WSP Canada Group Ltd.

2024 Local Street Renewal (24-K-01, 24-R1-01)

Prepared for:
Mark Vogt, M.Sc., P.Eng.
WSP Canada Group Ltd.
111-93 Lombard Avenue
Winnipeg, MB
R3B 3B1

Project Number: 1000-043-25

Date: March 21, 2024

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GEOTECHNICAL
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March 21, 2024

Our File No. 1000-043-25

Mark Vogt, M.Sc., P.Eng.
WSP Canada Group Ltd.
111-93 Lombard Avenue
Winnipeg, MB
R3B 3B1

RE: 2024 Local Street Renewal (24-K-01, 24-R1-01) - Revised

TREK Geotechnical Inc. is pleased to submit our Final Report for the geotechnical investigation for 2024 Local Street Renewal (24-K-01, 24-R1-01) project.

Please contact the undersigned should you have any questions.

Sincerely,

TREK Geotechnical Inc.
Per:

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

Encl.

Revision History

Revision No.	Author	Issue Date	Description
0	KF	March 21, 2024	Final Report
1	KF	March 21, 2024	Revision 1

Authorization Signatures

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ENGINEERS
GEOSCIENTISTS
MANITOBA
Certificate of Authorization
TREK GEOTECHNICAL INC.
No. 4877

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1.0 Introduction

This report summarizes the results of the road investigation completed for the 2024 Local Streets Renewal (23-K-01, 24-R1-01) project. The project included drilling test holes and collecting pavement cores along several streets. The test hole information collected describes the pavement structure of the existing road as well as the soil stratigraphy beneath the pavement structure. The investigation was carried out following the City of Winnipeg RFP No. 751-2023 (Section E3 – Site Investigation Requirements).

2.0 Road Investigation

The investigation included coring of pavement at 32 locations on 7 different Local streets with drilling of test holes occurring at 12 of the cored locations along four streets. The investigation locations are shown on Figures 01 to 04 (attached) and the table below summarizes the investigation program per street.

Table 1 – Road Investigation Program

24-K-01, 24-RI-01 Pavement and Geotechnical Investigation	# of Locations	Investigation
Adamar Rd – Pembina Hwy to End	4	4 Test holes to 3.0m
Daly St N - Lorette Ave to Pembina Hwy	1	1 Test hole to 3.0m 3 Cores
Dudley Ave – Pembina Hwy to Daly St N.	2	2 Test holes to 3.0m
Dudley Ave – Daly St N to End	1	1 Core
Harrow St – Sparling Ave to Harrow St.	3	3 Cores
Irene St – Clarence Ave to Waller Ave	5	5 Test holes to 3.0m
Irene St – Waller Ave to Sony Pl	4	4 Cores
Lorette Ave – Pembina Hwy to Daly St N	3	3 Cores
Sparling Ave – End (Walmart Parking Lot) to Harrow St.	6	6 Cores

The road investigation was conducted between February 20, 2024 to February 26, 2024. The pavement structure (asphalt/concrete) was cored by Tyler Green of TREK Geotechnical Inc. (TREK) using a portable coring press equipped with a hollow 150 mm diameter diamond core drill bits. The test holes were drilled by Paddock Drilling Ltd to a depth of approximately 3.0 m below road surface using a truck mounted drill rig equipped with 125 mm diameter solid stem augers. The sub-surface conditions were observed during drilling and visually classified by Kate Franklin 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. Pavement core samples were also retrieved and logged at TREK's material testing laboratory.

Core and test hole logs noted on the summary tables and test hole locations are based on UTM coordinates obtained using a hand-held GPS, and their location relative to the nearest address or intersection, measured distance 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 0.6 and 0.9 m below pavement as well as Standard Proctor and CBR testing. Information gathered for each street package is included in separate appendices (Appendices A to J). The information provided in the Appendices includes test hole logs, laboratory testing summary tables and results, photos of the concrete cores, and summary of pavement core compressive strength.

Six CBR's were completed on bulk samples of the soil units present below the pavement. Tests were performed on clay and silt layers encountered within the prescribed sample depth for CBR testing and the results are shown in the table below.

Table 1: CBR Testing Summary

Soil Unit	Street	Depth (m)	SPMDD (kg/m^3)	Opt. Moisture (%)	Percent Proctor (%)	Moisture Content (%)	CBR Value at 2.54 mm	CBR Value at 5.08 mm
Clay	Irene St: TH24-01 & TH24-02 Combined	1.4 – 2.0	1385	31.5	95.4	31.8	1.7%	1.3%
Clay	Irene St: TH24-03 & TH24-04 Combined	0.9 - 2.0	1390	30.3	94.8	29.7	1.7%	1.3%
Silt	Dudley Ave: TH24-06 & TH24-07 Combined	0.9 – 1.5	1864	14.3	94.9	14.4	6.8%	5.7%
Clay	Dudley Ave: TH24-06 & TH24-07 Combined	1.5 – 2.0	1397	30.8	94.7	30.7	1.5%	1.3%
Silt	Adamar Rd: TH24-09 & TH24-11 Combined	0.9 – 1.5	1704	15.4	94.8	15.1	3.5%	2.9%
Clay	Adamar Rd: TH24-11 & TH24-12 Combined	1.5 - 2.0 0.9 – 2.0	1421	28.5	96.7	27.6	1.5%	1.3%

The test hole logs include a description of the soil units encountered during drilling and other pertinent information such as groundwater conditions and a summary of the laboratory testing results. The soils were classified in general accordance with the Unified Soil Classification System (USCS) and the AASHTO soil classification system (American Association of state highway and transportation officials). The AASHTO system classifies soils based on laboratory testing results from Atterberg Limits and grain size testing methods (hydrometer and mechanical sieve method). Where laboratory testing was not conducted, the AASHTO classification of the soils were interpreted based on a visual assessment as indicated with a (I) on the test hole logs and attached tables. For cohesive soils, the AASHTO system uses a combination of testing results to determine the Group Index of the soils and thus, were only determined where sufficient laboratory test data was available.

Ten concrete cores were selected for concrete compressive strength breaks and the length to diameter ratio ranged between 1.00 to 1.30 for the cores collected. The core compressive strength tests were tested in accordance with CSA A23.2-14C – wet dried condition. The measured compressive strengths were also corrected based on an adapted ACI 214.4R-03 Standard to estimate the in-place concrete strengths. The table below summarizes the compressive strength results while the compressive strength testing details and the correction factor methodology are included in Appendix A and D through F.

Table 2: Concrete Core Compressive Strength Results

Core ID (Location)	Uncorrected Compressive Strength (MPa)	Corrected Compressive Strength (MPa)
PC24-06 (Daly Street)	41.57	43.67
PC24-10 (Daly Street)	58.68	63.07
PC24-12 (Harrow Street)	62.48	66.02
PC24-17 (Harrow Street)	47.91	49.59
PC24-01 (Irene Street)	35.91	39.83
PC24-03 (Irene Street)	53.29	55.86
PC24-07 (Lorette Avenue)	61.79	65.05
PC24-11 (Lorette Avenue)	63.83	66.68
PC24-14 (Sparling Avenue)	52.38	56.61
PC24-20 (Sparling Avenue)	60.62	63.08

3.0 Closure

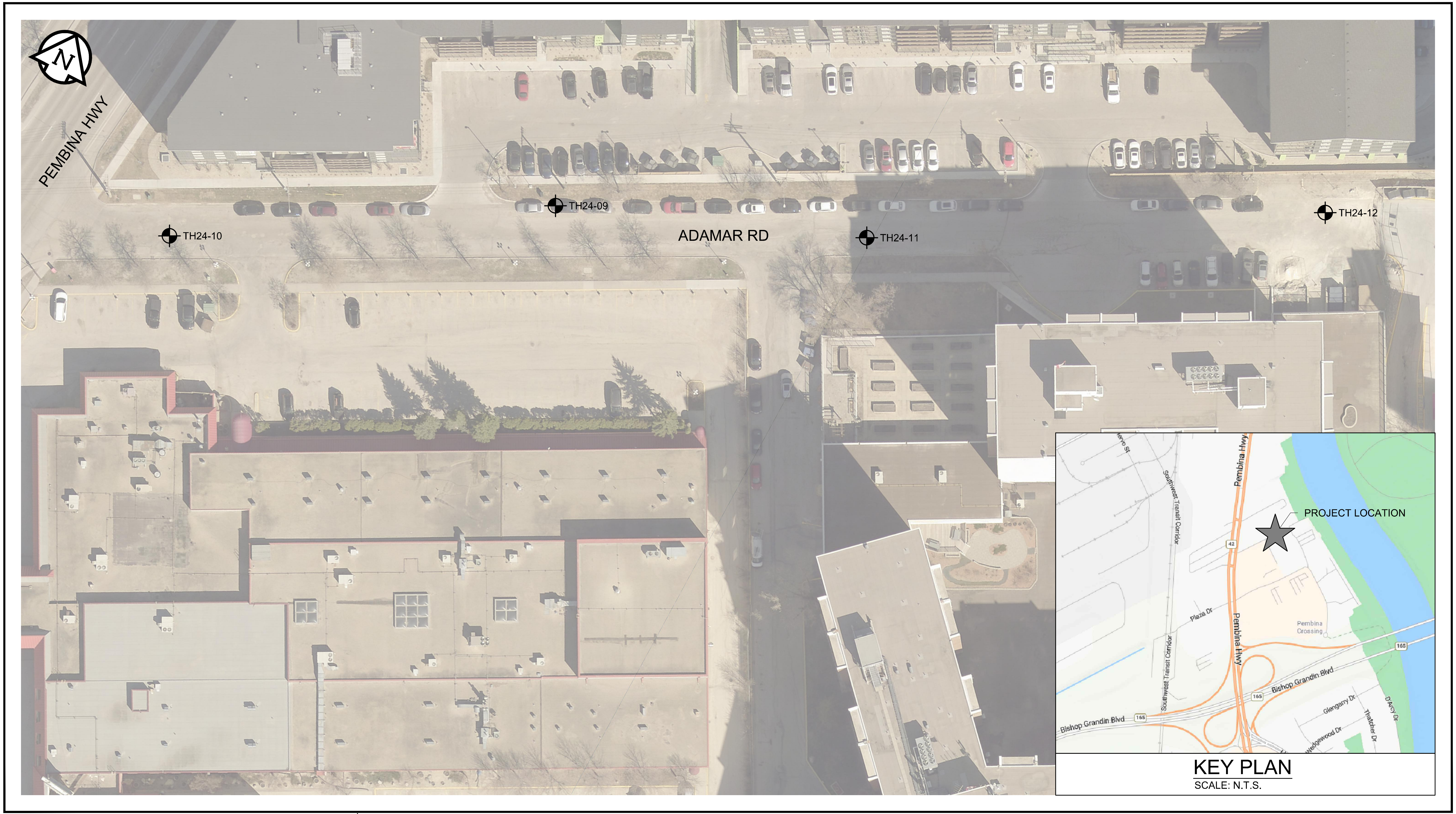
The information provided in this report is in accordance with current engineering principles and practices (Standard of Practice). The findings of this report were based on information provided (field investigation, laboratory testing, geometries). Soil conditions are natural deposits that can be highly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

1000 043 025
WSP
2024 Local Streets Renewal Package



0 5 10 15 20 25 m
SCALE = 1 : 600 (279 mm x 432 mm)

LEGEND: ⊕ TEST HOLE (TREK, 2024)

NOTES: 1. AERIAL IMAGERY FROM CITY OF WINNIPEG (2021) .

Figure 01
Test Hole Location Plan

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Z:\Projects\1000 Soils Lab\Lab Projects\1000 Lab Projects\1000-043 WSP\1000-043-25 2024 Local Street Renewal (24-K-01, 24-RI-01)\3 Survey and Dwg\3.4 CAD\3.4.3 Working Folder\Fig 02 2024-03-13 LSRP 0_A 1000-043-25.dwg, 2024-03-13 3:47:52 PM

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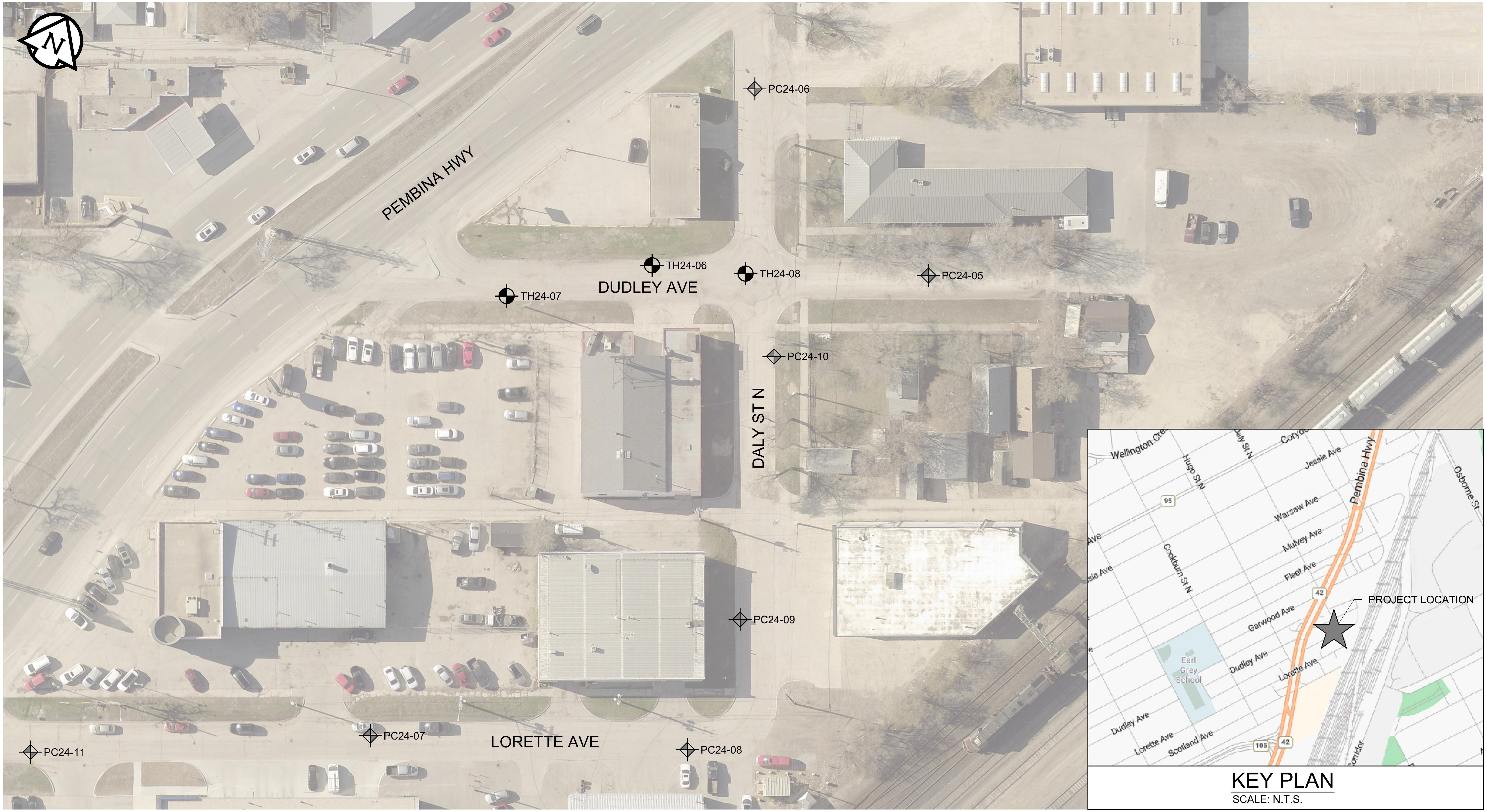
WSP
2024 Local Streets Renewal Package



KEY PLAN
SCALE: N.T.S.

0 10 20 30 m
SCALE = 1 : 700 (279 mm x 432 mm)

LEGEND:

- TEST HOLE (TREK, 2024)
- PAVEMENT CORE (TREK, 2024)

NOTES:

1. AERIAL IMAGERY FROM CITY OF WINNIPEG (2021) .

Figure 02

Test Hole and Pavement Core
Location Plan

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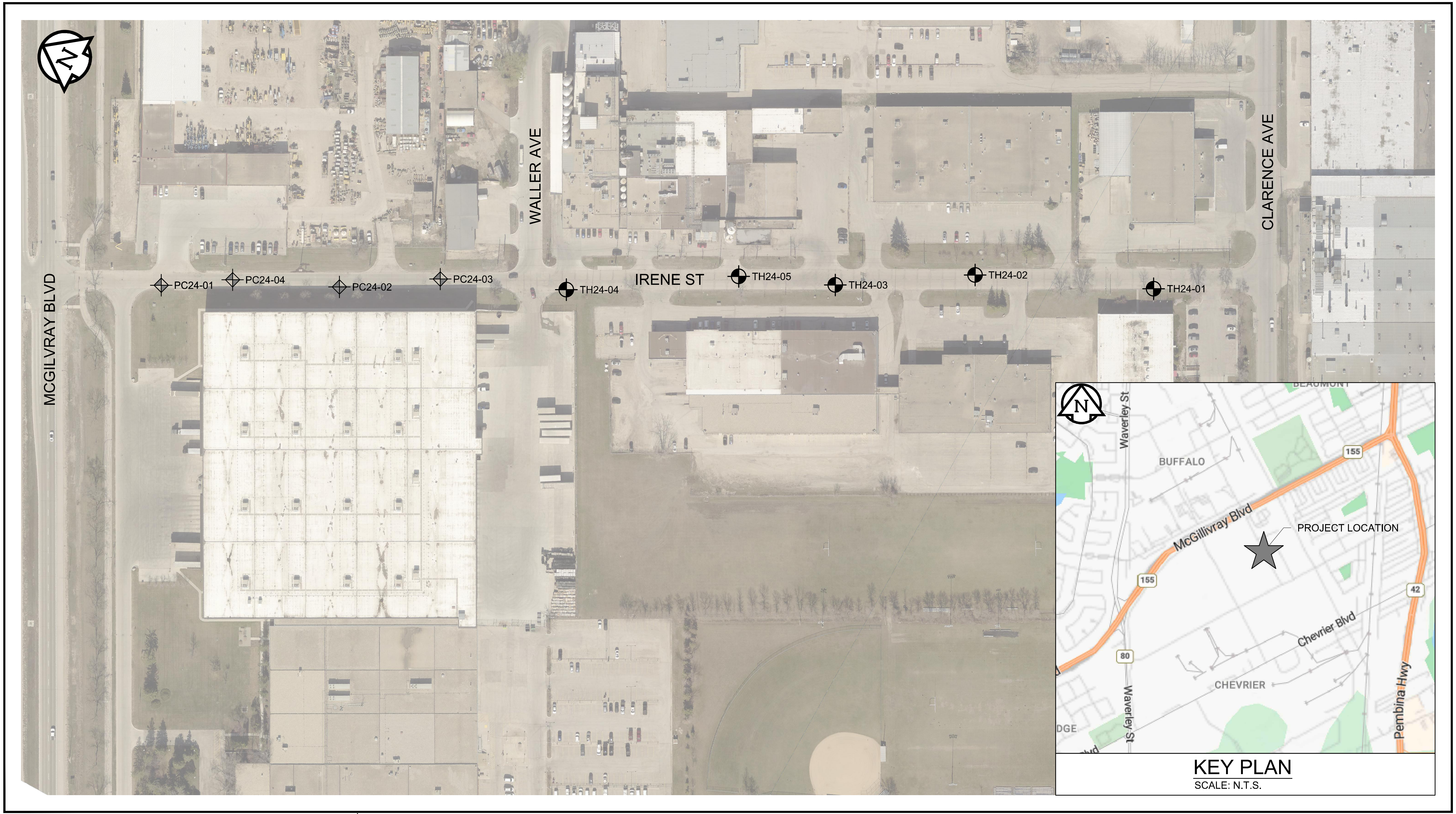
WSP
2024 Local Streets Renewal Package



0 25 50 75 m
SCALE = 1 : 1 750 (279 mm x 432 mm)

LEGEND:
⊕ TEST HOLE (TREK, 2024)
⌖ PAVEMENT CORE (TREK, 2024)

NOTES:
1. AERIAL IMAGERY FROM CITY OF WINNIPEG (2021) .

Figure 03
Test Hole and Pavement Core
Location Plan

1000 043 025
WSP
2024 Local Streets Renewal Package

0 10 20 30 40 50 m
SCALE = 1 : 1 250 (279 mm x 432 mm)

LEGEND: ⌖ PAVEMENT CORE (TREK, 2024)

NOTES: 1. AERIAL IMAGERY FROM CITY OF WINNIPEG (2021) .

Figure 04
Pavement Core Location Plan

Z:\Projects\1000 Soils Lab\Lab Projects\1000 Lab Projects\1000-043 WSP\1000-043-25 2024 Local Street Renewal (24-K-01, 24-RI-01)\3 Survey and Dwg\3.4 CAD\3.4.3 Working Folder\Fig 04 2024-03-13 LSRP 0_A 1000-043-25.dwg, 2024-03-13 3:36:00 PM

Appendix A

Test Hole Logs, Summary Table, Lab Testing Results and Pavement Core Photos

Adamar Rd – Pembina Hwy to End

Sub-Surface Log

Test Hole TH24-09

1 of 1

Client: WSP

Project Number: 1000-043-25

Project Name: 2024 Local Street Renewal (24-K-01, 24-R1-01)

Location: UTM N-5520803, E-632951 - Adamar Rd

Contractor: Paddock Drilling Ltd.

Ground Elevation: Top of Pavement

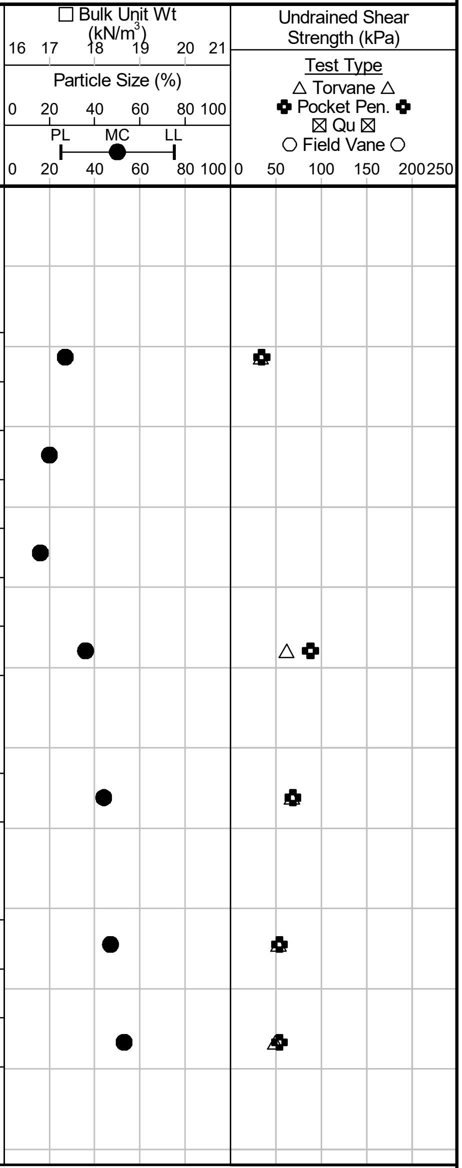
Method: 150 mm Solid Stem Auger, M10 Truck Mount

Date Drilled: February 27, 2024

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)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number
		ASPHALT		
0.5		CLAY (FILL) - silty, trace sand, trace gravel (<20 mm diam.) - dark grey - frozen, moist, firm when thawed - intermediate to high plasticity - AASHTO: A-7-6(I)	◢	G52
1.0		SILT - trace to some clay, trace sand - light brown - frozen, moist, firm when thawed - low to intermediate plasticity - AASHTO: A-6(I)	◢ ◢	G53 G54
1.5 2.0 2.5 3.0		CLAY - silty, trace sand - grey - moist, stiff - high plasticity - AASHTO: A-7-6(I) - silt seam, light brown, moist, trace oxidation, approximately 100 mm thick, at 2.0 m - trace sulphate inclusions (<10 mm diam.), firm to stiff below 2.3 m	◢ ◢ ◢ ◢	G55 G56 G57 G58



END TEST HOLE AT 3.0 m IN CLAY.

Notes:

1. Seepage or sloughing not observed.
2. Test Hole open to 3.0 m immediately after drilling.
3. Test Hole backfilled with cuttings, granular fill and cold patch asphalt.
4. Bulk samples were collected between 0.9 m and 1.4 m depth (silt) (L24-61-05).
5. Test Hole located on Adamar Rd, 75 m East of Pembina Highway, Westbound Lane, 1.6 m South of North curb.

Logged By: Kate Franklin **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

Sub-Surface Log

Test Hole TH24-10

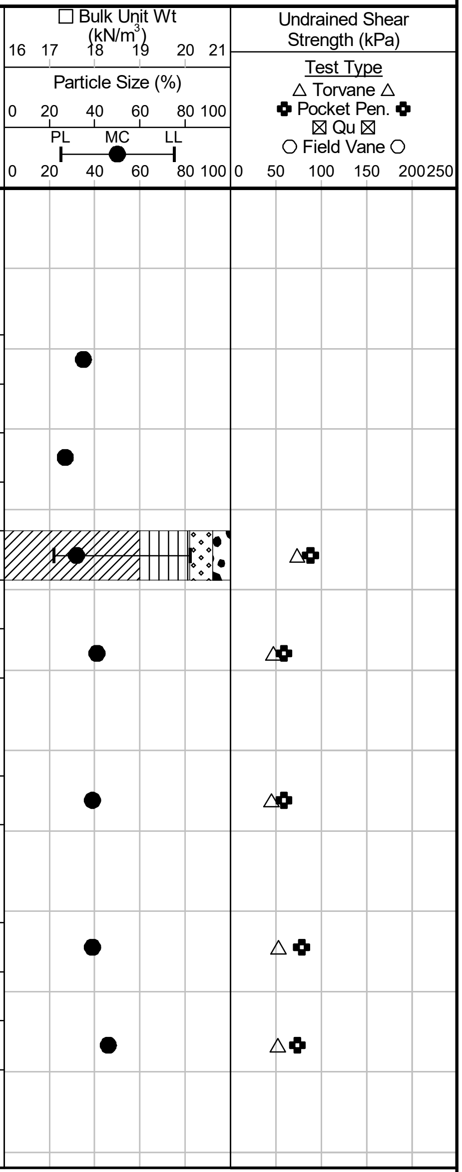
1 of 1

Client: WSP
Project Number: 1000-043-25
Project Name: 2024 Local Street Renewal (24-K-01, 24-R1-01)
Location: UTM N-5521685, E-631938 - Adamar Rd
Contractor: Paddock Drilling Ltd.
Ground Elevation: Top of Pavement
Method: 150 mm Solid Stem Auger, M10 Truck Mount
Date Drilled: February 27, 2024

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
	ASPHALT		
	CLAY (FILL) - silty, trace sand, trace gravel (<20 mm diam.) - dark grey - frozen, moist, firm when thawed - intermediate to high plasticity - AASHTO: A-7-6(53)		
0.5		◢	G59
	- stiff below 0.7 m	◢	G60
1.0		◢	G61
	CLAY - silty, trace sand - dark brown - moist, firm to stiff - high plasticity - AASHTO: A-7-6(I)		
1.5		◢	G62
	- trace gravel (<10 mm diam.) between 1.8 m and 2.1 m	◢	G63
2.0			
		◢	G64
2.5		◢	G65
3.0			



END TEST HOLE AT 3.0 m IN CLAY.
Notes:
1. Seepage or sloughing not observed.
2. Test Hole open to 3.0 m immediately after drilling.
3. Test Hole backfilled with cuttings, granular fill and cold patch asphalt.
4. Test Hole located on Adamar Rd, 15 m East of Pembina Highway, Eastbound Lane, 1.4 m North of South curb.

