Karman, Greg

From: Murray, Jen
Sent: February 27, 2020 9:01 AM
To: Karman, Greg
Cc: Williamson, Eryn; Akinnola, Dele
Subject: Panet Road Limited Soil Investigation Results
Attachments: Site Plan (BH01 to BH04).pdf; Lab Report - C010809V1-R2020-02-22_14-45-49 _R006.pdf

Hi Greg,

Laboratory analytical results have been received for the limited soil sampling program conducted along Panet Road as part of the 2020 Watermain Renewals Contract 6 Project (AECOM Project No. 60624016 / City File W-988).

A summary of the fieldwork program and the investigation findings is described below:

Field Program:
On February 12 and 13, 2020, AquaJet advanced four boreholes (BH20-01 to BH20-04) to a depth of 3.7 m below ground surface (bgs) with a hydrovac truck. The boreholes were advanced west of the existing watermain and force main fronting the old Shell Oil refinery. The collection of soil cores was not possible due to the advancement of boreholes via hydrovac operations. A site plan showing the borehole locations is attached.

Soil samples were collected with a side-wall sampler at intervals of approximately 0.756 m. Field screening were conducted on collected samples during the drilling program by measuring combustible headspace vapour (CHV) concentrations using an RKI Eagle combustible gas indicator calibrated to hexane and set on methane elimination mode. The CHV measurements conducted on the collected soil samples were 0 ppm.

Investigation Findings & Conclusion:
The soil encountered at the investigated borehole locations (BH20-01 to BH20-04) generally consisted of a surface layer of topsoil, underlain by a layer of clay (with some silt to silty) to approximately 1.5 m bgs, followed by silt to approximately 2.3 m bgs, followed by clay to the maximum investigation depth of 3.7 m bgs. The extents of the observed soil stratigraphy in the daylighted boreholes are approximates.

Based on the identified soil stratigraphy and the depth of proposed watermain, one soil sample per borehole was collected and submitted for the laboratory analysis of benzene, toluene, ethylbenzene, and xylenes (BTEX) and petroleum hydrocarbon (PHC) fractions F1 – F4. Soil samples were submitted to Bureau Veritas Laboratories (BV Labs) of Winnipeg, Manitoba.

The following table provides a summary of the soil laboratory analytical results with the referenced Canadian Council of Ministers of the Environment (CCME) soil quality guidelines for commercial land use and fine-grained soil. The analytical results indicate that the concentrations of BTEX and PHC F1 – F4 in the analyzed soil samples were either below the laboratory detection limits and/or below the referenced CCME soil quality guidelines. No indication of PHC impacts were observed at the investigated borehole locations (BH01 to BH04) based on the soil analytical results collected from these borehole locations.

Sample ID	Date Sampled	Depth (m)	Headspace (ppm)	PHC F1 (mg/kg)	PHC F2 (mg/kg)	PHC F3 (mg/kg)	PHC F4 (mg/kg)	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Xylenes (mg/kg)
BH20-01-3	2020/02/13	2.3	0	12	<10	<50	<50	<0.0050	<0.050	<0.010	<0.045
BH20-02-2	2020/02/13	1.5	0	<10	<10	<50	<50	<0.0050	<0.050	<0.010	<0.045
BH20-03-2	2020/02/13	1.5	0	<10	<10	<50	<50	<0.0050	<0.050	<0.010	<0.045
BH20-04-3	2020/02/12	2.3	0	<10	<10	<50	<50	<0.0050	<0.050	<0.010	<0.045
CCME Soil Quality Guidelines [a]											

Surface Soils (≤1.5 m bgs), Commercial, Fine-Grained	**170** [b]	**230** [b]	**2,500** [b]	**6,600** [b]	**0.0068** [a]	**0.08** [a]	**0.018** [a]	**2.4** [a]
Subsoil (>1.5 m bgs), Commercial, Fine-Grained	**170** [b]	**230** [b]	**5,000** [b]	**10,000** [b]	**0.0068** [a]	**0.08** [a]	**0.018** [a]	**2.4** [a]

[a] Canadian Council of Ministers of the Environment (CCME) Soil Quality Guidelines Summary Table (most recent online version) - Commercial Land Use, Human Health Guidelines Check Values 10-5 incremental risk

[b] Canada-Wide Standards for Petroleum Hydrocarbons (PHC) in Soil, Technical Supplement (2008) - Commercial Land Use, Fine Grained Soils, for protection of potable groundwater.

A copy of the laboratory analytical report is attached.

If you have any questions, please let me know.

Thanks,

Jen Murray, B.Env.Sc., EP (CECAB)
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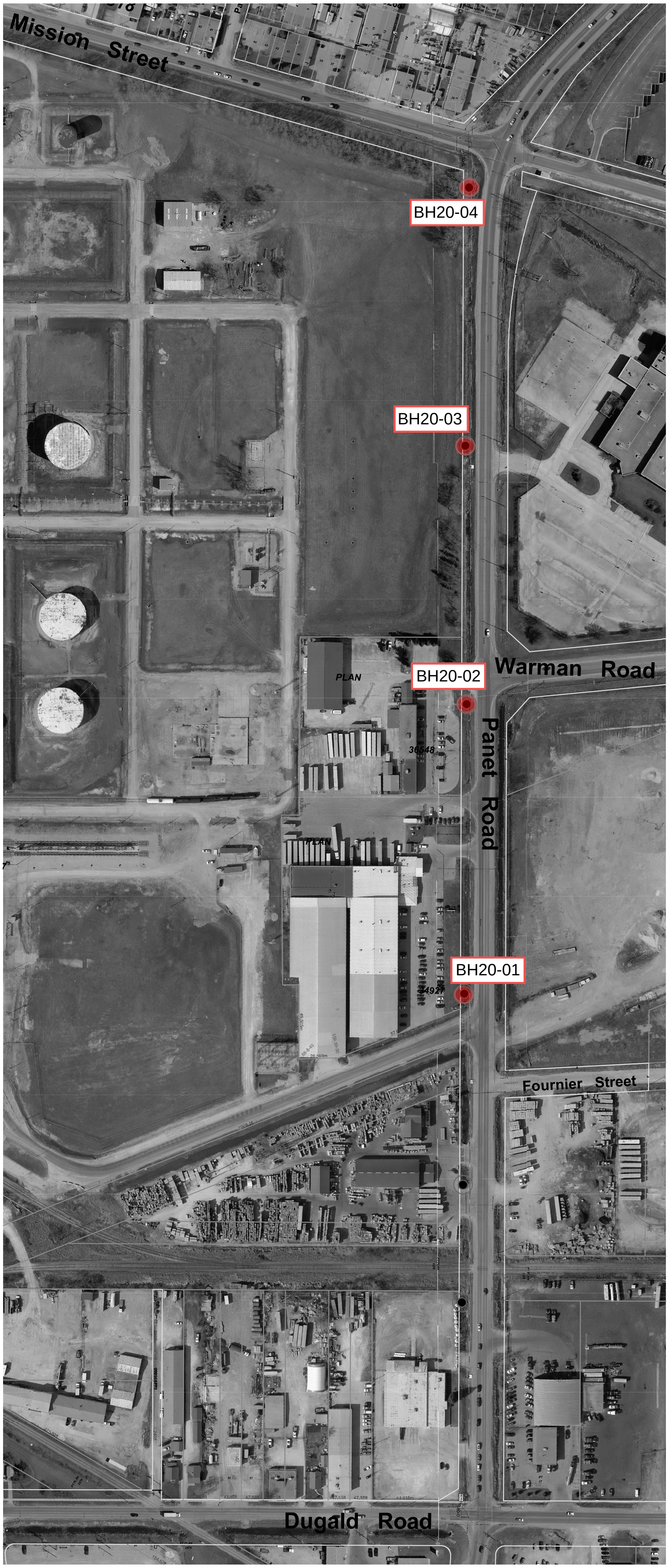
Mission Street
BH20-04
BH20-03
Warman Road
BH20-02
PLAN
36548
Panet Road
PLAN
BH20-01
Fournier Street
Dugald Road

