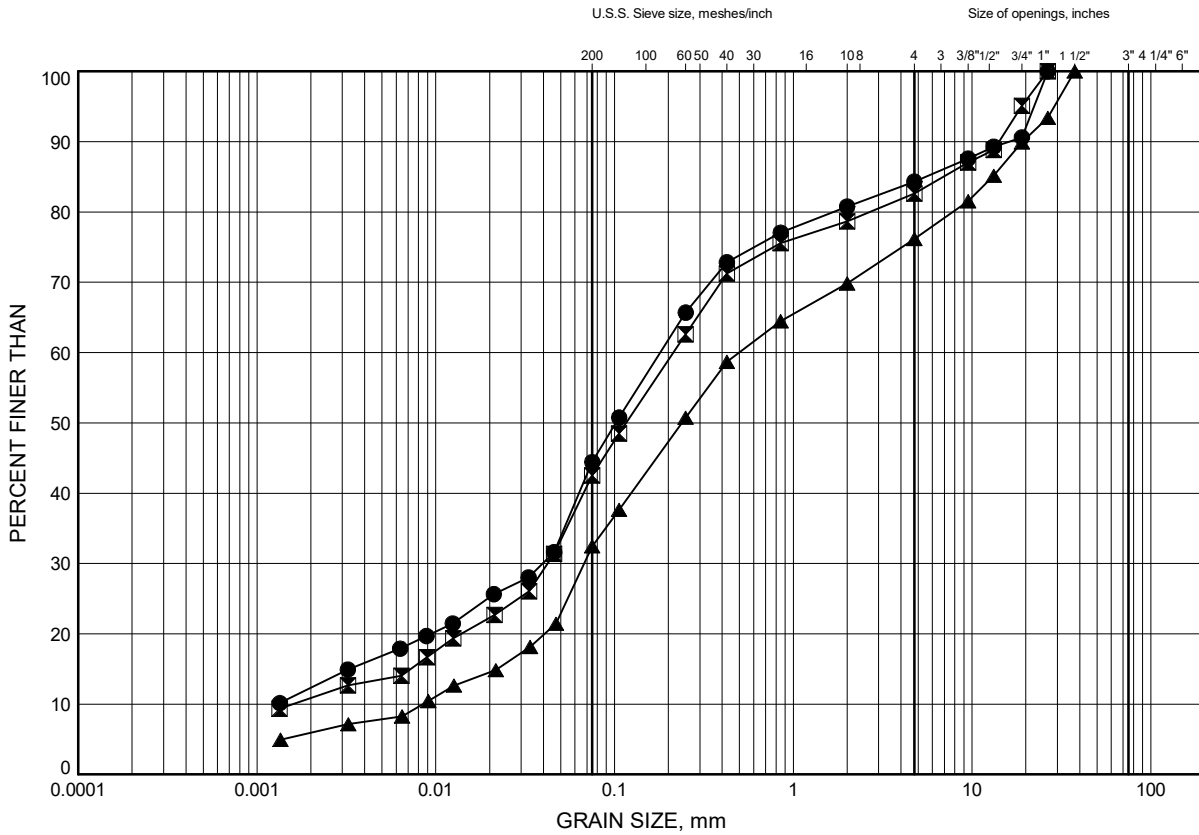
Prep'd CM
 Chkd. FJG

GRAIN SIZE DISTRIBUTION - THURBER 25964 GRAFTON PATROL YARD.GPJ 24/1/20

Hwy 401 Grafton Patrol Yard
GRAIN SIZE DISTRIBUTION

FIGURE C6

Glacial Till



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	19-6	10.9	156.4
⊠	19-7	7.8	159.5
▲	19-8	4.9	162.7