Logged By: Kate Franklin
Reviewed By: Angela Fidler-Kliewer
Project Engineer: Nelson Ferreira

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Sub-Surface Log

Test Hole TH24-11

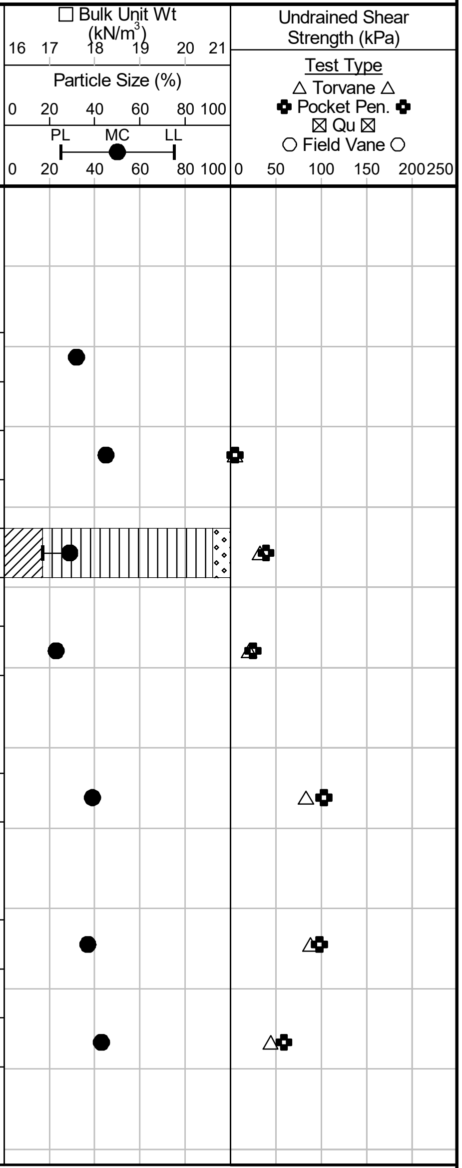
1 of 1

Client: WSP
Project Number: 1000-043-25
Project Name: 2024 Local Street Renewal (24-K-01, 24-R1-01)
Location: UTM N-5520863, E-633064 - Adamar Rd
Contractor: Paddock Drilling Ltd.
Ground Elevation: Top of Pavement
Method: 150 mm Solid Stem Auger, M10 Truck Mount
Date Drilled: February 27, 2024

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
	ASPHALT		
0.5	CLAY (FILL) - silty, trace sand, trace gravel (<20 mm diam.) - dark grey - frozen, moist, stiff when thawed - intermediate to high plasticity - AASHTO: A-7-6(I)	Grab (G)	G66
1.0	SILT - trace clay, trace to some fine sand to 0.9 m - grey - frozen, moist, very soft when thawed - low plasticity - AASHTO: A-6(11) - some clay, light brown, firm, low to intermediate plasticity below 0.8 m	Grab (G) Grab (G) Grab (G)	G67 G68 G69
1.5 2.0 2.5 3.0	CLAY - silty, trace sand - brown and grey - moist, stiff - high plasticity - AASHTO: A-7-6(I) - silt seam, light brown, moist, trace oxidation, approximately 100 mm thick, at 2.0 m - brown below 2.0 m depth - trace silt inclusions (<20 mm diam.), firm to stiff below 2.4 m	Grab (G) Grab (G) Grab (G)	G70 G71 G72



END TEST HOLE AT 3.0 m IN CLAY.

Notes:

1. Seepage or sloughing not observed.
2. Test Hole open to 3.0 m immediately after drilling.
3. Test Hole backfilled with cuttings, granular fill and cold patch asphalt.
4. Bulk samples were collected between 0.9 m and 1.5 m depth (silt) (L24-61-05) and between 1.5 m and 2.0 m depth (clay) (L24-061-06).
5. Test Hole located on Adamar Rd, 140 m East of Pembina Highway, Eastbound Lane, 1.3m North of South curb.

Logged By: Kate Franklin
Reviewed By: Angela Fidler-Kliewer
Project Engineer: Nelson Ferreira

Sub-Surface Log

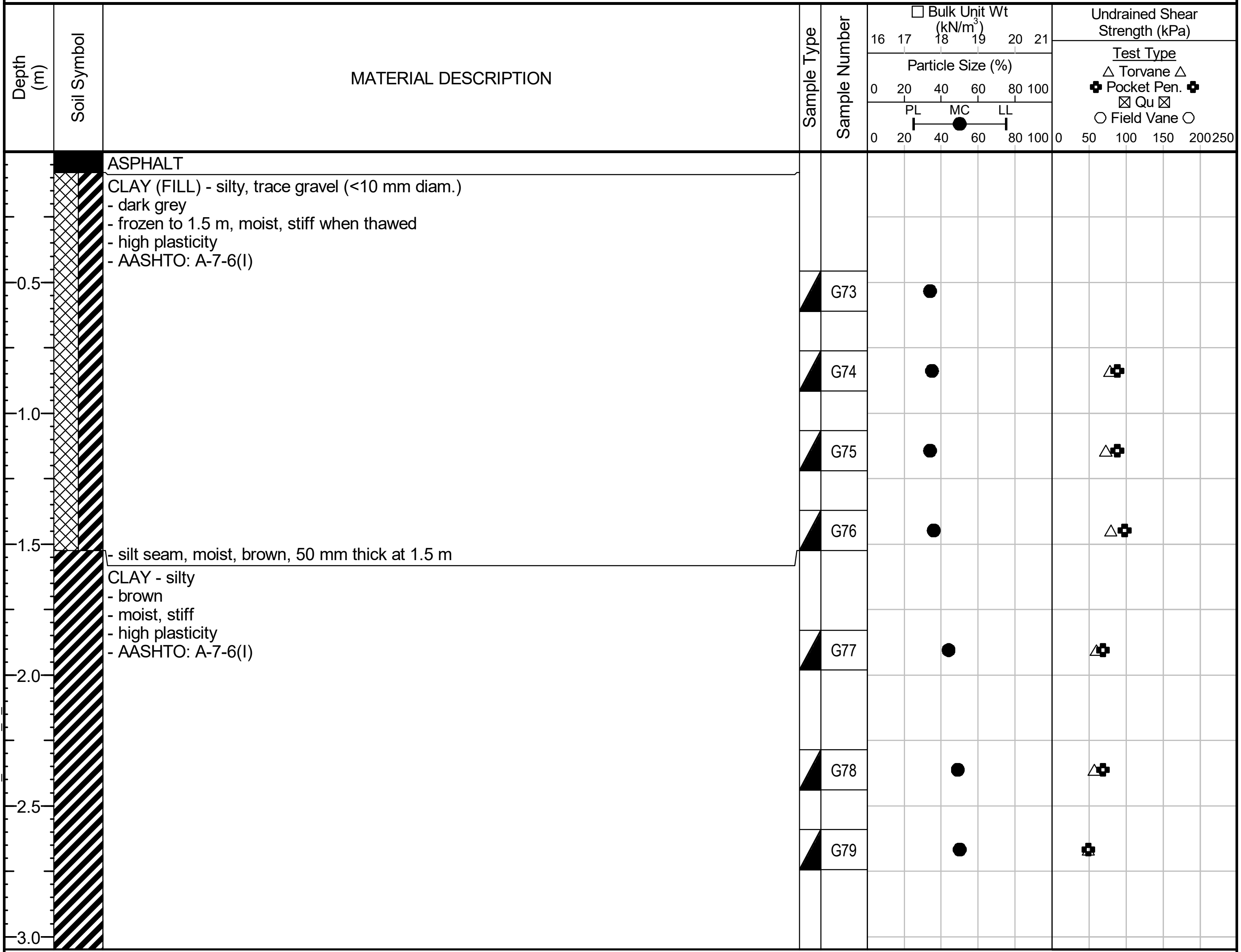
Test Hole TH24-12

1 of 1

Client: WSP
Project Number: 1000-043-25
Project Name: 2024 Local Street Renewal (24-K-01, 24-R1-01)
Location: UTM N-5521855, E-631836 - Adamar Rd
Contractor: Paddock Drilling Ltd.
Ground Elevation: Top of Pavement
Method: 150 mm Solid Stem Auger, M10 Truck Mount
Date Drilled: February 27, 2024

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



ASPHALT

CLAY (FILL) - silty, trace gravel (<10 mm diam.)
- dark grey
- frozen to 1.5 m, moist, stiff when thawed
- high plasticity
- AASHTO: A-7-6(I)

- silt seam, moist, brown, 50 mm thick at 1.5 m

CLAY - silty
- brown
- moist, stiff
- high plasticity
- AASHTO: A-7-6(I)

END TEST HOLE AT 3.0 m IN CLAY.
Notes:
1. Seepage or sloughing not observed.
2. Test Hole open to 3.0 m immediately after drilling.
3. Test Hole backfilled with cuttings, granular fill and cold patch asphalt.
4. Bulk samples were collected between 0.9 m and 2.0 m depth (L24-061-06).
5. Test Hole located on Adamar Rd, 207 m East of Pembina Highway, Westbound Lane, 2.0m South of North curb.

Logged By: Kate Franklin **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

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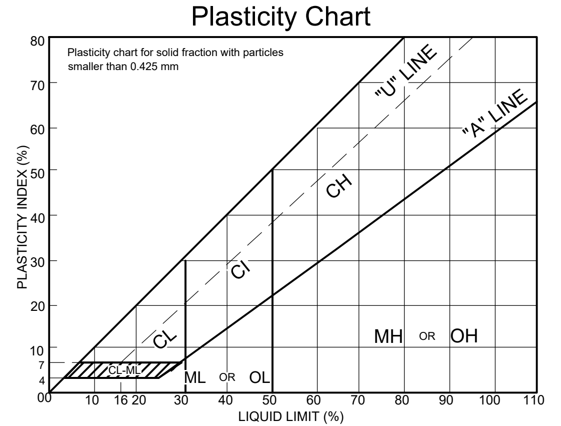
EXPLANATION OF FIELD AND LABORATORY TESTING

GENERAL NOTES

1. Classifications are based on the Unified 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			
			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	

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
with *	with silt, with sand	> 35 percent

* Used when the material is classified based on behaviour as a cohesive material

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

2024 Local Street Renewal (24-K-01, 24-R1-01)
Adamar Rd - Pembina Hwy to end
Sub-Surface Investigation

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
TH24-09	UTM : 5520803 N, 632951 E Located on Adamar Rd, 75 m East of Pembina Highway, Westbound Lane, 1.6 m South of North curb	Asphalt	55	Concrete	-	Clay, AASHTO: A-7-6 (I)	0.5	0.6	27							
						Silt, AASHTO: A-4 (I)	0.8	0.9	20							
						Silt, AASHTO: A-4 (I)	1.1	1.2	16							
						Clay, AASHTO: A-7-6 (I)	1.4	1.5	36							
						Clay, AASHTO: A-7-6 (I)	1.8	2.0	44							
						Clay, AASHTO: A-7-6 (I)	2.3	2.4	47							
						Clay, AASHTO: A-7-6 (I)	2.6	2.7	53							
TH24-10	UTM : 5521685 N, 631938 E Located on Adamar Rd, 15 m East of Pembina Highway, Eastbound Lane, 1.4 m North of South curb	Asphalt	105	Concrete	-	Clay, AASHTO: A-7-6 (53)	0.5	0.6	35							
						Clay, AASHTO: A-7-6 (53)	0.8	0.9	27							
						Clay, AASHTO: A-7-6 (53)	1.1	1.2	32	60	22	10	8	22	82	60
						Clay, AASHTO: A-7-6 (I)	1.4	1.5	41							
						Clay, AASHTO: A-7-6 (I)	1.8	2.0	39							
						Clay, AASHTO: A-7-6 (I)	2.3	2.4	39							
						Clay, AASHTO: A-7-6 (I)	2.6	2.7	46							
TH24-11	UTM : 5520863 N, 633064 E Located on Adamar Rd, 140 m East of Pembina Highway, Eastbound Lane, 1.3m North of South curb	Asphalt	60	Concrete	-	Clay, AASHTO: A-7-6 (I)	0.5	0.6	32							
						Silt, AASHTO: A-6 (11)	0.8	0.9	45							
						Silt, AASHTO: A-6 (11)	1.1	1.2	29	17	75	8	0	17	30	13
						Silt, AASHTO: A-6 (11)	1.4	1.5	23							
						Clay, AASHTO: A-7-6 (I)	1.8	2.0	39							
						Clay, AASHTO: A-7-6 (I)	2.3	2.4	37							
						Clay, AASHTO: A-7-6 (I)	2.6	2.7	43							
TH24-12	UTM : 5521855 N, 631836 E Located on Adamar Rd, 207 m East of Pembina Highway, Westbound Lane, 2.0m South of North curb	Asphalt	80	Concrete	-	Clay, AASHTO: A-7-6 (I)	0.5	0.6	34							
						Clay, AASHTO: A-7-6 (I)	0.8	0.9	35							
						Clay, AASHTO: A-7-6 (I)	1.1	1.2	34							
						Clay, AASHTO: A-7-6 (I)	1.4	1.5	36							
						Clay, AASHTO: A-7-6 (I)	1.8	2.0	44							
						Clay, AASHTO: A-7-6 (I)	2.3	2.4	49							
						Clay, AASHTO: A-7-6 (I)	2.6	2.7	50							

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Moisture Content Report
ASTM D2216-98

Project No. 1000-043-25
Client WSP
Project 2024 Local Street Renewal (24-K-01, 24-R1-01)-Adamar Rd.

Sample Date 27-Feb-24
Test Date 01-Mar-24
Technician KF

Test Hole	TH24-09	TH24-09	TH24-09	TH24-09	TH24-09	TH24-09
Depth (m)	0.5 - 0.6	0.8 - 0.9	1.1 - 1.2	1.4 - 1.5	1.8 - 2.0	2.3 - 2.4
Sample #	G52	G53	G54	G55	G56	G57
Tare ID	H43	F69	Z32	H65	F153	P12
Mass of tare	8.6	8.6	9.0	8.9	8.5	8.7
Mass wet + tare	249.7	210.2	178.7	174.2	217.9	230.9
Mass dry + tare	198.4	176.9	155.2	130.8	153.6	159.6
Mass water	51.3	33.3	23.5	43.4	64.3	71.3
Mass dry soil	189.8	168.3	146.2	121.9	145.1	150.9
Moisture %	27.0%	19.8%	16.1%	35.6%	44.3%	47.2%

Test Hole	TH24-09	TH24-10	TH24-10	TH24-10	TH24-10	TH24-10
Depth (m)	2.6 - 2.7	0.5 - 0.6	0.8 - 0.9	1.1 - 1.2	1.4 - 1.5	1.8 - 2.0
Sample #	G58	G59	G60	G61	G62	G63
Tare ID	AA20	N40	AB40	J85	H4	H38
Mass of tare	6.6	8.7	6.8	6.9	8.6	8.6
Mass wet + tare	254.6	236.6	278.5	449.3	277.1	250.2
Mass dry + tare	168.7	178.0	220.9	342.8	199.2	181.8
Mass water	85.9	58.6	57.6	106.5	77.9	68.4
Mass dry soil	162.1	169.3	214.1	335.9	190.6	173.2
Moisture %	53.0%	34.6%	26.9%	31.7%	40.9%	39.5%

Test Hole	TH24-10	TH24-10	TH24-11	TH24-11	TH24-11	TH24-11
Depth (m)	2.3 - 2.4	2.6 - 2.7	0.5 - 0.6	0.8 - 0.9	1.1 - 1.2	1.4 - 1.5
Sample #	G64	G65	G66	G67	G68	G69
Tare ID	F31	E114	M18	F131	E88	H59
Mass of tare	8.6	8.5	7.0	8.7	6.9	8.7
Mass wet + tare	272.9	265.7	217.9	244.0	470.1	268.4
Mass dry + tare	198.6	184.1	167.1	171.2	366.7	219.4
Mass water	74.3	81.6	50.8	72.8	103.4	49.0
Mass dry soil	190.0	175.6	160.1	162.5	359.8	210.7
Moisture %	39.1%	46.5%	31.7%	44.8%	28.7%	23.3%

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Moisture Content Report
ASTM D2216-98

Project No. 1000-043-25
Client WSP
Project 2024 Local Street Renewal (24-K-01, 24-R1-01)-Adamar Rd.

Sample Date 27-Feb-24
Test Date 01-Mar-24
Technician KF

Test Hole	TH24-11	TH24-11	TH24-11	TH24-12	TH24-12	TH24-12
Depth (m)	1.8 - 2.0	2.3 - 2.4	2.6 - 2.7	0.5 - 0.6	0.8 - 0.9	1.1 - 1.2
Sample #	G70	G71	G72	G73	G74	G75
Tare ID	Z84	AB08	Z67	W106	N28	K7
Mass of tare	8.5	6.9	8.4	8.4	6.9	8.7
Mass wet + tare	289.0	250.0	274.0	202.3	225.1	246.3
Mass dry + tare	210.2	184.3	193.7	153.2	168.6	185.8
Mass water	78.8	65.7	80.3	49.1	56.5	60.5
Mass dry soil	201.7	177.4	185.3	144.8	161.7	177.1
Moisture %	39.1%	37.0%	43.3%	33.9%	34.9%	34.2%

Test Hole	TH24-12	TH24-12	TH24-12	TH24-12		
Depth (m)	1.4 - 1.5	1.8 - 2.0	2.3 - 2.4	2.6 - 2.7		
Sample #	G76	G77	G78	G79		
Tare ID	D50	AB63	W32	C30		
Mass of tare	8.5	6.9	8.5	8.6		
Mass wet + tare	152.7	272.4	218.2	245.0		
Mass dry + tare	114.4	191.1	149.0	166.1		
Mass water	38.3	81.3	69.2	78.9		
Mass dry soil	105.9	184.2	140.5	157.5		
Moisture %	36.2%	44.1%	49.3%	50.1%		

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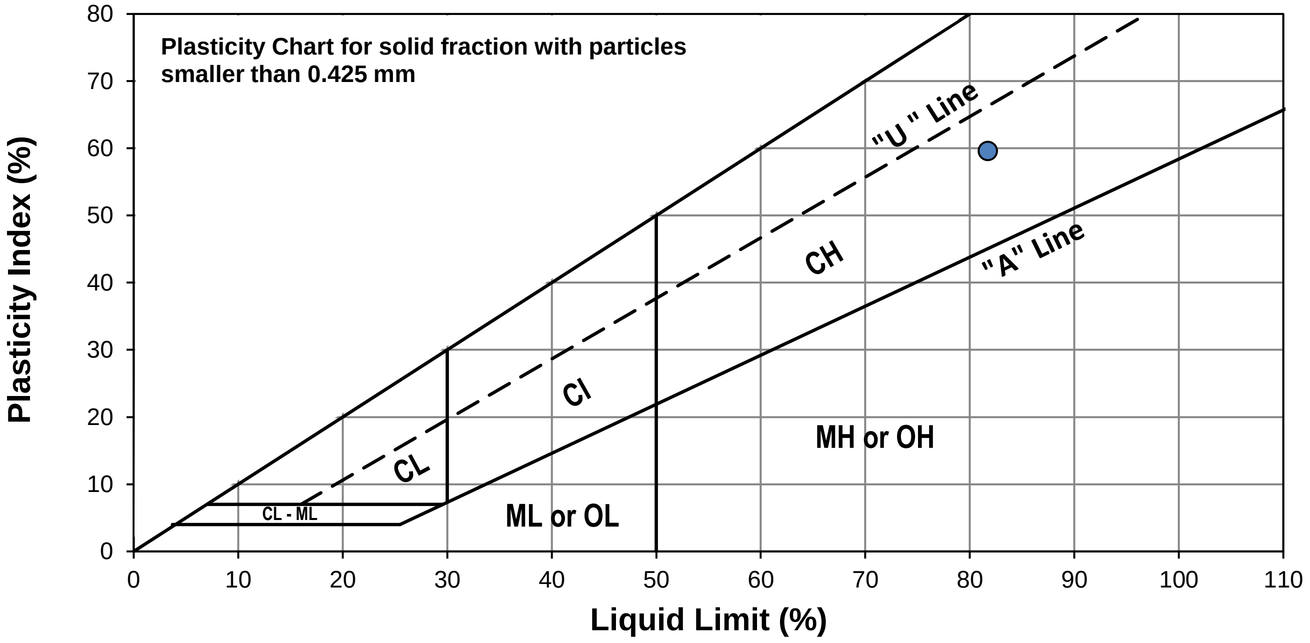
Atterberg Limits
ASTM D4318-10e1

Project No.	1000-043-25
Client	WSP
Project	2024 Local Street Renewal (24-K-01, 24-RI-01) - Adamar Rd.
Test Hole	TH24-10
Sample #	G61
Depth (m)	1.1 - 1.2
Sample Date	27-Feb-24
Test Date	07-Mar-24
Technician	PC

Liquid Limit	82
Plastic Limit	22
Plasticity Index	60

Liquid Limit

Trial #	1	2	3		
Number of Blows (N)	15	22	26		
Mass Tare (g)	14.109	13.961	14.175		
Mass Wet Soil + Tare (g)	19.605	20.625	20.776		
Mass Dry Soil + Tare (g)	17.022	17.598	17.815		
Mass Water (g)	2.583	3.027	2.961		
Mass Dry Soil (g)	2.913	3.637	3.640		
Moisture Content (%)	88.671	83.228	81.346		



Plastic Limit

Trial #	1	2	3	4	5
Mass Tare (g)	13.838	14.105			
Mass Wet Soil + Tare (g)	19.130	20.100			
Mass Dry Soil + Tare (g)	18.155	19.033			
Mass Water (g)	0.975	1.067			
Mass Dry Soil (g)	4.317	4.928			
Moisture Content (%)	22.585	21.652			

Note: Additional information recorded/measured for this test is available upon request.

Atterberg Limits
ASTM D4318-10e1

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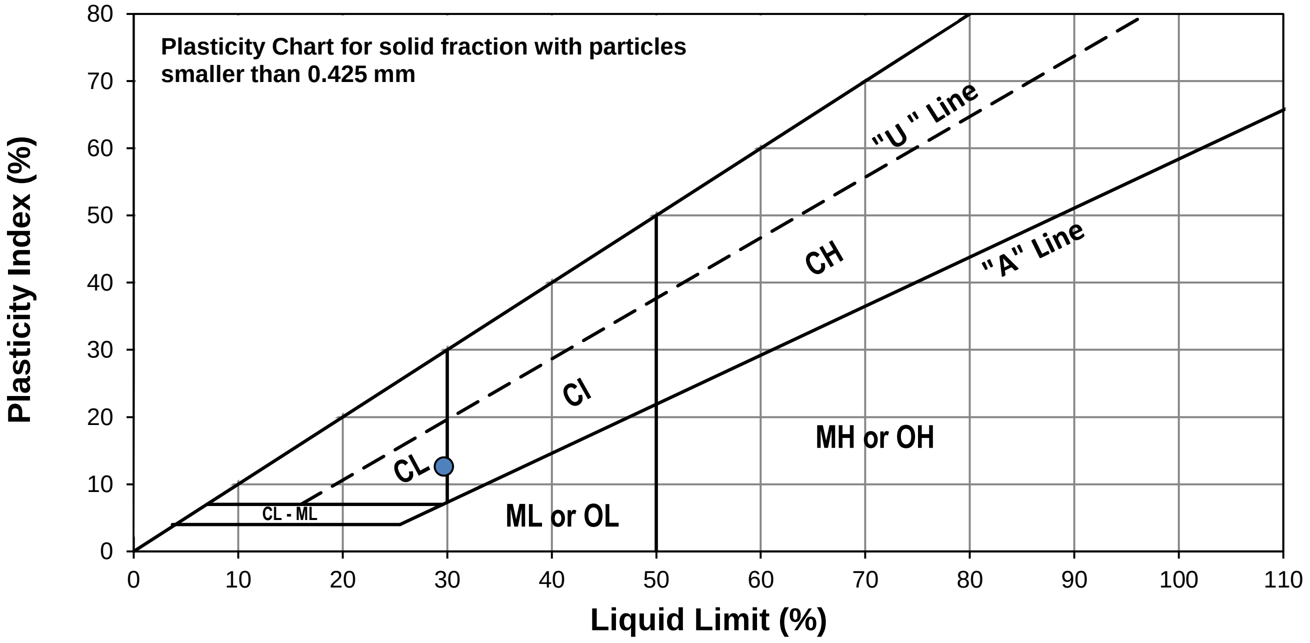
Project No. 1000-043-25
Client WSP
Project 2024 Local Street Renewal (24-K-01, 24-RI-01) - Adamar Rd.

Test Hole TH24-11
Sample # G68
Depth (m) 1.1 - 1.2
Sample Date 27-Feb-24
Test Date 07-Mar-24
Technician PC

Liquid Limit	30
Plastic Limit	17
Plasticity Index	13

Liquid Limit

Trial #	1	2	3		
Number of Blows (N)	15	24	35		
Mass Tare (g)	13.938	14.045	13.958		
Mass Wet Soil + Tare (g)	21.711	21.670	20.709		
Mass Dry Soil + Tare (g)	19.857	19.924	19.203		
Mass Water (g)	1.854	1.746	1.506		
Mass Dry Soil (g)	5.919	5.879	5.245		
Moisture Content (%)	31.323	29.699	28.713		



Plastic Limit

Trial #	1	2	3	4	5
Mass Tare (g)	14.034	14.119			
Mass Wet Soil + Tare (g)	20.981	20.798			
Mass Dry Soil + Tare (g)	19.965	19.829			
Mass Water (g)	1.016	0.969			
Mass Dry Soil (g)	5.931	5.710			
Moisture Content (%)	17.130	16.970			

Note: Additional information recorded/measured for this test is available upon request.

