

Submitted to:

City of Winnipeg

SLOPE STABILITY ASSESSMENT AND PROPOSED STABILITY IMPROVEMENTS LOT 16 DRAIN, WINNIPEG, MANITOBA



FEBRUARY 2024

FILE NO. 20-217-01



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ATTACHMENTS

- Figure 1 – Existing Site, Test Hole Location Plan and Photographs 1 and 2
- Figure 2 – Overall Site Plan, Test Hole Location Plan, and Cross Section Overlay
- Figure 3 – Overall Site Plan and Test Hole Location Plan
- Figure 4 – Slope Stability Analysis Result on Cross Section 1, 2 and 3
- Figure 5 – Slope Stability Analysis Result on Cross Section 4 and 5
- Figure 6 – Photographs 3-8
- Soil Classification Sheet
- Test Hole Summary Logs (9)

1.0 INTRODUCTION

ENG-TECH Consulting Limited (ENG-TECH) completed the requested slope stability assessment for a channel bank known as Lot 16 Drain located between Brady Road and Bishop Grandin Boulevard in Winnipeg, Manitoba. ENG-TECH understands that the channel bank movements have occurred within +/- 1300 m of the North end of the channel. The purpose of the assessment is to evaluate the overall stability and provide remedial options to stabilize this section of the channel bank.

1.1 Scope of Work

ENG-TECH completed the following scope of work:

- Survey of the channel bank in the zones of concern including several cross sections and spot elevations.
- A test hole drilling and soil sampling program.
- Review of the existing information about the site and nearby properties.
- Installation and monitoring of a groundwater vibrating wire piezometer (VW) to evaluate the groundwater condition.
- A slope stability assessment of the channel bank and report outlining the geotechnical investigation and recommendations as outlined in the introduction.

2.0 BACKGROUND

ENG-TECH supervised the drilling of nine (9) test holes (TH1–TH9) at Lot 16 Drain, Winnipeg, Manitoba, on April 13, 2020.

The test holes were drilled using a CME-55 Track-Mounted drill rig equipped with 125 mm diameter solid stem continuous flight augers owned and operated by Maple Leaf Drilling Ltd. TH6 and TH8 were advanced to 7.6 meters below grade (mbg), while TH1-TH5, TH7 and TH9 were drilled to 3.0 mbg. Soil samples were collected off auger flights at select depth intervals. The soil stratigraphy was visually classified using the modified Unified Soil Classification System (USCS) during drilling. Pocket Penetrometer field tests were completed at various depth intervals during drilling to evaluate the consistency of the cohesive soils with depth. One (1) Vibrating Wire Piezometer was installed in TH8 at depths of 7.0 m mbg.

In ENG-TECH's Winnipeg laboratory, moisture contents were completed on all soil samples collected (46) and three (3) Atterberg Limit tests, three (3) hydrometer tests, and four (4) unconfined tests were completed on selected samples. All laboratory test results are shown on the test hole summary logs, with the particle size results shown on a separate graph.

3.0 STRATIGRAPHY

Based on the results of the drilling program, the following summarizes the general soil stratigraphy at the subject property:

- The stratigraphy consisted of clay followed by silt in TH1. The stratigraphy in TH2 consisted of clay fill, followed by clay, and then silt. In TH3 and TH9, the stratigraphy consisted of clay fill followed by clay. The stratigraphy consisted of clay fill, followed by a layer of clay, followed by a silt layer overlaying high plastic clay in TH4-TH8.
- The clay fill was mostly medium brown to medium grey, frozen, highly plastic, and contained some to with silt and trace sand. Salts were observed in TH3 and TH4.
- The clay was mostly medium brown to dark grey, highly plastic, firm to very stiff (frozen until 1.5- 2.0 m), trace sand, some silt, oxidation in TH4 and salts in TH5 and TH6.
- The silt layer was light brown to light grey, wet, soft, low plastic, trace gravel in TH1, trace sand in TH1 & TH7, some sand in TH2, TH4, TH5, TH6, and TH8, and some clay in TH1-TH2, and TH4-TH8.

Detailed stratigraphy descriptions are outlined on the attached test hole summary logs.

4.0 TOPOGRAPHIC SURVEY AND SITE VISITS

A survey of the property consisting of spot elevations and twelve (12) cross-sections was completed by ENG-TECH personnel using GPS and total station survey equipment on April 16 and April 24, 2020 and August 24, 2022. Additionally, lidar data was provided by the City of Winnipeg for referencing the existing drainage system.