Your P.O. #: 60624016
Your Project #: 60624016
Site Location: Panet Road
Your C.O.C. #: 605518-04-01

Attention: Jen Murray

AECOM CANADA LTD.
WINNIPEG
PO BOX 5250 WEST BEAVER CREEK
RICHMOND HILL, ON
CANADA L4B 0E4

Report Date: 2020/02/22
Report #: R2848076
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: C010809
Received: 2020/02/14, 11:50

Sample Matrix: Soil
Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
BTEX/F1 by HS GC/MS/FID (MeOH extract) (1, 2)	4	N/A	2020/02/20	AB SOP-00039	CCME CWS/EPA 8260d m
F1-BTEX (1)	4	N/A	2020/02/21		Auto Calc
CCME Hydrocarbons (F2-F4 in soil) (1, 3)	4	2020/02/20	2020/02/21	AB SOP-00036	CCME PHC-CWS m
Moisture (1)	4	N/A	2020/02/21	AB SOP-00002	CCME PHC-CWS m

Remarks:

Bureau Veritas Laboratories are accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by BV Labs are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in BV Labs profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and BV Labs in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

BV Labs liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. BV Labs has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by BV Labs, unless otherwise agreed in writing. BV Labs is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by BV Labs, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) This test was performed by BV Labs Calgary Environmental
(2) No lab extraction date is given for F1BTEX & VOC samples that are field preserved with methanol. Extraction date is date sampled unless otherwise stated.
(3) All CCME results met required criteria unless otherwise stated in the report. The CWS PHC methods employed by Bureau Veritas Laboratories conform to all prescribed elements of the reference method and performance based elements have been validated. All modifications have been validated and proven equivalent following Alberta Environment’s Interpretation of the Reference Method for the Canada-Wide Standard for Petroleum Hydrocarbons in Soil, Validation of Performance-Based Alternative Methods September 2003. Documentation is available upon request. Modifications from Reference Method for the Canada-wide Standard for Petroleum Hydrocarbons in Soil-Tier 1 Method: F2/F3/F4 data reported using validated cold solvent extraction instead of Soxhlet extraction.

Your P.O. #: 60624016
Your Project #: 60624016
Site Location: Panet Road
Your C.O.C. #: 605518-04-01

Attention: Jen Murray

AECOM CANADA LTD.
WINNIPEG
PO BOX 5250 WEST BEAVER CREEK
RICHMOND HILL, ON
CANADA L4B 0E4

Report Date: 2020/02/22
Report #: R2848076
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: C010809
Received: 2020/02/14, 11:50

Encryption Key

AUTHORIZED REPORT
RAPPORT AUTORISÉ

Bureau Veritas Laboratories
22 Feb 2020 14:46:27

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Jenelle Feller, Key Account Specialist
Email: Jenelle.Feller@bvlabs.com
Phone# (403)735-2264
==
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PETROLEUM HYDROCARBONS (CCME)

BV Labs ID		XJ9648	XJ9649	XJ9650	XJ9651		
Sampling Date		2020/02/12 13:30	2020/02/13 09:45	2020/02/13 11:15	2020/02/13 13:00		
COC Number		605518-04-01	605518-04-01	605518-04-01	605518-04-01		
	UNITS	**BH20-04-3**	**BH20-03-2**	**BH20-02-2**	**BH20-01-3**	**RDL**	**QC Batch**
Ext. Pet. Hydrocarbon							
F2 (C10-C16 Hydrocarbons)	mg/kg	<10	<10	<10	<10	10	9772077
F3 (C16-C34 Hydrocarbons)	mg/kg	<50	<50	<50	<50	50	9772077
F4 (C34-C50 Hydrocarbons)	mg/kg	<50	<50	<50	<50	50	9772077
Reached Baseline at C50	mg/kg	Yes	Yes	Yes	Yes	N/A	9772077
Surrogate Recovery (%)							
O-TERPHENYL (sur.)	%	108	125	126	140	N/A	9772077

RDL = Reportable Detection Limit
N/A = Not Applicable

PHYSICAL TESTING (SOIL)

BV Labs ID		XJ9648	XJ9649	XJ9650	XJ9651		
Sampling Date		2020/02/12 13:30	2020/02/13 09:45	2020/02/13 11:15	2020/02/13 13:00		
COC Number		605518-04-01	605518-04-01	605518-04-01	605518-04-01		
	UNITS	**BH20-04-3**	**BH20-03-2**	**BH20-02-2**	**BH20-01-3**	**RDL**	**QC Batch**
Physical Properties							
Moisture	%	37	20	22	22	0.30	9773132
RDL = Reportable Detection Limit							

VOLATILE ORGANICS BY GC-MS (SOIL)