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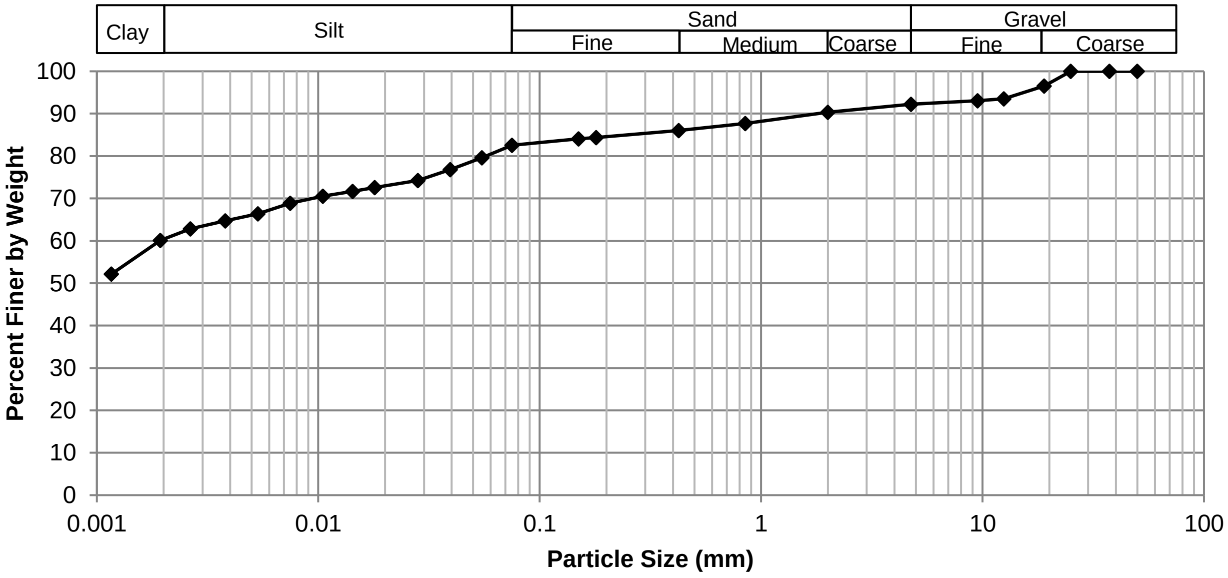
Grain Size Analysis (Hydrometer Method)
AASHTO T 88

Project No.	1000-043-25
Client	WSP
Project	2024 Local Street Renewal (24-K-01, 24-RI-01) - Adamar Ave.
Test Hole	TH24-010
Sample #	G61
Depth (m)	1.0 - 1.2
Sample Date	27-Feb-24
Test Date	07-Mar-23
Technician	DS

Gravel	7.8%
Sand	9.7%
Silt	22.2%
Clay	60.3%

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	92.24	0.0750	82.58
37.5	100.00	2.00	90.37	0.0549	79.61
25.0	100.00	0.850	87.66	0.0394	76.79
19.0	96.54	0.425	86.04	0.0282	74.24
12.5	93.53	0.180	84.39	0.0180	72.55
9.50	93.06	0.150	84.08	0.0143	71.70
4.75	92.24	0.075	82.58	0.0105	70.57
				0.0075	68.88
				0.0053	66.37
				0.0038	64.72
				0.0026	62.87
				0.0019	60.08
				0.0012	52.16

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Grain Size Analysis (Hydrometer Method)
AASHTO T 88

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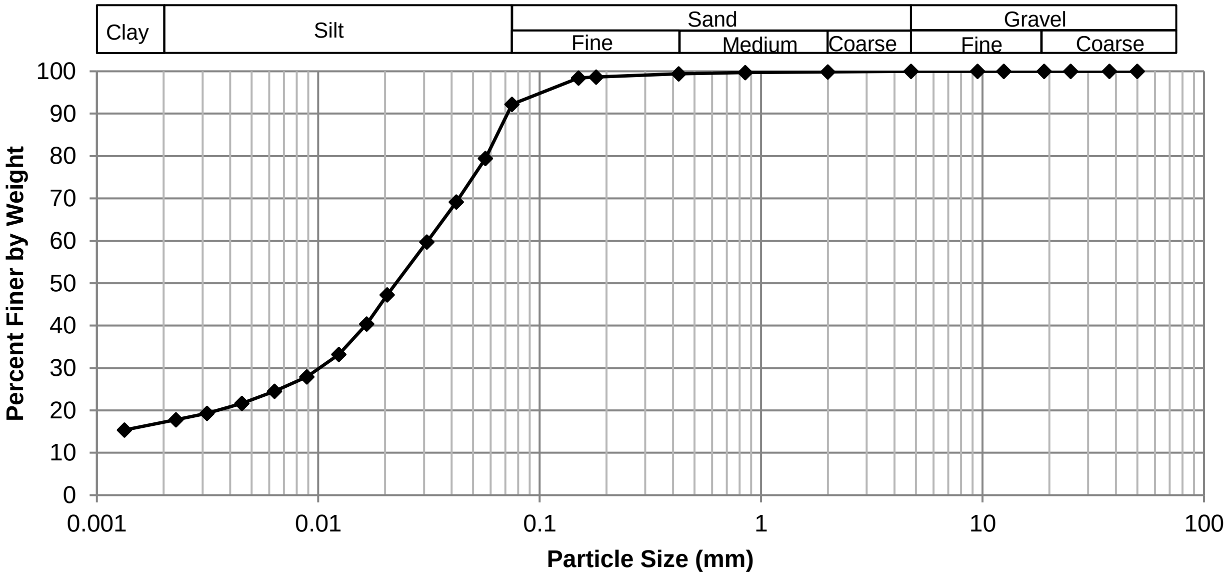
Project No.	1000-043-25
Client	WSP
Project	2024 Local Street Renewal (24-K-01, 24-RI-01)- Adamar Ave.
Test Hole	TH24-011
Sample #	G68
Depth (m)	1.0 - 1.2
Sample Date	27-Feb-24
Test Date	07-Mar-23
Technician	DS

Gravel	0.0%
Sand	7.8%
Silt	75.1%
Clay	17.1%

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	92.23
37.5	100.00	2.00	99.86	0.0570	79.48
25.0	100.00	0.850	99.70	0.0421	69.17
19.0	100.00	0.425	99.42	0.0309	59.77
12.5	100.00	0.180	98.66	0.0205	47.25
9.50	100.00	0.150	98.39	0.0166	40.38
4.75	100.00	0.075	92.23	0.0124	33.20
				0.0089	27.89
				0.0064	24.49
				0.0045	21.68
				0.0031	19.32
				0.0023	17.80
				0.0013	15.37

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Standard Proctor Compaction Test

ASTM D698-12 (2021)

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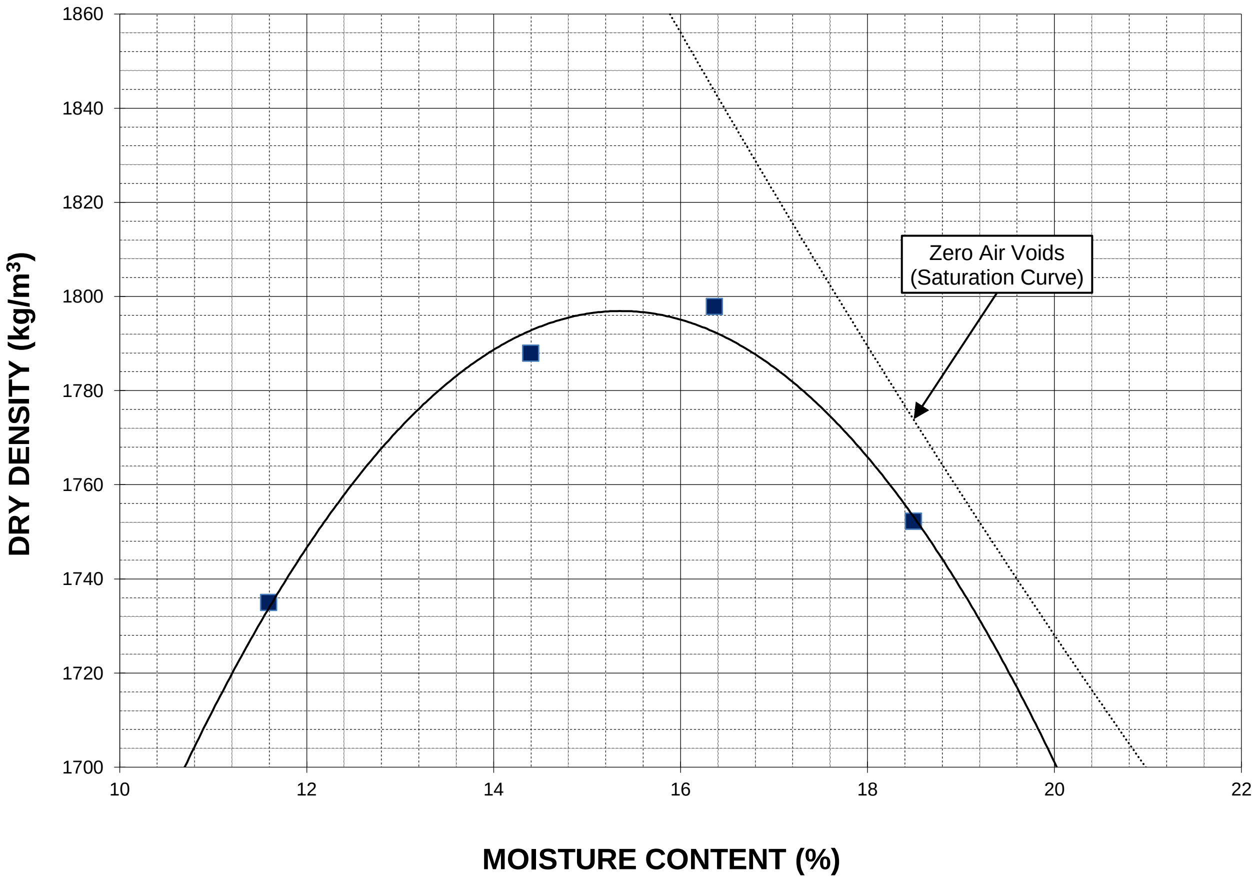
Project No.	1000-043-25
Client	WSP
Project	2024 Local Street Renewal (24-K-01, 24-RI-01)- Adamar Rd.
Sample #	L24-061-05
Source	TH24-09 and TH24-11 (0.9m to 1.5m)
Material	Silt
Sample Date	27-Feb-24
Test Date	06-Mar-24
Technician	AD

Maximum Dry Density (kg/m3)	1797
Optimum Moisture (%)	15.4

Trial Number	1	2	3	4	
Wet Density (kg/m^3)	1936	2045	2092	2076	
Dry Density (kg/m^3)	1735	1788	1798	1752	
Moisture Content (%)	11.6	14.4	16.4	18.5	



Note: Additional information recorded/measured for this test is available upon request.

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California Bearing Ratio Test Data Sheet

ASTM D1883-16

Project No.	1000-043-25	**Source**	Adamar Rd: TH24-09 & TH24-11 (0.9 m - 1.5 m)
Client	WSP	**Material**	Silt
Project	2024 Local Street Renewal (24-K-01, 24-RI-01)	**Sample Date**	2024-02-27
Sample #	L24-061	**Test Date**	2024-03-09
		Technician	DS

Proctor Results (ASTM D698)

Maximum Dry Density	1797	kg/m3
Optimum Moisture Content	15.4	%
Material Retained on 19 mm Sieve	0.0	%

CBR Sample Compaction

Dry Density	1704	kg/m3
Initial Moisture Content	15.1	%
Relative Density	94.8	% SPMDD

Soaking Results

Surcharge	4.54	kg
Swell	0.7	%
Moisture Content in top 25 mm	22.2	%
Immersion Period	96	h

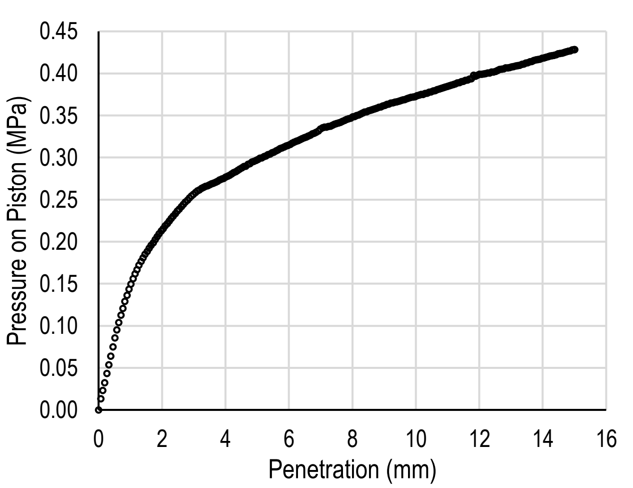
CBR Results

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	0.10	0.10
1.27	0.17	0.17
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	0.29	0.29
5.08	0.30	0.30
7.62	0.34	0.34
10.16	0.38	0.38
12.70	0.41	0.41

Load/Penetration Curve



Comments:

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Standard Proctor Compaction Test

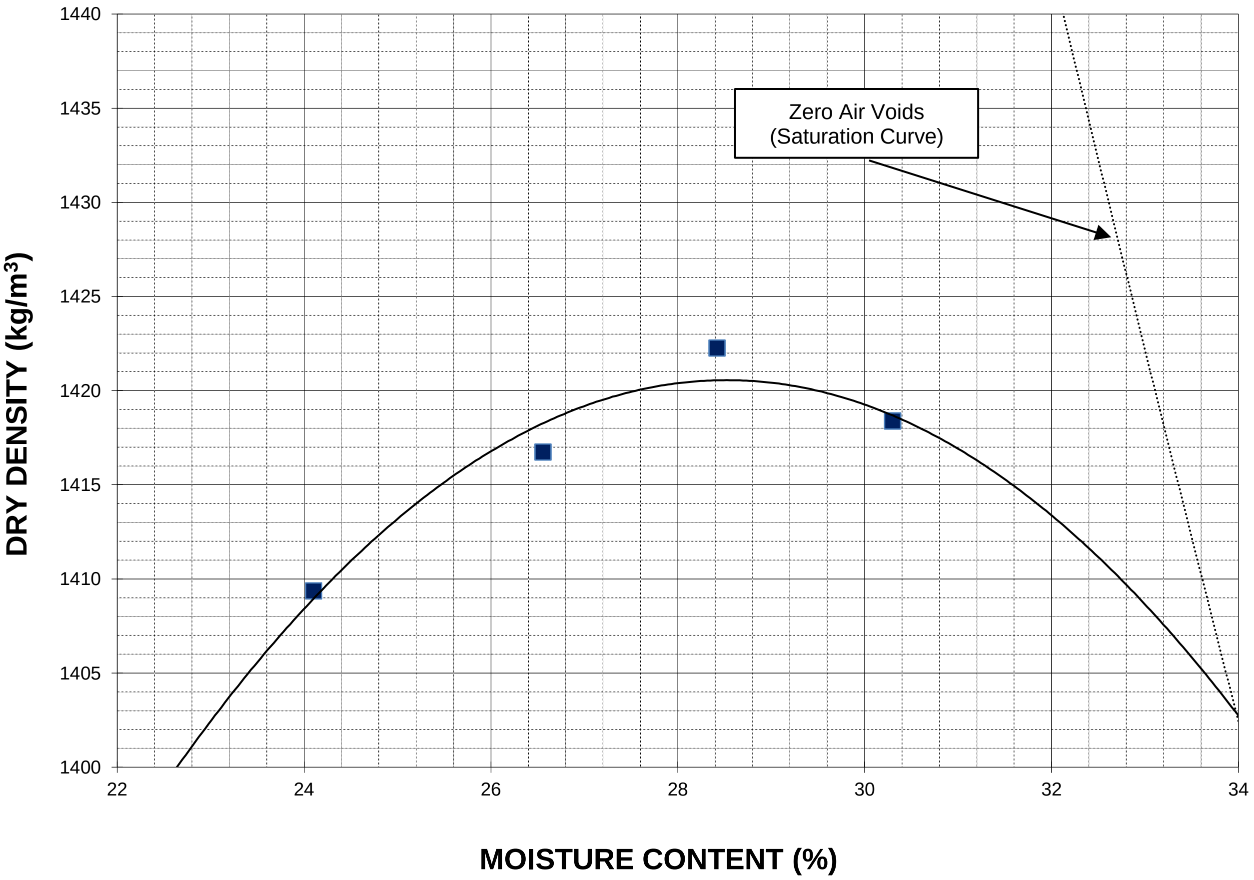
ASTM D698-12 (2021)

CERTIFIED BY CCIL Canadian Council of Independent Laboratories For specific tests as listed on www.ccil.com

Project No.	1000-043-25
Client	WSP
Project	2024 Local Street Renewal (24-K-01, 24-RI-01)- Adamar Rd.
Sample #	L24-061-06
Source	TH24-11 (1.5m - 2.0m) and TH23-12 (0.9m - 2.0m)
Material	Clay
Sample Date	27-Feb-24
Test Date	07-Mar-24
Technician	AD

Maximum Dry Density (kg/m3)	1421
Optimum Moisture (%)	28.5

Trial Number	1	2	3	4	
Wet Density (kg/m^3)	1749	1793	1827	1848	
Dry Density (kg/m^3)	1409	1417	1422	1418	
Moisture Content (%)	24.1	26.6	28.4	30.3	



Note: Additional information recorded/measured for this test is available upon request.

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California Bearing Ratio Test Data Sheet

ASTM D1883-16

Project No.	1000-043-25	**Source**	Adamar Rd: TH24-11 (1.5 m -2.0 m) & TH24-12 (0.9 m - 2.0 m)
Client	WSP	**Material**	Clay
Project	2024 Local Street Renewal (24-K-01, 24-RI-01)	**Sample Date**	2024-02-27
Sample #	L24-061	**Test Date**	2024-03-11
		Technician	DS

Proctor Results (ASTM D698)

Maximum Dry Density	1421	kg/m3
Optimum Moisture Content	28.5	%
Material Retained on 19 mm Sieve	0.0	%

CBR Sample Compaction

Dry Density	1374	kg/m3
Initial Moisture Content	27.6	%
Relative Density	96.7	% SPMDD

Soaking Results

Surcharge	4.54	kg
Swell	2.5	%
Moisture Content in top 25 mm	50.4	%
Immersion Period	96	h

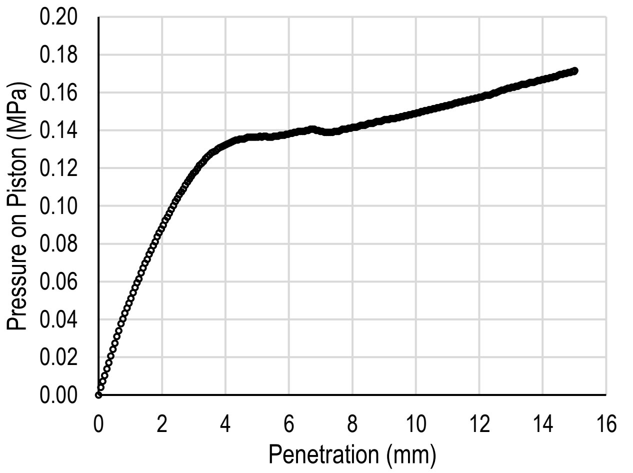
CBR Results

CBR at 2.54 mm	1.5	%
CBR at 5.08 mm	1.3	%
Zero Correction	0	mm

Test Data

Penetration (mm)	Measured Pressure (MPa)	Corrected Pressure (MPa)
0.64	0.03	0.03
1.27	0.06	0.06
1.91	0.09	0.09
2.54	0.11	0.11
3.18	0.12	0.12
3.81	0.13	0.13
4.45	0.14	0.14
5.08	0.14	0.14
7.62	0.14	0.14
10.16	0.15	0.15
12.70	0.16	0.16

Load/Penetration Curve



Comments:

Template Rev. B - 2018-04-07

Photo 1: Pavement Core Sample at TH24-09

Photo 2: Pavement Core Sample at TH24-10

Photo 3: Pavement Core Sample at TH24-11

Photo 4: Pavement Core Sample at TH24-12

Appendix B

Test Hole Logs, Summary Table, Lab Testing Results and Pavement Core Photos

Daly St N – Lorette Ave to Pembina Hwy

Sub-Surface Log

Test Hole TH24-08

1 of 1

Client: WSP
Project Number: 1000-043-25
Project Name: 2024 Local Street Renewal (24-K-01, 24-R1-01)
Location: UTM N-5525613, E-633291 - Daly St N
Contractor: Paddock Drilling Ltd.
Ground Elevation: Top of Pavement
Method: 150 mm Solid Stem Auger, M10 Truck Mount
Date Drilled: February 26, 2024

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)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	☐ 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
0.0	■	Pavement				
	⛆	SAND (FILL) - some gravel (<50 mm diam.), trace silt, trace clay - brown - frozen to 1.5 m, moist when thawed - poorly graded, medium grained, rounded to subanglular - no plasticity - AASHTO: A-1(I)				
0.5						
			◪	G51		
1.0						
1.5						
2.0						
2.5						
3.0						

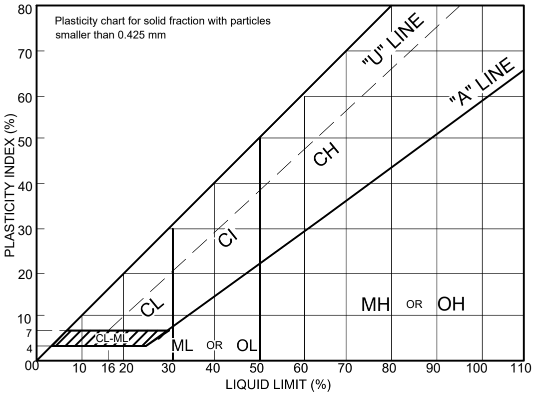
END TEST HOLE AT 3.0 m IN SAND.
Notes:
1. Seepage not observed.
2. Sloughing observed during drilling.
3. Test Hole open to 1.8 m immediately after drilling.
4. Test Hole backfilled with cuttings, granular fill and cold patch asphalt.
5. Bulk samples were collected between 0.9 m and 2.0 m depth.
6. Difficult to obtain grab samples due to the nature of the sand.
7. Test Hole located at centre of intersection of Daly St N and Dudley Ave, Southbound Lane, 1.5 m East of West curb.

Logged By: Kate Franklin
Reviewed By: Angela Fidler-Kliewer
Project Engineer: Nelson Ferreira

EXPLANATION OF FIELD AND LABORATORY TESTING

GENERAL NOTES

1. Classifications are based on the Unified 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	ψ	Peat and other highly organic soils	Von Post Classification Limit	Strong colour or odour, and often fibrous texture	

Material		Particle Size	
		ASTM Sieve sizes	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

Material		Particle Size	
		ASTM Sieve Sizes	mm
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

TREK GEOTECHNICAL

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
with *	with silt, with sand	> 35 percent

* Used when the material is classified based on behaviour as a cohesive material

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

TREK GEOTECHNICAL

2024 Local Street Renewal (24-K-01, 24-R1-01)
Daly St N - Lorette Ave to Pembina Hwy
Sub-Surface Investigation

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
TH24-08	UTM : 5525613 N, 633291 E Located at centre of intersection of Daly St N and Dudley Ave, Southbound Lane, 1.5 m East of West curb	Asphalt	110	Concrete	-	Sand, AASHTO: A-1 (I)	0.8	0.9	-	-	-	-	-	-	-	-

TREK GEOTECHNICAL

Project 1000-043-25
Location Daly St. Intersection
Hole No. Th24-08 Sample No. PC24-26
Depth 110mm
Technician TG Date Feb 23/24

Photo 1: Pavement Core Sample at TH24-08

Appendix C

Test Hole Logs, Summary Table, Lab Testing Results and Pavement Core Photos

Dudley Ave – Pembina Hwy to Daly St N.

Sub-Surface Log

Test Hole TH24-06

1 of 1

Client: WSP

Project Name: 2024 Local Street Renewal (24-K-01, 24-R1-01)

Contractor: Paddock Drilling Ltd.

Method: 150 mm Solid Stem Auger, M10 Truck Mount

Project Number: 1000-043-25

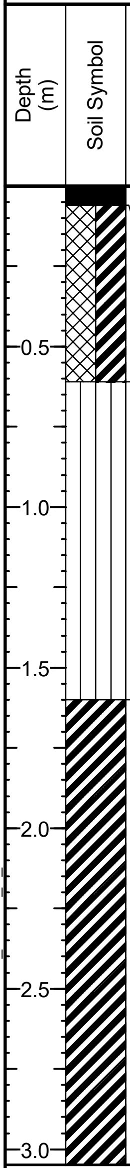
Location: UTM N-5525606, E-633275 - Dudley Ave

Ground Elevation: Top of Pavement

Date Drilled: February 26, 2024

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



MATERIAL DESCRIPTION

ASPHALT

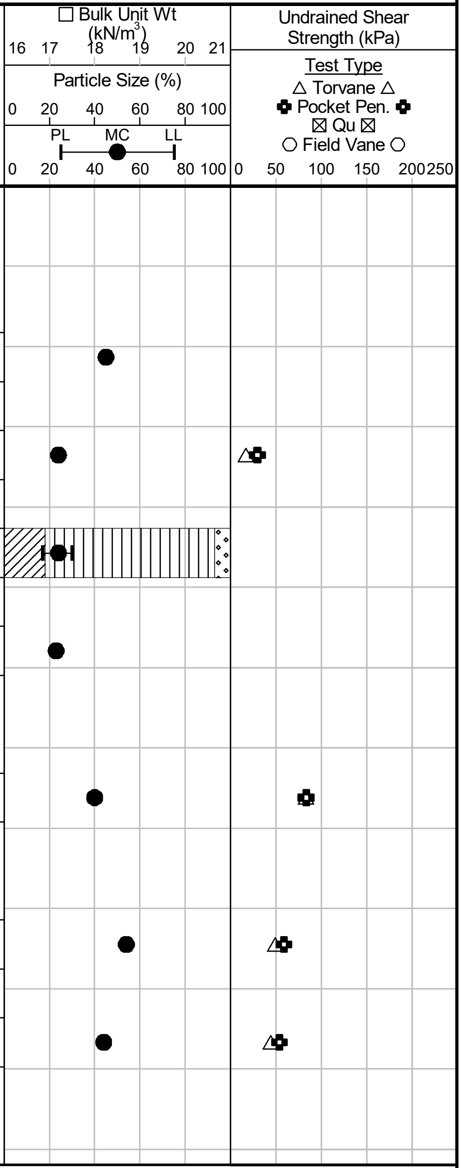
CLAY (FILL) - silty, trace sand
- dark grey
- frozen, moist, stiff when thawed
- high plasticity
- AASHTO: A-7-6(I)

SILT - some clay, trace sand
- light brown
- frozen to 1.5 m, moist, firm when thawed
- low to intermediate plasticity
- AASHTO: A-6(11)

CLAY - silty, trace sand
- brown
- moist, stiff
- high plasticity
- AASHTO: A-7-6(I)

- trace oxidation below 2.4 m

Sample Type	Sample Number
Grab	G37
Grab	G38
Grab	G39
Grab	G40
Grab	G41
Grab	G42
Grab	G43



END TEST HOLE AT 3.0 m IN CLAY.

Notes:

1. Seepage or sloughing not observed.
2. Test Hole open to 3.0 m immediately after drilling.
3. Test Hole backfilled with cuttings, granular fill and cold patch asphalt.
4. Bulk samples were collected between 0.9 m and 1.5 m depth (silt) (L24-061-04) and between 1.5 m and 2.0 m depth (clay) (L24-061-03).
5. Test Hole located in front of #614 Dudley Ave, Westbound lane, 1.4 m South of North curb.

