APPENDIX 'A'

GEOTECHNICAL REPORT

Quality Engineering | Valued Relationships

Morrison Hershfield

19-C-10 Sargent Avenue Pavement Renewal

Prepared for:

Morrison Hershfield
1-59 Scurfield Boulevard
Winnipeg, MB R3Y 1V2
Attention: Ron Bruce, P. Eng

Project Number:
0035 082 00 403

Date:
November 19, 2019
Final Report

Quality Engineering | Valued Relationships

November 19, 2019

Our File No. 0035 082 00

Mr. Ron Bruce, P. Eng
Morrison Hershfield
1-59 Scurfield Boulevard
Winnipeg, Manitoba, R3Y 1V2

RE: Sub-Surface Investigation Report for 19-C-10 Sargent Avenue Pavement Renewal

TREK Geotechnical Inc. is pleased to submit our report for the sub-surface investigations for the 19-C-10 Sargent Avenue Pavement Renewal project.

Please contact the undersigned if you have any questions. Thank you for the opportunity to serve you on this assignment.

Sincerely,

TREK Geotechnical Inc.
Per:

Nelson John Ferreira, Ph.D., P. Eng.
Geotechnical Engineer, Principal
Tel: 204.975.9433 ext. 103

cc: Angela Fidler-Kliewer C.Tech. (TREK Geotechnical)

Revision History

Revision No.	Author	Issue Date	Description
0	AFK	November 19, 2019	Final Report

Authorization Signatures

Prepared By:

Angela Fidler-Kliewer, C. Tech
Manager of Laboratory and Field Services

PROVINCE OF MANITOBA
N. J. FERREIRA
Member
22892
Nov 19, 2019
REGISTERED PROFESSIONAL ENGINEER

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
TREK GEOTECHNICAL INC.
No. 4877 Date: Nov 19, 2019

Reviewed By:

Nelson John Ferreira, Ph.D., P.Eng.
Geotechnical Engineer

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1.0 Introduction

This report summarizes the results of the road investigation completed for the 19-C-10 Sargent Ave Pavement Renewal project. The test holes were located along Sargent Avenue between Erin Street and Arlington Street. The information collected describes the pavement structure of the existing road as well as the soil stratigraphy beneath the pavement structure at select locations.

2.0 Road Investigation and Laboratory Program

The investigation included coring of pavement and drilling test holes. TREK Geotechnical and Morrison Hershfield selected the investigation locations as shown on Figure 01 (attached). The road investigation was conducted between October 3, 2019, October 10, 2019 and October 18, 2019. The pavement structure (asphalt and/or concrete) was cored by Harsimran Singh of TREK Geotechnical Inc. (TREK) using a portable coring press equipped with a hollow 150 mm diameter diamond core drill bit. Fourteen test holes were drilled to a depth of 3.0 m below road surface by Maple Leaf Drilling Ltd. using a truck mounted drill rig equipped with 125 mm diameter solid stem augers. Due to overhead powerlines, one test hole was drilled using a 50 mm diameter hand auger to a depth of 2.1 m below the road surface. The sub-surface conditions were observed during drilling and visually classified by Bryan Hiebert of TREK. Other pertinent information such as groundwater and drilling conditions were also recorded during the drilling investigation. Disturbed (auger cuttings) samples and bulk samples retrieved during the sub-surface investigation were transported to TREK's material testing laboratory for further testing. Core samples were also retrieved and logged at TREK's material testing laboratory.

Core and test hole locations noted on the summary tables and test hole logs are based on UTM coordinates obtained using a hand-held GPS and their location relative to the nearest address, and measured distances from the edge of pavement or other permanent features.

The laboratory testing program consisted of moisture content determination on all samples, as well as Atterberg limits, and grain size analysis (mechanical sieve and hydrometer methods) on select samples between 0.5 and 1.0 m below pavement as well as Standard Proctor and CBR testing. Laboratory testing results are included on the test hole logs in Appendix A, while the individual test results are included in Appendix B with a summary table. Photos of the asphalt and concrete pavement cores are included in Appendix C.

Three CBR's were completed on bulk samples of differing soil units and the results are shown in the table below.

Table 1. CBR Testing Summary

Sample Description	Test Hole	Depth (m)	SPMDD (kg/m³)	Opt. Moisture (%)	Percent Proctor (%)	Moisture Content (%)	CBR Value at 2.54 mm	CBR Value at 5.08 mm
Silt and Clay	TH19-05	0.4-1.5	1645	21.1	96.1	21.3	3.5%	2.9%
Silt, Sand and Clay	TH19-01	0.3-1.5	1622	21.3	94.1	25.8	4.8%	3.8%
	TH19-04	0.3-1.5						
Silt and Clay	TH19-03	0.3-1.5	1726	17.8	95.6	20.9	3.4%	3.0%

* Testing completed on bulk samples

3.0 Closure

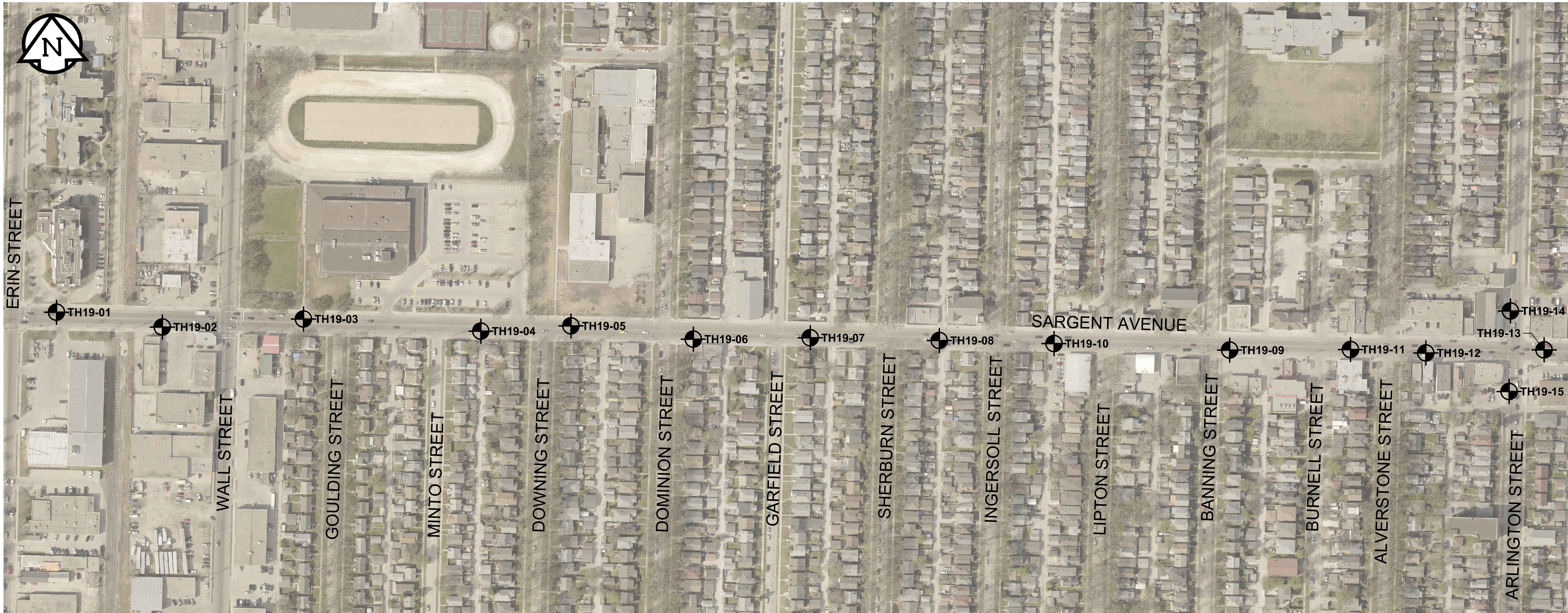
The information provided in this report is in accordance with current engineering principles and practices (Standard of Practice). The findings of this report were based on information provided (field investigation, laboratory testing, geometries). Soil conditions are natural deposits that can be highly 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.

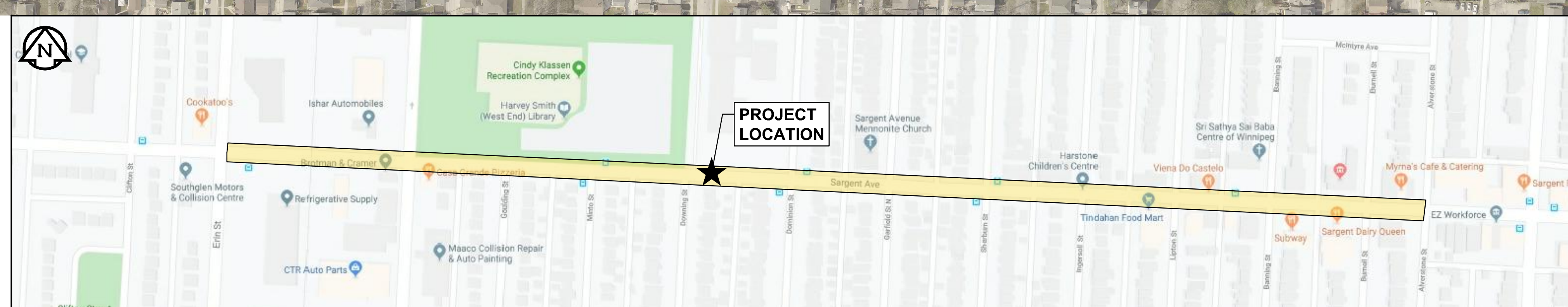
All information provided in this report is subject to our standard terms and conditions for engineering services, a copy of which is provided to each of our clients with the original scope of work, or a mutually executed standard engineering services agreement. If these conditions are not attached, and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

This report has been prepared by TREK Geotechnical Inc. (the Consultant) for the exclusive use of Morrison Hershfield (the Client) and their agents for the work product presented in the report. Any findings or recommendations provided in this report are not to be used or relied upon by any third parties, except as agreed to in writing by the Client and Consultant prior to use.

Figures

0035 082 00
Morrison Hershfield
19-C-10 SARGENT AVENUE PAVEMENT RENEWAL





KEY PLAN

SCALE : N.T.S.

0 50 100 150 m

SCALE = 1 : 3 000 (279 mm x 432 mm)

LEGEND: TEST HOLE (TREK, 2019)

NOTES:
1. AERIAL PHOTO FROM CITY of WINNIPEG 2018
2. COORDINATES FROM HAND HELD GPS UNIT

FIGURE 01
TEST HOLE LOCATION PLAN

Appendix A

Test Hole Logs

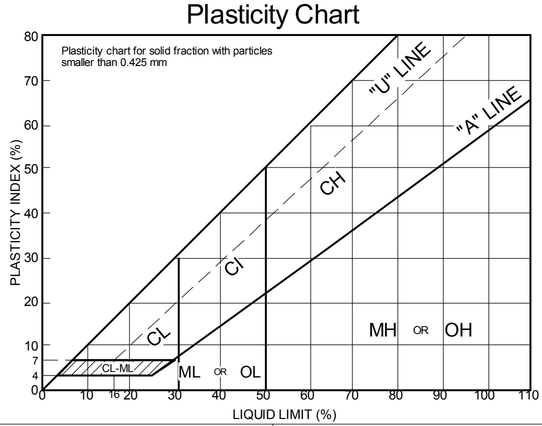
EXPLANATION OF FIELD AND LABORATORY TESTING

GENERAL NOTES

1. Classifications are based on the United Soil Classification System and include consistency, moisture, and color. Field descriptions have been modified to reflect results of laboratory tests where deemed appropriate.
2. Descriptions on these test hole logs apply only at the specific test hole locations and at the time the test holes were drilled. Variability of soil and groundwater conditions may exist between test hole locations.
3. When the following classification terms are used in this report or test hole logs, the primary and secondary soil fractions may be visually estimated.

Major Divisions			USCS Classification	Symbols	Typical Names	Laboratory Classification Criteria		
Coarse-Grained soils (More than half the material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than 4.75 mm)	Clean gravel (Little or no fines)	GW		Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain size curve, depending on percentage of fines (fraction smaller than No. 200 sieve) coarse-grained soils are classified as follows: Less than 5 percent....... GW, GP, SW, SP; More than 12 percent....... GM, GC, SM, SC; 6 to 12 percent...... Borderline case4s requiring dual symbols*	$C_U = \frac{D_{60}}{D_{10}}$ greater than 4; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP		Poorly-graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravel with fines (Appreciable amount of fines)	GM		Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are border-line cases requiring use of dual symbols
			GC		Clayey gravels, gravel-sand-silt mixtures		Atterberg limits above "A" line or P.I. greater than 7	
	Sands (More than half of coarse fraction is smaller than 4.75 mm)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines		$C_U = \frac{D_{60}}{D_{10}}$ greater than 6; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP		Poorly-graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM		Silty sands, sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are border-line cases requiring use of dual symbols
			SC		Clayey sands, sand-clay mixtures		Atterberg limits above "A" line or P.I. greater than 7	
Fine-Grained soils (More than half the material is smaller than No. 200 sieve size)	Silts and Clays (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock floor, silty or clayey fine sands or clayey silts with slight plasticity	Plasticity Chart		
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL		Organic silts and organic silty clays of low plasticity			
	Silts and Clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or distomaceous fine sandy or silty soils, organic silts			
			CH		Inorganic clays of high plasticity, fat clays			
			OH		Organic clays of medium to high plasticity, organic silts			
	Highly Organic Soils		Pt		Peat and other highly organic soils	Von Post Classification Limit	Strong colour or odour, and often fibrous texture	

Plasticity Chart



Material		Particle Size: mm	Particle Size: ASTM Sieve sizes
Sand	Coarse	2.00 to 4.75	#10 to #4
	Medium	0.425 to 2.00	#40 to #10
	Fine	0.075 to 0.425	#200 to #40
Silt or Clay		< 0.075	< #200

Material		Particle Size: mm	Particle Size: ASTM Sieve Sizes
Boulders		> 300	> 12 in.
Cobbles		75 to 300	3 in. to 12 in.
Gravel	Coarse	19 to 75	3/4 in. to 3 in.
	Fine	4.75 to 19	#4 to 3/4 in.

* Borderline classifications used for soils possessing characteristics of two groups are designated by combinations of groups symbols. For example; GW-GC, well-graded gravel-sand mixture with clay binder.

Other Symbol Types

	Asphalt		Bedrock (undifferentiated)		Cobbles
	Concrete		Limestone Bedrock		Boulders and Cobbles
	Fill		Cemented Shale		Silt Till
			Non-Cemented Shale		Clay Till

EXPLANATION OF FIELD AND LABORATORY TESTING

LEGEND OF ABBREVIATIONS AND SYMBOLS

LL - Liquid Limit (%)
PL - Plastic Limit (%)
PI - Plasticity Index (%)
MC - Moisture Content (%)
SPT - Standard Penetration Test
RQD - Rock Quality Designation
Qu - Unconfined Compression
Su - Undrained Shear Strength
VW - Vibrating Wire Piezometer
SI - Slope Inclinometer

▽ Water Level at Time of Drilling

▼ Water Level at End of Drilling

▼ Water Level After Drilling as Indicated on Test Hole Logs

FRACTION OF SECONDARY SOIL CONSTITUENTS ARE BASED ON THE FOLLOWING TERMINOLOGY

TERM	EXAMPLES	PERCENTAGE
and	and CLAY	35 to 50 percent
"y" or "ey"	clayey, silty	20 to 35 percent
some	some silt	10 to 20 percent
trace	trace gravel	1 to 10 percent

TERMS DESCRIBING CONSISTENCY OR COMPACTION CONDITION

The Standard Penetration Test blow count (N) of a non-cohesive soil can be related to compactness condition as follows:

Descriptive Terms	SPT (N) (Blows/300 mm)
Very loose	< 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	> 50

The Standard Penetration Test blow count (N) of a cohesive soil can be related to its consistency as follows:

Descriptive Terms	SPT (N) (Blows/300 mm)
Very soft	< 2
Soft	2 to 4
Firm	4 to 8
Stiff	8 to 15
Very stiff	15 to 30
Hard	> 30

The undrained shear strength (Su) of a cohesive soil can be related to its consistency as follows:

Descriptive Terms	Undrained Shear Strength (kPa)
Very soft	< 12
Soft	12 to 25
Firm	25 to 50
Stiff	50 to 100
Very stiff	100 to 200
Hard	> 200

Sub-Surface Log

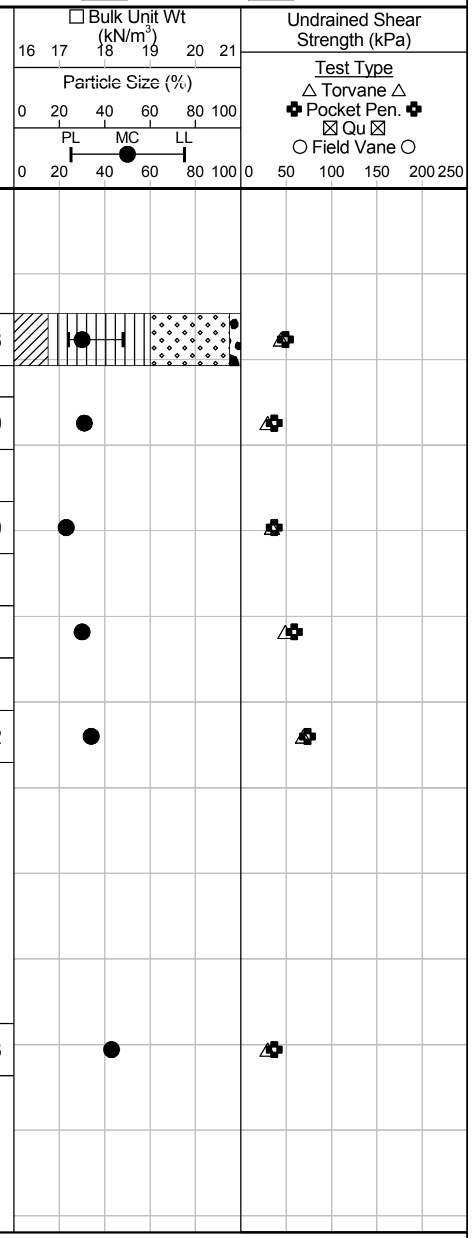
TREK GEOTECHNICAL

Client:	Morrison Hershfield	**Project Number:**	0035-082-00-403
Project Name:	19-C-10 Pavement Renewals - Sargent Ave	**Location:**	N-5528801, E-630445
Contractor:	Maple Leaf Drilling Ltd.	**Ground Elevation:**	Top of Pavement
Method:	125 mm Solid Stem Auger, CME55 Truck Mount	**Date Drilled:**	October 10, 2019

Sample Type: Grab (G) Shelby Tube (T) Split Spoon (SS) Split Barrel (SB) Core (C)

Particle Size Legend: Fines Clay Silt Sand Gravel Cobbles Boulders

Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number
0.0–0.13	ASPHALT - 130 mm thick		
0.13–0.37	CONCRETE - 240 mm thick		
0.37–1.22	SILT AND CLAY - sandy, trace gravel (<10 mm diam.), trace organics - black - moist, firm to stiff - intermediate plasticity	Grab	G78, G79, G80
1.22–3.0	CLAY - silty - grey - moist, firm to stiff - high plasticity	Grab	G81, G82, G83



END OF TEST HOLE AT 3.0 m IN CLAY
1) No seepage or sloughing observed.
2) Test hole open to 2.4 m immediately after drilling.
3) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
4) Test hole located in Westbound median lane, 4 m South of curb and 51 m East of Wall St.

Logged By: Bryan Hiebert **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

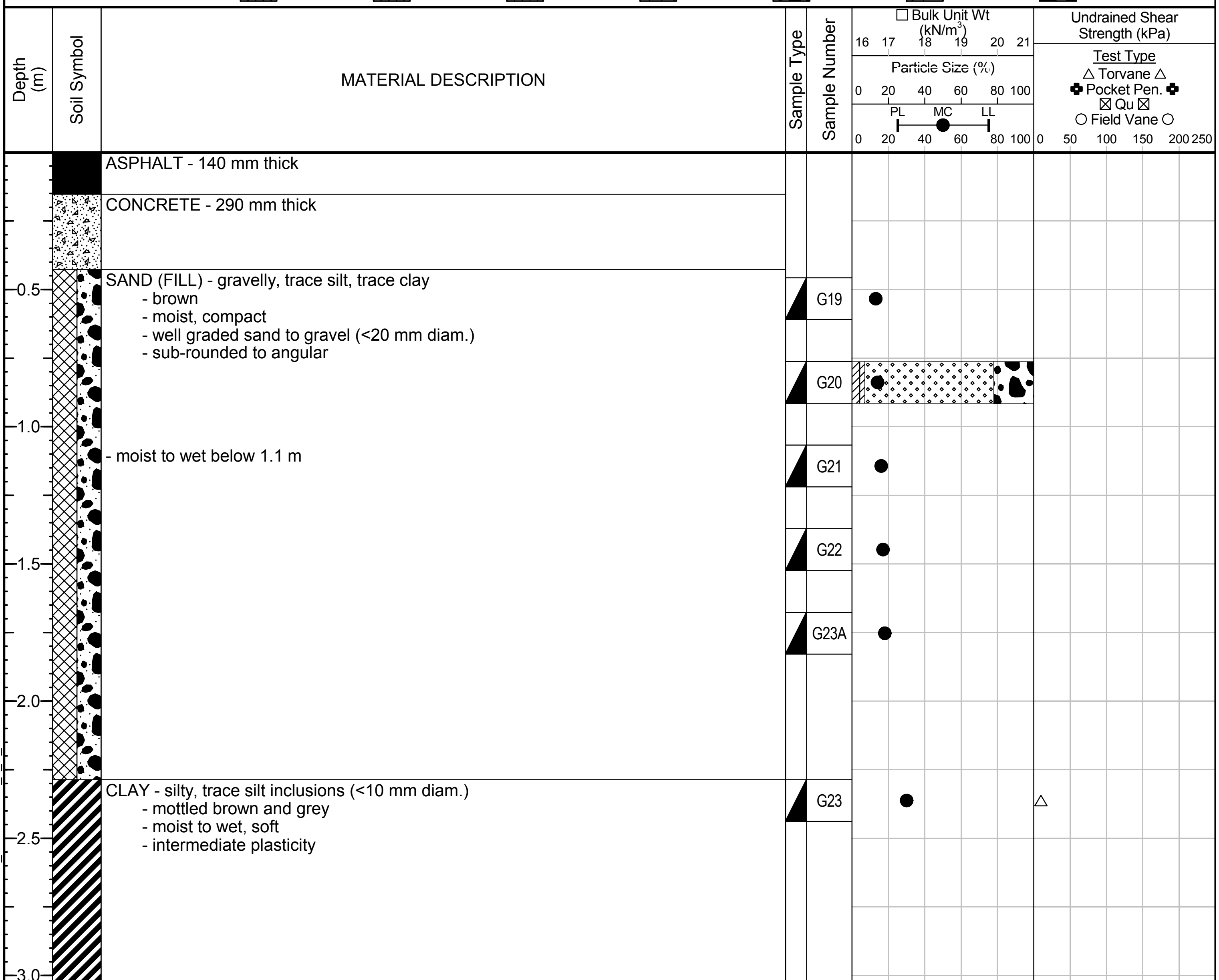
TREK GEOTECHNICAL

Sub-Surface Log

Client:	Morrison Hershfield	**Project Number:**	0035-082-00-403
Project Name:	19-C-10 Pavement Renewals - Sargent Ave	**Location:**	N-5528786, E-630524
Contractor:	Maple Leaf Drilling Ltd.	**Ground Elevation:**	Top of Pavement
Method:	125 mm Solid Stem Auger, CME55 Truck Mount	**Date Drilled:**	October 10, 2019

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) | Split Barrel (SB) | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders



END OF TEST HOLE AT 3.0 m IN CLAY
1) Seepage observed below 1.5 m.
2) Sloughing from sand and gravel layer observed between 0.4 to 2.3 m depth.
3) Test hole open to 0.6 m immediately after drilling.
4) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
5) Test hole located in Eastbound curb lane, 2 m North of curb and 41 m West of Wall St.

Logged By: Bryan Hiebert **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

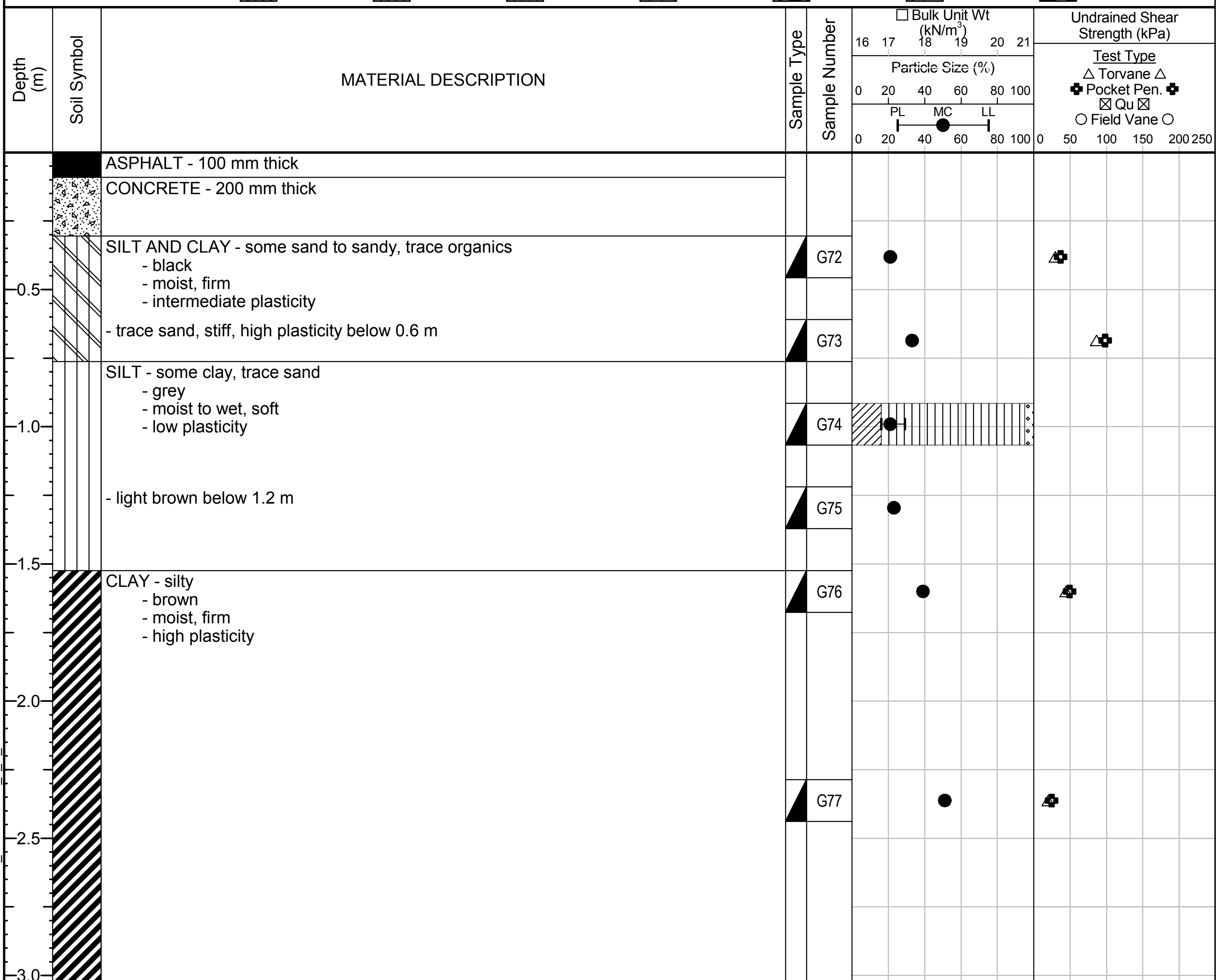
Sub-Surface Log

TREK GEOTECHNICAL

Client: Morrison Hershfield
Project Number: 0035-082-00-403
Project Name: 19-C-10 Pavement Renewals - Sargent Ave
Location: N-5528792, E-630629
Contractor: Maple Leaf Drilling Ltd.
Ground Elevation: Top of Pavement
Method: 125 mm Solid Stem Auger, CME55 Truck Mount
Date Drilled: October 10, 2019

Sample Type: Grab (G) Shelby Tube (T) Split Spoon (SS) Split Barrel (SB) Core (C)

Particle Size Legend: Fines Clay Silt Sand Gravel Cobbles Boulders



END OF TEST HOLE AT 3.0 m IN CLAY
1) No seepage observed.
2) Sloughing from silt layer observed between 0.7 to 1.5 m depth.
3) Test hole open to 1.4 m immediately after drilling.
4) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
5) Test hole located in Westbound median lane, 4 m South of curb and 51 m East of Wall St.

Logged By: Bryan Hiebert **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

Sub-Surface Log

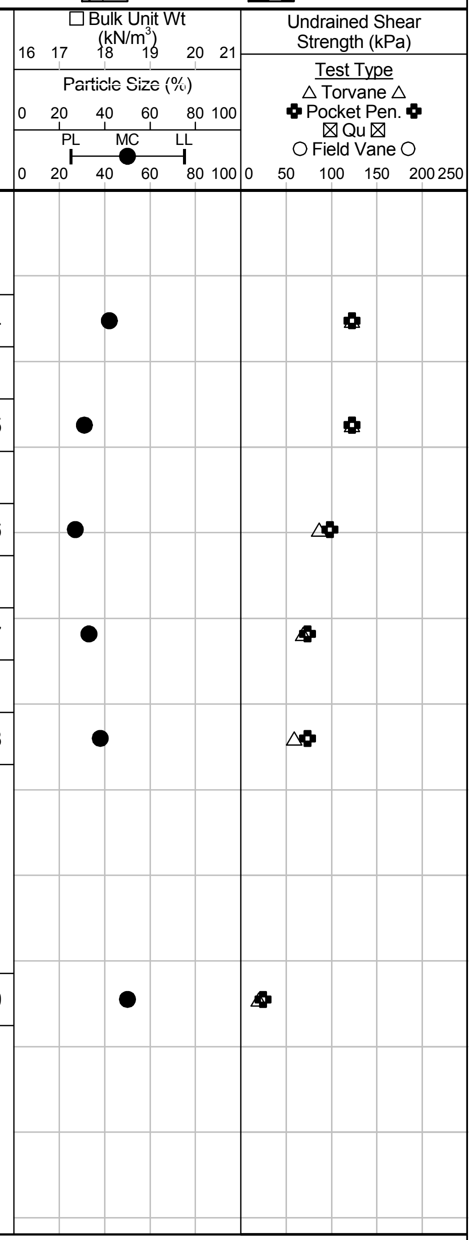
TREK GEOTECHNICAL

Client:	Morrison Hershfield	**Project Number:**	0035-082-00-403
Project Name:	19-C-10 Pavement Renewals - Sargent Ave	**Location:**	N-5528783, E-630761
Contractor:	Maple Leaf Drilling Ltd.	**Ground Elevation:**	Top of Pavement
Method:	125 mm Solid Stem Auger, CME55 Truck Mount	**Date Drilled:**	October 10, 2019

Sample Type: Grab (G) Shelby Tube (T) Split Spoon (SS) Split Barrel (SB) Core (C)

Particle Size Legend: Fines Clay Silt Sand Gravel Cobbles Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number
		ASPHALT - 110 mm thick		
		CONCRETE - 180 mm thick		
0.5		SILT AND CLAY - trace sand, trace organics - black - moist, stiff to very stiff - intermediate to high plasticity	Grab	G24
			Grab	G25
1.0			Grab	G26
		CLAY - silty - light grey - moist, stiff - intermediate to high plasticity	Grab	G27
1.5			Grab	G28
		- mottled brown and grey, high plasticity below 1.8 m		
2.0		- soft to firm below 2.1 m		
			Grab	G29
2.5				
3.0				



END OF TEST HOLE AT 3.0 m IN CLAY
1) No seepage or sloughing observed.
2) Test hole open to 2.6 m immediately after drilling.
3) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
4) Test hole located in Eastbound median lane, 4.5 m North of curb and 30 m East of Minto St.

Logged By: Bryan Hiebert **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

Sub-Surface Log

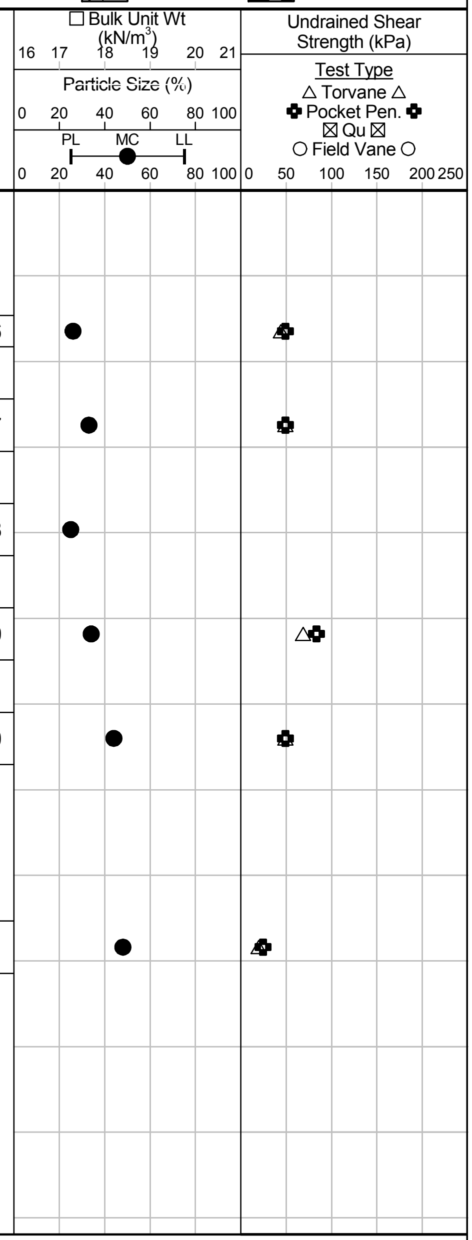
TREK GEOTECHNICAL

Client:	Morrison Hershfield	**Project Number:**	0035-082-00-403
Project Name:	19-C-10 Pavement Renewals - Sargent Ave	**Location:**	N-5528791, E-630828
Contractor:	Maple Leaf Drilling Ltd.	**Ground Elevation:**	Top of Pavement
Method:	125 mm Solid Stem Auger, CME55 Truck Mount	**Date Drilled:**	October 10, 2019

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) | Split Barrel (SB) | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number
		ASPHALT - 100 mm thick		
		CONCRETE - 250 mm thick		
0.5		SILT AND CLAY - some sand, trace organics - black - moist, firm to stiff - intermediate plasticity	Grab	G66
		- trace sand, grey, high plasticity below 0.6 m	Grab	G67
1.0		SILT - trace clay, trace sand - light brown - moist to wet, soft - low plasticity	Grab	G68
		CLAY - silty - brown - moist, stiff - high plasticity	Grab	G69
1.5		- firm below 1.5 m	Grab	G70
2.0				
		- soft to firm below 2.1 m	Grab	G71
2.5				
3.0				



END OF TEST HOLE AT 3.0 m IN CLAY
1) No seepage observed.
2) Sloughing from silt layer observed between 0.7 to 1.1 m depth.
3) Test hole open to 1.2 m immediately after drilling.
4) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
5) Test hole located in Westbound median lane, 6 m North of curb and 15 m East of Downing St.