The topography at the site is relatively flat from the existing field to an existing swale on the south bank of the channel and then slopes up to the top of the south channel bank, where it starts sloping down towards the channel with a slope of approx. 5.5H:1V. There was evidence of local and global slope failures throughout the entire south channel bank.

The piezometer was installed in TH8 at a depth of 7.0 mbg in the high plastic clay layer. Table 1 shown on Figure 1 outlines the results of the readings of the VW piezometer. As shown in Table 1, the groundwater (GW) fluctuated between 229.78 m and 229.89 m during the monitoring period between April 2020 and November 2020. A conservative GW value of 233.0 m was used in all the slope stability analyses to model an extreme GW condition.

5.0 SLOPE STABILITY ASSESSMENT

5.1 General

Slope stability analysis was completed using SLOPE/W, a two-dimensional finite element analysis computer program. The analysis was completed to assess the channel stability considering its existing condition. The soil and geometry conditions used in the analysis are shown on Figure 4.

5.2 Assessment Criteria

- The soil shear strength parameter values used should be representative of the in-situ soils;
- The GWL should be representative of GW conditions at the site.
- The combined GW and channel water level used in the analysis should be representative of a conservative condition that is normally not experienced at the property.

5.3 Soil and Groundwater Values

The assessment was conducted based on both post-peak and residual values for clay shear strength properties. The results of both analyses were recorded and compared in order to examine the effect of the brown clay shear strength properties on the overall slope stability of the riverbank. Visual inspection showed evidence of slope failure on the southern channel bank in the clay fill layer, therefore, residual shear strength values were used for the clay fill in all the analyses. Outlined below are the soil shear strength values and water levels used in the model.

Stiff Brown Clay (CH)	Unit Wt = 18 kN/m ³	c' = 2 kPa	φ' = 15°
Silt	Unit Wt = 18 kN/m ³	c' = 0 kPa	φ' = 19°
Clay Fill	Unit Wt = 18 kN/m ³	c' = 0 kPa	φ' = 12°
Residual Soil	Unit Wt = 18 kN/m ³	c' = 1 kPa	φ' = 12°
Extreme GWL		Elev. = 233.0 m	
Channel Water Level		Elev. = 231.0 m	

The above assumptions do not necessarily represent a combined GW and channel water level condition that has been experienced at the property. However, they are considered a worst-case GW and channel water level condition.

5.4 Methodology

ENG-TECH evaluated five (5) cross-sectional profiles based on the soil and topographic characteristics. The location of the cross-sections and the sectional profiles are shown on Figure 1-5. The stability assessment of the slope was completed using Morgenstern-Price circular slip surfaces with a half-sine interslice force function to estimate the FS of potential slip surfaces (PSSs). Various PSSs were assessed to evaluate the FSs against slope failure.

5.5 Results and Assessment

Based on the results of the analysis, the channel bank requires stabilization measures. ENG-TECH examined different stabilization measures and provided the City of Winnipeg with different channel bank stabilization options, such as using sand drains, offloading with multiple slopes and also offloading with a single slope. Based on the preliminary estimated quotes ENG-TECH received for each option from contractors, and consulting with the City of Winnipeg, offloading with a single slope was chosen as the stabilization measure. Below is a summary of the proposed work with detailed illustrations shown on Figures 4 and 5.

Slope Stabilization

The City of Winnipeg expressed interest in stabilizing the area of the channel bank from Kenaston Boulevard to Eldorado Boulevard, which is approx. 1300 m long, by offloading and building a new berm on the south bank. This section consists of a 75 m curved section, up to STA 0+075, and a 1225 m straight section to the end at STA 1+300. The results of the slope stability analysis show that offloading the bank with a single slope of 7H:1V provides adequate stability for the channel bank and produces FSs acceptable for slope stability (Figures 4 and 5). Overall, the FSs of all PSSs will improve significantly after the offloading and placing fill for the new berm. The most critical PSSs of each cross-section are detailed in the table below:

Cross section	Most critical PSS	Post-peak Assessment		Residual Assessment	
		Existing Condition	With Offload and Backfill	Existing Condition	With Offload and Backfill
1	PSS2 (Figure 4)	1.20	1.39	1.11	1.30
2	PSS3 (Figure 4)	1.13	1.83	0.99	1.64
3	PSS2 (Figure 4)	1.26	1.62	1.12	1.42
4	PSS3 (Figure 5)	1.18	1.96	0.99	1.66
5	PSS3 (Figure 5)	1.13	>2	0.83	1.54

As shown in the table above, all the FSs increased to more than 1.30 in both post-peak and residual assessments, and are acceptable for slope stability. The above stabilization work will result in 16,200 m³ of soil offloaded from the bank and 5650 m³ of backfill placed for the construction of the new berm, as shown on Figures 4 and 5.

