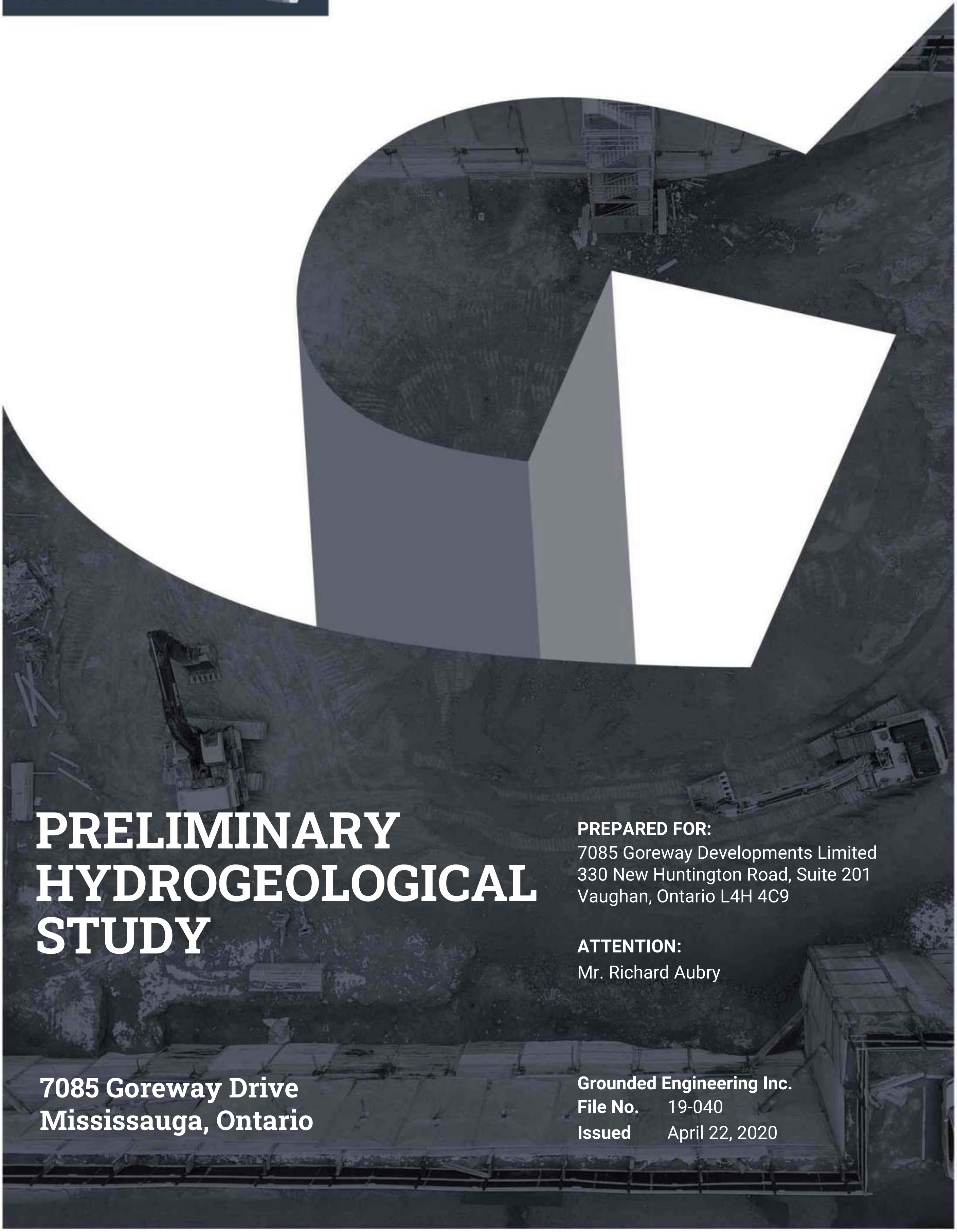

PRELIMINARY HYDROGEOLOGICAL STUDY

PREPARED FOR:
7085 Goreway Developments Limited
330 New Huntington Road, Suite 201
Vaughan, Ontario L4H 4C9

ATTENTION:
Mr. Richard Aubry

7085 Goreway Drive
Mississauga, Ontario

Grounded Engineering Inc.
File No. 19-040
Issued April 22, 2020

Executive Summary

Grounded Engineering Inc. (Grounded) was retained by 7085 Goreway Developments Limited to conduct a Preliminary Hydrogeological Desktop Study in advance of the subsurface investigation for the proposed redevelopment of 7085 Goreway Drive in Mississauga, Ontario (site).

No monitoring wells are currently present on site. Monitoring wells will be installed in the future to confirm the findings of this report.

Grounded has been provided with factual borehole information from Soil Engineers Ltd. Those borehole logs are provided in a professional engineer's signed and sealed report. As such, this borehole information (appended) is taken as factual for present purposes. Other factual information has been gathered from publicly available sources.

The conclusions of the investigation are summarized as follows:

Development Information

Current Development					
Development Phase	Above Grade Levels	Below Grade Levels			
		Level #	Lowest Finished Floor		Approximate Base of Footings (masl)
			Depth (m)	Elevation (masl)	
Grocery Store	1.5	0	N/A	N/A	N/A

Proposed Development					
Development Phase	Above Grade Levels	Below Grade Levels			
		Level #	Lowest Finished Floor		Approximate Base of Footings (masl)
			Depth (m)	Elevation (masl)	
18-storey Tower	18	3	9.3	156.7	155.2
16-storey Tower	16	3	9.3	156.7	155.2
Townhouses	2	3	9.3	156.7	155.2

Site Conditions

Site Stratigraphy				
Stratum/Formation	Aquifer or Aquitard	Depth Range (mbgs)	Elevation Range (masl)	Hydraulic Conductivity (m/s)
Earth Fill	Aquifer	0.7 to 1.7	166.2 to 164.0	1 x 10^{-4} **
Silty Clay (sometimes described as a glacial till)	Aquitard	7.2 to 8.1	158.6 to 157.4	1 x 10^{-7} **
Sandy Silt Till	Aquitard	8.1	157.7	1 x 10^{-6} **

*Indicates conductivity was estimated using grain size analysis

**Indicates conductivity was estimated using typical published values from Freeze and Cherry (1979)

Maximum Groundwater Elevation (unstabilized)		
Borehole	**Depth Below Grade (m)**	**Elevation (masl)**
BH5	6.4	160.5

Groundwater Control

Stored Groundwater (pre-excavation/dewatering)			
Volume of Excavation (m³)	**Volume of Excavation Below Water Table (m³)**	**Volume of Storage Groundwater (m³)**	**Volume of Storage Groundwater (L)**
52,038	22,833	8,762	8,762,000

Preliminary Short Term (Construction) Groundwater Quantity Estimate – Safety Factor of 2.0 Used					
Ground Water Seepage		**Design Rainfall Event (25mm)**		**Total Daily Water Takings**	
L/day	**L/min**	**L/day**	**L/min**	**L/day**	**L/min**
105,000	72.9	135,000	93.8	240,000	166.7

Preliminary Long Term (Permanent) Groundwater Quantity Estimate – Safety Factor of 2.0 Used					
Ground Water Seepage		**Infiltration Design Rainfall Event (25mm)**		**Total Daily Water Takings**	
L/day	**L/min**	**L/day**	**L/min**	**L/day**	**L/min**
110,000	76.4	20,000	13.9	130,000	90.3

Zone of Influence	
Zone of Influence	**Maximum Potential Settlement**
±7.1 m	6 mm

Regulatory Requirements	
Environmental Activity and Sector Registry (EASR) Posting	Required
Short Term Permit to Take Water (PTTW)	Not Required
Long Term Permit to Take Water (PTTW)	Required

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FIGURES

APPENDICES

1 Introduction

7085 Goreway Developments Limited has retained Grounded Engineering Inc. (“Grounded”) to complete a hydrogeological engineering desktop study for the purpose of providing preliminary design advice for their proposed redevelopment at 7085 Goreway Drive, in Mississauga, Ontario.

Property Information	
Location of Property	7085 Goreway Drive
Ownership of Property	7085 Goreway Developments Limited
Property Dimensions (m)	73 x 135
Property Area (m2)	9,870

Existing Development	
Number of Building Structures	One (1)
Number of Above Grade Levels	Two (2)
Number of Underground Levels	None
Sub-Grade Depth of Development (m)	N/A
Sub-Grade Area (m2)	N/A
Land Use Classification	Commercial

Proposed Development	
Building Structures	Two (2) residential towers, connected via podium as well as a block of townhouses. The new structures will have shared underground parking.
Number of Above Grade Levels	Residential towers: 18 and 16 storeys Podium: 2 storeys Townhouses: 2 storeys
Number of Underground Levels	Three (3)
Sub-Grade Depth of Development (m)	9.3
Sub-Grade Area (m2)	5,310
Land Use Classification	Residential

Qualified Person and Hydrogeological Review Information	
Qualified Person	Mat Bielaski, P.Eng.
Consulting Firm	Grounded Engineering Inc.
Date of Hydrogeological Review	April 22, 2020
Scope of Work	▪ Review of MECP Water Well Records for the area ▪ Review of geological information for the area ▪ Review of topographic information for the area ▪ Assessment of ground water controls and potential impacts

General Hydrogeological Characterization	
Property Topography	The site has an approximate ground surface elevation of 166 masl.
Local Physiographic Features	The site is composed of Halton Till comprised of clayey silt to silt till derived from glaciolacustrine deposits or shale and glaciolacustrine deposits comprised of clay, silt, minor sand and gravel, massive to laminated silt and clay, may contain poorly sorted diamicton layers.
Regional Physiographic Features	The West St Lawrence Lowland consists of a limestone plain (elevation 200–250 masl) that is separated by a broad, shale lowland from a broader dolomite and limestone plateau west of Lake Ontario. This plateau is bounded by the Niagara Escarpment. From the escarpment the plateau slopes gently southwest to lakes Huron and Erie (elevation 173 masl). Glaciation has mantled this region with several layers of glacial till (i.e., an unsorted mixture of clay, sand, etc.), the youngest forming extensive, undulating till plains, often enclosing rolling drumlin fields.
Surface Drainage	Surface water is expected to flow to the catch basins located on the site the site.

2 Study Area Map

A map has been enclosed which shows the following information:

- All monitoring wells identified on-site
- All monitoring wells identified off-site within the study area
- All boreholes identified on-site
- All buildings identified on Site and within the study area
- The property boundaries of the Site
- Any watercourses and drainage features within the study area.

3 Geology and Physical Hydrogeology

The site stratigraphy, including soil materials, composition and texture are presented in detail on the borehole logs in Appendix A. A summary of stratigraphic units that were encountered at the site are as follows:

Site Stratigraphy

Stratum/Formation	Aquifer or Aquitard	Depth Range (mbgs)	Elevation Range (masl)	Hydraulic Conductivity (m/s)
Earth Fill	Aquifer	0.7 to 1.7	166.2 to 164.0	1 x 10^{-4}
Silty Clay (sometimes described as a glacial till)	Aquifer	7.2 and below	158.6 and below	1 x 10^{-7}
Sandy Silt Till	Aquifer	7.2 to 8.1	158.6 to 157.7	1 x 10^{-6}

Surface Water

Surface Water Body	Distance from site (m)	Hydraulically Connected to Property (yes/no)
Mimico Creek	25 m east	Yes

4 Monitoring Well Information

The Ministry of the Environment, Conservation and Parks (MECP) well records database was accessed online. All the well records located on the Property and in the Study Area were identified. The comprehensive well record is provided in Appendix B and is summarized below:

Well Records	Property: • No wells were identified on the Property. Study Area: • The following well types were identified within the Study Area: ○ One (1) test hole installed in 2010 ○ One (1) well of unknown use installed in 1952
Stratigraphy	MW 7147719 (2010): • 0 to 1.2 mbgs – Fill • 1.2 to 4 mbgs – Silty Sand, brown • 4 to 4.6 mbgs – Silty Sand, grey MW 4902467 (1952): • 0 to 14 mbgs – Clay, blue • 14 to 14.5 mbgs – Shale Bedrock, blue
Depth to Bedrock	Bedrock was encountered at approximately 14 mbgs.
Depth to the Water Table	No ground water levels were available for review.

5 Ground Water Elevations

No monitoring wells are currently present on site. Groundwater elevations will be measured after monitoring wells have been installed at the site.

The unstabilized ground water table was observed by Soil Engineers Ltd. on September 23, 2016 in BH5. It was measured at approximately 6.4 mbgs (Elevation 160.5 m). A visual inspection of the slope and Mimico Creek, roughly supports the water table being at an elevation of 160.5 m.

6 Hydraulic Conductivity

6.1 Single-Well Response Tests

No monitoring wells are currently present on site. Single-well response tests will be conducted on all monitoring wells after they have been installed at the site.

6.2 Soil Grain Size Distribution

The hydraulic conductivities of various soil types can also be estimated from grain size analyses. An assessment of the grain sizes was conducted using the excel-based tool, HydrogeoSieve XL (*HydrogeoSieve XL ver.2.2, J.F. Devlin, University of Kansas, 2015*). HydrogeoSieve XL compares the results of the grain size analyses against fifteen (15) different analytical methods.

Given our experience in the area as well as published literature, some of the geometric means provided for the soil were biased low by one or more methods. In these instances, the values determined by these methods were excluded from the mean. The table below illustrates the hydraulic conductivity values estimated from the mean of the analytical methods where the soil met the applicable analysis criteria.

Sample ID	Soil Description	Applicable Analysis Methods	Hydraulic Conductivity (m/s)
BH2-SS1A	Granular fill	Slichter, Terzaghi, Sauerbrei, Zunker, Zamarin, Barr, Alyamani and Sen	3×10^{-4}
BH2-SS2	Silty clay (disturbed native)	Alyamani and Sen	2×10^{-8}
BH1-SS3	Silty clay till	Alyamani and Sen, Barr, Sauerbrei	7×10^{-9}
BH4-SS6	Silty clay till	Alyamani and Sen, Barr, Sauerbrei	2×10^{-9}
BH6-SS5	Silty clay till	Alyamani and Sen, Barr, Sauerbrei	8×10^{-9}
BH1-SS8	Sandy silt till	Alyamani and Sen, Barr, Sauerbrei	9×10^{-8}

The results of the analyses are presented in Appendix D.

6.3 Literature

According to Freeze and Cherry (1979), the typical hydraulic conductivity of the strata investigated at the site are:

Stratum/Formation	Hydraulic Conductivity (m/s)
Earth Fill	1 x 10^{-4} to 1 x 10^{-6}
Silty Clay	1 x 10^{-7} to 1 x 10^{-10}
Sandy Silt Till	1 x 10^{-6} to 1 x 10^{-8}

7 Proposed Construction Method

The proposed shoring at the site is unknown at the time or writing this report.

The following assumptions have been made about the proposed shoring plan for the purpose of this report:

- The proposed shoring at the site will consist of conventional soldier piling and lagging.
- The proposed structures will consist of a drained foundation.

8 Private Water Drainage System (PWDS)

If the proposed development is designed as a leak tight structure, then a private water drainage system will not be required. However, the structure must then be designed to resist hydrostatic pressure and uplift forces.

If the proposed development is not a leak tight structure, then a private water drainage system will be required. The total sub floor drain area will be approximately 5310 m^2 based on the drawings which have been provided.

If the development is designed with a private water drainage system, the drainage system is a critical structural element since it keeps water pressure from acting on the basement walls and floor slab. As such, the sump that ensures the performance of this system must have a duplexed pump arrangement for 100% pumping redundancy and these pumps must be on emergency power. The size of the sump should be adequate to accommodate the estimated groundwater seepage. It is anticipated that the groundwater seepage can be controlled with typical, widely available, commercial/residential sump pumps.

9 Groundwater Extraction and Discharge

Groundwater seepage estimates were conducted for both short-term and long-term dewatering scenarios. The modeling was conducted using an equivalent well radius approximation. The

Excel-based calculation for groundwater seepage indicates the short-term (construction) and long-term (permanent) dewatering requirements as provided below. Since there are no monitoring wells currently on site, the calculations for seepage are considered preliminary rough estimates, based on literature values, that will need to be refined later. The results are presented in Appendix E.

The groundwater seepage estimates, which have been provided, represent the steady state ground water seepage. There will be an initial drawdown of the groundwater before a steady state condition is reached. The rate of the initial drawdown, and therefore discharge, is dependent on the dewatering contractor and how the groundwater is being dealt with at the site. An estimate initial volume of stored groundwater which will require removal before steady state is reached has been provided below.

Please note that if excavation is exposed to the elements, storm water will have to be managed. The short-term control of groundwater should consider stormwater management from rainfall events. A dewatering system should be designed to consider the removal of rainfall from excavation. A design storm of 25 mm has been used in the quantity estimates.

As required by Ontario Regulation 63/16, a plan for discharge must consider the conveyance of storm water from a 100-year storm. The additional volume that will be generated in the occurrence of a 100-year storm event is approximately 500,000 L.

Stored Groundwater (pre-excavation/dewatering)			
Volume of Excavation (m^3)	**Volume of Excavation Below Water Table (m^3)**	**Volume of Storage Groundwater (m^3)**	**Volume of Storage Groundwater (L)**
52,038	22,833	8,762	8,762,000

Preliminary Short Term (Construction) Groundwater Quantity Estimate – Safety Factor of 2.0 Used					
Ground Water Seepage		**Design Rainfall Event (25mm)**		**Total Daily Water Takings**	
L/day	**L/min**	**L/day**	**L/min**	**L/day**	**L/min**
105,000	72.9	135,000	93.8	240,000	166.7

Preliminary Long Term (Permanent) Groundwater Quantity Estimate – Safety Factor of 2.0 Used					
Ground Water Seepage		**Infiltration Design Rainfall Event (25mm)**		**Total Daily Water Takings**	
L/day	**L/min**	**L/day**	**L/min**	**L/day**	**L/min**
110,000	76.4	20,000	13.9	130,000	90.3

Regulatory Requirements	
Environmental Activity and Sector Registry (EASR) Posting	Required
Short Term Permit to Take Water (PTTW)	Not Required
Long Term Permit to Take Water (PTTW)	Required

Please note:

- The native soils must be dewatered a minimum of 1 m below the footing elevation prior to excavation to preserve the in-situ integrity of the native soils during construction dewatering activities. It is anticipated that the groundwater elevation will rise to the elevation of the subfloor drainage in the event of a drained structure or the waterproofing in the event of a leak tight structure.
- The proposed pump schedule for short-term construction dewatering has not been completed. As such the actual peak short-term discharge rate is not available at the time of writing this report. The pump schedule must be specified by either the dewatering contractor retained or the mechanical consultant.
- The proposed pump schedule for long-term permanent drainage has not been completed. As such the actual peak long-term discharge rate is not available at the time writing of this report. The pump schedule must be specified by the mechanical consultant.
- Leak tight structure (structure that has not included a private water drainage system) has not been considered as part of the proposed development at this time.