Date January 2020
 WP#

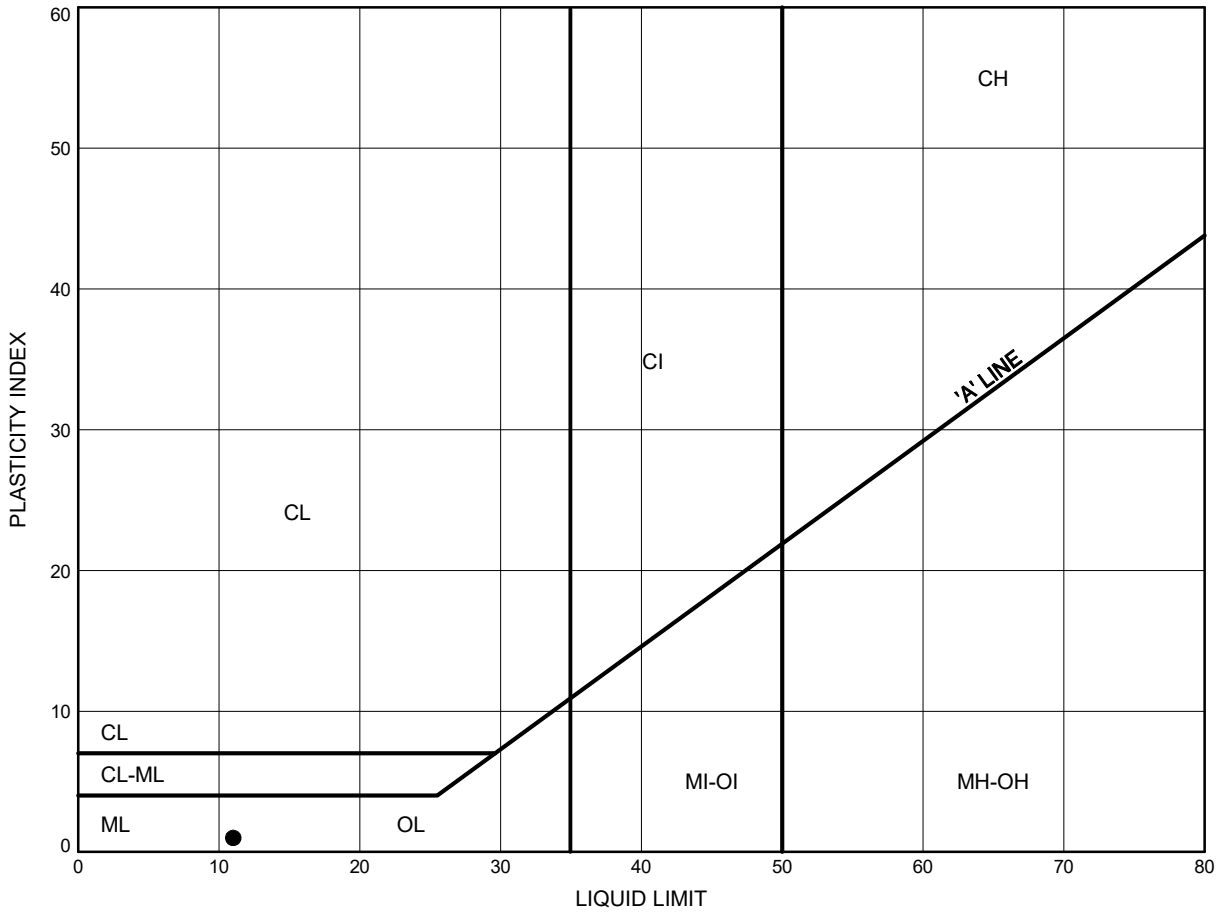


Prep'd CM
 Chkd. FJG

Hwy 401 Grafton Patrol Yard
ATTERBERG LIMITS TEST RESULTS

FIGURE C7

Glacial Till



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	19-6	10.9	156.4

Date .. January 2020 ..
 WP#



Prep'd .. CM ..
 Chkd. .. FJG ..

THURBALT 25964 GRAFTON PATROL YARD.GPJ 24/1/20



Appendix C.2

Analytical Testing Results

Certificate of Analysis
 Client: Thurber Engineering Ltd.
 Client PO:

Report Date: 20-Dec-2019

Order Date: 17-Dec-2019

Project Description: 25964

Client ID:	19-7, SS4 (7'6"-9'6")	19-2, SS5 (10'-12')	19-4, SS4 (7'6"-9'6")	-
Sample Date:	12-Dec-19 09:00	10-Dec-19 09:00	12-Dec-19 09:00	-
Sample ID:	1951218-01	1951218-02	1951218-03	-
MDL/Units	Soil	Soil	Soil	-

Physical Characteristics

% Solids	0.1 % by Wt.	84.7	87.5	93.0	-
----------	--------------	------	------	------	---

General Inorganics

Conductivity	5 uS/cm	218	429	611	-
pH	0.05 pH Units	7.75	7.72	7.79	-
Resistivity	0.10 Ohm.m	45.9	23.3	16.4	-

Anions

Chloride	5 ug/g dry	82	222	257	-
Sulphate	5 ug/g dry	8	15	12	-



SGS Canada Inc.