Logged By: Bryan Hiebert **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

Sub-Surface Log

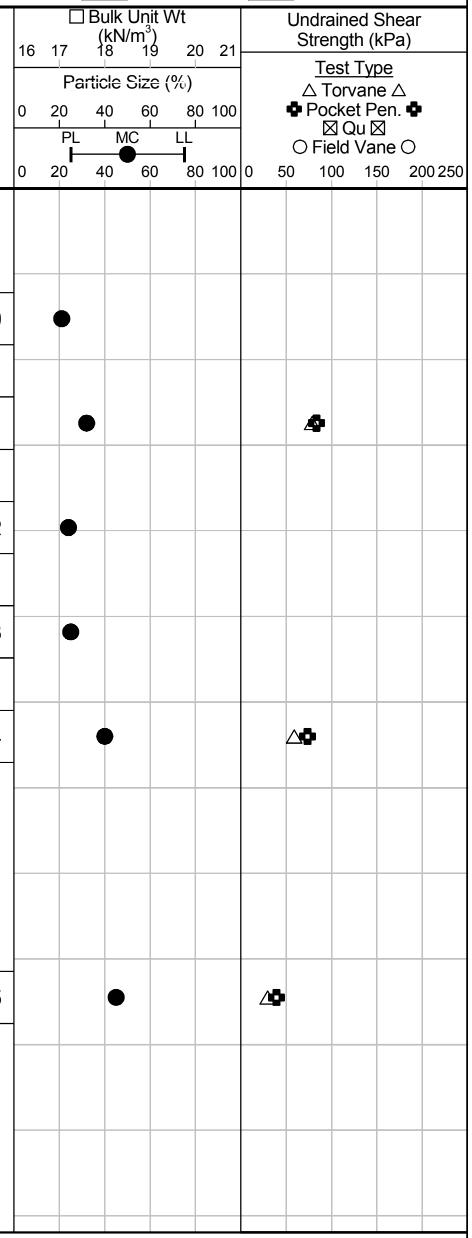
TREK GEOTECHNICAL

Client:	Morrison Hershfield	**Project Number:**	0035-082-00-403
Project Name:	19-C-10 Pavement Renewals - Sargent Ave	**Location:**	N-5528777, E-630919
Contractor:	Maple Leaf Drilling Ltd.	**Ground Elevation:**	Top of Pavement
Method:	125 mm Solid Stem Auger, CME55 Truck Mount	**Date Drilled:**	October 10, 2019

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) | Split Barrel (SB) | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number
0.0–0.11	Asphalt	ASPHALT - 110 mm thick		
0.11–0.29	Concrete	CONCRETE - 180 mm thick		
0.29–0.9	Silt and Clay	SILT AND CLAY - some sand, trace gravel (<40 mm diam.), trace organics - black - moist, stiff - intermediate plasticity - trace sand, high plasticity below 0.6 m	G G	G30 G31
0.9–1.5	Silt	SILT - trace clay, trace sand - light brown - moist to wet, soft - low plasticity	G G	G32 G33
1.5–3.0	Clay	CLAY - silty, trace silt inclusions (<10 mm diam.) - mottled brown and grey - moist, stiff - high plasticity - firm below 2.3 m	G G	G34 G35



END OF TEST HOLE AT 3.0 m IN CLAY
1) No seepage or sloughing observed.
2) Test hole open to 2.1 m immediately after drilling.
3) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
4) Test hole located in Eastbound curb lane, 2 m North of curb and 17 m East of Dominion St.

Logged By:	Bryan Hiebert	**Reviewed By:**	Angela Fidler-Kliewer	**Project Engineer:**	Nelson Ferreira

Sub-Surface Log

TREK GEOTECHNICAL

Client:	Morrison Hershfield	**Project Number:**	0035-082-00-403
Project Name:	19-C-10 Pavement Renewals - Sargent Ave	**Location:**	N-5528778, E-631006
Contractor:	Maple Leaf Drilling Ltd.	**Ground Elevation:**	Top of Pavement
Method:	125 mm Solid Stem Auger, CME55 Truck Mount	**Date Drilled:**	October 10, 2019

Sample Type: Grab (G), Shelby Tube (T), Split Spoon (SS), Split Barrel (SB), Core (C)

Particle Size Legend: Fines, Clay, Silt, Sand, Gravel, Cobbles, Boulders

Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number
0.0–0.13	ASPHALT - 130 mm thick		
0.13–0.42	CONCRETE - 290 mm thick		
0.42–0.6	SAND (FILL) - gravelly, some silt, trace to some clay, brown, wet, compact, well graded sand to gravel (<20 mm diam.), sub-rounded to angular	G	G36
0.6–3.0	CLAY - silty some sand - dark grey - moist, stiff to very stiff - high plasticity	G	G37
		G	G38
		G	G39
		G	G40
	- firm below 2.1 m	G	G41

Chart column headings: Bulk Unit Wt (kN/m³) 16 17 18 19 20 21; Particle Size (%) 0 20 40 60 80 100; PL MC LL 0 20 40 60 80 100; Undrained Shear Strength (kPa) Test Type: △ Torvane △, ✚ Pocket Pen. ✚, ⊠ Qu ⊠, ○ Field Vane ○; 0 50 100 150 200 250

Depth scale: -0.5-, -1.0-, -1.5-, -2.0-, -2.5-, -3.0-

END OF TEST HOLE AT 3.0 m IN CLAY
1) No seepage or sloughing observed.
2) Test hole open to 2.7 m immediately after drilling.
3) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
4) Test hole located in Eastbound median lane, 4 m North of curb and 22 m East of Garfield St.

Logged By: Bryan Hiebert **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

Sub-Surface Log

TREK GEOTECHNICAL

Client:	Morrison Hershfield	**Project Number:**	0035-082-00-403
Project Name:	19-C-10 Pavement Renewals - Sargent Ave	**Location:**	N-5528776, E-631102
Contractor:	TREK Geotechnical	**Ground Elevation:**	Top of Pavement
Method:	Hand Auger	**Date Drilled:**	October 18, 2019

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) | Split Barrel (SB) | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number	Bulk Unit Wt (kN/m³) / Particle Size (%) / PL MC LL	Undrained Shear Strength (kPa) — Test Type: △ Torvane △, ✽ Pocket Pen. ✽, ⊠ Qu ⊠, ○ Field Vane ○
	ASPHALT - 120 mm thick				
	CONCRETE - 380 mm thick				
0.5	GRAVEL (FILL) - trace sand - light brown - damp, compact - poorly graded coarse gravel (<50 mm diam.), angular limestone	Grab	G84		
	SILT AND CLAY - trace sand - light brown - moist, firm to stiff - intermediate to high plasticity				
1.0		Grab	G85		
	- stiff to very stiff below 1.2 m	Grab	G86		
1.5		Grab	G87		
		Grab	G88		
2.0	- stiff below 2.0 m	Grab	G89		

END OF TEST HOLE AT 2.1 m in SILT AND CLAY
2) No seepage or sloughing observed.
1) Test hole open to 2.1 m immediately after drilling.
3) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
4) Test hole located in Eastbound median lane, 5 m North of curb and 35 m East of Sherburn St.

Logged By: Bryan Hiebert **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

Sub-Surface Log

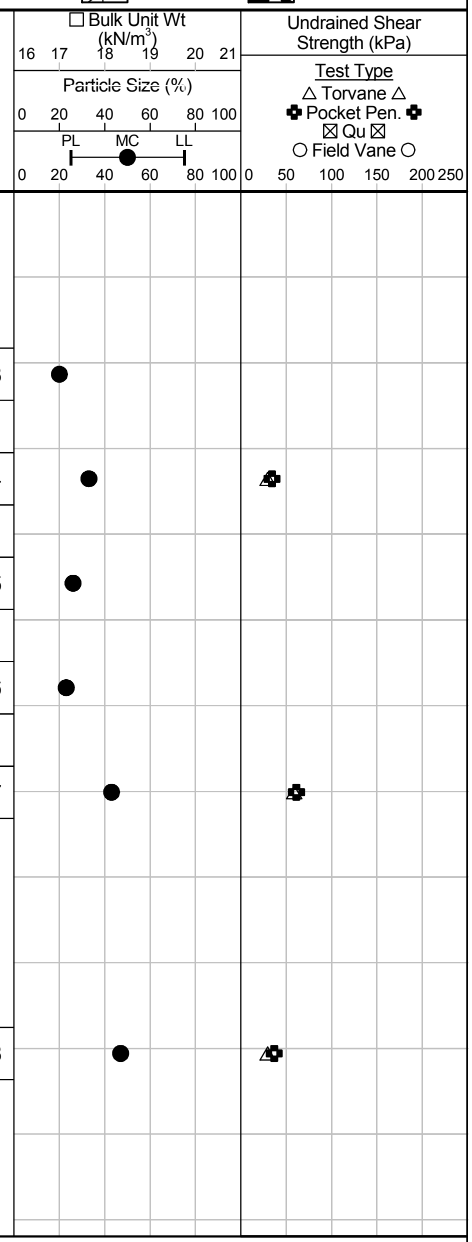
TREK GEOTECHNICAL

Client:	Morrison Hershfield	**Project Number:**	0035-082-00-403
Project Name:	19-C-10 Pavement Renewals - Sargent Ave	**Location:**	N-5528767, E-631318
Contractor:	Maple Leaf Drilling Ltd.	**Ground Elevation:**	Top of Pavement
Method:	125 mm Solid Stem Auger, CME55 Truck Mount	**Date Drilled:**	October 10, 2019

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) | Split Barrel (SB) | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number
		ASPHALT - 230 mm thick		
-0.5-		SAND (FILL) - gravelly, some silt, some clay - light brown - moist, compact - well graded sand to gravel (<20 mm diam.) - sub-rounded to angular	Grab	G43
		SILT AND CLAY - trace sand, trace organics - black - moist, firm - intermediate plasticity	Grab	G44
-1.0-		SILT - trace clay, trace sand - light brown - moist to wet, soft - low plasticity	Grab	G45
-1.5-			Grab	G46
		CLAY - silty, trace silt inclusions (<10 mm diam.) - mottled brown and grey - moist, stiff - high plasticity	Grab	G47
-2.0-				
		- firm below 2.3 m		
-2.5-			Grab	G48
-3.0-				



END OF TEST HOLE AT 3.0 m IN CLAY
1) No seepage observed.
2) Sloughing from silt layer observed between 0.9 to 1.5 m depth.
3) Test hole open to 1.2 m immediately after drilling.
4) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
5) Test hole located in Eastbound curb lane, 2 m North of curb and 10 m West of Banning St.

Logged By: Bryan Hiebert **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

Sub-Surface Log

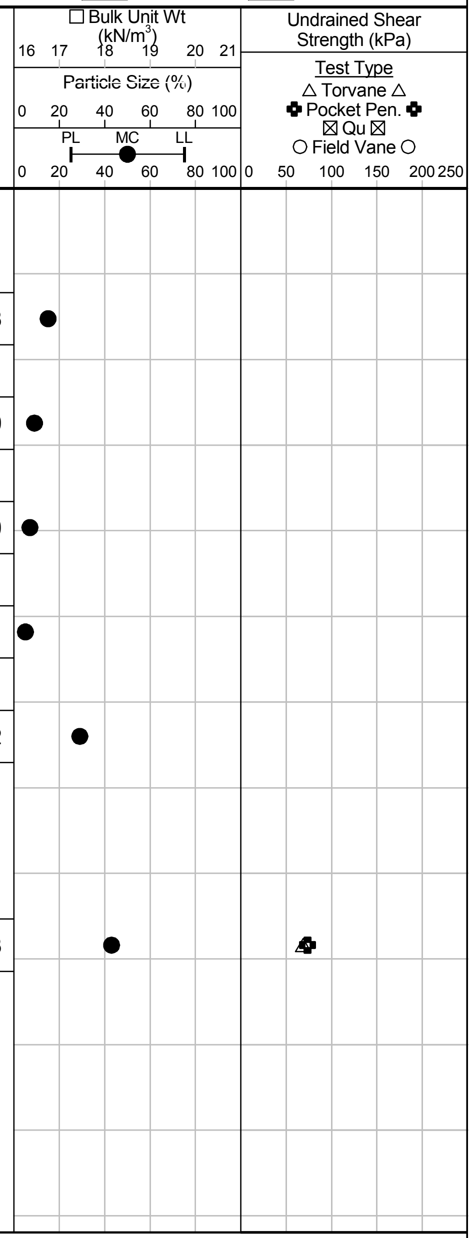
TREK GEOTECHNICAL

Client:	Morrison Hershfield	**Project Number:**	0035-082-00-403
Project Name:	19-C-10 Pavement Renewals - Sargent Ave	**Location:**	N-5528766, E-631187
Contractor:	Maple Leaf Drilling Ltd.	**Ground Elevation:**	Top of Pavement
Method:	125 mm Solid Stem Auger, CME55 Truck Mount	**Date Drilled:**	October 10, 2019

Sample Type: Grab (G) Shelby Tube (T) Split Spoon (SS) Split Barrel (SB) Core (C)

Particle Size Legend: Fines Clay Silt Sand Gravel Cobbles Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number
0.0–0.08		ASPHALT - 80 mm thick		
0.08–0.3		CONCRETE - 220 mm thick		
0.3–1.5		SAND (FILL) - gravelly, some silt, trace clay - brown - moist, compact - well graded sand to gravel (<20 mm diam.) - sub-rounded to angular	Grab	G48, G49, G50, G51
1.5–2.1		TRANSITION: SAND (FILL) to CLAY	Grab	G52
2.1–3.0		CLAY - silty - grey - moist, stiff - high plasticity	Grab	G53



END OF TEST HOLE AT 3.0 m IN CLAY
1) No seepage observed.
2) Sloughing from sand and gravel layer observed between 0.3 to 2.1 m depth.
3) Test hole open to 2.1 m immediately after drilling.
4) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
5) Test hole located in Eastbound median lane, 5 m North of curb and 16 m West of Lipton St.

Logged By: Bryan Hiebert **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

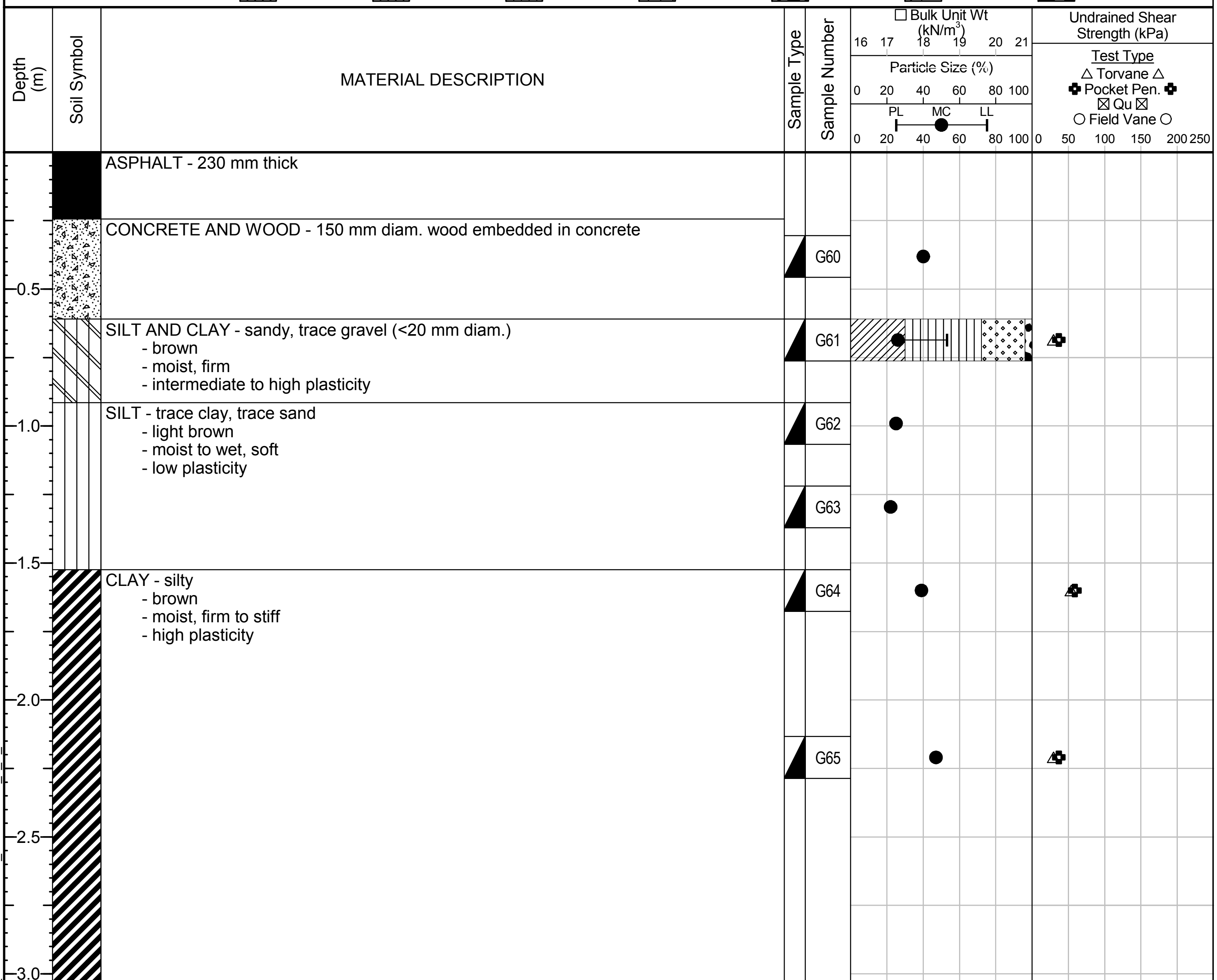
Sub-Surface Log

TREK GEOTECHNICAL

Client:	Morrison Hershfield	**Project Number:**	0035-082-00-403
Project Name:	19-C-10 Pavement Renewals - Sargent Ave	**Location:**	N-5528777, E-631408
Contractor:	Maple Leaf Drilling Ltd.	**Ground Elevation:**	Top of Pavement
Method:	125 mm Solid Stem Auger, CME55 Truck Mount	**Date Drilled:**	October 10, 2019

Sample Type: Grab (G) Shelby Tube (T) Split Spoon (SS) Split Barrel (SB) Core (C)

Particle Size Legend: Fines Clay Silt Sand Gravel Cobbles Boulders



END OF TEST HOLE AT 3.0 m IN CLAY
1) No seepage observed.
2) Sloughing from silt layer between 0.9 to 1.5 m depth.
3) Test hole open to 1.2 m immediately after drilling.
4) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
5) Test hole located in Eastbound median lane, 4 m North of curb and 15 m East of Burnell St.

Logged By:	Bryan Hiebert	**Reviewed By:**	Angela Fidler-Kliewer	**Project Engineer:**	Nelson Ferreira

TREK GEOTECHNICAL

Sub-Surface Log

Client:	Morrison Hershfield	**Project Number:**	0035-082-00-403
Project Name:	19-C-10 Pavement Renewals - Sargent Ave	**Location:**	N-5528771, E-631464
Contractor:	Maple Leaf Drilling Ltd.	**Ground Elevation:**	Top of Pavement
Method:	125 mm Solid Stem Auger, CME55 Truck Mount	**Date Drilled:**	October 10, 2019

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) | Split Barrel (SB) | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number
0.0	ASPHALT - 120 mm thick		
	CONCRETE - 220 thick		
	CONCRETE AND WOOD - 150 mm diam. wood embedded in concrete	G	G54
0.5	SILT AND CLAY - some sand - brown - moist, firm - intermediate plasticity	G	G55
1.0	SILT - trace clay, trace sand - light brown - moist to wet, soft - low plasticity	G	G56
		G	G57
1.5	CLAY - silty - brown - moist, very stiff - high plasticity	G	G58
2.0	- firm below 2.1 m	G	G59
2.5			
3.0			

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21
Particle Size (%): 0 20 40 60 80 100
PL MC LL: 0 20 40 60 80 100
Undrained Shear Strength (kPa): 0 50 100 150 200 250
Test Type: △ Torvane △ | ✚ Pocket Pen. ✚ | ⊠ Qu ⊠ | ○ Field Vane ○

END OF TEST HOLE AT 3.0 m IN CLAY
1) No seepage or sloughing observed.
2) Test hole open to 2.7 m immediately after drilling.
3) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
4) Test hole located in Eastbound median lane, 5 m North of curb and 26 m East of Alverstone St.

Logged By: Bryan Hiebert **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

Sub-Surface Log

TREK GEOTECHNICAL

Client:	Morrison Hershfield	**Project Number:**	0035-082-00-403
Project Name:	19-C-10 Pavement Renewals - Sargent Ave	**Location:**	N-5528769, E-631552
Contractor:	Maple Leaf Drilling Ltd.	**Ground Elevation:**	Top of Pavement
Method:	125 mm Solid Stem Auger, CME55 Truck Mount	**Date Drilled:**	October 3, 2019

Sample Type: Grab (G) Shelby Tube (T) Split Spoon (SS) Split Barrel (SB) Core (C)

Particle Size Legend: Fines Clay Silt Sand Gravel Cobbles Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number
		ASPHALT - 220 mm thick		
		CONCRETE - 390 mm thick		
		SILT AND CLAY - some sand - light brown - moist, very stiff - low to intermediate plasticity	Grab	G13
		SILT - trace clay, trace sand - light brown - moist to wet, soft - low plasticity	Grab	G14
			Grab	G15
			Grab	G16
			Grab	G17
			Grab	G18

Depth scale: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21
Particle Size (%): 0 20 40 60 80 100
PL MC LL: 0 20 40 60 80 100
Undrained Shear Strength (kPa)
Test Type
△ Torvane △
✚ Pocket Pen. ✚
☒ Qu ☒
○ Field Vane ○
0 50 100 150 200 250

END OF TEST HOLE AT 3.0 m IN SILT.
1) No seepage observed.
2) Sloughing from silt layer observed between 2.0 to 3.0 m depth.
3) Test hole open to 2.0 m immediately after drilling.
4) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
5) Test hole located in Eastbound median lane, 4 m North of curb across from 795 Sargent Ave.

Logged By: Bryan Hiebert **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

TREK GEOTECHNICAL

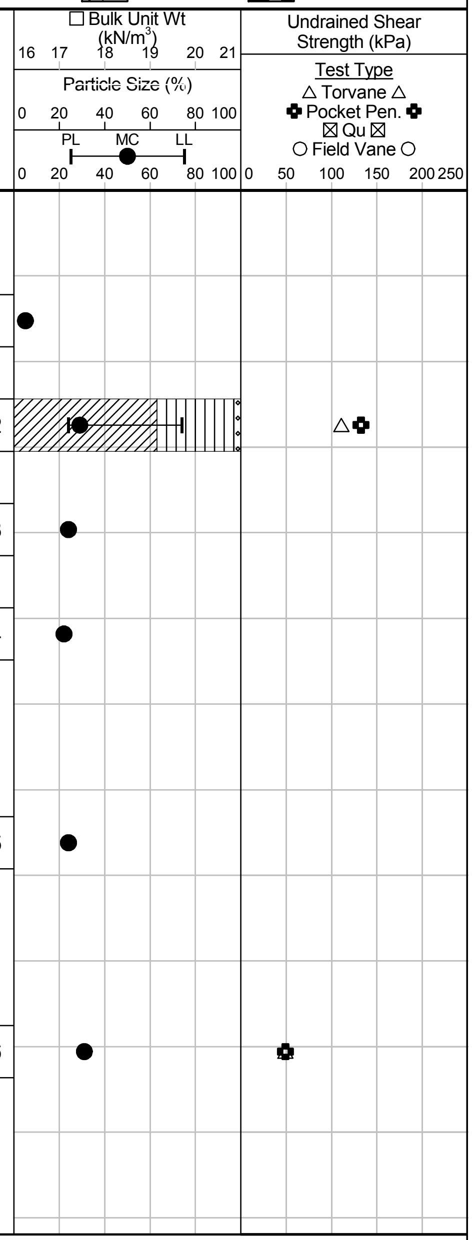
Sub-Surface Log

Client:	Morrison Hershfield	**Project Number:**	0035-082-00-403
Project Name:	19-C-10 Pavement Renewals - Sargent Ave	**Location:**	N-5528798, E-631527
Contractor:	Maple Leaf Drilling Ltd.	**Ground Elevation:**	Top of Pavement
Method:	125 mm Solid Stem Auger, CME55 Truck Mount	**Date Drilled:**	October 3, 2019

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) | Split Barrel (SB) | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number
0.0	ASPHALT - 50 mm thick		
	CONCRETE - 200 mm thick		
	SAND (FILL) - gravelly, some silt, trace clay - brown - moist, compact - well graded sand to gravel (<20 mm diam.) - sub-rounded to angular	Grab	G01
	CLAY - silty, trace sand - grey - moist, very stiff - high plasticity	Grab	G02
1.0	SILT - trace clay, trace sand - light brown - moist to wet, soft - low plasticity	Grab	G03
		Grab	G04
2.0		Grab	G05
2.5	CLAY - silty - mottled brown and grey - moist, firm to stiff - high plasticity	Grab	G06
3.0			



END OF TEST HOLE AT 3.0 m IN CLAY
1) No seepage observed.
2) Sloughing from silt layer observed between 0.9 to 2.4 m depth.
3) Test hole open to 2.6 m immediately after drilling.
4) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
5) Test hole located in Arlington Southbound curb lane, 2 m East of curb and 19 m South of 666 Arlington St.

Logged By: Bryan Hiebert **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

TREK GEOTECHNICAL

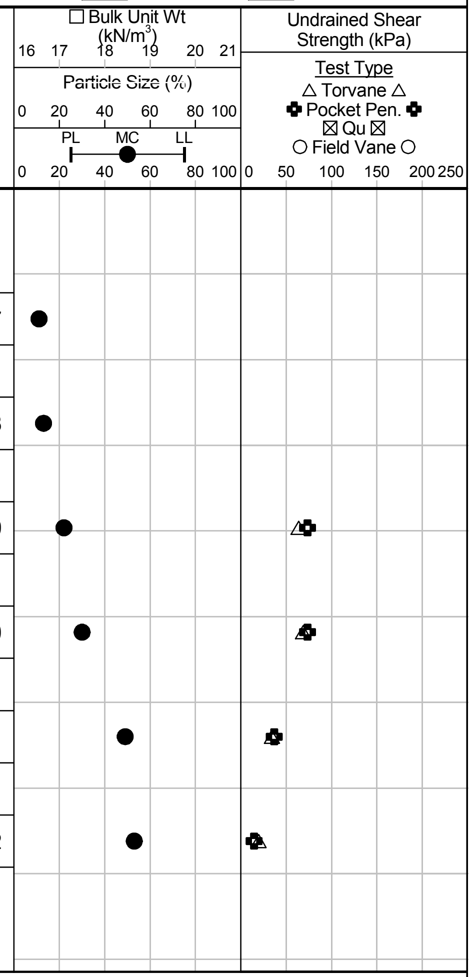
Sub-Surface Log

Client:	Morrison Hershfield	**Project Number:**	0035-082-00-403
Project Name:	19-C-10 Pavement Renewals - Sargent Ave	**Location:**	N-5528738, E-631526
Contractor:	Maple Leaf Drilling Ltd.	**Ground Elevation:**	Top of Pavement
Method:	125 mm Solid Stem Auger, CME55 Truck Mount	**Date Drilled:**	October 3, 2019

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) | Split Barrel (SB) | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number
	ASPHALT - 50 mm thick		
	CONCRETE - 170 mm thick		
	SAND (FILL) - gravelly, some silt, trace clay - brown, moist, compact, well graded sand to gravel (<20 mm diam.) - sub-rounded to angular	Grab	G07
0.5	SILT AND SAND - some clay, trace gravel (<20 mm diam.), trace organics - black - moist, soft - low to intermediate plasticity	Grab	G08
1.0	SILT AND CLAY - trace sand - grey - moist, stiff - intermediate plasticity	Grab	G09
		Grab	G10
1.5	CLAY - silty - grey - moist, firm - high plasticity	Grab	G11
2.0		Grab	G12



END OF TEST HOLE AT 2.3 m IN CLAY
1) No seepage or sloughing observed.
2) Test hole open to 2.3 m immediately after drilling.
3) Test hole backfilled with auger cuttings, granular fill and cold patch asphalt.
4) Test hole located in Arlington Southbound lane, 9 m West and 10 m South of fire hydrant near the intersection of Sargent Ave and Arlington St.

Logged By: Bryan Hiebert **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

Appendix B

Summary Table & Lab Testing Results

19-C-10 Sargent Avenue Street Renewal
Sub-Surface Investigation
Sargent Avenue

Test Hole No.	Test Hole Location	Pavement Surface		Pavement Structure Material		Subgrade Description	Sample Depth (m)		Moisture Content (%)	Grain Size Analysis				Atterberg Limits		
		Type	Thickness (mm)	Type	Thickness (mm)		Top (m)	Bottom (m)		Clay (%)	Silt (%)	Sand (%)	Gravel (%)	Plastic	Liquid	Plasticity Index
TH19-01	UTM : 5528801 N, 630445 E Located in Westbound median lane, 4 m South of curb and 51 m East of Wall St.	Asphalt	130	Concrete	240	Silt and Sand	0.3	0.5	30	15	45	35	5	24	48	24
						Silt and Sand	0.6	0.8	31							
						Silt and Sand	0.9	1.1	23							
						Clay	1.2	1.4	30							
						Clay	1.5	1.7	34							
						Clay	2.4	2.6	43							
TH19-02	UTM : 5528786 N, 630524 E Located in Eastbound curb lane, 2 m North of curb and 41 m West of Wall St.									-	Fines (%)	Sand (%)	Gravel (%)	Plastic	Liquid	Plasticity Index
		Asphalt	140	Concrete	290	Sand (Fill)	0.5	0.6	13							
						Sand (Fill)	0.8	0.9	14		7	71	22			
						Sand (Fill)	1.1	1.2	16							
						Sand (Fill)	1.4	1.5	17							
						Sand (Fill)	1.7	1.8	18							
						Clay	2.3	2.4	30							
TH19-03	UTM : 5528792 N, 630629 E Located in Westbound median lane, 4 m South of curb and 51 m East of Wall Street	Asphalt	100	Concrete	200	Silt and Clay	0.3	0.5	21							
						Silt and Clay	0.6	0.8	33							
						Silt	0.9	1.1	21	16	73	5		16	29	14
						Silt	1.2	1.4	23							
						Clay	1.5	1.7	39							
						Clay	2.3	2.4	51							
TH19-04	UTM : 5528783 N, 630761 E Located in Eastbound median lane, 4.5 m North of curb and 30 m East of Minto St.	Asphalt	110	Concrete	180	Silt and Clay	0.3	0.5	42							
						Silt and Clay	0.6	0.8	31							
						Silt and Clay	0.9	1.1	27							
						Clay	1.2	1.4	33							
						Clay	1.5	1.7	38							
						Clay	2.3	2.4	50							

19-C-10 Sargent Avenue Street Renewal
Sub-Surface Investigation
Sargent Avenue

Test Hole No.	Test Hole Location	Pavement Surface		Pavement Structure Material		Subgrade Description	Sample Depth (m)		Moisture Content (%)	Grain Size Analysis				Atterberg Limits		
		Type	Thickness (mm)	Type	Thickness (mm)		Top (m)	Bottom (m)		Clay (%)	Silt (%)	Sand (%)	Gravel (%)	Plastic	Liquid	Plasticity Index
TH19-05	UTM : 5528792 N, 630828 E Located in Westbound median lane, 6 m North of curb and 15 m East of Downing St.	Asphalt	100	Concrete	250	Silt and Clay	0.3	0.5	26							
						Silt and Clay	0.6	0.8	33							
						Silt	0.9	1.1	25							
						Clay	1.2	1.4	34							
						Clay	1.5	1.7	44							
						Clay	2.1	2.3	48							
TH19-06	UTM : 5528777 N, 630919 E Located in Eastbound curb lane, 2 m North of curb and 17 m East of Dominion St.	Asphalt	110	Concrete	180	Silt and Clay	0.3	0.5	21							
						Silt and Clay	0.6	0.8	32							
						Silt	0.9	1.1	24							
						Silt	1.2	1.4	25							
						Clay	1.5	1.7	40							
						Clay	2.3	2.4	45							
TH19-07	UTM : 5528778 N, 630006 E Located in Eastbound median lane, 4 m North of curb and 22 m East of Garfield St.	Asphalt	130	Concrete	290	Sand (Fill)	0.5	0.6	17							
						Silt and Clay	0.8	0.9	37	56	33	11		27	75	49
						Silt and Clay	1.1	1.2	37							
						Silt and Clay	1.4	1.5	36							
						Silt and Clay	1.7	1.8	34							
						Clay	2.3	2.4	45							
										-	Fines (%)	Sand (%)	Gravel (%)	Plastic	Liquid	Plasticity Index
TH19-08	UTM : 5528776 N, 631102 E Located in Eastbound median lane, 5 m North of curb and 35 m East of Sherburn St.	Asphalt	120	Concrete	380	Gravel (Fill)	0.6	0.8	4		2	2	96			
						Silt and Clay	0.9	1.1	28							
						Silt and Clay	1.2	1.4	28							
						Silt and Clay	1.5	1.7	33							
						Silt and Clay	1.8	2.0	34							
						Silt and Clay	2.0	2.1	33							