Channel Erosion Protection

Some erosion was observed in the channel bank during the site visits. Installing erosion protection can help reduce the amount of erosion and can also slightly further improve the channel bank's stability. Placing a 0.3 m thick layer of rip-rap stone on the south bank will provide adequate erosion protection for the bank. Placing erosion protection is optional at this time and can be completed after the channel bank's stabilization work.

New Berm

The top of the new berm elevation was mandated by the City of Winnipeg to be at 234.0 m to prevent channel overflow. The side slope of the new berm on the channel side, as shown on Figures 4 and 5, matches with the 7H:1V offload of the existing bank, while the field side slope of the berm is designed at 3H:1V. From STA 0+000 to STA 0+350, the width of the berm top is 0.6 m and this width gradually increases to 3.0 m from STA 0+350 to STA 0+400, after which the width remains constant at 3.0 m. The dimensions and location of the new berm are shown on Figures 2, 3, 4 and 5.

New Swale

The existing swale had to be filled and removed due to the construction of the new berm. As mandated by the City of Winnipeg, a new swale should be constructed at the location shown on Figures 2 and 3. The new swale should be constructed closer to the field and further from the channel due to the location of the new berm.

The location and all the elevations of the new swale were chosen under the City of Winnipeg's direction and solely based on the location of the new berm. The drainage and flow capacity, water flow directions and all other hydraulic and drainage-related properties of the new swale must be checked, verified and modified (if necessary) before the commencement of any field construction.

6.0 STATEMENT OF LIMITATIONS AND THIRD-PARTY USE

The geotechnical information provided in this report is in accordance with acceptable engineering principles and practices (Standard of Practice). The findings of this report were based on information provided (field investigation and laboratory testing). Soil conditions are natural deposits that can be highly variable across a site. If sub-surface conditions are different than the conditions previously encountered on-site or those presented here, we should be notified to adjust our findings if necessary.

All information provided in this report is subject to ENG-TECH's standard terms and conditions for engineering services, a copy of which is provided to each of our clients with the original scope of work, or a mutually executed standard engineering services agreement. If these conditions are not attached, and you are not already in possession of such terms and conditions, contact our office and you will be promptly provided with a copy.

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7.0 CLOSURE

This report was based on the scope of work outlined for the purpose of the investigation and was prepared in accordance with acceptable professional engineering principles and practices. If you have any questions, please contact the undersigned.