BV Labs ID		XJ9648	XJ9649	XJ9650	XJ9651		
Sampling Date		2020/02/12 13:30	2020/02/13 09:45	2020/02/13 11:15	2020/02/13 13:00		
COC Number		605518-04-01	605518-04-01	605518-04-01	605518-04-01		
	UNITS	**BH20-04-3**	**BH20-03-2**	**BH20-02-2**	**BH20-01-3**	**RDL**	**QC Batch**
Volatiles							
Xylenes (Total)	mg/kg	<0.045	<0.045	<0.045	<0.045	0.045	9767765
F1 (C6-C10) - BTEX	mg/kg	12	<10	<10	<10	10	9767765
Field Preserved Volatiles							
Benzene	mg/kg	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	9768669
Toluene	mg/kg	<0.050	<0.050	<0.050	<0.050	0.050	9768669
Ethylbenzene	mg/kg	<0.010	<0.010	<0.010	<0.010	0.010	9768669
m & p-Xylene	mg/kg	<0.040	<0.040	<0.040	<0.040	0.040	9768669
o-Xylene	mg/kg	<0.020	<0.020	<0.020	<0.020	0.020	9768669
F1 (C6-C10)	mg/kg	12	<10	<10	<10	10	9768669
Surrogate Recovery (%)							
1,4-Difluorobenzene (sur.)	%	100	101	92	100	N/A	9768669
4-Bromofluorobenzene (sur.)	%	100	100	102	98	N/A	9768669
D10-o-Xylene (sur.)	%	126	116	111	116	N/A	9768669
D4-1,2-Dichloroethane (sur.)	%	104	103	127	101	N/A	9768669

RDL = Reportable Detection Limit
N/A = Not Applicable

GENERAL COMMENTS

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**
9768669	1,4-Difluorobenzene (sur.)	2020/02/20	99	50 - 140	100	50 - 140	99	%		
9768669	4-Bromofluorobenzene (sur.)	2020/02/20	99	50 - 140	101	50 - 140	99	%		
9768669	D10-o-Xylene (sur.)	2020/02/20	116	50 - 140	106	50 - 140	104	%		
9768669	D4-1,2-Dichloroethane (sur.)	2020/02/20	99	50 - 140	103	50 - 140	103	%		
9772077	O-TERPHENYL (sur.)	2020/02/21	117	60 - 140	120	60 - 140	129	%		
9768669	Benzene	2020/02/20	96	50 - 140	89	60 - 130	<0.0050	mg/kg	NC	50
9768669	Ethylbenzene	2020/02/20	94	50 - 140	87	60 - 130	<0.010	mg/kg	NC	50
9768669	F1 (C6-C10)	2020/02/20	78	60 - 140	94	60 - 140	<10	mg/kg	NC	30
9768669	m & p-Xylene	2020/02/20	93	50 - 140	87	60 - 130	<0.040	mg/kg	NC	50
9768669	o-Xylene	2020/02/20	92	50 - 140	86	60 - 130	<0.020	mg/kg	NC	50
9768669	Toluene	2020/02/20	90	50 - 140	84	60 - 130	<0.050	mg/kg	NC	50
9772077	F2 (C10-C16 Hydrocarbons)	2020/02/21	100	60 - 140	103	60 - 140	<10	mg/kg	NC	40
9772077	F3 (C16-C34 Hydrocarbons)	2020/02/21	107	60 - 140	109	60 - 140	<50	mg/kg	NC	40
9772077	F4 (C34-C50 Hydrocarbons)	2020/02/21	107	60 - 140	107	60 - 140	<50	mg/kg	NC	40
9773132	Moisture	2020/02/21					<0.30	%	0.63	20

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

FUNDAMENTAL LABORATORY ACCEPTANCE GUIDELINE

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Your Project #:	60624016
Your P.O. #:	60624016
BV Labs Project Manager:	Jenelle Feller
Quote #:	B90316

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ATTN: ACCOUNTS PAYABLE
PO BOX 5250 WEST BEAVER CREEK
RICHMOND HILL, ON
CANADA L4B 0E4
Client Contact:
Jen Murray

No discrepancies noted.

Report Comments

Received Date:	**2020/02/14**	**Time:**	**11:50**	**By:**	
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VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Junzhi Gao

Janet Gao, B.Sc., QP, Supervisor, Organics

Veronica Falk

Veronica Falk, B.Sc., P.Chem., QP, Scientific Specialist, Organics

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Winnipeg MB R3P 0Y7
Canada

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To:	Greg Karman	Date:	March 19, 2020
		Project #:	60624016 (435.9)
		From:	Ryan Harras Faris Alobaidy
cc:	Jon Pedersen		

Memorandum

Subject: **The City of Winnipeg – 2020 Watermain Renewals – Contract 6, Winnipeg, Manitoba Geotechnical Investigation**

1. Introduction

The City of Winnipeg (The City) is planning the construction of a new watermain along Panet Road as part of the 2020 watermain renewal project. The proposed new watermain will be a 300 mm (inside diameter) polyvinyl chloride (PVC) sewer pipe that will be installed within a 500 mm (inside diameter) steel casing pipe using trenchless construction methods beneath the Canadian National Railway (CNR) Industrial Spur Old Beach Line at Mile 0.74. The casing pipe invert will be approximately 4.2 m below base of rail (BOR) elevation (pipe invert elevation from 228.00 m to 228.08 m) at the proposed crossing location, and about 50 m in length.

This memo summarizes the findings of a geotechnical field investigation, describes potential trenchless installation methods, and provides a geotechnical assessment for the potential impact of the proposed watermain installation on the existing CNR tracks.

2. Scope

The scope of the geotechnical services to be provided included a review of the conceptual project layout, geotechnical investigation, laboratory testing, and geotechnical recommendations related to trenchless installation of the proposed watermain beneath the existing CNR tracks.

Subsurface conditions and construction recommendations along the proposed watermain alignment in areas outside of the CNR crossing location are not within the current geotechnical scope of work.

3. Geotechnical Investigation

3.1 General

On February 14, 2020 two (2) test holes (TH20-01 and TH20-02) were drilled at the approximate locations shown on Drawing C-0008 in **Appendix A**. Test holes were advanced through the southbound shoulder of Panet Road offset approximately 9.0 to 10.0 m from the proposed watermain alignment due to drill rig accessibility concerns along the alignment and the presence of existing utility lines in close proximity to the proposed alignment. All test holes were located outside of CNR and Shell pipeline right-of-ways. A safe work plan was prepared by AECOM prior to the field investigation, and utility clearance certificates at the site were obtained by AECOM from representatives of ClickBeforeYouDigMB and DigShaw.