- On-site containment (infiltration gallery/dry well etc.) has not been considered as part of the proposed development at this time. If this option is considered additional work will have to be conducted (i.e. infiltration testing).

10 Evaluation of Impact

10.1 Zone of Influence (ZOI)

The Zone of Influence (ZOI) with respect to ground water was calculated based on the estimated ground water taking rate and the hydraulic conductivity of the unit which water will be taken at the Property.

The ZOI was calculated using the Sichart equation below.

Equation: $R_0 = 3000*dH*K^{0.5}$

Where:

dH is the dewatering thickness (m)

K is the hydraulic conductivity (m/s)

Calculation:

The ZOI with respect to groundwater seepage at the site is:

West:

$R_0 = 3000*0.9\text{ m}*(1 \times 10^{-6})^{0.5}\text{ m/s} + 3000*4.6\text{ m}*(1 \times 10^{-7})^{0.5}\text{ m/s}$

$R_0 = \pm 7.1\text{ m}$

East:

$R_0 = 3000*5.5\text{ m}*(1 \times 10^{-7})^{0.5}\text{ m/s}$

$R_0 = \pm 5.2\text{ m}$

10.2 Land Stability

The impacts to land stability of the proposed short term and long term dewatering at the site on adjacent structures are summarized as follows:

- The proposed dewatering at the subject site locally lowers the ground water table within the ZOI by a maximum of 7.1 m. This has the potential imply an increase of effective stress of approximately 54 kPa in the native soils.

- Based on the change in effective stress and the compressibility of the soil subjected to that change, the proposed dewatering activities will induce a maximum 6 mm of additional settlement in the adjacent soils.
- The maximum induced settlement occurs directly adjacent to the proposed excavation and decreases in a nonlinear fashion with distance away from the excavation.
- For the structures within the public realm adjacent to the site, the dewatering-induced settlement is calculated to be 3 mm or less (depending on the depth of the structure).

On this basis, the impact of the proposed dewatering on the existing adjacent structures is considered by Grounded to be within acceptable limits.

10.3 City's Sewage Works

Negative impacts to City's sewage works may occur in terms of the quantity or quality of the groundwater discharged. This report provided the estimated quantity of the water discharge. However, this report does not speak to the sewer capacities. The sewer capacity analysis is provided under a separate cover by the civil consultant.

The quality of the proposed groundwater discharge will be provided in a future report, after monitoring wells at the site have been installed and tested.

10.4 Natural Environment

There are no natural waterbodies within the ZOI that will be caused by the proposed construction dewatering or permanent drainage. Any groundwater which will be taken from the site will be discharged (if required) into the City's sewer systems and not into any natural water body. As such, there will be no impact to the natural environment caused by the water takings at the site.

10.5 Local Drinking Water Wells

The site is located within the municipal boundaries of the City of Mississauga. The site and surrounding area are provided with municipal piped water and sewer supply. There is no use of the ground water for water supply in this area of Mississauga. As such, there will be no impact to drinking water wells

10.6 Contamination Source

The site and immediately surrounding area currently consist mostly of residential and commercial areas. Some commercial land use, like gas stations or dry cleaners have the potential to be a source of potential contamination and can provide an Area of Potential Environmental Concern for the site. As such, the pumping of groundwater at the site has the potential to facilitate the movement of potential contaminants onto the site. Evaluation of the environmental condition of the site will be completed under a separate cover.

11 Proposed Mitigation Measures and Monitoring Plan

The extent of the negative impact identified in pervious sections and will be limited to the ZOI caused by the groundwater taking at the site.

As a result of dewatering and draining the soil, changes in ground water level have the potential to cause settlement based on the change in the effective stresses within the ZOI.

If adjacent buildings or municipal infrastructure are within the ZOI and will undergo settlement that may be considered unacceptable as identified the Land Stability Section, consideration should be given to implement a monitoring and mitigation program during dewatering activities.

Both the temporary construction dewatering system and the permanent building drainage system must be properly installed and screened to ensure sediments and fines will not be removed, which is typically a primary cause of dewatering related settlement.

12 Limitations

No monitoring wells are currently present on site. Monitoring wells will be installed in the future to confirm the findings of this report.

Natural occurrences, the passage of time, local construction, and other human activity all have the potential to directly or indirectly alter the subsurface conditions at or near the project site. Contractual obligations related to groundwater or stormwater control must be considered with attention and care as they relate this potential site alteration.

The hydrogeological engineering advice provided in this report is based on the factual observations made from the site investigations as reported. It is intended for use by the owner and their retained design team. If there are changes to the features of the development or to the scope, the interpreted subsurface information, geotechnical engineering design parameters, advice, and discussion on construction considerations may not be relevant or complete for the project. Grounded should be retained to review the implications of such changes with respect to the contents of this report.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Grounded accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report, including consequential financial effects on transactions or property values, or requirements for follow-up actions and costs.

12.1 Report Use

The authorized users of this report are 7085 Goreway Developments Limited and their design team, for whom this report has been prepared. Grounded Engineering Inc. maintains the copyright and ownership of this document. Reproduction of this report in any format or medium requires explicit prior authorization from Grounded Engineering Inc. The City of Toronto may also make use of and rely upon this report, subject to the limitations as stated.

13 Closure

If there are any questions regarding the discussion and advice provided, please do not hesitate to contact our office. We trust that this report meets your requirements at present.

For and on behalf of our team,

GROUNDED
ENGINEERING

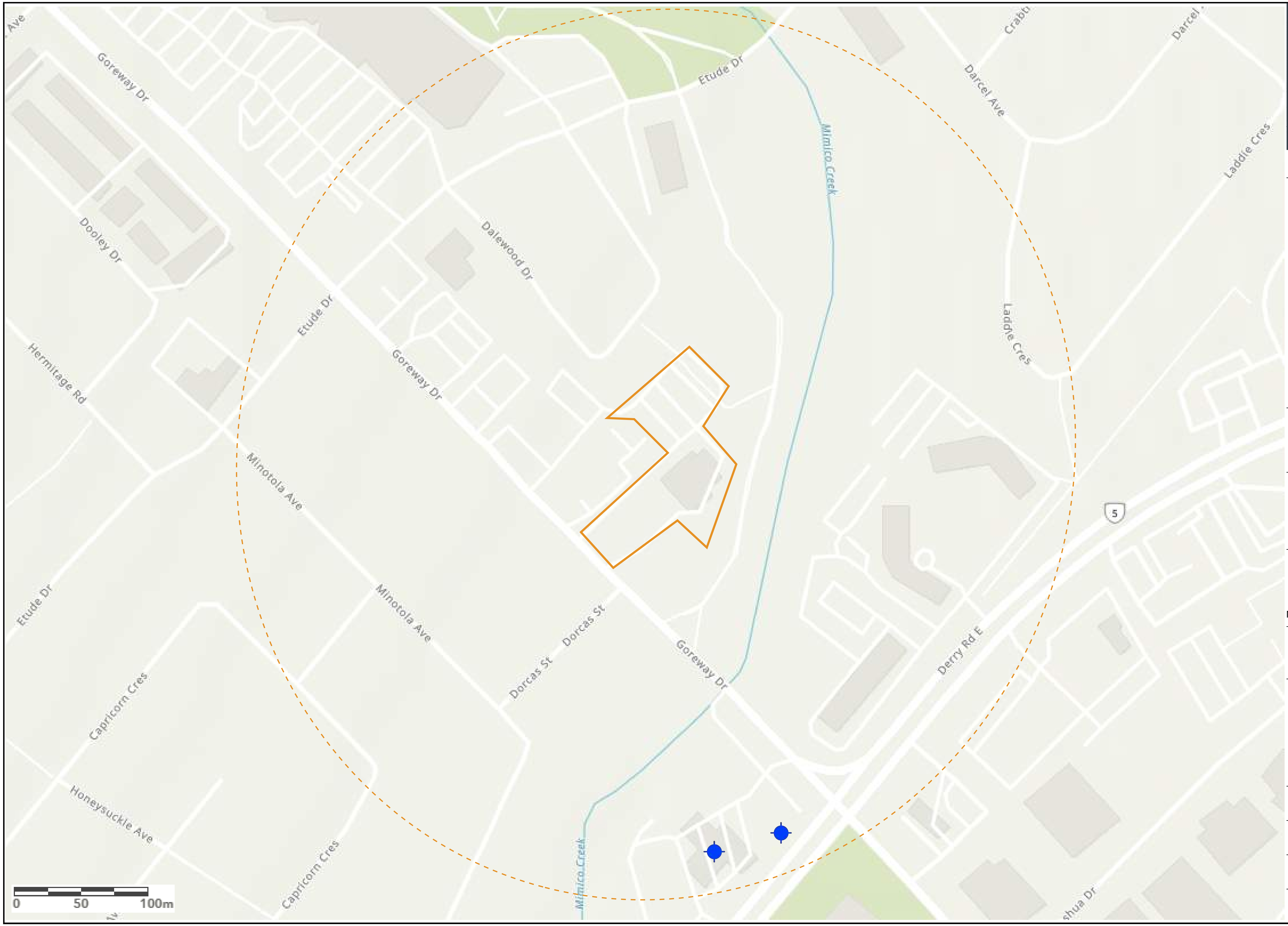
LICENSED PROFESSIONAL ENGINEER
M. J. BIELASKI
100131738
2020-04-21
PROVINCE OF ONTARIO

TARAKALi

Tarak Ali, EIT

Matthew Bielaski, P.Eng., $QP_{ESA\text{-}RA}$
Principal

FIGURES



GROUNDED
ENGINEERING

12 Banigan Drive, Toronto, Ont., M4H 1E9
www.groundedeng.ca

LEGEND

— SITE BOUNDARY

- - STUDY AREA (250 m RADIUS)

● MECP WELL LOCATION

Note

Reference
ArcGIS, 2020

Project
PRELIMINARY HYDROGEOLOGICAL STUDY
7085 GOREWAY DRIVE,
MISSISSAUGA, ONTARIO, L4T 3X6

Figure Title
SITE LOCATION PLAN

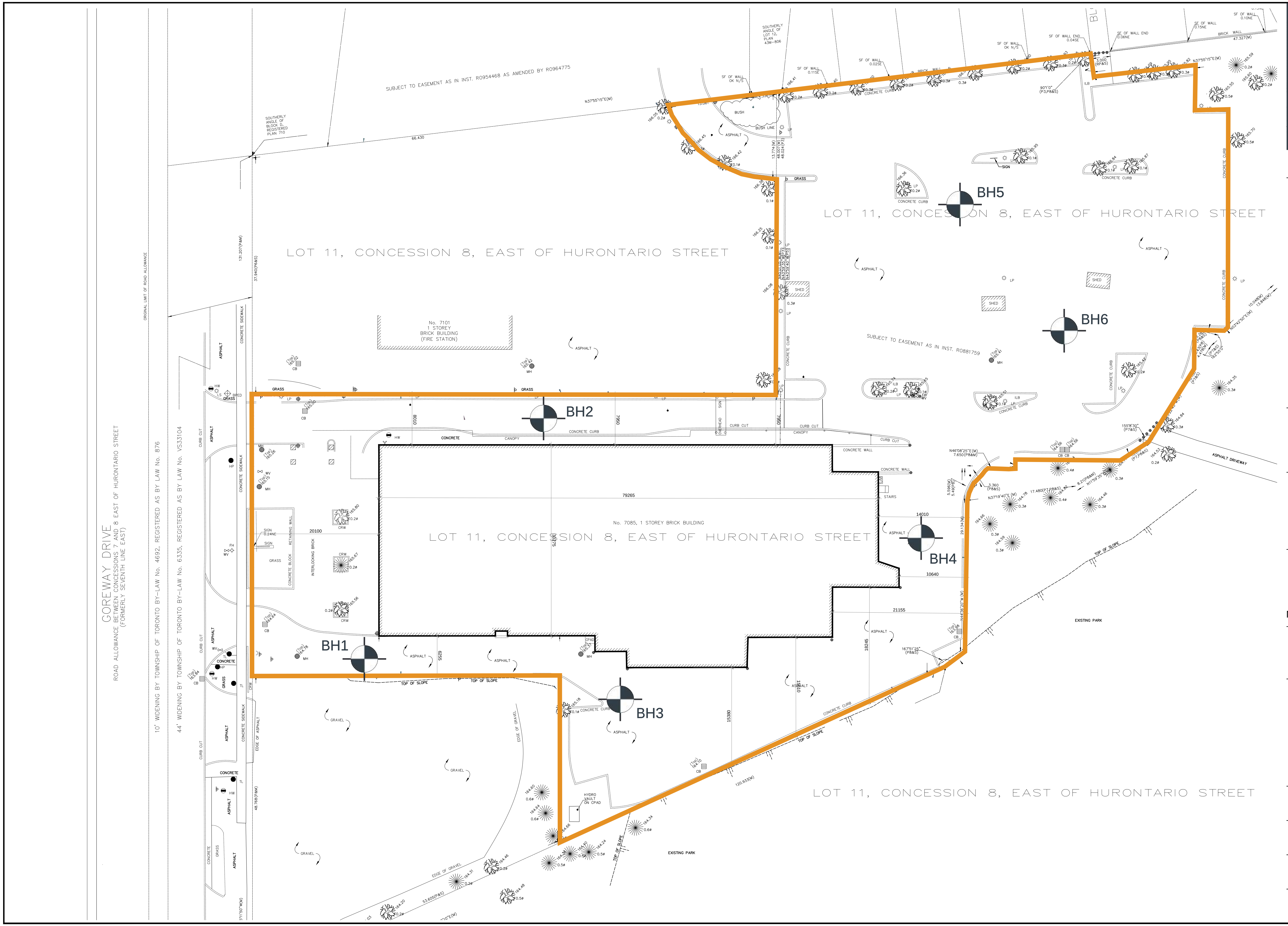
North
TRUE
PROJECT

Date
APRIL 2020

Scale
AS INDICATED

Job No
19-040

Figure No
FIGURE 1



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LEGEND

―	SITE BOUNDARY
⊕	BOREHOLE (SOIL ENGINEERS LTD. 2016)

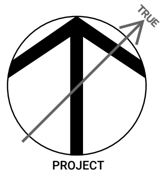
Note

Reference
Survey Drawing Reference no. 17-103BT01.
Date: JUNE 20, 2017.
Prepared by KRCMAR Surveyors Ltd.
Received on November 26, 2019.

Project
PRELIMINARY HYDROGEOLOGICAL STUDY
7085 GOREWAY DRIVE,
MISSISSAUGA, ONTARIO, L4T 3X6

Figure Title
BOREHOLE LOCATION PLAN

North

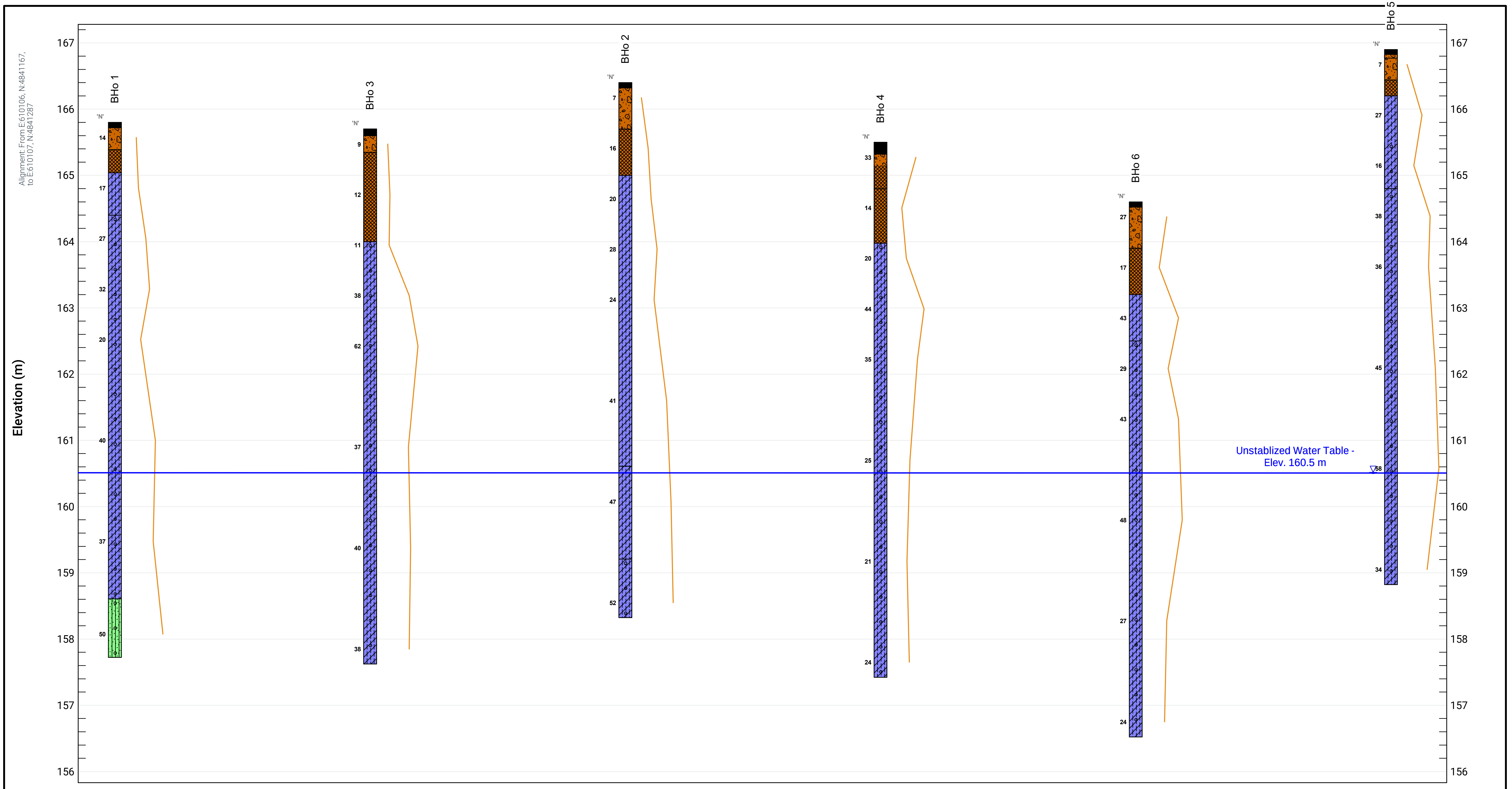


Date
APRIL 2020

Scale
N.T.S.

