Fieldgate Properties Limited.

Slope Stability Analysis
Proposed Residential Redevelopment
1600 Kerns Road
City of Burlington, Ontario

Project Number
BRM-00801554-G0

Prepared By:

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1 Introduction

This report was originally issued on October 18, 2018. Reported physical site conditions at that time were based on observations made during a site visit by EXP Services Inc. (EXP) on September 17, 2018. For the purposes of this updated report, a follow-up site visit was made by EXP on February 24, 2021. Physical site conditions observed during the February 24, 2021 site visit were found to be the essentially the same as those observed during the September 17, 2018 site visit. As such, the observations, analyses, conclusions and recommendations included herein remain valid.

The report presents the results of a slope stability evaluation to verify the potential impact on the existing slopes along the west property boundary due to construction of a Proposed Residential Development at 1600 Kerns Road, Burlington, Ontario. This report provides the stability analyses for the interpreted post construction conditions.

The slope stability analyses were carried out using the borehole information from a geotechnical report titled “Preliminary Geotechnical Report, 1600 Kerns Road, Burlington, Ontario” (Reference BRM-00801554-B0) dated October 18, 2018 prepared by EXP Services Inc. (EXP) and from a draft environmental report titled “Environmental Subsurface Investigation, 1600 Kerns Road, Burlington, Ontario” (Reference BRM-00801554-D0) dated December 1, 2018.

For this study, EXP was provided with Grading Plan Contour Drawing No. 18-30-288-00-A prepared by J. D. Barnes, dated September 14, 2018 and Survey Plan Reference No. 18-30-288-01-6 dated January 8, 2020 prepared by J.D. Barnes Limited showing the Top of Bank as staked by Conservation Halton on November 29, 2019. The grading plan shows existing grades along the slopes at the property boundaries. The proposed Grading Plan is not yet available. However, we understand that the proposed residential building will be about 7.5 m from the top of slope. Hence, the proposed foundation will not impinge on the slope and it will not change the slope conditions.

EXP carried out analyses on three (3) slope cross-sections, namely Cross-Sections 1-1, 2-2 and 3-3, as shown on the attached Drawing No.1. The Survey Plan Reference No. 18-30-288-01-6 dated January 8, 2020 prepared by J.D. Barnes Limited is included in this report following Drawing No.1.

2 Site Visit

The study included a site visit to visually inspect the conditions of the slopes and to record the current general slope condition, including signs of instability, if any, vegetative cover, and any internal or surface erosion.

3 Slope Conditions

The subject slopes are located on the west side of the proposed Residential Redevelopment, at 1600 Kerns Road, Burlington, Ontario.

The slopes are approximately 9 to 10.9 m high. The overall slope gradient varies from approximately 1.3H:1V to 3.4H:1V. The slopes are covered with tall grasses and there are also some mature trees growing on the slopes.

During the site visit on September 17, 2018, no visible signs of instability (e.g., surface failure, leaning trees, tension cracks, etc.) were noted. Approximately 0.3 m deep stream flow off the toe of the slope was observed during our site visit.

For this study, the site conditions, contour drawing and available plan showing pre-development site conditions were reviewed. Based on the information, Sections 1-1, 2-2 and 3-3 as shown on the attached Drawing No. 1, were selected by EXP as critical sections for slope stability analysis under pre-development conditions.

Photographs 1 through 4 attached in Appendix C, show the general conditions of the slopes at the time of this study.

4 Subsurface Conditions

The detailed soil profiles encountered in each borehole and the results of laboratory moisture content determinations are indicated on the attached borehole logs. It should be noted that the soil boundaries indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect approximate transition zones for the purpose of geotechnical design and should not be interpreted as exact planes of geological change.

The "Notes on Sample Descriptions" preceding the borehole logs form an integral part of and should be read in conjunction with this report.

4.1 Subsoil

4.1.1 Section 1-1 (Borehole 6 and 7)

Borehole 6 was drilled along the top of the slope and Borehole 7 was drilled at the bottom of the slope.

4.1.1.1 Asphalt Concrete Pavement Structure

Present at the ground surface at the top of the slope is a 135 mm asphalt concrete surface finish over 250 mm Granular base (pavement structure).

4.1.1.2 Existing Fill

A deposit of existing fill consisting of clayey silt and trace gravel was encountered below the asphalt concrete pavement structure to the depth of 7.2 m below the existing ground surface in Borehole 6. The fill is brown to grey in colour and has a natural moisture content of 6 to 27 percent. The SPT ‘N’ values of the fill were 5 to 9 blows per 300 mm.

4.1.1.3 Clayey Silt

A deposit of clayey silt was encountered below the fill in Borehole 6 to a borehole termination depth of 8.2 m below the existing ground surface. The clayey silt was encountered from surface to approximately 1.4 m depth in Borehole 7. The clayey silt is grey to black in colour and has a natural moisture content of 48 percent. The SPT ‘N’ values of the clayey silt were 4 to 16 blows per 300 mm, which indicates a soft to very stiff consistency.

4.1.1.4 Clayey Silt Till

A deposit of clayey silt till was found below the clayey silt in Borehole 7 and extends to a borehole termination depth of about 1.9 m. The clayey silt till is generally grey in colour. The SPT 'N' value of the clayey silt till was 85 blows per 250 mm, which indicates a hard consistency.

4.1.1.5 Groundwater

The groundwater condition at the site was assessed by observing the water levels in the open holes during the field work and observation the monitoring well in Borehole 6. Groundwater was observed at 4.65 m depth upon completion of drilling of the borehole and 3.57 m four days after drilling. Seasonal fluctuations of the groundwater level at the site should be anticipated.

4.1.2 Section 2-2 (Borehole 4)

Borehole 4 was drilled along the top of the slope.

4.1.2.1 Asphalt Concrete Pavement Structure

Present at the ground surface of the slope is a 90 mm asphalt concrete surface finish over 125 mm Granular base (pavement structure).

4.1.2.2 Clayey Silt Till

A deposit of clayey silt till was found below the asphalt concrete pavement structure in Borehole 4 and extends to the borehole termination depth of 9.75 m below the existing ground surface. The clayey silt till is generally reddish brown in colour. This deposit has a natural moisture content of 12 to 18 percent. The SPT 'N' values of the clayey silt till were 13 to 63 blows per 300 mm, which indicates stiff to hard consistency.

4.1.2.3 Groundwater

The groundwater condition at the site was assessed by observing the water level in the open holes during the field work. No groundwater was observed upon completion of drilling of the borehole. Seasonal fluctuations of the groundwater level at the site should be anticipated.

4.1.3 Section 3-3 (Boreholes 4 and HA 3)

Borehole 4 was drilled along the top of the slope and Borehole HA 3 was drilled partially down the slope.

4.1.3.1 Asphalt Concrete Pavement Structure

Present at the ground surface of the slope in Borehole 4 is a 90 mm asphalt concrete surface finish over 125 mm Granular base (pavement structure).

4.1.3.2 Existing Fill

A deposit of existing fill consisting of clayey silt with trace sand, trace gravel and trace organics was encountered from surface to the depth of 1.2 m below the existing ground surface in Borehole HA 3. The fill is brown in colour.

4.1.3.3 Clayey Silt Till

A deposit of clayey silt till was found below the existing fill in Borehole HA 3 and below the asphalt concrete surface finish in Borehole 4 and extends to the borehole termination depths of 3.1 to 9.75 m below the existing ground surface. The clayey silt till is described as clayey silt on the log of Borehole HA 3. The clayey silt till is generally reddish brown in colour. This deposit has a natural moisture content of 12 to 18 percent. The SPT 'N' values of the clayey silt till were 13 to 53 blows per 300 mm, which indicates stiff to hard consistency.

4.1.3.4 Groundwater

The groundwater condition at the site was assessed by observing the water level in the open holes during the field work. No groundwater was observed upon completion of drilling of the boreholes. Seasonal fluctuations of the groundwater level at the site should be anticipated.

5 Slope Stability Analysis

5.1 Methodology

Stability analysis was performed at three critical pre-development (same as post-development) slope sections (Section 1-1, Section 2-2 and Section 3-3) as shown on Drawing No. 1. Embankment geometry as provided in the earlier referenced Drawing No. 18-30-288-00-A (J. D. Barnes) was utilized for analyses at Sections 1-1, 2-2 and 3-3.

All stability analyses were carried out using the Slope/W software (GeoStudio 2012), and subsurface conditions revealed by the boreholes referenced for the respective slope sections. The factor of safety (F.S.) against slope failure was evaluated based on the limit equilibrium analysis method proposed by Morgenstern and Price for circular sliding surfaces.

The soil parameters adopted in the analyses are summarized in Table 1. These parameters are estimated from the index properties of the soil units, and are considered to be realistic and slightly conservative.

Table 1: Soil Properties used in Analysis

Material	Unit Weight (kN/m^3)	Effective Cohesion (kPa)	Angle of Shearing Resistance
Existing Fill	19	0	28°
Clayey Silt	19	0	22°
Clayey Silt Till	22	0	36°

Each section was analyzed under static and seismic conditions. Design ground acceleration for the project site was determined from the Earthquake Hazards Program Website by interpolating 2015 National Building Code of Canada Seismic Hazard values. The map indicates a peak horizontal ground acceleration (PHGA) value of approximately 0.156 g at the project site[1]. The value is associated with an earthquake having 2 percent probability of exceedance in a 50-year period, (0.000404 per annum probability).

The results of the analyses are shown in Figures 1 to 6 in Appendix 'B' and are summarized in the following Table 2.

[1] g = the acceleration of gravity = ~9.81 m/sec^2

Table 2: Stability Analyses Results

Sections	Minimum Safety Factors			
	Static	Figure	Seismic	Figure
1	1.41	1	1.00	2
2	1.36	3	1.09	4
3	1.44	5	1.09	6

The failure surfaces representing the minimum F.S.s from the analyses are shown with hatched lines above with the corresponding F.S. identified in red font.

In general, according to guidelines of Conservation Halton (CH), acceptable minimum Factors of Safety under static and seismic conditions are 1.5 and 1.1, respectively. Where minimum F.S.s less than these values were returned by the analyses, the failure surfaces associated with the minimum acceptable F.S.s as indicated by the analyses and in accordance with CH guidelines, are indicated with their centres identified in black font.