Drilling was completed by Maple Leaf Drilling Ltd. using a Geoprobe 7822DT equipped with 125 mm Solid Stem Augers (SSA's) to a maximum depth of 7.6 m below ground surface (m BGS). Subsurface conditions observed during drilling were documented by AECOM geotechnical personnel according to the Modified Unified Classification System for soils. Other pertinent information such as groundwater and drilling conditions were also recorded during drilling. Samples retrieved during the field investigation were tested in AECOM's Materials Testing Laboratory and H.Manalo Consulting Ltd.'s Materials Testing Laboratory, both located in Winnipeg, Manitoba. Standard penetration tests (SPT) were performed at select depths within both test holes. Disturbed grab and split spoon samples and relatively undisturbed Shelby Tube samples were retrieved from test holes at select intervals.

Detailed test hole logs have been prepared for each test hole and are attached as **Appendix B**. The test hole logs include descriptions and depths of the soil units encountered, sample type, sample location, results of field and laboratory testing and other pertinent information such as seepage and sloughing related to groundwater conditions.

Table 3-1 summarizes the location, elevation, and depth of each test hole.

Table 3-1: Test Hole Information Summary

Test Hole ID	Northing (m)	Easting (m)	Elevation (m)	Termination Depth (m BGS)
TH19-01	5527863	637979	232.24	7.62
TH19-02	5527954	637976	232.32	7.62

3.2 Laboratory and In-situ Testing

In-situ SPT testing was completed during the investigations at select depths. Laboratory testing was conducted on select soil samples collected during the geotechnical investigation. The soil testing program included the determination of moisture content, grain size distribution (hydrometer/sieve analysis), Atterberg Limits, bulk unit weight, and undrained shear strength (unconfined compressive strength method). The laboratory test results are presented in **Appendix C**. **Table 3-2** summarizes the number of each test completed, and **Figure 3-1** illustrates specific soil index properties at varying depths.

Table 3-2: Summary of Laboratory Testing

Test	Number
SPT's	3
Moisture Content	15
Atterberg Limits	2
Grain Size Distribution (Hydrometer/Sieve Analysis)	2
Undrained Shear Strength (Unconfined Compressive Strength Method)	2
Bulk Unit Weight	2

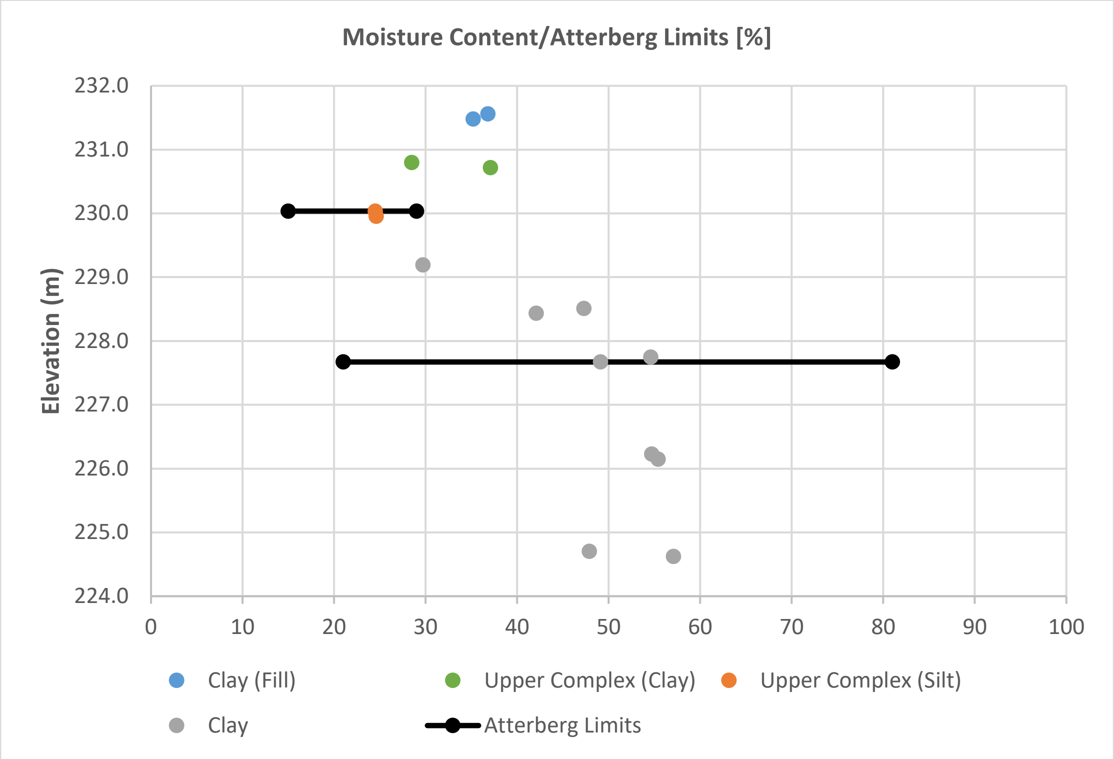


Figure 3-1: Summary of Soil Index Testing

4. Subsurface Conditions

The following sections describe the subsurface conditions encountered during the geotechnical investigation. Subsurface conditions can vary across the site and information provided in this section is a summary of the findings from the investigation and laboratory testing.

In descending order, the general soil profile consisted of:

- Roadway Pavement (Asphalt/Granular)
- Clay Fill
- Upper Complex
  - Clay/Clay and Silt
  - Silt
- Glaciolacustrine Clay

Each of these units are described separately below.

Roadway Pavement (Asphalt/Granular)

A layer of asphalt pavement was encountered at ground surface in test hole TH20-02 and was approximately 25 mm thick. A layer of granular fill was encountered at ground surface in test hole TH20-01 and beneath the asphalt pavement in test hole TH20-02, and ranged in thickness from 0.1 m to 0.2 m. The granular fill was dark brown, and frozen at the time of the investigation.