19-C-10 Sargent Avenue Street Renewal
Sub-Surface Investigation
Sargent Avenue

Test Hole No.	Test Hole Location	Pavement Surface		Pavement Structure Material		Subgrade Description	Sample Depth (m)		Moisture Content (%)	Grain Size Analysis				Atterberg Limits		
		Type	Thickness (mm)	Type	Thickness (mm)		Top (m)	Bottom (m)		Clay (%)	Silt (%)	Sand (%)	Gravel (%)	Plastic	Liquid	Plasticity Index
TH19-09	UTM : 5528767 N, 631318 E Located in in Eastbound curb lane, 2 m North of curb and 10 m West of Banning St.	Asphalt	150	Concrete		Sand (Fill)	0.3	0.5	20							
						Silt and Clay	0.6	0.8	33							
						Silt	0.9	1.1	26							
						Silt	1.2	1.4	23							
						Clay	1.5	1.7	43							
						Clay	2.1	2.3	47							
TH19-10	UTM : 5528766 N, 631187 E Located in Eastbound median lane, 5 m North of curb and 16 m West of Lipton St.	Asphalt	80	Concrete	220	Sand (Fill)	0.3	0.5	15							
						Sand (Fill)	0.6	0.8	9							
						Sand (Fill)	0.9	1.1	7							
						Sand (Fill)	1.2	1.4	5							
						Transition from Sand to Clay	1.5	1.7	29							
						Clay	2.1	2.3	43							
TH19-11	UTM : 5528777 N, 631408 E Located in Eastbound median lane, 4 m North of curb and 15 m East of Burnell St.	Asphalt	230	Concrete	N/A	Concrete Rubble and Wood Debris	0.3	0.5	40							
						Silt and Clay	0.6	0.8	26	30	42	24	4	26	53	27
						Silt	0.9	1.1	25							
						Silt	1.2	1.4	22							
						Clay	1.5	1.7	39							
						Clay	2.1	2.3	47							
TH19-12	UTM : 5528771 N, 631464 E Located in Eastbound median lane, 5 m North of curb and 26 m East of Alverstone St.	Asphalt	120	Concrete	220	Concrete Rubble and Wood Debris	0.3	0.5	45							
						Silt and Clay	0.6	0.8	27							
						Silt	0.9	1.1	20							
						Silt	1.2	1.4	22							
						Clay	1.5	1.7	32							
						Clay	2.1	2.3	48							

19-C-10 Sargent Avenue Street Renewal
Sub-Surface Investigation
Sargent Avenue

Test Hole No.	Test Hole Location	Pavement Surface		Pavement Structure Material		Subgrade Description	Sample Depth (m)		Moisture Content (%)	Grain Size Analysis				Atterberg Limits		
		Type	Thickness (mm)	Type	Thickness (mm)		Top (m)	Bottom (m)		Clay (%)	Silt (%)	Sand (%)	Gravel (%)	Plastic	Liquid	Plasticity Index
TH19-13	UTM : 5528769 N, 630552 E Located in Eastbound median lane, 4 m North of curb across from 795 Sargent Ave.	Asphalt	220	Concrete	390	Silt and Clay	0.8	0.9	22							
						Silt	1.1	1.2	20							
						Silt	1.4	1.5	20							
						Silt	1.7	1.8	19							
						Silt	2.0	2.1	22							
						Silt	2.3	2.4	25							
TH19-14	UTM : 5528798 N, 631527 E Located in Arlington St. Southbound curb lane, 2 m East of curb and 19 m South of 666 Arlington St.	Asphalt	50	Concrete	200	Sand (Fill)	0.3	0.5	5							
						Silt and Clay	0.6	0.8	29	63	34	3		74	24	49
						Silt	0.9	1.1	24							
						Silt	1.2	1.4	22							
						Silt	1.8	2.0	24							
						Clay	2.4	2.6	31							
TH19-15	UTM : 5528738 N, 631526 E Located in Arlington St. Southbound lane, 9 m West and 10 m South of fire hydrant at the intersection of Sargent Ave and Arlington St.	Asphalt	50	Concrete	170	Sand (Fill)	0.3	0.5	11							
						Silt and Sand	0.6	0.8	13							
						Silt and Clay	0.9	1.1	22							
						Silt and Clay	1.2	1.4	30							
						Clay	1.5	1.7	49							
						Clay	1.8	2.0	53							

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Moisture Content Report
ASTM D2216-10

Project No. 0035-082-00-403
Client Morrison Hershfield
Project 19-C-10 Pavement Renewal - Sargent Ave

Sample Date 10-Oct-19
Test Date 22-Oct-19
Technician HS

Test Hole	TH19-01	TH19-01	TH19-01	TH19-01	TH19-01	TH19-01
Depth (m)	0.3 - 0.5	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4	1.5 - 1.7	2.4 - 2.6
Sample #	G78	G79	G80	G81	G82	G83
Tare ID	D32	Z102	F44	C22	P20	P85
Mass of tare	8.6	8.5	8.5	8.6	8.6	8.6
Mass wet + tare	376.2	272.8	287.7	232.5	253.1	214.4
Mass dry + tare	290.4	210.2	235.2	180.8	190.7	152.8
Mass water	85.8	62.6	52.5	51.7	62.4	61.6
Mass dry soil	281.8	201.7	226.7	172.2	182.1	144.2
Moisture %	30.4%	31.0%	23.2%	30.0%	34.3%	42.7%

Test Hole	TH19-02	TH19-02	TH19-02	TH19-02	TH19-02	TH19-02
Depth (m)	0.5 - 0.6	0.8 - 0.9	1.1 - 1.2	1.4 - 1.5	1.7 - 1.8	2.3 - 2.4
Sample #	G19	G20	G21	G22	G23A	G23
Tare ID	Z16	STEPHEN	A13	AC03	F35	Z134
Mass of tare	8.7	255.8	8.4	6.8	8.5	8.4
Mass wet + tare	404.4	790.3	221.0	176.3	153.2	222.8
Mass dry + tare	358.7	723.3	191.0	151.5	131.5	172.8
Mass water	45.7	67.0	30.0	24.8	21.7	50.0
Mass dry soil	350.0	467.5	182.6	144.7	123.0	164.4
Moisture %	13.1%	14.3%	16.4%	17.1%	17.6%	30.4%

Test Hole	TH19-03	TH19-03	TH19-03	TH19-03	TH19-03	TH19-03
Depth (m)	0.3 - 0.5	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4	1.5 - 1.7	2.3 - 2.4
Sample #	G72	G73	G74	G75	G76	G77
Tare ID	F129	D49	D10	AB18	N62	F144
Mass of tare	8.4	8.5	8.6	6.8	8.6	8.5
Mass wet + tare	277.8	247.3	422.0	318.5	223.8	213.1
Mass dry + tare	231.7	188.2	349.4	259.5	163.4	144.1
Mass water	46.1	59.1	72.6	59.0	60.4	69.0
Mass dry soil	223.3	179.7	340.8	252.7	154.8	135.6
Moisture %	20.6%	32.9%	21.3%	23.3%	39.0%	50.9%

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Moisture Content Report
ASTM D2216-10

Project No. 0035-082-00-403
Client Morrison Hershfield
Project 19-C-10 Pavement Renewal - Sargent Ave

Sample Date 10-Oct-19
Test Date 22-Oct-19
Technician HS

Test Hole	TH19-04	TH19-04	TH19-04	TH19-04	TH19-04	TH19-04
Depth (m)	0.3 - 0.5	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4	1.5 - 1.7	2.3 - 2.4
Sample #	G24	G25	G26	G27	G28	G29
Tare ID	H13	Z116	W97	H90	D47	D19
Mass of tare	8.6	8.7	8.5	8.5	8.5	8.4
Mass wet + tare	163.1	185.0	196.9	185.9	198.0	198.5
Mass dry + tare	117.4	143.0	157.3	142.4	146.0	135.0
Mass water	45.7	42.0	39.6	43.5	52.0	63.5
Mass dry soil	108.8	134.3	148.8	133.9	137.5	126.6
Moisture %	42.0%	31.3%	26.6%	32.5%	37.8%	50.2%

Test Hole	TH19-05	TH19-05	TH19-05	TH19-05	TH19-05	TH19-05
Depth (m)	0.3 - 0.5	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4	1.5 - 1.7	2.1 - 2.3
Sample #	G66	G67	G68	G69	G70	G71
Tare ID	AB47	W27	AC29	AB60	F8	F38
Mass of tare	6.8	8.4	6.9	6.6	8.8	8.5
Mass wet + tare	265.7	177.1	200.3	193.2	218.9	258.3
Mass dry + tare	213.0	134.9	161.7	145.9	155.1	176.8
Mass water	52.7	42.2	38.6	47.3	63.8	81.5
Mass dry soil	206.2	126.5	154.8	139.3	146.3	168.3
Moisture %	25.6%	33.4%	24.9%	34.0%	43.6%	48.4%

Test Hole	TH19-06	TH19-06	TH19-06	TH19-06	TH19-06	TH19-06
Depth (m)	0.3 - 0.5	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4	1.5 - 1.7	2.3 - 2.4
Sample #	G30	G31	G32	G33	G34	G35
Tare ID	W36	N01	AB09	K10	H9	F9
Mass of tare	8.5	8.6	6.7	8.5	8.8	8.9
Mass wet + tare	199.4	191.3	213.2	166.3	178.0	172.2
Mass dry + tare	166.8	147.2	173.6	134.7	129.3	121.2
Mass water	32.6	44.1	39.6	31.6	48.7	51.0
Mass dry soil	158.3	138.6	166.9	126.2	120.5	112.3
Moisture %	20.6%	31.8%	23.7%	25.0%	40.4%	45.4%

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Moisture Content Report
ASTM D2216-10

Project No.	0035-082-00-403
Client	Morrison Hershfield
Project	19-C-10 Pavement Renewal - Sargent Ave
Sample Date	10-Oct-19
Test Date	22-Oct-19
Technician	HS

Test Hole	TH19-07	TH19-07	TH19-07	TH19-07	TH19-07	TH19-07
Depth (m)	0.5 - 0.6	0.8 - 0.9	1.1 - 1.2	1.4 - 1.5	1.7 - 1.8	2.3 - 2.4
Sample #	G36	G37	G38	G39	G40	G41
Tare ID	N02	E13	AB43	F124	E2	K4
Mass of tare	8.6	8.8	6.7	8.5	8.8	8.6
Mass wet + tare	251.7	485.1	228.7	207.6	196.0	174.0
Mass dry + tare	217.0	355.4	168.9	155.3	148.1	123.1
Mass water	34.7	129.7	59.8	52.3	47.9	50.9
Mass dry soil	208.4	346.6	162.2	146.8	139.3	114.5
Moisture %	16.7%	37.4%	36.9%	35.6%	34.4%	44.5%

Test Hole	TH19-08	TH19-08	TH19-08	TH19-08	TH19-08	TH19-08
Depth (m)	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4	1.5 - 1.7	1.8 - 2.0	2.0 - 2.1
Sample #	G84	G85	G86	G87	G88	G89
Tare ID	Z1	Z11	AB100	Z118	F131	Z93
Mass of tare	238.0	8.8	7.0	8.4	8.5	8.8
Mass wet + tare	1665.8	234.6	208.5	174.8	190.1	226.6
Mass dry + tare	1605.8	185.2	164.3	133.5	143.9	172.6
Mass water	60.0	49.4	44.2	41.3	46.2	54.0
Mass dry soil	1367.8	176.4	157.3	125.1	135.4	163.8
Moisture %	4.4%	28.0%	28.1%	33.0%	34.1%	33.0%

Test Hole	TH19-09	TH19-09	TH19-09	TH19-09	TH19-09	TH19-09
Depth (m)	0.3 - 0.5	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4	1.5 - 1.7	2.1 - 2.3
Sample #	G42	G43	G44	G45	G46	G47
Tare ID	F56	W29	W41	F42	AB88	Z24
Mass of tare	8.4	8.6	8.6	8.4	6.7	8.4
Mass wet + tare	278.7	238.7	246.4	253.5	213.9	234.3
Mass dry + tare	234.0	181.7	197.6	207.0	151.4	162.0
Mass water	44.7	57.0	48.8	46.5	62.5	72.3
Mass dry soil	225.6	173.1	189.0	198.6	144.7	153.6
Moisture %	19.8%	32.9%	25.8%	23.4%	43.2%	47.1%

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Moisture Content Report
ASTM D2216-10

Project No. 0035-082-00-403
Client Morrison Hershfield
Project 19-C-10 Pavement Renewal - Sargent Ave

Sample Date 10-Oct-19
Test Date 22-Oct-19
Technician HS

Test Hole	TH19-10	TH19-10	TH19-10	TH19-10	TH19-10	TH19-10
Depth (m)	0.3 - 0.5	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4	1.5 - 1.7	2.1 - 2.3
Sample #	G48	G49	G50	G51	G52	G53
Tare ID	E8	P24	A17	P10	K1	N56
Mass of tare	8.6	8.6	8.6	8.9	8.4	8.4
Mass wet + tare	201.1	186.9	184.1	188.7	234.8	238.8
Mass dry + tare	175.7	171.9	172.2	180.0	183.7	169.6
Mass water	25.4	15.0	11.9	8.7	51.1	69.2
Mass dry soil	167.1	163.3	163.6	171.1	175.3	161.2
Moisture %	15.2%	9.2%	7.3%	5.1%	29.2%	42.9%

Test Hole	TH19-11	TH19-11	TH19-11	TH19-11	TH19-11	TH19-11
Depth (m)	0.3 - 0.5	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4	1.5 - 1.7	2.1 - 2.3
Sample #	G60	G61	G62	G63	G64	G65
Tare ID	D12	W35	W103	K5	C19	AA23
Mass of tare	8.4	8.4	8.4	8.6	8.6	6.8
Mass wet + tare	124.4	393.6	287.6	397.8	220.8	303.4
Mass dry + tare	91.5	314.6	231.4	326.5	161.6	208.4
Mass water	32.9	79.0	56.2	71.3	59.2	95.0
Mass dry soil	83.1	306.2	223.0	317.9	153.0	201.6
Moisture %	39.6%	25.8%	25.2%	22.4%	38.7%	47.1%

Test Hole	TH19-12	TH19-12	TH19-12	TH19-12	TH19-12	TH19-12
Depth (m)	0.3 - 0.5	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4	1.5 - 1.7	2.1 - 2.3
Sample #	G54	G55	G56	G57	G58	G59
Tare ID	P14	N113	Z44	F50	F48	A109
Mass of tare	9	8.6	8.6	8.6	8.6	8.4
Mass wet + tare	123.6	288.8	152.0	254.2	283.4	293.4
Mass dry + tare	87.8	229.9	128.0	210.6	217.4	201.2
Mass water	35.8	58.9	24.0	43.6	66.0	92.2
Mass dry soil	78.8	221.3	119.4	202.0	208.8	192.8
Moisture %	45.4%	26.6%	20.1%	21.6%	31.6%	47.8%

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Moisture Content Report
ASTM D2216-10

Project No.	0035-082-00-403
Client	Morrison Hershfield
Project	19-C-10 Pavement Renewal - Sargent Ave
Sample Date	10-Oct-19
Test Date	22-Oct-19
Technician	HS

Test Hole	TH19-13	TH19-13	TH19-13	TH19-13	TH19-13	TH19-13
Depth (m)	0.8 - 0.9	1.1 - 1.2	1.4 - 1.5	1.7 - 1.8	2.0 - 2.1	2.3 - 2.4
Sample #	G13	G14	G15	G16	G17	G18
Tare ID	H6	E92	C8	W91	F98	AB19
Mass of tare	8.6	8.4	8.4	8.6	8.5	6.7
Mass wet + tare	192.2	195.4	212.3	199.3	248.7	253.0
Mass dry + tare	159.0	164.6	177.9	168.4	206.0	203.8
Mass water	33.2	30.8	34.4	30.9	42.7	49.2
Mass dry soil	150.4	156.2	169.5	159.8	197.5	197.1
Moisture %	22.1%	19.7%	20.3%	19.3%	21.6%	25.0%

Test Hole	TH19-14	TH19-14	TH19-14	TH19-14	TH19-14	TH19-14
Depth (m)	0.3 - 0.5	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4	1.8 - 2.0	2.4 - 2.6
Sample #	G01	G02	G03	G04	G05	G06
Tare ID	F128	E110	C14	AB91	N110	E53
Mass of tare	8.7	8.6	8.5	6.6	8.5	8.6
Mass wet + tare	268.4	342.8	231.2	441.9	252.0	272.1
Mass dry + tare	255.4	267.3	188.1	363.5	205.5	209.8
Mass water	13.0	75.5	43.1	78.4	46.5	62.3
Mass dry soil	246.7	258.7	179.6	356.9	197.0	201.2
Moisture %	5.3%	29.2%	24.0%	22.0%	23.6%	31.0%

Test Hole	TH19-15	TH19-15	TH19-15	TH19-15	TH19-15	TH19-15
Depth (m)	0.3 - 0.5	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4	1.5 - 1.7	1.8 - 2.0
Sample #	G07	G08	G09	G10	G11	G12
Tare ID	W35	E110	W59	N27	Z77	E15
Mass of tare	8.7	8.6	8.5	8.6	8.5	9
Mass wet + tare	257.1	131.0	199.1	184.2	180.2	251.1
Mass dry + tare	231.6	117.2	164.5	143.9	124.0	167.4
Mass water	25.5	13.8	34.6	40.3	56.2	83.7
Mass dry soil	222.9	108.6	156.0	135.3	115.5	158.4
Moisture %	11.4%	12.7%	22.2%	29.8%	48.7%	52.8%

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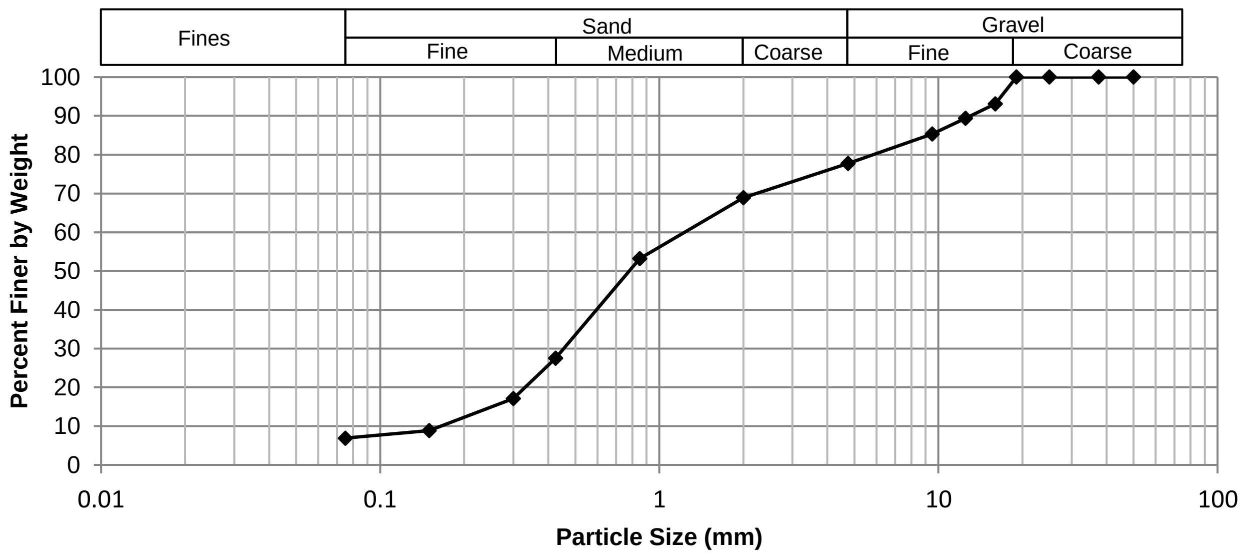
Grain Size Analysis (Sieve Method)
ASTM C136-14

Project No.	0035-082-00-403
Client	Morrison Hershfield
Project	19-C-10 Pavement Renewal - Sargent Ave
Test Hole	TH19-02
Sample #	G20
Depth	0.8 - 0.9
Date Sampled	10-Oct-19
Date Tested	28-Oct-19
Technician	HS

Gravel %	22.3
Sand %	70.8
Fines %	6.9

Particle Size Distribution Curve



Sieve Number	Sieve Opening (mm)	Percent Passing	Specification (Min-Max)
3/4"	19.0	100	-
5/8"	16.0	93	-
1/2"	12.5	89	-
3/8"	9.50	85	-
no. 4	4.75	78	-
no. 10	2.00	69	-
no. 20	0.850	53	-
no. 40	0.425	27	-
no. 50	0.300	17	-
no. 100	0.150	8.8	-
no. 200	0.075	6.9	-

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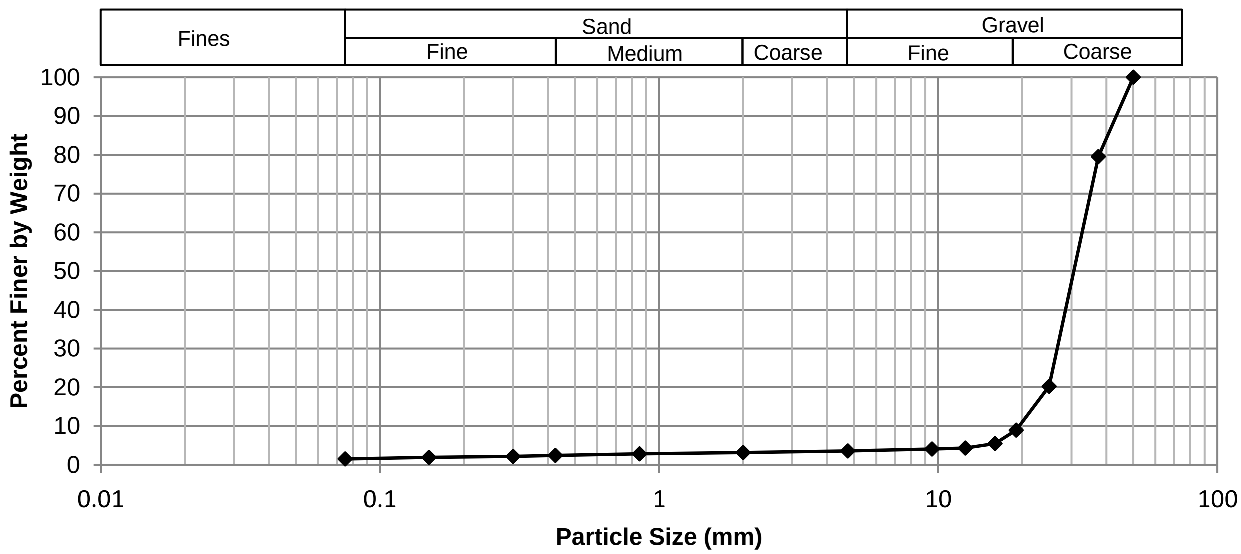
Grain Size Analysis (Sieve Method)
ASTM C136-14

Project No.	0035-082-00-403
Client	Morrison Hershfield
Project	19-C-10 Pavement Renewal - Sargent Ave

Test Hole	TH19-08
Sample #	G84
Depth	0.6 - 0.8
Date Sampled	10-Oct-19
Date Tested	28-Oct-19
Technician	HS

Gravel %	96.4
Sand %	2.1
Fines %	1.5

Particle Size Distribution Curve



Sieve Number	Sieve Opening (mm)	Percent Passing	Specification (Min-Max)
2"	50.0	100	-
1 1/2"	37.5	80	-
1"	25.0	20	-
3/4"	19.0	9.0	-
5/8"	16.0	5.5	-
1/2"	12.5	4.3	-
3/8"	9.50	4.0	-
no. 4	4.75	3.6	-
no. 10	2.00	3.2	-
no. 20	0.850	2.8	-
no. 40	0.425	2.4	-
no. 50	0.300	2.2	-
no. 100	0.150	1.9	-
no. 200	0.075	1.5	-

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Grain Size Analysis (Hydrometer Method)
AASHTO T 88

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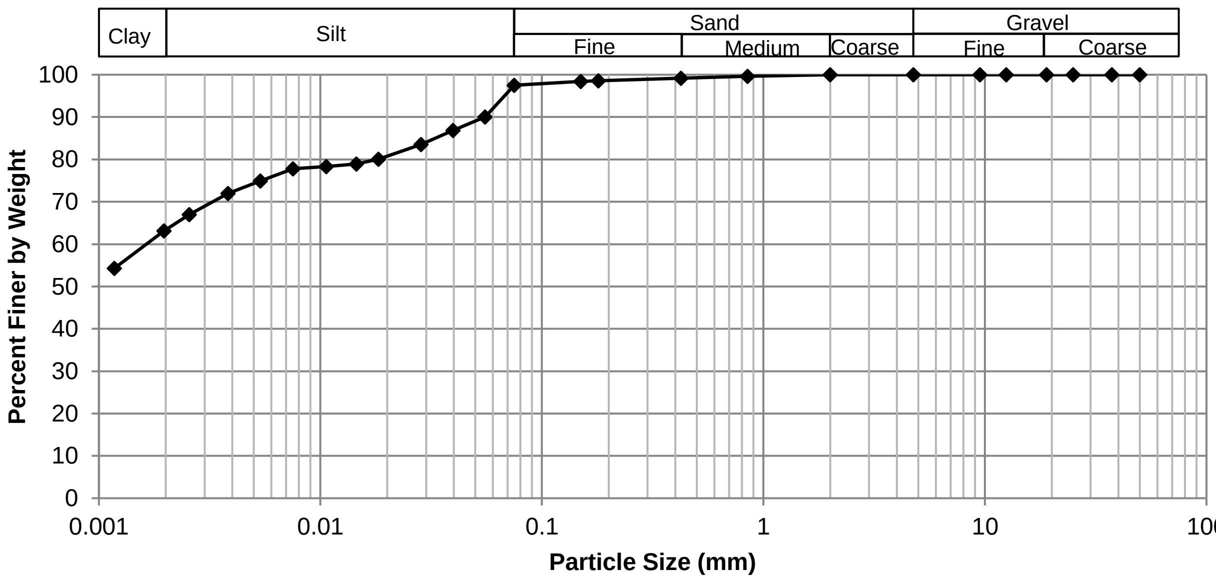
Project No.	0035-082-00-403
Client	Morrison Hershfield
Project	19-C-10 Pavement Renewal - Sargent Ave
Test Hole	TH19-14
Sample #	G02
Depth (m)	0.6 - 0.8
Sample Date	10-Oct-19
Test Date	23-Oct-19
Technician	AFK

Gravel	0.0%
Sand	2.5%
Silt	34.2%
Clay	63.3%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	100.00	0.0750	97.51
37.5	100.00	2.00	100.00	0.0554	90.01
25.0	100.00	0.850	99.61	0.0398	86.88
19.0	100.00	0.425	99.19	0.0285	83.52
12.5	100.00	0.180	98.54	0.0183	80.08
9.50	100.00	0.150	98.42	0.0145	78.90
4.75	100.00	0.075	97.51	0.0106	78.35
				0.0075	77.80
				0.0054	74.89
				0.0038	71.99
				0.0026	66.97
				0.0020	63.13
				0.0012	54.30

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Grain Size Analysis (Hydrometer Method)
AASHTO T 88

Project No.	0035-082-00-403
Client	Morrison Hershfield
Project	19-C-10 Pavement Renewal - Sargent Ave
Test Hole	TH19-07
Sample #	G37
Depth (m)	0.8 - 0.9
Sample Date	10-Oct-19
Test Date	23-Oct-19
Technician	AFK

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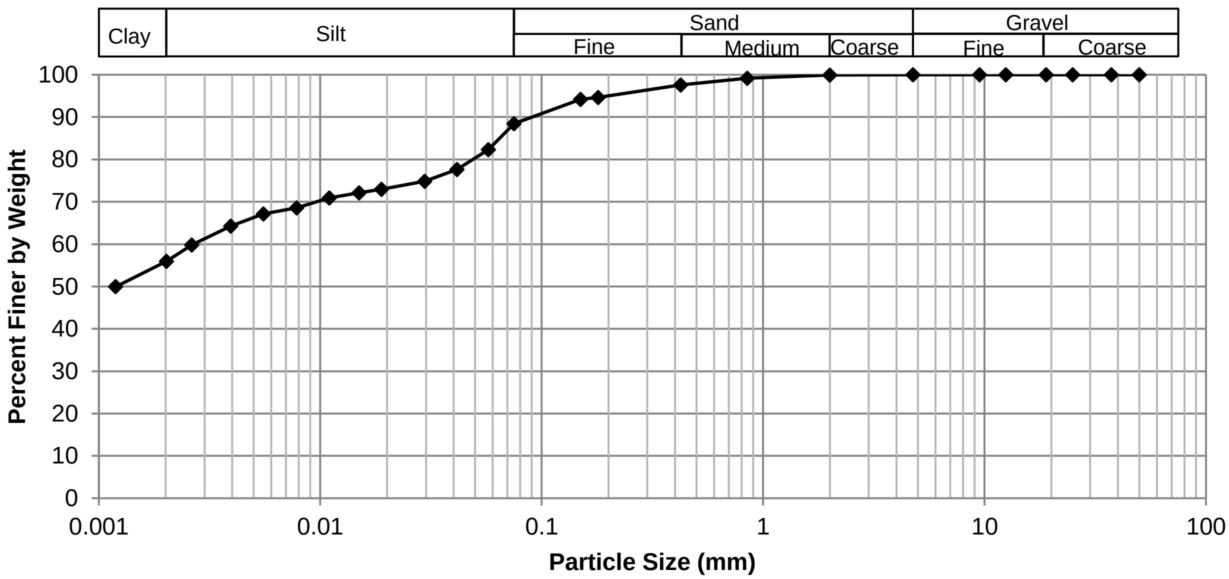
For specific tests as listed on www.ccil.com

Gravel	0.0%
Sand	11.6%
Silt	32.6%
Clay	55.8%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	100.00	0.0750	88.42
37.5	100.00	2.00	99.95	0.0574	82.34
25.0	100.00	0.850	99.20	0.0415	77.66
19.0	100.00	0.425	97.57	0.0297	74.84
12.5	100.00	0.180	94.65	0.0189	72.97
9.50	100.00	0.150	94.19	0.0150	72.10
4.75	100.00	0.075	88.42	0.0110	70.91
				0.0078	68.54
				0.0055	67.11
				0.0039	64.25
				0.0026	59.82
				0.0020	55.95
				0.0012	49.95

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Grain Size Analysis (Hydrometer Method)
AASHTO T 88

Project No.	0035-082-00-403
Client	Morrison Hershfield
Project	19-C-10 Pavement Renewal - Sargent Ave
Test Hole	TH19-11
Sample #	G61
Depth (m)	0.6 - 0.8
Sample Date	10-Oct-19
Test Date	23-Oct-19
Technician	AFK

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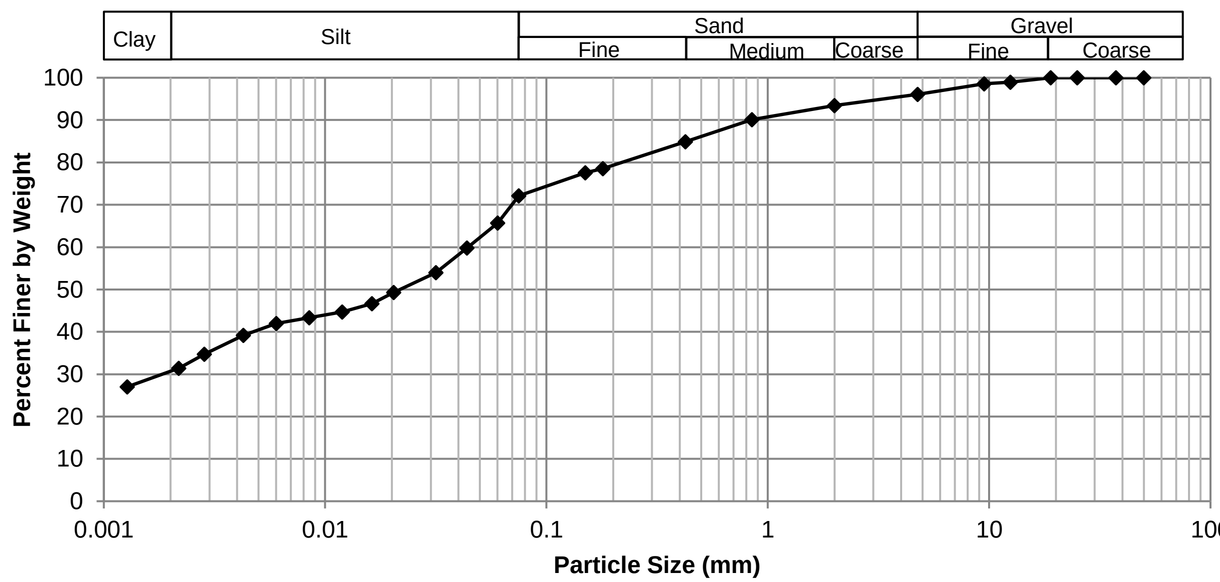
Gravel	3.9%
Sand	24.0%
Silt	41.6%
Clay	30.5%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	96.09	0.0750	72.11
37.5	100.00	2.00	93.42	0.0603	65.68
25.0	100.00	0.850	90.11	0.0437	59.84
19.0	100.00	0.425	84.88	0.0317	54.00
12.5	98.97	0.180	78.55	0.0204	49.32
9.50	98.54	0.150	77.58	0.0163	46.69
4.75	96.09	0.075	72.11	0.0120	44.70
				0.0085	43.34
				0.0060	41.99
				0.0043	39.22
				0.0028	34.75
				0.0022	31.40
				0.0013	27.02

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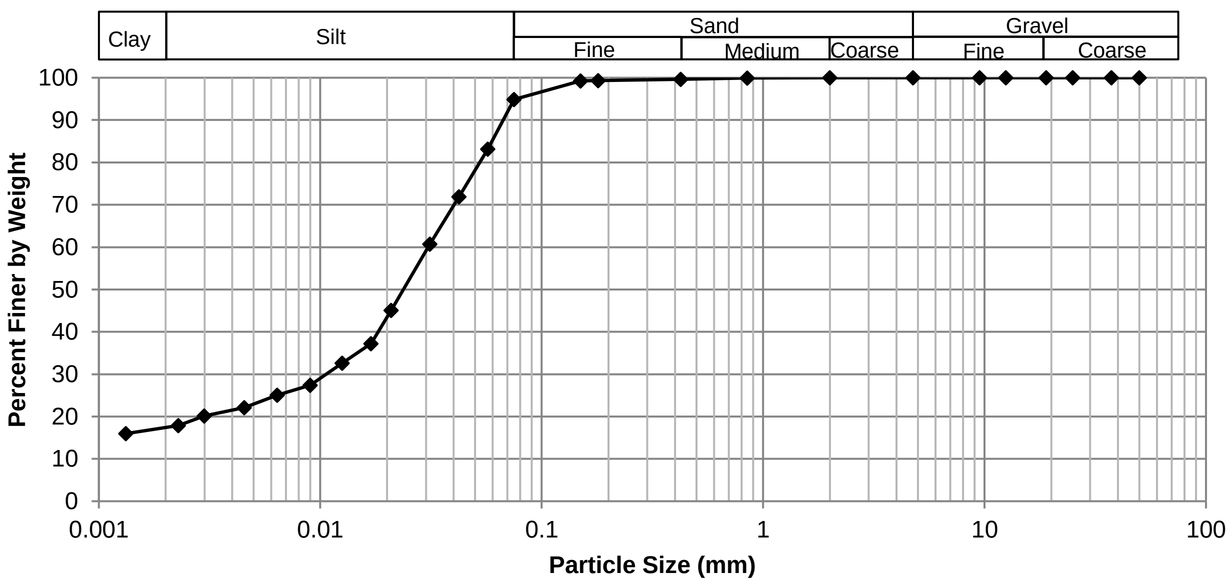
Grain Size Analysis (Hydrometer Method)
AASHTO T 88