5.2 Results of Stability Analyses

5.2.1 Section 1-1 (Figures 1 and 2)

The existing slope at this section is about 10.9 m high, and the slope gradient is gentle at about 1.3H:1V at the toe and 2.3H:1V in the upper slope. The minimum calculated values of F.S. for this proposed section are 1.41 and 1.00 under static and seismic conditions, respectively. The results indicate that the physical top of slope will be the long term stable top of slope.

5.2.2 Section 2-2 (Figure 3 and 4)

The existing slope at this section is about 9.0 m high, and the slope gradient is at about 1.7H:1V in upper slope and with 3.4H:1.0V at lower slope. The minimum calculated values of F.S. for this proposed section are 1.36 and 1.09 under static and seismic conditions, respectively. The results indicate that the physical top of slope will be the long term stable top of slope.

5.2.3 Section 3-3 (Figure 5 and 6)

The existing slope at this section is about 8.5 m high, and the slope gradient is at about 1.3H:1V. The minimum calculated values of F.S. for this proposed section are 1.44 and 1.09 under static and seismic conditions, respectively. The results indicate that the physical top of slope will be the long term stable top of slope.

5.3 Toe Erosion

Toe erosion due to creek flow needs to be considered. No erosion was observed and based on the channel width of less than 5.0 m and clayey silt soil condition encountered, a toe erosion allowance of 1.0 m is recommended.

It is understood that a 7.5 m setback has been imposed by Conservation Halton. Based on current site conditions, the existing slope is stable. Consideration of the recommended 1.0 m toe erosion allowance results in no change to the calculated stable top of bank location.

All vegetative cover on the slope should be retained in order to minimize surface erosion on the slope.

6 Conclusions and Recommendations

It is the conclusion of this study that the construction of Proposed Residential Redevelopment is feasible and the proposed development would not impact the current stability of the slopes at the site. The physical Top of Bank as staked by Conservation Halton, has been determined to be the stable Top of Bank.

The following are our recommendations:

1. Any engineered fill should be constructed under the full-time supervision of a qualified geotechnical engineer.

2. No storm water should be allowed to be discharged onto the slope in an uncontrolled manner.

3. During construction, no stockpiles of construction material should be placed within about 10 m of the crest of the slope or on the existing slope surface.

4. All vegetative cover should be retained on the slope surface.

7 General Comments

When design and specifications based on the results reported herein are required, EXP should be retained for a general review to verify that this report has been properly interpreted and implemented. If not accorded the privilege of making this review, EXP will assume no responsibility for interpretation of the recommendations in the report.

This report has been prepared for and is intended for the exclusive use of Fieldgate Properties Limited, Conservation Halton, Municipality of Burlington and its clients and engineers. Any use which a third party makes of this report, or any part thereof, of any reliance on or decision to be made based on it, are the responsibility of such third parties. EXP accepts no responsibility for damages, if any, suffered by any third party as a result of decision made or actions based on this report. The contents of this report should not be relied upon by any other party without the express written consent of EXP. The findings are relevant for the dates of our site visits and should not be relied upon to represent conditions at later dates.

We trust that this report is sufficient for your purposes. Should you have any questions regarding this report, please do not hesitate to contact the undersigned.

EXP Services Inc.

Thein Aung, M.Sc., P.Eng., M.ASCE;F.G.S.
Senior Geotechnical Engineer
Geotechnical Division

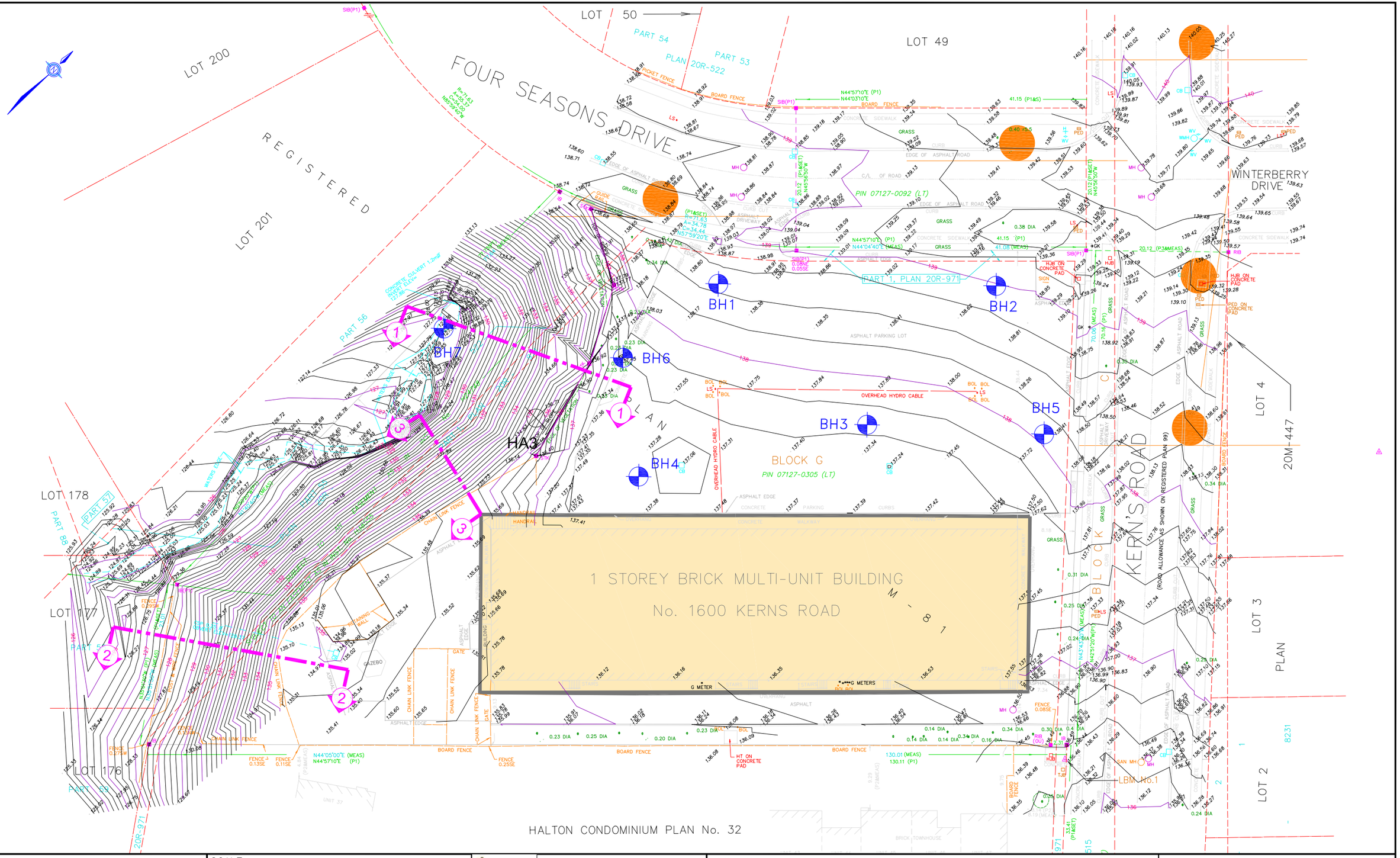
David Dennison, P.Eng.
Project Manager
Geotechnical Division

LICENSED PROFESSIONAL ENGINEER
PROVINCE OF ONTARIO
Feb 25, 2021

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Appendix A:

Borehole Location Plan;
Survey Plan Reference No. 18-30-288-01-6;
Notes on Sample Descriptions
Borehole Logs



LEGEND:

- Borehole Location
- Hand auger Location

SCALE:

0 5 10 15 m

EXP Services Inc.

PROJECT:

Preliminary Geotechnical Investigation, Slope Stability Assessment
Residential Redevelopment, 1600 Kern's Road
Burlington, ON

TITLE:

BOREHOLE LOCATION PLAN

APPROVED BY:	DATE:	PROJECT NO.:
D.D.	December 20, 2019	BRM-00801554-E0
DRAWN BY:	SCALE:	DRAWING NO.:
S.H.	As Shown	1

SKETCH SHOWING DRIPLINE AND TOP OF BANK
AS STAKED ON NOVEMBER 29th, 2019 ON

1600 KERNS ROAD
CITY OF BURLINGTON
REGIONAL MUNICIPALITY OF HALTON

SCALE 1 : 250

5 0 5 5 10 15 metres

J. D. BARNES LIMITED

© COPYRIGHT

METRIC DISTANCES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048.

CAUTION

THIS IS NOT A PLAN OF SURVEY AND SHALL NOT BE USED EXCEPT FOR THE PURPOSE INDICATED IN THE TITLE BLOCK.

NOTE

BOUNDARY INFORMATION IS COMPILED FROM AVAILABLE PAPER RECORDS, AND HAS NOT BEEN VERIFIED BY ACTUAL FIELD MEASUREMENTS.

LEGEND

○ DENOTES SET WOOD STAKE FOR TREE DRIPLINE, AS DETERMINED BY REGION OF HALTON ON SITE WALK ON NOVEMBER 29th, 2019.

☒ DENOTES SET WOOD STAKE FOR TOP OF BANK, AS DETERMINED BY HRCA ON SITE WALK ON NOVEMBER 29th, 2019.

ELEVATION NOTE

ELEVATIONS SHOWN ON THIS PLAN ARE DERIVED FROM CITY OF BURLINGTON
BENCHMARK No. 1081
ELEVATION = 157.586m
AND
BENCHMARK No. 1082
ELEVATION = 139.47m

ROOF PEAK=146.79
DWELLING

ROOF PEAK=148.40
DWELLING

FOUR SEASONS DRIVE
(DEDICATED AS PER REGISTERED PLAN M-81)

Arc=34.78
41.08

REGISTERED PLAN

LOT 201
PART 56
20R-

LOT 178
PART 57

LOT 177
PART 58

LOT 176
PART 59

WALSH'S EDGE

AREA BELOW TOP OF BANK = 1,754 sq.m.
PART

DRIPLINE AS STAKED BY REGION OF HALTON ON NOVEMBER 29th, 2019
SUBJECT TO AN EASEMENT AS IN INST. No.H24748

TOP OF BANK AS STAKED BY HRCA ON NOVEMBER 29th, 2019

CONSERVATION HALTON

CHAIN LINK FENCE

7.5m SETBACK FROM TOP OF BANK

BLOCK G

AREA ABOVE TOP OF BANK = 6,235 sq.m.