Clay Fill

A layer of clay fill was encountered below the roadway pavement in both test holes, and ranged in thickness from 0.6 m to 1.1 m. The clay fill was generally silty, contained some sand, trace gravel, and was dark brown mottled grey. The clay fill in test hole TH20-01 was frozen at the time of the investigation, whereas the clay fill in test hole TH20-02 was frozen to a depth of 0.9 m BGS. The clay fill was firm, moist, and of high plasticity below 0.9 m. A summary of the index properties of the clay fill is presented in **Table 4-1.**

Table 4-1: Summary of Index Properties of Clay Fill

Test	Minimum Value	Maximum Value	Number of Tests
Moisture Content (%)	35	37	2

Upper Complex

The upper complex is a near ground surface zone common to the Winnipeg area that typically consists of interlayered clays, silts, sands, and organics near ground surface that are thought to be a mixture of lacustrine and alluvial sediments. Upper complex layers of clay, silt, and clay and silt were encountered beneath the clay fill in both test holes at this site. The upper complex deposit observed in the test holes extended to a depth ranging from 3.1 m to 3.2 m BGS in test holes TH20-01 and TH20-02, respectively.

Upper complex clay was encountered in both test holes and contained some silt to silty and trace to some sand. In test hole TH20-02, the upper complex clay layer was classified as clay and silt. The upper complex clay was generally dark grey to brown, firm to stiff, moist, and of high plasticity. A summary of the index properties of the upper complex clay is presented in **Table 4-2.**

Table 4-2: Summary of Index Properties of Upper Complex Clay

Test	Minimum Value	Maximum Value	Number of Tests
Moisture Content (%)	29	37	2

The upper complex silt was encountered in both test holes and contained some clay, trace sand, and was generally light brown, soft, moist, and of low plasticity. A summary of the index properties of the upper complex silt is presented in **Table 4-3.**

Table 4-3: Summary of Index Properties of Upper Complex Silt

Test	Minimum Value	Maximum Value	Number of Tests
Moisture Content (%)	25		2
Atterberg – Plastic Limit (%)	15		1
Atterberg – Liquid Limit (%)	29		1
Grain Size – Gravel (%)	0		1
Grain Size – Sand (%)	5		1
Grain Size – Silt (%)	76		1
Grain Size – Clay (%)	20		1

Glaciolacustrine Clay

A layer of glaciolacustrine clay was encountered beneath the upper complex layer at depths of 3.1 m and 3.2 m BGS in test holes TH20-01 and TH20-02, respectively. The glaciolacustrine clay extended to test hole termination depth at 7.6 m BGS in both test holes. The glaciolacustrine clay was silty, contained trace sand, and was brown to grey, soft to very stiff, moist, and of high plasticity. A summary of the index properties of the glaciolacustrine clay is presented in **Table 4-4**.

Table 4-4: Summary of Index Properties of Glaciolacustrine Clay

Test	Minimum Value	Maximum Value	Number of Tests
Moisture Content (%)	30	57	9
SPT ‘N’ Blow Count (uncorrected)	4	7	3
Atterberg – Plastic Limit (%)	21		1
Atterberg – Liquid Limit (%)	81		1
Grain Size – Gravel (%)	0		1
Grain Size – Sand (%)	0		1
Grain Size – Silt (%)	27		1
Grain Size – Clay (%)	73		1
Unconfined Compressive Strength (kPa)	172	204	2
Undrained Shear Strength (kPa)	86	102	2
Bulk Unit Weight (kN/m^3)	16.8	17.5	2

4.1 Sloughing and Groundwater Conditions

Sloughing was not encountered within test holes TH20-01 or TH20-02 during drilling. Seepage was not encountered in test hole TH20-01 but was observed during drilling of TH20-02 at depths below 4.6 m BGS. Detailed information about the nature and location of the sloughing and/or seepage are provided on the test hole logs included in **Appendix B**. Two (2) standpipe piezometers were installed in test holes TH20-01 and TH20-02 within the glacio-lacustrine clay layer at depths of 7.5 m BGS. Short-term monitoring results of the groundwater level (GWL) from the piezometers installed at the site are provided in **Table 4-5**.

Table 4-5: Piezometer Monitoring Data

Test Hole Number	**TH20-01**	**TH20-02**
Test Hole Elevation [m]	232.24	232.32
Tip Depth [m BGS]	7.52	7.52
Tip Elevation [m]	224.72	224.80
Tip Location	Glaciolacustrine Clay	Glaciolacustrine Clay
Dates	**GWL Measurement Depth (Elevation) [m]**	
March 4, 2020	6.09 (226.15)	4.68 (227.64)

It should be noted that groundwater levels, seepage, and sloughing may vary seasonally, annually, or as a result of construction activities.
Trenchless Installation Methods

There are trenchless installation methods incorporating pipe jacking available to install the proposed pipe, of which the Atkins Method, the Akkerman Method, and the Auger Boring Method are most commonly used locally. In general, the Atkins Method and Akkerman Method follow similar construction approaches and result in similar ground responses, while the Auger Boring Method is generally associated with shorter drive lengths where minimizing surface settlements is required.

It is understood at this time that the Auger Boring Method is the preferred installation method for the proposed watermain given the short drive length required and the need to reduce surface settlement at the rail crossing. Therefore, only the Auger Boring Method is considered and discussed in subsequent sections.

4.2 Pipe Jacking by Auger Boring Method

The Auger Boring Method uses a helical screw auger advanced through a steel casing. A cutting head is attached to the front of the auger. The soil cuttings are removed towards the launching/jacking shaft by turning the auger. The casing is jacked simultaneously as the soil cuttings are removed. Depending on soil conditions the auger can be advanced ahead of the casing leading edge or recessed a given distance within the casing. When unstable soil conditions are encountered the casing is advanced ahead of the auger to allow for a soil plug to improve face stability and reduce the potential for ground subsidence. Common practice is to leave a minimum soil plug of 2 times the casing diameter.

The major advantage of this method is the reduced ground disturbance (i.e., settlement/heave) during installation, as the casing can be jacked ahead of the face of the bore. For this project, it is understood that the specified construction methodology will prohibit soil removal ahead of the casing pipe to improve face stability and reduce the potential for ground subsidence. A potential disadvantage of this method is the limitation on controlling installation grade and alignment. However, given the short drive length required for this project (less than 50 m), maintaining grade and alignment control is not considered to be a significant construction concern.