Logged By: Kate Franklin **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

Sub-Surface Log

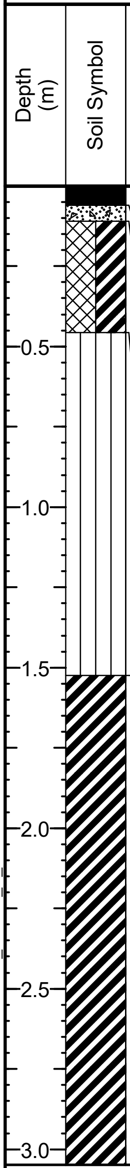
Test Hole TH24-07

1 of 1

Client: WSP
Project Number: 1000-043-25
Project Name: 2024 Local Street Renewal (24-K-01, 24-R1-01)
Location: UTM N-5525588, E-633254 - Dudley Ave
Contractor: Paddock Drilling Ltd.
Ground Elevation: Top of Pavement
Method: 150 mm Solid Stem Auger, M10 Truck Mount
Date Drilled: February 26, 2024

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



MATERIAL DESCRIPTION

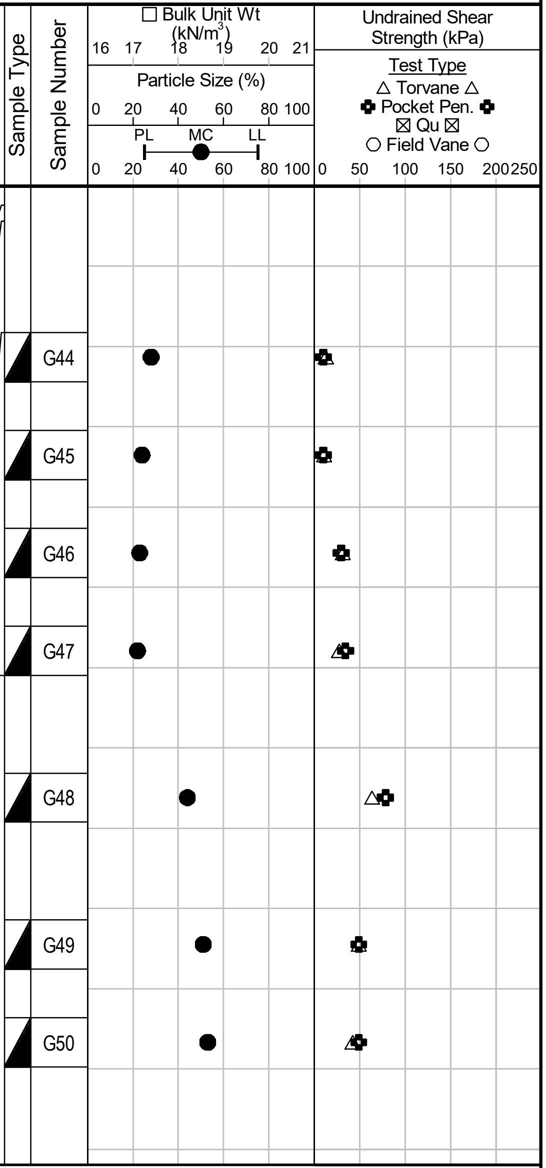
ASPHALT

CONCRETE

CLAY - silty, trace sand
- dark grey
- frozen, moist, firm when thawed
- high plasticity
- AASHTO: A-7-6(I)

SILT - trace to some clay, trace sand
- light brown
- frozen, moist, soft when thawed
- low to intermediate plasticity
- AASHTO: A-6(I)
- firm below 0.9 m

CLAY - silty, trace sand
- brown
- moist, stiff
- high plasticity
- AASHTO: A-7-6(I)
- firm to stiff below 2.3 m



END TEST HOLE AT 3.0 m IN CLAY.
Notes:
1. Seepage or sloughing not observed.
2. Test Hole open to 3.0 m immediately after drilling.
3. Test Hole backfilled with cuttings, granular fill and cold patch asphalt.
4. Bulk samples were collected between 0.9 m and 1.5 m depth (silt) (L24-061-04) and between 1.5 m and 2.0 m depth (clay) (L24-061-03).
5. Test Hole located on Dudley Ave, 30 m East of Pembin Hwy, Eastbound Lane, 1.5 m North of South curb.

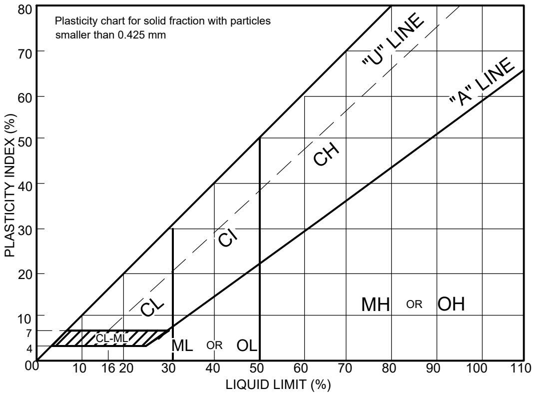
Logged By: Kate Franklin **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

TREK GEOTECHNICAL

EXPLANATION OF FIELD AND LABORATORY TESTING

GENERAL NOTES

1. Classifications are based on the Unified 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	

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
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
with *	with silt, with sand	> 35 percent

* Used when the material is classified based on behaviour as a cohesive material

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

2024 Local Street Renewal (24-K-01, 24-R1-01)
Dudley Ave - Pembina Hwy to Daly St N
Sub-Surface Investigation

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
TH24-06	UTM : 5525606 N, 633275 E Located in front of #614 Dudley Ave, Westbound lane, 1.4 m South of North curb	Asphalt	60	Concrete	-	Clay, AASHTO: A-7-6 (I)	0.5	0.6	45							
						Silt, AASHTO: A-6 (11)	0.8	0.9	24							
						Silt, AASHTO: A-6 (11)	1.1	1.2	24	18	75	7	0	17	30	13
						Silt, AASHTO: A-6 (11)	1.4	1.5	23							
						Clay, AASHTO: A-7-6 (I)	1.8	2.0	40							
						Clay, AASHTO: A-7-6 (I)	2.3	2.4	54							
						Clay, AASHTO: A-7-6 (I)	2.6	2.7	44							
TH24-07	UTM : 5525588 N, 633254 E Located on Dudley Ave, 30 m East of Pembin Hwy, Eastbound Lane, 1.5 m North of South curb	Asphalt	60	Concrete	110	Silt, AASHTO: A-6 (I)	0.5	0.6	28							
						Silt, AASHTO: A-6 (I)	0.8	0.9	24							
						Silt, AASHTO: A-6 (I)	1.1	1.2	23							
						Silt, AASHTO: A-6 (I)	1.4	1.5	22							
						Clay, AASHTO: A-7-6 (I)	1.8	2.0	44							
						Clay, AASHTO: A-7-6 (I)	2.3	2.4	51							
						Clay, AASHTO: A-7-6 (I)	2.6	2.7	53							

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Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Moisture Content Report
ASTM D2216-98

Project No. 1000-043-25
Client WSP
Project 2024 Local Street Renewal (24-K-01, 24-R1-01)- Dudley Ave.

Sample Date 26-Feb-24
Test Date 01-Mar-24
Technician KF

Test Hole	TH24-06	TH24-06	TH24-06	TH24-06	TH24-06	TH24-06
Depth (m)	0.5 - 0.6	0.8 - 0.9	1.1 - 1.2	1.4 - 1.5	1.8 - 2.0	2.3 - 2.4
Sample #	G37	G38	G39	G40	G41	G42
Tare ID	Z77	W27	M13	AB88	Z58	AC28
Mass of tare	8.6	8.3	6.9	6.8	8.7	6.6
Mass wet + tare	222.9	287.7	461.8	313.1	260.8	242.1
Mass dry + tare	156.8	234.2	372.8	255.0	188.4	159.9
Mass water	66.1	53.5	89.0	58.1	72.4	82.2
Mass dry soil	148.2	225.9	365.9	248.2	179.7	153.3
Moisture %	44.6%	23.7%	24.3%	23.4%	40.3%	53.6%

Test Hole	TH24-06	TH24-07	TH24-07	TH24-07	TH24-07	TH24-07
Depth (m)	2.6 - 2.7	0.5 - 0.6	0.8 - 0.9	1.1 - 1.2	1.4 - 1.5	1.8 - 2.0
Sample #	G43	G44	G45	G46	G47	G48
Tare ID	P10	E80	F135	P31	P85	I72
Mass of tare	8.2	8.5	8.6	8.4	8.6	7.0
Mass wet + tare	247.7	229.3	247.5	232.8	283.2	255.6
Mass dry + tare	175.0	181.0	201.6	191.1	234.6	179.3
Mass water	72.7	48.3	45.9	41.7	48.6	76.3
Mass dry soil	166.8	172.5	193.0	182.7	226.0	172.3
Moisture %	43.6%	28.0%	23.8%	22.8%	21.5%	44.3%

Test Hole	TH24-07	TH24-07				
Depth (m)	2.3 - 2.4	2.6 - 2.7				
Sample #	G49	G50				
Tare ID	D500	M80				
Mass of tare	6.8	7.0				
Mass wet + tare	261.5	281.0				
Mass dry + tare	175.5	185.6				
Mass water	86.0	95.4				
Mass dry soil	168.7	178.6				
Moisture %	51.0%	53.4%				

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Atterberg Limits
ASTM D4318-10e1

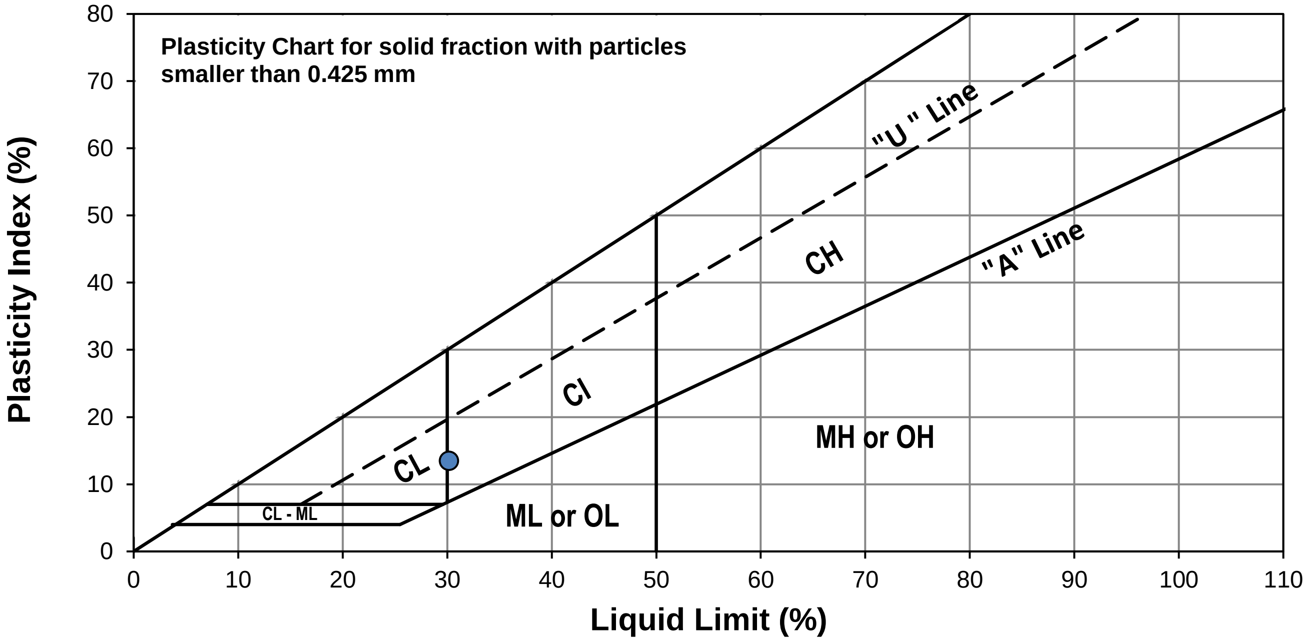
Project No. 1000-043-25
Client WSP
Project 2024 Local Street Renewal (24-K-01, 24-RI-01)- Dudley Ave.

Test Hole TH24-06
Sample # G39
Depth (m) 1.1 - 1.2
Sample Date 26-Feb-24
Test Date 07-Mar-24
Technician PC

Liquid Limit	30
Plastic Limit	17
Plasticity Index	13

Liquid Limit

Trial #	**1**	**2**	**3**		
Number of Blows (N)	23	27	35		
Mass Tare (g)	14.221	14.219	13.721		
Mass Wet Soil + Tare (g)	20.994	21.979	22.193		
Mass Dry Soil + Tare (g)	19.407	20.200	20.326		
Mass Water (g)	1.587	1.779	1.867		
Mass Dry Soil (g)	5.186	5.981	6.605		
Moisture Content (%)	30.602	29.744	28.266		



Plastic Limit

Trial #	**1**	**2**	**3**	**4**	**5**
Mass Tare (g)	13.964	14.102			
Mass Wet Soil + Tare (g)	20.840	20.227			
Mass Dry Soil + Tare (g)	19.851	19.356			
Mass Water (g)	0.989	0.871			
Mass Dry Soil (g)	5.887	5.254			
Moisture Content (%)	16.800	16.578			

Note: Additional information recorded/measured for this test is available upon request.

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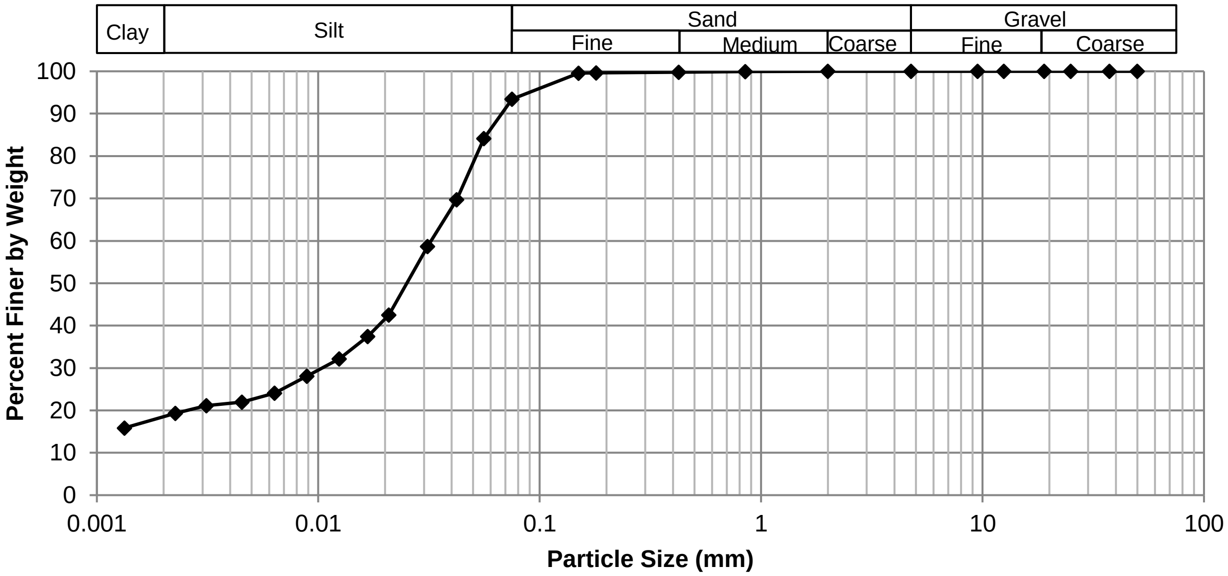
Grain Size Analysis (Hydrometer Method)
AASHTO T 88

CERTIFIED BY CCIL Canadian Council of Independent Laboratories For specific tests as listed on www.ccil.com

Project No.	1000-043-25
Client	WSP
Project	2024 Local Street Renewal (24-K-01, 24-RI-01)- Dudley Ave.
Test Hole	TH24-06
Sample #	G39
Depth (m)	1.0 - 1.2
Sample Date	26-Feb-24
Test Date	07-Mar-23
Technician	DS

Gravel	0.0%
Sand	6.6%
Silt	75.1%
Clay	18.3%

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	93.43
37.5	100.00	2.00	100.00	0.0559	84.11
25.0	100.00	0.850	99.91	0.0421	69.69
19.0	100.00	0.425	99.79	0.0311	58.70
12.5	100.00	0.180	99.61	0.0208	42.48
9.50	100.00	0.150	99.52	0.0167	37.48
4.75	100.00	0.075	93.43	0.0124	32.17
				0.0089	28.10
				0.0064	24.08
				0.0045	21.94
				0.0031	21.14
				0.0023	19.31
				0.0013	15.86

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Standard Proctor Compaction Test

ASTM D698-12 (2021)

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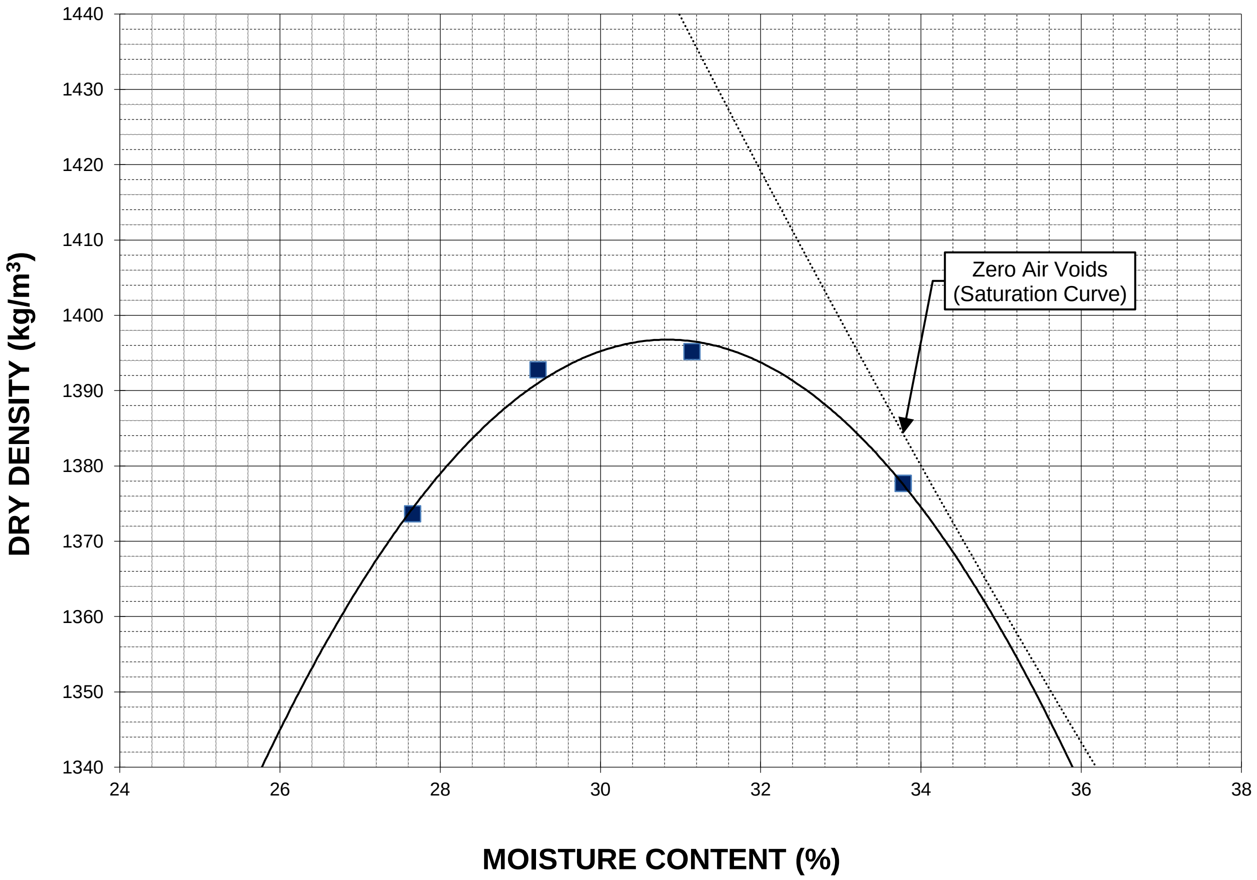
For specific tests as listed on www.ccil.com

Project No.	1000-043-25
Client	WSP
Project	2024 Local Street Renewal (24-K-01, 24-RI-01)- Dudley Ave.
Sample #	L24-061-03
Source	TH24-06 and TH24-07 (1.5m - 2.0m)
Material	Clay
Sample Date	27-Feb-24
Test Date	07-Mar-24
Technician	AD

Maximum Dry Density (kg/m3)	1397
Optimum Moisture (%)	30.8

Trial Number	1	2	3	4	
Wet Density (kg/m^3)	1754	1800	1830	1843	
Dry Density (kg/m^3)	1374	1393	1395	1378	
Moisture Content (%)	27.7	29.2	31.1	33.8	



Note: Additional information recorded/measured for this test is available upon request.

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California Bearing Ratio Test Data Sheet

ASTM D1883-16

Project No.	1000-043-25	**Source**	Dudley Ave: TH24-06 & TH24-07 (1.5 m - 2.0 m)
Client	WSP	**Material**	Clay
Project	2024 Local Street Renewal (24-K-01, 24-RI-01)	**Sample Date**	2024-02-27
Sample #	L24-061	**Test Date**	2024-03-11
		Technician	DS

Proctor Results (ASTM D698)

Maximum Dry Density	1397	kg/m3
Optimum Moisture Content	30.8	%
Material Retained on 19 mm Sieve	0.0	%

CBR Sample Compaction

Dry Density	1323	kg/m3
Initial Moisture Content	30.7	%
Relative Density	94.7	% SPMDD

Soaking Results

Surcharge	4.54	kg
Swell	4.1	%
Moisture Content in top 25 mm	54.2	%
Immersion Period	96	h

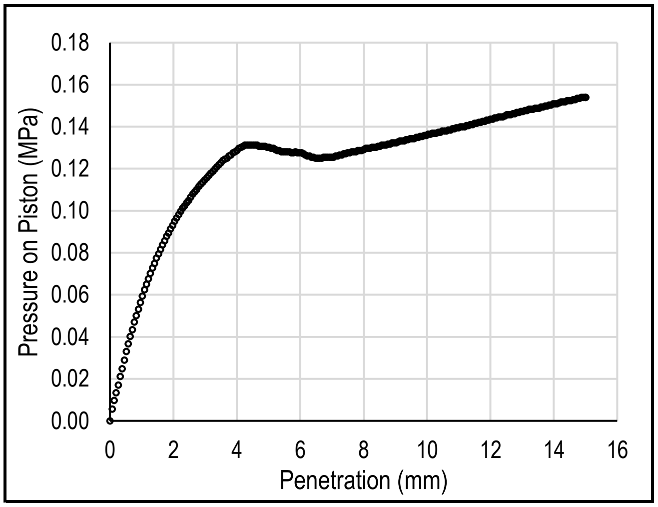
CBR Results

CBR at 2.54 mm	1.5	%
CBR at 5.08 mm	1.3	%
Zero Correction	0	mm

Test Data

Penetration (mm)	Measured Pressure (MPa)	Corrected Pressure (MPa)
0.64	0.04	0.04
1.27	0.07	0.07
1.91	0.09	0.09
2.54	0.11	0.11
3.18	0.12	0.12
3.81	0.13	0.13
4.45	0.13	0.13
5.08	0.13	0.13
7.62	0.13	0.13
10.16	0.14	0.14
12.70	0.15	0.15

Load/Penetration Curve



Comments:

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Standard Proctor Compaction Test

ASTM D698-12 (2021)

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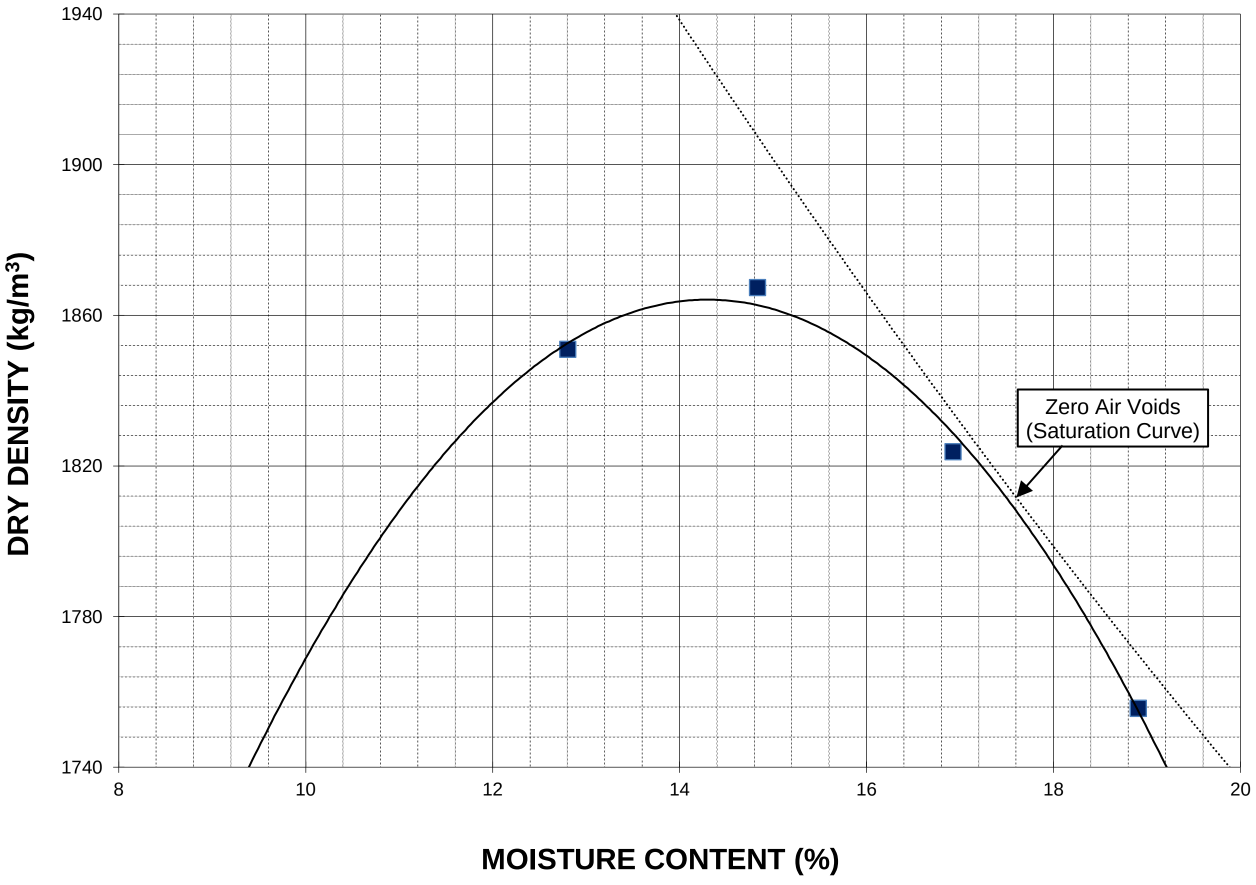
Project No.	1000-043-25
Client	WSP
Project	2024 Local Street Renewal (24-K-01, 24-RI-01)- Dudley Ave.
Sample #	L24-061-04
Source	TH24-06 and TH24-07 (0.9m - 1.5m)
Material	Silt
Sample Date	26-Feb-24
Test Date	08-Mar-24
Technician	AD

Maximum Dry Density (kg/m3)	1864
Optimum Moisture (%)	14.3

Trial Number	1	2	3	4	
Wet Density (kg/m^3)	2088	2144	2133	2088	
Dry Density (kg/m^3)	1851	1867	1824	1756	
Moisture Content (%)	12.8	14.8	16.9	18.9	



Note: Additional information recorded/measured for this test is available upon request.