AREA OUTSIDE 7.5m SETBACK = 5,504 sq.m.

1 STOREY BRICK MULTI-UNIT BUILDING
No. 1600 KERNS ROAD

PART 1, PLAN 20R-971
SUBJECT TO AN EASEMENT AS IN INST. No. H38555

PART 2
PLAN 20R-971

N28°59'00"W 8.73
9.46
N34°19'20"W 6.58
N62°43'20"E 9.12
N13°59'20"W 10.84
N44°44'10"W 6.48
N62°15'20"W 6.01
N48°54'30"W 8.76
N17°34'50"W 11.14
N12°40'10"W 11.98
N41°30'20"W 8.10
N37°09'20"W 8.18
N11°25'57"E 22.59
N5°50'20"W 9.37
N49°42'30"W 16.54
77.64
23.01
130.01
70.06

KERN'S ROAD
(ROAD ALLOWANCE AS SHOWN ON REGISTERED PLAN 99)

BLOCK C
(DEDICATED AS PER REGISTERED PLAN M-81)

M-81

HALTON CONDOMINIUM PLAN No. 32

TOWNHOUSE
ROOF PEAK=143.80

GARAGE

TOWNHOUSE
ROOF PEAK=142.80

TOWNHOUSE
ROOF PEAK=143.35

TOWNHOUSE
ROOF PEAK=143.85

ROOF PEAK=143.93

ROOF PEAK=147.82
DWELLING

DWELLING
ROOF PEAK=146.91

DWELLING
ROOF PEAK=145.63

DWELLING
ROOF PEAK=145.45

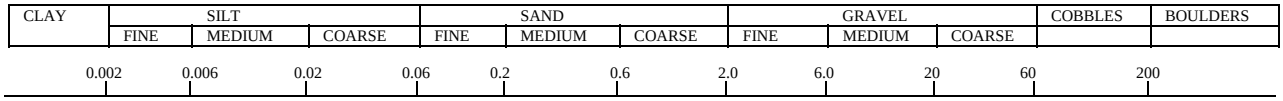
J.D.BARNES LIMITED
SURVEYING MAPPING GIS
LAND INFORMATION SPECIALISTS
401 WHEELABRATOR WAY, SUITE A, MILTON, ON L9T 3C1
T: (905) 875-9955 F: (905) 875-9956 www.jdbarnes.com

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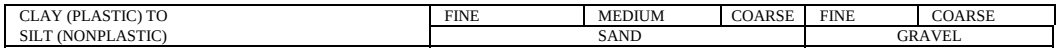
Notes on Sample Descriptions and Soil Types — Drawing 1A

1. All sample descriptions included in this report follow the Canadian Foundations Engineering Manual soil classification system. This system follows the standard proposed by the International Society for Soil Mechanics and Foundation Engineering. Laboratory grain size analyses provided by **exp** also follow the same system. Others may use different classification systems; one such system is the Unified Soil Classification. Please note that, with the exception of those samples where a grain size analysis has been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.

ISSMFE SOIL CLASSIFICATION



EQUIVALENT GRAIN DIAMETER IN MILLIMETERS



UNIFIED SOIL CLASSIFICATION

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

3. Till: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of

till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

4. Excerpt from “OHSA Regulations for Construction Projects,” Part III, Section 226:

- **Soil Types**

Type 1 Soil

a) is hard, very dense and only able to be penetrated with difficulty by a small sharp object;
b) has a low natural moisture content and a high degree of internal strength;
c) has no signs of water seepage; and
d) can be excavated only by mechanical equipment.

Type 2 Soil

a) is very stiff, dense and can be penetrated with moderate difficulty by a small sharp object;
b) has a low to medium natural moisture content and a medium degree of internal strength; and
c) has a damp appearance after it is excavated.

Type 3 Soil

a) is stiff to firm and compact to loose in consistency or is previously excavated soil;
b) exhibits signs of surface cracking;
c) exhibits signs of water seepage;
d) if it is dry, may run easily into a well-defined conical pile; and
e) has a low degree of internal strength.

Type 4 Soil

a) is soft to very soft and very loose in consistency, very sensitive and upon disturbance is significantly reduced in natural strength;
b) runs easily or flows, unless it is completely supported before excavating procedures;
c) has almost no internal strength;
d) is wet or muddy; and
e) exerts substantial fluid pressure on its supporting system. O. Reg. 213/91, s. 226.

Log of Borehole 1

Project No. BRM-00801554-B0 | Drawing No. 2

Project: Geotechnical Investigation | Sheet No. 1 of 2

Location: 1600 Kerns Rd., Burlington

Date Drilled: October 12, 2018

Drill Type: CME 55, Solid Stem Augers

Datum: Geodetic

Auger Sample ☒ | Combustible Vapour Reading □

SPT (N) Value ○ ▨ | Natural Moisture ×

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

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

Field Vane Test S | Penetrometer ▲

Soil Description	ELEV. m	Depth (m)	SPT (N Value) / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	Sample	Natural Unit Weight kN/m³
~ 140 mm **ASPHALTIC CONCRETE** over ~ 180 mm **GRANULAR BASE** over **FILL**: Reworked clayey silt, some gravel, medium grained sand pockets, glass fragments, brown to grey, black pockets, moist	138.67 ~138.5	0 1	7 7	×		21.5
Becoming brown to reddish brown sand and gravel, red brick, glass and ceramic fragments, moist	~136.5	2 3	4 3	×		
Becoming wet	~134.2 ~133.9	4 5 6	7 3 2	×		

Groundwater ▽

Continued Next Page

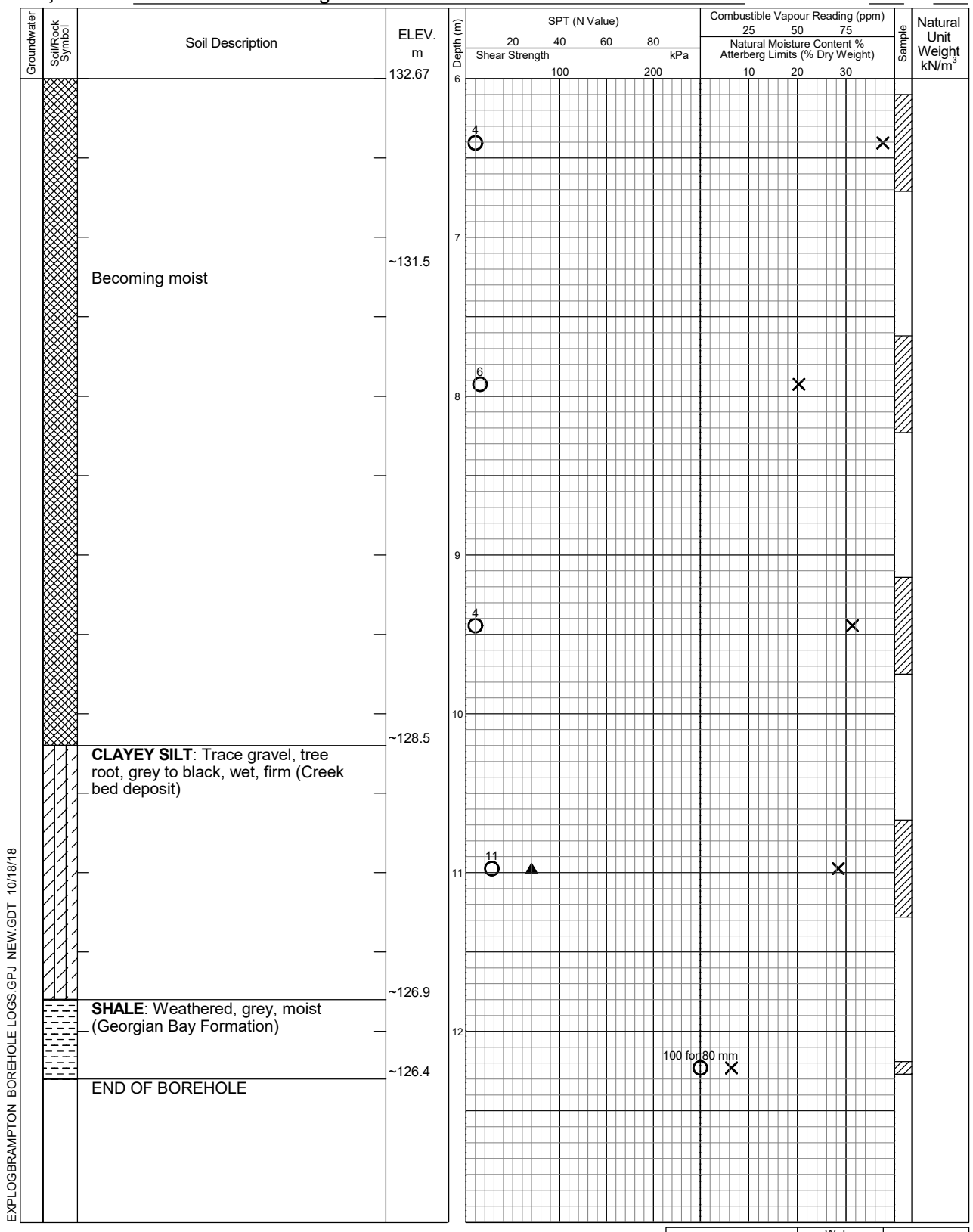
Elapsed Time	Water Level (m)	Hole Open to (m)
On Completion	4.82	8.61