Sincerely,
ENG-TECH Consulting Limited



Arash Gholamzadehabolfaz, M.Sc., E.I.T.
Engineering Department

CDH/ag



Clark Hryhoruk, M.Sc., P. Eng.
Principal, Geotechnical Engineer

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

MAJOR DIVISION		GROUP SYMBOL	GRAPH SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
COARSE GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 75 µm)	GRAVELS MORE THAN HALF THE COARSE FRACTION LARGER THAN 4.75 mm	CLEAN GRAVELS (TRACE OR NO FINES)	GW		WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 4; C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ TO } 3$
			GP		POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS
		DIRTY GRAVELS (WITH SOME OR MORE FINES)	GM		SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	ATTERBERG LIMITS BELOW "A" LINE OR P.I. LESS THAN 4
			GC		CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES	ATTERBERG LIMITS ABOVE "A" LINE AND P.I. MORE THAN 7
	SANDS MORE THAN HALF THE COARSE FRACTION SMALLER THAN 4.75 mm	CLEAN SANDS (TRACE OR NO FINES)	SW		WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 6; C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ TO } 3$
			SP		POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS
		DIRTY SANDS (WITH SOME OR MORE FINES)	SM		SILTY SANDS, SAND-SILT MIXTURES	ATTERBERG LIMITS BELOW "A" LINE OR P.I. LESS THAN 4
			SC		CLAYEY SANDS, SAND-CLAY MIXTURES	ATTERBERG LIMITS ABOVE "A" LINE AND P.I. MORE THAN 7
FINE GRAINED SOILS (MORE THAN HALF BY WEIGHT SMALLER THAN 75 µm)	SILTS BELOW "A" LINE NEGLECTIBLE ORGANIC CONTENT	LL ≤ 50%	ML		INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHTY PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (SEE BELOW)
		LL > 50%	MH		INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS	
	CLAYS ABOVE "A" LINE NEGLECTIBLE ORGANIC CONTENT	LL ≤ 30%	CL		INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY OR SILTY CLAYS, LEAN CLAYS	
		30% < LL ≤ 50%	CI		INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS	
		LL > 50%	CH		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	
	ORGANIC SILTS & CLAYS BELOW "A" LINE	LL < 50%	OL		ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	
		LL > 50%	OH		ORGANIC CLAYS OF HIGH PLASTICITY	
	HIGHLY INORGANIC SOILS	Pt		PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOUR OR ODOUR, AND OFTEN FIBROUS TEXTURE	

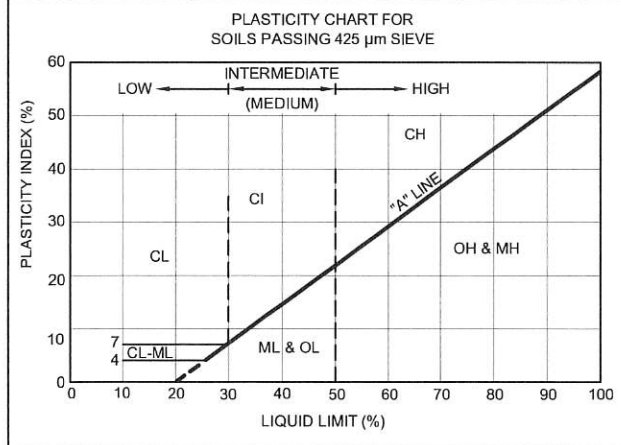
ADDITIONAL SYMBOLS

TILL		SANDSTONE	
FILL		GRANITE	
TOPSOIL			
CONCRETE			
SHALE			
LIMESTONE			

PLASTIC SOILS

MOISTURE	PLASTICITY	INTRUSIONS	CONSISTENCY	POCKET PEN (TSF)	(N)
DRY	LOW	ROOTLETS	VERY SOFT		< 2
DAMP	MEDIUM	OXIDES	SOFT	0 - 0.5	2 - 4
MOIST	HIGH	MICA	FIRM	0.5 - 1.0	4 - 8
WET		GYPHUM	STIFF	1.0 - 2.0	8 - 15
		ETC.	VERY STIFF	2.0 - 4.0	15 - 30
			HARD	> 4.0	> 30

TSF x 95.8 = kPa (q_u) S_u = 1/2 x q_u



SOIL DESCRIPTIONS

TRACE: 0 - 10%	BOULDERS: > 200 mm	COARSE SAND: 2 - 4.75 mm
SOME: 10 - 20%	COBBLES: 75 - 200 mm	MEDIUM SAND: 0.425 - 2 mm
WITH: 20 - 35%	COURSE GRAVEL: 19 - 75 mm	FINE SAND: 0.075 - 0.425 mm
AND: 35 - 50%	FINE GRAVEL: 4.75 - 75 mm	FINES: < 0.075 mm

GRANULAR SOILS

MOISTURE	DENSITY	GRADATION	INTRUSIONS	SPT (N)
DRY	VERY LOOSE	POORLY	ROOTLETS	0 - 4
DAMP	LOOSE	WELL	OXIDES	4 - 10
MOIST	MED. DENSE		MICA	10 - 30
WET	DENSE		FINES	30 - 50
	VERY DENSE		ETC.	> 50

DEFINITIONS
 LL = LIQUID LIMIT C_c = COMPRESSION INDEX
 P.I. = PLASTICITY INDEX PL = PLASTIC LIMIT
 C_u = COEFFICIENT OF UNIFORMITY
 q_u = UNCONFINED COMPRESSIVE STRENGTH
 S_u = UNDRAINED SHEAR STRENGTH