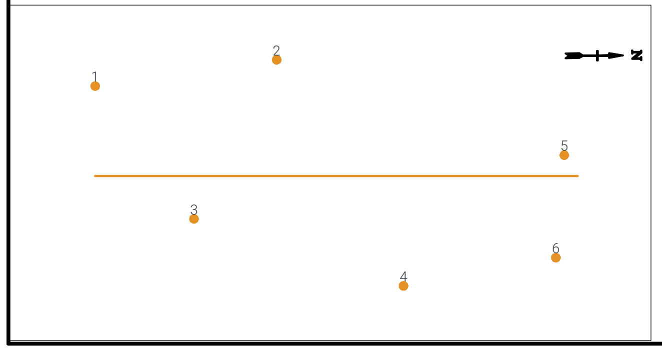
Job No
19-040

Figure No
FIGURE 2



Boreholes Equally Spaced

SITE MAP



LITHOLOGY GRAPHIC LEGEND

- ■ Asphalt
- ▨ Silty Clay Till
- ▨ Aggregate
- ▨ Sandy Silt Till
- ▩ Fill
- ▨ Silty Clay

▽ water level, unstabilized

▼ water level, stabilized

- 🟧 FILL
- 🟩 COHESIONLESS TILLS
- 🟧 GRAVELS (gravel to gravelly sand)
- 🟪 COHESIVE SOILS (clayey silt to clay, incl. tills)
- 🟨 SILT TO SAND (not till)
- 🟦 DISTURBED/REWORKED SOILS

GROUNDED
ENGINEERING

Title: **HYDROLOGIC CROSS-SECTION**

File No.: **19-040**

FIGURE: **3**

APPENDIX A

LIST OF ABBREVIATIONS AND DESCRIPTION OF TERMS

The abbreviations and terms commonly employed on the borehole logs and figures, and in the text of the report, are as follows:

SAMPLE TYPES

AS	Auger sample
CS	Chunk sample
DO	Drive open (split spoon)
DS	Denison type sample
FS	Foil sample
RC	Rock core (with size and percentage recovery)
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

PENETRATION RESISTANCE

Dynamic Cone Penetration Resistance:

A continuous profile showing the number of blows for each foot of penetration of a 2-inch diameter, 90° point cone driven by a 140-pound hammer falling 30 inches.

Plotted as '—●—'

Standard Penetration Resistance or 'N' Value:

The number of blows of a 140-pound hammer falling 30 inches required to advance a 2-inch O.D. drive open sampler one foot into undisturbed soil.

Plotted as '○'

WH	Sampler advanced by static weight
PH	Sampler advanced by hydraulic pressure
PM	Sampler advanced by manual pressure
NP	No penetration

SOIL DESCRIPTION

Cohesionless Soils:

'N' (blows/ft)	Relative Density
0 to 4	very loose
4 to 10	loose
10 to 30	compact
30 to 50	dense
over 50	very dense

Cohesive Soils:

Undrained Shear Strength (ksf)	'N' (blows/ft)	Consistency
less than 0.25	0 to 2	very soft
0.25 to 0.50	2 to 4	soft
0.50 to 1.0	4 to 8	firm
1.0 to 2.0	8 to 16	stiff
2.0 to 4.0	16 to 32	very stiff
over 4.0	over 32	hard

Method of Determination of Undrained Shear Strength of Cohesive Soils:

x 0.0 Field vane test in borehole; the number denotes the sensitivity to remoulding

△ Laboratory vane test

☐ Compression test in laboratory

For a saturated cohesive soil, the undrained shear strength is taken as one half of the undrained compressive strength

METRIC CONVERSION FACTORS

1 ft = 0.3048 metres

1lb = 0.454 kg

1 inch = 25.4 mm

1ksf = 47.88 kPa

Soil Engineers Ltd.
CONSULTING ENGINEERS
GEOTECHNICAL • ENVIRONMENTAL • HYDROGEOLOGICAL • BUILDING SCIENCE

Job Number: 1609-S061

LOG OF BOREHOLE NO.: 1

Figure No.: 1

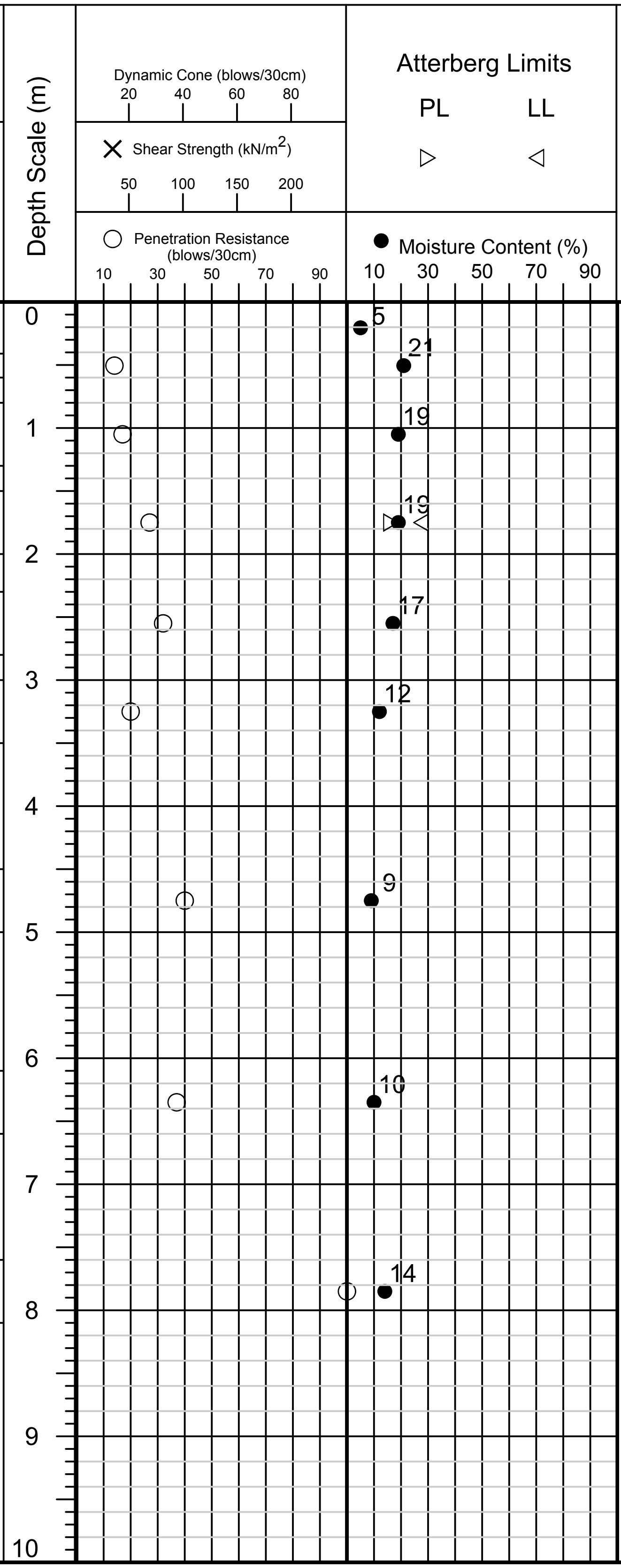
Project Description: Proposed Property Acquisition

Job Location: 7085 Goreway Drive, City of Mississauga

Method of Boring: Flight-Auger

Drilling Date: September 26, 2016

Elevation (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	Water Level
165.8	Pavement Surface				
0.0	80 mm **ASPHALTIC CONCRETE** 330 mm **GRANULAR, Fill**	1A	DO		
	Brown, stiff to very stiff	1B	DO	14	
	weathered				
	SILTY CLAY	2	DO	17	
164.4 1.4	Very stiff to hard	3	DO	27	
		4	DO	32	
	brown grey	5	DO	20	
	SILTY CLAY, Till occ. wet sand and silt seams and layers, cobbles and boulders	6	DO	40	Dry on completion
		7	DO	37	
158.6 7.2	Grey, very dense **SANDY SILT, Till**	8	DO	50/8	
157.7 8.1	END OF BOREHOLE				



SOIL ENGINEERS LTD.

Job Number: 1609-S061

LOG OF BOREHOLE NO.: 2

Figure No.: 2

Project Description: Proposed Property Acquisition

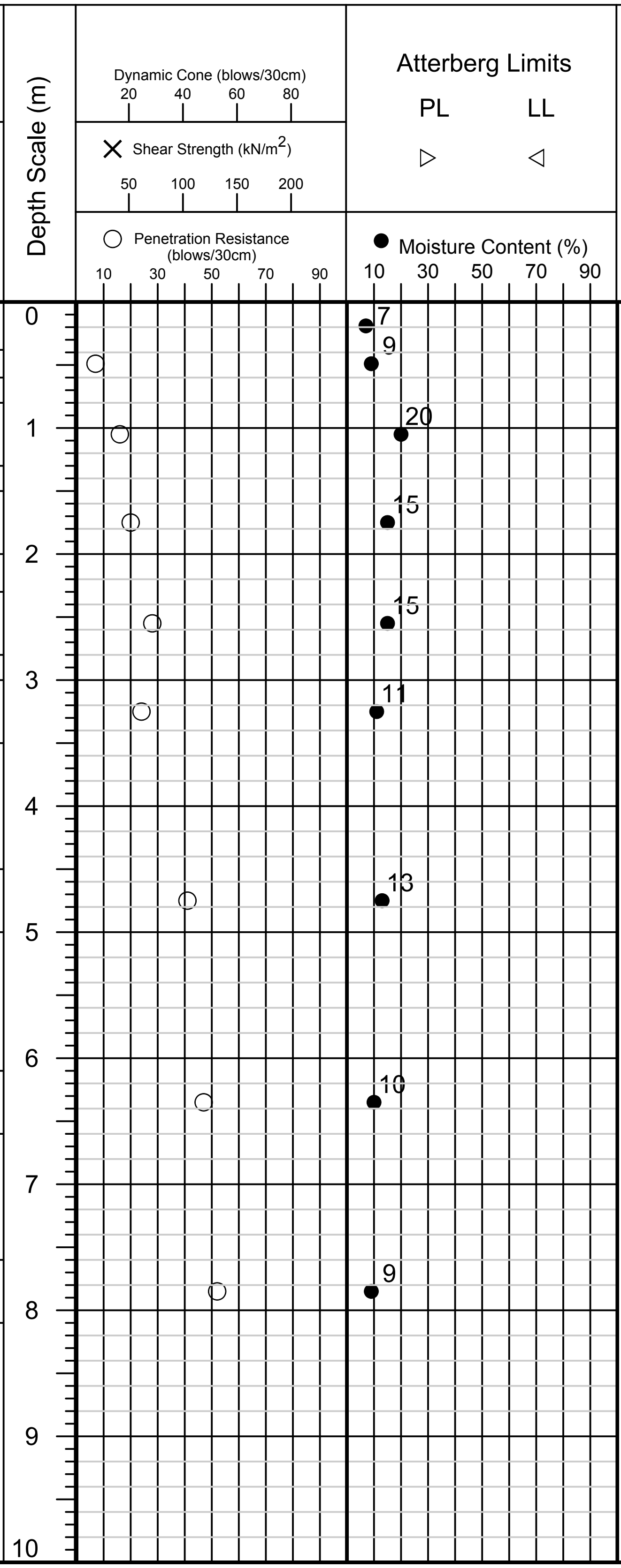
Job Location: 7085 Goreway Drive, City of Mississauga

Method of Boring: Flight-Auger

Drilling Date: September 23, 2016

Elevation (m)	SOIL DESCRIPTION
166.4	Pavement Surface
0.0	80 mm **ASPHALTIC CONCRETE** 620 mm **GRANULAR, Fill**
	Brown **SILTY CLAY, Fill**
165.0 1.4	Very stiff to hard **SILTY CLAY, Till** occ. wet sand and silt seams and layers, cobbles and boulders brown grey
160.6 5.8	Grey, hard **SILTY CLAY**
159.2 7.2	Grey, hard **SILTY CLAY, Till**
158.3 8.1	END OF BOREHOLE

SAMPLES			
Number	Type	N-Value	Moisture Content (%)
1A	DO		7
1B	DO	7	9
2	DO	16	20
3	DO	20	15
4	DO	28	15
5	DO	24	11
6	DO	41	13
7	DO	47	10
8	DO	52	9



Water Level

Dry on completion

SOIL ENGINEERS LTD.

Job Number: 1609-S061

LOG OF BOREHOLE NO.: 3

Figure No.: 3

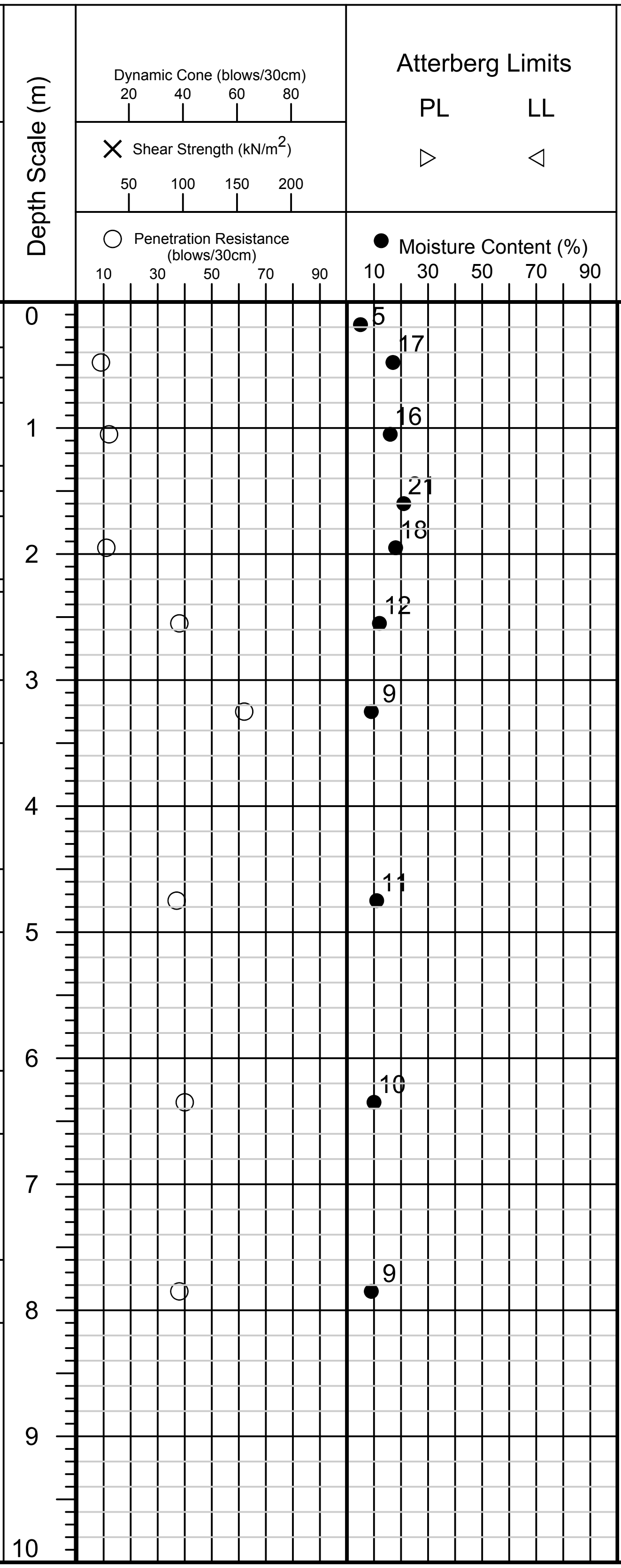
Project Description: Proposed Property Acquisition

Job Location: 7085 Goreway Drive, City of Mississauga

Method of Boring: Flight-Auger

Drilling Date: September 23, 2016

Elevation (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
165.7	Pavement Surface			
0.0	100 mm **ASPHALTIC CONCRETE** 250 mm **GRANULAR, Fill**	1A	DO	
	Brown/grey	1B	DO	9
	SILTY CLAY, Fill	2	DO	12
164.0		3A	DO	
1.7	Stiff to hard	3B	D0	11
	weathered	4	DO	38
		5	DO	62
	SILTY CLAY, Till occ. wet sand and silt seams and layers, cobbles and boulders brown grey	6	DO	37
		7	DO	40
157.6		8	DO	38
8.1	END OF BOREHOLE			



Water Level

Dry on completion

SOIL ENGINEERS LTD.