Project No.	0035-082-00-403
Client	Morrison Hershfield
Project	19-C-10 Pavement Renewal - Sargent Ave
Test Hole	TH19-03
Sample #	G74
Depth (m)	0.9 - 1.1
Sample Date	10-Oct-19
Test Date	23-Oct-19
Technician	AFK

Gravel	0.0%
Sand	5.1%
Silt	79.3%
Clay	15.6%

Particle Size Distribution Curve



Gravel		**Sand**		**Silt and Clay**	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	100.00	0.0750	94.90
37.5	100.00	2.00	100.00	0.0571	83.14
25.0	100.00	0.850	99.91	0.0424	71.89
19.0	100.00	0.425	99.65	0.0313	60.70
12.5	100.00	0.180	99.33	0.0209	45.06
9.50	100.00	0.150	99.27	0.0170	37.25
4.75	100.00	0.075	94.90	0.0126	32.62
				0.0090	27.37
				0.0064	25.07
				0.0045	22.14
				0.0030	20.15
				0.0023	17.84
				0.0013	15.96

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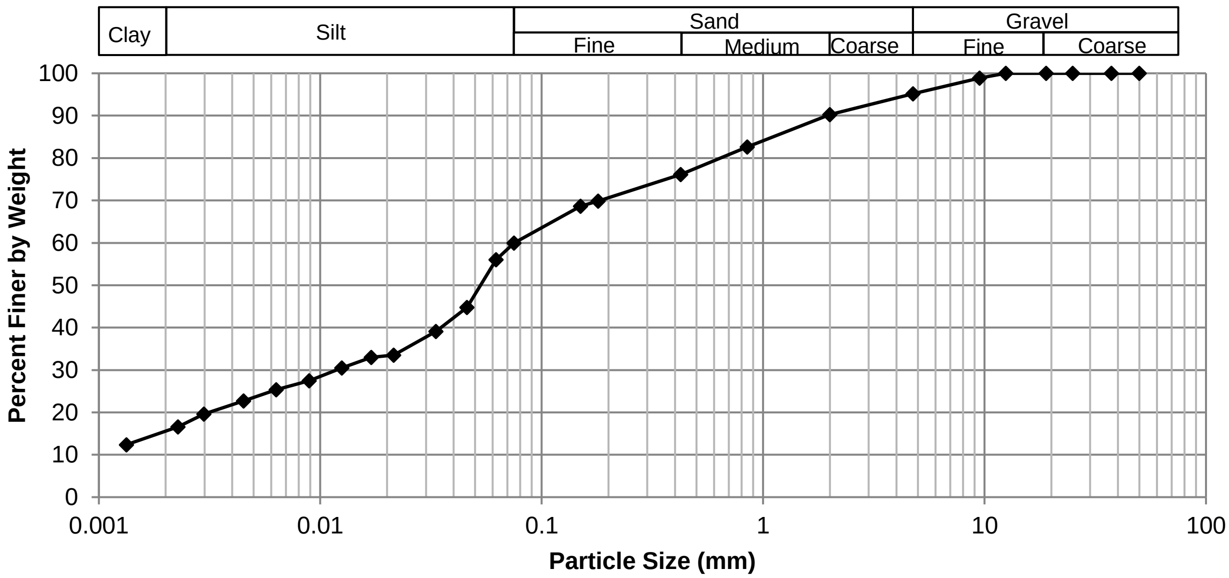
Grain Size Analysis (Hydrometer Method)
AASHTO T 88

Project No.	0035-082-00-403
Client	Morrison Hershfield
Project	19-C-10 Pavement Renewal - Sargent Ave
Test Hole	TH19-01
Sample #	G78
Depth (m)	0.3 - 0.5
Sample Date	10-Oct-19
Test Date	23-Oct-19
Technician	AFK

Gravel	4.8%
Sand	35.2%
Silt	44.6%
Clay	15.4%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	95.17	0.0750	59.95
37.5	100.00	2.00	90.27	0.0622	56.05
25.0	100.00	0.850	82.61	0.0461	44.76
19.0	100.00	0.425	76.15	0.0333	39.11
12.5	100.00	0.180	69.89	0.0215	33.54
9.50	98.88	0.150	68.65	0.0170	32.97
4.75	95.17	0.075	59.95	0.0125	30.50
				0.0089	27.46
				0.0063	25.34
				0.0045	22.72
				0.0030	19.60
				0.0023	16.63
				0.0013	12.39

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Atterberg Limits
ASTM D4318-10e1

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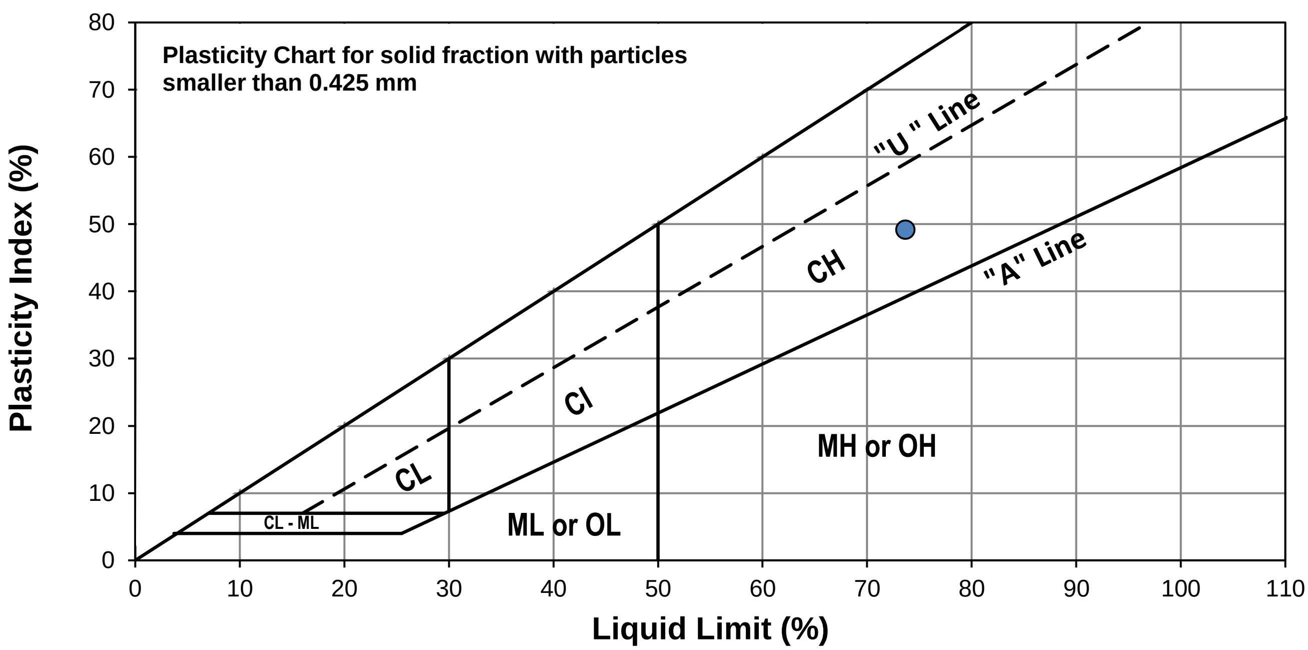
Project No.	0035-82-00-403
Client	Morrison Hershfield
Project	19-C-10 Pavement Renewal - Sargent Ave
Test Hole	TH19-14
Sample #	G02
Depth (m)	0.6 - 0.8
Sample Date	10-Oct-19
Test Date	23-Oct-19
Technician	HS

Liquid Limit	74
Plastic Limit	24
Plasticity Index	49

Liquid Limit

Trial #	**1**	**2**	**3**		
Number of Blows (N)	19	21	32		
Mass Wet Soil + Tare (g)	27.544	28.680	25.630		
Mass Dry Soil + Tare (g)	21.605	22.326	20.818		
Mass Tare (g)	14.031	14.031	13.889		
Mass Water (g)	5.939	6.354	4.812		
Mass Dry Soil (g)	7.574	8.295	6.929		
Moisture Content (%)	78.413	76.600	69.447		



Plastic Limit

Trial #	**1**	**2**	**3**	**4**	**5**
Mass Tare (g)	13.961	14.150			
Mass Wet Soil + Tare (g)	20.411	23.424			
Mass Dry Soil + Tare (g)	19.146	21.593			
Mass Water (g)	1.265	1.831			
Mass Dry Soil (g)	5.185	7.443			
Moisture Content (%)	24.397	24.600			

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Atterberg Limits
ASTM D4318-10e1

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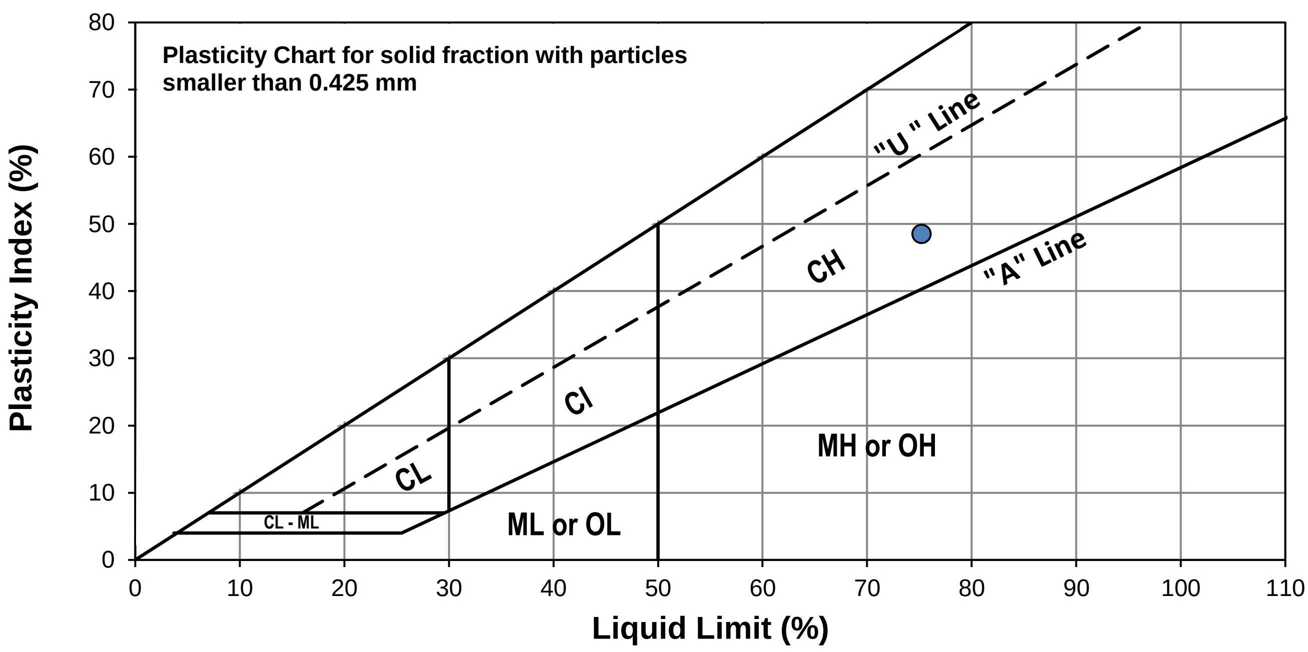
Project No.	0035-82-00-403
Client	Morrison Hershfield
Project	19-C-10 Pavement Renewal - Sargent Ave
Test Hole	TH19-07
Sample #	G37
Depth (m)	0.8 - 0.9
Sample Date	10-Oct-19
Test Date	23-Oct-19
Technician	HS

Liquid Limit	75
Plastic Limit	27
Plasticity Index	49

Liquid Limit

Trial #	**1**	**2**	**3**		
Number of Blows (N)	17	23	34		
Mass Wet Soil + Tare (g)	31.046	29.434	29.430		
Mass Dry Soil + Tare (g)	23.414	22.727	22.976		
Mass Tare (g)	13.677	13.896	14.085		
Mass Water (g)	7.632	6.707	6.454		
Mass Dry Soil (g)	9.737	8.831	8.891		
Moisture Content (%)	78.381	75.948	72.590		



Plastic Limit

Trial #	**1**	**2**	**3**	**4**	**5**
Mass Tare (g)	14.260	14.121			
Mass Wet Soil + Tare (g)	22.170	21.610			
Mass Dry Soil + Tare (g)	20.497	20.041			
Mass Water (g)	1.673	1.569			
Mass Dry Soil (g)	6.237	5.920			
Moisture Content (%)	26.824	26.503			

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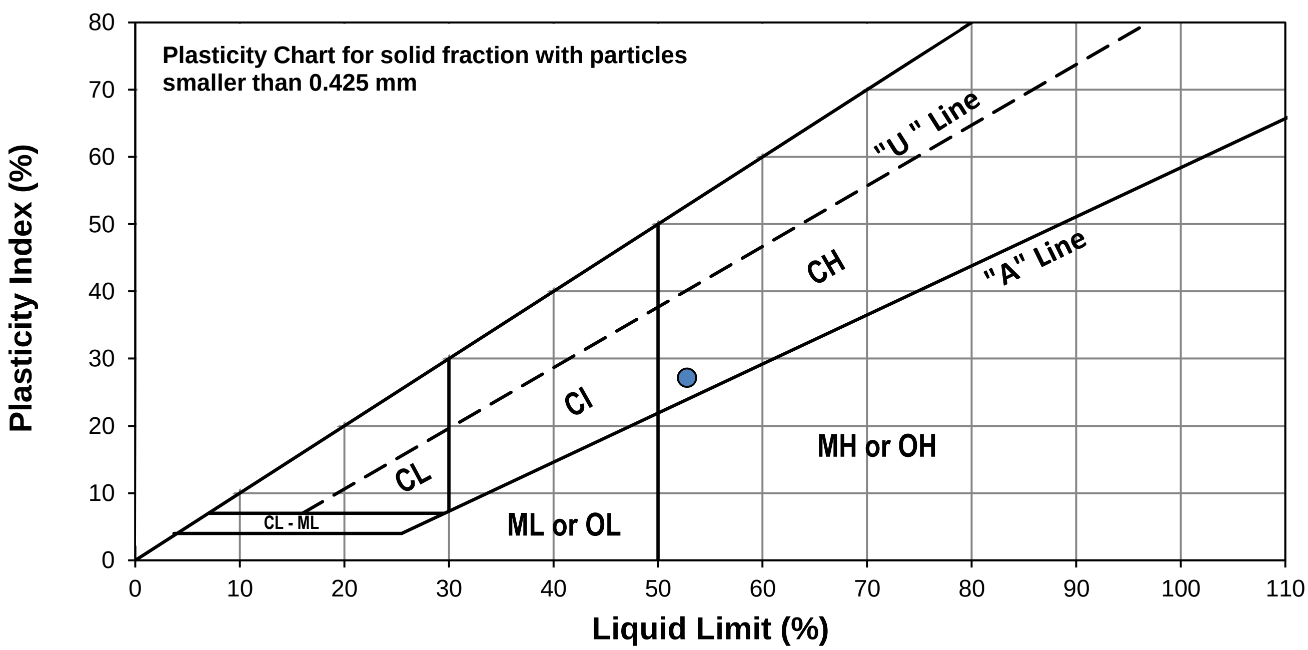
Atterberg Limits
ASTM D4318-10e1

Project No.	0035-82-00-403
Client	Morrison Hershfield
Project	19-C-10 Pavement Renewal - Sargent Ave
Test Hole	TH19-11
Sample #	G61
Depth (m)	0.6 - 0.8
Sample Date	10-Oct-19
Test Date	23-Oct-19
Technician	HS

Liquid Limit	53
Plastic Limit	26
Plasticity Index	27

Liquid Limit

Trial #	**1**	**2**	**3**		
Number of Blows (N)	21	27	34		
Mass Wet Soil + Tare (g)	27.358	30.620	34.765		
Mass Dry Soil + Tare (g)	22.742	24.972	27.829		
Mass Tare (g)	14.230	14.146	14.001		
Mass Water (g)	4.616	5.648	6.936		
Mass Dry Soil (g)	8.512	10.826	13.828		
Moisture Content (%)	54.229	52.171	50.159		



Plastic Limit

Trial #	**1**	**2**	**3**	**4**	**5**
Mass Tare (g)	14.290	14.197			
Mass Wet Soil + Tare (g)	23.512	21.570			
Mass Dry Soil + Tare (g)	21.612	20.082			
Mass Water (g)	1.900	1.488			
Mass Dry Soil (g)	7.322	5.885			
Moisture Content (%)	25.949	25.285			

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Atterberg Limits
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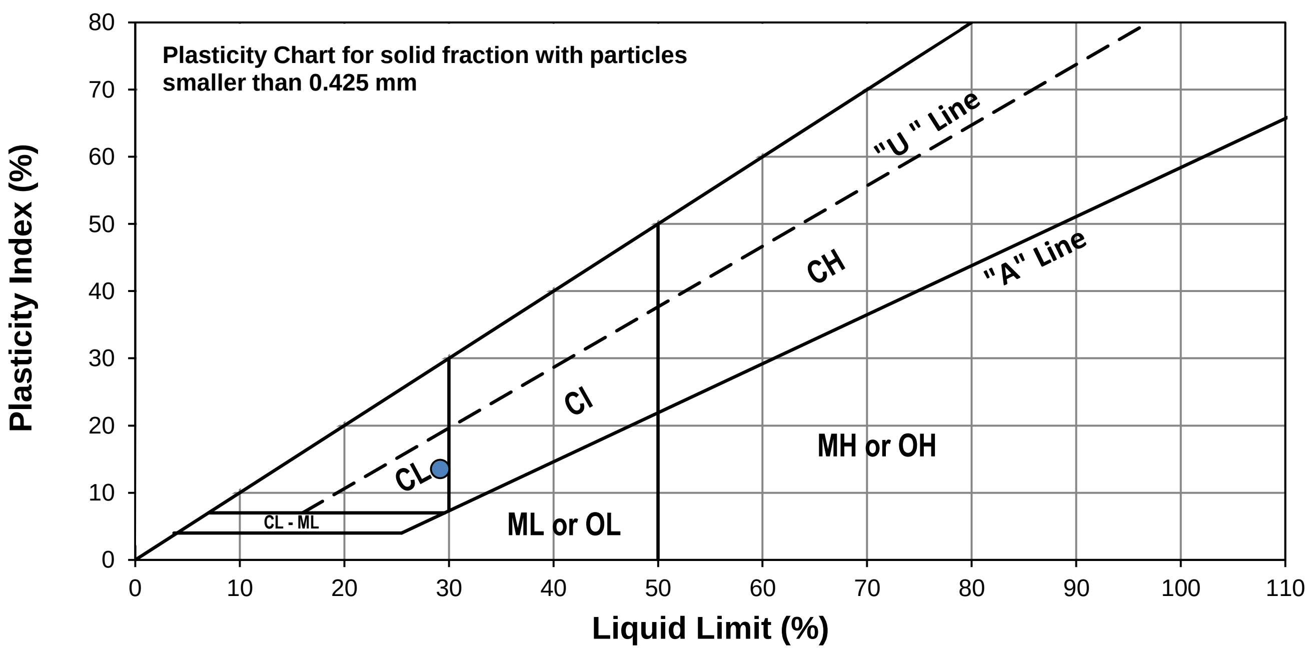
Project No.	0035-82-00-403
Client	Morrison Hershfield
Project	19-C-10 Pavement Renewal - Sargent Ave
Test Hole	TH19-03
Sample #	G74
Depth (m)	0.9 - 1.1
Sample Date	10-Oct-19
Test Date	23-Oct-19
Technician	HS

Liquid Limit	29
Plastic Limit	16
Plasticity Index	14

Liquid Limit

Trial #	**1**	**2**	**3**		
Number of Blows (N)	15	20	30		
Mass Wet Soil + Tare (g)	36.251	36.298	33.447		
Mass Dry Soil + Tare (g)	31.077	31.241	29.138		
Mass Tare (g)	14.105	14.120	14.167		
Mass Water (g)	5.174	5.057	4.309		
Mass Dry Soil (g)	16.972	17.121	14.971		
Moisture Content (%)	30.486	29.537	28.782		



Plastic Limit

Trial #	**1**	**2**	**3**	**4**	**5**
Mass Tare (g)	14.257	14.189			
Mass Wet Soil + Tare (g)	22.328	21.351			
Mass Dry Soil + Tare (g)	21.238	20.383			
Mass Water (g)	1.090	0.968			
Mass Dry Soil (g)	6.981	6.194			
Moisture Content (%)	15.614	15.628			

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Atterberg Limits
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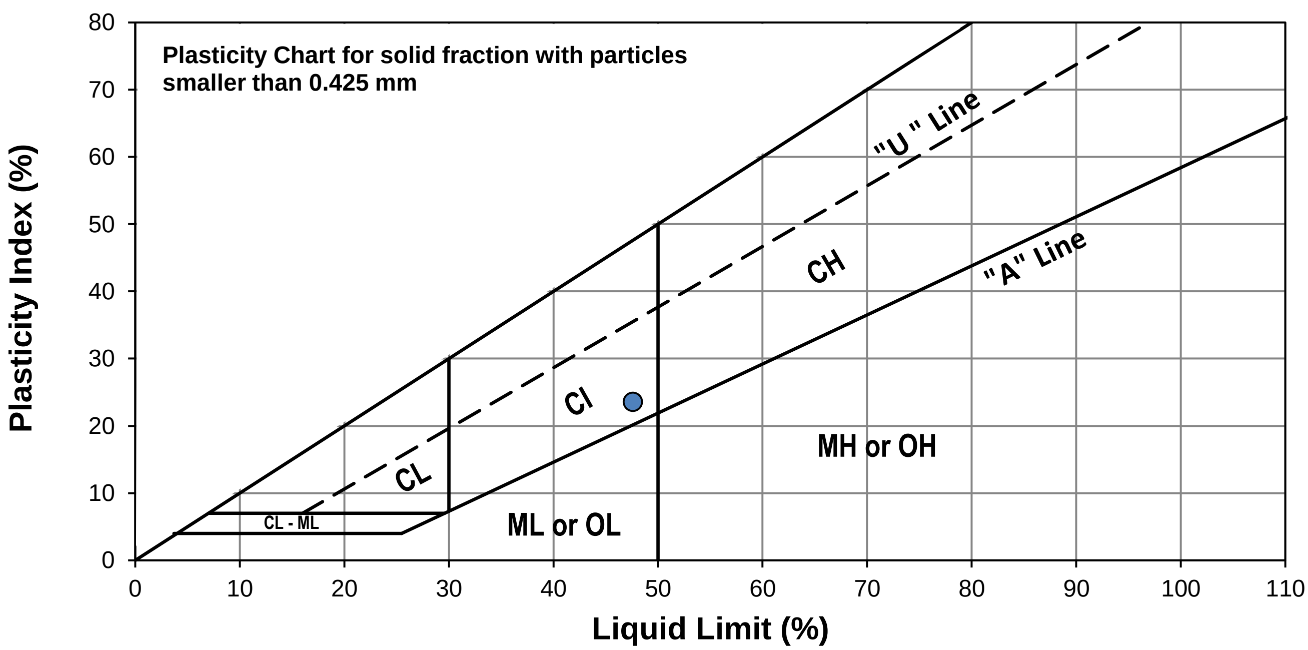
Project No.	0035-82-00-403
Client	Morrison Hershfield
Project	19-C-10 Pavement Renewal - Sargent Ave
Test Hole	TH19-01
Sample #	G78
Depth (m)	0.3 - 0.5
Sample Date	10-Oct-19
Test Date	23-Oct-19
Technician	HS

Liquid Limit	48
Plastic Limit	24
Plasticity Index	24

Liquid Limit

Trial #	**1**	**2**	**3**		
Number of Blows (N)	18	23	34		
Mass Wet Soil + Tare (g)	32.089	29.785	36.125		
Mass Dry Soil + Tare (g)	26.127	24.715	29.242		
Mass Tare (g)	14.134	14.209	14.122		
Mass Water (g)	5.962	5.070	6.883		
Mass Dry Soil (g)	11.993	10.506	15.120		
Moisture Content (%)	49.712	48.258	45.522		



Plastic Limit

Trial #	**1**	**2**	**3**	**4**	**5**
Mass Tare (g)	14.232	14.117			
Mass Wet Soil + Tare (g)	21.509	21.688			
Mass Dry Soil + Tare (g)	20.102	20.217			
Mass Water (g)	1.407	1.471			
Mass Dry Soil (g)	5.870	6.100			
Moisture Content (%)	23.969	24.115			

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Standard Proctor Compaction Test

ASTM D698-12e2

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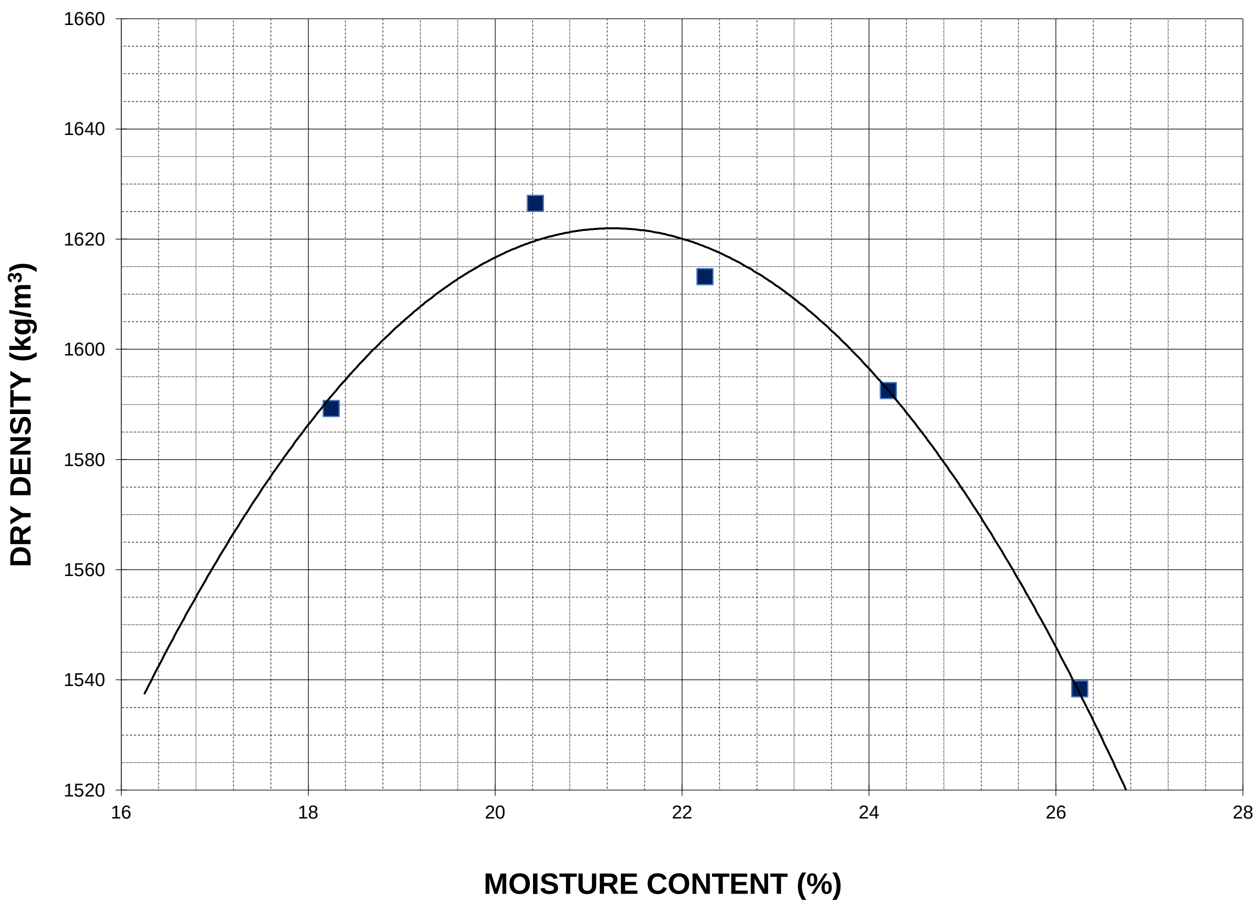
Project No. 0035-082-00-403
Client Morrison Hershfield
Project 19-C-10 Pavement Renewal - Sargent Ave

Sample # Bulk (TH19-01 & TH19-04)
Source TH19-01 & TH19-04
Material Clay
Sample Date 10-Oct-19
Test Date 27-Oct-19
Technician HS

Maximum Dry Density (kg/m3)	1622
Optimum Moisture (%)	21.3

Trial Number	1	2	3	4	5
Wet Density (kg/m^3)	1879	1959	1972	1978	1942
Dry Density (kg/m^3)	1589	1627	1613	1593	1538
Moisture Content (%)	18.2	20.4	22.2	24.2	26.3



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Standard Proctor Compaction Test
ASTM D698-12e2

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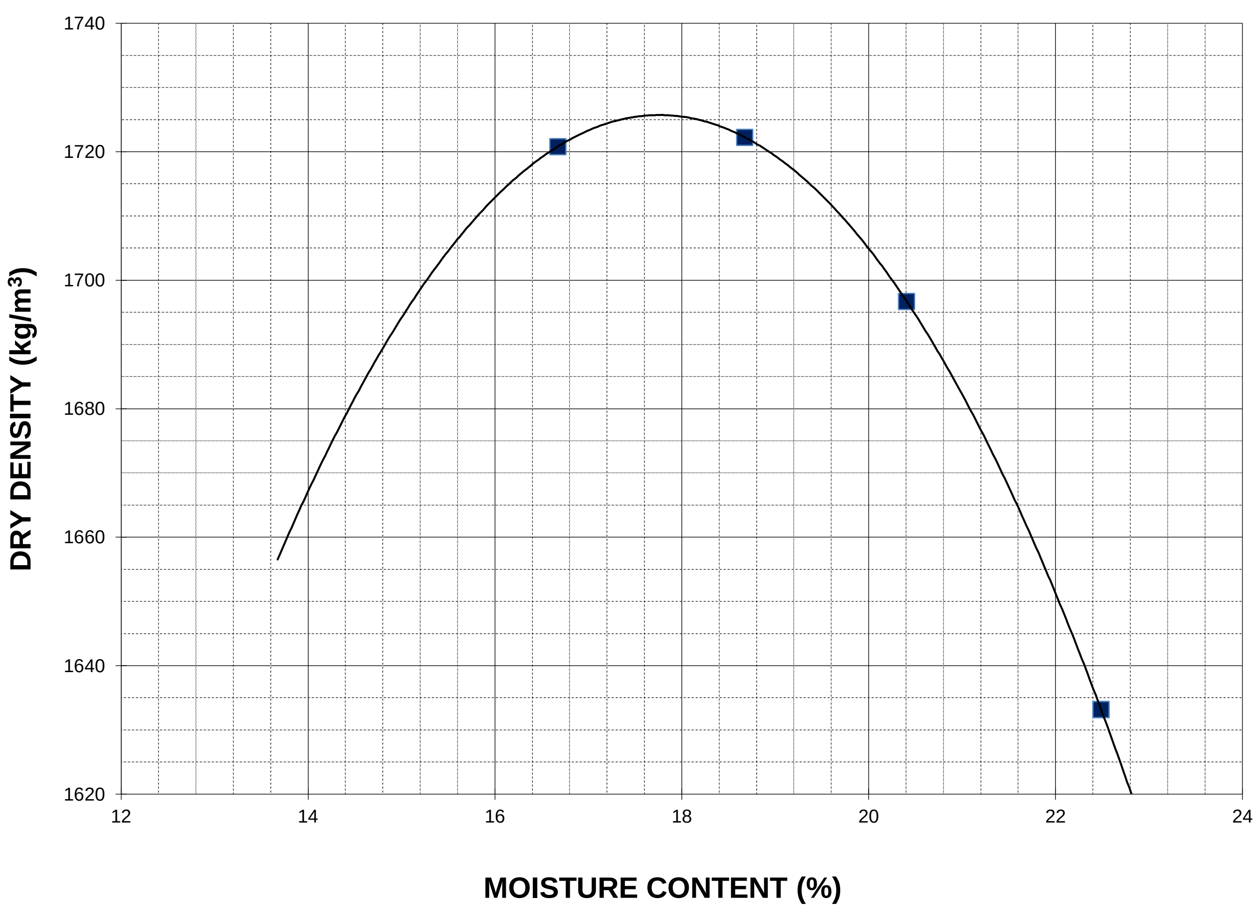
Project No.	0035-082-00-403
Client	Morrison Hershfield
Project	19-C-10 Pavement Renewal - Sargent Ave
Sample #	Bulk TH19-03
Source	TH19-03
Material	Silt and Clay
Sample Date	10-Oct-19
Test Date	26-Oct-19
Technician	HS

Maximum Dry Density (kg/m3)	1726
Optimum Moisture (%)	17.8

Trial Number	1	2	3	4	
Wet Density (kg/m^3)	2008	2044	2043	2000	
Dry Density (kg/m^3)	1721	1722	1697	1633	
Moisture Content (%)	16.7	18.7	20.4	22.5	



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Standard Proctor Compaction Test
ASTM D698-12e2