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California Bearing Ratio Test Data Sheet

ASTM D1883-16

Project No.	1000-043-25	**Source**	Dudley Ave: TH24-06 & TH24-07 (0.9 m - 1.5 m)
Client	WSP	**Material**	Silt
Project	2024 Local Street Renewal (24-K-01, 24-RI-01)	**Sample Date**	2024-02-26
Sample #	L24-061	**Test Date**	2024-03-09
		Technician	IA

Proctor Results (ASTM D698)

Maximum Dry Density	1864	kg/m3
Optimum Moisture Content	14.3	%
Material Retained on 19 mm Sieve	0.0	%

CBR Sample Compaction

Dry Density	1769	kg/m3
Initial Moisture Content	14.4	%
Relative Density	94.9	% SPMDD

Soaking Results

Surcharge	4.54	kg
Swell	0.4	%
Moisture Content in top 25 mm	19.4	%
Immersion Period	96	h

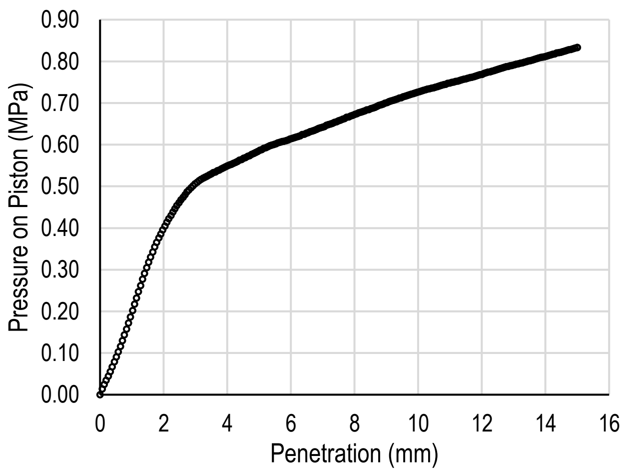
CBR Results

CBR at 2.54 mm	6.8	%
CBR at 5.08 mm	5.7	%
Zero Correction	0	mm

Test Data

Penetration (mm)	Measured Pressure (MPa)	Corrected Pressure (MPa)
0.64	0.12	0.12
1.27	0.26	0.26
1.91	0.39	0.39
2.54	0.47	0.47
3.18	0.52	0.52
3.81	0.54	0.54
4.45	0.57	0.57
5.08	0.59	0.59
7.62	0.66	0.66
10.16	0.73	0.73
12.70	0.79	0.79

Load/Penetration Curve



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Project 1000-043-25
Location 614 Dudley Ave
Hole No. TH24-06 Sample No. PC24-27
Depth 60mm
Technician TG Date Feb 23/24

Photo 1: Pavement Core Sample at TH24-06

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Project 1000-043-25
Location Dudley Ave
Hole No. TH24-07 Sample No. PC24-28
Depth 170mm
Technician TG Date Feb 23/24

Photo 2: Pavement Core Sample at TH24-07

Appendix D

Test Hole Logs, Summary Table, Lab Testing Results and Pavement Core Photos

Irene St – Clarence Ave to Waller Ave

Sub-Surface Log

Test Hole TH24-01

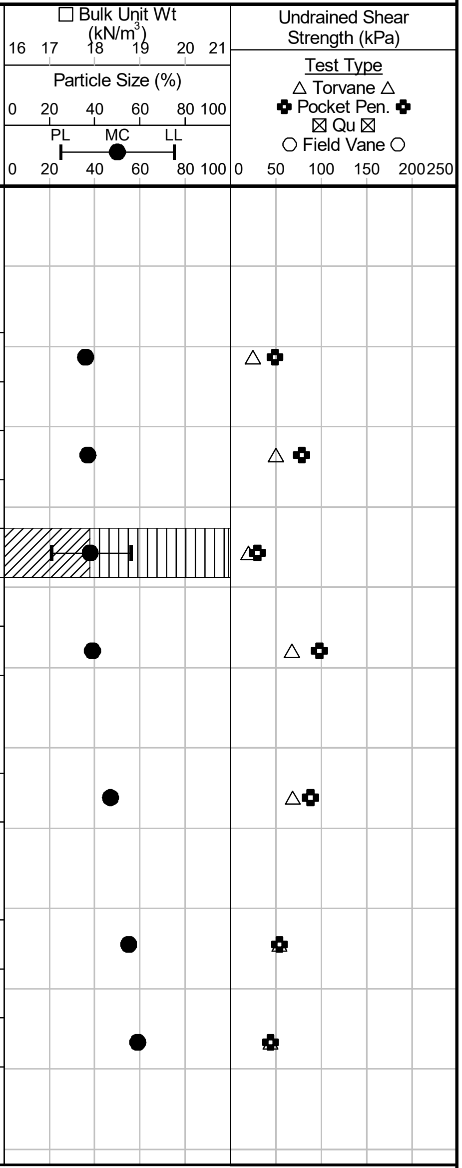
1 of 1

Client: WSP
Project Name: 2024 Local Street Renewal (24-K-01, 24-R1-01)
Contractor: Paddock Drilling Ltd.
Method: 150 mm Solid Stem Auger, M10 Truck Mount
Project Number: 1000-043-25
Location: UTM N-5521606, E-631974 - Irene St
Ground Elevation: Top of Pavement
Date Drilled: February 26, 2024

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)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number
		ASPHALT		
		CONCRETE		
0.5		CLAY (FILL) - silty, trace sand, trace gravel (<10 mm diam.) - dark brown - frozen, moist, firm when thawed - high plasticity - AASHTO: A-7-6(I)	◢	G1
		CLAY - silty, trace sand - dark brown - frozen to 1.5 m, moist, stiff, when thawed - high plasticity - AASHTO: A-7-6(39)	◢	G2
1.0		- with silt, light brown, mottled grey, firm, below 1.0 m	◢	G3
1.5		- silty, brown, stiff, below 1.4 m	◢	G4
2.0		- trace silt inclusions (<5 mm diam.) below 1.8 m	◢	G5
2.5			◢	G6
			◢	G7
3.0				



END TEST HOLE AT 3.0 m IN CLAY.
Notes:
1. Seepage or sloughing not observed.
2. Test Hole open to 3.0 m immediately after drilling.
3. Test Hole backfilled with cuttings, granular fill and cold patch asphalt.
4. Bulk samples were collected between 1.4 m and 2.0 m depth (clay) (L24-061-01).
5. Test Hole located in front of #121 Irene St, Southbound Lane, 1.5 m East of West curb.

Logged By: Kate Franklin
Reviewed By: Angela Fidler-Kliewer
Project Engineer: Nelson Ferreira

Test Hole TH24-02

1 of 1

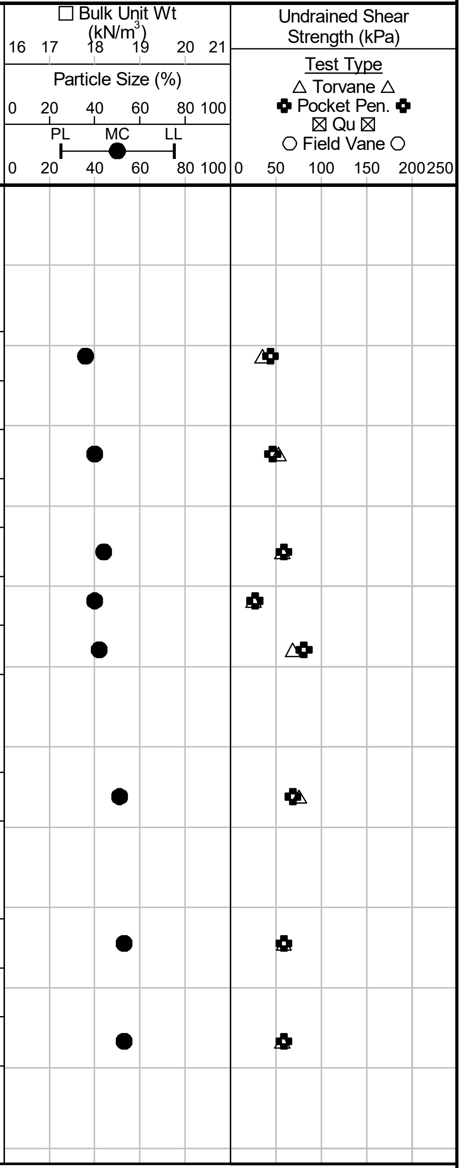
Sub-Surface Log

Client: WSP
Project Name: 2024 Local Street Renewal (24-K-01, 24-R1-01)
Contractor: Paddock Drilling Ltd.
Method: 150 mm Solid Stem Auger, M10 Truck Mount
Project Number: 1000-043-25
Location: UTM N-5521685, E-631938 - Irene St
Ground Elevation: Top of Pavement
Date Drilled: February 26, 2024

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
	ASPHALT		
0.5	CLAY (FILL) - silty, trace sand - dark brown - frozen, moist, firm when thawed - high plasticity, frozen - AASHTO: A-7-6(I)	◪ ◪	G8 G9
1.0 1.5 2.0 2.5 3.0	CLAY - silty - dark brown - frozen to 1.5 m, moist, firm to stiff when thawed - high plasticity - AASHTO: A-7-6(I) - with silt, light brown, mottled grey, firm, below 1.2 m - silty, brown, stiff, below 1.4 m	◪ ◪ ◪ ◪ ◪ ◪	G10 G11 G12 G13 G14 G15



END TEST HOLE AT 3.0 m IN CLAY.
Notes:
1. Seepage or sloughing not observed.
2. Test Hole open to 3.0 m immediately after drilling.
3. Test Hole backfilled with cuttings, granular fill and cold patch asphalt.
4. Bulk samples were collected between 1.4 m and 2.0 m depth (clay) (L24-061-01).
5. Test Hole located in front of #101 Irene St, Northbound Lane, 1.5 m West of East curb.

Logged By: Kate Franklin **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

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Sub-Surface Log

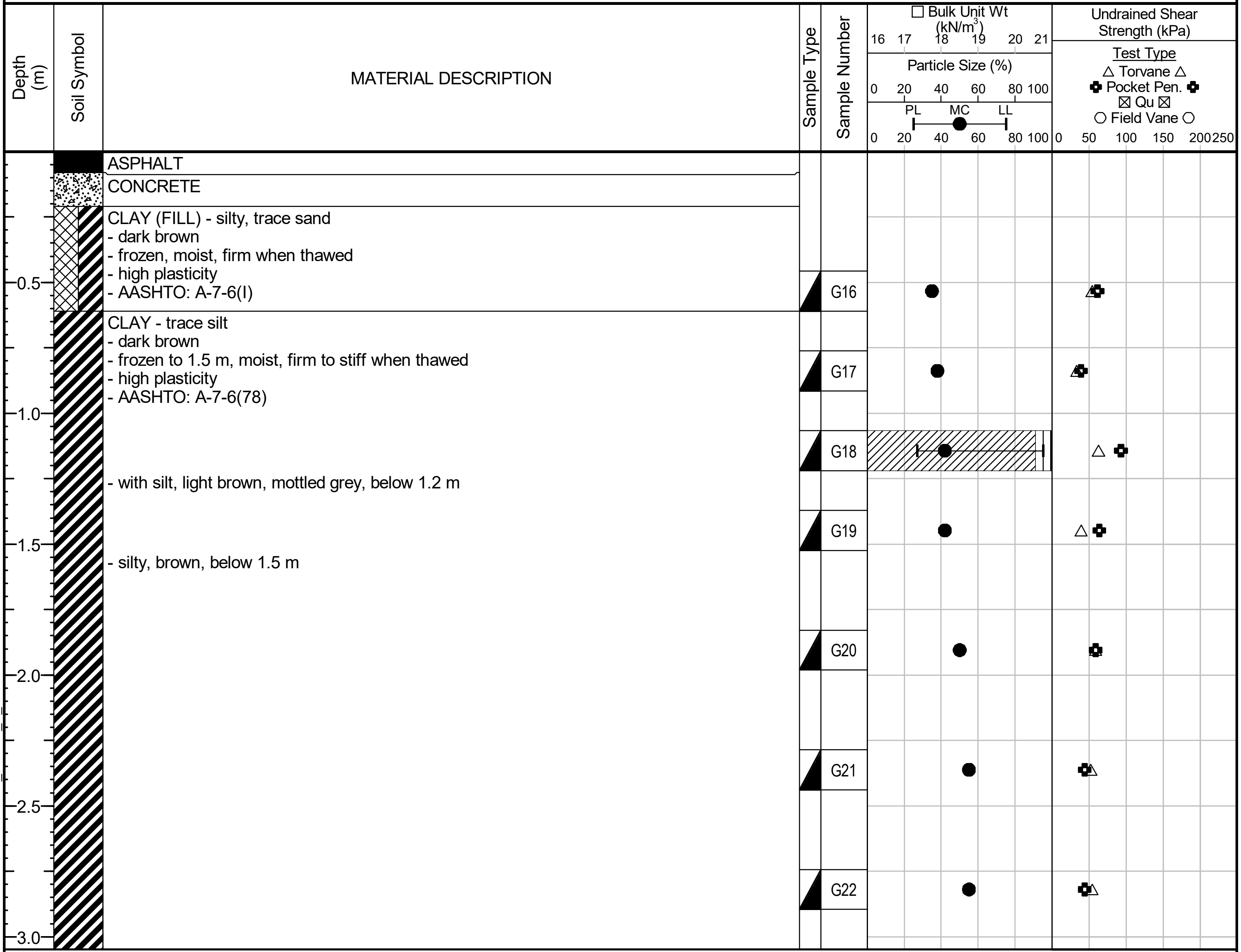
Test Hole TH24-03

1 of 1

Client:	WSP	**Project Number:**	1000-043-25
Project Name:	2024 Local Street Renewal (24-K-01, 24-R1-01)	**Location:**	UTM N-5521742, E-631901 - Irene St
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	Top of Pavement
Method:	150 mm Solid Stem Auger, M10 Truck Mount	**Date Drilled:**	February 26, 2024

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



ASPHALT

CONCRETE

CLAY (FILL) - silty, trace sand
- dark brown
- frozen, moist, firm when thawed
- high plasticity
- AASHTO: A-7-6(I)

CLAY - trace silt
- dark brown
- frozen to 1.5 m, moist, firm to stiff when thawed
- high plasticity
- AASHTO: A-7-6(78)

- with silt, light brown, mottled grey, below 1.2 m

- silty, brown, below 1.5 m

END TEST HOLE AT 3.0 m IN CLAY.

Notes:
1. Seepage or sloughing not observed.
2. Test Hole open to 3.0 m immediately after drilling.
3. Test Hole backfilled with cuttings, granular fill and cold patch asphalt.
4. Bulk samples were collected between 0.9 m and 2.0 m depth (clay) (L24-061-02).
5. Test Hole located in front of #77 Irene St, Southbound Lane, 1.7 m East of West curb.

Logged By:	Kate Franklin	**Reviewed By:**	Angela Fidler-Kliewer	**Project Engineer:**	Nelson Ferreira

Test Hole TH24-04

1 of 1

Sub-Surface Log

Client: WSP

Project Name: 2024 Local Street Renewal (24-K-01, 24-R1-01)

Contractor: Paddock Drilling Ltd.

Method: 150 mm Solid Stem Auger, M10 Truck Mount

Project Number: 1000-043-25

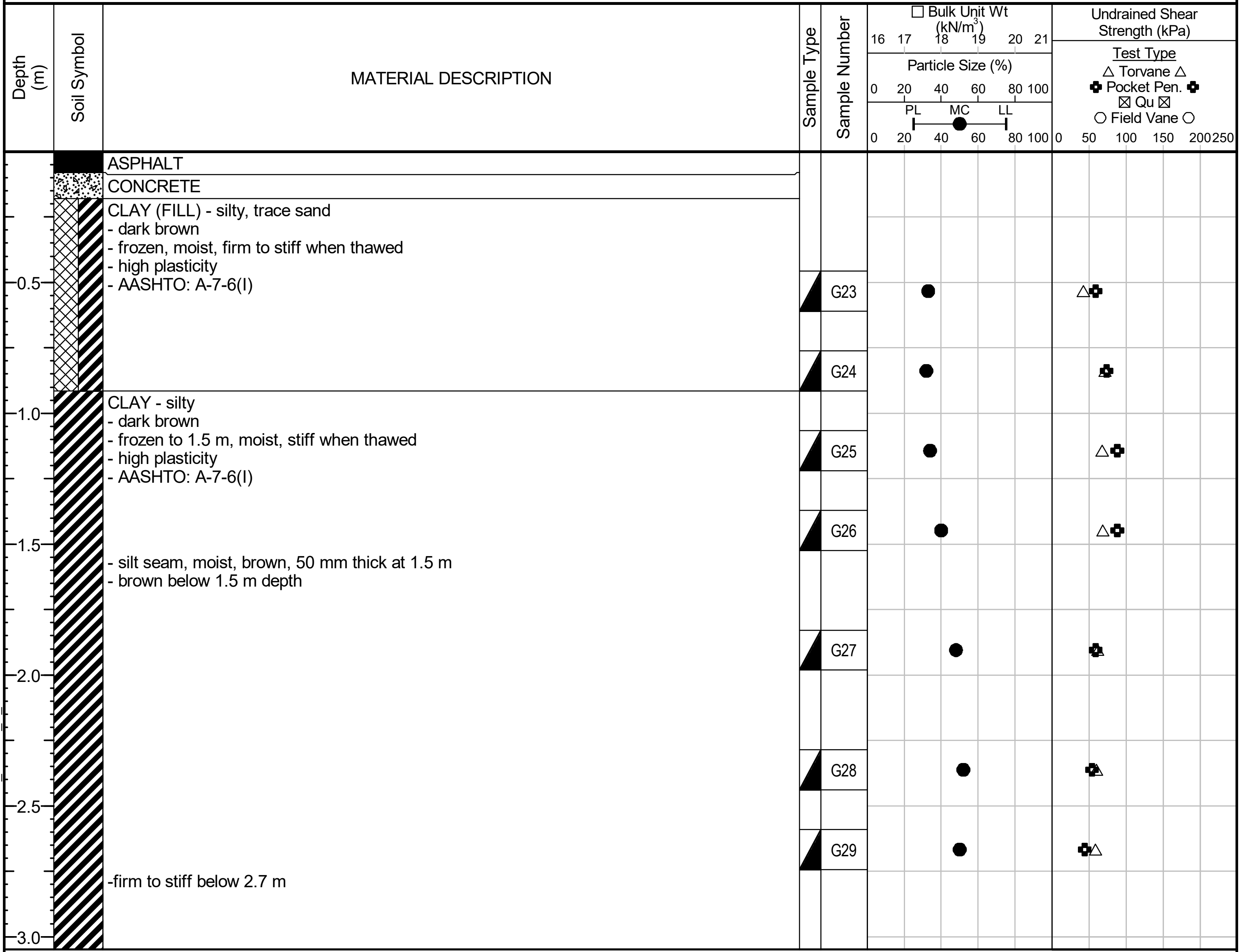
Location: UTM N-5521855, E-631836 - Irene St

Ground Elevation: Top of Pavement

Date Drilled: February 26, 2024

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



ASPHALT

CONCRETE

CLAY (FILL) - silty, trace sand
- dark brown
- frozen, moist, firm to stiff when thawed
- high plasticity
- AASHTO: A-7-6(I)

CLAY - silty
- dark brown
- frozen to 1.5 m, moist, stiff when thawed
- high plasticity
- AASHTO: A-7-6(I)

- silt seam, moist, brown, 50 mm thick at 1.5 m
- brown below 1.5 m depth

-firm to stiff below 2.7 m

END TEST HOLE AT 3.0 m IN CLAY.
Notes:
1. Seepage or sloughing not observed.
2. Test Hole open to 3.0 m immediately after drilling.
3. Test Hole backfilled with cuttings, granular fill and cold patch asphalt.
4. Bulk samples were collected between 0.9 m and 2.0 m depth (clay) (L24-061-02).
5. Test Hole located 10 m South of Waller St, Southbound Lane, 1.7 m East of West curb.

Logged By: Kate Franklin **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

Sub-Surface Log

Test Hole TH24-05

1 of 1

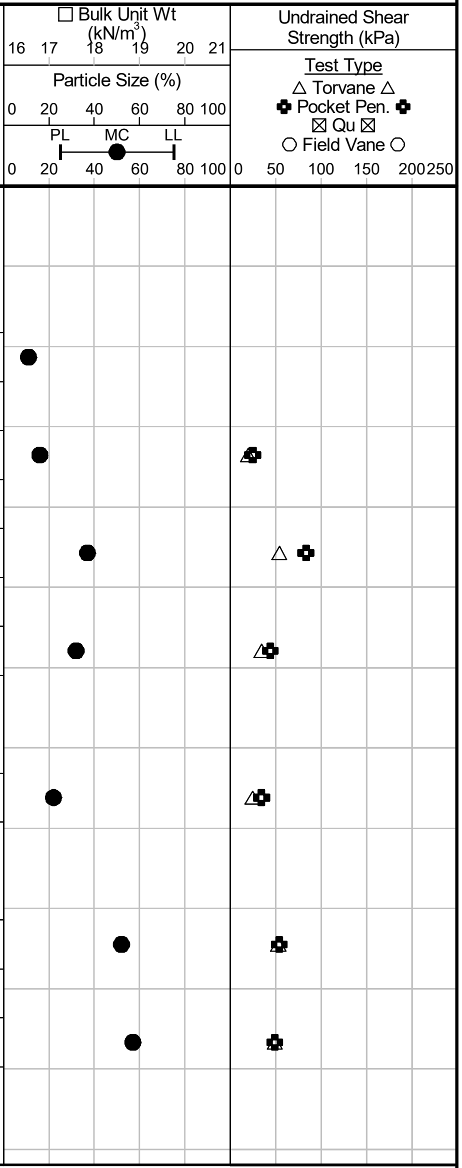
Client: WSP
Project Name: 2024 Local Street Renewal (24-K-01, 24-R1-01)
Contractor: Paddock Drilling Ltd.
Method: 150 mm Solid Stem Auger, M10 Truck Mount
Project Number: 1000-043-25
Location: UTM N-5521785, E-631882 - Irene St
Ground Elevation: Top of Pavement
Date Drilled: February 26, 2024

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
	ASPHALT
	CONCRETE
-0.5	SAND (fill) - some gravel (<30 mm diam.), trace clay - brown - frozen, moist, compact when thawed - poorly graded, medium grained, rounded to subanglular - no to low plasticity, frozen - AASHTO: A-1(I)
-1.0 -1.5 -2.0	CLAY (FILL) - silty, trace sand, trace gravel (<10 mm diam.) - grey - frozen to 1.5 m, moist, firm to stiff when thawed - high plasticity, - AASHTO: A-7-6(I)
-2.5 -3.0	CLAY - silty, trace sand - dark brown - moist, firm to stiff - high plasticity - AASHTO: A-7-6(I)

Sample Type	Sample Number
G	G30
G	G31
G	G32
G	G33
G	G34
G	G35
G	G36



END TEST HOLE AT 3.0 m IN CLAY.
Notes:
1. Seepage or sloughing not observed.
2. Test Hole open to 3.0 m immediately after drilling.
3. Test Hole backfilled with cuttings, granular fill and cold patch asphalt.
4. Test Hole located in front of #77 Irene St, Northbound Lane, 1.5 m West of East curb.

Logged By: Kate Franklin **Reviewed By:** Angela Fidler-Kliewer **Project Engineer:** Nelson Ferreira

SUB-SURFACE LOG LOGS 2024-02-27 2024 LOCAL STREET PACKAGE 0_DRAFT_A KF 1000-043-25.GPJ TREK.GDT 3/21/24

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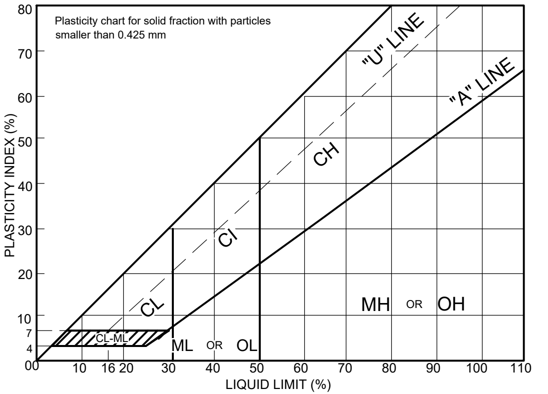
EXPLANATION OF FIELD AND LABORATORY TESTING

GENERAL NOTES

1. Classifications are based on the Unified 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	

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
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

TREK GEOTECHNICAL

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
with *	with silt, with sand	> 35 percent

* Used when the material is classified based on behaviour as a cohesive material

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

2024 Local Street Renewal (24-K-01, 24-R1-01)
Irene St - Clarence Ave to Waller Ave
Sub-Surface Investigation

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
TH24-01	UTM : 5521606 N, 631974 E Located in front of #121 Irene St, Southbound Lane, 1.5 m East of West curb	Asphalt	90	Concrete	190	Clay, AASHTO: A-7-6 (I)	0.5	0.6	36							
						Clay, AASHTO: A-7-6 (39)	0.8	0.9	37							
						Clay, AASHTO: A-7-6 (39)	1.1	1.2	38	38	61	1	0	21	56	35
						Clay, AASHTO: A-7-6 (39)	1.4	1.5	39							
						Clay, AASHTO: A-7-6 (39)	1.8	2.0	47							
						Clay, AASHTO: A-7-6 (39)	2.3	2.4	55							
						Clay, AASHTO: A-7-6 (39)	2.6	2.7	59							
TH24-02	UTM : 5521685 N, 631938 E Located in front of #101 Irene St, Northbound Lane, 1.5 m West of East curb	Asphalt	90	Concrete	195	Clay, AASHTO: A-7-6 (I)	0.5	0.6	36							
						Clay, AASHTO: A-7-6 (I)	0.8	0.9	40							
						Clay, AASHTO: A-7-6 (I)	1.1	1.2	44							
						Clay, AASHTO: A-7-6 (I)	1.2	1.4	40							
						Clay, AASHTO: A-7-6 (I)	1.4	1.5	42							
						Clay, AASHTO: A-7-6 (I)	1.8	2.0	51							
						Clay, AASHTO: A-7-6 (I)	2.3	2.4	53							
						Clay, AASHTO: A-7-6 (I)	2.6	2.7	53							
TH24-03	UTM : 5521742 N, 631901 E Located in front of #77 Irene St, Southbound Lane, 1.7 m East of West curb	Asphalt	80	Concrete	210	Clay, AASHTO: A-7-6 (I)	0.5	0.6	35							
						Clay, AASHTO: A-7-6 (78)	0.8	0.9	38							
						Clay, AASHTO: A-7-6 (78)	1.1	1.2	42	91	8	1	0	27	95	67
						Clay, AASHTO: A-7-6 (78)	1.4	1.5	42							
						Clay, AASHTO: A-7-6 (78)	1.8	2.0	50							
						Clay, AASHTO: A-7-6 (78)	2.3	2.4	55							
						Clay, AASHTO: A-7-6 (78)	2.6	2.7	55							

TREK GEOTECHNICAL

2024 Local Street Renewal (24-K-01, 24-R1-01)
Irene St - Clarence Ave to Waller Ave
Sub-Surface Investigation

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
TH24-04	UTM : 5521855 N, 631836 E Located 10 m South of Waller St, Southbound Lane, 1.7 m East of West curb	Asphalt	80	Concrete	180	Clay, AASHTO: A-7-6 (I)	0.5	0.6	33							
						Clay, AASHTO: A-7-6 (I)	0.8	0.9	32							
						Clay, AASHTO: A-7-6 (I)	1.1	1.2	34							
						Clay, AASHTO: A-7-6 (I)	1.4	1.5	40							
						Clay, AASHTO: A-7-6 (I)	1.8	2.0	48							
						Clay, AASHTO: A-7-6 (I)	2.3	2.4	52							
						Clay, AASHTO: A-7-6 (I)	2.6	2.7	50							
TH24-05	UTM : 5521785 N, 631882 E Located in front of #77 Irene St, Northbound Lane, 1.5 m West of East curb	Asphalt	90	Concrete	220	Sand, AASHTO: A-1 (I)	0.5	0.6	11							
						Clay, AASHTO: A-7-6 (I)	0.8	0.9	16							
						Clay, AASHTO: A-7-6 (I)	1.1	1.2	37							
						Clay, AASHTO: A-7-6 (I)	1.4	1.5	32							
						Clay, AASHTO: A-7-6 (I)	1.8	2.0	22							
						Clay, AASHTO: A-7-6 (I)	2.3	2.4	52							
						Clay, AASHTO: A-7-6 (I)	2.6	2.7	57							

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Moisture Content Report
ASTM D2216-98

Project No. 1000-043-25
Client WSP
Project 2024 Local Street Renewal (24-K-01, 24-R1-01)- Irene St.