5. Geotechnical Assessment

5.1 Anticipated Soil Conditions

The invert of the proposed casing pipe is 228.08 m at the south launching shaft and 228.00 m at the north receiving shaft. Soil conditions encountered in test holes TH20-01 and TH20-02 indicate that the trenchless installations of the proposed watermain and casing pipe will be within the glaciolacustrine clay layer. However, upper complex silt layers were encountered within 0.6 m above the crown of the proposed casing pipe, and may therefore be encountered during trenchless installation.

The base elevations for the proposed shafts are 227.0 m at the south launching shaft and 227.5 m at the north receiving shaft. Soil conditions encountered in the test holes completed by AECOM indicate that the shaft construction will require excavation of upper complex clay, upper complex silt, and glaciolacustrine clay.

The single piezometer reading taken on March 4, 2020 indicated a GWL at an elevation of 227.64 m, which is slightly above the base elevation of the shafts, and slightly below the invert elevation of the proposed tunneling installations.

5.2 Face Stability

The Face Stability Index, frequently referred to as the overload factor (OF), is the ratio of the difference between the vertical pressure at tunnel axis and the pressure applied to the tunnel face, and the undrained shear strength. In cohesive soils (clay), the tunnel face is considered stable when the index is less than six (6). While the limiting value of OF=6 represents a threshold of serious problems, a value of OF=5 represents a practical limit below which tunneling may be carried out without unusual difficulties.

Using a selected design value of 30 kPa for undrained shear strength and 17.0 kN/m3 for bulk unit weight, the estimated OF is between 1.7 and 2.3 along the pipe within the limits of the proposed trenchless installation. This suggests that tunnel face stability is satisfactory.

Caution should be exercised to monitor the face and minimize the time period associated with the tunneling operations. Upper complex silt layers were observed in both test holes approximately 0.6 m above the crown of the proposed casing pipe. Silt layers may be encountered at the pipe installation depth and cause delays or difficulties during construction. Therefore, a contractual requirement for a continuous jacking operation under the track and visual observation of the cuttings to confirm the silt zones (if encountered) will be necessary to allow for remedial actions to be implemented in the event that face instabilities are experienced during construction.

5.3 Ground Subsidence (Settlement Trough)

Like other tunneling methods, a trenchless bore will result in a change in the state of stress in the ground with the corresponding displacements. Ground subsidence can be caused by several factors such as ground loss at the tunnel face, behind the tail of the shield and through the pipe or linings deformation. Assuming a stable tunneling face, the only significant contribution to ground loss is the closure of the over-cut. The over-cut is the annular space between the boring walls and the installed pipe.

Some degree of ground surface subsidence can be expected from tunneling although in many instances its effects, from a practical perspective are negligible. Empirical methods of predicting settlement due to tunnelling induced ground movements have been used extensively and successfully over the years. Most methods derived for estimating surface or subsurface subsidence are empirical in nature and based on field observations. The most common method is estimating the value of i, a parameter used to define the distance from the tunnel centre line to the point of inflection of the settlement trough of a normal probability curve as shown in **Figure 6-1.** The distribution of the settlements or settlement trough approximates a normal probability distribution function described as:

$S_x = S_{max}\ exp\ [-x^2/2i^2]$ ………………………………………………………… **Equation 1**

Where:

S_x = *surface settlement at a transverse distance (x) from the tunnel center line*
S_{max} = *maximum settlement at x = 0*
i = *location of maximum settlement gradient or point of inflexion.*
= *0.43z + 1.1*
z = *distance from calculation elevation to center of tunnel*

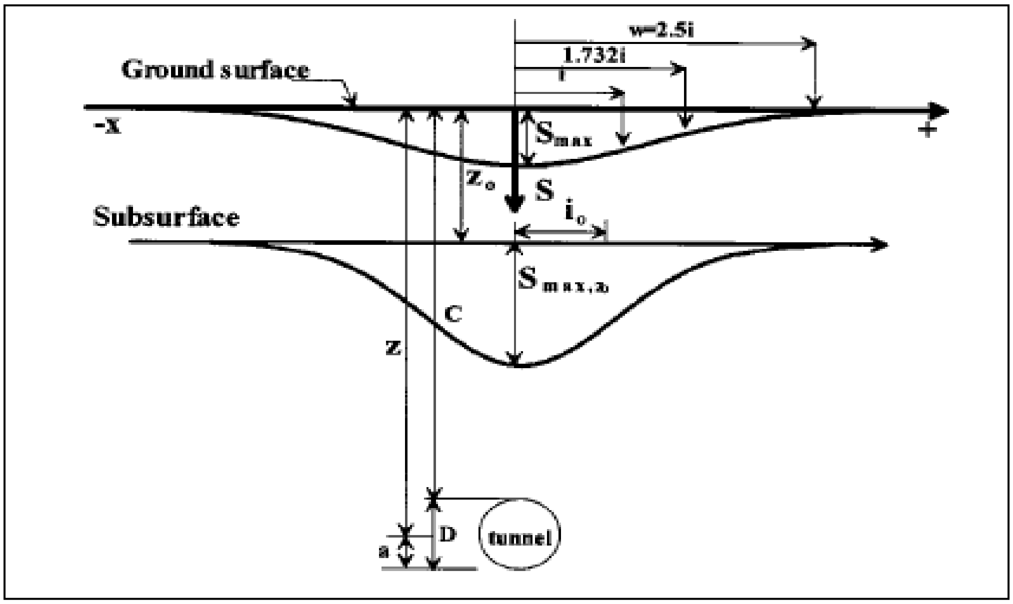


Figure 6-1: Form of Surface and Subsurface Settlement Trough

The proposed pipe/track crossing is of interest to examine the potential impact of settlement on the track. Based on **Equation 1**, the estimated *i* parameter, width of settlement trough, and max settlement at BOR elevation and other select subsurface elevations are presented in **Table 6-1**. In estimating these values, the volume of the settlement trough (per unit length) was considered to be equal to the ground loss from the total over-cut between the excavated tunnel bore and the outer pipe wall. One over-cut size (25 mm) was considered in these calculations, corresponding to a ground loss of 0.5% of the casing pipe diameter. The final selected installation methodology should be reviewed to confirm its compliance with these estimations before the start of construction. As shown in **Table 6-1**, the settlement troughs are deeper and narrower at depths closest to the pipe installation and become shallower and wider at depths near the ground surface.