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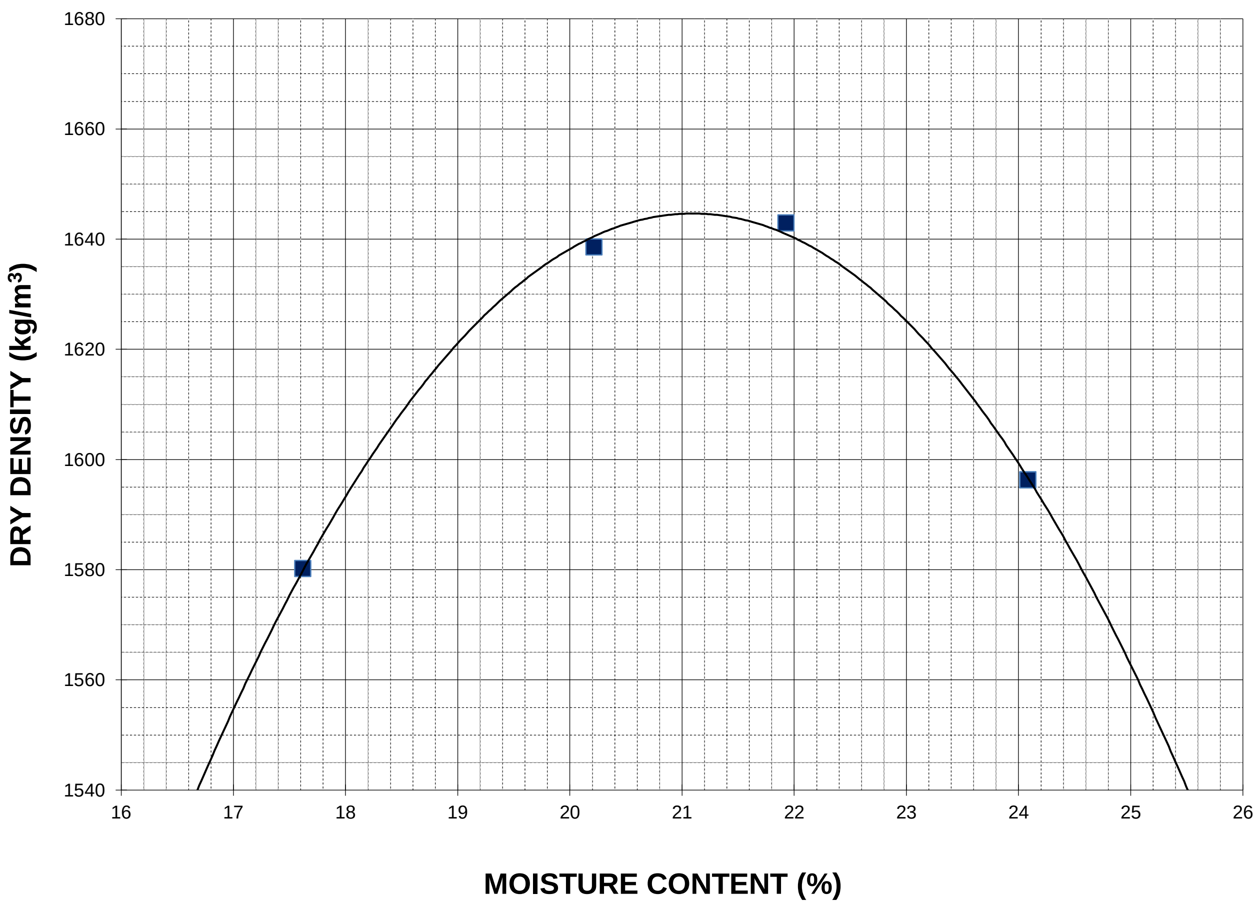
Project No.	0035-082-00-403
Client	Morrison Hershfield
Project	19-C-10 Pavement Renewal - Sargent Ave

Sample #	Bulk TH19-05
Source	TH19-05
Material	Silt and Clay
Sample Date	10-Oct-19
Test Date	26-Oct-19
Technician	HS

Maximum Dry Density (kg/m3)	1645
Optimum Moisture (%)	21.1

Trial Number	1	2	3	4	
Wet Density (kg/m^3)	1859	1970	2003	1981	
Dry Density (kg/m^3)	1580	1639	1643	1596	
Moisture Content (%)	17.6	20.2	21.9	24.1	



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California Bearing Ratio Test Data Sheet

ASTM D1883-16

Project No.	0035-082-00-403	**Source**	TH19-01 & TH19-04
Client	Morrison Hershfield	**Material**	Silt, Sand and Clay
Project	19-C-10 Pavement Renewal - Sargen	**Sample Date**	2019-10-03
Sample #		**Test Date**	2019-11-07
		Technician	BMH

Proctor Results (ASTM D698)

Maximum Dry Density	1622	kg/m3
Optimum Moisture Content	21.3	%
Material Retained on 19 mm Sieve	0.0	%

CBR Sample Compaction

Dry Density	1527	kg/m3
Initial Moisture Content	25.8	%
Relative Density	94.1	% SPMDD

Soaking Results

Surcharge	4.54	kg
Swell	0.1	%
Moisture Content in top 25 mm	26.5	%
Immersion Period	96	h

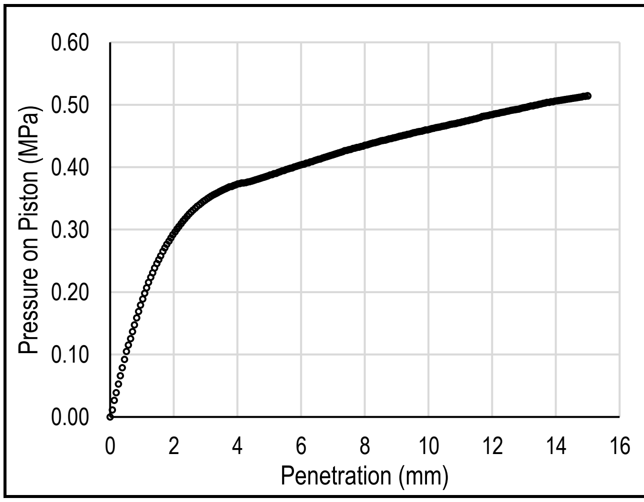
CBR Results

CBR at 2.54 mm	4.8	%
CBR at 5.08 mm	3.8	%
Zero Correction	0	mm

Test Data

Penetration (mm)	Measured Pressure (MPa)	Corrected Pressure (MPa)
0.64	0.13	0.13
1.27	0.22	0.22
1.91	0.29	0.29
2.54	0.33	0.33
3.18	0.35	0.35
3.81	0.37	0.37
4.45	0.38	0.38
5.08	0.39	0.39
7.62	0.43	0.43
10.16	0.46	0.46
12.70	0.49	0.49

Load/Penetration Curve



Comments:

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California Bearing Ratio Test Data Sheet

ASTM D1883-16

Project No.	0035-082-00-403	**Source**	TH19-03
Client	Morrison Hershfield	**Material**	Silt and Clay
Project	19-C-10 Pavement Renewal - Sargen	**Sample Date**	2019-10-03
Sample #		**Test Date**	2019-11-07
		Technician	BMH

Proctor Results (ASTM D698)

Maximum Dry Density	1726	kg/m3
Optimum Moisture Content	17.8	%
Material Retained on 19 mm Sieve	0.0	%

CBR Sample Compaction

Dry Density	1651	kg/m3
Initial Moisture Content	20.9	%
Relative Density	95.6	% SPMDD

Soaking Results

Surcharge	4.54	kg
Swell	0.1	%
Moisture Content in top 25 mm	21.7	%
Immersion Period	96	h

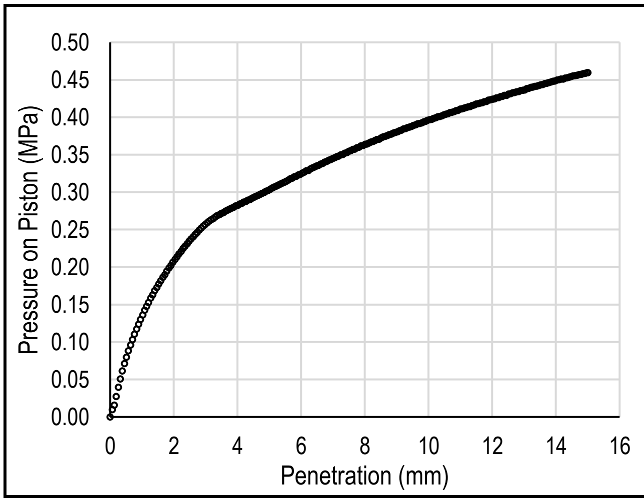
CBR Results

CBR at 2.54 mm	3.4	%
CBR at 5.08 mm	3.0	%
Zero Correction	0	mm

Test Data

Penetration (mm)	Measured Pressure (MPa)	Corrected Pressure (MPa)
0.64	0.10	0.10
1.27	0.16	0.16
1.91	0.20	0.20
2.54	0.24	0.24
3.18	0.26	0.26
3.81	0.28	0.28
4.45	0.29	0.29
5.08	0.31	0.31
7.62	0.36	0.36
10.16	0.40	0.40
12.70	0.43	0.43

Load/Penetration Curve



Comments:

Template Rev. B - 2018-04-07

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California Bearing Ratio Test Data Sheet

ASTM D1883-16

Project No.	0035-082-00-403	**Source**	TH19-05
Client	Morrison Hershfield	**Material**	Silt and Clay
Project	19-C-10 Pavement Renewal - Sargen	**Sample Date**	2019-10-03
Sample #		**Test Date**	2019-11-04
		Technician	SB

Proctor Results (ASTM D698)

Maximum Dry Density	1645	kg/m3
Optimum Moisture Content	21.1	%
Material Retained on 19 mm Sieve	0.0	%

CBR Sample Compaction

Dry Density	1580	kg/m3
Initial Moisture Content	21.3	%
Relative Density	96.1	% SPMDD

Soaking Results

Surcharge	4.54	kg
Swell	0.7	%
Moisture Content in top 25 mm	26.9	%
Immersion Period	96	h

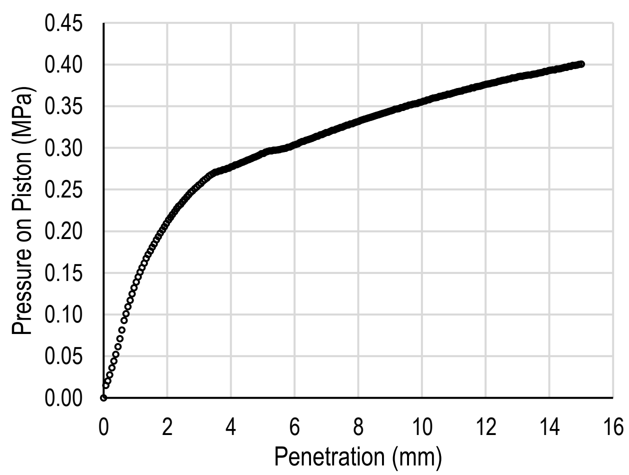
CBR Results

CBR at 2.54 mm	3.5	%
CBR at 5.08 mm	2.9	%
Zero Correction	0	mm

Test Data

Penetration (mm)	Measured Pressure (MPa)	Corrected Pressure (MPa)
0.64	0.09	0.09
1.27	0.16	0.16
1.91	0.21	0.21
2.54	0.24	0.24
3.18	0.26	0.26
3.81	0.27	0.27
4.45	0.28	0.28
5.08	0.30	0.30
7.62	0.33	0.33
10.16	0.36	0.36
12.70	0.38	0.38

Load/Penetration Curve



Comments:

Appendix C

Photographs of Pavement Core Samples

Photo 1: Pavement Core Sample at Test Hole TH19-01

Photo 2: Pavement Core Sample at Test Hole TH19-02

Photo 3: Pavement Core Sample at Test Hole TH19-03

Photo 4: Pavement Core Sample at Test Hole TH19-04

Photo 5: Pavement Core Sample at Test Hole TH19-05

Photo 6: Pavement Core Sample at Test Hole TH19-06

Photo 7: Pavement Core Sample at Test Hole TH19-07

Photo 8: Pavement Core Sample at Test Hole TH19-08

Photo 9: Pavement Core Sample at Test Hole TH19-09

Photo 10: Pavement Core Sample at Test Hole TH19-10

Photo 11: Pavement Core Sample at Test Hole TH19-11A

Photo 12: Pavement Core Sample at Test Hole TH19-11B

Photo 13: Pavement Core Sample at Test Hole TH19-12

Photo 14: Pavement Core Sample at Test Hole TH19-13

Photo 15: Pavement Core Sample at Test Hole TH19-14

Photo 16: Pavement Core Sample at Test Hole TH19-15

Quality Engineering | Valued Relationships

Morrison Hershfield Ltd.

Sargent Avenue Watermain CP Rail Crossing
Geotechnical Investigation Report

Prepared for:
Hartley Katz, CET, P. Eng.
Morrison Hershfield
Suite 1, 59 Scurfield Boulevard
Winnipeg, MB R3Y 1V2

Project Number: 0035-086-00

Date: February 28, 2020

TREK GEOTECHNICAL Quality Engineering | Valued Relationships

February 28, 2020 Our File No. 0035-086-00

Hartley Katz, CET, P. Eng.
Morrison Hershfield
Suite 1, 59 Scurfield Boulevard
Winnipeg, MB R3Y 1V2

RE: Sargent Avenue Watermain CPR Rail Crossing
Geotechnical Investigation Report

TREK Geotechnical Inc. is pleased to submit our final report for the geotechnical investigation for the above noted project.

Please contact the undersigned should you have any questions or require further information.

Sincerely,

TREK Geotechnical Inc.
Per:

Nelson Ferreira, Ph.D., P.Eng.
Senior Geotechnical Engineer

Encl.

Revision History

Revision No.	Author	Issue Date	Description
0	KF	February 25, 2020	Final Report
1	KF	February 28, 2020	Final Report

Authorization Signatures

Prepared By:

Kate Franklin, M.Sc.

for Steven Harms, M.Sc., P.Eng.
Geotechnical Engineer

Reviewed By:

PROVINCE OF MANITOBA
N. J. FERREIRA
Member
22892
Feb. 28, 2020
REGISTERED PROFESSIONAL ENGINEER

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ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
TREK GEOTECHNICAL INC.
No. 4877 Date: Feb 28, 2020

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1.0 Introduction

This report summarizes the results of the geotechnical investigation conducted by TREK Geotechnical Inc. (TREK) for Morrison Hershfield Ltd. (MHL) for the proposed watermain crossing under the Canadian Pacific Rail (CPR) line crossing Sargent Avenue between Wall Street and Erin Street in Winnipeg, Manitoba. The terms of reference for the investigation are included in our proposal to MHL dated January 8, 2020. The scope of work includes a sub-surface investigation, laboratory testing, and the provision of recommendations for the design and construction of the watermain in compliance with CPR requirements. As part of CPR's requirements, a construction monitoring program to monitor vertical track displacements to determine if movements are within CPR's tolerable limits is also included.

2.0 Project Understanding and Site Conditions

The proposed 250 mm diameter polyvinyl chloride (PVC) watermain will cross under CPR's rail line (Great West Development Lead, Mile 0.77), where it crosses Sargent Avenue between Wall Street and Erin Street. A 457 mm diameter steel casing will be used to convey the watermain beneath the rail line and is to be installed using auger boring trenchless methods. The obvert of the casing will be approximately 3.2 m below the bottom of rail beneath the track centerline. Sending and receiving pits (Figure 01) will be located outside of the CPR right of way, and the depth will be limited such that the excavations remain outside the CPR's zone of potential train loading (ZPTL).

CPR requires geotechnical protocols be followed for pipe installations below their right of way in accordance with their stipulated guidelines, CP Geotechnical Pipe and Utility Crossing Protocol 20170706. The guidelines include geotechnical protocols regarding subsurface investigations, recommendations and construction settlement monitoring. The Great West Development Lead is classified as a Class 1 track and the rail settlement thresholds for trenchless pipe installations based on CPR requirements are:

- A warning level of 11 mm and;
- A critical level of 22 mm or above, which if observed shall halt construction for a minimum of 12 hours.

Track classification and associated settlement tolerances for the rail were provided by CPR. Other relevant information regarding CPR's geotechnical protocols for trenchless pipe installations are included in Appendix A.

2.1 Site Conditions

The new watermain is being installed along Sargent Avenue below the eastbound lane, approximately 2.5 m north of the eastbound curb. The rail line runs in a north-south orientation where it crosses Sargent Ave, and the roadway is graded at a slope of approximately 1% to promote drainage away from the rail line. There are railway signal lights for both eastbound and westbound Sargent Avenue traffic. North and south of Sargent Ave, the rail line runs down the center of the CPR right of way (ROW), which is generally flat with grass, gravel and railway ballast visible at ground surface.

3.0 Sub-surface Investigation

3.1 Drilling Program

A sub-surface investigation was undertaken on January 28, 2020 under the supervision of TREK personnel to evaluate the subsurface conditions at the site. Test holes TH20-01 and TH20-02 were drilled to 6.1 m below ground surface near the proposed watermain alignment east and west of the rail line, respectively. Test hole locations are shown on Figure 01.

The test holes were drilled by Maple Leaf Drilling Ltd. using a truck mounted rig equipped with 125 mm diameter solid augers. Sub-surface soils observed during drilling were visually classified based on the Unified Soil Classification System (USCS). Samples retrieved during drilling include disturbed auger cuttings and relatively undisturbed Shelby tubes. All samples retrieved during drilling were transported to TREK's testing laboratory in Winnipeg, Manitoba. Laboratory testing consisted of moisture contents on all samples as well as bulk unit weight measurements and unconfined compressive strength tests on select Shelby tube samples. Laboratory testing results are included in Appendix B.

The test hole locations were determined by measuring offsets from site features and elevations were not surveyed. The attached test hole logs include a description of the soil units encountered and other pertinent information such as test hole location, groundwater and sloughing conditions, and a summary of the laboratory testing results.

3.2 Subsurface Conditions

3.2.1 Soil Stratigraphy

Brief descriptions of the soil units encountered at the test hole locations are provided below. All interpretations of soil stratigraphy for the purposes of design should refer to the detailed information provided on the attached test hole logs.

In general, soil stratigraphy below the roadway pavement consists of a thin layer of gravel fill (base) over clay fill, which is underlain by native silt and silty clay. The gravel fill is well-graded, rounded, 19 mm down and was found to be 100 to 300 mm thick. The underlying clay fill is silty, contains trace of sand, and mottled grey and brown. The clay fill was frozen at the time of the subsurface investigation and is moist, firm when thawed. At test hole TH20-01, a 1.1 m thick layer of silt is present below the fill. The silt is clayey, brown, moist, soft and of intermediate plasticity. Native silty clay was encountered below the fill and silt to the maximum depth of exploration (6.1 m below ground surface). The silty clay contains trace sand, trace silt inclusions, is moist, brownish grey and very stiff becoming soft to firm with depth and is of high plasticity.

3.2.2 Groundwater Conditions

Seepage or sloughing was not observed during drilling. The groundwater observations made during drilling are short-term and should not be considered reflective of long-term (static) groundwater levels. Long-term (static) groundwater conditions can only be determined by monitoring over an extended period to determine. It is important to recognize that groundwater conditions may vary seasonally, annually, or as a result of construction activities.

4.0 Trenchless Pipe Installation Recommendations

TREK understands MHL’s preferred installation method for the steel casing is auger boring. The steel casing recommendations provided were developed in consultation with local contractors and TREK’s geotechnical assessment of site conditions. The recommendations relate to settlement due to soil collapse and consolidation, and heave. The installation should be halted while trains are moving over the casing alignment.

4.1 Settlement

4.1.1 Soil Collapse

During auger boring, if the augers extend beyond the leading edge of the casing, there is a potential for an unsupported length of soil to be exposed in front of the casing should the augers be retracted mid-installation. TREK considered the potential collapse of this unsupported length and recommends the augers should not extending 150 mm beyond the end of the casing to reduce the risk of collapse.

4.1.2 Soil Consolidation

Casing vibrations can cause consolidation or even liquefaction of the soil surrounding the casing, depending on the nature of the soil and groundwater conditions. Soil settlements due to vibrations during installation are difficult to predict. However, the foundation soils at the site have been subjected to loading and vibrations associated with regular train and vehicular traffic and any vibration-induced settlement likely will have already occurred. However, the soils may react differently as the frequency and amplitude of pipe vibrations during installation will likely be different than from train loading and will be monitored during construction.

4.2 Heave

Heave can occur if the pipe is pushed forward without spinning the augers, causing the soil in front of the casing to displace as the pipe continues to move forward. This is not likely to occur with auger boring provided the material at the leading edge of the casing is drawn in and removed by the augers. TREK recommends the auger return in the jacking pit be monitored during installation by observing the rate of auger cutting return relative to the speed of casing advancement. If low auger cutting return is observed, installation should be halted to confirm the augers are operational.

5.0 Construction Monitoring Program

CPR requires sub-surface and surficial points be monitored prior to, during and after construction to measure any ground movements (settlement and heave) associated with any trenchless pipe installations. Sub-surface monitoring points will consist of sleeved rods anchored in the soil 1 m above the casing obvert elevation as shown on Figure 02; the sleeve is required to isolate the rod from the surrounding soil and provide an accurate reading of ground movement at the anchor depth. Based on experience on previous projects, the sub-surface monitoring points have the potential to settle under their own weight. Measures to minimize self-weight settlement should be considered and TREK can assist in the design of the sub-surface anchors, if requested. Surficial monitoring points will be in pairs at the base of each rail. In total, TREK recommends 2 sub-surface and 22 surficial monitoring points. The monitoring point locations are shown on Figure 01.

All monitoring points should be surveyed to an accuracy of +/- 2 mm (or better) every 12 hours beginning a minimum of 2 days before the excavation of the pits and finishing a minimum of three days after construction is complete. As per CPR requirements, there will be two ground movement thresholds (Warning and Critical) that will trigger response measures. The following is a brief summary of CPR's monitoring requirements as summarized in their April 29, 2014 document entitled *"Track Movement Monitoring Guidelines for Trenchless Pipe Installation"*, which is included in Appendix A:

Level 1: Warning

The warning level of ground movement for the CPR Great West Development Lead crossing Sargent Avenue is 11 mm. If 11 mm of ground movement is measured at the sub-surface monitoring points, the surficial survey points must be immediately measured:

- If the surficial monitoring points have not settled or heaved since the previous monitoring event, construction can continue;
- If settlement or heave has been observed at the surficial monitoring points, construction must be put on hold until the movement at both the sub-surface and surficial monitoring locations stops. TREK recommends construction can continue when two consecutive monitoring point surveys taken 30 minutes apart indicate no additional ground movement has occurred.

Level 2: Critical

The critical level of ground movement for the CPR Great West Development Lead crossing Sargent Avenue is 22 mm. If 22 mm of ground movement is measured at the sub-surface monitoring points, construction must be halted, and the surficial survey points must be immediately measured.

- If the surficial monitoring points have not settled or heaved since the previous monitoring event, construction must remain on hold for a minimum of 12 hours to confirm no surficial ground movement is occurring.
- If settlement or heave has been observed at the surficial monitoring points, monitoring of both sub-surface and surficial monitoring points must continue every 12 hours until movement has stopped. In addition, the installation procedure must be modified to mitigate ground movement and approved by CPR before construction can continue.

It should be noted that short-term natural movement (mostly horizontal) of the rails, in particular due to thermal changes, in the absence of any construction activities can exceed the tolerances outlined by CPR. TREK recommends surficial monitoring points using survey nails be located on the top of the rail tie beside the rail and not on the rail itself.

6.0 Excavations and Shoring

Excavations must be carried out in compliance with the appropriate regulations under the Manitoba Workplace Safety and Health Act. Any open-cut excavation greater than 3 m deep must be designed and sealed by a professional engineer and reviewed by the geotechnical engineer of record (TREK). If space is limited or the stability of adjacent structures or infrastructure may be endangered by an excavation, a shoring system may be required to prevent damage to, or movement of, any part of adjacent structures, and the creation of a hazard to workers and the public. Jacking pits should be designed by a qualified structural engineer to support anticipated jacking forces based on the soil conditions at the site.

Excavation stability is the responsibility of the Contractor for the duration of construction. Excavations should be monitored regularly and flattened as necessary to maintain stability recognizing that excavation stability is time and weather dependent. Excavated slopes should be covered with polyethylene sheets to prevent wetting and drying.

Stockpiles of excavated material and heavy equipment should be kept away from the edge of any excavation by a distance equal to or greater than the depth of excavation. Dewatering measures should be completed as necessary to maintain a dry excavation and permit proper completion of the work. If seepage is encountered, it should be collected and pumped out of the excavation. If saturated silts or sands are encountered, shoring or slope flattening may be required. To prevent wet silts and sands from entering the excavation, gravel buttressing could be used in conjunction with sump pits for dewatering. Surface water should be diverted away from the excavation and the excavation should be backfilled as soon as possible following construction.

Cantilevered (un-braced or braced) walls will be required for deep excavations or physically constrained areas where temporary shoring is necessary. Table 01 provides the recommended earth pressure coefficients and bulk unit weights of clay for use in the calculation of lateral earth pressures. Surcharge loads and hydrostatic water pressure should be incorporated into the design of cantilevered walls, as well as an adequate factor of safety against instability.

Table 01. Recommended Design Parameters for Cantilevered Walls

Design Parameter	Earth Pressure Coefficients and Bulk Unit Weights
	Silty Clay
Active (K_a)	0.5
At-rest (K_o)	0.7
Passive (K_p)	1.8
Bulk Unit Weight, γ (kN/m^3)	18

A certain amount of ground movement behind the shoring will occur and is largely unavoidable. The amount of movement that will occur cannot be accurately predicted, mainly because the movement is as much a function of installation procedures and workmanship as it is a function of theoretical considerations. It is anticipated that the design of temporary shoring will be the responsibility of the Contractor. Once the proposed shoring design is complete, it should be reviewed by TREK prior to construction to ensure the design is appropriate and to assess the need for groundwater control. Performance of the excavation system should be monitored from the onset of installation to removal of the shoring system.

7.0 Closure

The geotechnical information provided in this report is in accordance with current 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 our 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 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.

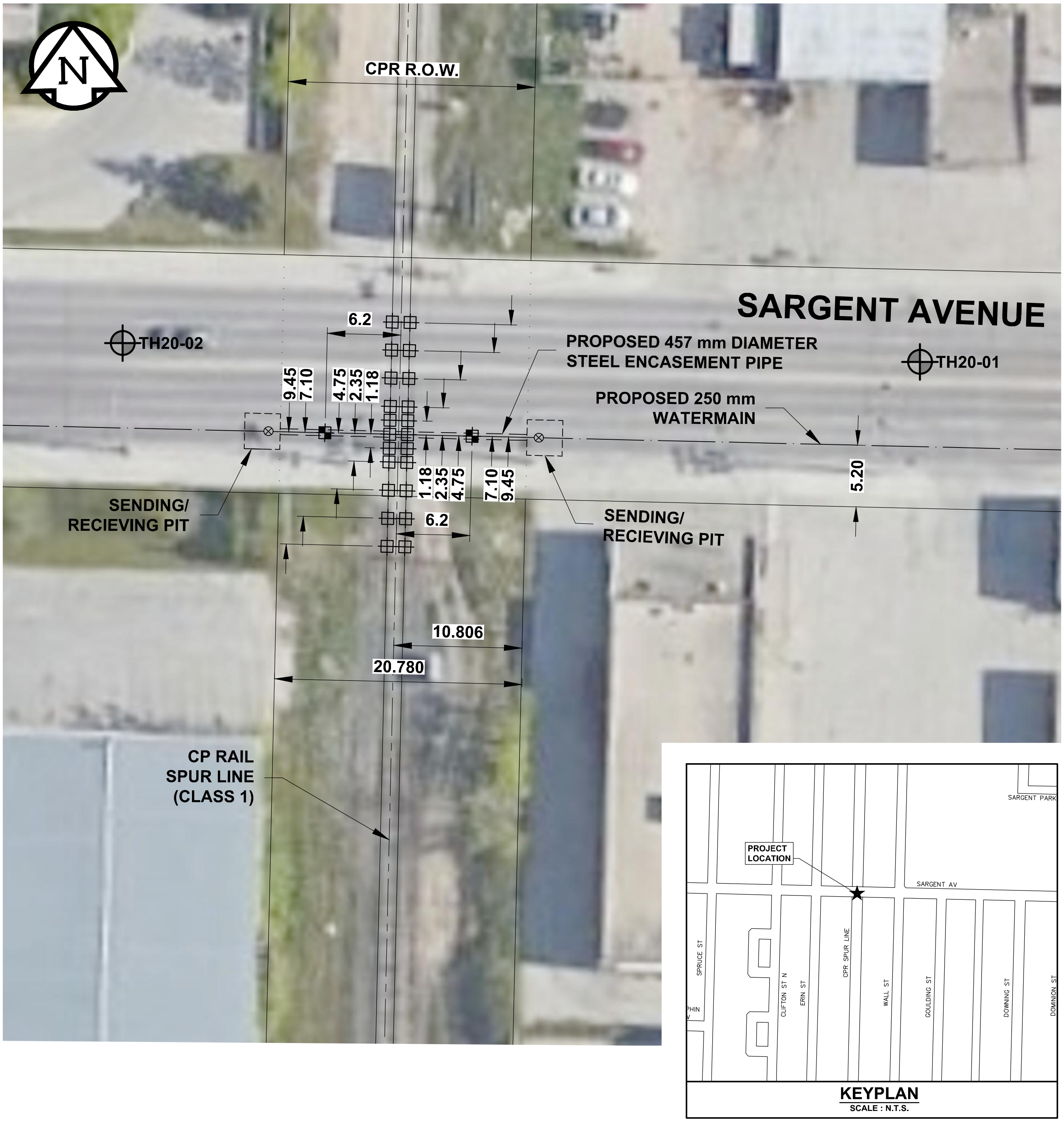
This report has been prepared by TREK Geotechnical Inc. (the Consultant) for the exclusive use of the Morrison Hershfield Ltd. (the Client), Canadian Pacific Railway and their agents for the work product presented in the report. Any findings or recommendations provided in this report are not to be used or relied upon by any third parties, except as agreed to in writing by the Client and Consultant prior to use.

Figures

TREK GEOTECHNICAL

0035 086 00

Morrison Hershfield Ltd.
Sargent Avenue Watermain CPR Crossing



LEGEND:

- TEST HOLE (TREK)
- SURFICIAL MONITORING POINT (BASE OF RAIL)
- SUB-SURFACE MONITORING POINT
- PROPOSED WATERMAIN VALVE

NOTES:

1. AERIAL IMAGE FROM GOOGLE EARTH (2020)
2. DIMENSIONS IN METERS.
3. SUB-SURFACE MONITORING POINTS TO BE INSTALLED 1 m ABOVE WATERMAIN CASING OBVERT.
4. TOP OF RAIL CAN BE SURVEYED IF BASE OF RAIL NOT ACCESSIBLE.

0 10 20 30 m
SCALE = 1 : 500 (216 x 279 mm)

Z:\Projects\0035 Morrison Hershfield\0035 086 00 Sargent Ave Rail Crossing\3 Survey and Dwg\3.4 CAD\3.4.3 Working Folder\Fig 01_SARGENT_CP RR CROSSING_0_A_CJH_0035-076-00.dwg, 2/25/2020 ... A (8.50 x 11.00 Inches)

Figure 01

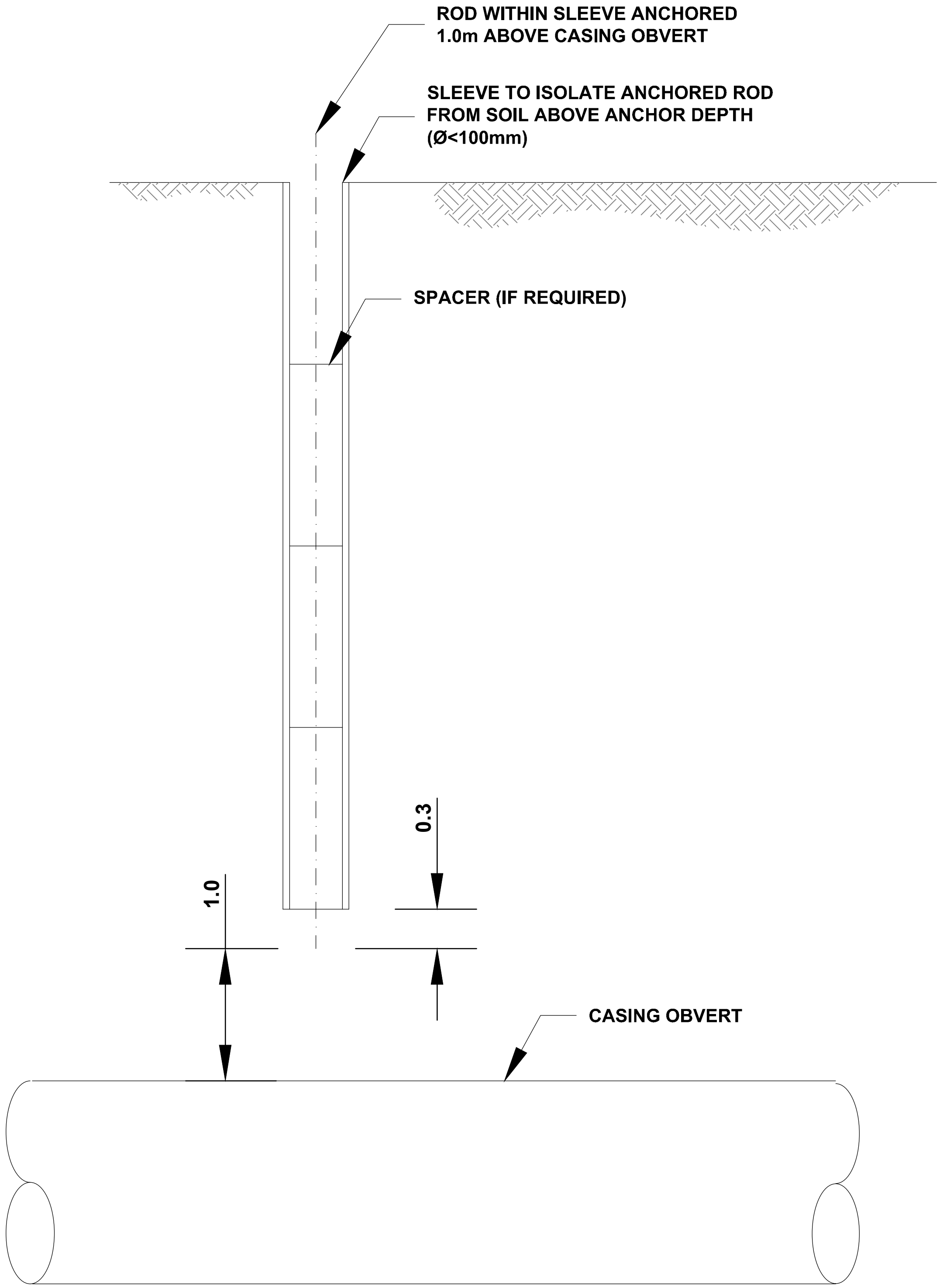
TEST HOLE AND MONITORING LOCATION PLAN

TREK GEOTECHNICAL

0035 086 00

Morrison Hershfield Ltd.