EXPLOGBRAMPTON BOREHOLE LOGS.GPJ NEW.GDT 10/18/18

Log of Borehole 1

Project No. BRM-00801554-B0 Drawing No. 2

Project: Geotechnical Investigation Sheet No. 2 of 2



EXPLOGBRAMPTON BOREHOLE LOGS.GPJ NEW.GDT 10/18/18

Elapsed Time	Water Level (m)	Hole Open to (m)
On Completion	4.82	8.61

Log of Borehole 2

Project No. BRM-00801554-B0

Drawing No. 3

Project: Geotechnical Investigation

Sheet No. 1 of 2

Location: 1600 Kerns Rd., Burlington

Date Drilled: October 12, 2018

Drill Type: CME 55, Solid Stem Augers

Datum: Geodetic

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

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

Groundwater	Soil/Rock Symbol	Soil Description	ELEV. m	Depth (m)	SPT (N Value) / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	Sample	Natural Unit Weight kN/m³
		~ 145 mm **ASPHALTIC CONCRETE** over ~ 190 mm **GRANULAR BASE** over **CLAYEY SILT TILL**: Fine sand seams, trace gravel, brown, moist, hard	138.92 ~138.8	0 1 2 3 4 5 6	7 23 42 46 41 47			22.1 22.4 22.3 22.7

Continued Next Page

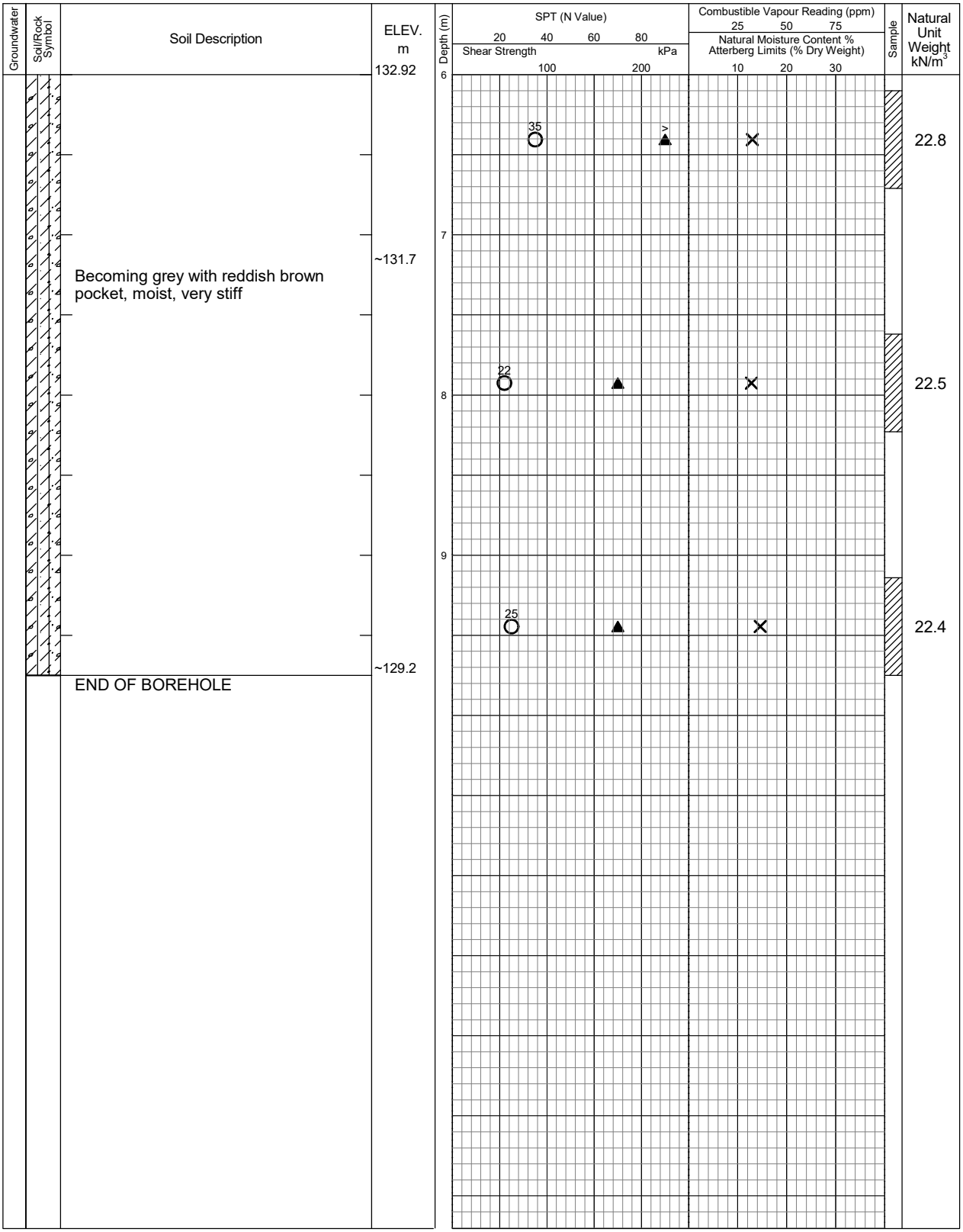
Elapsed Time	Water Level (m)	Hole Open to (m)
On Completion	Dry	Open

EXPLOGBRAMPTON BOREHOLE LOGS.GPJ NEW.GDT 10/18/18

Log of Borehole 2

Project No. BRM-00801554-B0 Drawing No. 3

Project: Geotechnical Investigation Sheet No. 2 of 2



EXPLOGBRAMPTON BOREHOLE LOGS.GPJ NEW.GDT 10/18/18

Elapsed Time	Water Level (m)	Hole Open to (m)
On Completion	Dry	Open

Log of Borehole 3

Project No. BRM-00801554-B0 | Drawing No. 4

Project: Geotechnical Investigation | Sheet No. 1 of 2

Location: 1600 Kerns Rd., Burlington

Date Drilled: October 11, 2018

Drill Type: CME 55, Solid Stem Augers

Datum: Geodetic

Auger Sample ☒ | Combustible Vapour Reading □

SPT (N) Value ○ ▨ | Natural Moisture ×

Dynamic Cone Test — | Plastic and Liquid Limit ⊢○

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

Field Vane Test S | Penetrometer ▲

Groundwater	Soil/Rock Symbol	Soil Description	ELEV. m	Depth (m)	SPT (N Value) / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	Sample	Natural Unit Weight kN/m³
		~ 100 mm **ASPHALTIC CONCRETE** over ~ 100 mm **GRANULAR BASE** over **CLAYEY SILT TILL**: Fine sand seams, trace gravel, occasional boulder fragments, brown, reddish brown pockets, moist, hard	137.63 ~137.5	0	19			21.5
				1	34			22.5
				2	38			22.5
				3	37			22.4
				4	40			23.2
				5	30			23.0
		Becoming grey with reddish brown pockets	~131.9	6				

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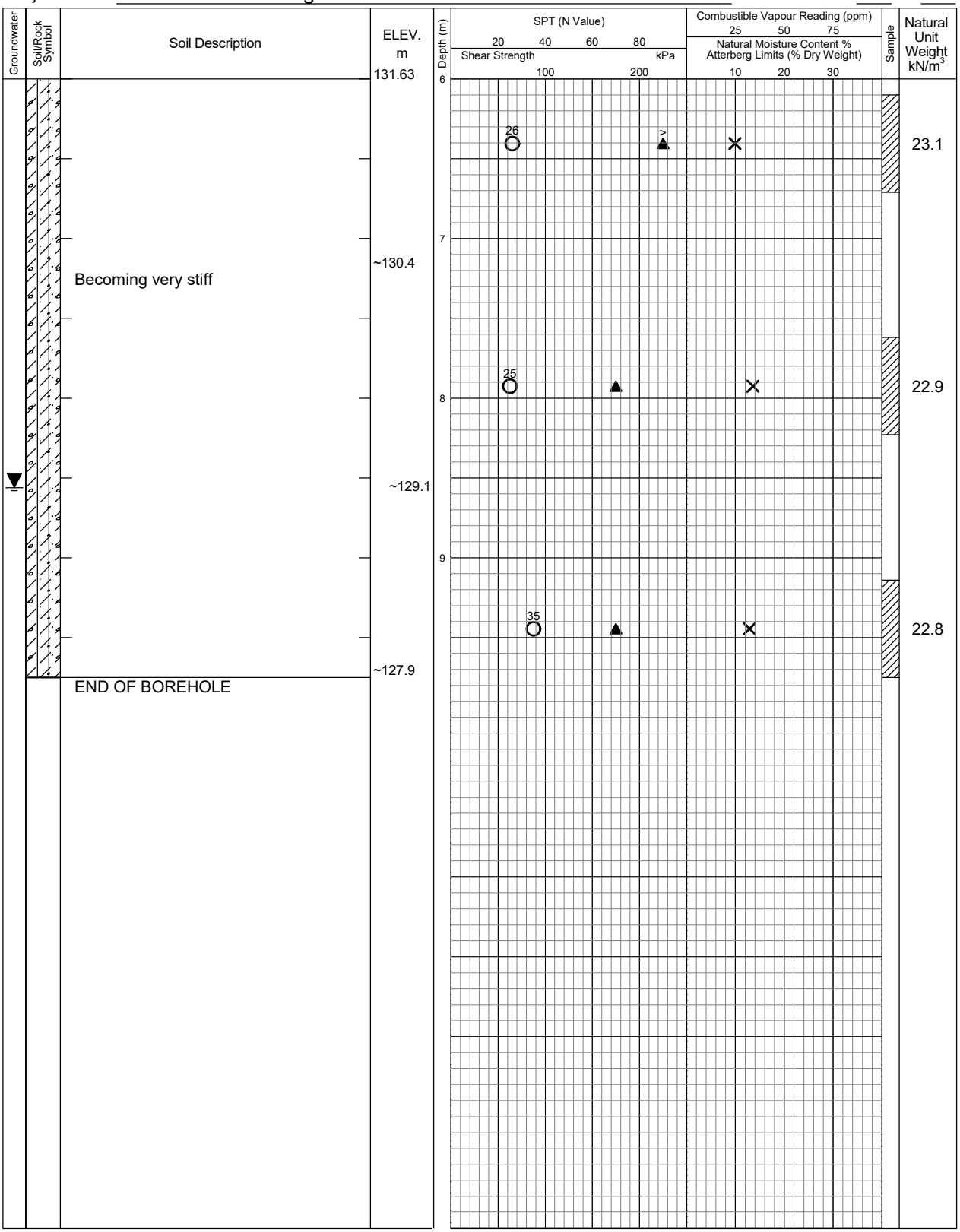
Elapsed Time	Water Level (m)	Hole Open to (m)
On Completion	8.58	9.19