Job Number: 1609-S061

LOG OF BOREHOLE NO.: 4

Figure No.: 4

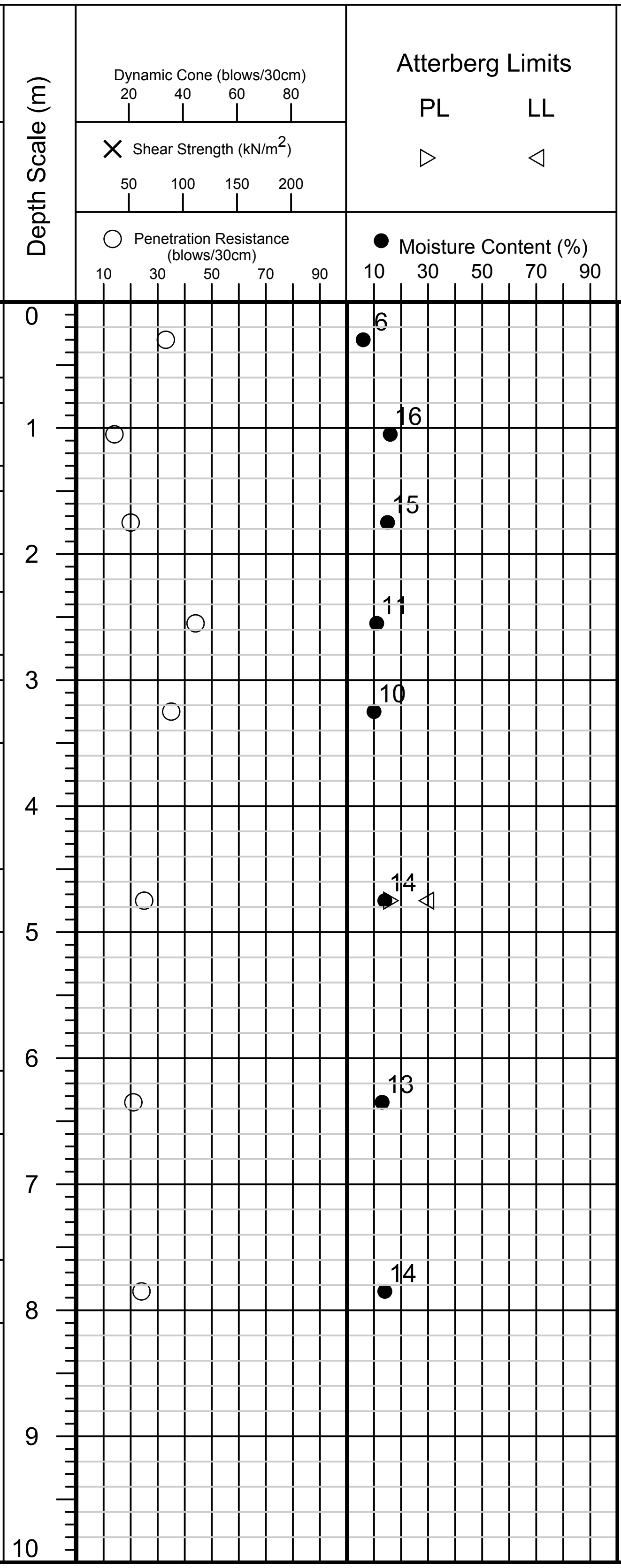
Project Description: Proposed Property Acquisition

Job Location: 7085 Goreway Drive, City of Mississauga

Method of Boring: Flight-Auger

Drilling Date: September 26, 2016

Elevation (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
165.5	Pavement Surface			
0.0	180 mm **ASPHALTIC CONCRETE** 520 mm **GRANULAR, Fill**	1	DO	33
	Stiff to hard	2	DO	14
	weathered	3	DO	20
	SILTY CLAY, Till occ. wet sand and silt seams and layers, cobbles and boulders	4	DO	44
	brown grey	5	DO	35
		6	DO	25
		7	DO	21
157.4		8	DO	24
8.1	END OF BOREHOLE			



Water Level

Dry on completion

Job Number: 1609-S061

LOG OF BOREHOLE NO.: 5

Figure No.: 5

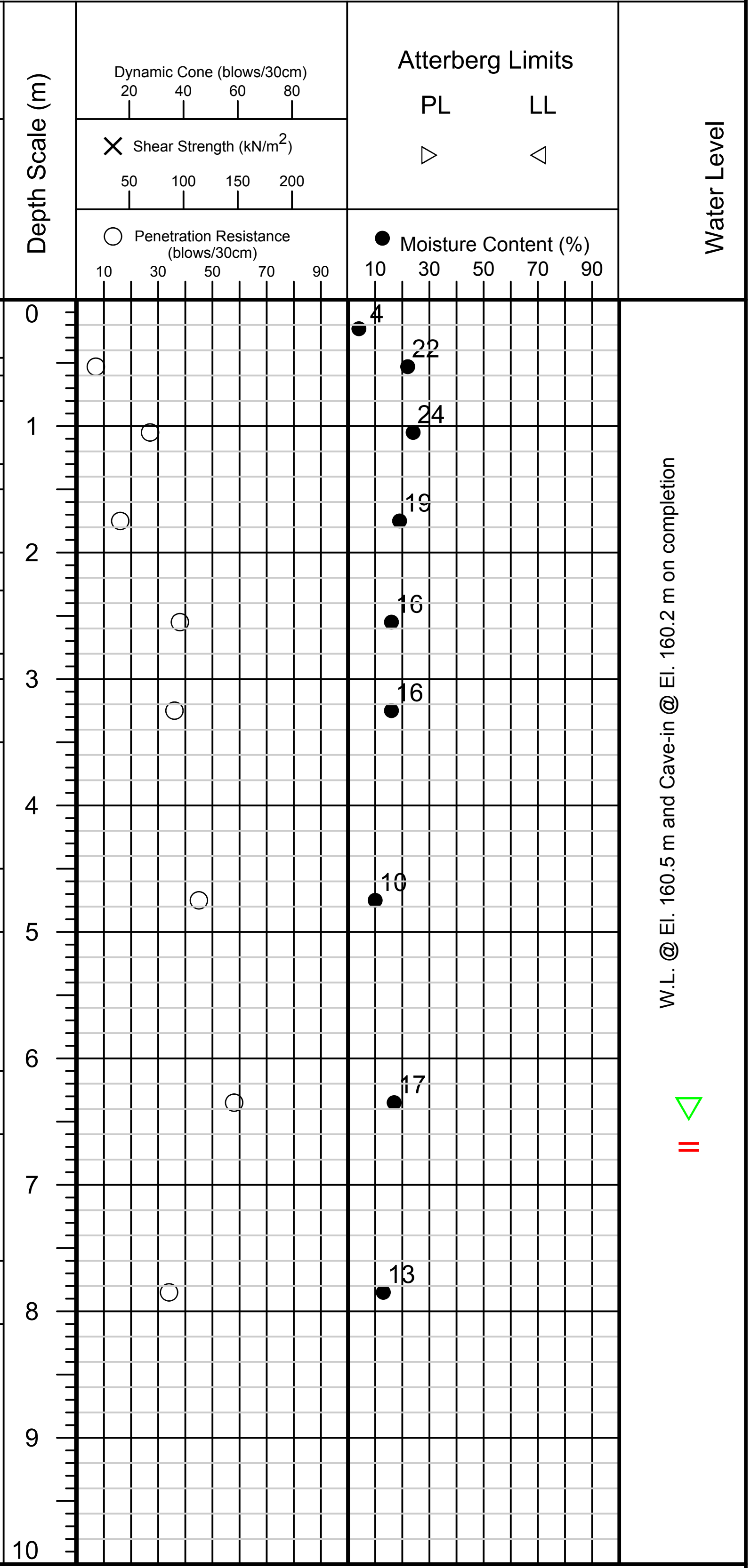
Project Description: Proposed Property Acquisition

Job Location: 7085 Goreway Drive, City of Mississauga

Method of Boring: Flight-Auger

Drilling Date: September 23, 2016

Elevation (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
166.9	Pavement Surface			
0.0	130 mm **ASPHALTIC CONCRETE** 330 mm **GRANULAR, Fill**	1A	DO	
	Brown **SILTY CLAY, Fill**	1B	DO	7
166.2 0.7	Brown, stiff to very stiff **SILTY CLAY** occ. wet sand and silt seams and layers	2	DO	27
		3	DO	16
164.8 2.1	Hard **SILTY CLAY, Till** occ. wet sand and silt seams and layers, cobbles and boulders brown grey	4	DO	38
		5	DO	36
		6	DO	45
		7	DO	58
		8	DO	34
158.8 8.1	END OF BOREHOLE			



W.L. @ El. 160.5 m and Cave-in @ El. 160.2 m on completion

Job Number: 1609-S061

LOG OF BOREHOLE NO.: 6

Figure No.: 6

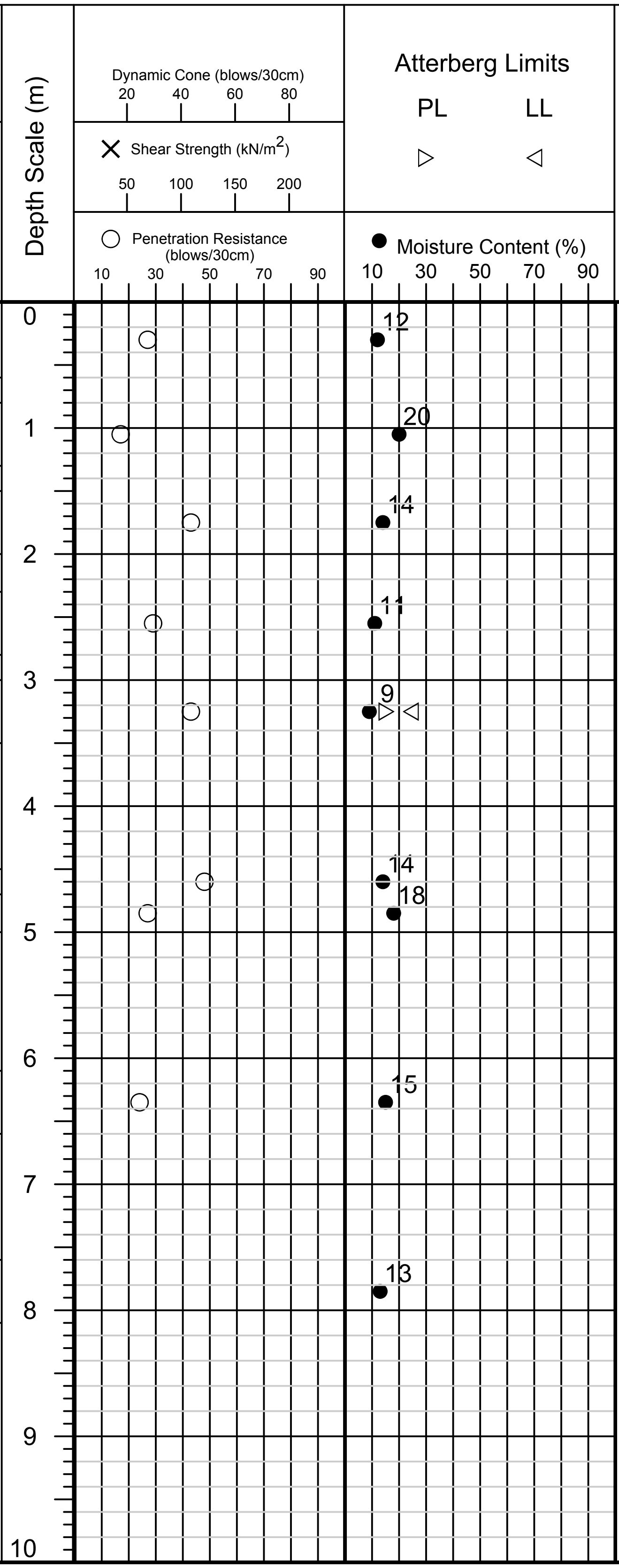
Project Description: Proposed Property Acquisition

Job Location: 7085 Goreway Drive, City of Mississauga

Method of Boring: Flight-Auger

Drilling Date: September 26, 2016

Elevation (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)	Moisture Content (%)	Water Level
166.0	Pavement Surface						
0.0	80 mm **ASPHALTIC CONCRETE** 620 mm **GRANULAR, Fill**	1	DO	27	0	12	
	Brown **SILTY CLAY, Fill**	2	DO	17	1	20	
164.6 1.4	Brown, hard **SILTY CLAY**	3	DO	43		14	
163.9 2.1	Very stiff to hard	4	DO	29	2	11	
	brown grey	5	DO	43	3	9	
	SILTY CLAY, Till occ. wet sand and silt seams and layers, cobbles and boulders	6A	DO		4	14	Dry on completion
	sandy silt layer	6B	DO	48		18	
		7	DO	27	6	15	
157.9 8.1	END OF BOREHOLE	8	DO	24	8	13	



SOIL ENGINEERS LTD.

APPENDIX B

Water Well Records

April 20, 2020

4:37:59 PM

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
MISSISSAUGA CITY	17 610138 4840947 W	2010-06 7215				TH	0010 10	7147719 (Z116304) A100062	BRWN FILL ---- 0004 BRWN SAND SLTY WBRG 0013 GREY SAND SLTY WBRG 0015
MISSISSAUGA CITY HS E 07 011	17 610191 4840958 W	1952-01 4823	4					4902467 () A	BLUE CLAY 0047 BLUE SHLE 0048

Notes:
UTM: UTM in Zone, Easting, Northing and Datum is NAD83; L: UTM estimated from Centroid of Lot; W: UTM not from Lot Centroid
DATE CNTR: Date Work Completedand Well Contractor Licence Number
CASING DIA: .Casing diameter in inches
WATER: Unit of Depth in Fee. See Table 4 for Meaning of Code

PUMP TEST: Static Water Level in Feet / Water Level After Pumping in Feet / Pump Test Rate in GPM / Pump Test Duration in Hour : Minutes
WELL USE: See Table 3 for Meaning of Code
SCREEN: Screen Depth and Length in feet
WELL: WEL (AUDIT #) Well Tag . A: Abandonment; P: Partial Data Entry Only
FORMATION: See Table 1 and 2 for Meaning of Code

1. Core Material and Descriptive terms

Code	Description	Code	Description	Code	Description	Code	Description	Code	Description
BLDR	BOULDERS	FCRD	FRACTURED	IRFM	IRON FORMATION	PORS	POROUS	SOFT	SOFT
BSLT	BASALT	FGRD	FINE-GRAINED	LIMY	LIMY	PRDG	PREVIOUSLY DUG	SPST	SOAPSTONE
CGRD	COARSE-GRAINED	FGVL	FINE GRAVEL	LMSN	LIMESTONE	PRDR	PREV. DRILLED	STKY	STICKY
CGVL	COARSE GRAVEL	FILL	FILL	LOAM	TOPSOIL	QRTZ	QUARTZITE	STNS	STONES
CHRT	CHERT	FLDS	FELDSPAR	LOOS	LOOSE	QSND	QUICKSAND	STNY	STONEY
CLAY	CLAY	FLNT	FLINT	LTCL	LIGHT-COLOURED	QTZ	QUARTZ	THIK	THICK
CLN	CLEAN	FOSS	FOSILIFEROUS	LYRD	LAYERED	ROCK	ROCK	THIN	THIN
CLYY	CLAYEY	FSND	FINE SAND	MARL	MARL	SAND	SAND	TILL	TILL
CMTD	CEMENTED	GNIS	GNEISS	MGRD	MEDIUM-GRAINED	SHLE	SHALE	UNKN	UNKNOWN TYPE
CONG	CONGLOMERATE	GRNT	GRANITE	MGVL	MEDIUM GRAVEL	SHLY	SHALY	VERY	VERY
CRYS	CRYSTALLINE	GRSN	GREENSTONE	MRBL	MARBLE	SHRP	SHARP	WBRG	WATER-BEARING
CSND	COARSE SAND	GRVL	GRAVEL	MSND	MEDIUM SAND	SHST	SCHIST	WDFR	WOOD FRAGMENTS
DKCL	DARK-COLOURED	GRWK	GREYWACKE	MUCK	MUCK	SILT	SILT	WTHD	WEATHERED
DLMT	DOLOMITE	GVLY	GRAVELLY	OBDN	OVERBURDEN	SLTE	SLATE		
DNSE	DENSE	GYPS	GYPSUM	PCKD	PACKED	SLTY	SILTY		
DRTY	DIRTY	HARD	HARD	PEAT	PEAT	SNDS	SANDSTONE		
DRY	DRY	HPAN	HARDPAN	PGVL	PEA GRAVEL	SNDY	SANDYOAPSTONE		

2. Core Color

Code	Description
WHIT	WHITE
GREY	GREY
BLUE	BLUE
GREN	GREEN
YLLW	YELLOW
BRWN	BROWN
RED	RED
BLCK	BLACK
BLGY	BLUE-GREY

3. Well Use

Code	Description	Code	Description
DO	Domestic	OT	Other
ST	Livestock	TH	Test Hole
IR	Irrigation	DE	Dewatering
IN	Industrial	MO	Monitoring
CO	Commercial	MT	Monitoring TestHole
MN	Municipal		
PS	Public		
AC	Cooling And A/C		
NU	Not Used		