Sample Date 26-Feb-24
Test Date 01-Mar-24
Technician KF

Test Hole	TH24-01	TH24-01	TH24-01	TH24-01	TH24-01	TH24-01
Depth (m)	0.5 - 0.6	0.8 - 0.9	1.1 - 1.2	1.4 - 1.5	1.8 - 2.0	2.3 - 2.4
Sample #	G1	G2	G3	G4	G5	G6
Tare ID	Z44	M92	E64	W111	F50	AC08
Mass of tare	8.5	6.8	6.9	8.5	8.7	6.9
Mass wet + tare	232.9	295.0	453.7	282.1	271.5	260.6
Mass dry + tare	173.8	217.3	330.4	205.3	187.5	170.3
Mass water	59.1	77.7	123.3	76.8	84.0	90.3
Mass dry soil	165.3	210.5	323.5	196.8	178.8	163.4
Moisture %	35.8%	36.9%	38.1%	39.0%	47.0%	55.3%

Test Hole	TH24-01	TH24-02	TH24-02	TH24-02	TH24-02	TH24-02
Depth (m)	2.6 - 2.7	0.5 - 0.6	0.8 - 0.9	1.1 - 1.2	1.2 - 1.4	1.4 - 1.5
Sample #	G7	G8	G9	G10	G11	G12
Tare ID	C3	A37	Z08	E10	AB75	W87
Mass of tare	8.6	8.4	8.4	6.8	6.8	8.6
Mass wet + tare	261.2	236.1	259.0	435.8	270.8	281.8
Mass dry + tare	167.7	175.9	187.4	304.1	195.7	201.5
Mass water	93.5	60.2	71.6	131.7	75.1	80.3
Mass dry soil	159.1	167.5	179.0	297.3	188.9	192.9
Moisture %	58.8%	35.9%	40.0%	44.3%	39.8%	41.6%

Test Hole	TH24-02	TH24-02	TH24-02	TH24-03	TH24-03	TH24-03
Depth (m)	1.8 - 2.0	2.3 - 2.4	2.6 - 2.7	0.5 - 0.6	0.8 - 0.9	1.1 - 1.2
Sample #	G13	G14	G15	G16	G17	G18
Tare ID	Z99	Z74	N22	Z56	Z109	M12
Mass of tare	8.4	8.5	8.5	8.5	8.6	6.8
Mass wet + tare	265.9	288.3	275.2	264.2	226.3	492.6
Mass dry + tare	179.1	191.1	182.6	198.2	166.0	349.7
Mass water	86.8	97.2	92.6	66.0	60.3	142.9
Mass dry soil	170.7	182.6	174.1	189.7	157.4	342.9
Moisture %	50.8%	53.2%	53.2%	34.8%	38.3%	41.7%

Moisture Content Report
ASTM D2216-98

Project No.	1000-043-25
Client	WSP
Project	2024 Local Street Renewal (24-K-01, 24-R1-01)- Irene St.
Sample Date	26-Feb-24
Test Date	01-Mar-24
Technician	KF

Test Hole	TH24-03	TH24-03	TH24-03	TH24-03	TH24-04	TH24-04
Depth (m)	1.4 - 1.5	1.8 - 2.0	2.3 - 2.4	2.6 - 2.7	0.5 - 0.6	0.8 - 0.9
Sample #	G19	G20	G21	G22	G23	G24
Tare ID	A16	F89	K39	E29	Z114	N42
Mass of tare	8.5	8.5	8.4	8.7	8.6	8.6
Mass wet + tare	263.5	276.8	310.4	274.3	215.6	240.4
Mass dry + tare	188.6	186.9	203.5	179.8	164.6	183.9
Mass water	74.9	89.9	106.9	94.5	51.0	56.5
Mass dry soil	180.1	178.4	195.1	171.1	156.0	175.3
Moisture %	41.6%	50.4%	54.8%	55.2%	32.7%	32.2%

Test Hole	TH24-04	TH24-04	TH24-04	TH24-04	TH24-04	TH24-05
Depth (m)	1.1 - 1.2	1.4 - 1.5	1.8 - 2.0	2.3 - 2.4	2.6 - 2.7	0.5 - 0.6
Sample #	G25	G26	G27	G28	G29	G30
Tare ID	E98	W98	W35	D56	Z70	AB03
Mass of tare	7.0	8.7	8.5	8.9	8.7	6.6
Mass wet + tare	455.1	245.7	258.7	236.2	278.3	274.0
Mass dry + tare	341.2	178.4	177.1	158.9	188.3	247.4
Mass water	113.9	67.3	81.6	77.3	90.0	26.6
Mass dry soil	334.2	169.7	168.6	150.0	179.6	240.8
Moisture %	34.1%	39.7%	48.4%	51.5%	50.1%	11.0%

Test Hole	TH24-05	TH24-05	TH24-05	TH24-05	TH24-05	TH24-05
Depth (m)	0.8 - 0.9	1.1 - 1.2	1.4 - 1.5	1.8 - 2.0	2.3 - 2.4	2.6 - 2.7
Sample #	G31	G32	G33	G34	G35	G36
Tare ID	E39	E25	E04	E	H22	E49
Mass of tare	6.9	6.9	6.8	6.7	6.8	6.8
Mass wet + tare	332.8	240.5	252.7	292.4	262.4	267.7
Mass dry + tare	287.5	177.5	192.5	240.4	175.0	172.7
Mass water	45.3	63.0	60.2	52.0	87.4	95.0
Mass dry soil	280.6	170.6	185.7	233.7	168.2	165.9
Moisture %	16.1%	36.9%	32.4%	22.3%	52.0%	57.3%

Atterberg Limits
ASTM D4318-10e1

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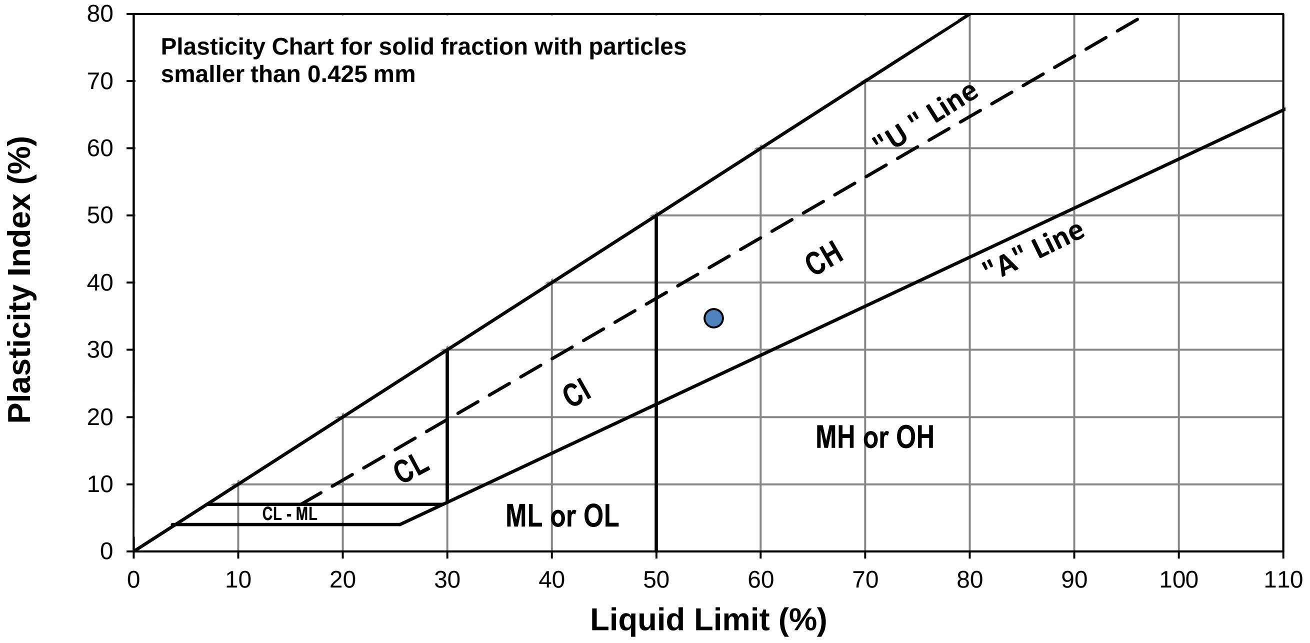
Project No. 1000-043-25
Client WSP
Project 2024 Local Street Renewal (24-K-01, 24-RI-01)- Irene St.

Test Hole TH24-01
Sample # G03
Depth (m) 1.1 - 1.2
Sample Date 26-Feb-24
Test Date 06-Mar-24
Technician PC

Liquid Limit	56
Plastic Limit	21
Plasticity Index	35

Liquid Limit

Trial #	**1**	**2**	**3**		
Number of Blows (N)	15	21	35		
Mass Tare (g)	13.716	14.039	13.906		
Mass Wet Soil + Tare (g)	22.311	19.845	21.294		
Mass Dry Soil + Tare (g)	19.140	17.749	18.717		
Mass Water (g)	3.171	2.096	2.577		
Mass Dry Soil (g)	5.424	3.710	4.811		
Moisture Content (%)	58.462	56.496	53.565		



Plastic Limit

Trial #	**1**	**2**	**3**	**4**	**5**
Mass Tare (g)	14.176	14.173			
Mass Wet Soil + Tare (g)	20.235	20.689			
Mass Dry Soil + Tare (g)	19.205	19.551			
Mass Water (g)	1.030	1.138			
Mass Dry Soil (g)	5.029	5.378			
Moisture Content (%)	20.481	21.160			

Note: Additional information recorded/measured for this test is available upon request.

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Grain Size Analysis (Hydrometer Method)
AASHTO T 88

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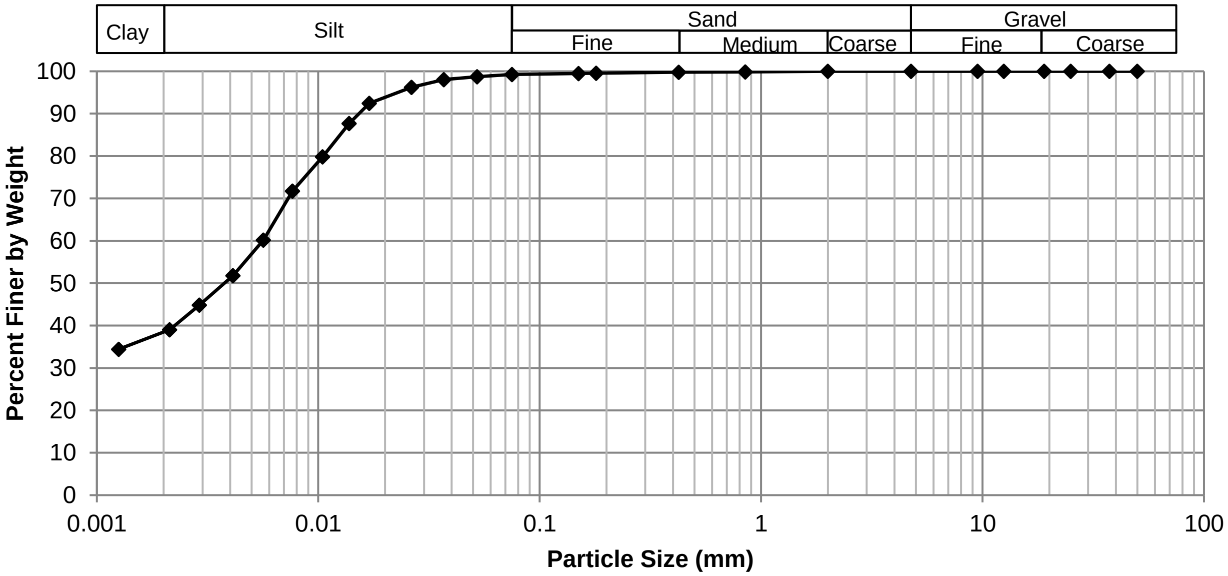
Project No.	1000-043-25
Client	WSP
Project	2024 Local Street Renewal (24-K-01, 24-RI-01)- Irene St.
Test Hole	TH24-01
Sample #	G3
Depth (m)	1.0 - 1.2
Sample Date	26-Feb-24
Test Date	05-Mar-23
Technician	DS

Gravel	0.0%
Sand	0.8%
Silt	60.9%
Clay	38.4%

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	100.00	0.0750	99.23
37.5	100.00	2.00	100.00	0.0521	98.70
25.0	100.00	0.850	99.87	0.0370	98.08
19.0	100.00	0.425	99.78	0.0264	96.20
12.5	100.00	0.180	99.55	0.0170	92.45
9.50	100.00	0.150	99.48	0.0138	87.72
4.75	100.00	0.075	99.23	0.0105	79.86
				0.0077	71.73
				0.0057	60.21
				0.0041	51.76
				0.0029	44.85
				0.0021	39.05
				0.0013	34.44

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Atterberg Limits
ASTM D4318-10e1

Project No.	1000-043-25
Client	WSP
Project	2024 Local Street Renewal (24-K-01, 24-RI-01)- Irene St.
Test Hole	TH24-03
Sample #	G18
Depth (m)	1.1 - 1.2
Sample Date	26-Feb-24
Test Date	06-Mar-24
Technician	PC

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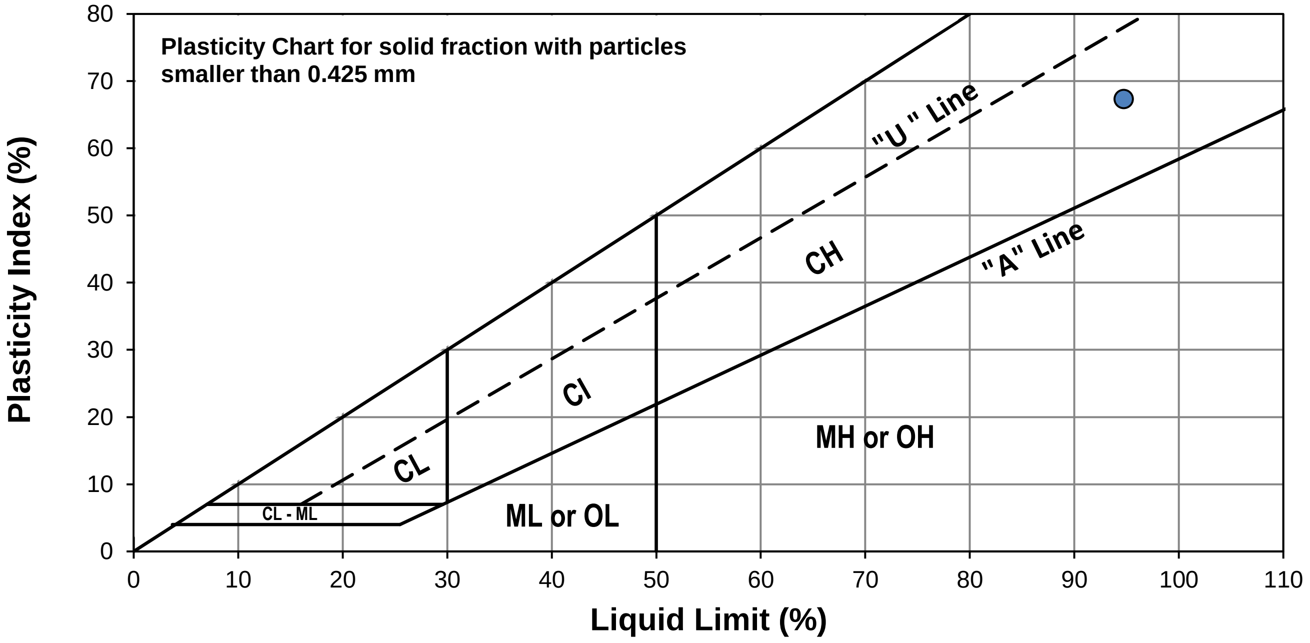
Liquid Limit	95
Plastic Limit	27
Plasticity Index	67

Liquid Limit

Trial #	**1**	**2**	**3**		
Number of Blows (N)	20	27	31		
Mass Tare (g)	14.130	14.129	13.886		
Mass Wet Soil + Tare (g)	21.042	20.575	20.719		
Mass Dry Soil + Tare (g)	17.636	17.450	17.441		
Mass Water (g)	3.406	3.125	3.278		
Mass Dry Soil (g)	3.506	3.321	3.555		
Moisture Content (%)	97.148	94.098	92.208		



Plastic Limit

Trial #	**1**	**2**	**3**	**4**	**5**
Mass Tare (g)	14.030	13.968			
Mass Wet Soil + Tare (g)	19.816	20.041			
Mass Dry Soil + Tare (g)	18.580	18.725			
Mass Water (g)	1.236	1.316			
Mass Dry Soil (g)	4.550	4.757			
Moisture Content (%)	27.165	27.664			

Note: Additional information recorded/measured for this test is available upon request.

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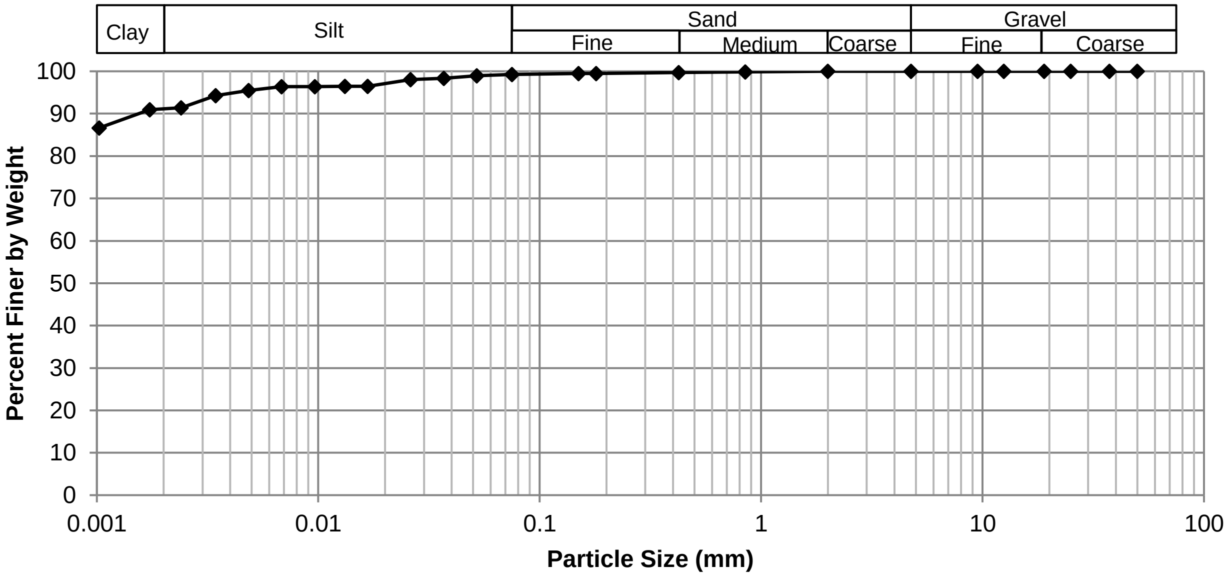
Grain Size Analysis (Hydrometer Method)
AASHTO T 88

CERTIFIED BY CCIL Canadian Council of Independent Laboratories For specific tests as listed on www.ccil.com

Project No.	1000-043-25
Client	WSP
Project	2024 Local Street Renewal (24-K-01, 24-RI-01)- Irene St.
Test Hole	TH24-03
Sample #	G18
Depth (m)	1.0 - 1.2
Sample Date	26-Feb-24
Test Date	05-Mar-23
Technician	DS

Gravel	0.0%
Sand	0.7%
Silt	8.2%
Clay	91.1%

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	99.26
37.5	100.00	2.00	99.99	0.0521	98.99
25.0	100.00	0.850	99.83	0.0369	98.36
19.0	100.00	0.425	99.72	0.0262	98.05
12.5	100.00	0.180	99.51	0.0167	96.44
9.50	100.00	0.150	99.46	0.0132	96.44
4.75	100.00	0.075	99.26	0.0097	96.40
				0.0068	96.40
				0.0048	95.50
				0.0034	94.25
				0.0024	91.40
				0.0017	90.91
				0.0010	86.66

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Standard Proctor Compaction Test

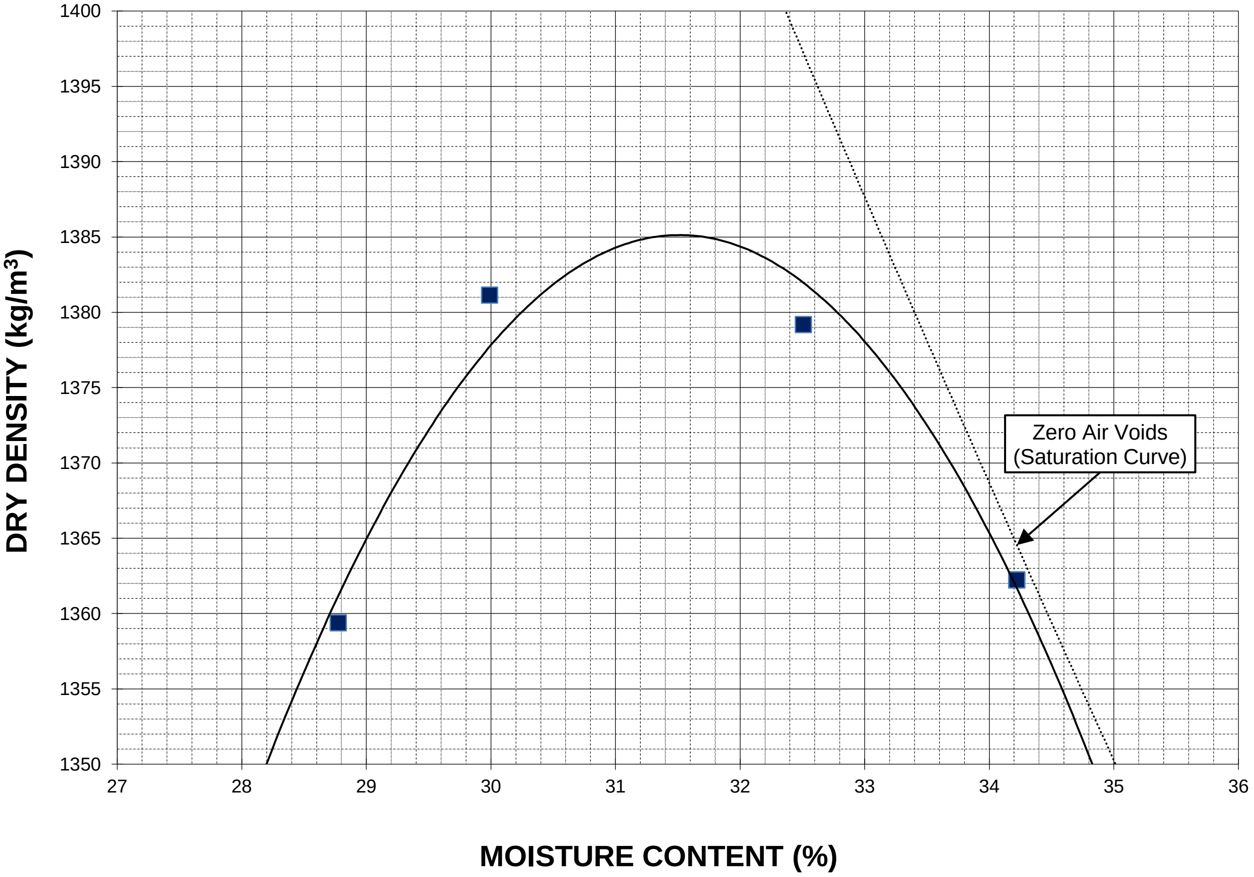
ASTM D698-12 (2021)

CERTIFIED BY CCIL Canadian Council of Independent Laboratories For specific tests as listed on www.ccil.com

Project No.	1000-043-25
Client	WSP
Project	2024 Local Street Renewal (24-K-01, 24-RI-01)- Irene St.
Sample #	L24-061-01
Source	TH24-01 and TH24-02 (1.4m - 2.0m)
Material	Clay
Sample Date	26-Feb-24
Test Date	08-Mar-24
Technician	AD

Maximum Dry Density (kg/m3)	1385
Optimum Moisture (%)	31.5

Trial Number	1	2	3	4	
Wet Density (kg/m^3)	1751	1795	1828	1828	
Dry Density (kg/m^3)	1359	1381	1379	1362	
Moisture Content (%)	28.8	30.0	32.5	34.2	



Note: Additional information recorded/measured for this test is available upon request.