P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - K0L 2H0
Phone: 705-652-2000 FAX: 705-652-6365

02-January-2020

Paracel Laboratories

Attn : Dale Robertson

300-2319 St.Laurent Blvd.
Ottawa, ON
K1G 4K6, Canada

Phone: 613-731-9577
Fax:613-731-9064

Date Rec. : 19 December 2019
LR Report: CA12694-DEC19
Reference: Project#: 1951218

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Sample ID	Sample Date & Time	Sulphide %
1: Analysis Start Date		31-Dec-19
2: Analysis Start Time		14:43
3: Analysis Completed Date		31-Dec-19
4: Analysis Completed Time		14:47
5: QC - Blank		< 0.02
6: QC - STD % Recovery		117%
7: QC - DUP % RPD		0%
8: RL		0.02
9: 19-7, SS4 (7'6"-9'6")	12-Dec-19	< 0.02
10: 19-2, SS5 (10'-12')	10-Dec-19	< 0.02
11: 19-4, SS4 (7'6"-9'6")	12-Dec-19	< 0.02

RL - SGS Reporting Limit

Kimberley Didsbury
Project Specialist,
Environment, Health & Safety



Appendix C.3

Organic Content Testing Results



Stantec

Stantec Consulting Ltd
100 A&B – 2781 Lancaster Rd
Ottawa, ON K1B 1A7
Tel: (613) 738-6075
Fax: (613) 738-6067

December 30, 2019
File: 122410864

Attention: Thurber Engineering, File #25964

Reference: ASTM D2974 Organic Matter of Peat & Other Soils

The following table summarizes two test results for Organic Matter of Peat and Other Soils.

Location	Source	Organic Content (%)
19-01 SS3	5'-7'	13.7
19-06 SS4	7'6"-9'6"	1.3

Sincerely,

Stantec Consulting Ltd.

Brian Prevost
Laboratory Supervisor
Tel: 613-738-6075
Fax: 613-738-6067
brian.prevost@stantec.com



Appendix D.
Site Photographs



Photo 1. Looking west from BH 19-6 towards proposed garage building



Photo 2. Looking north from BH 19-7 towards proposed cold storage building

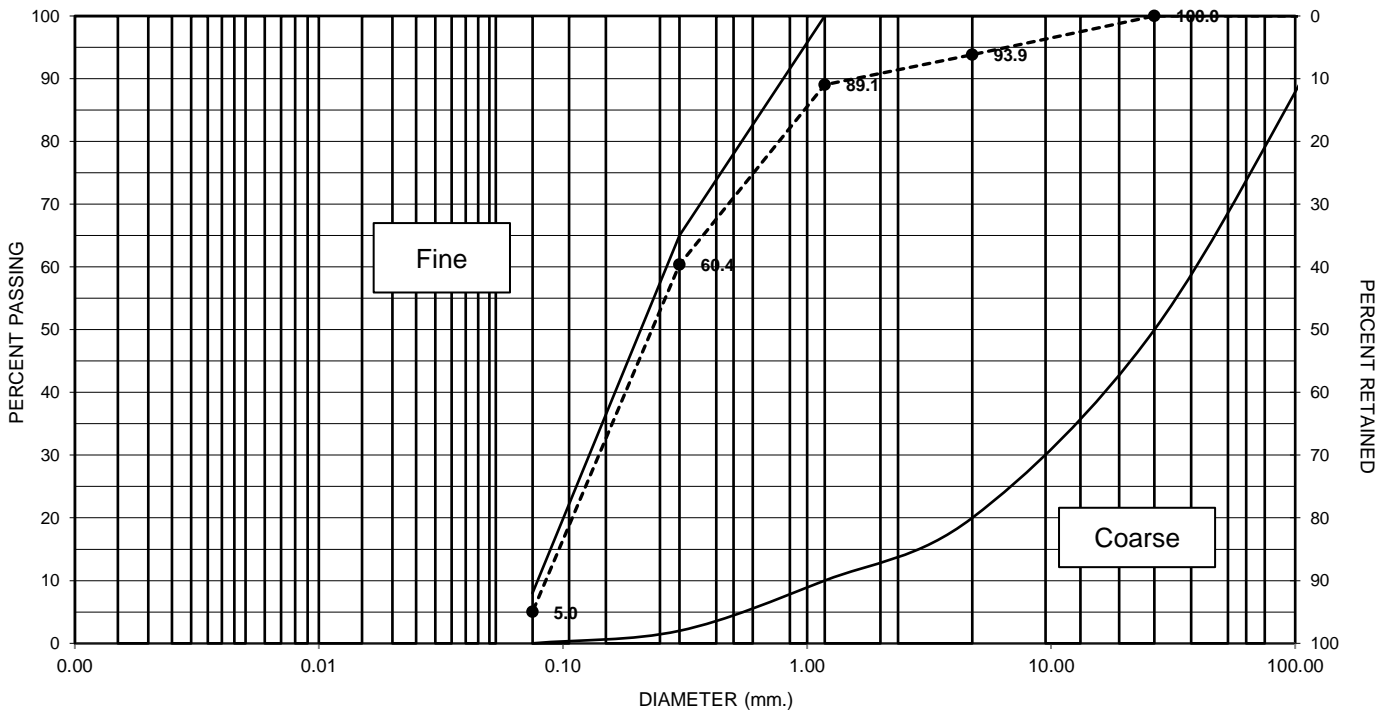
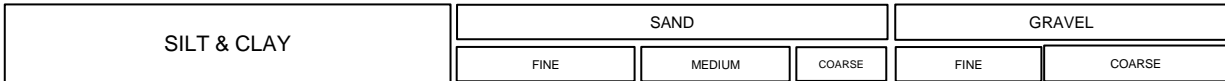
Appendix D
Grain Size Distribution - Proposed Engineered Fill