EXPLOGBRAMPTON BOREHOLE LOGS.GPJ NEW.GDT 10/18/18

Log of Borehole 3

Project No. BRM-00801554-B0 Drawing No. 4

Project: Geotechnical Investigation Sheet No. 2 of 2



Elapsed Time	Water Level (m)	Hole Open to (m)
On Completion	8.58	9.19

EXPLOGBRAMPTON BOREHOLE LOGS.GPJ NEW.GDT 10/18/18

Log of Borehole 4

Project No. BRM-00801554-B0 | Drawing No. 5

Project: Geotechnical Investigation | Sheet No. 1 of 2

Location: 1600 Kerns Rd., Burlington

Date Drilled: October 11, 2018

Drill Type: CME 55, Solid Stem Augers

Datum: Geodetic

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

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

Soil Description	ELEV. m	Depth (m)	SPT (N Value) / Shear Strength kPa	Natural Moisture Content % / Atterberg Limits (% Dry Weight)	Natural Unit Weight kN/m³
~ 90 mm **ASPHALTIC CONCRETE** over ~ 125 mm **GRANULAR BASE** over **CLAYEY SILT TILL**: Fine sand seams, trace gravel, occasional boulder fragments, brown, reddish brown and grey pockets, moist, hard	137.35 ~137.3	0	13		
		1	22		22.0
		2	26		22.1
		2.5	52		
		3	29		22.3
		4			
		4.5	30		22.3
Becoming grey with reddish brown pockets, stiff to very stiff	~131.8	5			
		6			

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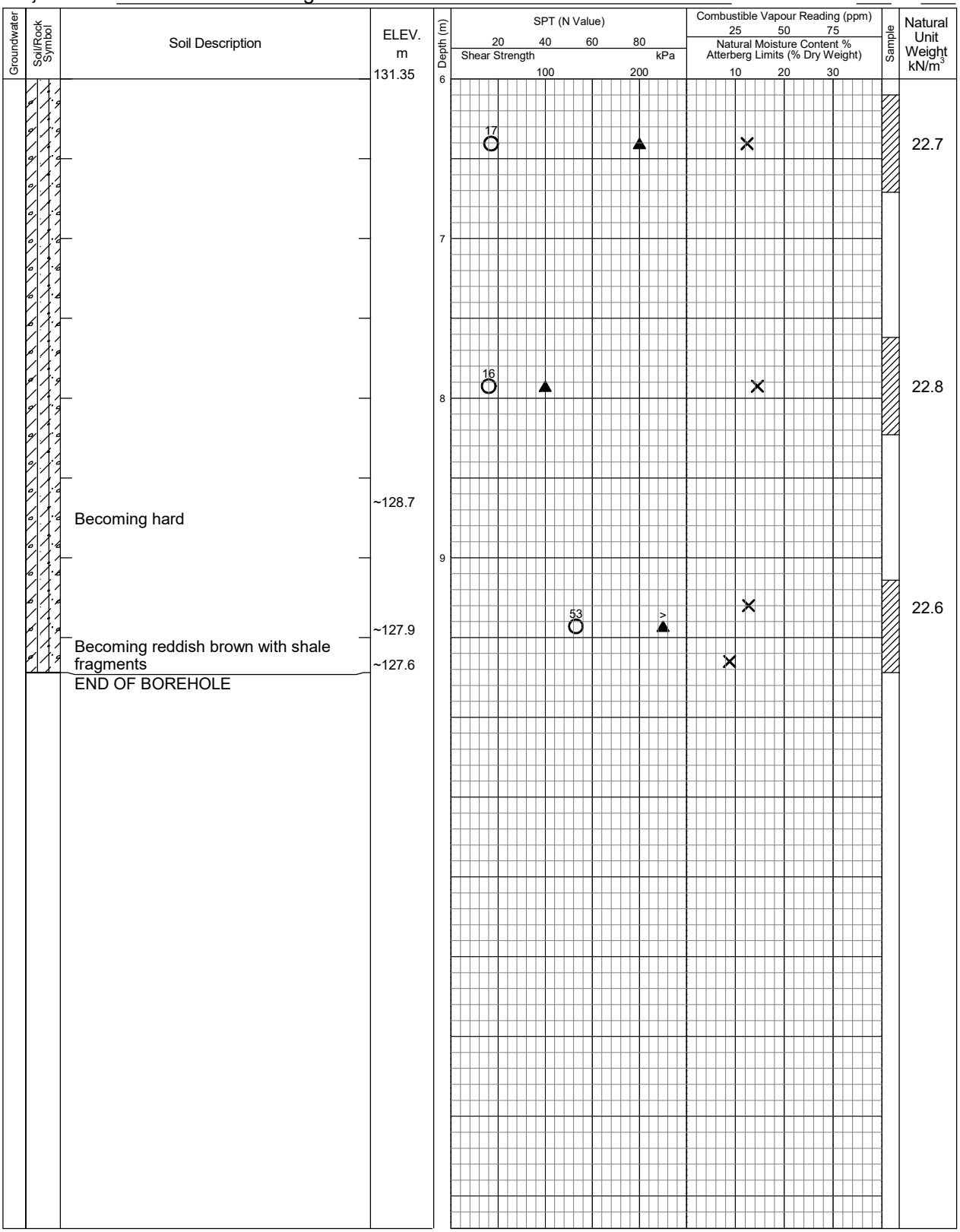
Elapsed Time	Water Level (m)	Hole Open to (m)
On Completion	Dry	9.7

EXPLOGBRAMPTON BOREHOLE LOGS.GPJ NEW.GDT 10/18/18

Log of Borehole 4

Project No. BRM-00801554-B0 Drawing No. 5

Project: Geotechnical Investigation Sheet No. 2 of 2



Elapsed Time	Water Level (m)	Hole Open to (m)
On Completion	Dry	9.7

EXPLOGBRAMPTON BOREHOLE LOGS.GPJ NEW.GDT 10/18/18

Log of Borehole 5

Project No. BRM-00801554-B0 | Drawing No. 6

Project: Geotechnical Investigation | Sheet No. 1 of 2

Location: 1600 Kerns Rd., Burlington

Date Drilled: October 11, 2018

Drill Type: CME 55, Solid Stem Augers

Datum: Geodetic

Auger Sample ☒
SPT (N) Value ○ ▨
Dynamic Cone Test —
Shelby Tube ■
Field Vane Test ✚ S

Combustible Vapour Reading □
Natural Moisture ×
Plastic and Liquid Limit ⊢○
Undrained Triaxial at % Strain at Failure ⊕
Penetrometer ▲

Groundwater	Soil/Rock Symbol	Soil Description	ELEV. m	Depth (m)	SPT (N Value) 20 40 60 80 / Shear Strength 100 200 kPa	Combustible Vapour Reading (ppm) 25 50 75 / Natural Moisture Content % Atterberg Limits (% Dry Weight) 10 20 30	Sample	Natural Unit Weight kN/m³
		~ 110 mm **ASPHALTIC CONCRETE** over ~ 290 mm **GRANULAR BASE** over **CLAYEY SILT TILL**: Fine sand seams, trace gravel, occasional boulder fragments, brown with reddish brown pockets, moist, hard	138.16 ~138.1	0	11			
				1	28			22.1
				2	44			22.5
				3	41			22.4
				4	40			22.9
				5	35			22.4
		Becoming grey with reddish brown pockets	~132.5	6				

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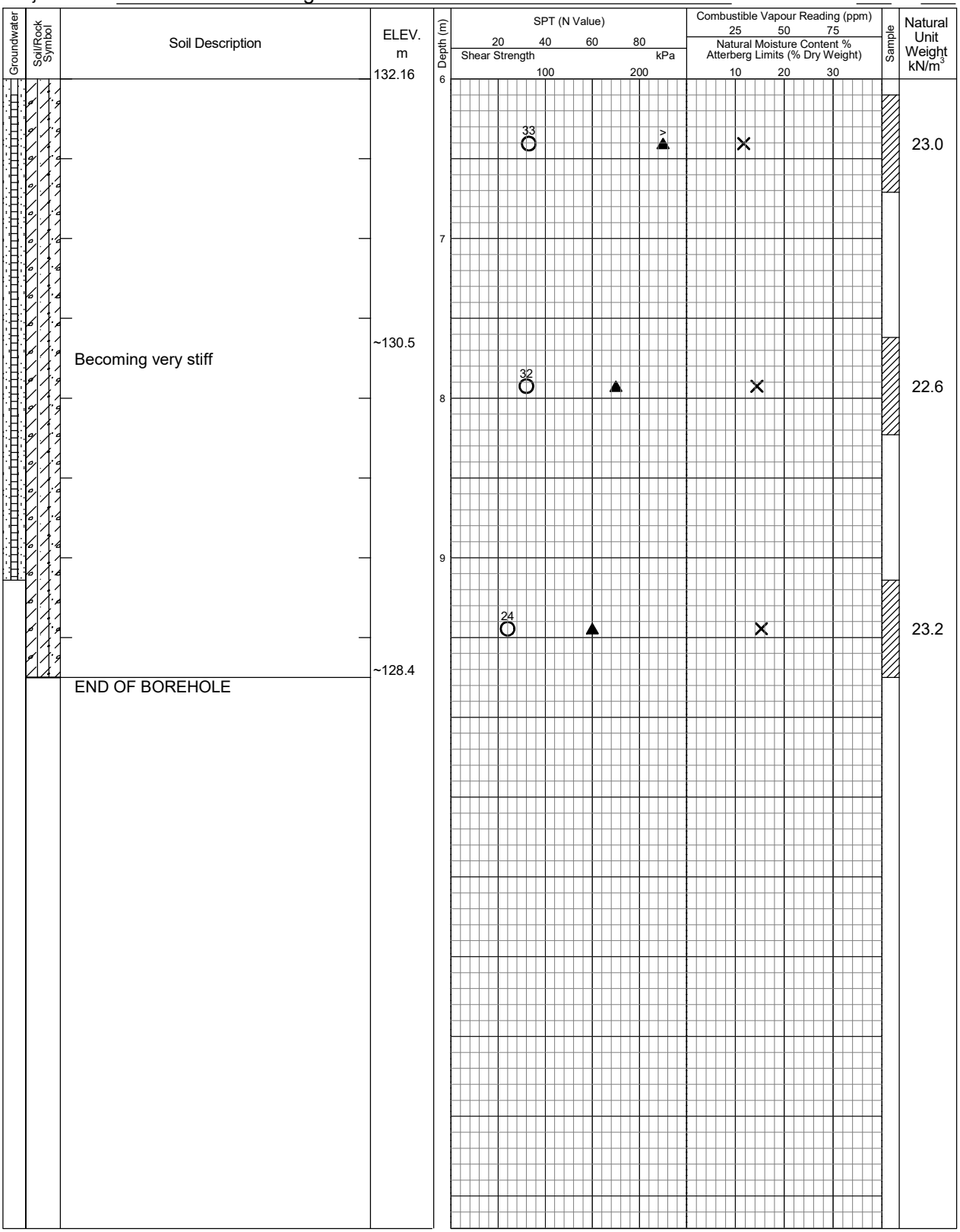
Elapsed Time	Water Level (m)	Hole Open to (m)
On Completion	Dry	Open
October 12, 2018	8.47	9.19
October 15, 2018	7.82	
October 16, 2018	6.31	