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California Bearing Ratio Test Data Sheet

ASTM D1883-16

Project No.	1000-043-25	**Source**	Irene St: TH24-01 & TH24-02 (1.4 m - 2.0 m)
Client	WSP	**Material**	Clay
Project	2024 Local Street Renewal (24-K-01, 24-RI-01)	**Sample Date**	2024-02-26
Sample #	L24-061	**Test Date**	2024-03-11
		Technician	IA

Proctor Results (ASTM D698)

Maximum Dry Density	1385	kg/m3
Optimum Moisture Content	31.5	%
Material Retained on 19 mm Sieve	0.0	%

CBR Sample Compaction

Dry Density	1321	kg/m3
Initial Moisture Content	31.8	%
Relative Density	95.4	% SPMDD

Soaking Results

Surcharge	4.54	kg
Swell	2.8	%
Moisture Content in top 25 mm	54.9	%
Immersion Period	96	h

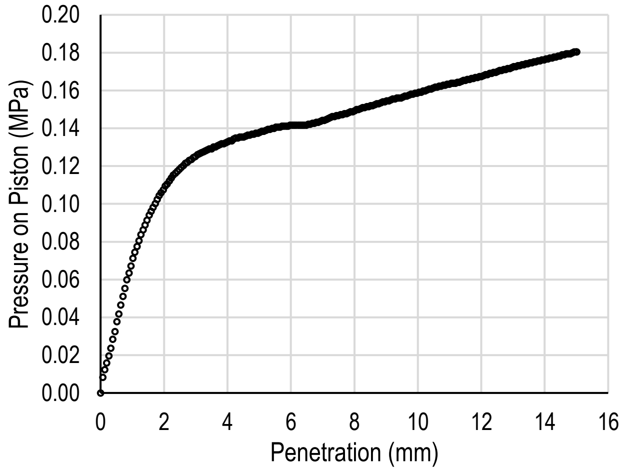
CBR Results

CBR at 2.54 mm	1.7	%
CBR at 5.08 mm	1.3	%
Zero Correction	0	mm

Test Data

Penetration (mm)	Measured Pressure (MPa)	Corrected Pressure (MPa)
0.64	0.05	0.05
1.27	0.08	0.08
1.91	0.11	0.11
2.54	0.12	0.12
3.18	0.13	0.13
3.81	0.13	0.13
4.45	0.14	0.14
5.08	0.14	0.14
7.62	0.15	0.15
10.16	0.16	0.16
12.70	0.17	0.17

Load/Penetration Curve



Comments:

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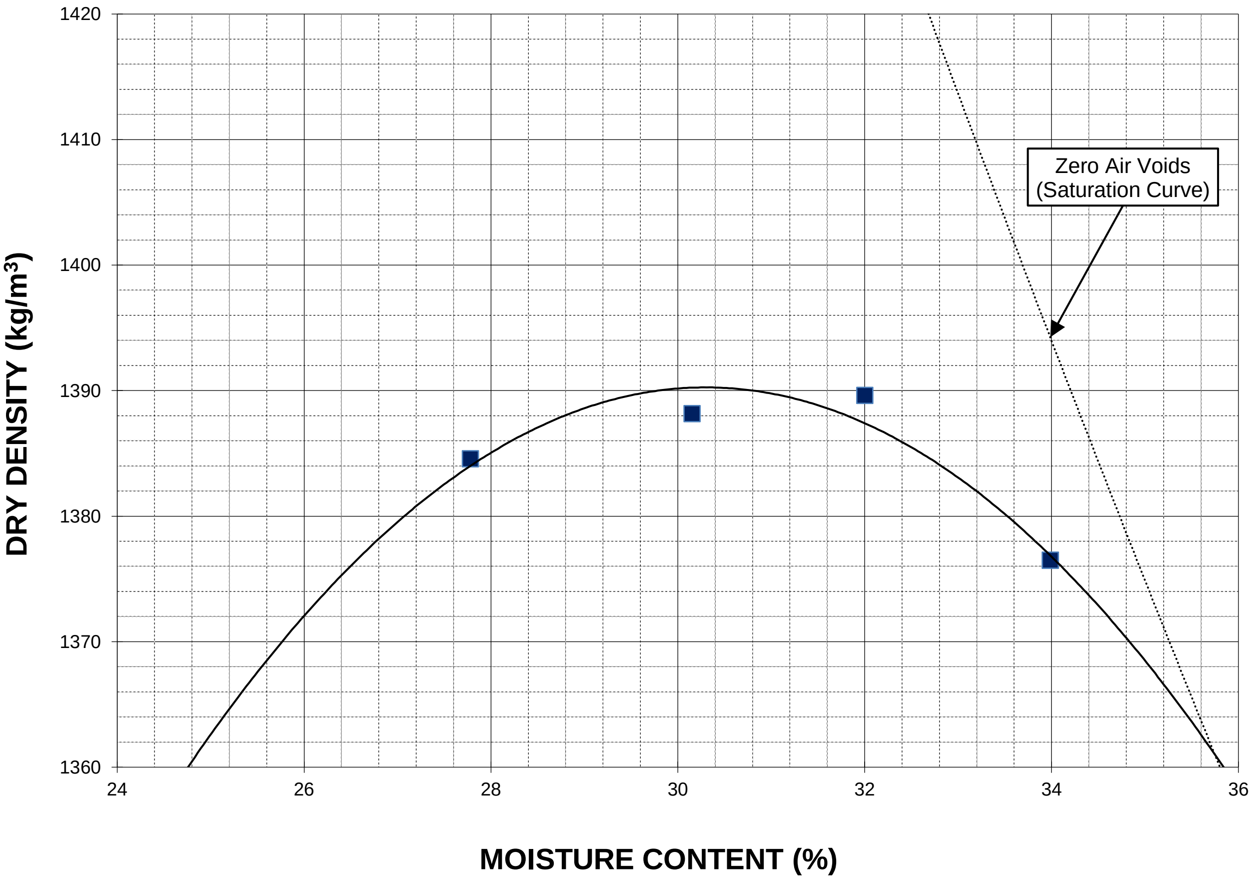
Standard Proctor Compaction Test

ASTM D698-12 (2021)

Project No.	1000-043-25
Client	WSP
Project	2024 Local Street Renewal (24-K-01, 24-RI-01) - Irene St.
Sample #	L24-061-02
Source	TH24-03 and TH 24-04 (0.9m - 2.0m)
Material	Clay
Sample Date	27-Feb-24
Test Date	07-Mar-24
Technician	AD

Maximum Dry Density (kg/m3)	1390
Optimum Moisture (%)	30.3

Trial Number	1	2	3	4	
Wet Density (kg/m^3)	1769	1807	1834	1844	
Dry Density (kg/m^3)	1385	1388	1390	1376	
Moisture Content (%)	27.8	30.2	32.0	34.0	



Note: Additional information recorded/measured for this test is available upon request.

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California Bearing Ratio Test Data Sheet

ASTM D1883-16

Project No.	1000-043-25	**Source**	Irene St: TH24-03 & TH24-04 (0.9 m - 2.0 m)
Client	WSP	**Material**	Clay
Project	2024 Local Street Renewal (24-K-01, 24-RI-01)	**Sample Date**	2024-02-26
Sample #	L24-061	**Test Date**	2024-03-09
		Technician	IA

Proctor Results (ASTM D698)

Maximum Dry Density	1390	kg/m3
Optimum Moisture Content	30.3	%
Material Retained on 19 mm Sieve	0.0	%

CBR Sample Compaction

Dry Density	1318	kg/m3
Initial Moisture Content	29.7	%
Relative Density	94.8	% SPMDD

Soaking Results

Surcharge	4.54	kg
Swell	3.0	%
Moisture Content in top 25 mm	48.6	%
Immersion Period	96	h

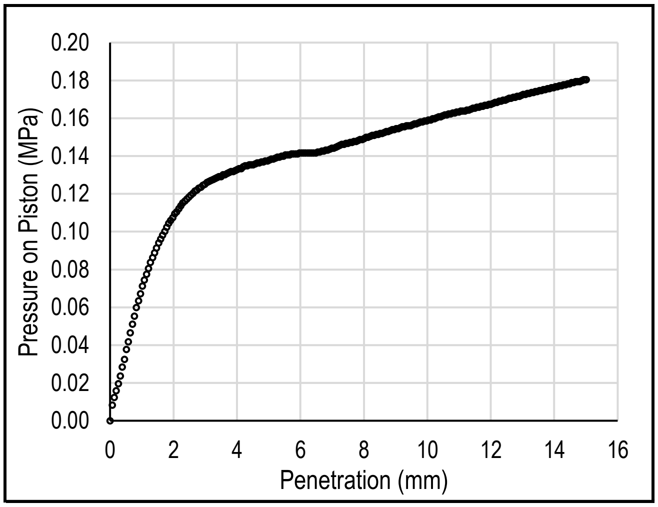
CBR Results

CBR at 2.54 mm	1.7	%
CBR at 5.08 mm	1.3	%
Zero Correction	0	mm

Test Data

Penetration (mm)	Measured Pressure (MPa)	Corrected Pressure (MPa)
0.64	0.05	0.05
1.27	0.08	0.08
1.91	0.11	0.11
2.54	0.12	0.12
3.18	0.13	0.13
3.81	0.13	0.13
4.45	0.14	0.14
5.08	0.14	0.14
7.62	0.15	0.15
10.16	0.16	0.16
12.70	0.17	0.17

Load/Penetration Curve



Comments:

Project 1000-043-25
Location Irene St.
Hole No. TH24-01 Sample No. PC24-23
Depth 280 mm
Technician TG Date Feb. 21/24

Photo 1: Pavement Core Sample at TH24-01

Project 1000-043-25
Location Irene St.
Hole No. TH24-02 Sample No. PC24
Depth 285 mm
Technician TG Date Feb 21/24

Photo 2: Pavement Core Sample at TH24-02

Photo 3: Pavement Core Sample at TH24-03

Photo 4: Pavement Core Sample at TH24-04

Project 1000-043-25
Location Irene St.
Hole No. TH24-05 Sample No. PC24-25
Depth 310mm
Technician TG Date Feb 21/24

Photo 5: Pavement Core Sample at TH24-05

Appendix E

Summary Table and Pavement Core Photos

Daly St N – Lorette Ave to Pembina Hwy

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2024 Local Street Renewal (24-K-01, 24-R1-01)

Daly St N - Lorette Ave to Pembina Hwy

Pavement Core No.	Pavement Core Location	Pavement Surface		Pavement Structure Material		
		Type	Thickness (mm)	Type	Thickness (mm)	Corrected Compressive Strength (Mpa)
PC24-06	UTM : 5525644 m N, 633276 m E; Located at #370 Daly St N, Northbound Lane, 1.3 m West of East curb	Asphalt	-	Concrete	180	43.67
PC24-09	UTM : 5525556 m N, 633321 m E; Located at #398 Daly St N, Southbound Lane, 1.3 m East of West curb	Asphalt	70	Concrete	200	
PC24-10	UTM : 5525602 m N, 633303 m E; Located 10 m South of Dudley Ave, Northbound Lane, 0.7 m West of East curb	Asphalt	90	Concrete	210	63.07

Project 1000-043-25
Location 370 Daly St. N
Hole No. PC24-06 Sample No. PC24-06
Depth 180 mm
Technician TG Date Feb. 21/24

Photo 1: Pavement Core Sample PC24-06

Project 1000-043-25
Location 398 Daly St.
Hole No. PC24-09 Sample No. PC24-09
Depth 180 mm
Technician TG Date Feb. 22/24

Photo 2: Pavement Core Sample PC24-09

Photo 3: Pavement Core Sample PC24-10

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Concrete Core Compressive Strength Report

CSA A23.2-14C

Project No. 1000-043-25

Date March 6, 2024

Project 2024 Local Street Package (24-K-01, 24-R1-01)

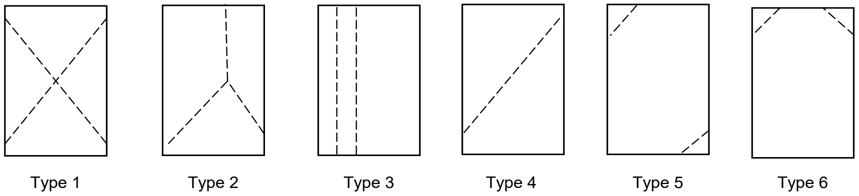
Technician TG

Client WSP Group Canada Inc.

Core Location	Core ID	Date Received	Date of Break	Age at Break	Diam. (mm)	Length (mm)	Moisture Conditioning	Compressive Strength (MPa)		Break Type	Correction Factors*				
								Uncorrected f_{conc}	Corrected* f_c		$F_{l/d}$	F_{dia}	F_{mc}	F_D	F_{reinf}
Daly Street	PC24-06	2024-02-21	2024-03-06	-	145	166	Soaked 48 h	41.57	43.67	1	0.93	0.98	1.09	1.06	1.00
Daly Street	PC24-10	2024-02-22	2024-03-06	-	145	182	Soaked 48 h	58.68	63.07	1	0.95	0.98	1.09	1.06	1.00

Comments

*Correction factors $F_{l/d}$, F_{dia}, F_{mc}, and F_D calculated as per ACI 214.4R-03, and correction factor F_{reinf} calculated as per Khoury et al. (2014): $f_c = f_{conc}F_{l/d}F_{dia}F_{mc}F_DF_{reinf}$



Reviewed by (print): Angela Fidler-Kliewer, C.Tech.

Signature: Angela Fidler-Kliewer

Table 1 Factors involved in interpretation of core results by different codes.

List	Code/standard	Edition	Factors Considered					
			Aspect ratio	Diameter	Reinforcing	Moisture	Damage	Direction
1	Egyptian Code/Standard Specification	2008	√		√			√
2	British Code/Standard Specification	2003	√		√			√
3	American Concrete Institute ACI	1998	√					
		2012	√	√		√	√	
4	European Standard Specification	1998	√	√	√		√	
		2009	√		√			
5	Japanese Standard	1998	√					
6	Concrete Society	1987	√		√		√	√

In addition, for core specimen containing two bars no further apart than the diameter of the larger bar, only the bar corresponding to the higher value of ($\Phi_r * d$) is considered. If the bars are further apart, their combined effect should be assessed by replacing the term ($\Phi_r * d$) by the term ($\sum \Phi_r * d$).

It should be pointed out that above equations used to interpret the core concrete strength to the in-situ concrete cube strength have been developed based on a set of assumptions and through many converting process. It is also of interest to note that the damage effect is considered in the development of the formulas in indirect way. The subject derivation and detailed formulas may be seen elsewhere [14].

3.2. American Concrete Institute (ACI)

3.2.1. Former ACI Code (2002) & Current ASTM (2009)

The methodology of core interpretation given in the former ACI code was remained without changes for decades and up to Year (2003). The in-place strength of concrete cylinder at the location from which a core test specimen was extracted can be computed using the equation:

$$f_{cy} = F_{l/d} \cdot f_{core} \tag{4}$$

where f_{cy} is the equivalent in-place concrete cylinder strength, f_{core} is concrete core strength, and $F_{l/d}$ is the strength correction factor for aspect ratio.

The former ACI code does not include any equation to calculate the correction factor ($F_{l/d}$); however, the code gives different values for this term that is associated with different aspect ratios (l/d) as given in Table 2. It should also be noted that the approach of current ASTM is similar to that mentioned above. The only considered variable is the aspect ratio (l/d). It should be noted that identical approach to that mentioned above is still effective in ASTM C42/C42M-03 [10].

3.2.2. Current ACI Code (2012) [15]

Starting from Year 2003, significant changes have been made to the relevant ACI Code provisions regarding the interpretation of core strength test results. New factors have been considered. These include core diameter, moisture content of core sample, core damage associated with drilling, in addition to the effect of aspect ratio that was previously considered in the former ACI edition (1998). According to the ACI 214.4R-03, the in-place concrete strength can be computed using the equation:

eq. 12

$$f_c = F_{l/d} \cdot F_{dia} \cdot F_{mc} \cdot F_D \cdot f_{core} \cdot F_{reinf} \tag{5}$$

or eq. 15

where f_c is the equivalent in-place concrete cylinder strength, f_{core} is concrete core strength, $F_{l/d}$ is strength correction factor for aspect ratio, F_{dia} is strength correction factors for diameter, F_{mc} is strength correction factor for moisture condition of core sample, and F_D is the strength correction factor that accounts for effect of damage sustained during core drilling including micro-cracking and undulations at the drilled surface and cutting through coarse-aggregate particles that may subsequently pop out during testing.

The ACI committee considered the correction factors presented in Table 3 for converting core strengths into equivalent in-place strengths based on the work reported by Bartlett and MacGregor [6]. It should be noted that the magnitude of

Table 2 Mean values for factor $F_{l/d}$ according to ACI Code (1998) and ASTM.

	Specimen length-to-diameter ratio, l/d			
	1.00	1.25	1.50	1.75
$F_{l/d}$	0.87	0.93	0.96	0.98

Table 3 Strength correction factors according to ACI 214.4R-03.

List	Factors	Mean values
(1)[b]	$F_{l/d}$:l/d ratio	
	As-received	$1 - \{0.130 - \alpha f_{core}\}(2 - \frac{l}{d})^2$
	Soaked 48 h	$1 - \{0.117 - \alpha f_{core}\}(2 - \frac{l}{d})^2$
	Air dried[a]	$1 - \{0.144 - \alpha f_{core}\}(2 - \frac{l}{d})^2$
(2)	F_{dia}: core diameter	
	50 mm	1.06
	100 mm	1.00
	150 mm	0.98
(3)	F_{mc}: core moisture content	
	As-received	1.00
	Soaked 48 h	1.09
	Air dried[a]	0.96
(4)	F_D: damage due to drilling	1.06

[a] Standard treatment specified in ASTM C 42/C 42M.

[b] Constant α equals $4.3(10^{-4})$ 1/MPa for f_{core} in MPa.

Table 6 List of comparisons between tested cores to determine.

	A18	A17	A16	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1
A1	♦●	●	♦●	■●	■●		●				●			▲	▲	■	▲	
A2																		
A3						■●				■●								
A4																		
A5																		
A6								■▲●	■▲●			■▲						
A7								■▲●	■▲●									
A8		●	♦	●	●													
A9																		
A10								■▲●										
A11																		
A12		●		●	●													
A13																		
A14		●		●														
A15		●																
A16	●♦																	
A17	♦																	
A18																		

● Diameter of steel bar.
▲ Distance of steel bar from nearly end of core.
■ Number of steel bars and spacing between bars.
♦ Distance of steel bar from vertical axis of specimen.

This brief review indicated that the various proposed relationships for correction factors are all nonlinear. It should be noted that the equations given by the Egyptian Code takes into account most variables that may affect the interpretation of the results; however, the code ignores the deterioration of steel–concrete bond that may occur and also the position of the reinforcement from vertical axis of core specimens.

Weighted nonlinear regression analysis has been performed to determine the factor (F_{reinf}) with the use of the software "SAS" package and "Data Fit." This shows that the correction factor for reinforcement (F_{reinf}) is given by the following expression:

- For cores containing a single bar:

single bar

$$F_{\text{reinf}} = \left[1 + 1.5\frac{[\Phi_r \times r + \Phi_r \times (S/10)]}{\Phi_c * L}\right] \times \frac{1.13}{f_{\text{core}}^{0.015}} \quad (12)$$

- For core specimen containing two bars no further apart than the diameter of the larger bar, only the bar corresponding to the higher value of ($\Phi_r * d$) is considered. If the bars are further apart, their combined effect is assessed by replacing the term ($\Phi_r * r$) by ($\sum \Phi_r * r$ as follows:

multiple bars

$$F_{\text{reinf}} = \left[1 + 1.5\frac{\sum[\Phi_r \times r + \Phi_r \times (S/10)]}{\Phi_c * L}\right] \times \frac{1.13}{f_{\text{core}}^{0.015}} \quad (13)$$

where F_{reinf} is the correction factor for reinforcement, Φ_r is the diameter of the reinforcement, Φ_c is the diameter of the concrete specimen, r is the distance of axis of bar from nearer end of specimen, S is the distance of axis of bar from axis of core specimen, L is the length of the specimen after end preparation by grinding or capping, and f_{core} is the concrete core strength (kg/cm^2).

6.1.6. *Effect of moisture condition of core*

Results of about 100 cores indicate that the strength of cores left to dry in air for 7 days is on average 13% greater than that of cores soaked at least 40 h before testing. The strength of cores with negligible moisture gradient and tested after cutting is found to be 7–9% larger than that of soaked cores as shown in Fig. 20. The authors strongly recommend to use a correction factor accounting for moisture condition (F_m) equals to 1.09 and 0.96, respectively, for cores tested after 48 h soaked in water and for those tested after 7 days dry in air.

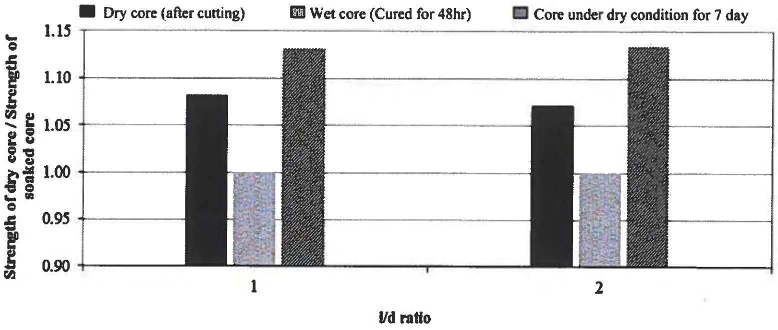


Figure 20 Effect of core moisture condition on core strength for different aspect ratios (l/d).

Appendix F

Summary Table and Pavement Core Photos

Dudley Ave – Daly St N to End

2024 Local Street Renewal (24-K-01, 24-R1-01)

Dudley Ave - Daly St N to End

Pavement Core No.	Pavement Core Location	Pavement Surface		Pavement Structure Material		
		Type	Thickness (mm)	Type	Thickness (mm)	Corrected Compressive Strength (Mpa)
PC24-05	UTM : 5525629 m N, 633321 m E; Located at #580 Dudley Ave, Westbound Lane, 1.3 m South of North curb.	Asphalt	-	Concrete	180	

Note: Core too fractured and short for compressive strength test

Photo 1: Pavement Core Sample PC24-05

Appendix G

Summary Table and Pavement Core Photos

Harrow St – Sparling Ave to Harrow St.

2024 Local Street Renewal (24-K-01, 24-R1-01)

Harrow St - Sparling Ave to Harrow St

Pavement Core No.	Pavement Core Location	Pavement Surface		Pavement Structure Material		
		Type	Thickness (mm)	Type	Thickness (mm)	Corrected Compressive Strength (Mpa)
PC24-12	UTM : 5524302 m N, 632630 m E; Located 90 m South of Taylor Ave, Southbound Lane, 1.1 m East of West curb	Asphalt	45	Concrete	200	66.02
PC24-17	UTM : 5524258 m N, 632655 m E; Located 90 m North of Sparling Ave, Southbound Lane, 1.3 m East of West curb	Asphalt	-	Concrete	175	49.59
PC24-18	UTM : 5524216 m N, 632684 m E; Located 35 m North of Sparling Ave, Northbound Lane, 1.0 m West of East curb	Asphalt	-	Concrete	190	

Project 1000-043-25
Location Harrow St.
Hole No. PC24-12 Sample No. PC24-12
Depth 245mm
Technician TG Date Feb 22/24

Photo 1: Pavement Core Sample PC24-12

Project 1000-043-25
Location Harrow St.
Hole No. PC24-17 Sample No. PC24-17
Depth 175mm
Technician TG. Date Feb.23/24

Photo 2: Pavement Core Sample PC24-17

Project 1000-043-25
Location 700 Harrow St.
Hole No. PC24-18 Sample No. PC24-18
Depth 190 mm
Technician TG Date Feb 23/24

Photo 3: Pavement Core Sample PC24-18

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Concrete Core Compressive Strength Report

CSA A23.2-14C

Project No. 1000-043-25

Date March 6, 2024

Project 2024 Local Street Package (24-K-01, 24-R1-01)

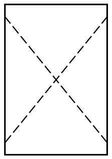
Technician TG

Client WSP Group Canada Inc.

Core Location	Core ID	Date Received	Date of Break	Age at Break	Diam. (mm)	Length (mm)	Moisture Conditioning	Compressive Strength (MPa)		Break Type	Correction Factors*				
								Uncorrected f_{conc}	Corrected* f_c		$F_{l/d}$	F_{dia}	F_{mc}	F_D	F_{reinf}
Harrow Street	PC24-12	2024-02-22	2024-03-06	-	145	165	Soaked 48 h	62.48	66.02	1	0.93	0.98	1.09	1.06	1.00
Harrow Street	PC24-17	2024-02-23	2024-03-06	-	145	153	Soaked 48 h	47.91	49.59	1	0.91	0.98	1.09	1.06	1.00

Comments

*Correction factors $F_{l/d}$, F_{dia}, F_{mc}, and F_D calculated as per ACI 214.4R-03, and correction factor F_{reinf} calculated as per Khoury et al. (2014): $f_c = f_{conc}F_{l/d}F_{dia}F_{mc}F_DF_{reinf}$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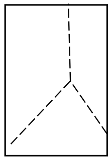
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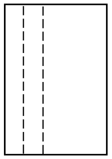
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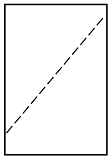
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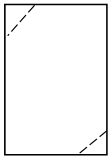
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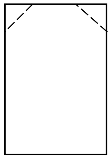
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Reviewed by (print): Angela Fidler-Kliewer,C.Tech.

Signature: Angela Fidler-Kliewer

Table 1 Factors involved in interpretation of core results by different codes.

List	Code/standard	Edition	Factors Considered					
			Aspect ratio	Diameter	Reinforcing	Moisture	Damage	Direction
1	Egyptian Code/Standard Specification	2008	√		√			√
2	British Code/Standard Specification	2003	√		√			√
3	American Concrete Institute ACI	1998	√					
		2012	√	√		√	√	
4	European Standard Specification	1998	√	√	√		√	
		2009	√		√			
5	Japanese Standard	1998	√					
6	Concrete Society	1987	√		√		√	√

In addition, for core specimen containing two bars no further apart than the diameter of the larger bar, only the bar corresponding to the higher value of ($\Phi_r * d$) is considered. If the bars are further apart, their combined effect should be assessed by replacing the term ($\Phi_r * d$) by the term ($\sum \Phi_r * d$).

It should be pointed out that above equations used to interpret the core concrete strength to the in-situ concrete cube strength have been developed based on a set of assumptions and through many converting process. It is also of interest to note that the damage effect is considered in the development of the formulas in indirect way. The subject derivation and detailed formulas may be seen elsewhere [14].

3.2. American Concrete Institute (ACI)

3.2.1. Former ACI Code (2002) & Current ASTM (2009)

The methodology of core interpretation given in the former ACI code was remained without changes for decades and up to Year (2003). The in-place strength of concrete cylinder at the location from which a core test specimen was extracted can be computed using the equation:

$$f_{cy} = F_{l/d} \cdot f_{core} \tag{4}$$

where f_{cy} is the equivalent in-place concrete cylinder strength, f_{core} is concrete core strength, and $F_{l/d}$ is the strength correction factor for aspect ratio.

The former ACI code does not include any equation to calculate the correction factor ($F_{l/d}$); however, the code gives different values for this term that is associated with different aspect ratios (l/d) as given in Table 2. It should also be noted that the approach of current ASTM is similar to that mentioned above. The only considered variable is the aspect ratio (l/d). It should be noted that identical approach to that mentioned above is still effective in ASTM C42/C42M-03 [10].

3.2.2. Current ACI Code (2012) [15]

Starting from Year 2003, significant changes have been made to the relevant ACI Code provisions regarding the interpretation of core strength test results. New factors have been considered. These include core diameter, moisture content of core sample, core damage associated with drilling, in addition to the effect of aspect ratio that was previously considered in the former ACI edition (1998). According to the ACI 214.4R-03, the in-place concrete strength can be computed using the equation:

eq. 12

$$f_c = F_{l/d} \cdot F_{dia} \cdot F_{mc} \cdot F_D \cdot f_{core} \cdot F_{reinf} \tag{5}$$

or eq. 15

where f_c is the equivalent in-place concrete cylinder strength, f_{core} is concrete core strength, $F_{l/d}$ is strength correction factor for aspect ratio, F_{dia} is strength correction factors for diameter, F_{mc} is strength correction factor for moisture condition of core sample, and F_D is the strength correction factor that accounts for effect of damage sustained during core drilling including micro-cracking and undulations at the drilled surface and cutting through coarse-aggregate particles that may subsequently pop out during testing.

The ACI committee considered the correction factors presented in Table 3 for converting core strengths into equivalent in-place strengths based on the work reported by Bartlett and MacGregor [6]. It should be noted that the magnitude of

Table 2 Mean values for factor $F_{l/d}$ according to ACI Code (1998) and ASTM.

	Specimen length-to-diameter ratio, l/d			
	1.00	1.25	1.50	1.75
$F_{l/d}$	0.87	0.93	0.96	0.98

Table 3 Strength correction factors according to ACI 214.4R-03.

List	Factors	Mean values
(1)[b]	$F_{l/d}$:l/d ratio	
	As-received	$1 - \{0.130 - \alpha f_{core}\}(2 - \frac{l}{d})^2$
	Soaked 48 h	$1 - \{0.117 - \alpha f_{core}\}(2 - \frac{l}{d})^2$
	Air dried[a]	$1 - \{0.144 - \alpha f_{core}\}(2 - \frac{l}{d})^2$
(2)	F_{dia}: core diameter	
	50 mm	1.06
	100 mm	1.00
	150 mm	0.98
(3)	F_{mc}: core moisture content	
	As-received	1.00
	Soaked 48 h	1.09
	Air dried[a]	0.96
(4)	F_D: damage due to drilling	1.06

[a] Standard treatment specified in ASTM C 42/C 42M.

[b] Constant α equals $4.3(10^{-4})$ 1/MPa for f_{core} in MPa.

Table 6 List of comparisons between tested cores to determine.