Sargent Avenue Watermain CPR Crossing



NOTES:

1. MONITORING POINT TO BE PROTECTED AT SURFACE AS REQUIRED, AND FLAGGED.
2. BASE OF ROD SHOULD BE DESIGNED TO PREVENT SETTLEMENT UNDER IT'S OWN WEIGHT.

SCALE: NTS

Figure 02

SUB-SURFACE MONITORING POINT CONCEPT

Test Hole Logs

GEOTECHNICAL

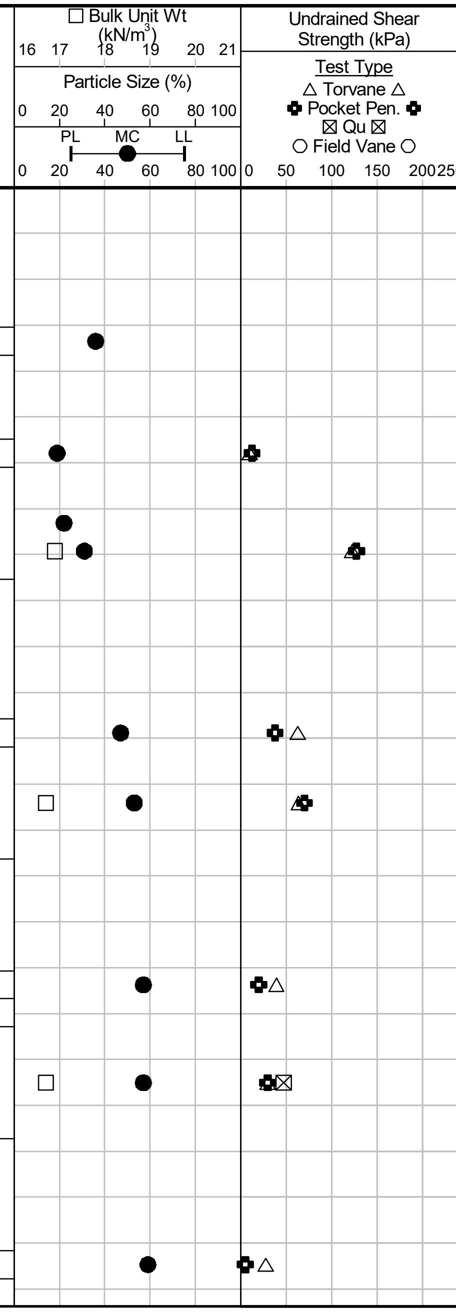
Sub-Surface Log

Client:	Morrison Hershfield Ltd.	**Project Number:**	0035 086 00
Project Name:	Sargent Avenue Watermain CPR Crossing	**Location:**	UTM N-5528793.67, E-630535.23
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	Not Surveyed
Method:	125mm Solid Stem Auger, B40 Mobile Truck Mount	**Date Drilled:**	28 January 2020

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number
0.0	ASPHALT		
	CONCRETE		
	GRAVEL (FILL) - some sand, dark brown, moist, 19 mm diameter down, well graded, rounded		
0.5	CLAY (FILL) - silty, trace sand - mottled black and grey - frozen, moist, firm when thawed - high plasticity	Grab	G1
1.0	SILT - clayey - brown - frozen to 1.2 m, moist, soft when thawed - intermediate plasticity	Grab	G2
		Shelby Tube	T3
2.0	CLAY - silty, trace sand, trace silt inclusions (< 5 mm diameter) - grey-brown - moist, very stiff - high plasticity		
3.0	- firm to stiff below 3.0 m	Grab	G4
		Shelby Tube	T5
		Grab	G6
		Shelby Tube	T7
5.5	- grey, soft below 5.5 m	Grab	G8



END OF TEST HOLE AT 6.1 m IN CLAY
Notes:
1) No sloughing or seepage observed.
2) Test hole open to 6.1 m at end of drilling.
3) Test hole backfilled with cuttings, bentonite pellets and quick set asphalt.

Logged By: Kate Franklin **Reviewed By:** Nelson Ferreira **Project Engineer:** Nelson Ferreira

TREK GEOTECHNICAL

Sub-Surface Log

Client:	Morrison Hershfield Ltd.	**Project Number:**	0035 086 00
Project Name:	Sargent Avenue Watermain CPR Crossing	**Location:**	UTM N-5528795.26, E-630468.1
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	Not Surveyed
Method:	125mm Solid Stem Auger, B40 Mobile Truck Mount	**Date Drilled:**	28 January 2020

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Column headings: Depth (m) | Soil Symbol | MATERIAL DESCRIPTION | Sample Type | Sample Number | ☐ Bulk Unit Wt (kN/m^3) 16 17 18 19 20 21; Particle Size (%) 0 20 40 60 80 100; PL MC LL 0 20 40 60 80 100 | Undrained Shear Strength (kPa) — Test Type: △ Torvane △, ✽ Pocket Pen. ✽, ⊠ Qu ⊠, ○ Field Vane ○; 0 50 100 150 200 250

Depth (m)	Material Description	Sample Type	Sample Number
0.0–0.1	ASPHALT		
	CONCRETE		
	GRAVEL (FILL) - some sand, dark brown, moist, 19 mm diameter down, well graded, rounded		
~0.5	CLAY (FILL) - silty, trace sand, mottled black, brown and grey - frozen, moist, firm when thawed, high plasticity	Grab	G9
~0.9	CLAY - silty, trace sand, trace silt inclusions (< 5 mm diameter) - brown - frozen to 1.4 m, moist, firm to stiff when thawed - high plasticity		
1.5		Grab	G10
1.8	- silt seam 10 mm thick at 1.8 m	Shelby Tube	T11
2.2	- silt seam 100 mm thick, clayey, brown, moist, soft, low plasticity		
3.0		Grab	G12
3.4		Shelby Tube	T13
4.3	- soft to firm below 4.3 m		
4.5		Grab	G14
4.9		Shelby Tube	T15
6.0		Grab	G16

Depth scale: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0

END OF TEST HOLE AT 6.1 m IN CLAY
Notes:
1) No sloughing or seepage observed.
2) Test hole open to 4.6 m at end of drilling.
3) Test hole backfilled with cuttings, bentonite pellets and quick set asphalt.

Logged By: Kate Franklin **Reviewed By:** Nelson Ferreira **Project Engineer:** Nelson Ferreira

Appendix A

CPR Geotechnical Protocols

CP Geotechnical Protocol for pipeline and utility installations within Railway Right of Way

Last updated 2017 07 06

1. Introduction

The purpose of this document is to assure the safety of rail operation during the process of third party pipe crossings of the Canadian Pacific Railway right-of-way. It is intended to guide the Applicant of the pipe crossing, and the CP Utility team and Geotechnical group in screening and approving applications for installations crossing under the railway right of way. The goal of the protocol is to:

1.1 Provide safe track conditions during and after installation.

1.2 Set out specifications and procedures to reduce problems during installation and operation of pipe/track crossing.

1.3 Specify minimum engineering standards.

1.4 Assure adequate geotechnical investigation and engineering review has been completed to achieve the above goals.

1.5 Allow timely processing of crossing approvals.

Limitations - The following protocol is independent of the requirements for assessing the structural components of the pipeline crossing. The structural requirements for all pipe crossings are included in CP – SP-TS-2.39 Pipeline and Cable Installations within Railway Right of Way. An agreement or permit from CP's Utilities group will be required before commencing with any work within the railway corridor. Proposals for pipelines and utilities parallel to the track are not covered by this protocol.

Geotechnical approval of a proposed crossing by CP in no way warrants the applicability of the construction method to the expected ground conditions nor does it warrant the suitability of the ground conditions for the use proposed by the proponent of the crossing. CP does not take any responsibility for the suitability of the construction method or warrantee the ground conditions. CP geotechnical approval of a specific design indicates that based on available information the proposed construction and design addresses the railways needs. With all third party work on our right-of-way CP will not attract any liability because of its approval of a specific design. As a result, CP does not provide recommendations, direction or minimum standards to the proponent or their contractor. CP insists that the proponent provide adequate documentation identifying the Geotechnical engineer of record and the components of the project for which they are responsible.

2. Emergencies

In the event of any occurrence that does or could pose a hazard immediately contact Canadian Pacific Railway at **1 800 716 9132**.

3. General terminology

3.1 Base of rail (BOR) is the bottom surface of the rail and is frequently used as a local datum from which vertical measurements are referenced. If an external datum is utilized the elevation of the BOR will be identified.

3.2 The "zone of potential track loading" (zptl) is considered the area under the track and within a 1V to 1.5H zone extending down from a point at the level of the BOR and 2 m (6.6 ft) from the centreline of track as shown in Figure 3.

4. Process

To provide the appropriate level of engineering review of a specific proposal and allow timely processing of applications, the Geotechnical review has been divided into three processes. Table 1 identifies the three levels, Minimum, Intermediate and Detailed, of geotechnical investigation and engineering dependent on the size, proximity and construction methodology of the proposed crossing. The proponent should consult Table 1 to assess what effort and detail of submission is required to meet the CP requirements.

Table 4.1 – Process identification

		Process		
		1. Minimum[1]	**2. Intermediate**	**3. Detailed**
Condition	Outside pipe diameter	Less than 300 mm (12")	300 mm (12") to 1500 mm (59")	Greater than 1500 mm (59")
	Cover between BOR and top of pipe	Greater than 1.5 m (5 ft) or three pipe diameters which ever is greater	Greater than 1.5 m (5 ft) or two (2) pipe diameters which ever is greater	Less than 1.5 m (5 ft) or two (2) pipe diameters
	Adjacent structures, switches and signals	Greater than 10 m (32.8 ft)	Within 2.5 times cover between BOR and top of pipe	

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="3">Process</td></tr>
<tr><td>1. Minimum[1]</td><td>2. Intermediate</td><td>3. Detailed</td></tr>
<tr><td rowspan="3">Conditions</td><td>Depth of pipes outside zptl</td><td>Refer to SP-TS 2.39 All pipes will be at least 0.91 m (3 ft) below ground where pipes are not below the zptl</td><td colspan="2">Less than 0.91 m (3 ft) burial within the zone of potential track loading</td></tr>
<tr><td>Excavation near the track</td><td>Jacking/access pits shall be more than 10 m (30 ft) from the closest track centreline and not encroach on the zptl.</td><td colspan="2">Excavations or jacking/access pits within 10 m (30 ft) of the closest track centreline</td></tr>
<tr><td>Crossing angle</td><td>Less than 45 degrees off perpendicular to the track</td><td colspan="2">More than 45 degrees off perpendicular to the track</td></tr>
<tr><td colspan="2" rowspan="2">Construction method</td><td colspan="2">Non-tunneling method[2]</td><td rowspan="2">All methods considered</td></tr>
<tr><td colspan="2">Pipe bursting will only be considered where the predicted heave is less than 10% of the movement that would result in a change of the FRA or TC track class.</td></tr>
<tr><td colspan="2">Approval process</td><td>Utility Group to approve with no Geotechnical submission</td><td>Proponent to pay the cost for CP to retain an independent geotechnical engineer to review the proponents engineers design, construction method and Geotech report</td><td>Proponent to pay the cost for CP to retain an independent geotechnical engineer to review the proponents engineers design, construction method and Geotech report</td></tr>
</table>

[1] Move to next class if one or more criteria are not met.
[2] Non – tunneling methods include all forms of pipe augering, pipe jacking, directional drilling or the use of tunnel boring machines (TBM's) but excludes any type of mining techniques where any stand up time is required before the tunnel support is placed.

5. General requirements

5.1 All proposals for crossing approvals will be under the signature of a locally registered professional engineer. The objective here is to ensure a registered professional / firm or organization is given the responsibility to assess the site and take responsibility to ensure the proposal is appropriate for the site conditions. This may be in addition to the requirement for the proposal to be signed by a geotechnical and or structural engineer.

5.2 Applications to meet current regulatory and industry criteria for structural capacity, etc.

5.3 The application will include a construction plan that specifies the terms and conditions for execution of the work, including assignment of responsibility. The proponent of the crossing is responsible to the railway and must ensure the work is executed in accordance with the terms of the agreement.
All pipe/track crossing will be accompanied by at least the following three drawings showing the features indicated in true scale.

- 5.3.1. Plan of the proposed pipe crossing under the track (Figure 1) – This drawing will show the following features:
  - 5.3.1.1 The location of the crossing referencing identifiable landmarks including the mileage and subdivision of the proposed crossing as per the CP subdivision naming and mileage convention. The proponent can obtain the mileage and subdivision information from the Utility Group.
  - 5.3.1.2 The pipe centerline, size and limits;
  - 5.3.1.3 Any adjacent structures, signals, switches;
  - 5.3.1.4 The location of the ditch line and any breaks in slope;
  - 5.3.1.5 The location of any boreholes or test pits; and
  - 5.3.1.6 The location of all tracks.
- 5.3.2 Profile of the track and proposed pipe crossing along the centreline of the track (Figure 2). This drawing will show the following features:
  - 5.3.2.1 The location of the crossing referencing identifiable landmarks including the mileage and subdivision of the proposed crossing;
  - 5.3.2.2 The pipe centerline, size and limits;
  - 5.3.2.3 Any adjacent structures, signals, switches or buried services including Fibre Optics Transmission Systems (FOTS);
  - 5.3.2.4 The elevation of the surface water in ditches, the elevation of the ground water table at all bore holes locations and the date they were measured;
  - 5.3.2.5 The test pit and borehole location and stratigraphic logs as determined by the geotechnical investigation;
  - 5.3.2.6 The depth of the top of pipe to the base of rail; and
  - 5.3.2.7 The profile of the track.

5.3.3 Section of the track along the centreline of the proposed pipe crossing (Figure 3). This drawing will show the following features:

5.3.3.1 The location of the crossing referencing identifiable landmarks including the mileage and subdivision of the proposed crossing;

5.3.3.2 The pipe centerline, size and limits;

5.3.3.3 Any adjacent structures, signals, switches and buried services including FOTS;

5.3.3.4 The elevation of the surface water in ditches, the elevation of the ground water table at all bore holes locations and the date they were measured;

5.3.3.5 The test pit and borehole location and stratigraphic logs as determined by the geotechnical investigation;

5.3.3.6 The location of jacking or access pits and proposed cut slope angles;

5.3.3.7 The location of the centerline of all tracks;

5.3.3.8 The depth of the top of pipe to the base of rail; and

5.3.3.9 Any excavations that encroach on the zptl;

5.4 Proposals for open cut will only be considered at sites where conditions make other installation techniques impractical or where rail traffic is low.

5.5 Installations using water jet methods will not be considered.

5.6 The cost of re-mediating any settlement or heave induced by the crossing installation will be borne by the crossing proponent.

5.7 All pipes installed below the highest ground water level predicted will be sealed during construction.

5.8 All pipes that will or could carry water shall be:

5.8.1 Installed with even bearing throughout its length to limit local settlement, and

5.8.2 Slope to one end and prevent standing water. Special exemptions will be considered for inverted siphons or other applications requiring level pipes.

5.9 CP head office is located in Calgary. As a result submissions received in English will generally be reviewed and processed more rapidly than those in French.

6. Process 1 – Minimum

6.1 Conditions

The general requirements included in Section 5 and the following requirements must be met to obtain approval for a pipe crossing that qualifies as a Process 1 crossing.

6.1.1 The pipe diameter is less than 300 mm (12.0 inches).

6.1.2 The cover between the BOR and the pipe obvert exceeds the greater of 1.5 m (5 ft) or three times the pipe diameter.
6.1.3 There are no structures, signals or track switches within 10 m horizontal of the pipe.
6.1.4 Installation is by a "non-tunneling method" (including boring, jacking, combined jack and bore, directional drilling, etc.).
6.1.5 All pipes will be at least 0.91 m (3 ft) below ground where pipes are not below the zone of potential track loading.
6.1.6 Jacking or access pits shall not be within 10 m (30 ft) from the centreline of track and not encroach on the zone of potential track loading.

6.2 Requirements

6.2.1 The proponent will provide drawings containing the information identified in Figures 1, 2 and 3.
6.2.2 Generally a geotechnical investigation is not required. However, in areas or conditions where problems have arisen with similar pipe crossings CP reserves the right to require a geotechnical investigation be completed and submitted with the application.
6.2.3 Even if not required by CP a geotechnical investigation may be completed at the discretion of the proponent.

6.3 Process

6.3.1 Proponent submits engineering documents to CP Utility & Flagging Dept.
6.3.2 Utility group reviews documents to assure appropriate engineering documents have been provided.
6.3.3 Utility & Flagging group to provide approval.

7. Processes 2 and 3

The intermediate and detailed processes pertain to those proposed pipe/track crossings that exceed the minimum criteria. The applicant will be required to submit information for review and approval by CP geotechnical engineers or their designated consultants at proponents cost.

CP requires that all designs, analysis and notification protocol be reviewed by a qualified geotechnical engineer.

8. Process 2 – Intermediate

The intermediate process pertains to those proposed pipe/track crossings that exceed the minimum criteria but do not exceed the maximum criteria. The applicant will be required to submit information for review and approval of our engineers but may not be subjected to additional engineering, monitoring and construction requirements.

8.1 Conditions

8.1.1 The general requirements identified in Section 5 must be met.
8.1.2 The pipe diameter is between 300mm (12"} and 1500 mm (59")

8.1.3 The cover between the BOR and the pipe obvert is the greater of 1.5 m (5 ft) or more than twice times the pipe diameter.
8.1.4 There are no structures, signals or track switches horizontally within 2.5 times the distance from the BOR to the invert of the pipe.
8.1.5 Installation is by a “non-tunneling method" (including boring, jacking, combined jack and bore, or directional drilling).
8.1.6 Pipe bursting methods will only be considered where the predicted heave is less than 10 percent of the movement that would result in a change of the FRA or TC track class as per latest Transport Canada - Track Safety Rules accessible at **www.tc.gc.ca**.
8.1.7 Excavations or jacking/access pits are within 10 m (30 ft) of the closest track centreline or encroach on the zone of potential track loading.

8.2 Requirements

8.2.1 Identification of the geotechnical engineer of record. The Geotechnical Engineer of Record will be responsible for the works on CP’s Right of Way.
8.2.2 Description of the subsurface soil and ground water conditions within and adjacent to CP embankment along the proposed pipe/track crossing alignment and to a depth no less that 1.5 times the invert depth below the BOR. This will consider the impact of silt, fine sand or sand soil, and their relation to the water table and pipe depth.
8.2.3 An estimate of the expected extent and magnitude of ground movement over time based on the proposed pipe installation method will be provided.
8.2.4 A program of ground surface and subsurface (settlement plates) movement monitoring will be implemented. The program must be capable of detecting movement of no less than 50 percent of the movement that would result in a change of the track FRA or TC class as per the latest Transport Canada - Track Safety Rules accessible at **www.tc.gc.ca**.
8.2.5 A procedure for notification of the appropriate CP personnel in the event that excessive or unexpected settlement occurs. A complete CP contact list, including local personnel and OC will be compiled.
8.2.6 A recovery plan will be provided outlining the steps to be implemented in the event of failure (excessive ground loss or settlement / collapse, heaving etc).
8.2.7 Design of de-watering control measures where applicable for the proposed construction method.
8.2.8 Temporary track support system will be required if any of the excavation is closer than 6 m (19.7 feet) from the centre of track and encroaches on the zone of potential track loading. The length of the excavation and an estimated stand-up time of the proposed cut within these limits must be provided and demonstrated to be safe.
8.2.9 A complete description of the proposed construction method.
8.2.10 Confirmation that the proposed construction/installation technique is suited to the site conditions and performance criteria. An assessment of the influence

of construction on the track structure including estimated settlement/heave and assessment of risk associated with uncontrolled loss of ground or heaving.

8.2.11 Upon review of the conditions, the geotechnical group may elevate a proposed crossing to Process 3 if complexities arise through the review of the project.

A qualified independent engineer is required to provide periodic or continuous (at the discretion of CP) on-site supervision and document conditions during construction.

8.2.12 - **Daily Inspection & Reporting during Construction :**

The proponent will identify a Geotechnical Engineer of Record (Engineer of Record) responsible for the work on CP's right of way. The Engineer of Record will assign a competent person to act as Site Inspector. The Site Inspector must have the required training, experience and understanding of the site conditions, proposed design, and construction methodology to make sound engineering decisions and reports during the course of the work. The Site Inspector must ensure the works are being done in accordance with the approved designs, procedures and/or specifications. The Site Inspector must report on any issues that arise over the course of the work that could have an effect on the stability of the embankment and/or potentially cause either future or immediate settlement. Any concerns about the imminent stability of the grade shall immediately be escalated to the CP Flagman in order to protect against train operations. The concerns shall also be escalated to the Engineer of Record and CP's Regional Utility & Flagging Representative so immediate remediation plans can be implemented.

The Site Supervisor will provide a daily report to CP's Regional Utility & Flagging Representative copying the Engineer of Record outlining the progress during the day, any deviations from the original plans, any unexpected ground conditions, or any other issues that arose during the course of construction worth noting. The report will include settlement monitoring data if required, along with a synopsis of the results highlighting any measures out of compliance or requiring attention.

Upon completion of the installation, the Engineer of Record will supply a letter/Final Construction report to CP's Regional Utility & Flagging Representative under his/her P.Eng. stamp confirming that the work has been completed in accordance with the submitted plans and procedures. If there are any deviations from the approved plans/procedures, these must be noted in the letter. As-built drawings if applicable should accompany this letter.

8.3 Process

- 8.3.1 Proponent submits engineering documents to CP Utility & Flagging Dept.
- 8.3.2 Utility group reviews documents to assure appropriate engineering documents have been provided.
- 8.3.3 CP Geotechnical Group to review and provide final geotechnical approval.
- 8.3.4 Structural Engineering Group may have to provide structural approval.
- 8.3.5 Utility & Flagging group to provide final approval.

9. Process 3 – Detailed

The third process will be followed for those crossing designs that do not meet the conditions of Process 2. In these instances, expert engineering submissions are required, along with preliminary work such as dewatering as well as, monitoring by on site engineering consultants during construction.

9.1 Conditions

- 9.1.1 Provided the above general requirements are met, and
- 9.1.2 Ground conditions, complex installation method, and/or the complexity of the project warrant that specialist-engineering personnel review the design and or construction of the pipe/track crossing.

9.2 Requirements

- 9.2.1 The proponent will meet the requirement outlined in Process 2 - Section 8.2.
- 9.2.2 The proponent will provide resources for CP to retain qualified geotechnical engineers or experts to analyses and advise CP on the impact of the proponent's proposal to the right-of-way.

9.2.3 Daily Inspection & Reporting during Construction:

The proponent will identify a Geotechnical Engineer of Record (Engineer of Record) responsible for the work on CP's right of way. The Engineer of Record will assign a competent person to act as Site Inspector. The Site Inspector must have the required training, experience and understanding of the site conditions, proposed design, and construction methodology to make sound engineering decisions and reports during the course of the work. The Site Inspector must ensure the works are being done in accordance with the approved designs, procedures and/or specifications. The Site Inspector must report on any issues that arise over the course of the work that could have an effect on the stability of the embankment and/or potentially cause either future or immediate settlement. Any concerns about the imminent stability of the grade shall immediately be escalated to the CP Flagman in order to protect against train operations. The concerns shall also be escalated to the Engineer of Record and CP's Regional Utility & Flagging Representative so immediate remediation plans can be implemented.

The Site Supervisor will provide a daily report to CP's Regional Utility & Flagging Representative copying the Engineer of Record outlining the progress during the day, any deviations from the original plans, any unexpected ground conditions, or any other issues that arose during the course of construction worth noting. The report will include settlement monitoring data if required, along with a synopsis of the results highlighting any measures out of compliance or requiring attention.

Upon completion of the installation, the Engineer of Record will supply a letter/Final Construction report to CP's Regional Utility & Flagging Representative under his/her P.Eng. stamp confirming that the work has been completed in accordance with the submitted plans and procedures. If there are any deviations from the approved plans/procedures, these must be noted in the letter. As-built drawings if applicable should accompany this letter.

9.3 Process

- 9.3.1 Proponent submits engineering documents to CP Utilities and Flagging department.
- 9.3.2 Utility group reviews documents to assure appropriate engineering documents have been provided.
- 9.3.3 Review by independent geotechnical or tunneling specialist (at the proponents cost).
- 9.3.4 Upon acceptable review by independent geotechnical consultant or tunneling specialist the CP Geotechnical Group to provide approval.
- 9.3.5 Structural Engineering Group to provide structural approval.
- 9.3.6 Utility & Flagging group to provide final approval.

10. Geotechnical Engineering check-list

The following is a check list of steps that will be completed to assure that the appropriate level of care has been taken for Process 2 and 3 pipe crossings below the track.

Table 2 – Check List

No.	Step	Group
10.1	Submission of crossing proposal by proponent including details of the crossing specification and potential construction method(s) to CP Utility & Flagging dept.	Proponent
10.2	Review of the proposal with respect to this protocol to determine what level of geotechnical engineering and review is required.	Utility Group
10.3	Designation of review (CP Utilities Application, CP Geotechnical or Engineering Consultant required)	Utility Application
10.4	Identification of the geotechnical engineer of record.	Geotechnical Engineering
10.5	Assessment of the adequacy of the geotechnical investigation.	Geotechnical Engineering

No.	Step	Group
10.6	Proponent's geotechnical engineer determines that the proposed construction/installation method will not cause settlement of the CP track or structures.	Geotechnical Engineering
10.7	If there is a possibility of track settlement, a monitoring program will be developed by the proponent's geotechnical engineer, and reviewed and approved by CP.	Geotechnical Engineering
10.8	Once a contractor has been selected, the geotechnical engineer of record will review the shop drawings submitted by the contractor or the sub-contractor(s) to determine if the tunnel and dewatering (if required) method proposed could cause track settlement.	Geotechnical Engineering
10.9	The proponent will provide CP with written documentation of who will be completing the onsite review of the contractor's construction practice and the specifics of the assignment.	Geotechnical Engineering
10.10	The proponent will enlist the services of a geotechnical engineer of record with the responsibility for inspection of the tunnel contractor's work. They will also assure that adequate measures are in place to minimize the potential for track settlement. The intention is not make the geotechnical engineer responsible for the settlement of the track but to empower an appropriate group with the task of assuring that actions undertaken by the contractor do not endanger the track structure as a result of ground loss during tunneling.	Geotechnical Engineering
10.11	An emergency response will be developed and posted on site and will reside with key personnel.	Geotechnical Engineering
10.12	A contingency plan will be identified that can be completed within hours if settlement is experienced.	Geotechnical Engineering

11. Abandoned pipe/track crossing

In the event that an existing installation is abandoned or a proposed crossing is abandoned during construction, all potential hazards to CP property must be removed or abated. This may be achieved by removal of any buried pipes and the backfill and compaction of any excavations. Alternately, upon approval of the CP Geotechnical group any voids within ground may be backfilled with non-shrinkable fill, or pressured grout sufficient to prevent future sloughing or track settlement. Any buried material (wood or metal) that could increase or decrease volume over time due to chemical reaction (oxidation) or decomposition must be removed or stabilized to the satisfaction of the CP.