EXPLOGBRAMPTON BOREHOLE LOGS.GPJ NEW.GDT 10/18/18

Log of Borehole 5

Project No. BRM-00801554-B0 Drawing No. 6

Project: Geotechnical Investigation Sheet No. 2 of 2



EXPLOGBRAMPTON BOREHOLE LOGS.GPJ NEW.GDT 10/18/18

Elapsed Time	Water Level (m)	Hole Open to (m)
On Completion	Dry	Open
October 12, 2018	8.47	9.19
October 15, 2018	7.82	
October 16, 2018	6.31	

Log of Borehole 6

Project No. BRM-00801554-B0

Drawing No. 7

Project: Geotechnical Investigation

Sheet No. 1 of 2

Location: 1600 Kerns Rd., Burlington

Date Drilled: October 12, 2018

Drill Type: CME 55, Solid Stem Augers

Datum: Geodetic

Auger Sample

SPT (N) Value

Dynamic Cone Test

Shelby Tube

Field Vane Test

Combustible Vapour Reading

Natural Moisture

Plastic and Liquid Limit

Undrained Triaxial at % Strain at Failure

Penetrometer

Groundwater	Soil/Rock Symbol	Soil Description	ELEV. m	Depth (m)	SPT (N Value) / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	Sample	Natural Unit Weight kN/m³
		~ 135 mm **ASPHALTIC CONCRETE** over ~ 250 mm **GRANULAR BASE** over **FILL**: Clayey silt, trace gravel, brown to grey, reddish brown pockets, moist to wet	137.58 ~137.4	0 1 2 3 4 5 6	7 8 5 6 8 9			21.6
			~132.9					

Continued Next Page

Elapsed Time	Water Level (m)	Hole Open to (m)
On Completion	4.65	Open
October 12, 2018	3.29	7.69
October 15, 2018	3.57	
October 16, 2018	3.57	

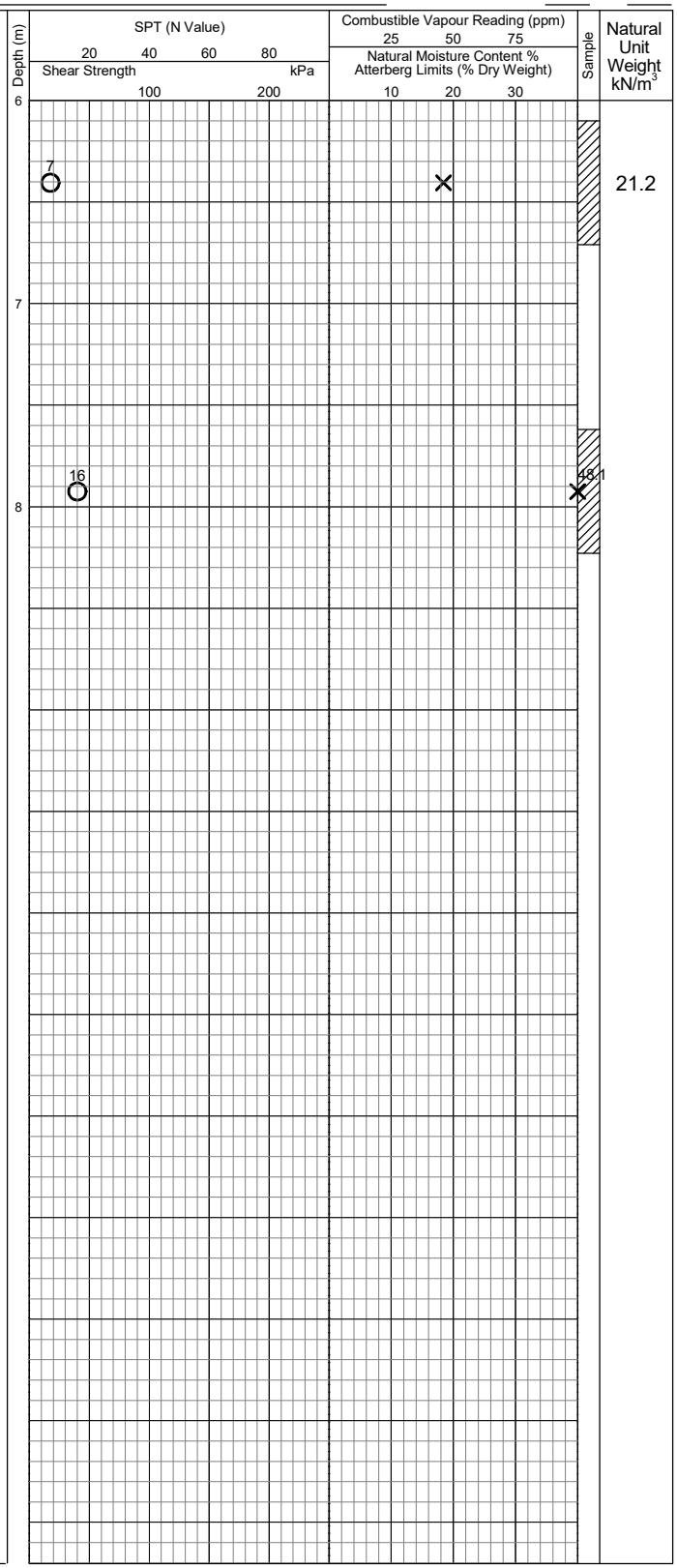
EXPLOGBRAMPTON BOREHOLE LOGS.GPJ NEW.GDT 10/18/18

Log of Borehole 6

Project No. BRM-00801554-B0 Drawing No. 7

Project: Geotechnical Investigation Sheet No. 2 of 2

Soil Description	ELEV. m
	131.58
	~130.4
CLAYEY SILT: Sand and gravel layers, decayed tree roots, silt pockets, grey to black, wet, compact (Creek bed deposit)	
	~129.4
END OF BOREHOLE	



Elapsed Time	Water Level (m)	Hole Open to (m)
On Completion	4.65	Open
October 12, 2018	3.29	7.69
October 15, 2018	3.57	
October 16, 2018	3.57	

EXPLOGBRAMPTON BOREHOLE LOGS.GPJ NEW.GDT 10/18/18

Log of Borehole 7

Project No. BRM-00801554-B0

Drawing No. 8

Project: Geotechnical Investigation

Sheet No. 1 of 1

Location: 1600 Kerns Rd., Burlington

Date Drilled: October 16, 2018

Drill Type: Manual Hammer (70 lb)

Datum: Geodetic

Auger Sample

SPT (N) Value

Dynamic Cone Test

Shelby Tube

Field Vane Test (S)

Combustible Vapour Reading

Natural Moisture

Plastic and Liquid Limit

Undrained Triaxial at % Strain at Failure

Penetrometer

Groundwater	Soil/Rock Symbol	Soil Description	ELEV. m	Depth (m)
▼		**CLAYEY SILT**: Trace gravel, reddish brown, black seams in upper ~300 mm, wet, soft	127.86	0
			~127.7	
				1
			~126.5	
		CLAYEY SILT TILL: Fine sand seams, trace gravel, shale lenses, olive grey, moist hard		
			~126.0	
		TERMINATED UPON PRACTICAL REFUSAL TO SAMPLING EQUIPMENT		

SPT (N Value): 20 40 60 80

Shear Strength: 100 200 kPa

Combustible Vapour Reading (ppm): 25 50 75

Natural Moisture Content % / Atterberg Limits (% Dry Weight): 10 20 30

Sample

Natural Unit Weight kN/m³

3

4

85 for 250 mm

Elapsed Time	Water Level (m)	Hole Open to (m)
On Completion	0.2	0.91

EXPLOGBRAMPTON BOREHOLE LOGS.GPJ NEW.GDT 10/18/18

Log of Borehole HA3

Project No. BRM-00801554-D0 Drawing No. 5

Project: Subsurface Environmental Investigation Sheet No. 1 of 1

Location: 1600 Kerns Road, Burlington, ON

Refer to Borehole Location Plan

Date Drilled: Nov. 29, 2018

Drill Type: ATCO Handheld

Datum:

Chemical Analysis

BTEX	Benzene, Toluene, Ethylbenzene and Xylenes	*	Duplicate Sample
ING	Metals and Inorganics	PCB	Polychlorinated Biphenyls
MET	Metals	PHC	Petroleum Hydrocarbons (F1-F4)
PAH	Polycyclic Aromatic Hydrocarbons	VOC	Volatile Organic Compounds
PEST	Organochlorine Pesticides		

GWL	SYMBOL	Soil Description	ELEV. m	DEPTH	N Value	Combustible Vapour Reading (ppm)	SAMPLES	% RECOV	SAMPLE ID	ANALYSIS
		CLAYEY SILT FILL: Brown, trace sand, trace gravel, trace organics, moist		0	20 40 60	25 50 75		60	SS1	
				1		0 ppm (HEX)		70	SS2	ING PAH
		CLAYEY SILT: Brown, trace gravel, damp		2		0 ppm		100	SS3	
				3		0 ppm		50	SS4	
		End of borehole at 3.1 m bgs		4		0 ppm		40	SS5	
		NOTES: - To be read with the subject report. - Soil vapour readings measured using an RKI Eagle instrument calibrated with hexane.		5						
				6						
				7						
				8						
				9						
				10						
				11						
				12						