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Test Hole #: TH1

Client: City of Winnipeg

Site: Lot 16 Drain, Winnipeg, Manitoba

Location: See Figure 1

Project: Slope Stabilization Work

File No.: 20-217-01

Date Drilled: April 13, 2020

Grade Elevation: 234.2 m

Water Elevation: --

SUBSURFACE PROFILE				SAMPLE DATA				SHEAR STRENGTH (kPa)				
Depth (m)	Soil Symbol	Description	Elevation (m)	Sample No.	Sample Type	Moisture Content (%)	Blows/300 mm	Moisture Content (%)				
								PL	X	LL	P. Pen	Torvane
0.0		Ground Surface	234.2									
		Clay (CH) - dark grey, frozen, high plastic, some silt, trace sand.	234.0									
		- below 0.9 m medium brown.		S1		26.2						
1.0			233.0									
		- below 1.7 m moist, very stiff.		S2		28.1						
2.0			232.0									
		Silt (ML) - light brown, wet, soft, low plastic, trace gravel, trace sand, some clay.		S3		26.4				144		
3.0			231.0									
		End of Test Hole - end of test hole at 3.0 m below grade. - slouging and seepage at 2.7 m immediately after completion of drilling. - test hole backfilled with auger cuttings and bentonite.		S4		26.4					20	
4.0												

ENG- TECH Consulting Limited

Logged by: WGH

Reviewed by:

Drilled By: Maple Leaf Drilling Ltd.

Drill Rig: CME-55 Track Rig

Auger Size: 125 mm

Completion Depth: 3.0 m

Completion Elevation: 231.2 m

Sheet: 1 of 1

SAMPLE TYPE



SPLIT BARREL



SHELBY TUBE



AUGER CUTTINGS



SPLIT SPOON



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Test Hole #: TH2
Client: City of Winnipeg
Site: Lot 16 Drain, Winnipeg, Manitoba
Location: See Figure 1
Project: Slope Stabilization Works

File No.: 20-217-01
Date Drilled: April 13, 2020
Grade Elevation: 234.1 m
Water Elevation: --

SUBSURFACE PROFILE				SAMPLE DATA				SHEAR STRENGTH (kPa)		
Depth (m)	Soil Symbol	Description	Elevation (m)	Sample No.	Sample Type	Moisture Content (%)	Blows/300 mm	Moisture Content (%)		
								PL	LL	UC
0.0		Ground Surface Clay Fill (CH) - medium brown, frozen, high plastic, some to with silt, trace sand.	234.1							
1.0		Clay (CH) - dark grey, frozen, high plastic, some silt, trace sand. - below 1.7 m moist, very stiff.	233.0	S1		23.0				
2.0		Silt (ML) - light grey, wet, soft, low plastic, some clay, some sand.	232.0	S3		21.6			144	
3.0		End of Test Hole - end of test hole at 3.0 m below grade. - slouging and seepage at 2.7 m immediately after completion of drilling. - test hole backfilled with auger cuttings and bentonite.	231.0	S4		22.9				25

ENG- TECH Consulting Limited

Logged by: WGH

Reviewed by:

Drilled By: Maple Leaf Drilling Ltd.

Drill Rig: CME-55 Track Rig

Auger Size: 125 mm

Completion Depth: 3.0 m

Completion Elevation: 231.1 m

Sheet: 1 of 1

SAMPLE TYPE



SPLIT BARREL



SHELBY TUBE



AUGER CUTTINGS



SPLIT SPOON



Engineering And Testing
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Test Hole #: TH3

Client: City of Winnipeg

Site: Lot 16 Drain, Winnipeg, Manitoba

Location: See Figure 1

Project: Slope Stabilization Works

File No.: 20-217-01

Date Drilled: April 13, 2020

Grade Elevation: 234.0 m

Water Elevation: --

SUBSURFACE PROFILE				SAMPLE DATA				SHEAR STRENGTH (kPa)				
Depth (m)	Soil Symbol	Description	Elevation (m)	Sample No.	Sample Type	Moisture Content (%)	Blows/300 mm	Moisture Content (%)				
								PL	X	LL	P. Pen	Torvane
0.0		Ground Surface Clay Fill (CH) - medium brown, frozen, high plastic, some to with silt, trace sand, salts.	234.0									
1.0		Clay (CH) - dark grey, frozen, high plastic, some silt, trace sand. - below 1.4 m medium brown, salts.	233.0	S1		24.5						
2.0		- below 2.0 m moist, very stiff.	232.0	S2		23.0						
3.0		End of Test Hole - end of test hole at 3.0 m below grade. - no sloughing or seepage observed immediately after completion of drilling. - test hole backfilled with auger cuttings and bentonite.	231.0	S3		27.5				168		
3.0			231.0	S4		40.7				120		
4.0			230.0									

ENG-TECH Consulting Limited

Logged by: WGH

Reviewed by:

Drilled By: Maple Leaf Drilling Ltd.