	A18	A17	A16	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1
A1	♦●	●	♦●	■●	■●		●				●			▲	▲	■	▲	
A2																		
A3						■●				■●								
A4																		
A5																		
A6								■▲●	■▲●			■▲						
A7								■▲●	■▲●									
A8		●	♦	●	●													
A9																		
A10								■▲●										
A11																		
A12		●		●	●													
A13																		
A14		●		●														
A15		●																
A16	●♦																	
A17	♦																	
A18																		

● Diameter of steel bar.
▲ Distance of steel bar from nearly end of core.
■ Number of steel bars and spacing between bars.
♦ Distance of steel bar from vertical axis of specimen.

This brief review indicated that the various proposed relationships for correction factors are all nonlinear. It should be noted that the equations given by the Egyptian Code takes into account most variables that may affect the interpretation of the results; however, the code ignores the deterioration of steel–concrete bond that may occur and also the position of the reinforcement from vertical axis of core specimens.

Weighted nonlinear regression analysis has been performed to determine the factor (F_{reinf}) with the use of the software "SAS" package and "Data Fit." This shows that the correction factor for reinforcement (F_{reinf}) is given by the following expression:

single bar

- For cores containing a single bar:

$$F_{\text{reinf}} = \left[1 + 1.5\frac{[\Phi_r \times r + \Phi_r \times (S/10)]}{\Phi_c * L}\right] \times \frac{1.13}{f_{\text{core}}^{0.015}} \quad (12)$$

- For core specimen containing two bars no further apart than the diameter of the larger bar, only the bar corresponding to the higher value of ($\Phi_r * d$) is considered. If the bars are further apart, their combined effect is assessed by replacing the term ($\Phi_r * r$) by ($\sum \Phi_r * r$ as follows:

multiple bars

$$F_{\text{reinf}} = \left[1 + 1.5\frac{\sum[\Phi_r \times r + \Phi_r \times (S/10)]}{\Phi_c * L}\right] \times \frac{1.13}{f_{\text{core}}^{0.015}} \quad (13)$$

where F_{reinf} is the correction factor for reinforcement, Φ_r is the diameter of the reinforcement, Φ_c is the diameter of the concrete specimen, r is the distance of axis of bar from nearer end of specimen, S is the distance of axis of bar from axis of core specimen, L is the length of the specimen after end preparation by grinding or capping, and f_{core} is the concrete core strength (kg/cm^2).

6.1.6. Effect of moisture condition of core

Results of about 100 cores indicate that the strength of cores left to dry in air for 7 days is on average 13% greater than that of cores soaked at least 40 h before testing. The strength of cores with negligible moisture gradient and tested after cutting is found to be 7–9% larger than that of soaked cores as shown in Fig. 20. The authors strongly recommend to use a correction factor accounting for moisture condition (F_m) equals to 1.09 and 0.96, respectively, for cores tested after 48 h soaked in water and for those tested after 7 days dry in air.

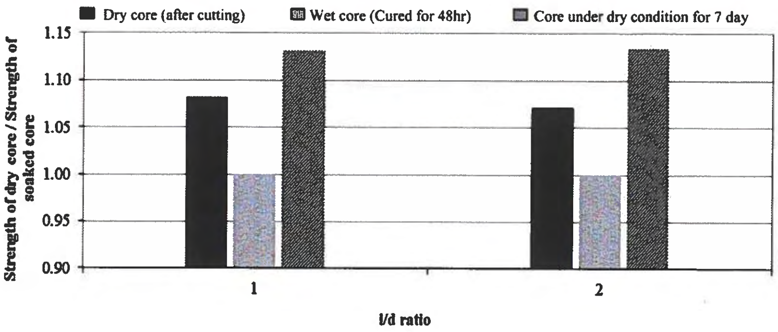

Figure 20 Effect of core moisture condition on core strength for different aspect ratios (l/d).

Appendix H

Summary Table and Pavement Core Photos

Irene St – Waller Ave to Sony Pl

2024 Local Street Renewal (24-K-01, 24-R1-01)

Irene St - Waller Ave to Sony Pl

Pavement Core No.	Pavement Core Location	Pavement Surface		Pavement Structure Material		
		Type	Thickness (mm)	Type	Thickness (mm)	Corrected Compressive Strength (Mpa)
PC24-01	UTM : 5522028 m N, 631743 m E; Located 15 m South of Sony Pl, Southbound Lane, 1.5 m East of West curb	Asphalt	45	Concrete	150	39.83
PC24-02	UTM : 5521952 m N, 631784 m E; Located 100 m South of Sony Pl, Southbound Lane, 1.5 m East of West curb	Asphalt	60	Concrete	140	-
PC24-03	UTM : 5521911 m N, 631811 m E; Located 40 m North of Waller Ave, Northbound Lane, 1.3 m West of East curb	Asphalt	50	Concrete	170	55.86
PC24-04	UTM : 5521999 m N, 631762 m E; Located 45 m South of Sony Pl, Northbound Lane, 1.3 m West of East curb	Asphalt	130	Concrete	140	-

Photo 1: Pavement Core Sample PC24-01

Photo 2: Pavement Core Sample PC24-02

Project 1000-043-25
Location Irene St.
Hole No. PC24-03 Sample No. PC24-03
Depth 220mm
Technician TG Date Feb. 20/24

Photo 3: Pavement Core Sample PC24-03

Project 1000-043-25
Location Irene st.
Hole No. Pc24-04 Sample No. Pc24-04
Depth 270mm
Technician TG Date Feb. 20/24

Photo 4: Pavement Core Sample PC24-04

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Concrete Core Compressive Strength Report

CSA A23.2-14C

Project No. 1000-043-25

Date March 6, 2024

Project 2024 Local Street Package (24-K-01, 24-R1-01)

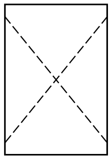
Technician TG

Client WSP Group Canada Inc.

Core Location	Core ID	Date Received	Date of Break	Age at Break	Diam. (mm)	Length (mm)	Moisture Conditioning	Compressive Strength (MPa)		Break Type	Correction Factors*				
								Uncorrected f_{conc}	Corrected* f_c		$F_{l/d}$	F_{dia}	F_{mc}	F_D	F_{reinf}
Irene Street	PC24-01	2024-02-20	2024-03-06	-	145	145	Soaked 48 h	35.91	39.83	1	0.90	0.98	1.09	1.06	1.09
Irene Street	PC24-03	2024-02-20	2024-03-06	-	145	161	Soaked 48 h	53.29	55.86	1	0.93	0.98	1.09	1.06	1.00

Comments

*Correction factors $F_{l/d}$, F_{dia}, F_{mc}, and F_D calculated as per ACI 214.4R-03, and correction factor F_{reinf} calculated as per Khoury et al. (2014): $f_c = f_{conc}F_{l/d}F_{dia}F_{mc}F_DF_{reinf}$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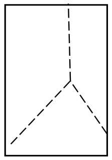
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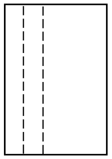
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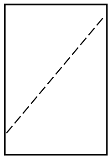
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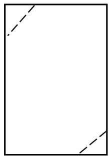
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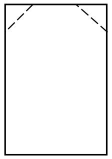
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Reviewed by (print): Angela Fidler-Kliewer, C.Tech.

Signature: Angela Fidler-Kliewer

Table 1 Factors involved in interpretation of core results by different codes.

List	Code/standard	Edition	Factors Considered					
			Aspect ratio	Diameter	Reinforcing	Moisture	Damage	Direction
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3	American Concrete Institute ACI	1998	✓					
		2012	✓	✓		✓	✓	
4	European Standard Specification	1998	✓	✓	✓		✓	
		2009	✓		✓			
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In addition, for core specimen containing two bars no further apart than the diameter of the larger bar, only the bar corresponding to the higher value of ($\Phi_r * d$) is considered. If the bars are further apart, their combined effect should be assessed by replacing the term ($\Phi_r * d$) by the term ($\sum \Phi_r * d$).

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(2)	F_{dia}: core diameter	
	50 mm	1.06
	100 mm	1.00
	150 mm	0.98
(3)	F_{mc}: core moisture content	
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	Soaked 48 h	1.09
	Air dried[a]	0.96
(4)	F_D: damage due to drilling	1.06

[a] Standard treatment specified in ASTM C 42/C 42M.

[b] Constant α equals $4.3(10^{-4})$ 1/MPa for f_{core} in MPa.

Table 6 List of comparisons between tested cores to determine.

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A1	♦●	●	♦●	■●	■●		●				●			▲	▲	■	▲	
A2																		
A3						■●				■●								
A4																		
A5																		
A6								■▲●	■▲●			■▲						
A7								■▲●	■▲●									
A8		●	♦	●	●													
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▲ Distance of steel bar from nearly end of core.
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Weighted nonlinear regression analysis has been performed to determine the factor (F_{reinf}) with the use of the software "SAS" package and "Data Fit." This shows that the correction factor for reinforcement (F_{reinf}) is given by the following expression:

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$$F_{\text{reinf}} = \left[1 + 1.5\frac{[\Phi_r \times r + \Phi_r \times (S/10)]}{\Phi_c * L}\right] \times \frac{1.13}{f_{\text{core}}^{0.015}} \tag{12}$$

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multiple bars

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where F_{reinf} is the correction factor for reinforcement, Φ_r is the diameter of the reinforcement, Φ_c is the diameter of the concrete specimen, r is the distance of axis of bar from nearer end of specimen, S is the distance of axis of bar from axis of core specimen, L is the length of the specimen after end preparation by grinding or capping, and f_{core} is the concrete core strength (kg/cm^2).

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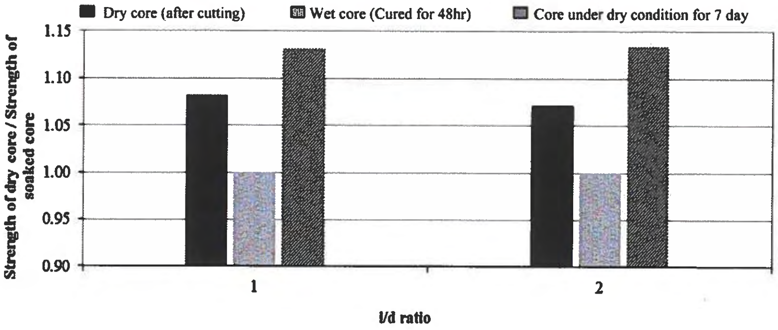

Figure 20 Effect of core moisture condition on core strength for different aspect ratios (l/d).

Appendix I

Summary Table and Pavement Core Photos

Lorette Ave – Pembina Hwy to Daly St N

TREK GEOTECHNICAL

2024 Local Street Renewal (24-K-01, 24-R1-01)

Lorette Ave - Pembina Hwy to Daly St N

Pavement Core No.	Pavement Core Location	Pavement Surface		Pavement Structure Material		
		Type	Thickness (mm)	Type	Thickness (mm)	Corrected Compressive Strength (Mpa)
PC24-07	UTM : 5525504 m N, 633271 m E; Located at #620 Lorette Ave, Westbound Lane, 1.1 m South of North curb.	Asphalt	-	Concrete	180	65.05
PC24-08	UTM : 5525530 m N, 633324 m E; Located at #614 Lorette Ave, Eastbound Lane, 1.1 m North of South curb.	Asphalt	-	Concrete	160	-
PC24-11	UTM : 5525471 m N, 633217 m E; Located 20 m East of Pembina Highway, Eastbound Lane, 1.3 m North of South curb.	Asphalt	-	Concrete	170	66.68

Photo 1: Pavement Core Sample PC24-07

Photo 2: Pavement Core Sample PC24-08

Project 1000-043-25
Location Lorette Ave
Hole No. PC24-11 Sample No. PC24-11
Depth 170 mm
Technician TG Date Feb. 22/24

Photo 3: Pavement Core Sample PC24-11

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Concrete Core Compressive Strength Report

CSA A23.2-14C

Project No. 1000-043-25

Date March 6, 2024

Project 2024 Local Street Package (24-K-01, 24-R1-01)

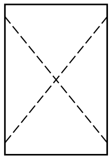
Technician TG

Client WSP Group Canada Inc.

Core Location	Core ID	Date Received	Date of Break	Age at Break	Diam. (mm)	Length (mm)	Moisture Conditioning	Compressive Strength (MPa)		Break Type	Correction Factors*				
								Uncorrected f_{conc}	Corrected* f_c		$F_{l/d}$	F_{dia}	F_{mc}	F_D	F_{reinf}
Lorette Avenue	PC24-07	2024-02-22	2024-03-06	-	145	162	Soaked 48 h	61.79	65.05	1	0.93	0.98	1.09	1.06	1.00
Lorette Avenue	PC24-11	2024-02-22	2024-03-06	-	145	155	Soaked 48 h	63.83	66.68	1	0.92	0.98	1.09	1.06	1.00

Comments

*Correction factors $F_{l/d}$, F_{dia}, F_{mc}, and F_D calculated as per ACI 214.4R-03, and correction factor F_{reinf} calculated as per Khoury et al. (2014): $f_c = f_{conc}F_{l/d}F_{dia}F_{mc}F_DF_{reinf}$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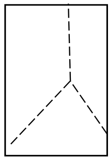
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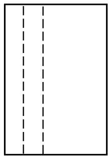
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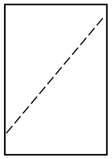
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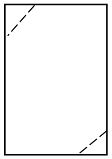
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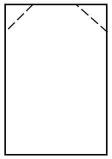
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		2012	✓	✓		✓	✓	
4	European Standard Specification	1998	✓	✓	✓		✓	
		2009	✓		✓			
5	Japanese Standard	1998	✓					
6	Concrete Society	1987	✓		✓		✓	✓

In addition, for core specimen containing two bars no further apart than the diameter of the larger bar, only the bar corresponding to the higher value of ($\Phi_r * d$) is considered. If the bars are further apart, their combined effect should be assessed by replacing the term ($\Phi_r * d$) by the term ($\sum \Phi_r * d$).

It should be pointed out that above equations used to interpret the core concrete strength to the in-situ concrete cube strength have been developed based on a set of assumptions and through many converting process. It is also of interest to note that the damage effect is considered in the development of the formulas in indirect way. The subject derivation and detailed formulas may be seen elsewhere [14].

3.2. American Concrete Institute (ACI)

3.2.1. Former ACI Code (2002) & Current ASTM (2009)

The methodology of core interpretation given in the former ACI code was remained without changes for decades and up to Year (2003). The in-place strength of concrete cylinder at the location from which a core test specimen was extracted can be computed using the equation:

$$f_{cy} = F_{l/d} \cdot f_{core} \quad (4)$$

where f_{cy} is the equivalent in-place concrete cylinder strength, f_{core} is concrete core strength, and $F_{l/d}$ is the strength correction factor for aspect ratio.

The former ACI code does not include any equation to calculate the correction factor ($F_{l/d}$); however, the code gives different values for this term that is associated with different aspect ratios (l/d) as given in Table 2. It should also be noted that the approach of current ASTM is similar to that mentioned above. The only considered variable is the aspect ratio (l/d). It should be noted that identical approach to that mentioned above is still effective in ASTM C42/C42M-03 [10].

3.2.2. Current ACI Code (2012) [15]

Starting from Year 2003, significant changes have been made to the relevant ACI Code provisions regarding the interpretation of core strength test results. New factors have been considered. These include core diameter, moisture content of core sample, core damage associated with drilling, in addition to the effect of aspect ratio that was previously considered in the former ACI edition (1998). According to the ACI 214.4R-03, the in-place concrete strength can be computed using the equation:

$$f_c = F_{l/d} \cdot F_{dia} \cdot F_{mc} \cdot F_D \cdot f_{core} \cdot F_{reinf} \quad (5)$$

← eq. 12
or
eq. 15

where f_c is the equivalent in-place concrete cylinder strength, f_{core} is concrete core strength, $F_{l/d}$ is strength correction factor for aspect ratio, F_{dia} is strength correction factors for diameter, F_{mc} is strength correction factor for moisture condition of core sample, and F_D is the strength correction factor that accounts for effect of damage sustained during core drilling including micro-cracking and undulations at the drilled surface and cutting through coarse-aggregate particles that may subsequently pop out during testing.

Table 2 Mean values for factor $F_{l/d}$ according to ACI Code (1998) and ASTM.

	Specimen length-to-diameter ratio, l/d			
	1.00	1.25	1.50	1.75
$F_{l/d}$	0.87	0.93	0.96	0.98

The ACI committee considered the correction factors presented in Table 3 for converting core strengths into equivalent in-place strengths based on the work reported by Bartlett and MacGregor [6]. It should be noted that the magnitude of

Table 3 Strength correction factors according to ACI 214.4R-03.

List	Factors	Mean values
(1)[b]	$F_{l/d}$:l/d ratio	
	As-received	$1 - \{0.130 - \alpha f_{core}\}(2 - \frac{l}{d})^2$
	Soaked 48 h	$1 - \{0.117 - \alpha f_{core}\}(2 - \frac{l}{d})^2$
	Air dried[a]	$1 - \{0.144 - \alpha f_{core}\}(2 - \frac{l}{d})^2$
(2)	F_{dia}: core diameter	
	50 mm	1.06
	100 mm	1.00
	150 mm	0.98
(3)	F_{mc}: core moisture content	
	As-received	1.00
	Soaked 48 h	1.09
	Air dried[a]	0.96
(4)	F_D: damage due to drilling	1.06

[a] Standard treatment specified in ASTM C 42/C 42M.

[b] Constant α equals $4.3(10^{-4})$ 1/MPa for f_{core} in MPa.

Table 6 List of comparisons between tested cores to determine.

	A18	A17	A16	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1
A1	♦●	●	♦●	■●	■●		●				●			▲	▲	■	▲	
A2																		
A3						■●				■●								
A4																		
A5																		
A6								■▲●	■▲●			■▲						
A7								■▲●	■▲●									
A8		●	♦	●	●													
A9																		
A10								■▲●										
A11																		
A12		●		●	●													
A13																		
A14		●		●														
A15		●																
A16	●♦																	
A17	♦																	
A18																		

● Diameter of steel bar.
▲ Distance of steel bar from nearly end of core.
■ Number of steel bars and spacing between bars.
♦ Distance of steel bar from vertical axis of specimen.

This brief review indicated that the various proposed relationships for correction factors are all nonlinear. It should be noted that the equations given by the Egyptian Code takes into account most variables that may affect the interpretation of the results; however, the code ignores the deterioration of steel–concrete bond that may occur and also the position of the reinforcement from vertical axis of core specimens.

Weighted nonlinear regression analysis has been performed to determine the factor (F_{reinf}) with the use of the software "SAS" package and "Data Fit." This shows that the correction factor for reinforcement (F_{reinf}) is given by the following expression:

single bar

- For cores containing a single bar:

$$F_{\text{reinf}} = \left[1 + 1.5\frac{[\Phi_r \times r + \Phi_r \times (S/10)]}{\Phi_c * L}\right] \times \frac{1.13}{f_{\text{core}}^{0.015}} \qquad (12)$$

- For core specimen containing two bars no further apart than the diameter of the larger bar, only the bar corresponding to the higher value of ($\Phi_r * d$) is considered. If the bars are further apart, their combined effect is assessed by replacing the term ($\Phi_r * r$) by ($\sum \Phi_r * r$ as follows:

multiple bars

$$F_{\text{reinf}} = \left[1 + 1.5\frac{\sum[\Phi_r \times r + \Phi_r \times (S/10)]}{\Phi_c * L}\right] \times \frac{1.13}{f_{\text{core}}^{0.015}} \qquad (13)$$

where F_{reinf} is the correction factor for reinforcement, Φ_r is the diameter of the reinforcement, Φ_c is the diameter of the concrete specimen, r is the distance of axis of bar from nearer end of specimen, S is the distance of axis of bar from axis of core specimen, L is the length of the specimen after end preparation by grinding or capping, and f_{core} is the concrete core strength (kg/cm^2).

6.1.6. *Effect of moisture condition of core*

Results of about 100 cores indicate that the strength of cores left to dry in air for 7 days is on average 13% greater than that of cores soaked at least 40 h before testing. The strength of cores with negligible moisture gradient and tested after cutting is found to be 7–9% larger than that of soaked cores as shown in Fig. 20. The authors strongly recommend to use a correction factor accounting for moisture condition (F_m) equals to 1.09 and 0.96, respectively, for cores tested after 48 h soaked in water and for those tested after 7 days dry in air.

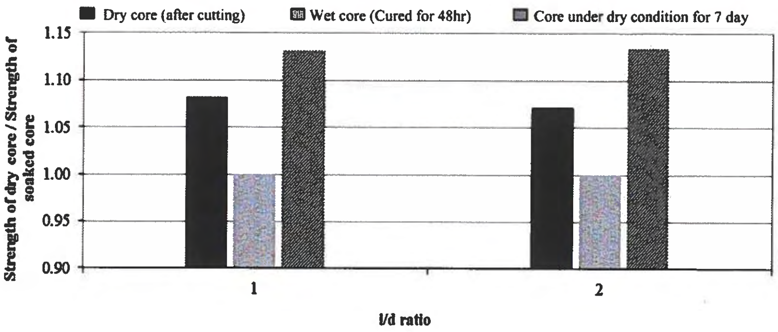


Figure 20 Effect of core moisture condition on core strength for different aspect ratios (*l*/*d*).

Appendix J

Summary Table and Pavement Core Photos

Sparling Ave – End (Walmart Parking Lot) to Harrow St

TREK GEOTECHNICAL

2024 Local Street Renewal (24-K-01, 24-R1-01)

Sparling Ave - End (Walmart Parking Lot) to Harrow St

Pavement Core No.	Pavement Core Location	Pavement Surface		Pavement Structure Material		
		Type	Thickness (mm)	Type	Thickness (mm)	Corrected Compressive Strength (Mpa)
PC24-13	UTM : 5524138 m N, 632629 m E; Located at #100 Sparling Ave, Eastbound Lane, 0.8 m North of South curb.	Asphalt	-	Concrete	185	
PC24-14	UTM : 5524164 m N, 632668 m E; Located 30 m West of Harrow St, Westbound Lane, 1.2 m South of North curb.	Asphalt	-	Concrete	200	56.61
PC24-15	UTM : 5524119 m N, 632587 m E; Located 125 m West of Harrow St, Westbound Lane, 1.5 m South of North curb.	Asphalt	-	Concrete	215	
PC24-16	UTM : 5524164 m N, 632668 m E; Located 173 m West of Harrow St, Westbound Lane, 1.5 m South of North curb.	Asphalt	-	Concrete	150	
PC24-19	UTM : 5524064 m N, 632493 m E; Located 100 m East of Wilton St, Eastbound Lane, 1.1 m North of South curb.	Asphalt	-	Concrete	150	
PC24-20	UTM : 5524044 m N, 632450 m E; Located 50 m East of Wilton St, Westbound Lane, 1.2 m South of North curb.	Asphalt	-	Concrete	160	63.08

Project 1000-043-25
Location 100 Sparling Ave
Hole No. PC24-13 Sample No. PC24-13
Depth 185 mm
Technician TG Date Feb.22/24

Photo 1: Pavement Core Sample PC24-13

Project 1000-043-25
Location Sparling Ave
Hole No. PC24-14 Sample No. PC24-14
Depth 200 mm
Technician TG Date Feb.22/24

Photo 2: Pavement Core Sample PC24-14

Project 1000-043-25
Location Sparling Ave
Hole No PC24-15 Sample No. PC24-15
Depth 215 mm
Technician TG Date Feb22/24

Photo 3: Pavement Core Sample PC24-15

Project 1000-043-25
Location Sparling Ave
Hole No. PC24-16 Sample No. PC24-16
Depth 150 mm
Technician TG Date Feb 22/24

Photo 4: Pavement Core Sample PC24-16

Photo 5: Pavement Core Sample PC24-19

Photo 6: Pavement Core Sample PC24-20

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Concrete Core Compressive Strength Report

CSA A23.2-14C

Project No. 1000-043-25

Date March 6, 2024

Project 2024 Local Street Package (24-K-01, 24-R1-01)

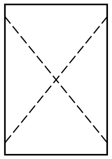
Technician TG

Client WSP Group Canada Inc.

Core Location	Core ID	Date Received	Date of Break	Age at Break	Diam. (mm)	Length (mm)	Moisture Conditioning	Compressive Strength (MPa)		Break Type	Correction Factors*				
								Uncorrected f_{conc}	Corrected* f_c		$F_{l/d}$	F_{dia}	F_{mc}	F_D	F_{reinf}
Sparling Ave	PC24-14	2024-02-22	2024-03-06	-	145	189	Soaked 48 h	52.38	56.61	1	0.95	0.98	1.09	1.06	1.00
Sparling Ave	PC24-20	2024-02-23	2024-03-06	-	145	153	Soaked 48 h	60.62	63.08	1	0.92	0.98	1.09	1.06	1.00

Comments

*Correction factors $F_{l/d}$, F_{dia}, F_{mc}, and F_D calculated as per ACI 214.4R-03, and correction factor F_{reinf} calculated as per Khoury et al. (2014): $f_c = f_{conc}F_{l/d}F_{dia}F_{mc}F_DF_{reinf}$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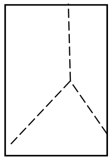
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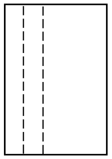
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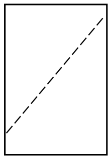
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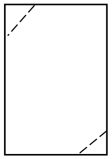
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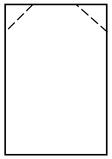
Type 6

Reviewed by (print): Angela Fidler-Kliewer, C.Tech.

Signature: Angela Fidler-Kliewer

Table 1 Factors involved in interpretation of core results by different codes.

List	Code/standard	Edition	Factors Considered					
			Aspect ratio	Diameter	Reinforcing	Moisture	Damage	Direction
1	Egyptian Code/Standard Specification	2008	√		√			√
2	British Code/Standard Specification	2003	√		√			√
3	American Concrete Institute ACI	1998	√					
		2012	√	√		√	√	
4	European Standard Specification	1998	√	√	√		√	
		2009	√		√			
5	Japanese Standard	1998	√					
6	Concrete Society	1987	√		√		√	√

In addition, for core specimen containing two bars no further apart than the diameter of the larger bar, only the bar corresponding to the higher value of ($\Phi_r * d$) is considered. If the bars are further apart, their combined effect should be assessed by replacing the term ($\Phi_r * d$) by the term ($\sum \Phi_r * d$).

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Table 6 List of comparisons between tested cores to determine.

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A3						■●				■●								
A4																		
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A6								■▲●	■▲●			■▲						
A7								■▲●	■▲●									
A8		●	♦	●	●													
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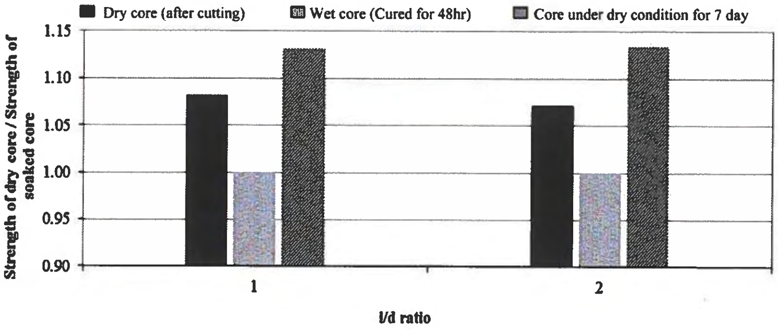

Figure 20 Effect of core moisture condition on core strength for different aspect ratios (*l*/*d*).