ENVIRONMENTAL-EXP 1600 KERNS BH LOGS.GPJ 12/10/18

Time	Water Level (m)	Depth to Cave (m)

EXP Services Inc.
Brampton, Ontario
Telephone: 905-793-9800
Facsimile: 905-793-0641

Appendix B:

Figures – Slope Stability Analysis Results

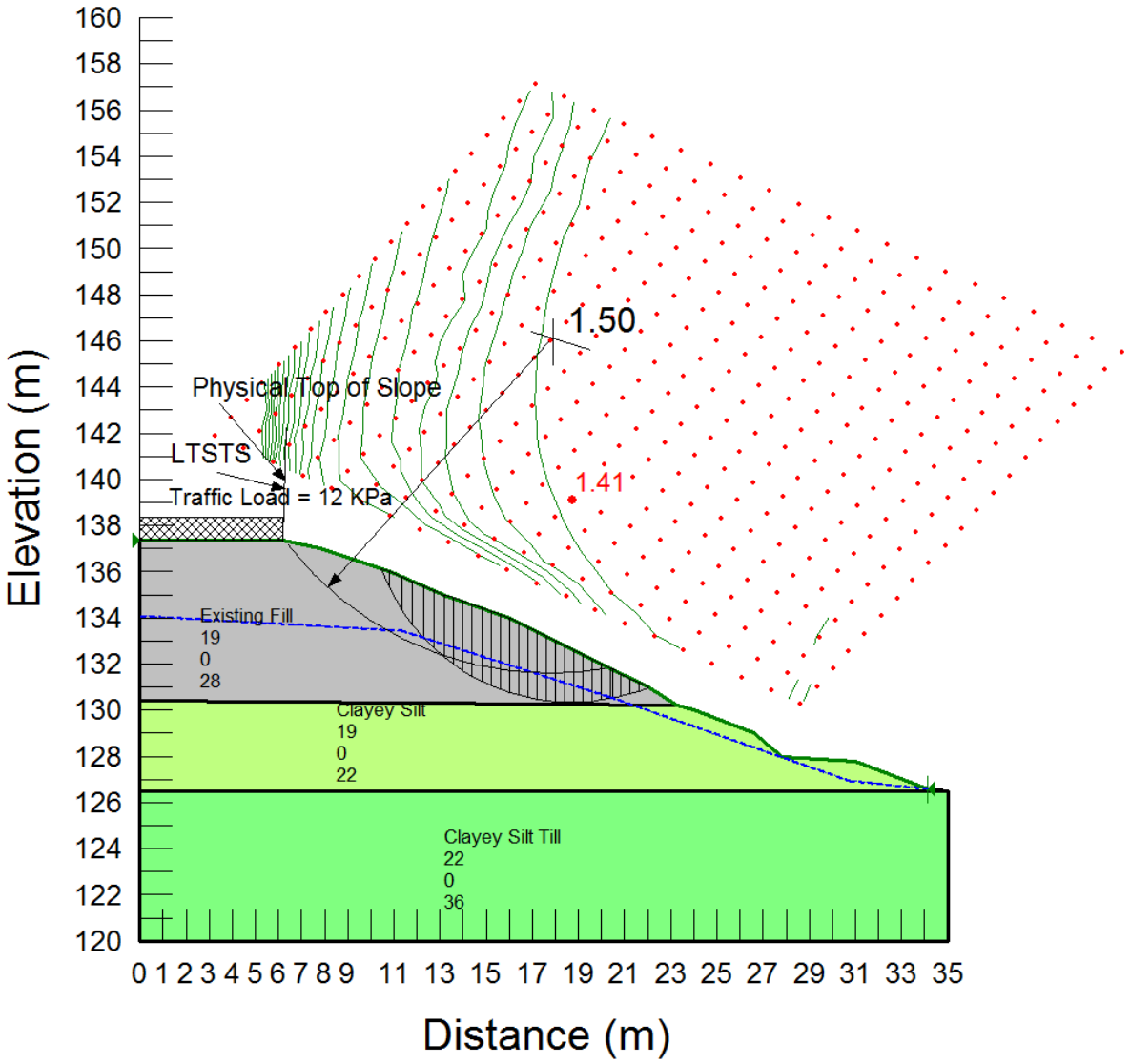


Figure 1
Section 1-1 Existing Condition (Static)

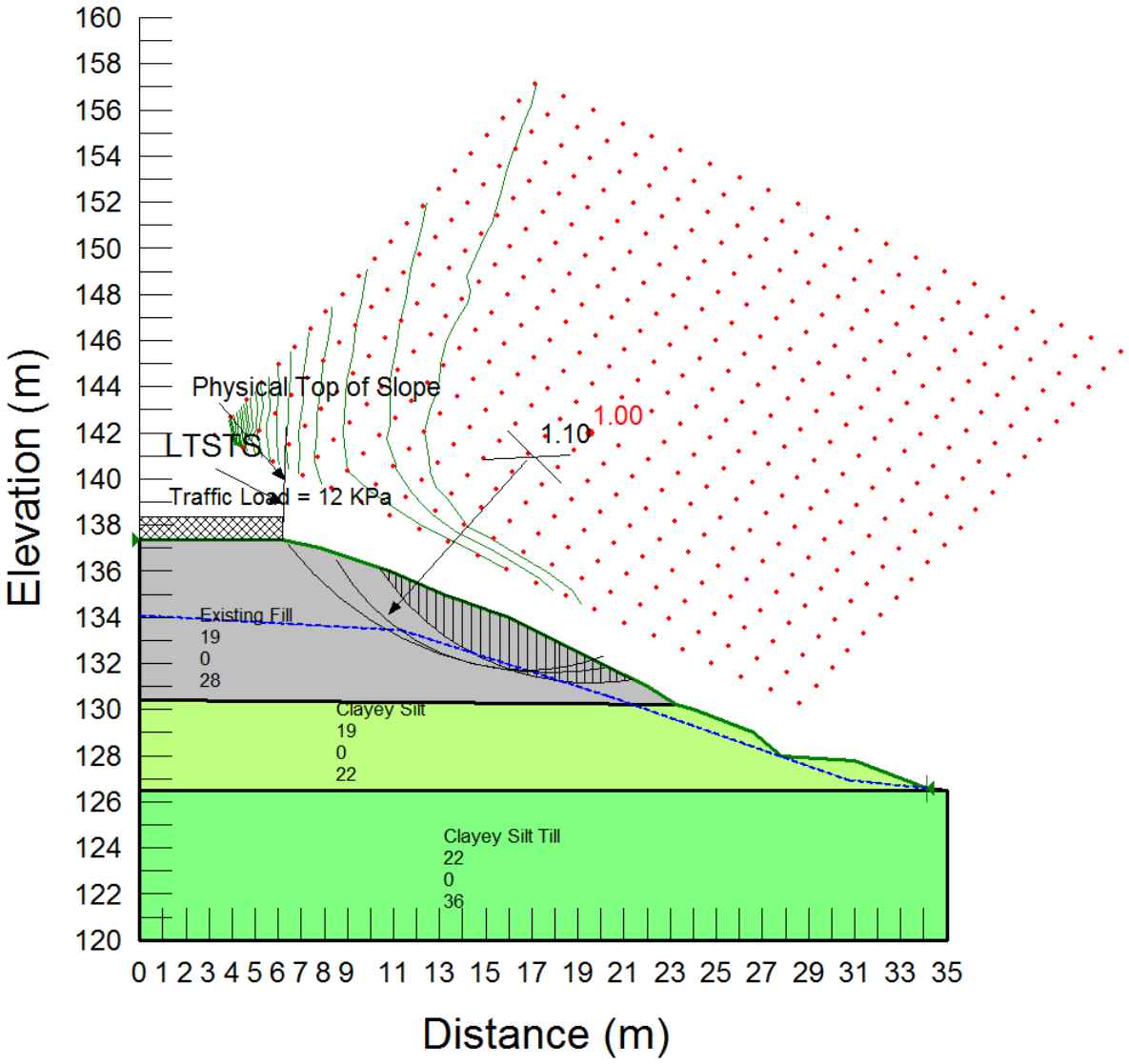


Figure 2
Section 1-1 Existing Condition (Seismic)