4. Water Detail

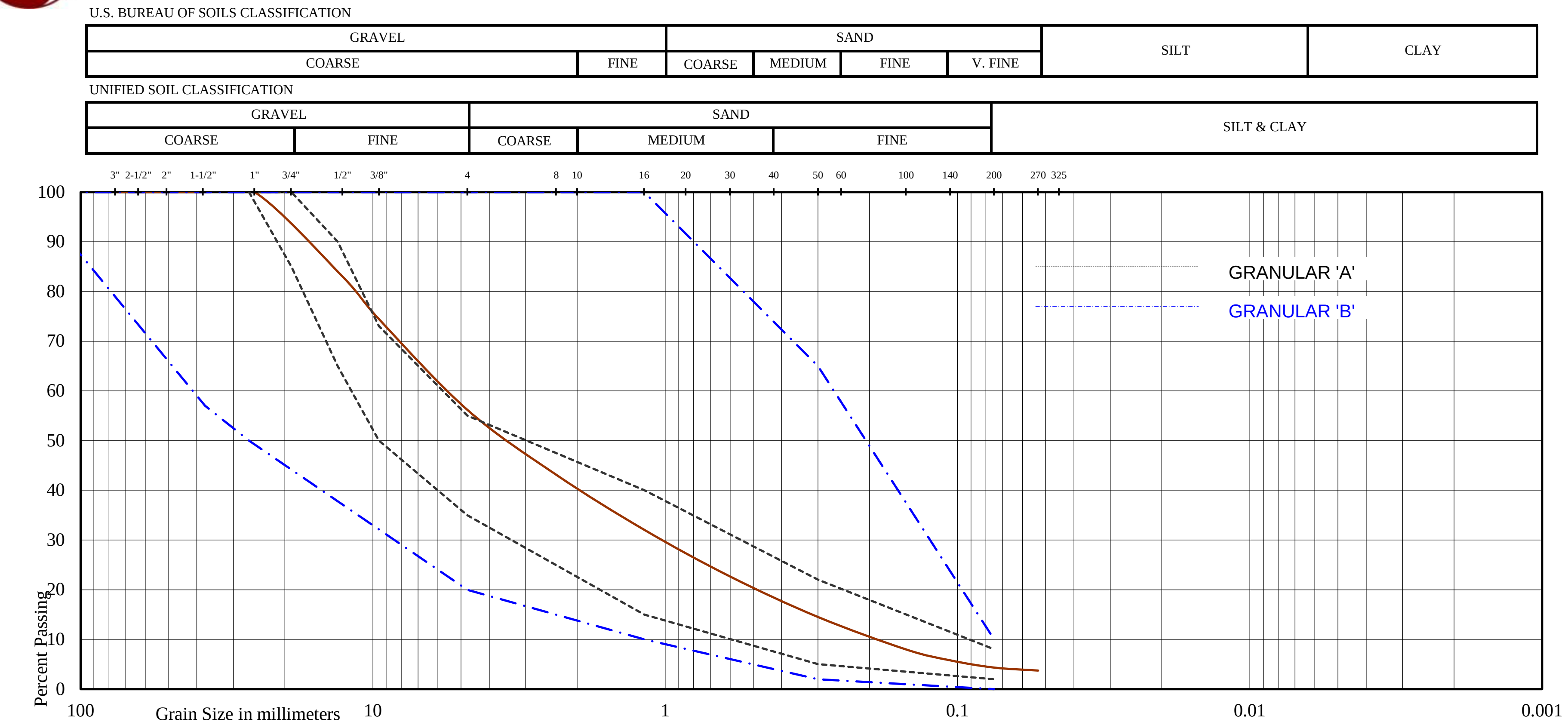
Code	Description	Code	Description
FR	Fresh	GS	Gas
SA	Salty	IR	Iron
SU	Sulphur		
MN	Mineral		
UK	Unknown		

APPENDIX C

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 1609-S061



Project: Proposed Property Acquistion

Location: 7085 Goreway Drive, City of Mississauga

Liquid Limit (%) = -

Plastic Limit (%) = -

Borehole No: 2

Plasticity Index (%) = -

Sample No: 1A

Moisture Content (%) = 7

Depth (m): 0.2

Estimated Permeability

Elevation (m): 166.2

(cm./sec.) = 10^{-2}

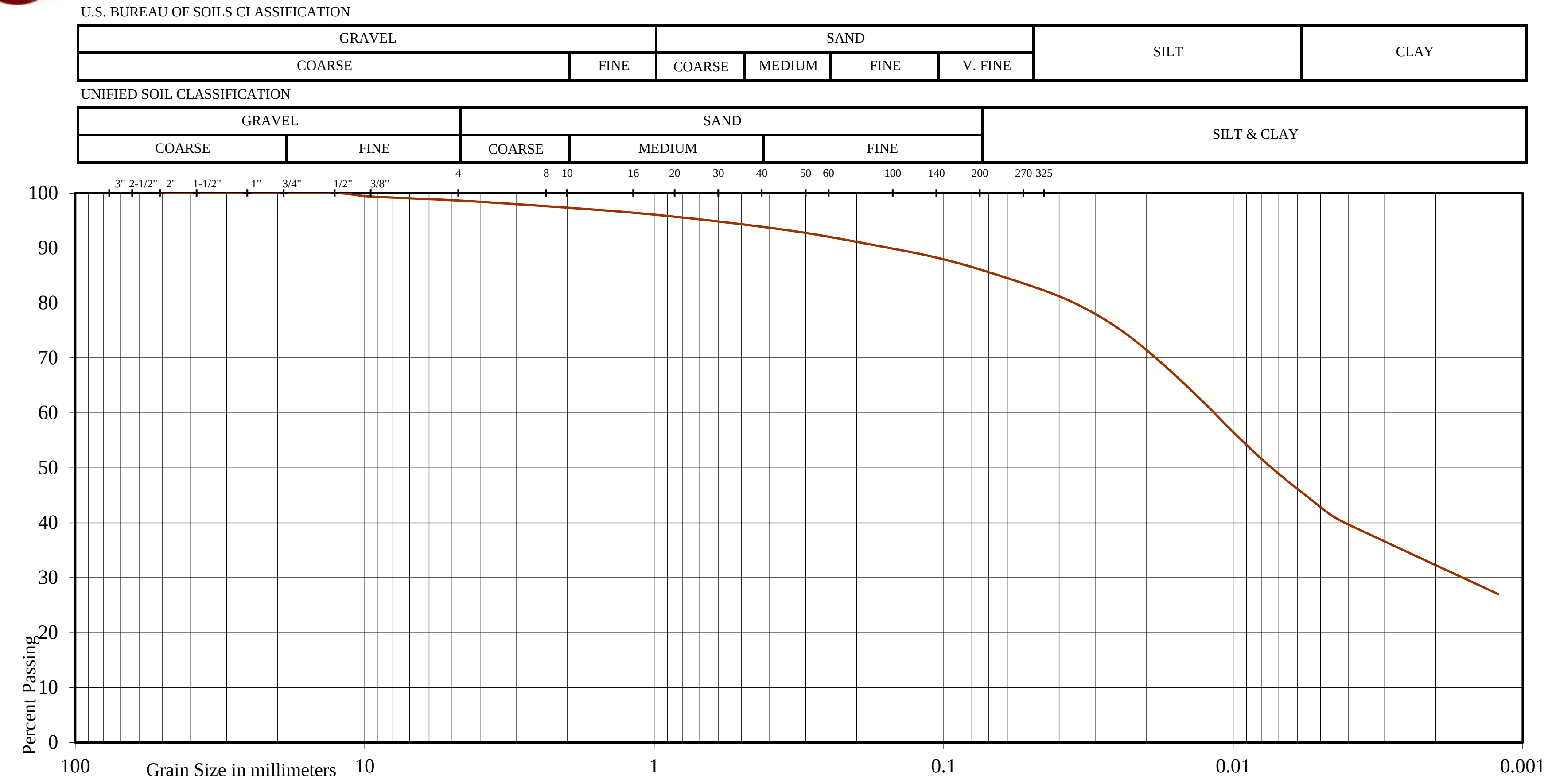
Classification of Sample [& Group Symbol]: GRANULAR, Fill

Figure: 7

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 1609-S061



Project: Proposed Property Acquistion

Location: 7085 Goreway Drive, City of Mississauga

Liquid Limit (%) =	-
Plastic Limit (%) =	-
Plasticity Index (%) =	-
Moisture Content (%) =	20
Estimated Permeability (cm./sec.) =	10^{-7}

Borehole No: 2

Sample No: 2

Depth (m): 1.1

Elevation (m): 165.3

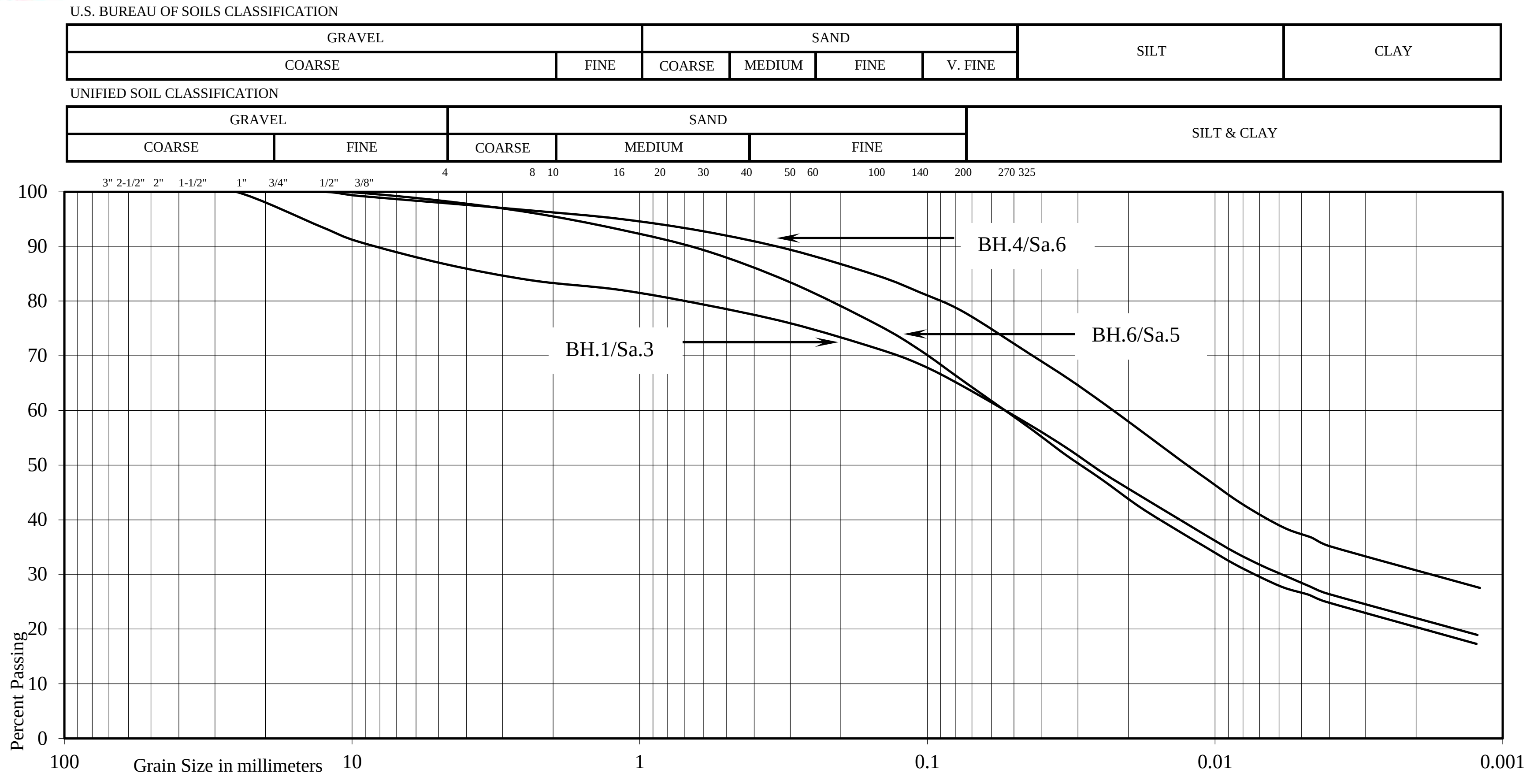
Classification of Sample [& Group Symbol]: SILTY CLAY, Fill
some sand, a tr. of gravel

Figure: 8

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 1609-S061



Project: Proposed Property Acquistion

Location: 7085 Goreway Drive, City of Mississauga

Borehole No:	1	4	6
Sample No:	3	6	5
Depth (m):	1.7	4.7	3.3
Elevation (m):	164.1	160.8	162.7

BH./Sa.	1/3	4/6	6/5
Liquid Limit (%) =	28	30	25
Plastic Limit (%) =	17	17	16
Plasticity Index (%) =	11	13	9
Moisture Content (%) =	19	14	9
Estimated Permeability (cm./sec.) =	10^{-7}	10^{-7}	10^{-7}

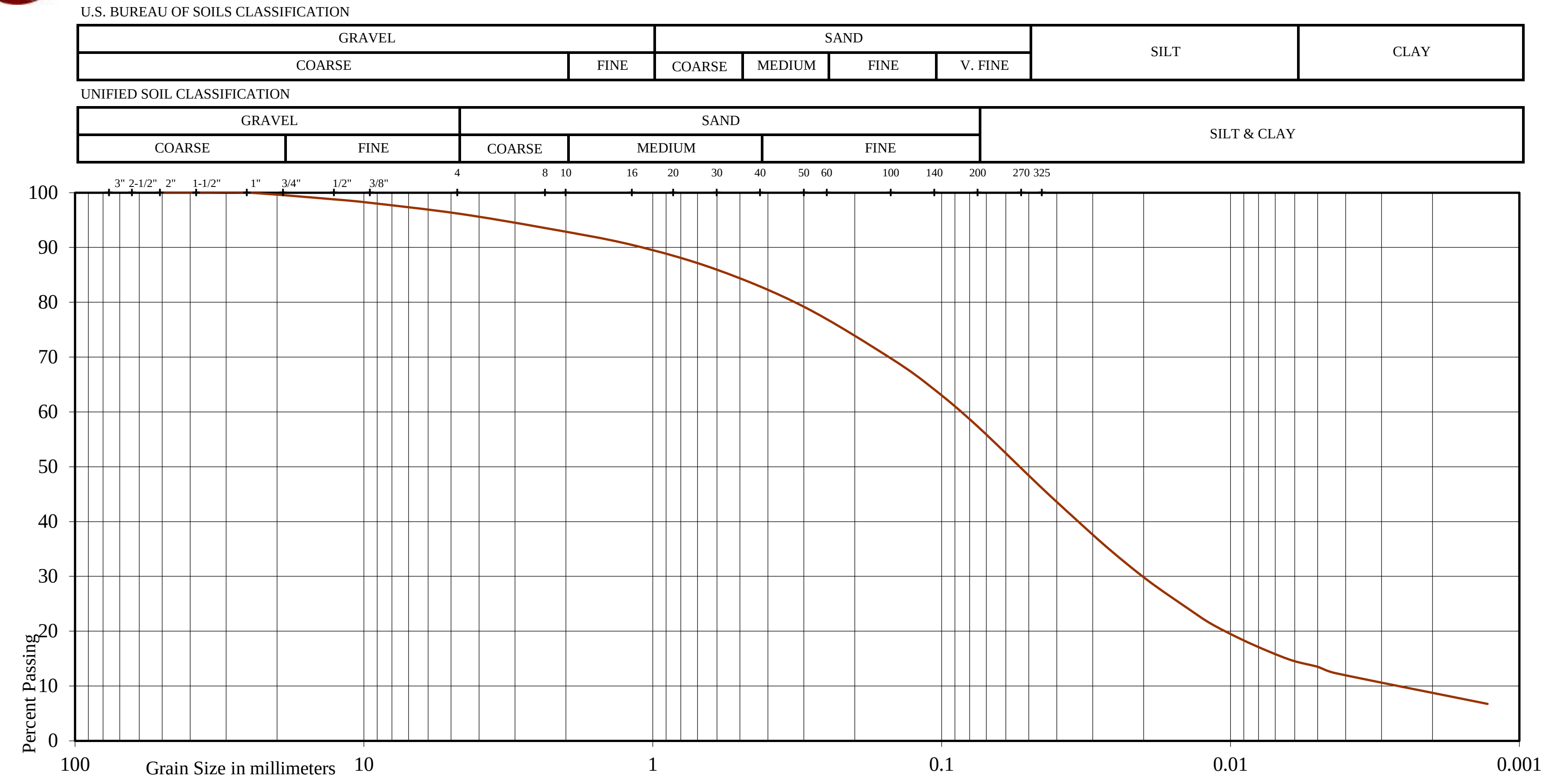
Classification of Sample [& Group Symbol]: SILTY CLAY, Till
some sand to sandy, a tr. to some gravel

Figure: 9

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 1609-S061



Project: Proposed Property Acquistion

Location: 7085 Goreway Drive, City of Mississauga

Borehole No: 1

Sample No: 8

Depth (m): 7.9

Elevation (m): 157.9

Liquid Limit (%) = -

Plastic Limit (%) = -

Plasticity Index (%) = -

Moisture Content (%) = 14

Estimated Permeability (cm./sec.) = 10^{-6}

Classification of Sample [& Group Symbol]: SANDY SILT, Till
trs. of clay and gravel