Drill Rig: CME-55 Track Rig

Auger Size: 125 mm

Completion Depth: 3.0 m

Completion Elevation: 231.0 m

Sheet: 1 of 1

SAMPLE TYPE



SPLIT BARREL



SHELBY TUBE



AUGER CUTTINGS



SPLIT SPOON



Engineering And Testing
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Test Hole #: TH4

Client: City of Winnipeg

Site: Lot 16 Drain, Winnipeg, Manitoba

Location: See Figure 1

Project: Slope Stabilization Works

File No.: 20-217-01

Date Drilled: April 13, 2020

Grade Elevation: 233.9 m

Water Elevation: --

SUBSURFACE PROFILE				SAMPLE DATA				SHEAR STRENGTH (kPa)		
Depth (m)	Soil Symbol	Description	Elevation (m)	Sample No.	Sample Type	Moisture Content (%)	Blows/300 mm	Moisture Content (%)		
								P. Pen	Torvane	UC
0.0		Ground Surface Clay Fill (CH) - medium brown, frozen, high plastic, some to with silt, trace sand, salts.	0.0							
1.0		Clay (CH) - dark grey, frozen, high plastic, some silt, trace sand. - below 1.4 m medium brown.	-1.0	S1		24.9				
2.0		Silt (ML) - light brown, moist to wet, soft, low plastic, some sand, some clay.	-2.0	S3		21.6				25
3.0		Clay (CH) - medium brown, moist, very stiff, high plastic, some silt, trace sand, oxidation.	-3.0	S4		41.3				144
4.0		End of Test Hole - end of test hole at 3.0 m below grade. - no slouging or seepage observed immediately after completion of drilling. - test hole backfilled with auger cuttings and bentonite.	-4.0							

ENG- TECH Consulting Limited

Logged by: WGH

Reviewed by:

Drilled By: Maple Leaf Drilling Ltd.

Drill Rig: CME-55 Track Rig

Auger Size: 125 mm

Completion Depth: 3.0 m

Completion Elevation: 230.9 m

Sheet: 1 of 1

SAMPLE TYPE



SPLIT BARREL



SHELBY TUBE



AUGER CUTTINGS



SPLIT SPOON



Engineering And Testing
Solutions That Work For You

Test Hole #: TH5
Client: City of Winnipeg
Site: Lot 16 Drain, Winnipeg, Manitoba
Location: See Figure 1
Project: Slope Stabilization Works

File No.: 20-217-01
Date Drilled: April 13, 2020
Grade Elevation: 234.2 m
Water Elevation: --

SUBSURFACE PROFILE			SAMPLE DATA				SHEAR STRENGTH (kPa)				
Depth (m)	Soil Symbol	Description	Elevation (m)	Sample No.	Sample Type	Moisture Content (%)	Blows/300 mm	Moisture Content (%)			
								PL	X	LL	P. Pen
0.0		Ground Surface Clay Fill (CH) - medium grey/brown, frozen, high plastic, some silt, trace sand.	231.2								
1.0		Clay (CH) - dark grey, frozen, high plastic, some silt, trace sand. - below 1.5 m medium brown, very stiff, salts.	230.0	S1		31.4					
2.0		Silt (ML) - light brown, dry, friable, low plastic, some sand, some clay.	229.0	S3		26.8			192		
3.0		Clay (CH) - medium brown, moist, very stiff, high plastic, some silt, trace sand, salts.		S4		34.8			168		
3.0		End of Test Hole - end of test hole at 3.0 m below grade. - no sloughing or seepage observed immediately after completion of drilling. - test hole backfilled with auger cuttings and bentonite.	228.0								
4.0											

ENG-TECH Consulting Limited

Logged by: WGH

Reviewed by:

Drilled By: Maple Leaf Drilling Ltd.