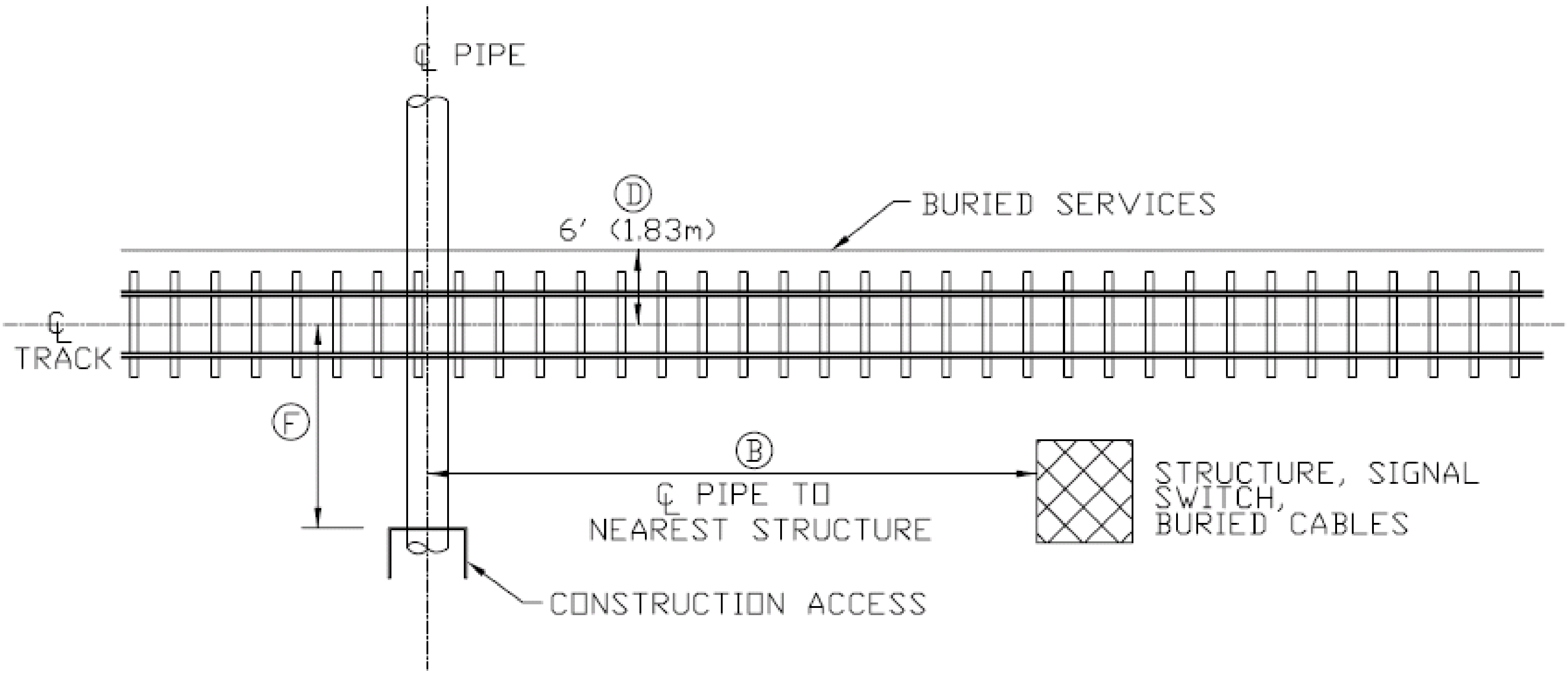


Figure 1 – Plan of the proposed pipe crossing

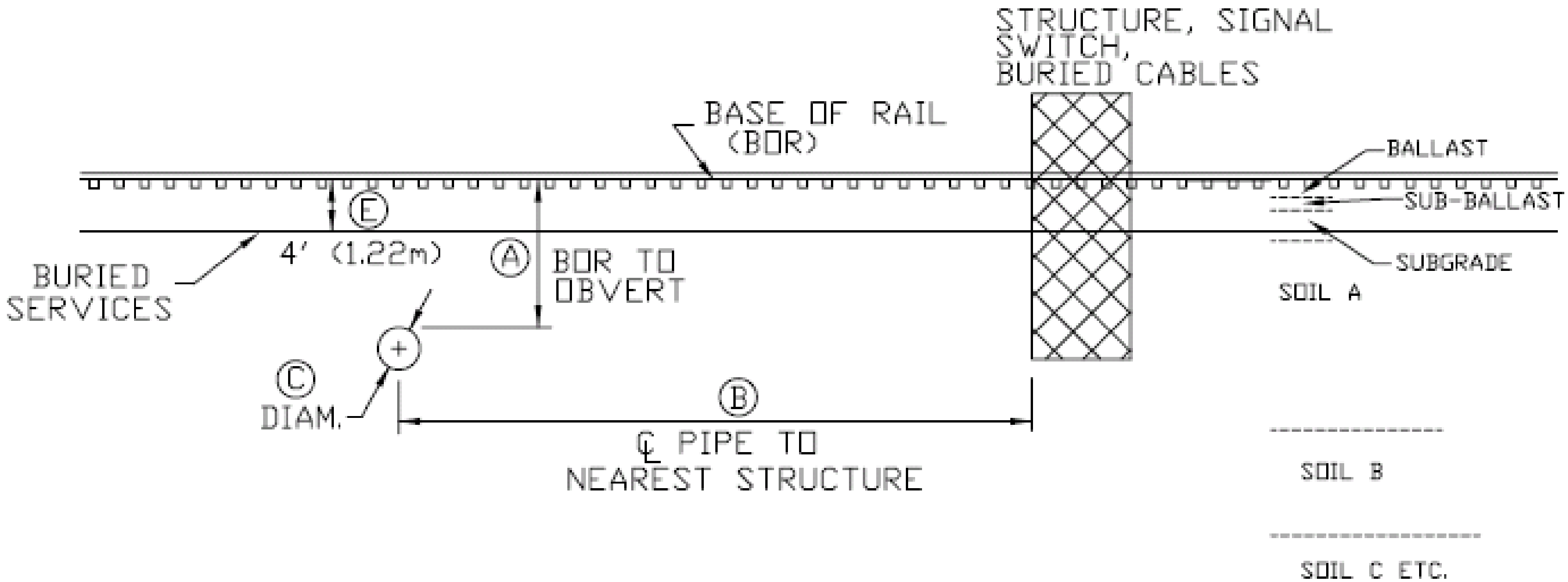
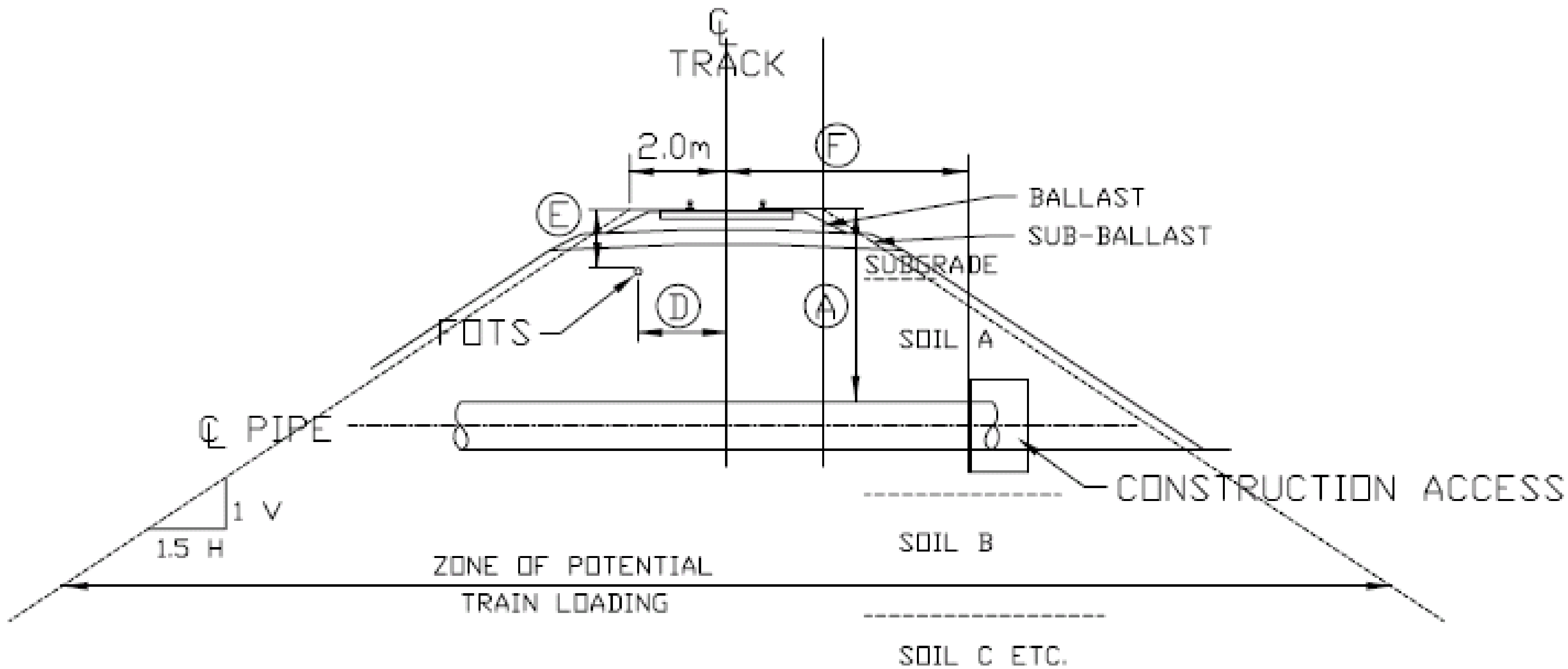
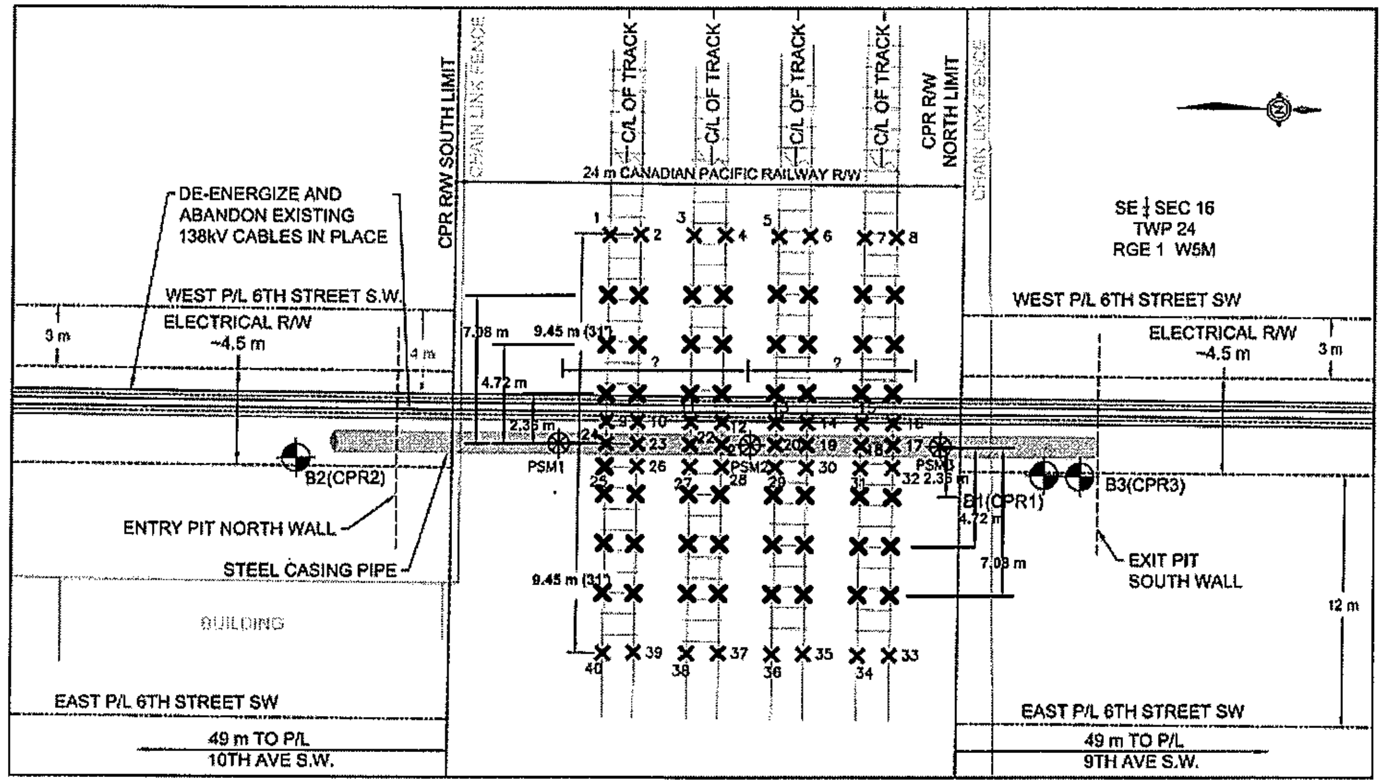


Figure 2 – Profile of the track and proposed pipe crossing along the centerline of track

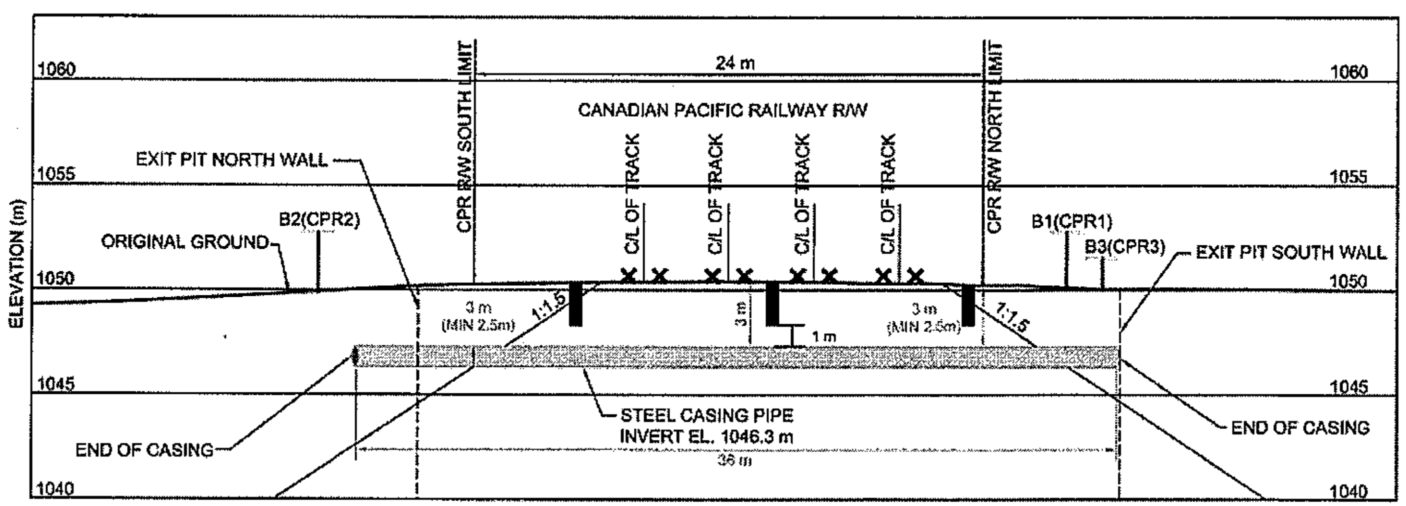


FOTS = FIBRE OPTICS TRANSMISSIONS SYSTEM

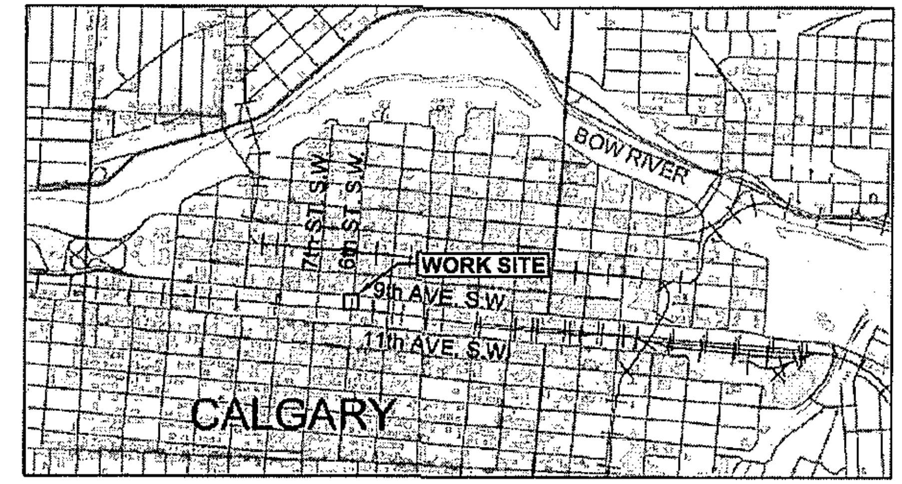
Figure 3 – Section of Track along centerline of proposed pipe



PLAN
SCALE 1:300



CROSS-SECTION
90° TO TRACK
HORIZONTAL SCALE 1:300
VERTICAL SCALE 1:300



LOCATION PLAN
SCALE 1:30,000

CROSSING SPECIFICATIONS	
GENERAL	SIX (6) 152 mm OD X 7 mm WT AND THREE (3) 152 mm OD X 7 mm WT SPARE DUCTS AND THREE (3) 70 mm OD X 5 mm WT PVC SCHEDULE 40 CONDUITS CONVEYING CONDUCTORS WITH A MAXIMUM OF 138 kV INSIDE A STEEL CASING PIPE
CONVEYING	COPPER, SINGLE CONDUCTOR 138kV XLPE CABLE COMPACT 5 SEGMENTAL
CASING PIPE	OUTER DIAMETER = 914 mm WALL THICKNESS = 13.5 mm LENGTH = 38 m
MINIMUM YIELD STRENGTH	241 MPA
EXTERNAL COATING	NO
CATHODIC PROTECTION	NO
JOINT TYPE	WELDED
ENDS SEALED	YES
INSTALLATION METHOD	PIPE RAMMING - SEE NOTE 1

LEGEND

- GOLDER GEOTECHNICAL BOREHOLE (2000)
- × SURFACE MONITORING LOCATION (2010)
- SUBSURFACE MONITORING LOCATION (2010)

CANADIAN PACIFIC
Engineering Services - Geotechnical

SAMPLE SURFACE & SUB -SURFACING SETTLEMENT

DWG. BY: JANE FENG	CHECK BY: EDDIE CHOI
SCALE: AS SHOWN	DATE: APR. 30, 2014

Track Movement Monitoring Guidelines for Trenchless Pipe Installation

Last updated April 9, 2014

The monitoring of track settlement should be accomplished by means of surface and subsurface settlement points. The intent of subsurface settlement points is to measure soil voids created just above the pipe during construction in order to help predict the potential movement of tracks above. The settlement point essentially consists of a small diameter pipe anchored at the bottom of a vertical borehole and an outer casing to isolate the pipe from down drag forces caused by settlement of soil above the anchor. The subsurface settlement points will be installed to 1 m above the crown of the casing profile. A total of (specified the number) subsurface settlement points will be installed within the CPR right of way along the axis of the proposed pipe crossing installation. The proposed locations are shown on the attached sketch. The surface settlement points should be monitored in pairs at the base of rails perpendicular to the center line of the track. As a minimum, the first pairs of surface settlement points have to be monitored at the intersection of the proposed center line of the pipe crossing and the existing center line of track. The next pairs of surface settlement points are to be monitored at a distance of 9.45 m (31') along the center line of track on each side of the first surface monitoring pairs taken at the intersection of the center line of the pipe crossing. Any additional surface monitoring points should be spaced with the same measurement of 9.45 m (31') from the last monitored pairs. The intent is to monitor differential transversal elevation between both rails over the projected settlement trough. A total of at least (specified the number) surface points will be installed on the right of way. The proposed locations are shown on the attached sketch. These points would be monitored simultaneously with the subsurface settlement points which act as a precursor to potential surface movement during pipe installation.

Once the installation is complete, a monitoring program of all points is to be conducted in accordance with the following instructions:

1. Monitoring should start before the excavation of the pits and pipe installation begins and be done at least twice per day for no less than two days. This is required to establish a reliable methodology and demonstrate the accuracy achievable.
2. Monitoring should proceed through the construction period and should be completed at least twice daily.
3. Monitoring should continue for at least 3 days after the completion of construction.
4. If there is any loss of ground during pipe installation, any reason to believe settlement may be delayed or any settlement is identified during the installation of pipe or subsequent monitoring period, the monitoring must be continued until the proponent's geotechnical engineer deems it is safe to discontinue such monitoring.

Monitoring measurements should be taken with sufficient frequency to capture the unexpected performance at the earliest possible stage and be evaluated in a timely manner. Additional measures will be proposed should this monitoring protocol is considered insufficient based on the ground conditions or installation process. Two alarm levels are proposed:-

Level 1:
"WARNING" will be indicated on the field memo when a settlement of 50% of the critical monitoring threshold is obtained from the subsurface settlement point. A survey of the surface points will then be conducted and work will be authorized to continue if no movement has been measured from the previous reading. If movement of the rails is recorded, monitoring will be continued until movement is stopped at which time the drilling work will then be authorized to continue.

Level 2:
"CRITICAL" will be indicated on the field memo when a settlement of (specified monitoring threshold) is obtained from the subsurface settlement point. A survey of the surface points will then be conducted and work will be authorized to continue if no movement is measured for at

least two (2) readings taken 12 hours apart. If movement of the rails is recorded, monitoring will be continued until movement is stopped and a new pipe installation procedure has been submitted by the proponent and approved.

The proponent and their engineer are responsible for ensuring that track settlement does not occur and notifying CP Roadmaster should unforeseeable track settlement occur or be expected. The above guidelines do not relieve the proponent and their engineer of this responsibility. The proponent or their engineer shall provide the settlement information and their interpretation of the data (no track settlement, deep settlement, etc. and how much track settlement has occurred, is likely to occur and when it is likely to occur) in terms that CP Roadmaster can easily understand. This information should be directed to local CP Roadmaster, Manager Structures and Director Geotechnical Engineering.

Track Settlement Monitoring Review and Alert Thresholds

Class	Alert Threshold	Review Threshold
1	22 mm	11 mm
2	22 mm	11 mm
3	19 mm	10 mm
4	16 mm	8 mm
5	13 mm	6 mm
6	10 mm	5 mm

Class of Track

TRACK CLASSES		
Class	**Freight Train Speed**	**Passenger Train Speed**
1	10 MPH	15 MPH
2	25 MPH	30 MPH
3	40 MPH	60 MPH
4	60 MPH	80 MPH
5	80 MPH	95 MPH ❶ 90 MPH ❷

❶ *For LRC Trains, 100 MPH*

❷ *Applies to US only*

Figure 5-1

Appendix B

Laboratory Results

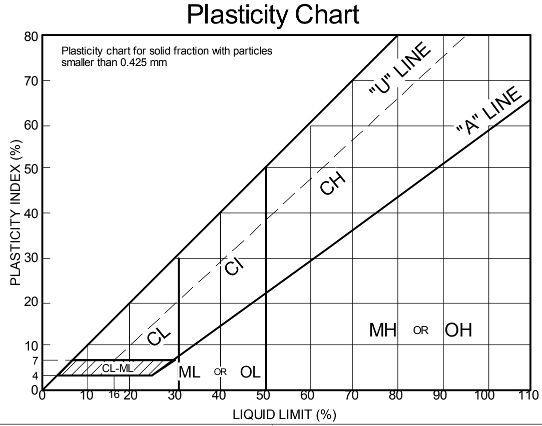
EXPLANATION OF FIELD AND LABORATORY TESTING

GENERAL NOTES

1. Classifications are based on the United Soil Classification System and include consistency, moisture, and color. Field descriptions have been modified to reflect results of laboratory tests where deemed appropriate.
2. Descriptions on these test hole logs apply only at the specific test hole locations and at the time the test holes were drilled. Variability of soil and groundwater conditions may exist between test hole locations.
3. When the following classification terms are used in this report or test hole logs, the primary and secondary soil fractions may be visually estimated.

Major Divisions			USCS Classi-fication	Symbols	Typical Names	Laboratory Classification Criteria		
Coarse-Grained soils (More than half the material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than 4.75 mm)	Clean gravel (Little or no fines)	GW		Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain size curve, depending on percentage of fines (fraction smaller than No. 200 sieve) coarse-grained soils are classified as follows: Less than 5 percent...... GW, GP, SW, SP More than 12 percent....... GM, GC, SM, SC 6 to 12 percent...... Borderline case4s requiring dual symbols*	$C_U = \frac{D_{60}}{D_{10}}$ greater than 4; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP		Poorly-graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravel with fines (Appreciable amount of fines)	GM		Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are border-line cases requiring use of dual symbols
			GC		Clayey gravels, gravel-sand-silt mixtures		Atterberg limits above "A" line or P.I. greater than 7	
	Sands (More than half of coarse fraction is smaller than 4.75 mm)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines		$C_U = \frac{D_{60}}{D_{10}}$ greater than 6; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP		Poorly-graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM		Silty sands, sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are border-line cases requiring use of dual symbols
			SC		Clayey sands, sand-clay mixtures		Atterberg limits above "A" line or P.I. greater than 7	
Fine-Grained soils (More than half the material is smaller than No. 200 sieve size)	Silts and Clays (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock floor, silty or clayey fine sands or clayey silts with slight plasticity	Plasticity Chart		
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL		Organic silts and organic silty clays of low plasticity			
	Silts and Clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or distomaceous fine sandy or silty soils, organic silts			
			CH		Inorganic clays of high plasticity, fat clays			
			OH		Organic clays of medium to high plasticity, organic silts			
	Highly Organic Soils		Pt		Peat and other highly organic soils	Von Post Classification Limit	Strong colour or odour, and often fibrous texture	

Plasticity Chart



Material		Particle Size: ASTM Sieve sizes	Particle Size: mm
Sand	Coarse	#10 to #4	2.00 to 4.75
	Medium	#40 to #10	0.425 to 2.00
	Fine	#200 to #40	0.075 to 0.425
Silt or Clay		< #200	< 0.075
Boulders		> 12 in.	> 300
Cobbles		3 in. to 12 in.	75 to 300
Gravel	Coarse	3/4 in. to 3 in.	19 to 75
	Fine	#4 to 3/4 in.	4.75 to 19

* Borderline classifications used for soils possessing characteristics of two groups are designated by combinations of groups symbols. For example; GW-GC, well-graded gravel-sand mixture with clay binder.

Other Symbol Types

	Asphalt		Bedrock (undifferentiated)		Cobbles
	Concrete		Limestone Bedrock		Boulders and Cobbles
	Fill		Cemented Shale		Silt Till
			Non-Cemented Shale		Clay Till

EXPLANATION OF FIELD AND LABORATORY TESTING

LEGEND OF ABBREVIATIONS AND SYMBOLS

LL - Liquid Limit (%)
PL - Plastic Limit (%)
PI - Plasticity Index (%)
MC - Moisture Content (%)
SPT - Standard Penetration Test
RQD - Rock Quality Designation
Qu - Unconfined Compression
Su - Undrained Shear Strength
VW - Vibrating Wire Piezometer
SI - Slope Inclinometer

▽ Water Level at Time of Drilling
▼ Water Level at End of Drilling
▼ Water Level After Drilling as Indicated on Test Hole Logs

FRACTION OF SECONDARY SOIL CONSTITUENTS ARE BASED ON THE FOLLOWING TERMINOLOGY

TERM	EXAMPLES	PERCENTAGE
and	and CLAY	35 to 50 percent
"y" or "ey"	clayey, silty	20 to 35 percent
some	some silt	10 to 20 percent
trace	trace gravel	1 to 10 percent

TERMS DESCRIBING CONSISTENCY OR COMPACTION CONDITION

The Standard Penetration Test blow count (N) of a non-cohesive soil can be related to compactness condition as follows:

Descriptive Terms	SPT (N) (Blows/300 mm)
Very loose	< 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	> 50

The Standard Penetration Test blow count (N) of a cohesive soil can be related to its consistency as follows:

Descriptive Terms	SPT (N) (Blows/300 mm)
Very soft	< 2
Soft	2 to 4
Firm	4 to 8
Stiff	8 to 15
Very stiff	15 to 30
Hard	> 30

The undrained shear strength (Su) of a cohesive soil can be related to its consistency as follows:

Descriptive Terms	Undrained Shear Strength (kPa)
Very soft	< 12
Soft	12 to 25
Firm	25 to 50
Stiff	50 to 100
Very stiff	100 to 200
Hard	> 200

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Moisture Content Report
ASTM D2216-10

Project No. 0035-086-00-100
Client Morrison Hershfield
Project Sargent Avenue Watermain CP Rail Crossing

Sample Date 28-Jan-20
Test Date 01-Feb-20
Technician HS

Test Hole	TH 01	TH 01	TH 01	TH 01	TH 01	TH 02
Depth (m)	0.8 - 0.9	1.4 - 1.5	2.9 - 3.0	4.3 - 4.4	5.8 - 5.9	0.5 - 0.6
Sample #	G1	G2	G4	G6	G8	G9
Tare ID	W102	Z45	K16	N59	K11	AC09
Mass of tare	8.4	8.7	8.3	8.4	8.8	6.6
Mass wet + tare	160.0	179.8	201.8	207.3	310.5	260.5
Mass dry + tare	119.6	152.4	140.2	134.9	198.9	202.7
Mass water	40.4	27.4	61.6	72.4	111.6	57.8
Mass dry soil	111.2	143.7	131.9	126.5	190.1	196.1
Moisture %	36.3%	19.1%	46.7%	57.2%	58.7%	29.5%

Test Hole	TH 02	TH 02	TH 02	TH 02		
Depth (m)	1.4 - 1.5	2.9 - 3.0	4.4 - 4.6	5.9 - 6.1		
Sample #	G10	G12	G14	G16		
Tare ID	AB50	Z51	W79	E131		
Mass of tare	6.9	8.5	8.7	8.8		
Mass wet + tare	204.9	236.5	225.1	169.3		
Mass dry + tare	166.4	159.2	148.9	111.5		
Mass water	38.5	77.3	76.2	57.8		
Mass dry soil	159.5	150.7	140.2	102.7		
Moisture %	24.1%	51.3%	54.4%	56.3%		

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Shelby Tube Visual

Project No.	0035-086-00-100
Client	Morrison Hershfield
Project	Sargent Avenue Watermain CP Rail Crossing
Test Hole	TH 01
Sample #	T3
Depth (m)	1.5 - 2.1
Sample Date	28-Jan-20
Test Date	02-Feb-20
Technician	HS

Tube Extraction

Recovery (mm) 620

Bottom - 2.1 m	A	2.00 m	1.74 m	B 1.64 m	Top - 1.5 m
Keep Bulk Insufficient clay sample for Qu	Moisture Content Visual PP/TV	Keep	Visual	Moisture Content	
140 mm (A)	20 mm (A)	240 mm (B)	100 mm (B)	120 mm (B)	

Visual Classification

	A	B
Material	CLAY	SILT
Composition	silty	clayey
	trace sand	
Color	grey	brown
Moisture	moist	moist
Consistency	very stiff	soft
Plasticity	intermediate plasticity	intermediate plasticity
Structure	-	-
Gradation		

Moisture Content

	A	B
Tare ID	Z24	F124
Mass tare (g)	8.4	8.4
Mass wet + tare (g)	225	314.4
Mass dry + tare (g)	173.4	259.1
Moisture %	31.3%	22.1%

Torvane

	A	B	
Reading	0.5	-	
Vane Size (s,m,l)	s	-	
Undrained Shear Strength	122.6	-	(kPa)

Pocket Penetrometer

		A	B	
Reading	**1**	2.500	-	
	2	2.700	-	
	3	2.700	-	
	Average	2.633	-	
Undrained Shear Strength		129.1	-	(kPa)

Unit Weight

		A	B
Bulk Weight (g)		857.80	-
Length (mm)	**1**	112.37	-
	2	112.51	-
	3	112.44	-
	4	112.60	-
Average Length (m)		0.122	-
Diam. (mm)	**1**	71.78	-
	2	71.78	-
	3	71.90	-
	4	71.68	-
Average Diameter (m)		0.072	-
Volume (m^3)		4.97E-04	-
Bulk Unit Weight (kN/m^3)		16.9	-
Bulk Unit Weight (pcf)		107.8	-
Dry Unit Weight (kN/m^3)		12.9	-
Dry Unit Weight (pcf)		82.1	-

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Shelby Tube Visual

Project No.	0035-086-00-100
Client	Morrison Hershfield
Project	Sargent Avenue Watermain CP Rail Crossing

Test Hole	TH 01
Sample #	T5
Depth (m)	3.0 - 3.7
Sample Date	28-Jan-20
Test Date	02-Feb-20
Technician	HS

Tube Extraction

Recovery (mm) 560

Bottom - 3.6 m	3.33 m	3.29 m	3.13 m	**Top - 3 m**
Keep	Moisture Content	Bulk Qu	PP TV Visual	
280 mm	40 mm	160 mm	80 mm	

Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<10 mm diam.)	
trace sand	
trace oxidation	
Color	grey
Moisture	moist
Consistency	firm to stiff
Plasticity	intermediate plasticity
Structure	-
Gradation	

Torvane

Reading	0.65
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	63.8

Pocket Penetrometer

Reading	**1**	1.50
	2	1.40
	3	1.40
	Average	1.43
Undrained Shear Strength (kPa)		70.3

Moisture Content

Tare ID	Z18
Mass tare (g)	8.4
Mass wet + tare (g)	307.4
Mass dry + tare (g)	204.4
Moisture %	52.6%

Unit Weight

Bulk Weight (g)		975.8
Length (mm)	**1**	142.43
	2	142.95
	3	142.23
	4	142.68
Average Length (m)		0.143
Diam. (mm)	**1**	71.21
	2	71.58
	3	71.33
	4	71.72
Average Diameter (m)		0.071
Volume (m^3)		5.72E-04
Bulk Unit Weight (kN/m^3)		16.7
Bulk Unit Weight (pcf)		106.5
Dry Unit Weight (kN/m^3)		11.0
Dry Unit Weight (pcf)		69.8

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Unconfined Compressive Strength

ASTM D2166

Project No.	0035-086-00-100
Client	Morrison Hershfield
Project	Sargent Avenue Watermain CP Rail Crossing

Test Hole	TH 01
Sample #	T5
Depth (m)	3.0 - 3.7
Sample Date	28-Jan-20
Test Date	2-Feb-20
Technician	HS

Unconfined Strength

	kPa	ksf
Max q_u	74.9	1.6
Max S_u	37.4	0.8

Specimen Data

Description CLAY - silty, trace silt inclusions (<10 mm diam.), trace sand, trace oxidation, grey, moist, firm to stiff, intermediate plasticity

Length	142.6	(mm)	**Moisture %**	53%	
Diameter	71.5	(mm)	**Bulk Unit Wt.**	16.7	(kN/m^3)
L/D Ratio	2.0		**Dry Unit Wt.**	11.0	(kN/m^3)
Initial Area	0.00401	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	kPa	ksf
0.65	63.8	1.33

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	kPa	ksf
	1.50	73.6	1.54
	1.40	68.7	1.43
	1.40	68.7	1.43
Average	**1.43**	**70.3**	**1.47**

Failure Geometry

Sketch:

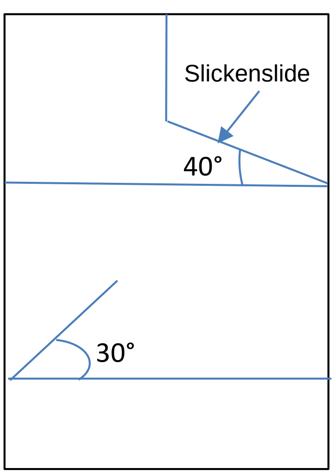

Photo:

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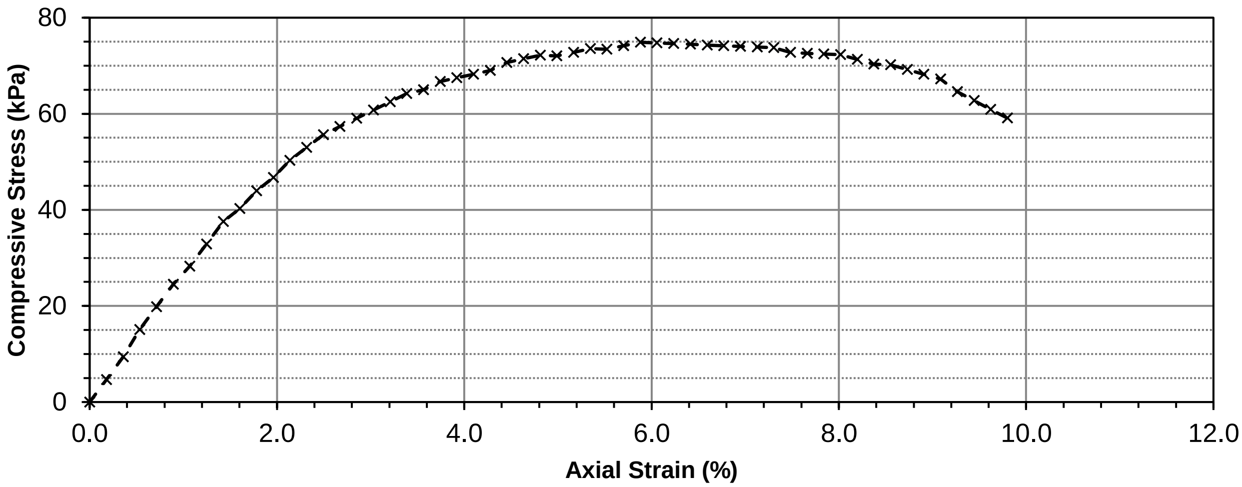
Unconfined Compressive Strength
ASTM D2166

Project No. 0035-086-00-100
Client Morrison Hershfield
Project Sargent Avenue Watermain CP Rail Crossing

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004011	0.0	0.00	0.00
10	5	0.2540	0.18	0.004018	18.7	4.66	2.33
20	10	0.5080	0.36	0.004025	37.9	9.41	4.71
30	16	0.7620	0.53	0.004032	60.8	15.09	7.55
40	21	1.0160	0.71	0.004039	80.0	19.80	9.90
50	26	1.2700	0.89	0.004047	99.1	24.50	12.25
60	30	1.5240	1.07	0.004054	114.4	28.23	14.11
70	35	1.7780	1.25	0.004061	133.6	32.89	16.45
80	40	2.0320	1.43	0.004069	152.7	37.54	18.77
90	43	2.2860	1.60	0.004076	164.2	40.29	20.14
100	47	2.5400	1.78	0.004083	179.5	43.96	21.98
110	50	2.7940	1.96	0.004091	191.0	46.69	23.34
120	54	3.0480	2.14	0.004098	206.1	50.29	25.15
130	57	3.3020	2.32	0.004106	217.4	52.96	26.48
140	60	3.5560	2.49	0.004113	228.8	55.62	27.81
150	62	3.8100	2.67	0.004121	236.3	57.35	28.67
160	64	4.0640	2.85	0.004128	243.9	59.07	29.54
170	66	4.3180	3.03	0.004136	251.4	60.79	30.39
180	68	4.5720	3.21	0.004144	259.0	62.50	31.25
190	70	4.8260	3.38	0.004151	266.5	64.20	32.10
200	71	5.0800	3.56	0.004159	270.3	64.99	32.50
210	73	5.3340	3.74	0.004167	277.8	66.69	33.34
220	74	5.5880	3.92	0.004174	281.6	67.47	33.73
230	75	5.8420	4.10	0.004182	285.4	68.24	34.12

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Unconfined Compressive Strength
ASTM D2166

Project No. 0035-086-00-100
Client Morrison Hershfield
Project Sargent Avenue Watermain CP Rail Crossing

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	76	6.0960	4.28	0.004190	289.1	69.01	34.51
250	78	6.3500	4.45	0.004198	296.6	70.66	35.33
260	79	6.6040	4.63	0.004205	300.4	71.42	35.71
270	80	6.8580	4.81	0.004213	304.1	72.18	36.09
280	80	7.1120	4.99	0.004221	304.1	72.04	36.02
290	81	7.3660	5.17	0.004229	307.8	72.79	36.39
300	82	7.6200	5.34	0.004237	311.6	73.54	36.77
310	82	7.8740	5.52	0.004245	311.6	73.40	36.70
320	83	8.1280	5.70	0.004253	315.3	74.14	37.07
330	84	8.3820	5.88	0.004261	319.1	74.88	37.44
340	84	8.6360	6.06	0.004269	319.1	74.73	37.37
350	84	8.8900	6.24	0.004277	319.1	74.59	37.30
360	84	9.1440	6.41	0.004286	319.1	74.45	37.23
370	84	9.3980	6.59	0.004294	319.1	74.31	37.15
380	84	9.6520	6.77	0.004302	319.1	74.17	37.08
390	84	9.9060	6.95	0.004310	319.1	74.03	37.01
400	84	10.1600	7.13	0.004318	319.1	73.88	36.94
410	84	10.4140	7.30	0.004327	319.1	73.74	36.87
420	83	10.6680	7.48	0.004335	315.3	72.74	36.37
430	83	10.9220	7.66	0.004343	315.3	72.60	36.30
440	83	11.1760	7.84	0.004352	315.3	72.46	36.23
450	83	11.4300	8.02	0.004360	315.3	72.32	36.16
460	82	11.6840	8.20	0.004369	311.6	71.32	35.66
470	81	11.9380	8.37	0.004377	307.8	70.33	35.16
480	81	12.1920	8.55	0.004386	307.8	70.19	35.10
490	80	12.4460	8.73	0.004394	304.1	69.20	34.60
500	79	12.7000	8.91	0.004403	300.4	68.22	34.11
510	78	12.9540	9.09	0.004411	296.6	67.24	33.62
520	75	13.2080	9.26	0.004420	285.4	64.57	32.28
530	73	13.4620	9.44	0.004429	277.8	62.74	31.37
540	71	13.7160	9.62	0.004438	270.3	60.91	30.46
550	69	13.9700	9.80	0.004446	262.7	59.09	29.55