Figure: 10

APPENDIX D

K from Grain Size Analysis Report

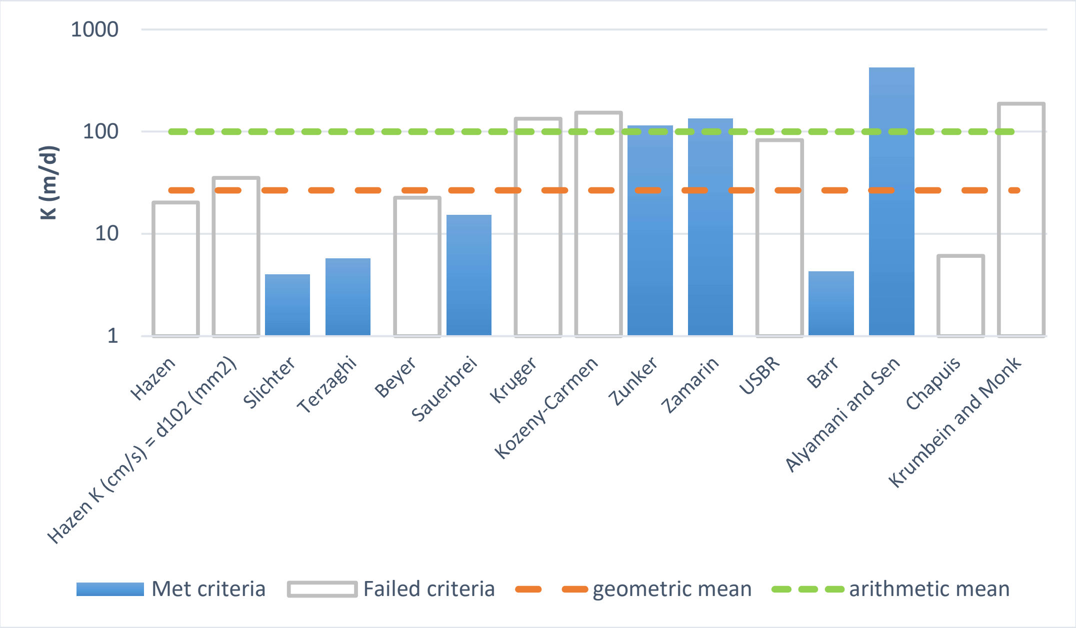
Date: 16-Apr-20

Sample Name: BH2 SS1A

Mass Sample (g): 100

T (oC) 20

Poorly sorted sandy gravel low in fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	2.3E-02	2.3E-04	20.22	
Hazen K (cm/s) = d_{10} (mm)	4.1E-02	4.1E-04	35.25	
Slichter	4.6E-03	4.6E-05	3.99	
Terzaghi	6.6E-03	6.6E-05	5.71	
Beyer	2.6E-02	2.6E-04	22.65	
Sauerbrei	1.8E-02	1.8E-04	15.39	
Kruger	1.5E-01	1.5E-03	133.46	
Kozeny-Carmen	1.8E-01	1.8E-03	153.74	
Zunker	1.3E-01	1.3E-03	115.22	
Zamarin	1.6E-01	1.6E-03	134.44	
USBR	9.6E-02	9.6E-04	82.58	
Barr	5.0E-03	5.0E-05	4.28	
Alyamani and Sen	4.9E-01	4.9E-03	421.66	
Chapuis	7.0E-03	7.0E-05	6.07	
Krumbein and Monk	2.2E-01	2.2E-03	187.46	
geometric mean	3.1E-02	3.1E-04	26.75	
arithmetic mean	1.2E-01	1.2E-03	100.10	

K from Grain Size Analysis Report

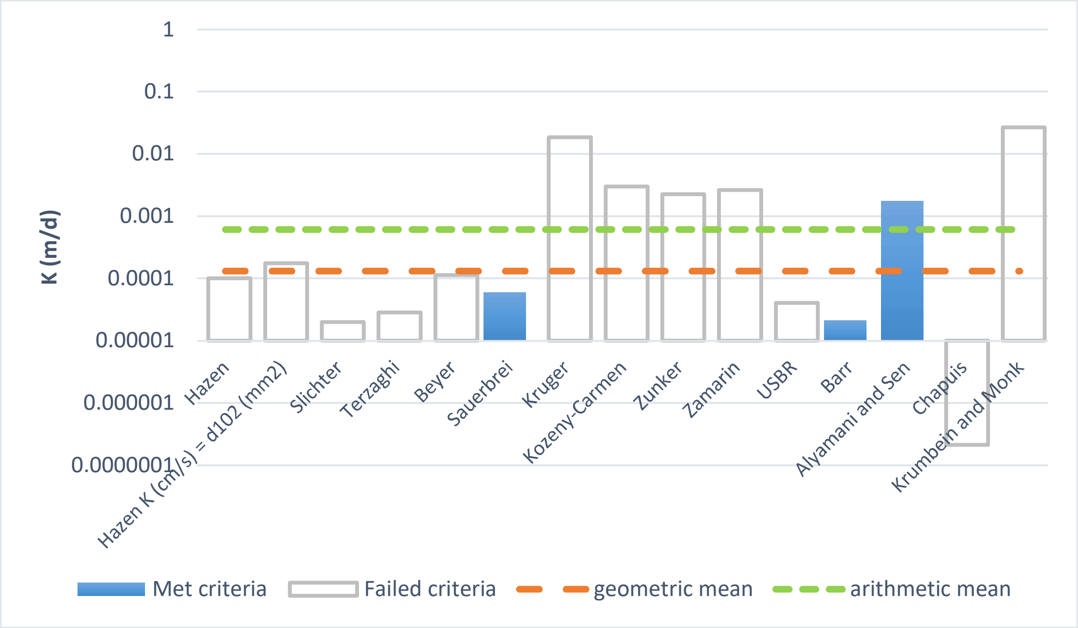
Date: 16-Apr-20

Sample Name: BH2 SS2

Mass Sample (g): 100

T (oC) 20

Poorly sorted clay with fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	1.2E-07	1.2E-09	0.00	
Hazen K (cm/s) = d_{10} (mm)	2.0E-07	2.0E-09	0.00	
Slichter	2.3E-08	2.3E-10	0.00	
Terzaghi	3.3E-08	3.3E-10	0.00	
Beyer	1.3E-07	1.3E-09	0.00	
Sauerbrei	7.0E-08	7.0E-10	0.00	
Kruger	2.1E-05	2.1E-07	0.02	
Kozeny-Carmen	3.5E-06	3.5E-08	0.00	
Zunker	2.6E-06	2.6E-08	0.00	
Zamarin	3.1E-06	3.1E-08	0.00	
USBR	4.7E-08	4.7E-10	0.00	
Barr	2.5E-08	2.5E-10	0.00	
Alyamani and Sen	2.0E-06	2.0E-08	0.00	
Chapuis	2.4E-10	2.4E-12	0.00	
Krumbein and Monk	3.1E-05	3.1E-07	0.03	
geometric mean	1.5E-07	1.5E-09	0.00	
arithmetic mean	7.1E-07	7.1E-09	0.00	

K from Grain Size Analysis Report

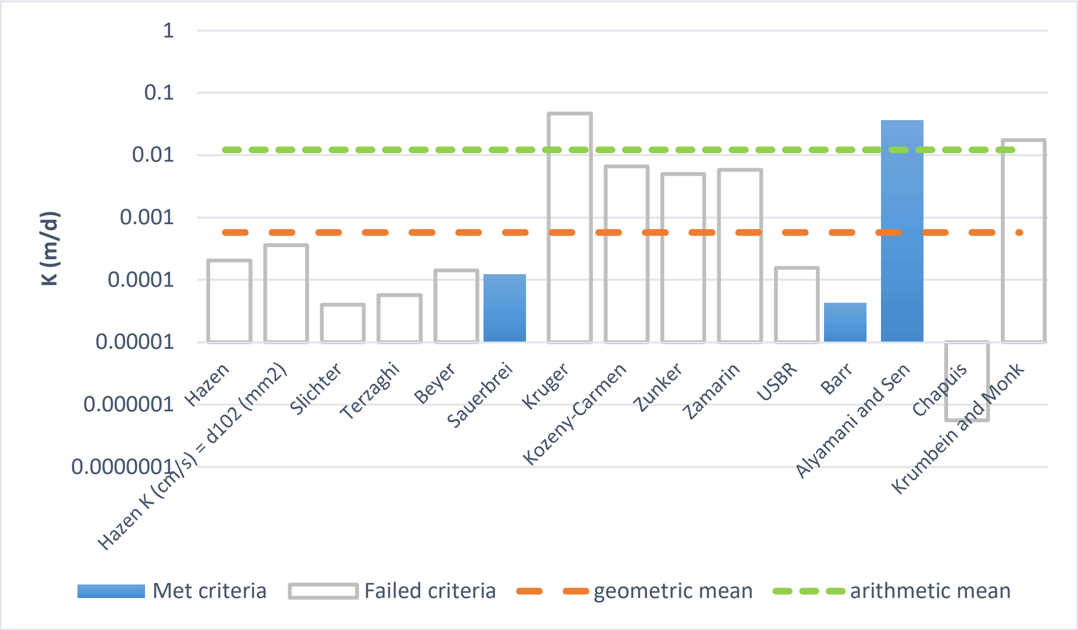
Date: 16-Apr-20

Sample Name: BH1 SS3

Mass Sample (g): 100

T (oC) 20

Poorly sorted sandy gravelly silt with fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	2.4E-07	2.4E-09	0.00	
Hazen K (cm/s) = d_{10} (mm)	4.2E-07	4.2E-09	0.00	
Slichter	4.6E-08	4.6E-10	0.00	
Terzaghi	6.6E-08	6.6E-10	0.00	
Beyer	1.6E-07	1.6E-09	0.00	
Sauerbrei	1.4E-07	1.4E-09	0.00	
Kruger	5.4E-05	5.4E-07	0.05	
Kozeny-Carmen	7.6E-06	7.6E-08	0.01	
Zunker	5.7E-06	5.7E-08	0.00	
Zamarin	6.7E-06	6.7E-08	0.01	
USBR	1.8E-07	1.8E-09	0.00	
Barr	5.0E-08	5.0E-10	0.00	
Alyamani and Sen	4.2E-05	4.2E-07	0.04	
Chapuis	6.4E-10	6.4E-12	0.00	
Krumbein and Monk	2.0E-05	2.0E-07	0.02	
geometric mean	6.7E-07	6.7E-09	0.00	
arithmetic mean	1.4E-05	1.4E-07	0.01	

K from Grain Size Analysis Report

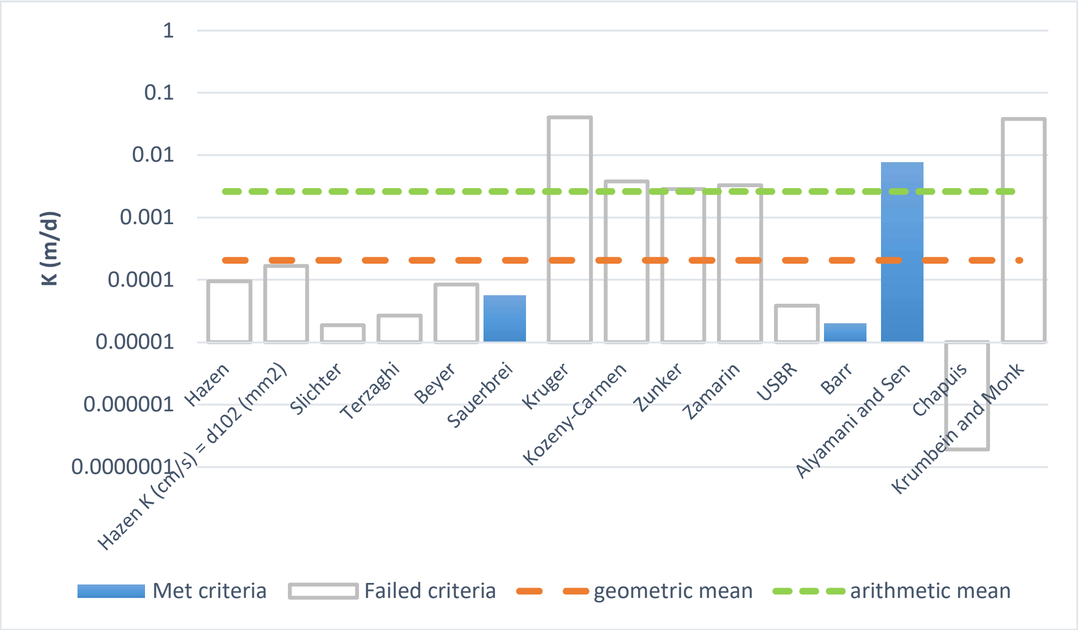
Date: 16-Apr-20

Sample Name: BH4 SS6

Mass Sample (g): 100

T (oC) 20

Poorly sorted clay with fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	1.1E-07	1.1E-09	0.00	
Hazen K (cm/s) = d_{10} (mm)	1.9E-07	1.9E-09	0.00	
Slichter	2.2E-08	2.2E-10	0.00	
Terzaghi	3.1E-08	3.1E-10	0.00	
Beyer	9.8E-08	9.8E-10	0.00	
Sauerbrei	6.6E-08	6.6E-10	0.00	
Kruger	4.7E-05	4.7E-07	0.04	
Kozeny-Carmen	4.4E-06	4.4E-08	0.00	
Zunker	3.3E-06	3.3E-08	0.00	
Zamarin	3.8E-06	3.8E-08	0.00	
USBR	4.5E-08	4.5E-10	0.00	
Barr	2.3E-08	2.3E-10	0.00	
Alyamani and Sen	9.0E-06	9.0E-08	0.01	
Chapuis	2.2E-10	2.2E-12	0.00	
Krumbein and Monk	4.4E-05	4.4E-07	0.04	
geometric mean	2.4E-07	2.4E-09	0.00	
arithmetic mean	3.0E-06	3.0E-08	0.00	

K from Grain Size Analysis Report

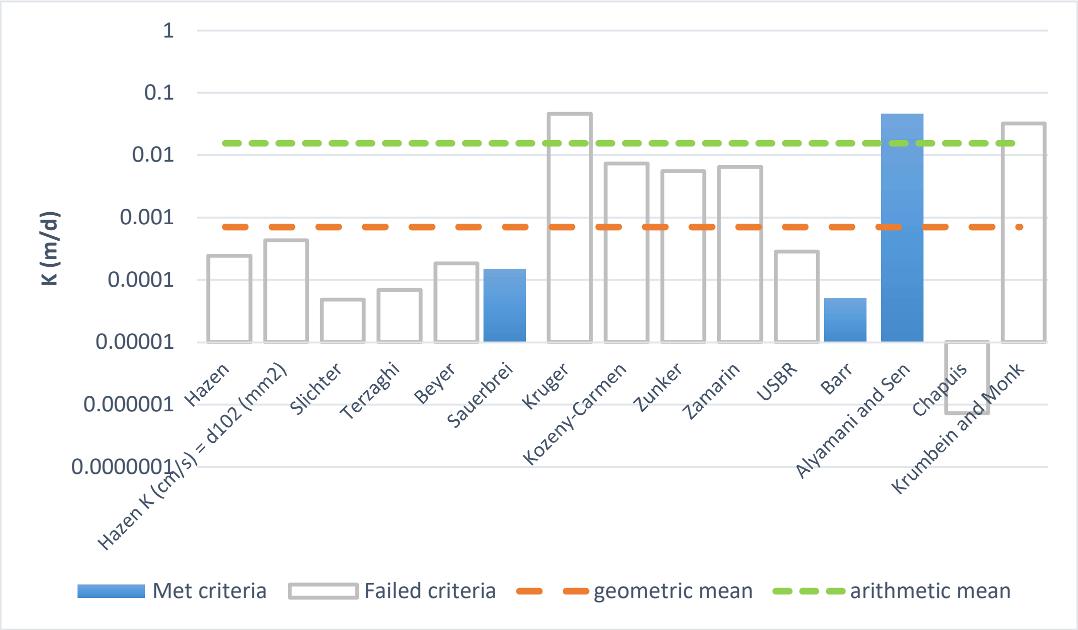
Date: 16-Apr-20

Sample Name: BH6 SS5

Mass Sample (g): 100

T (oC) 20

Poorly sorted sandy silt with fines



Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	2.8E-07	2.8E-09	0.00	
Hazen K (cm/s) = d_{10} (mm)	5.0E-07	5.0E-09	0.00	
Slichter	5.6E-08	5.6E-10	0.00	
Terzaghi	7.9E-08	7.9E-10	0.00	
Beyer	2.1E-07	2.1E-09	0.00	
Sauerbrei	1.7E-07	1.7E-09	0.00	
Kruger	5.3E-05	5.3E-07	0.05	
Kozeny-Carmen	8.5E-06	8.5E-08	0.01	
Zunker	6.4E-06	6.4E-08	0.01	
Zamarin	7.5E-06	7.5E-08	0.01	
USBR	3.3E-07	3.3E-09	0.00	
Barr	6.0E-08	6.0E-10	0.00	
Alyamani and Sen	5.4E-05	5.4E-07	0.05	
Chapuis	8.4E-10	8.4E-12	0.00	
Krumbein and Monk	3.7E-05	3.7E-07	0.03	
geometric mean	8.2E-07	8.2E-09	0.00	
arithmetic mean	1.8E-05	1.8E-07	0.02	