Drill Rig: CME-55 Track Rig

Auger Size: 125 mm

Completion Depth: 3.0 m

Completion Elevation: 231.2 m

Sheet: 1 of 1

SAMPLE TYPE



SPLIT BARREL



SHELBY TUBE



AUGER CUTTINGS



SPLIT SPOON



Engineering And Testing
Solutions That Work For You

Test Hole #: TH6
Client: City of Winnipeg
Site: Lot 16 Drain, Winnipeg, Manitoba
Location: See Figure 1
Project: Slope Stabilization Works

File No.: 20-217-01
Date Drilled: April 13, 2020
Grade Elevation: 234.4 m
Water Elevation: --

SUBSURFACE PROFILE			SAMPLE DATA				SHEAR STRENGTH (kPa)				
Depth (m)	Soil Symbol	Description	Elevation (m)	Sample No.	Sample Type	Moisture Content (%)	Blows/300 mm	Moisture Content (%)			
								PL	X	LL	P. Pen
0.0		Ground Surface Clay Fill (CH) - medium grey, frozen, high plastic, some to with silt, trace sand.	234.4								
1.0				S1		23.7					
2.0		Clay (CH) - dark grey, frozen, high plastic, some silt, trace sand. - at 1.5 m silt lens (100 mm), light brown, dry.	233.0	S2		19.3					
2.5		Silt (ML) - light brown, moist to wet, firm, low plastic, some sand, some clay.	232.0	S3		21.9			48	59	
3.0				S4		29.7			192		
3.5		Clay (CH) - medium brown, moist, very stiff, high plastic, some silt, trace sand, salts. - below 3.4 m stiff.	231.0	S5		42.8			72		53.3
4.0				S6		51.6			48	49	
5.0		- below 4.6 m firm.	229.0								
6.0		- below 6.7 m medium grey.	228.0	S7		50.8			48	54	
6.5				S8		47.6			36		40.3
7.0			227.0	S9		46.5				39	
8.0		End of Test Hole - end of test hole at 7.6 m below grade. - no sloughing or seepage observed immediately after completion of drilling. - test hole backfilled with auger cuttings and bentonite.	226.0								
9.0			225.0								
10.0											

ENG-TECH Consulting Limited

Logged by: WGH

Reviewed by:

Drilled By: Maple Leaf Drilling Ltd.

Drill Rig: CME-55 Track Rig

Auger Size: 125 mm

Completion Depth: 7.6 m

Completion Elevation: 226.8 m

Sheet: 1 of 1

SAMPLE TYPE



SPLIT BARREL



SHELBY TUBE



AUGER CUTTINGS



SPLIT SPOON



Engineering And Testing
Solutions That Work For You

Test Hole #: TH7
Client: City of Winnipeg
Site: Lot 16 Drain, Winnipeg, Manitoba
Location: See Figure 1
Project: Slope Stabilization Works

File No.: 20-217-01
Date Drilled: April 13, 2020
Grade Elevation: 234.4 m
Water Elevation: --

SUBSURFACE PROFILE				SAMPLE DATA				SHEAR STRENGTH (kPa)				
Depth (m)	Soil Symbol	Description	Elevation (m)	Sample No.	Sample Type	Moisture Content (%)	Blows/300 mm	Moisture Content (%)				
								PL	X	LL	P. Pen	Torvane
0.0		Ground Surface Clay Fill (CH) - medium grey/brown, frozen, high plastic, some to with silt, trace sand.	234.4									
			234.0									
				S1		24.0						
1.0												
		Clay (CH) - dark grey, frozen, high plastic, some silt, trace sand.	233.0	S2		19.3						
		Silt (ML) - light brown, damp, firm, low plastic, trace sand, some clay.		S3		18.0					39	
2.0												
		Clay (CH) - medium brown, moist, very stiff, high plastic, some silt, trace sand.	232.0									
				S4		36.5					168	
3.0		End of Test Hole - end of test hole at 3.0 m below grade. - no sloughing or seepage observed immediately after completion of drilling. - test hole backfilled with auger cuttings and bentonite.	231.0									
4.0												

ENG-TECH Consulting Limited

Logged by: WGH

Reviewed by:

Drilled By: Maple Leaf Drilling Ltd.