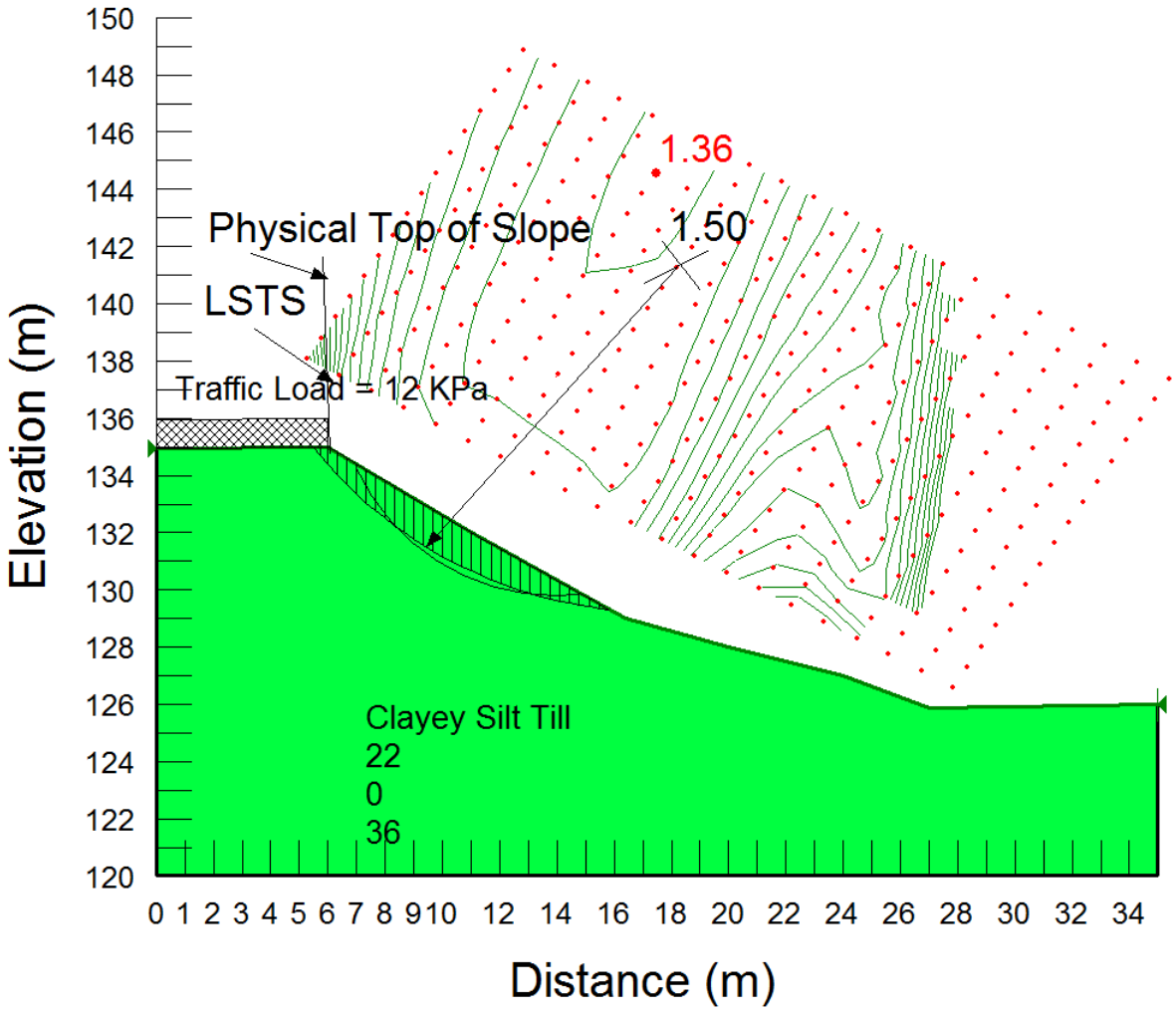


Figure 3
Section 2-2 Existing Condition (Static)

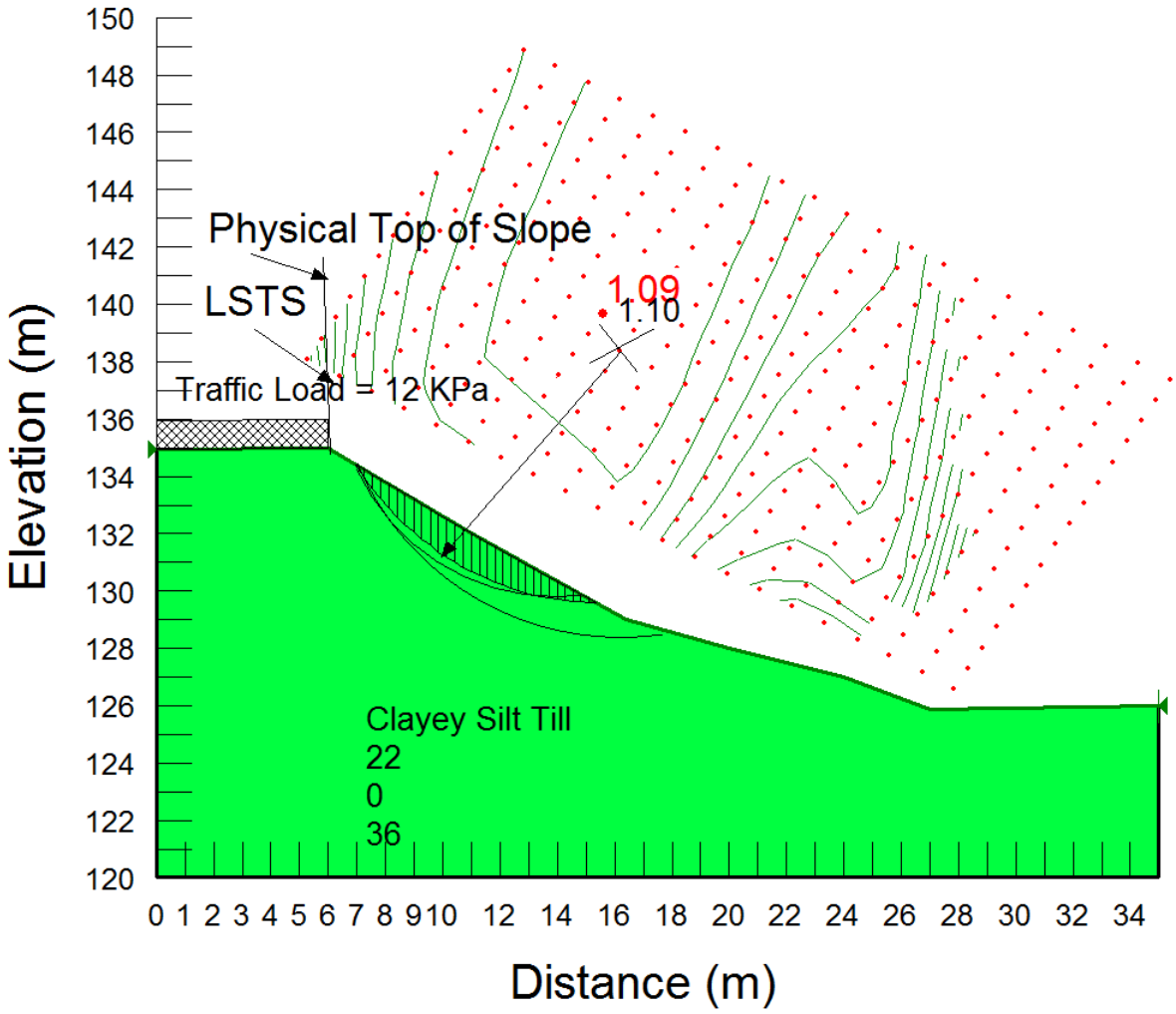


Figure 4
Section 2-2 Existing Condition (Seismic)

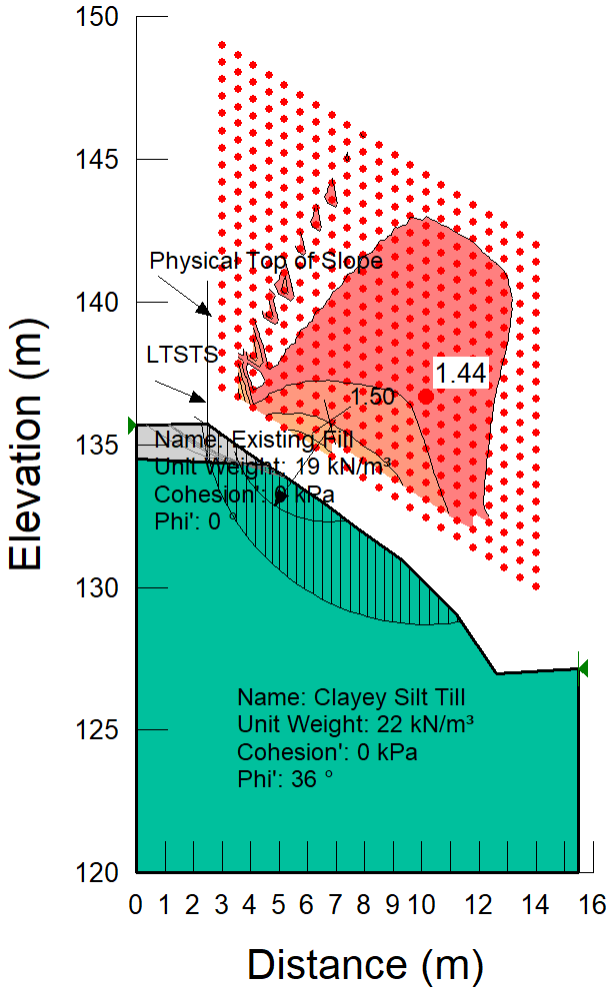


Figure 5
Section 3-3 Existing Condition (Static)

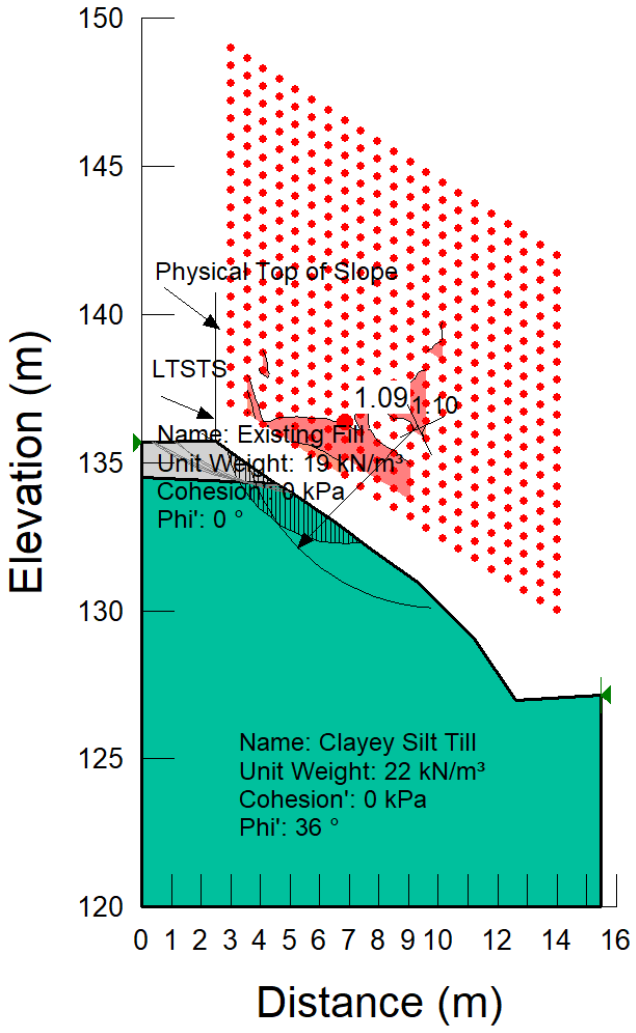


Figure 6
Section 3-3 Existing Condition (Seismic)

Appendix C:

Photographs



Photo 1. General View of Existing Slope



Photo 2. General View of Existing top of Slope



Photo 3. General View of Existing top of Slope



Photo 4. General View of Existing bottom of Slope