K from Grain Size Analysis Report

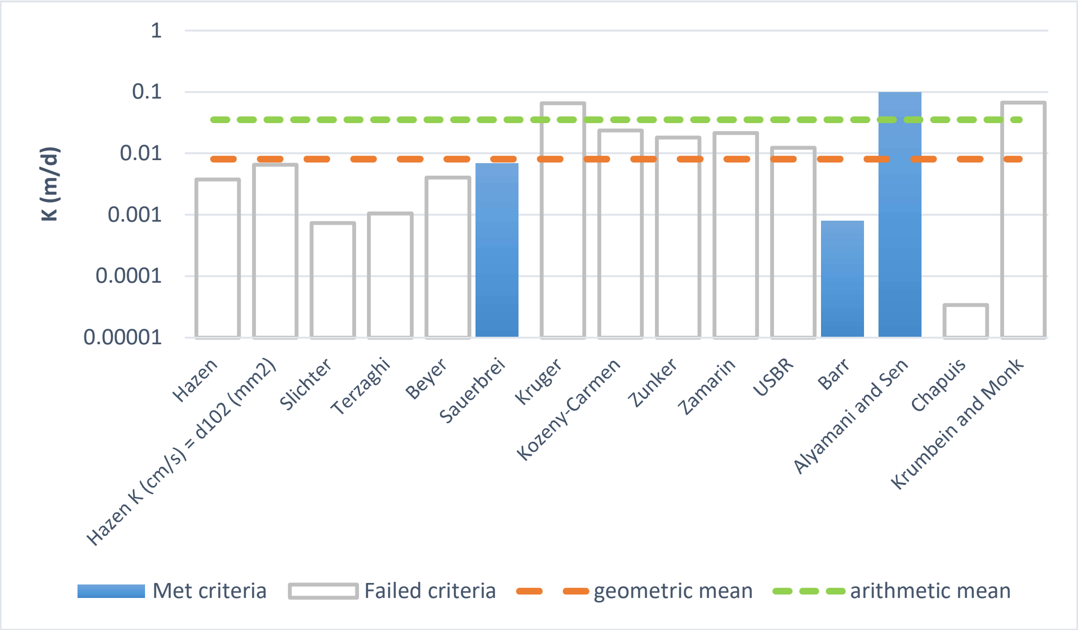
Date: 16-Apr-20

Sample Name: BH1 SS8

Mass Sample (g): 100

T (oC) 20

Poorly sorted sandy silt with fines



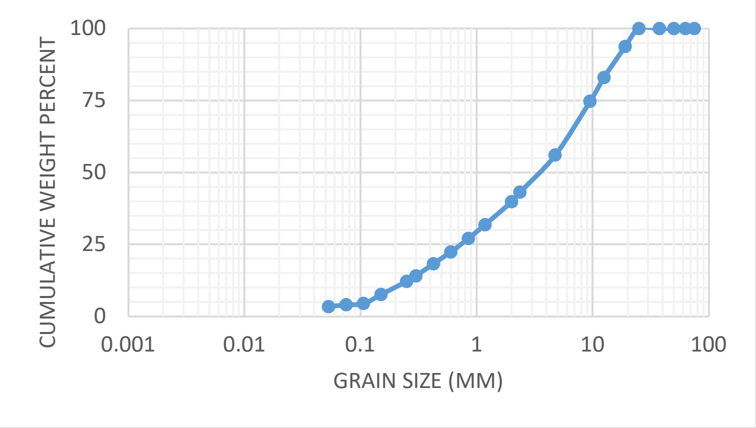
Estimation of Hydraulic Conductivity	cm/s	m/s	m/d	de
Hazen	4.3E-06	4.3E-08	0.00	
Hazen K (cm/s) = d_{10} (mm)	7.6E-06	7.6E-08	0.01	
Slichter	8.5E-07	8.5E-09	0.00	
Terzaghi	1.2E-06	1.2E-08	0.00	
Beyer	4.7E-06	4.7E-08	0.00	
Sauerbrei	7.9E-06	7.9E-08	0.01	
Kruger	7.6E-05	7.6E-07	0.07	
Kozeny-Carmen	2.7E-05	2.7E-07	0.02	
Zunker	2.1E-05	2.1E-07	0.02	
Zamarin	2.5E-05	2.5E-07	0.02	
USBR	1.4E-05	1.4E-07	0.01	
Barr	9.1E-07	9.1E-09	0.00	
Alyamani and Sen	1.1E-04	1.1E-06	0.10	
Chapuis	3.9E-08	3.9E-10	0.00	
Krumbein and Monk	7.8E-05	7.8E-07	0.07	
geometric mean	9.4E-06	9.4E-08	0.01	
arithmetic mean	4.1E-05	4.1E-07	0.04	

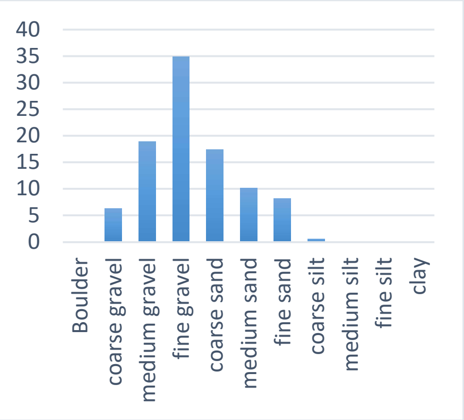
Grain Size Analysis Report Date: 16-Apr-20

Sample Name: BH2 SS1A

Mass Sample (g): 100 T (oC) 20

Poorly sorted sandy gravel low in fines





Sieve opening (ps) di (mm)	Mass of retained (mr) (g)	mass fraction (mf)	Percent Passing (pp)
75	0	0	100
63	0	0	100
50	0	0	100
37.5	0	0	100
25	0	0	100
19	6.3	0.063	93.7
12.5	10.74	0.1074	82.96
9.5	8.22	0.0822	74.74
4.75	18.69	0.1869	56.05
2.36	12.92	0.1292	43.13
2	3.3	0.033	39.83
1.18	7.98	0.0798	31.85
0.85	4.75	0.0475	27.1
0.6	4.68	0.0468	22.42
0.425	4.12	0.0412	18.3
0.3	4.2	0.042	14.1
0.25	1.91	0.0191	12.19
0.15	4.56	0.0456	7.63
0.106	3.19	0.0319	4.44
0.075	0.41	0.0041	4.03
0.053	0.6	0.006	3.43

Effective Grain Diameters (mm)		Other Useful Parameters	
d10	0.202	Uniformity Coef.	28.49
d17	0.386	n computed	0.26
d20	0.497	g (cm/s^2)	980.00
d50	3.631	ρ (g/cm^3)	0.9981
d60	5.754	μ (g/cm s)	0.0098
de (Kruger)	0.878	$\rho g/\mu$ (1/cm s)	9.9327E+04
de (Kozeny)	0.842	tau (Sauerbrei)	1.053
de (Zunker)	0.854	$d_{\text{geometric mean}}$	2.656
de (Zamarin)	0.866	σ_ϕ	2.433
Io (Alyameni)	-0.655		

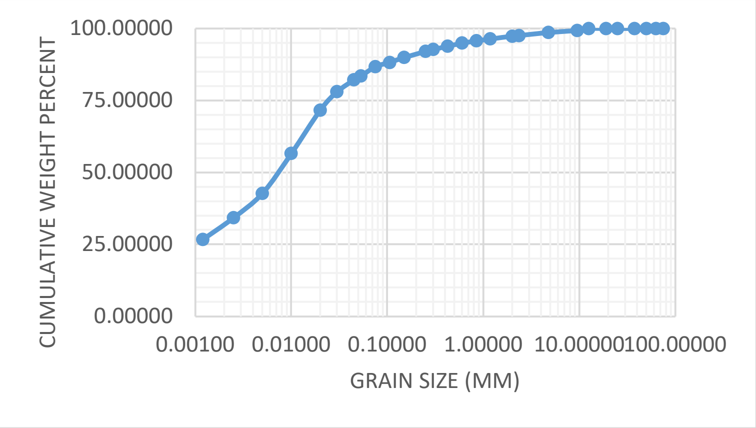
mm	0	% in sample
>64	Boulder	0
16 - 64	coarse gravel	6.3
8 - 16	medium gravel	18.96
2 - 8	fine gravel	34.91
0.5 - 2	coarse sand	17.41
0.25 - 0.5	medium sand	10.23
0.063 - 0.25	fine sand	8.16
0.016 - 0.063	coarse silt	0.6
0.008 - 0.016	medium silt	
0.002 - 0.008	fine silt	
<0.002	clay	

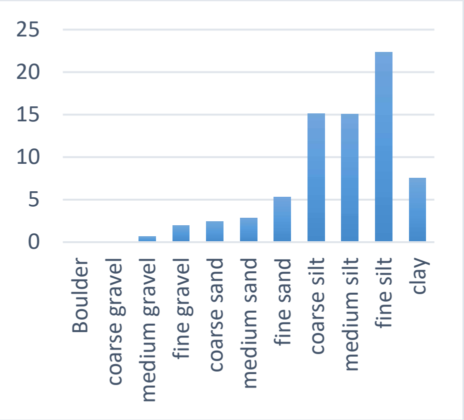
Grain Size Analysis Report Date: 16-Apr-20

Sample Name: BH2 SS2

Mass Sample (g): 100 T (oC) 20

Poorly sorted clay with fines





Sieve opening (ps) di (mm)	Mass of retained (mr) (g)	mass fraction (mf)	Percent Passing (pp)
75	0	0	100
63	0	0	100
50	0	0	100
37.5	0	0	100
25	0	0	100
19	0	0	100
12.5	0	0	100
9.5	0.67	0.0067	99.33
4.75	0.72	0.0072	98.61
2.36	1.04	0.0104	97.57
2	0.23	0.0023	97.34
1.18	0.97	0.0097	96.37
0.85	0.66	0.0066	95.71
0.6	0.8	0.008	94.91
0.425	1.03	0.0103	93.88
0.3	1.18	0.0118	92.7
0.25	0.66	0.0066	92.04
0.15	2.09	0.0209	89.95
0.106	1.73	0.0173	88.22
0.075	1.49	0.0149	86.73
0.053	3.26	0.0326	83.47
0.045	1.33	0.0133	82.14

Effective Grain Diameters (mm)		Other Useful Parameters	
d10	0.000	Uniformity Coef.	27.31
d17	0.001	n computed	0.26
d20	0.001	g (cm/s^2)	980.00
d50	0.008	ρ (g/cm^3)	0.9981
d60	0.012	μ (g/cm s)	0.0098
de (Kruger)	0.010	$\rho g/\mu$ (1/cm s)	9.9327E+04
de (Kozeny)	0.004	tau (Sauerbrei)	1.053
de (Zunker)	0.004	$d_{\text{geometric mean}}$	0.056
de (Zamarin)	0.004	σ_ϕ	3.309
Io (Alyameni)	-0.001		

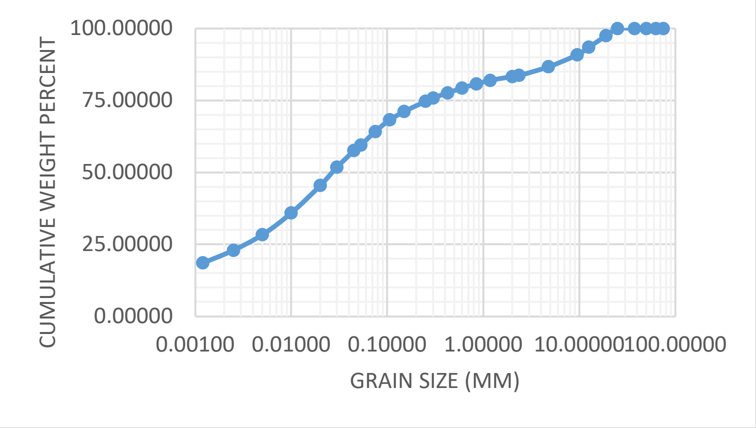
mm	0	% in sample
>64	Boulder	0
16 - 64	coarse gravel	0
8 - 16	medium gravel	0.67
2 - 8	fine gravel	1.99
0.5 - 2	coarse sand	2.43
0.25 - 0.5	medium sand	2.87
0.063 - 0.25	fine sand	5.31
0.016 - 0.063	coarse silt	15.12
0.008 - 0.016	medium silt	15.02
0.002 - 0.008	fine silt	22.36
<0.002	clay	7.52

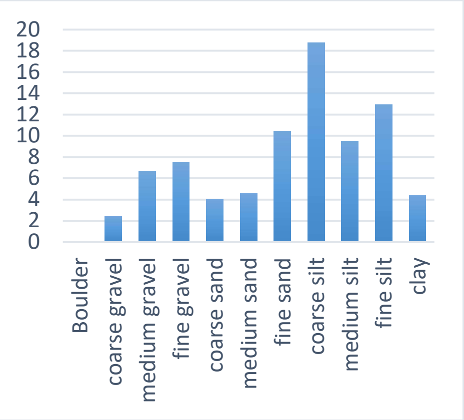
Grain Size Analysis Report Date: 16-Apr-20

Sample Name: BH1 SS3

Mass Sample (g): 100 T (oC) 20

Poorly sorted sandy gravelly silt with fines





Sieve opening (ps) di (mm)	Mass of retained (mr) (g)	mass fraction (mf)	Percent Passing (pp)
75	0	0	100
63	0	0	100
50	0	0	100
37.5	0	0	100
25	0	0	100
19	2.45	0.0245	97.55
12.5	4.07	0.0407	93.48
9.5	2.63	0.0263	90.85
4.75	4.14	0.0414	86.71
2.36	3.01	0.0301	83.7
2	0.38	0.0038	83.32
1.18	1.33	0.0133	81.99
0.85	1.21	0.0121	80.78
0.6	1.49	0.0149	79.29
0.425	1.62	0.0162	77.67
0.3	1.79	0.0179	75.88
0.25	1.2	0.012	74.68
0.15	3.48	0.0348	71.2
0.106	2.92	0.0292	68.28
0.075	4.05	0.0405	64.23
0.053	4.75	0.0475	59.48
0.045	1.91	0.0191	57.57

Effective Grain Diameters (mm)		Other Useful Parameters	
d10	0.001	Uniformity Coef.	85.88
d17	0.001	n computed	0.26
d20	0.002	g (cm/s^2)	980.00
d50	0.027	ρ (g/cm^3)	0.9981
d60	0.055	μ (g/cm s)	0.0098
de (Kruger)	0.016	ρg/μ (1/cm s)	9.9327E+04
de (Kozeny)	0.006	tau (Sauerbrei)	1.053
de (Zunker)	0.006	$d_{geometric\ mean}$	0.154
de (Zamarin)	0.006	σ_{ϕ}	5.173
Io (Alyameni)	-0.006		

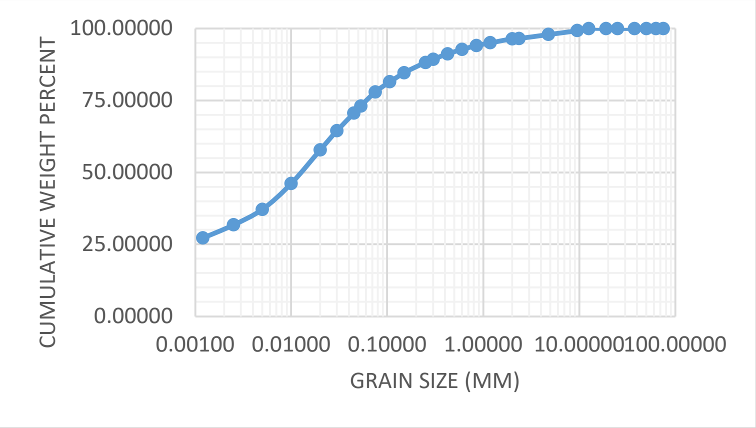
mm	0	% in sample
>64	Boulder	0
16 - 64	coarse gravel	2.45
8 - 16	medium gravel	6.7
2 - 8	fine gravel	7.53
0.5 - 2	coarse sand	4.03
0.25 - 0.5	medium sand	4.61
0.063 - 0.25	fine sand	10.45
0.016 - 0.063	coarse silt	18.76
0.008 - 0.016	medium silt	9.52
0.002 - 0.008	fine silt	12.96
<0.002	clay	4.39

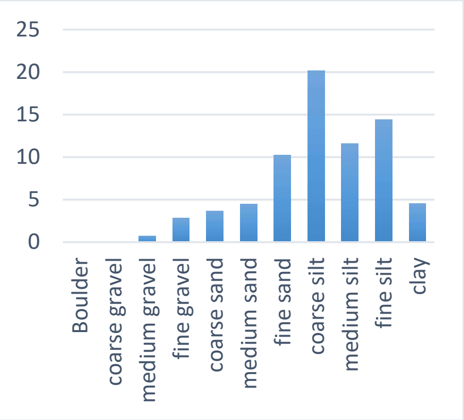
Grain Size Analysis Report Date: 16-Apr-20

Sample Name: BH4 SS6

Mass Sample (g): 100 T (oC) 20

Poorly sorted clay with fines





Sieve opening (ps) di (mm)	Mass of retained (mr) (g)	mass fraction (mf)	Percent Passing (pp)
75	0	0	100
63	0	0	100
50	0	0	100
37.5	0	0	100
25	0	0	100
19	0	0	100
12.5	0	0	100
9.5	0.75	0.0075	99.25
4.75	1.34	0.0134	97.91
2.36	1.38	0.0138	96.53
2	0.1	0.001	96.43
1.18	1.4	0.014	95.03
0.85	1	0.01	94.03
0.6	1.28	0.0128	92.75
0.425	1.54	0.0154	91.21
0.3	1.88	0.0188	89.33
0.25	1.11	0.0111	88.22
0.15	3.59	0.0359	84.63
0.106	3.14	0.0314	81.49
0.075	3.55	0.0355	77.94
0.053	4.87	0.0487	73.07
0.045	2.44	0.0244	70.63

Effective Grain Diameters (mm)		Other Useful Parameters	
d10	0.000	Uniformity Coef.	52.81
d17	0.001	n computed	0.26
d20	0.001	g (cm/s^2)	980.00
d50	0.013	ρ (g/cm^3)	0.9981
d60	0.023	μ (g/cm s)	0.0098
de (Kruger)	0.015	$\rho g/\mu$ (1/cm s)	9.9327E+04
de (Kozeny)	0.004	tau (Sauerbrei)	1.053
de (Zunker)	0.004	$d_{geometric\ mean}$	0.092
de (Zamarin)	0.004	σ_{ϕ}	3.787
Io (Alyameni)	-0.003		

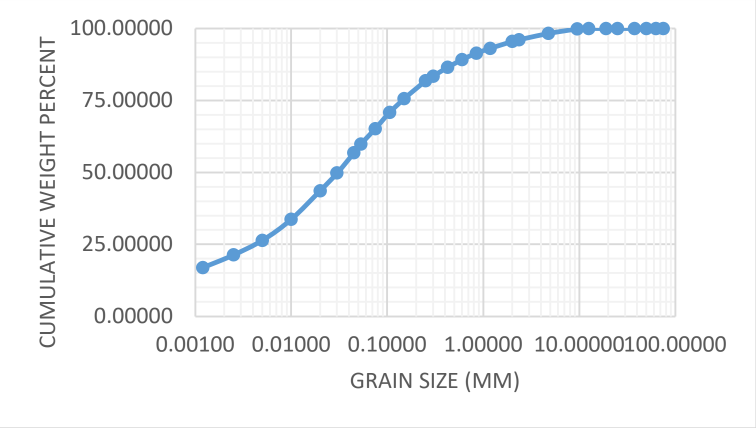
mm	0	% in sample
>64	Boulder	0
16 - 64	coarse gravel	0
8 - 16	medium gravel	0.75
2 - 8	fine gravel	2.82
0.5 - 2	coarse sand	3.68
0.25 - 0.5	medium sand	4.53
0.063 - 0.25	fine sand	10.28
0.016 - 0.063	coarse silt	20.14
0.008 - 0.016	medium silt	11.61
0.002 - 0.008	fine silt	14.4
<0.002	clay	4.55