Drill Rig: CME-55 Track Rig

Auger Size: 125 mm

Completion Depth: 3.0 m

Completion Elevation: 231.4 m

Sheet: 1 of 1

SAMPLE TYPE



SPLIT BARREL



SHELBY TUBE



AUGER CUTTINGS



SPLIT SPOON



Engineering And Testing
Solutions That Work For You

Test Hole #: TH8

Client: City of Winnipeg

Site: Lot 16 Drain, Winnipeg, Manitoba

Location: See Figure 1

Project: Slope Stabilization Works

File No.: 20-217-01

Date Drilled: April 13, 2020

Grade Elevation: 233.8 m

Water Elevation: --

SUBSURFACE PROFILE			SAMPLE DATA				SHEAR STRENGTH (kPa)				
Depth (m)	Soil Symbol	Description	Elevation (m)	Sample No.	Sample Type	Moisture Content (%)	Blows/300 mm	Moisture Content (%)			
								PL	X	LL	P. Pen
0.0		Ground Surface	233.8								
		Clay Fill (CH) - medium brown, frozen, high plastic, some silt, trace sand.									
1.0			233.0	S1		32.9					
		Clay (CH) - dark grey, frozen, high plastic, some silt, trace sand.									
2.0			232.0	S2		30.0					
		Silt (ML) - light brown, moist, soft, low plastic, some sand, some clay.								25	
3.0			231.0	S3		19.3					
		Clay (CH) - medium brown, moist, very stiff, high plastic, some silt, trace sand.									
4.0			230.0	S4		37.3				168	
		- below 3.8 m stiff.									
5.0			229.0	S5		48.7				48	33.7
6.0			228.0	S6		53.1				60	59
			227.0	S7		51.3					59
			226.0	S8		46.2					48
			225.0	S9		51.9					39
7.0			224.0								
		End of Test Hole - end of test hole at 7.6 m below grade. - piezometer installed at approximately 7.0 m below grade. - no sloughing or seepage observed immediately after completion of drilling. - test hole backfilled with auger cuttings and bentonite.									

ENG- TECH Consulting Limited

Logged by: WGH

Reviewed by:

Drilled By: Maple Leaf Drilling Ltd.

Drill Rig: CME-55 Track Rig

Auger Size: 125 mm

Completion Depth: 7.6 m

Completion Elevation: 226.2 m

Sheet: 1 of 1

SAMPLE TYPE



SPLIT BARREL



SHELBY TUBE



AUGER CUTTINGS



SPLIT SPOON



**Engineering And Testing
Solutions That Work For You**

Test Hole #: TH9
Client: City of Winnipeg
Site: Lot 16 Drain, Winnipeg, Manitoba
Location: See Figure 1
Project: Slope Stabilization Works

File No.: 20-217-01
Date Drilled: April 13, 2020
Grade Elevation: 233.7 m
Water Elevation: --

SUBSURFACE PROFILE			SAMPLE DATA				SHEAR STRENGTH (kPa)			
Depth (m)	Soil Symbol	Description	Elevation (m)	Sample No.	Sample Type	Moisture Content (%)	Blows/300 mm	Moisture Content (%)		
								PL	LL	UC
0.0		Ground Surface Clay Fill (CH) - medium brown, frozen, high plastic, some to with silt, trace sand.	233.7							
1.0		Clay (CH) - dark grey, frozen, high plastic, some silt, trace sand. - below 1.5 m medium brown, very stiff.	233.0	S1		26.7				
2.0		Clay (CH) - dark grey, frozen, high plastic, some silt, trace sand. - below 1.5 m medium brown, very stiff.	232.0	S2		24.3				
3.0		- at 2.7 m silt lens (150 mm thick), light brown, moist to wet, soft, low plastic.	231.0	S3		30.9			168	
3.0		End of Test Hole - end of test hole at 3.0 m below grade. - no sloughing or seepage observed immediately after completion of drilling. - test hole backfilled with auger cuttings and bentonite.	230.0	S4		41.5			120	
4.0										

ENG-TECH Consulting Limited

Logged by: WGH

Reviewed by:

Drilled By: Maple Leaf Drilling Ltd.

Drill Rig: CME-55 Track Rig

Auger Size: 125 mm

Completion Depth: 3.0 m

Completion Elevation: 230.7 m

Sheet: 1 of 1

SAMPLE TYPE



SPLIT BARREL



SHELBY TUBE



AUGER CUTTINGS



SPLIT SPOON