Table 6-1: Estimated Surface and Subsurface Settlement Trough Parameters

Total Over-Cut [mm]	Elevation [m]	*i* Parameter [m]	Total Trough Width (Approx. 5*i*) [m]	Maximum Settlement [mm]
25	232.22 (at BOR)	2.81	14	3
	231.22 (1.0 m below BOR)	2.38	12	3.5
	230.22 (2.0 m below BOR)	1.95	10	4.5
	229.22 (3.0 m below BOR)	1.52	8	5.5

** BOR: Base of Rail at 232.22 m*

** Proposed Casing Pipe Invert Elevation: 228.00 to 228.08 m*

** Casing Pipe Nominal Diameter: 500 mm*

** Casing Pipe Outside Diameter: 508 mm*

The maximum anticipated settlement values are presented graphically on **Figure 6-2**. The maximum estimated ground subsidence at the BOR elevation is in the order of about 3 mm above the pipe centerline for an over-cut size of 25 mm, and diminishes to zero across the width of the settlement trough which is estimated to be about 28 m (14 m on each side of the pipe centerline). The above estimates are based on stable bore face and are derived from an empirical method. Therefore, actual settlement might differ from the above estimate based on the construction methodology and ground conditions encountered along the alignment. Continuous monitoring during construction is recommended to monitor actual ground subsidence and to protect against development of unanticipated conditions.

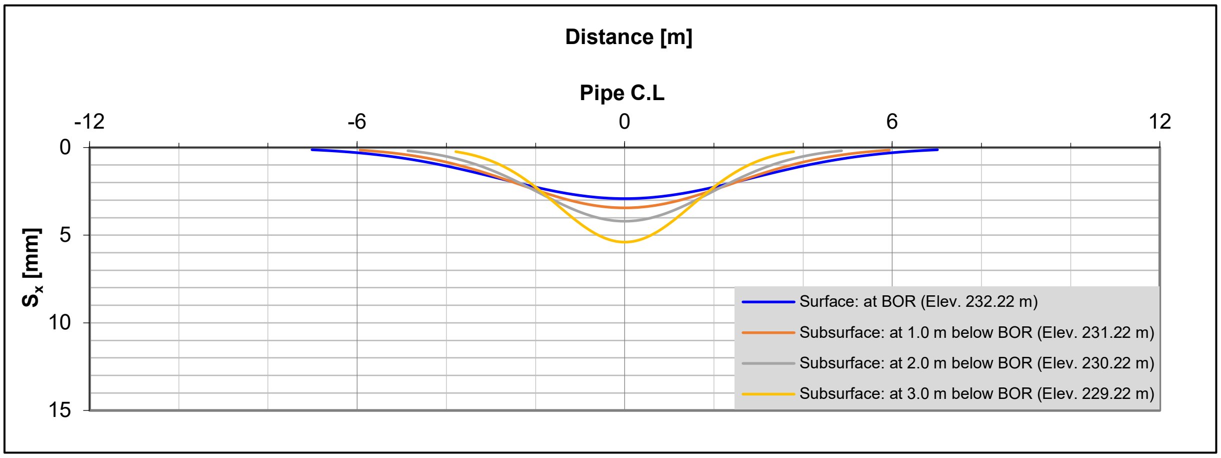


Figure 6-2: Estimated Extent and Amount of Surface and Subsurface Subsidence for 25 mm Over-Cut

6. Construction Monitoring Program

It is understood that existing underground utilities in the vicinity of the proposed CNR track crossing location include:

1) City of Winnipeg Feedermain, running parallel to and east of the proposed watermain
2) City of Winnipeg Watermain, running parallel to and east of the proposed watermain
3) City of Winnipeg Wastewater Sewer, running perpendicular to the proposed watermain to the north of the CNR tracks
4) Shell Oil Pipelines, running approximately perpendicular to the proposed watermain to the north of the CNR tracks
5) BellMTS Buried Cable, running perpendicular to the proposed watermain to the north of the CNR tracks
6) Manitoba Hydro Secondary Cables, crossing the proposed watermain to the north of the CNR tracks
7) Manitoba Hydro Gas Service Line, crossing the proposed watermain to the north of the CNR tracks.

It is recommended to communicate the details of the proposed construction and the anticipated impact with all utility providers mentioned above in addition to CNR signals to confirm acceptable displacement tolerance and define monitoring requirements, if any. Ground surface subsidence monitoring using standard survey points on the ground surface and on the rail ties is recommended. The proposed monitoring program may include the following:

1) Inspection of 30 m by 30 m area at the proposed pipe/track crossing location and establishment of base lines and control points before construction.
2) Perform three monitoring events before construction to assess the survey precision and the impact of other factors such as train traffic on survey data.
3) Monitoring to commence when pipe installation takes place between the shafts to the north and south of the existing track.
4) Scheduled collection and distribution of the survey data.

6.1 Proposed Notification and Action Plan

The proposed watermain and casing pipe exceed 250 mm (10”) in outside diameter, and the CNR track at the project site is classified as a branch line. Therefore, the proposed installation is subject to settlement tolerances identified for branch lines in “Geo Form 2” of the “CN Pipeline Crossing/Encroachment Application Form (Water/Sewer)”. These settlement tolerances are summarized as follows:

- Any settlements of 8 mm are to be reported to CN immediately
- For any settlement of 16 mm or greater, work is to stop immediately

These limits of track displacement, the estimated surface subsidence above pipe, and the expected precision of the survey equipment were considered in establishing trigger levels to control construction and protect CNR track operations. **Figure 7-1** illustrates the proposed numerical values for the trigger levels for decision making and action plan implementation. These trigger levels should be reviewed and may be adjusted based on the results of the pre-construction monitoring and CNR requirements. **Figure 7-2** illustrates the proposed notification plan and potential action(s) required to protect against the development of critical conditions.