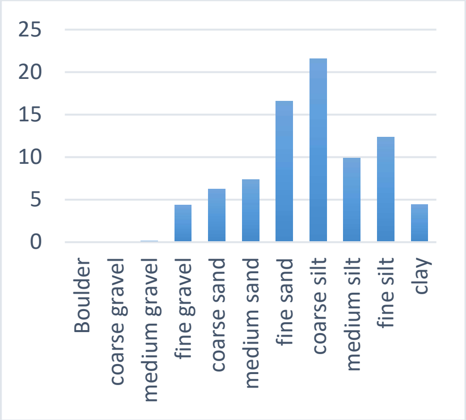
Grain Size Analysis Report Date: 16-Apr-20

Sample Name: BH6 SS5

Mass Sample (g): 100 T (oC) 20

Poorly sorted sandy silt with fines





Sieve opening (ps) di (mm)	Mass of retained (mr) (g)	mass fraction (mf)	Percent Passing (pp)
75	0	0	100
63	0	0	100
50	0	0	100
37.5	0	0	100
25	0	0	100
19	0	0	100
12.5	0	0	100
9.5	0.17	0.0017	99.83
4.75	1.56	0.0156	98.27
2.36	2.16	0.0216	96.11
2	0.64	0.0064	95.47
1.18	2.38	0.0238	93.09
0.85	1.68	0.0168	91.41
0.6	2.23	0.0223	89.18
0.425	2.63	0.0263	86.55
0.3	3.11	0.0311	83.44
0.25	1.64	0.0164	81.8
0.15	6.17	0.0617	75.63
0.106	4.76	0.0476	70.87
0.075	5.66	0.0566	65.21
0.053	5.39	0.0539	59.82
0.045	2.98	0.0298	56.84

Effective Grain Diameters (mm)		Other Useful Parameters	
d10	0.001	Uniformity Coef.	75.95
d17	0.001	n computed	0.26
d20	0.002	g (cm/s^2)	980.00
d50	0.030	ρ (g/cm^3)	0.9981
d60	0.054	μ (g/cm s)	0.0098
de (Kruger)	0.016	ρg/μ (1/cm s)	9.9327E+04
de (Kozeny)	0.006	tau (Sauerbrei)	1.053
de (Zunker)	0.006	$d_{geometric\ mean}$	0.092
de (Zamarin)	0.006	σ_ϕ	3.909
Io (Alyameni)	-0.007		

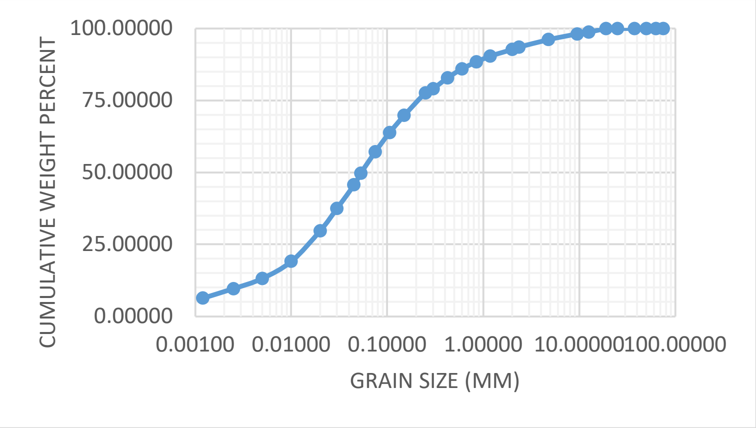
mm	0	% in sample
>64	Boulder	0
16 - 64	coarse gravel	0
8 - 16	medium gravel	0.17
2 - 8	fine gravel	4.36
0.5 - 2	coarse sand	6.29
0.25 - 0.5	medium sand	7.38
0.063 - 0.25	fine sand	16.59
0.016 - 0.063	coarse silt	21.57
0.008 - 0.016	medium silt	9.89
0.002 - 0.008	fine silt	12.37
<0.002	clay	4.42

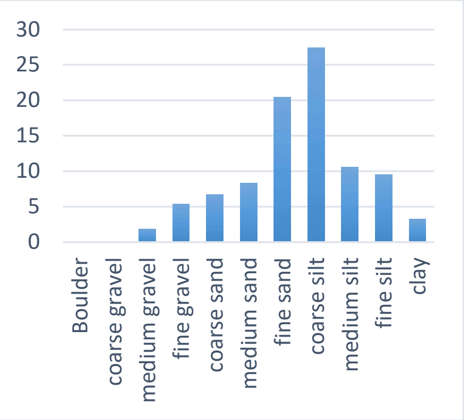
Grain Size Analysis Report Date: 16-Apr-20

Sample Name: BH1 SS8

Mass Sample (g): 100 T (oC) 20

Poorly sorted sandy silt with fines





Sieve opening (ps) di (mm)	Mass of retained (mr) (g)	mass fraction (mf)	Percent Passing (pp)
75	0	0	100
63	0	0	100
50	0	0	100
37.5	0	0	100
25	0	0	100
19	0.05	0.0005	99.95
12.5	1.21	0.0121	98.74
9.5	0.64	0.0064	98.1
4.75	1.95	0.0195	96.15
2.36	2.62	0.0262	93.53
2	0.81	0.0081	92.72
1.18	2.28	0.0228	90.44
0.85	2.02	0.0202	88.42
0.6	2.42	0.0242	86
0.425	3.13	0.0313	82.87
0.3	3.77	0.0377	79.1
0.25	1.46	0.0146	77.64
0.15	7.8	0.078	69.84
0.106	5.95	0.0595	63.89
0.075	6.73	0.0673	57.16
0.053	7.4	0.074	49.76
0.045	4.04	0.0404	45.72

Effective Grain Diameters (mm)		Other Useful Parameters	
d10	0.003	Uniformity Coef.	31.97
d17	0.008	n computed	0.26
d20	0.011	g (cm/s^2)	980.00
d50	0.054	ρ (g/cm^3)	0.9981
d60	0.088	μ (g/cm s)	0.0098
de (Kruger)	0.019	ρg/μ (1/cm s)	9.9327E+04
de (Kozeny)	0.010	tau (Sauerbrei)	1.053
de (Zunker)	0.011	$d_{geometric\ mean}$	0.090
de (Zamarin)	0.011	σ_ϕ	3.322
Io (Alyameni)	-0.010		

mm	0	% in sample
>64	Boulder	0
16 - 64	coarse gravel	0.05
8 - 16	medium gravel	1.85
2 - 8	fine gravel	5.38
0.5 - 2	coarse sand	6.72
0.25 - 0.5	medium sand	8.36
0.063 - 0.25	fine sand	20.48
0.016 - 0.063	coarse silt	27.42
0.008 - 0.016	medium silt	10.58
0.002 - 0.008	fine silt	9.52
<0.002	clay	3.28

Adopting the equation form presented in Vukovic and Soro (1992),

$$K = \frac{\rho g}{\mu} N \varphi(n) d_e^2$$

the following values and equations aresubstituted into the appropriate terms to evalute the models listed in the table below. The values of d_e to be entered should be in cm units. The values of K calculated have the units cm/s, except for the Alyamani and Sen model (see footnote).

Source	***N***	***φ(n)***	**d_e**	**Applicable Conditions**
Hazen simplified (Freeze and Cherry, 1979)	$10\,\frac{\mu}{\rho g}$	1	d_{10}	uniformly graded sand, $n = 0.375$ $T = 10\,^{\circ}\mathrm{C}$
Hazen (1892)[a]	6×10^{-4}	$[1 + 10(n - 0.26)]$	d_{10}	0.01 cm < d_{10} < 0.3 cm $U < 5$
Slichter (1898)[a]	1×10^{-2}	$n^{3.287}$	d_{10}	0.01 cm < d_{10} < 0.5 cm
Terzaghi (1925)[a]	10.7×10^{-3} smooth grains 6.1×10^{-3} coarse grains	$\left(\frac{n - 0.13}{\sqrt[3]{1-n}}\right)^2$	d_{10}	sandy soil, coarse sand
Beyer (1964)[a]	$5.2 \times 10^{-4} \log \frac{500}{U}$	1	d_{10}	0.006 cm < d_{10} <0.06 cm $1 < U < 20$
Sauerbrei (1932)[a] (Vuković and Soro, 1992)	$(3.75 \times 10^{-5}) \times \tau$ $\tau \cong 1.093 \times 10^{-4} T^2 + 2.102 \times 10^{-2} T + 0.5889$	$\frac{n^3}{(1-n)^2}$	d_{17}	sand and sandy clay d_{17} < 0.05 cm
Krüger (1919)[a]	4.35×10^{-4}	$\frac{n}{(1-n)^2}$	$\frac{1}{\sum_{i=1}^{n} \frac{\Delta w_i}{d_i}}$	medium sand $U > 5$ $T = 0\,^{\circ}\mathrm{C}$
Kozeny-Carmen (1953)[a]	8.3×10^{-3}	$\frac{n^3}{(1-n)^2}$	d_{10} or $\frac{1}{\frac{3}{2}\frac{\Delta w_1}{d_1} + \sum_{i=2}^{n} \Delta g_i \frac{d_i^{\mathrm{g}} + d_i^{\mathrm{d}}}{2 d_i^{\mathrm{g}} d_i^{\mathrm{d}}}}$ $d_1 = \frac{1}{\frac{1}{2}\left(\frac{1}{d_i^{\mathrm{g}}} + \frac{1}{d_i^{\mathrm{d}}}\right)}$	Coarse sand
Zunker (1930)[a]	0.7×10^{-3} for nonuniform, clayey, angular grains 1.2×10^{-3} for nonuniform 1.4×10^{-3} for uniform, coarse grains 2.4×10^{-3} for uniform sand, well rounded grains	$\frac{n}{(1-n)}$	$\frac{1}{\sum_{i=1}^{n} \Delta g_i \frac{d_i^{\mathrm{g}} - d_i^{\mathrm{d}}}{d_i^{\mathrm{g}} d_i^{\mathrm{d}} \, ln\left(\frac{d_i^{\mathrm{g}}}{d_i^{\mathrm{d}}}\right)}}$	no fractions finer than d = 0.0025 mm
Zamarin (1928)[a]	8.65×10^{-3}	$\frac{n^3}{(1-n)^2} C_{\mathrm{n}}$ $C_{\mathrm{n}} = (1.275 - 1.5n)^2$	$\frac{1}{\sum_{i=1}^{n} \Delta g_i \frac{\ln\left(\frac{d_i^{\mathrm{g}}}{d_i^{\mathrm{d}}}\right)}{d_i^{\mathrm{g}} - d_i^{\mathrm{d}}}}$	Large grained sands with no fractions having d < 0.00025 mm
USBR (United States Bureau of Reclamation) (Bialas, 1966)[a]	$(4.8 \times 10^{-4})(10^{0.3})$	1.0	$d_{20}^{\,1.15}$	Medium grained sands with $U < 5$; derived for $T = 15\,^{\circ}\mathrm{C}$
Barr (2001)	$\frac{1}{(36)5C_s^2}$ $C_s^2 = 1$ for spherical grains $C_s^2 = 1.35$ for angular grains	$\frac{n^3}{(1-n)^2}$	d_{10}	unspecified

Alyamani and Sen (1993)	1300	1.0	$[I_o + 0.025(d_{50} - d_{10})]$	unspecified
Chapuis (2004)	$\frac{\mu}{\rho g}$	$10^{1.291\xi - 0.6435}$ $\xi = \frac{n}{1-n}$	$d_{10}{}^{\left(\frac{10^{(0.5504-0.2937\xi)}}{2}\right)}$	$0.3 < n < 0.7$ $0.10 < d_{10} < 2.0$ mm $2 < U < 12$ $d_{10}/d_5 < 1.4$
Krumbein and Monk (1942)	7.501×10^{-6}	$e^{(-1.31 \times \sigma_{\emptyset})}$ $\sigma_{\emptyset} = \frac{d_{84\emptyset} - d_{16\emptyset}}{4} - \frac{d_{95\emptyset} - d_{5\emptyset}}{6.6}$	$2^{\left(\frac{d_{16\emptyset} + d_{50\emptyset} + d_{84\emptyset}}{3}\right)}$	natural sands with lognormal grain size distribution

* indicates formulas were taken from Vuković and Soro, (1992)
N = constant dependent on characteristics of the porous medium
$\varphi(n)$ = function of porosity
T = water temp. (°C)
g = 980 cm s^{-2}
$\rho = 3.1 \times 10^{-8}\ T^3 - 7.0 \times 10^{-6}\ T^2 + 4.19 \times 10^{-5} T + 0.99985$
$\mu = -7.0 \times 10^{-8}\ T^3 + 1.002 \times 10^{-5}\ T^2 - 5.7 \times 10^{-4} T + 0.0178$
$\tau = 1.093 \times 10^{-4} T^2 + 2.102 \times 10^{-2} T + 0.5889$
n = porosity as fraction of aquifer volume
d_i^g = the maximum grain diameter in fraction i
d_i^d = the minimum grain diameter in fraction i
d_{10} = grain size (cm) corresponding to 10% by weight passing through the sieves
d_{20} = grain size (cm) corresponding to 20% by weight passing through the sieves
d_{50} = grain size (cm) corresponding to 50% by weight passing through the sieves
d_{60} = grain size (cm) corresponding to 60% by weight passing through the sieves
$U = d_{60}/d_{10}$
Δg_i = the fraction of mass that passes between sieves i and $i+1$ where i is the smaller sieve
Δw_i = fraction of total weight of sample with fraction identifier 'i'
d_i = mean grain diameter of the fraction i
$d_{i\phi}$ = mean grain diameter of the fraction i in phi units ($\phi = \log_2 (d_e/d_o)$, d_e in mm, d_o = 1 mm)
I_o = x-intercept (grain size) of a percent grain retention curve plotted on arithmetic axes and focussing on data below 50% retained

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APPENDIX E

Scenario - Short Term Dewatering

$$R_0 = 3000*dH*K^{0.5}$$

$$r_s = (a+b)/3.14$$

applies when a/b <1.5 and R_0>>rs

$$r_s = ((a*b)/3.14)^{0.5}$$

$$Q = \frac{3.14*K*(H^2-h_w^2)}{\ln(R_0/r_s)}$$

	Site		
Ground Surface	166	masl	
Highest Water Level	160.5	masl	
Base of Excavation	156.2	masl	
Drawdown Target	155	masl	
Aquifer Bottom	150	masl	
Rain Fall	25.0	mm	
Factor of Saftey	2		
Hydrualic Gradient	1		
K =	5.00E-07	m/s	Hydrulic Conductivity
H =	10.5	m	Depth from static wate table to the assumed aquifer bottom
h_w =	5.0	m	Depth from the dewatering target to the assumed aquifer bottom
dH =	5.5	m	Dewatering thickness
R_0 =	11.67	m	
r_s+ R_0=	59	m	
a =	59	m	Length of Exvation
b =	90	m	Width of Excavation
r_s =	47	m	

Q =	**52,603**	**L/day**	
Q =	**105,205**	**L/day**	
Q_{RAIN} =	**132,750**	**L/day**	**Rainfall**

Reference: J. Patrick Powers... [et al.] (2007), "Construction Dewatering and Groundwater Control: New Methods and Applications, 3rd ed." Wiley, Hoboken, NJ.

Scenario - Long Term Dewatering

R_0 = $3000*dH*K^{0.5}$

r_s = $(a+b)/3.14$ applies when a/b <1.5 and R_0>>rs

r_s = $((a*b)/3.14)^{0.5}$

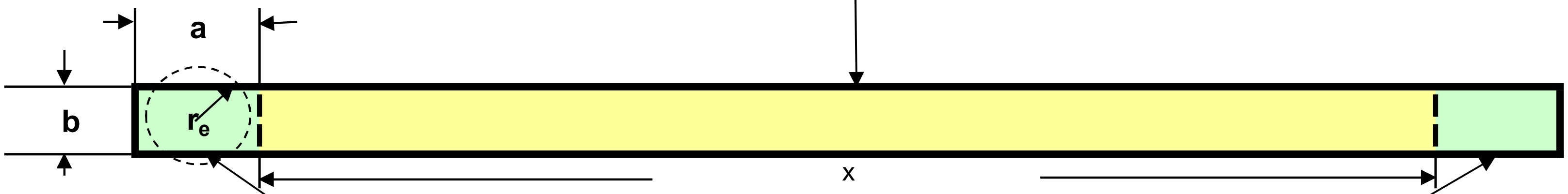
$$Q = \frac{3.14*K*(H^2-h_w^2)}{\ln(R_0/r_s)}$$

	Site		
Ground Surface	166	masl	
Highest Water Level	160.5	masl	
Base of Excavation	156.2	masl	
Drawdown Target	156.2	masl	
Aquifer Bottom	150	masl	
Rain Fall	25.0	mm	
Factor of Saftey	2		
Hydrualic Gradient	1		
K =	5.00E-07	m/s	Hydrulic Conductivity
H =	10.5	m	Depth from static wate table to the assumed aquifer bottom
h_w =	6.2	m	Depth from the dewatering target to the assumed aquifer bottom
dH =	4.3	m	Dewatering thickness
R_0 =	9.12	m	
r_s+ R_0=	57	m	
a =	59	m	Length of Exvation
b =	90	m	Width of Excavation
r_s =	47	m	

Q =	**55,401**	**L/day**	
Q =	**110,802**	**L/day**	
Q_{INFIL} =	**20,115**	**L/day**	**Infiltration**

Reference: J. Patrick Powers... [et al.] (2007), "Construction Dewatering and Groundwater Control:
New Methods and Applications, 3rd ed." Wiley, Hoboken, NJ.

Flow to a Drainage Trench from a Line Source - "*The northward and southward fow from the line sources at distance L can be approximated from the trench Eqs. 6.6 or 6.7. However, these equations assume drainage trenches or infinite length. Since the length of the actual system is finite, the end effects must be considered.*"



Radial Flow to a Well - End Effects - "*assuming that at each end of the system there is a flow equal to one half the flow to a circular well of radius r_e*" (Powers et al, 2007)