Granular "B" - Type 1 (Gravel)
Ontario Provincial Standard 1010 - Table 3

Project Name: *Granular B Type 1 / Earth Borrow*
Client Name: *Fidelity Engineering*
Source: *Telephone Road Pit*
Sampled By: *Client*

Project No.: *FID-20-01*
Date Taken: *February 12 2020*
Time: *--*
Lab No.: *FID-20-GRB1-001*

Sieve Size (mm's)		Sample % Passing	OPSS Form 1010 - Table 3 - % Passing		
Stone (150.00 - 4.75mm)	150.00	100.0	100		
	26.50	100.0	50	-	100
	4.75	93.9	20	-	100
Sand (<4.75 - 0.075 mm)	1.18	89.1	10	-	100
	0.300	60.4	2	-	65
	0.075	5.0	0	-	8
Moisture Content (%)		7.3			



Remarks:

- Sample meets the Ontario Provincial Standard (1010) grading requirements Granular "B" Type 1 aggregate.
- (*) Denotes sieve that does not meet the Ontario Provincial Standard (1010) grading requirements for Granular "B" Type 1 aggregate.

Issued By: *Wayne Dykstra*
(Laboratory Manager)

Date: February 13, 2020

Please feel free to contact us should you have any questions or require any additional information.

MOISTURE DENSITY TEST - 152mm Diameter Mold

Project Name:	<u>MTO Project Hwy 401</u>	Project No.:	<u>FID-20-01</u>
Client:	<u>Fidelity Engineering & Constr.</u>	Material:	<u>Granular B Type 1</u>
Sampled By:	<u>Mark Minaker - Fidelity Eng.</u>	Location:	<u>Telephone Road Pit</u>
Tested By:	<u>Wayne Rayfuse</u>	Date:	<u>February 13, 2020</u>
Lab No.:	<u>FID-20-GRB1-001</u>	Method:	<u>ASTM D698 - Method C</u>

Unit Weight Determination (t/m ³)						
Trial Number	1	2	3	4	5	
Mold No.	Mold 1	Mold 1	Mold 1	Mold 1	Mold 1	
Wt. Sample Wet + Mold (kgs.)	10.548	10.756	10.897	10.824	10.780	
Weight of Mold (kgs.)	6.499	6.499	6.499	6.499	6.499	
Wet Sample (kgs.)	4.05	4.26	4.40	4.33	4.28	
Volume of Mold	2.13	2.13	2.13	2.13	2.13	
Wet Density (t/m ³)	1.901	1.999	2.065	2.031	2.010	
Dry Density (t/m ³)	1.789	1.810	1.835	1.773	1.703	

Moisture Content (%)						
Container No.	105	102	104	110	109	
Wt. Sample Wet + Tare gms.	484.2	477.3	452.0	509.5	584.9	
Wt. Sample Dry + Tare gms.	460.0	440.3	411.5	457.7	513.8	
Wt. Water gms.	24.2	37.0	40.5	51.8	71.1	
Tare Container gms.	49.3	48.2	48.2	48.8	48.3	
Wt. Dry Soil gms.	410.7	392.1	363.3	408.9	465.5	
Moisture Content %	5.9	9.4	11.1	12.7	15.3	