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Shelby Tube Visual

Project No.	0035-086-00-100
Client	Morrison Hershfield
Project	Sargent Avenue Watermain CP Rail Crossing
Test Hole	TH 01
Sample #	T7
Depth (m)	4.6 - 5.2
Sample Date	28-Jan-20
Test Date	02-Feb-20
Technician	HS

Tube Extraction

Recovery (mm) 610

Bottom - 5.2 m — 4.89 m — 4.72 m — 4.64 m — **Top - 4.6 m**

Keep	Bulk Qu	PP TV Visual	Moisture Content
290 mm	170 mm	80 mm	70 mm

Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<10 mm diam.)	
Color	grey
Moisture	moist
Consistency	firm
Plasticity	high plasticity
Structure	-
Gradation	

Torvane

Reading	0.30
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	29.4

Pocket Penetrometer

Reading	**1**	0.60
	2	0.60
	3	0.60
	Average	0.60
Undrained Shear Strength (kPa)		29.4

Moisture Content

Tare ID	W100
Mass tare (g)	8.5
Mass wet + tare (g)	263.3
Mass dry + tare (g)	170.8
Moisture %	57.0%

Unit Weight

Bulk Weight (g)		1036.4
Length (mm)	**1**	150.03
	2	149.90
	3	149.95
	4	150.15
Average Length (m)		0.150
Diam. (mm)	**1**	71.77
	2	71.76
	3	71.70
	4	71.90
Average Diameter (m)		0.072
Volume (m^3)		6.07E-04
Bulk Unit Weight (kN/m^3)		16.7
Bulk Unit Weight (pcf)		106.6
Dry Unit Weight (kN/m^3)		10.7
Dry Unit Weight (pcf)		67.9

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Unconfined Compressive Strength
ASTM D2166

Project No.	0035-086-00-100
Client	Morrison Hershfield
Project	Sargent Avenue Watermain CP Rail Crossing

Test Hole	TH 01
Sample #	T7
Depth (m)	4.6 - 5.2
Sample Date	28-Jan-20
Test Date	2-Feb-20
Technician	HS

Unconfined Strength

	kPa	**ksf**
Max q_u	94.8	2.0
Max S_u	47.4	1.0

Specimen Data

Description CLAY - silty, trace silt inclusions (<10 mm diam.), grey, moist, firm, high plasticity

Length	150.0	(mm)	**Moisture %**	57%	
Diameter	71.8	(mm)	**Bulk Unit Wt.**	16.7	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	10.7	(kN/m^3)
Initial Area	0.00405	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.30	29.4	0.61

Pocket Penetrometer

	Reading	**Undrained Shear Strength**	
	tsf	**kPa**	**ksf**
	0.60	29.4	0.61
	0.60	29.4	0.61
	0.60	29.4	0.61
Average	**0.60**	**29.4**	**0.61**

Failure Geometry

Sketch:

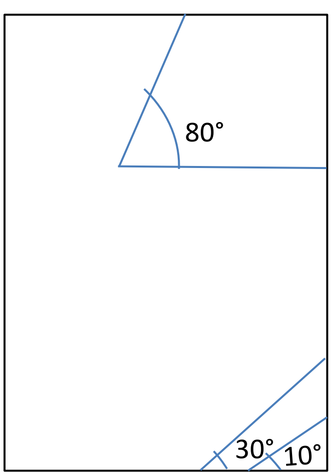

Photo:

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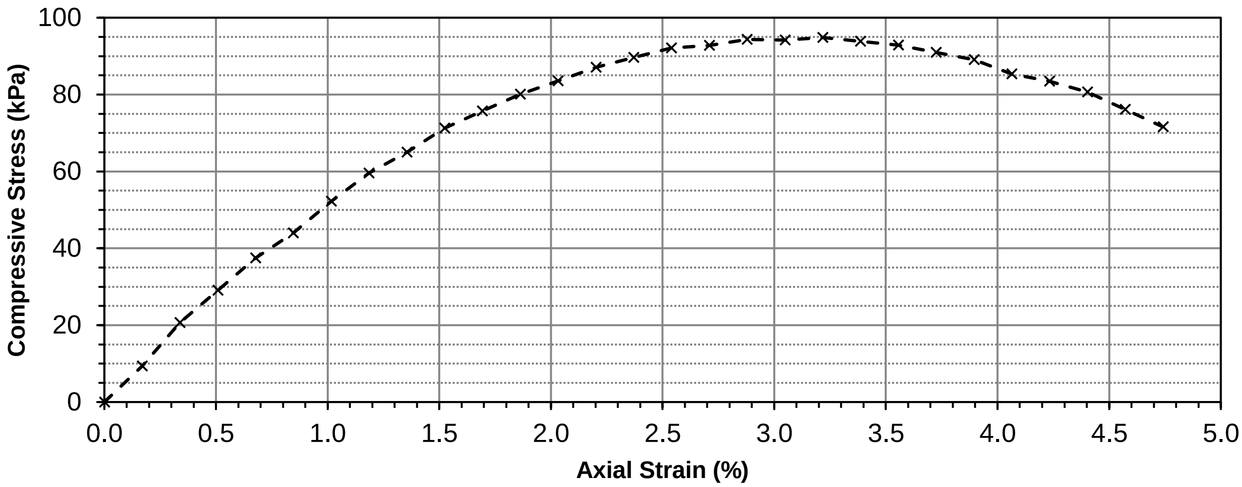
Unconfined Compressive Strength
ASTM D2166

Project No. 0035-086-00-100
Client Morrison Hershfield
Project Sargent Avenue Watermain CP Rail Crossing

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004047	0.0	0.00	0.00
10	10	0.2540	0.17	0.004054	37.9	9.34	4.67
20	22	0.5080	0.34	0.004061	83.8	20.64	10.32
30	31	0.7620	0.51	0.004068	118.3	29.08	14.54
40	40	1.0160	0.68	0.004075	152.7	37.48	18.74
50	47	1.2700	0.85	0.004081	179.5	43.98	21.99
60	56	1.5240	1.02	0.004088	213.7	52.26	26.13
70	64	1.7780	1.19	0.004095	243.9	59.54	29.77
80	70	2.0320	1.35	0.004103	266.5	64.97	32.48
90	77	2.2860	1.52	0.004110	292.9	71.27	35.63
100	82	2.5400	1.69	0.004117	311.6	75.69	37.84
110	87	2.7940	1.86	0.004124	330.3	80.09	40.05
120	91	3.0480	2.03	0.004131	345.2	83.58	41.79
130	95	3.3020	2.20	0.004138	360.2	87.05	43.52
140	98	3.5560	2.37	0.004145	371.4	89.60	44.80
150	101	3.8100	2.54	0.004152	382.4	92.10	46.05
160	102	4.0640	2.71	0.004160	386.0	92.79	46.39
170	104	4.3180	2.88	0.004167	393.0	94.32	47.16
180	104	4.5720	3.05	0.004174	393.0	94.16	47.08
190	105	4.8260	3.22	0.004181	396.6	94.84	47.42
200	104	5.0800	3.39	0.004189	393.0	93.83	46.91
210	103	5.3340	3.56	0.004196	389.5	92.82	46.41
220	101	5.5880	3.73	0.004204	382.4	90.98	45.49
230	99	5.8420	3.89	0.004211	375.2	89.09	44.55

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Unconfined Compressive Strength
ASTM D2166

Project No. 0035-086-00-100
Client Morrison Hershfield
Project Sargent Avenue Watermain CP Rail Crossing

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	95	6.0960	4.06	0.004218	360.2	85.39	42.69
250	93	6.3500	4.23	0.004226	352.7	83.47	41.73
260	90	6.6040	4.40	0.004233	341.5	80.67	40.33
270	85	6.8580	4.57	0.004241	322.8	76.12	38.06
280	80	7.1120	4.74	0.004248	304.1	71.58	35.79

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Shelby Tube Visual

Project No.	0035-086-00-100
Client	Morrison Hershfield
Project	Sargent Avenue Watermain CP Rail Crossing
Test Hole	TH 02
Sample #	T11
Depth (m)	1.5 - 2.1
Sample Date	28-Jan-20
Test Date	02-Feb-20
Technician	HS

Tube Extraction

Recovery (mm) 410

Bottom - 1.9 m	1.80 m	1.79 m	1.63 m	1.58 m Top - 1.5 m
Keep	Silt Seam	Bulk Qu	PP TV Visual	Moisture Content
135 mm	10 mm	155 mm	55 mm	55 mm

Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<10 mm diam.)	
trace sand	
10 mm thick silt seam observed at 1.8 m	
Color	grey
Moisture	moist
Consistency	stiff to very stiff
Plasticity	intermediate plasticity
Structure	blocky
Gradation	

Torvane

Reading	0.45
Vane Size (s,m,l)	s
Undrained Shear Strength (kPa)	110.3

Pocket Penetrometer

Reading	**1**	2.20
	2	2.30
	3	2.20
	Average	2.23
Undrained Shear Strength (kPa)		109.5

Moisture Content

Tare ID	E2
Mass tare (g)	8.7
Mass wet + tare (g)	239.7
Mass dry + tare (g)	191.1
Moisture %	26.6%

Unit Weight

Bulk Weight (g)		1160.8
Length (mm)	**1**	153.71
	2	153.51
	3	153.21
	4	152.90
Average Length (m)		0.153
Diam. (mm)	**1**	71.51
	2	71.50
	3	71.90
	4	71.40
Average Diameter (m)		0.072
Volume (m^3)		6.17E-04
Bulk Unit Weight (kN/m^3)		18.5
Bulk Unit Weight (pcf)		117.5
Dry Unit Weight (kN/m^3)		14.6
Dry Unit Weight (pcf)		92.7

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Unconfined Compressive Strength
ASTM D2166

Project No.	0035-086-00-100
Client	Morrison Hershfield
Project	Sargent Avenue Watermain CP Rail Crossing

Test Hole	TH 02
Sample #	T11
Depth (m)	1.5 - 2.1
Sample Date	28-Jan-20
Test Date	2-Feb-20
Technician	HS

Unconfined Strength

	kPa	ksf
Max q_u	67.6	1.4
Max S_u	33.8	0.7

Specimen Data

Description CLAY - silty, trace silt inclusions (<10 mm diam.), trace sand, 10 mm thick silt seam observed at 1.8 m, grey, moist, stiff to very stiff, intermediate plasticity, blocky

Length	153.3	(mm)	**Moisture %**	27%	
Diameter	71.6	(mm)	**Bulk Unit Wt.**	18.5	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	14.6	(kN/m^3)
Initial Area	0.00402	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
0.45	110.3	2.30

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	**kPa**	**ksf**
	2.20	107.9	2.25
	2.30	112.8	2.36
	2.20	107.9	2.25
Average	**2.23**	**109.5**	**2.29**

Failure Geometry

Sketch:

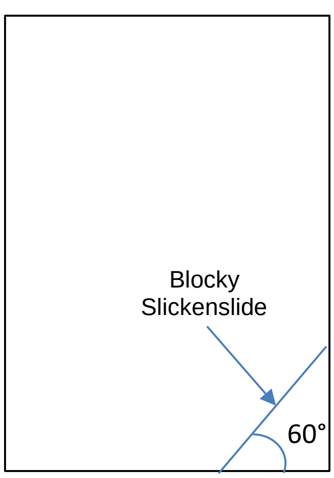

Photo:

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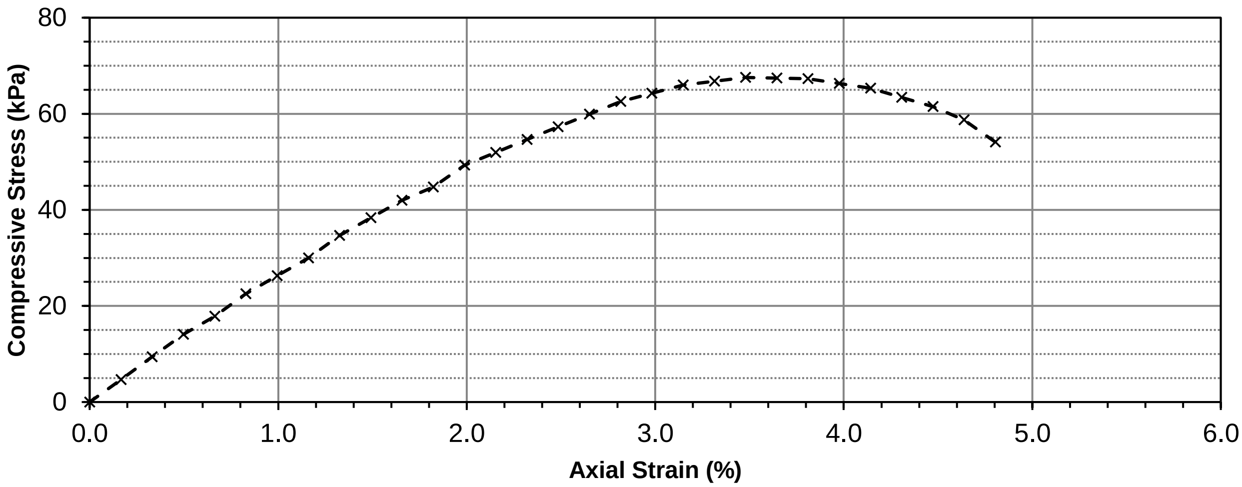
Unconfined Compressive Strength
ASTM D2166

Project No. 0035-086-00-100
Client Morrison Hershfield
Project Sargent Avenue Watermain CP Rail Crossing

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004024	0.0	0.00	0.00
10	5	0.2540	0.17	0.004031	18.7	4.65	2.32
20	10	0.5080	0.33	0.004037	37.9	9.38	4.69
30	15	0.7620	0.50	0.004044	57.0	14.10	7.05
40	19	1.0160	0.66	0.004051	72.3	17.86	8.93
50	24	1.2700	0.83	0.004057	91.5	22.54	11.27
60	28	1.5240	0.99	0.004064	106.8	26.27	13.14
70	32	1.7780	1.16	0.004071	122.1	29.99	15.00
80	37	2.0320	1.33	0.004078	141.2	34.63	17.32
90	41	2.2860	1.49	0.004085	156.5	38.32	19.16
100	45	2.5400	1.66	0.004092	171.9	42.00	21.00
110	48	2.7940	1.82	0.004099	183.3	44.73	22.37
120	53	3.0480	1.99	0.004105	202.3	49.28	24.64
130	56	3.3020	2.15	0.004112	213.7	51.95	25.98
140	59	3.5560	2.32	0.004119	225.0	54.62	27.31
150	62	3.8100	2.48	0.004126	236.3	57.27	28.63
160	65	4.0640	2.65	0.004133	247.6	59.91	29.96
170	68	4.3180	2.82	0.004140	259.0	62.55	31.27
180	70	4.5720	2.98	0.004148	266.5	64.26	32.13
190	72	4.8260	3.15	0.004155	274.1	65.97	32.98
200	73	5.0800	3.31	0.004162	277.8	66.76	33.38
210	74	5.3340	3.48	0.004169	281.6	67.55	33.78
220	74	5.5880	3.64	0.004176	281.6	67.44	33.72
230	74	5.8420	3.81	0.004183	281.6	67.32	33.66

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Unconfined Compressive Strength
ASTM D2166

Project No. 0035-086-00-100
Client Morrison Hershfield
Project Sargent Avenue Watermain CP Rail Crossing

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	73	6.0960	3.98	0.004190	277.8	66.30	33.15
250	72	6.3500	4.14	0.004198	274.1	65.29	32.65
260	70	6.6040	4.31	0.004205	266.5	63.38	31.69
270	68	6.8580	4.47	0.004212	259.0	61.48	30.74
280	65	7.1120	4.64	0.004220	247.6	58.69	29.34
290	60	7.3660	4.80	0.004227	228.8	54.12	27.06

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Shelby Tube Visual

Project No.	0035-086-00-100
Client	Morrison Hershfield
Project	Sargent Avenue Watermain CP Rail Crossing

Test Hole	TH 02
Sample #	T13
Depth (m)	3.0 - 3.7
Sample Date	28-Jan-20
Test Date	02-Feb-20
Technician	HS

Tube Extraction

Recovery (mm) 430

Bottom - 3.5 m	3.32 m	3.18 m	3.14 m	3.12 m Top - 3 m
Bulk Qu	Keep	PP TV Visual	Silt Seam	Moisture Content
160 mm	140 mm	60 mm	70 mm	70 mm

Visual Classification

Material	CLAY
Composition	silty
trace sand	
trace gravel	
trace precipitates (sulphates)	
25 mm thick silt seam observed at 3.12 m	
Color	grey
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	-
Gradation	

Torvane

Reading	0.80
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	78.5

Pocket Penetrometer

Reading	**1**	1.90
	2	1.80
	3	1.80
	Average	1.83
Undrained Shear Strength (kPa)		89.9

Moisture Content

Tare ID	F131
Mass tare (g)	8.5
Mass wet + tare (g)	253.4
Mass dry + tare (g)	188.1
Moisture %	36.4%

Unit Weight

Bulk Weight (g)		1055.5
Length (mm)	**1**	150.43
	2	149.90
	3	150.25
	4	149.98
Average Length (m)		0.150
Diam. (mm)	**1**	71.51
	2	71.21
	3	71.31
	4	71.36
Average Diameter (m)		0.071
Volume (m^3)		6.00E-04
Bulk Unit Weight (kN/m^3)		17.2
Bulk Unit Weight (pcf)		109.8
Dry Unit Weight (kN/m^3)		12.6
Dry Unit Weight (pcf)		80.5

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Unconfined Compressive Strength
ASTM D2166

Project No.	0035-086-00-100
Client	Morrison Hershfield
Project	Sargent Avenue Watermain CP Rail Crossing

Test Hole	TH 02
Sample #	T13
Depth (m)	3.0 - 3.7
Sample Date	28-Jan-20
Test Date	2-Feb-20
Technician	HS

Unconfined Strength

	kPa	ksf
Max q_u	102.4	2.1
Max S_u	51.2	1.1

Specimen Data

Description CLAY - silty, trace sand, trace gravel , trace precipitates (sulphates), 25 mm thick silt seam observed at 3.12 m, grey, moist, stiff, high plasticity

Length	150.1	(mm)	**Moisture %**	36%	
Diameter	71.3	(mm)	**Bulk Unit Wt.**	17.2	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	12.6	(kN/m^3)
Initial Area	0.00400	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading tsf	Undrained Shear Strength kPa	Undrained Shear Strength ksf
0.80	78.5	1.64

Pocket Penetrometer

	Reading tsf	Undrained Shear Strength kPa	Undrained Shear Strength ksf
	1.90	93.2	1.95
	1.80	88.3	1.84
	1.80	88.3	1.84
Average	**1.83**	**89.9**	**1.88**

Failure Geometry

Sketch:

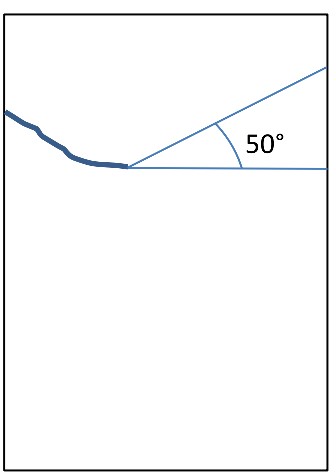

Photo:

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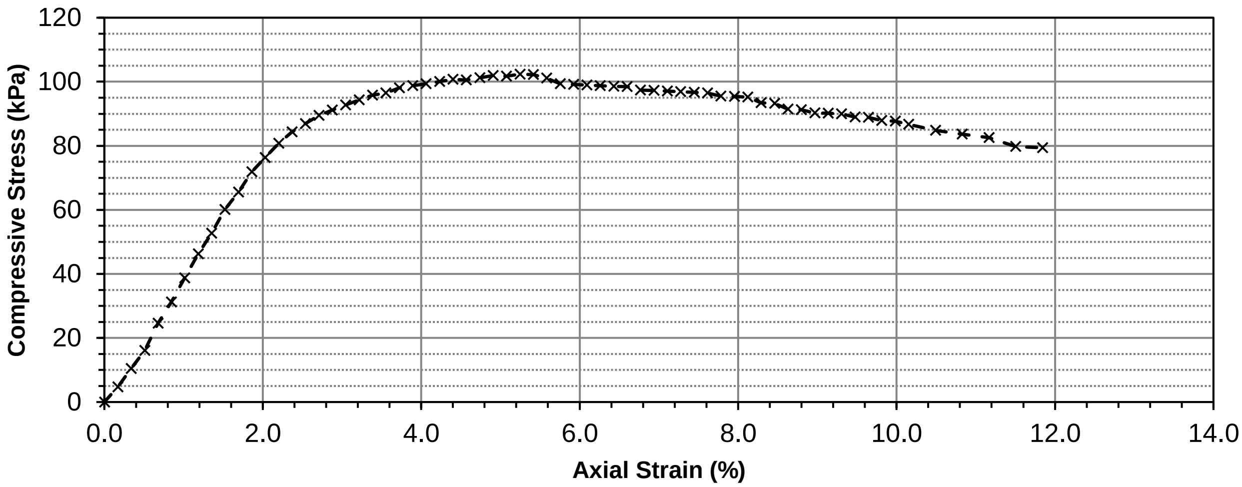
Unconfined Compressive Strength
ASTM D2166

Project No. 0035-086-00-100
Client Morrison Hershfield
Project Sargent Avenue Watermain CP Rail Crossing

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.003998	0.0	0.00	0.00
10	5	0.2540	0.17	0.004005	18.7	4.68	2.34
20	11	0.5080	0.34	0.004012	41.7	10.40	5.20
30	17	0.7620	0.51	0.004018	64.7	16.09	8.05
40	26	1.0160	0.68	0.004025	99.1	24.63	12.31
50	33	1.2700	0.85	0.004032	125.9	31.23	15.61
60	41	1.5240	1.02	0.004039	156.5	38.76	19.38
70	49	1.7780	1.18	0.004046	187.2	46.26	23.13
80	56	2.0320	1.35	0.004053	213.7	52.72	26.36
90	64	2.2860	1.52	0.004060	243.9	60.07	30.03
100	70	2.5400	1.69	0.004067	266.5	65.53	32.77
110	77	2.7940	1.86	0.004074	292.9	71.89	35.95
120	82	3.0480	2.03	0.004081	311.6	76.35	38.18
130	87	3.3020	2.20	0.004088	330.3	80.79	40.40
140	91	3.5560	2.37	0.004095	345.2	84.31	42.15
150	94	3.8100	2.54	0.004102	356.5	86.90	43.45
160	97	4.0640	2.71	0.004109	367.7	89.48	44.74
170	99	4.3180	2.88	0.004116	375.2	91.14	45.57
180	101	4.5720	3.05	0.004124	382.4	92.74	46.37
190	103	4.8260	3.21	0.004131	389.5	94.29	47.15
200	105	5.0800	3.38	0.004138	396.6	95.83	47.92
210	106	5.3340	3.55	0.004145	400.1	96.52	48.26
220	108	5.5880	3.72	0.004153	407.2	98.05	49.02
230	109	5.8420	3.89	0.004160	410.7	98.73	49.36

Unconfined Compressive Strength
ASTM D2166

Project No. 0035-086-00-100
Client Morrison Hershfield
Project Sargent Avenue Watermain CP Rail Crossing

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	110	6.0960	4.06	0.004167	414.2	99.40	49.70
250	111	6.3500	4.23	0.004175	417.8	100.07	50.03
260	112	6.6040	4.40	0.004182	421.3	100.74	50.37
270	112	6.8580	4.57	0.004189	421.3	100.56	50.28
280	113	7.1120	4.74	0.004197	424.8	101.22	50.61
290	114	7.3660	4.91	0.004204	428.3	101.88	50.94
300	114	7.6200	5.08	0.004212	428.3	101.70	50.85
310	115	7.8740	5.24	0.004219	431.9	102.36	51.18
320	115	8.1280	5.41	0.004227	431.9	102.17	51.09
330	114	8.3820	5.58	0.004234	428.3	101.16	50.58
340	112	8.6360	5.75	0.004242	421.3	99.31	49.66
350	112	8.8900	5.92	0.004250	421.3	99.13	49.57
360	112	9.1440	6.09	0.004257	421.3	98.96	49.48
370	112	9.3980	6.26	0.004265	421.3	98.78	49.39
380	112	9.6520	6.43	0.004273	421.3	98.60	49.30
390	112	9.9060	6.60	0.004280	421.3	98.42	49.21
400	111	10.1600	6.77	0.004288	417.8	97.42	48.71
410	111	10.4140	6.94	0.004296	417.8	97.24	48.62
420	111	10.6680	7.11	0.004304	417.8	97.06	48.53
430	111	10.9220	7.27	0.004312	417.8	96.89	48.44
440	111	11.1760	7.44	0.004320	417.8	96.71	48.36
450	111	11.4300	7.61	0.004327	417.8	96.53	48.27
460	110	11.6840	7.78	0.004335	414.2	95.54	47.77
470	110	11.9380	7.95	0.004343	414.2	95.37	47.68
480	110	12.1920	8.12	0.004351	414.2	95.19	47.60
490	108	12.4460	8.29	0.004359	407.2	93.40	46.70
500	108	12.7000	8.46	0.004367	407.2	93.22	46.61
510	106	12.9540	8.63	0.004376	400.1	91.44	45.72
520	106	13.2080	8.80	0.004384	400.1	91.27	45.63
530	105	13.4620	8.97	0.004392	396.6	90.30	45.15
540	105	13.7160	9.14	0.004400	396.6	90.13	45.06
550	105	13.9700	9.30	0.004408	396.6	89.96	44.98
560	104	14.2240	9.47	0.004416	393.0	88.99	44.50
570	104	14.4780	9.64	0.004425	393.0	88.83	44.41
580	103	14.7320	9.81	0.004433	389.5	87.86	43.93
590	103	14.9860	9.98	0.004441	389.5	87.70	43.85
600	102	15.2400	10.15	0.004450	386.0	86.74	43.37
620	100	15.7480	10.49	0.004467	378.9	84.83	42.42
640	99	16.2560	10.83	0.004483	375.2	83.68	41.84
660	98	16.7640	11.17	0.004501	371.4	82.53	41.26
680	95	17.2720	11.50	0.004518	360.2	79.73	39.86
700	95	17.7800	11.84	0.004535	360.2	79.42	39.71

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Shelby Tube Visual

Project No.	0035-086-00-100
Client	Morrison Hershfield
Project	Sargent Avenue Watermain CP Rail Crossing

Test Hole	TH 02
Sample #	T15
Depth (m)	4.6 - 5.2
Sample Date	28-Jan-20
Test Date	01-Feb-20
Technician	HS

Tube Extraction

Recovery (mm) 640

Bottom - 5.2 m	4.94 m	4.76 m	4.66 m Top - 4.6 m
Keep	Bulk Qu	PP TV Visual	Moisture Content
270 mm	180 mm	100 mm	90 mm

Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<5 mm diam.)	
trace oxidation	
Color	grey
Moisture	moist
Consistency	firm
Plasticity	high plasticity
Structure	-
Gradation	

Torvane

Reading	0.35
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	34.3

Pocket Penetrometer

Reading	**1**	0.70
	2	0.70
	3	0.70
	Average	0.70
Undrained Shear Strength (kPa)		34.3

Moisture Content

Tare ID	AB51
Mass tare (g)	6.8
Mass wet + tare (g)	271.8
Mass dry + tare (g)	180.8
Moisture %	52.3%

Unit Weight

Bulk Weight (g)		1028.8
Length (mm)	**1**	151.40
	2	151.20
	3	150.90
	4	150.98
Average Length (m)		0.151
Diam. (mm)	**1**	71.76
	2	71.57
	3	71.90
	4	72.20
Average Diameter (m)		0.072
Volume (m^3)		6.13E-04
Bulk Unit Weight (kN/m^3)		16.5
Bulk Unit Weight (pcf)		104.8
Dry Unit Weight (kN/m^3)		10.8
Dry Unit Weight (pcf)		68.8

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Unconfined Compressive Strength
ASTM D2166

Project No.	0035-086-00-100
Client	Morrison Hershfield
Project	Sargent Avenue Watermain CP Rail Crossing
Test Hole	TH 02
Sample #	T15
Depth (m)	4.6 - 5.2
Sample Date	28-Jan-20
Test Date	1-Feb-20
Technician	HS

Unconfined Strength

	kPa	**ksf**
Max q_u	84.9	1.8
Max S_u	42.5	0.9

Specimen Data

Description CLAY - silty, trace silt inclusions (<5 mm diam.), trace oxidation, grey, moist, firm, high plasticity

Length	151.1	(mm)	**Moisture %**	52%	
Diameter	71.9	(mm)	**Bulk Unit Wt.**	16.5	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	10.8	(kN/m^3)
Initial Area	0.00406	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.35	34.3	0.72

Pocket Penetrometer

	Reading	**Undrained Shear Strength**	
	tsf	**kPa**	**ksf**
	0.70	34.3	0.72
	0.70	34.3	0.72
	0.70	34.3	0.72
Average	**0.70**	**34.3**	**0.72**

Failure Geometry

Sketch:

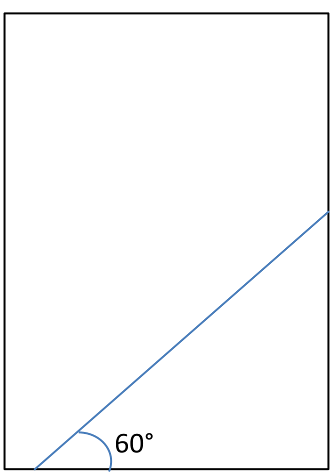

Photo:

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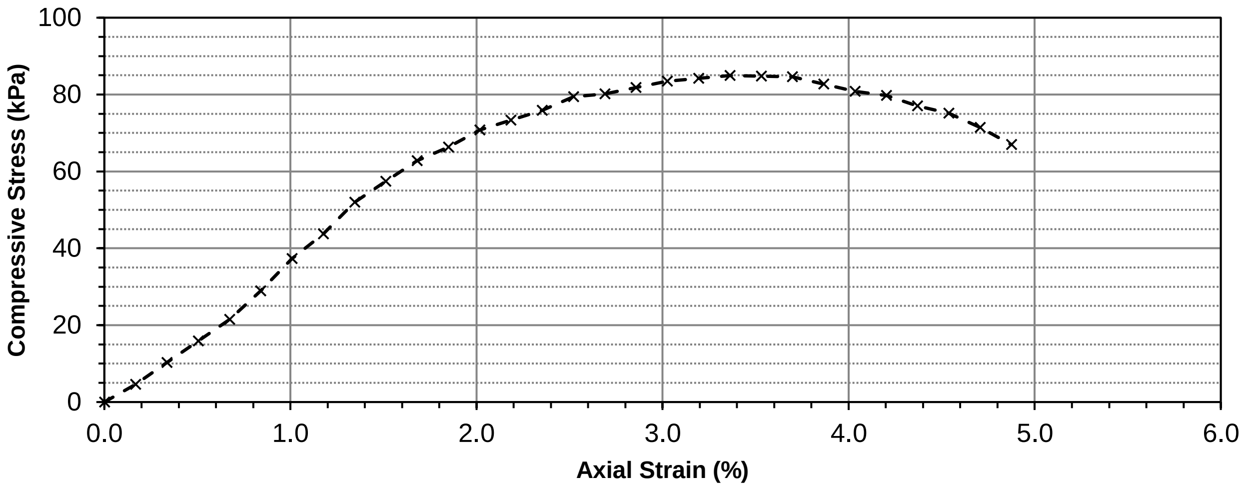
Unconfined Compressive Strength

ASTM D2166

Project No. 0035-086-00-100
Client Morrison Hershfield
Project Sargent Avenue Watermain CP Rail Crossing

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004055	0.0	0.00	0.00
10	5	0.2540	0.17	0.004062	18.7	4.61	2.31
20	11	0.5080	0.34	0.004069	41.7	10.25	5.12
30	17	0.7620	0.50	0.004076	64.7	15.87	7.93
40	23	1.0160	0.67	0.004083	87.6	21.47	10.73
50	31	1.2700	0.84	0.004090	118.3	28.92	14.46
60	40	1.5240	1.01	0.004097	152.7	37.28	18.64
70	47	1.7780	1.18	0.004104	179.5	43.75	21.87
80	56	2.0320	1.34	0.004111	213.7	51.98	25.99
90	62	2.2860	1.51	0.004118	236.3	57.39	28.69
100	68	2.5400	1.68	0.004125	259.0	62.78	31.39
110	72	2.7940	1.85	0.004132	274.1	66.33	33.17
120	77	3.0480	2.02	0.004139	292.9	70.76	35.38
130	80	3.3020	2.19	0.004146	304.1	73.35	36.67
140	83	3.5560	2.35	0.004153	315.3	75.92	37.96
150	87	3.8100	2.52	0.004160	330.3	79.39	39.69
160	88	4.0640	2.69	0.004167	334.0	80.15	40.07
170	90	4.3180	2.86	0.004175	341.5	81.80	40.90
180	92	4.5720	3.03	0.004182	349.0	83.45	41.72
190	93	4.8260	3.19	0.004189	352.7	84.20	42.10
200	94	5.0800	3.36	0.004196	356.5	84.94	42.47
210	94	5.3340	3.53	0.004204	356.5	84.80	42.40
220	94	5.5880	3.70	0.004211	356.5	84.65	42.32
230	92	5.8420	3.87	0.004218	349.0	82.73	41.36

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Unconfined Compressive Strength
ASTM D2166

Project No. 0035-086-00-100
Client Morrison Hershfield
Project Sargent Avenue Watermain CP Rail Crossing

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	90	6.0960	4.03	0.004226	341.5	80.81	40.41
250	89	6.3500	4.20	0.004233	337.8	79.79	39.89
260	86	6.6040	4.37	0.004241	326.5	77.00	38.50
270	84	6.8580	4.54	0.004248	319.1	75.10	37.55
280	80	7.1120	4.71	0.004256	304.1	71.46	35.73
290	75	7.3660	4.87	0.004263	285.4	66.94	33.47