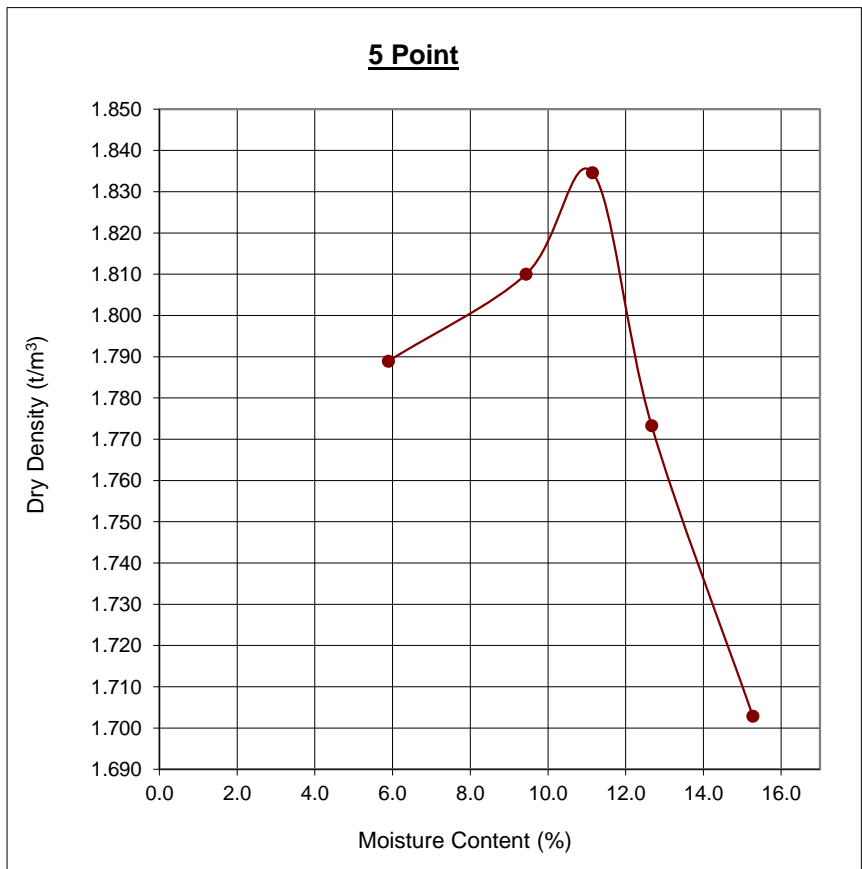
Oversize Correction Calculation	
Sample Wt. (gms.)	34245.0
Oversize Wt. (gms.)	0.00
% Oversize - (Method A & C)	0.0

Test Results	
Uncor. Max. Dry Density (t/m ³)	1.836
Specific Gravity - Oversize	--
Cor. Max Dry Density (t/m ³)	1.836 ←
Uncor. Optimum Moisture Content (%)	11.0
Cor. Optimum Moisture Content (%)	11.0 ←
Water Content of Oversize	--

Doughty Aggregates

Form LS-706-152-5

Revision 2



Appendix E
Seismic Hazard Values

2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

Site: 44.003N 78.024W

2021-04-20 14:10 UT

Probability of exceedance per annum	0.000404	0.001	0.0021	0.01
Probability of exceedance in 50 years	2 %	5 %	10 %	40 %
Sa (0.05)	0.159	0.083	0.048	0.014
Sa (0.1)	0.200	0.111	0.068	0.022
Sa (0.2)	0.175	0.103	0.066	0.024
Sa (0.3)	0.139	0.085	0.056	0.021
Sa (0.5)	0.105	0.067	0.045	0.016
Sa (1.0)	0.059	0.038	0.026	0.008
Sa (2.0)	0.030	0.019	0.012	0.003
Sa (5.0)	0.008	0.004	0.003	0.001
Sa (10.0)	0.003	0.002	0.001	0.001
PGA (g)	0.110	0.062	0.038	0.012
PGV (m/s)	0.087	0.053	0.033	0.010

Notes: Spectral ($S_a(T)$, where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s . Values are for "firm ground" (NBCC2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are highlighted in yellow. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. **These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.**

References

National Building Code of Canada 2015 NRCC no. 56190; Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

Structural Commentaries (User's Guide - NBC 2015: Part 4 of Division B)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites www.EarthquakesCanada.ca and www.nationalcodes.ca for more information