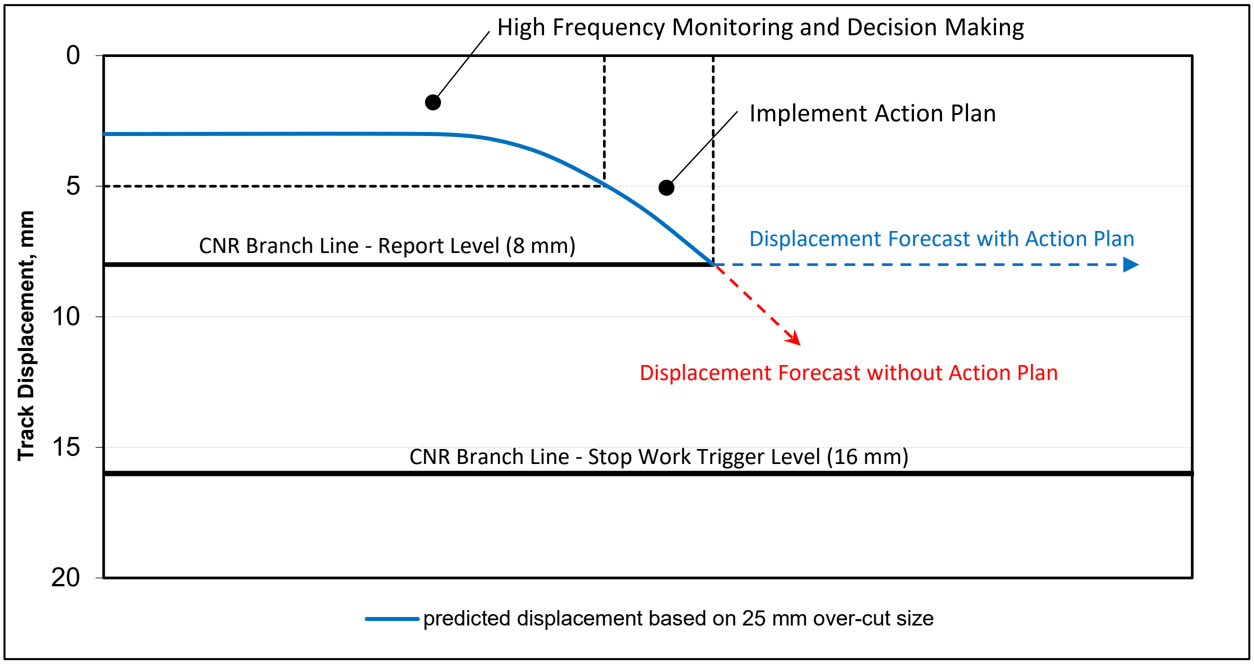
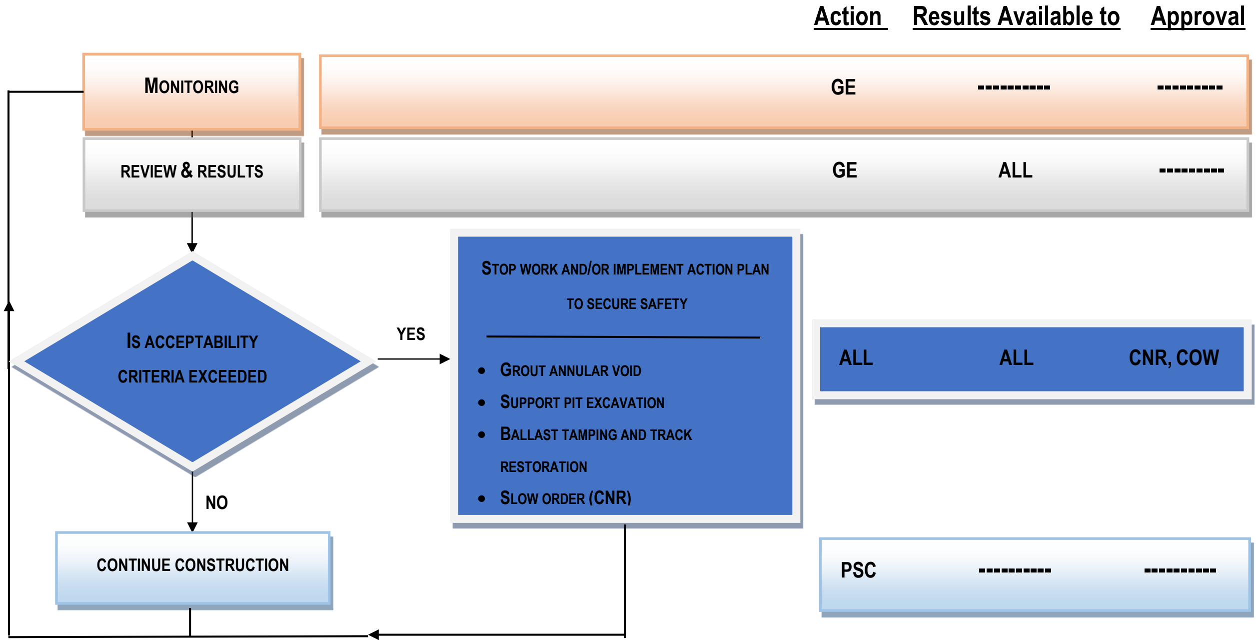


Figure 7-1: Proposed Track Displacement Trigger Levels



ALL: (CNR, COW, GE, PSC)

CNR: Canadian National Railway, COW: The City of Winnipeg

GE: Geotechnical Engineer, PSC: Pipe Specialist Contractor

Figure 7-2: Proposed Notification and Action Plan

7. Temporary Excavations

Temporary excavations will likely be required to facilitate the construction of trenchless installations. The depths of the proposed shaft excavations are anticipated to be approximately 4.3 m BGS and should be located out of CNR right-of-way. The method of excavation, safe support of excavation sidewalls and protection of the existing infrastructure are the responsibility of the contractor and are subject to applicable regulations. All excavations must comply with the Manitoba Workplace Safety and Health Act Regulations. If the lateral earth pressure coefficients and pressure distribution are required for the design of temporary excavations, these can be provided by AECOM upon request.

8. Closure

The analysis and recommendations presented in this memorandum are based on the data obtained from test hole drilled at discrete locations. This memorandum does not reflect any variations which may occur between the test hole locations. In the performance of subsurface explorations, specific information is obtained at specific locations at specific times. However, it is well known that variations in soil and groundwater conditions exist on most sites between test hole locations. The nature and extent of variations may not become evident until the course of construction. If variations are then evident, it will be necessary for a re-evaluation of the recommendations presented in this memorandum after performing on-site observations during the construction period and noting the characteristics on any variations. A qualified geotechnical engineer should be retained to provide inspection services during construction.

Please contact the undersigned if you have any questions regarding any of the information or recommendations contained within this Technical Memorandum.

Sincerely,

AECOM Canada Ltd.

Prepared by:

Ryan Harras

Ryan Harras, B.Sc, EIT
Geotechnical EIT

Reviewed by:

Faris Alobaidy, M.Sc., P.Eng.
Senior Geotechnical Engineer

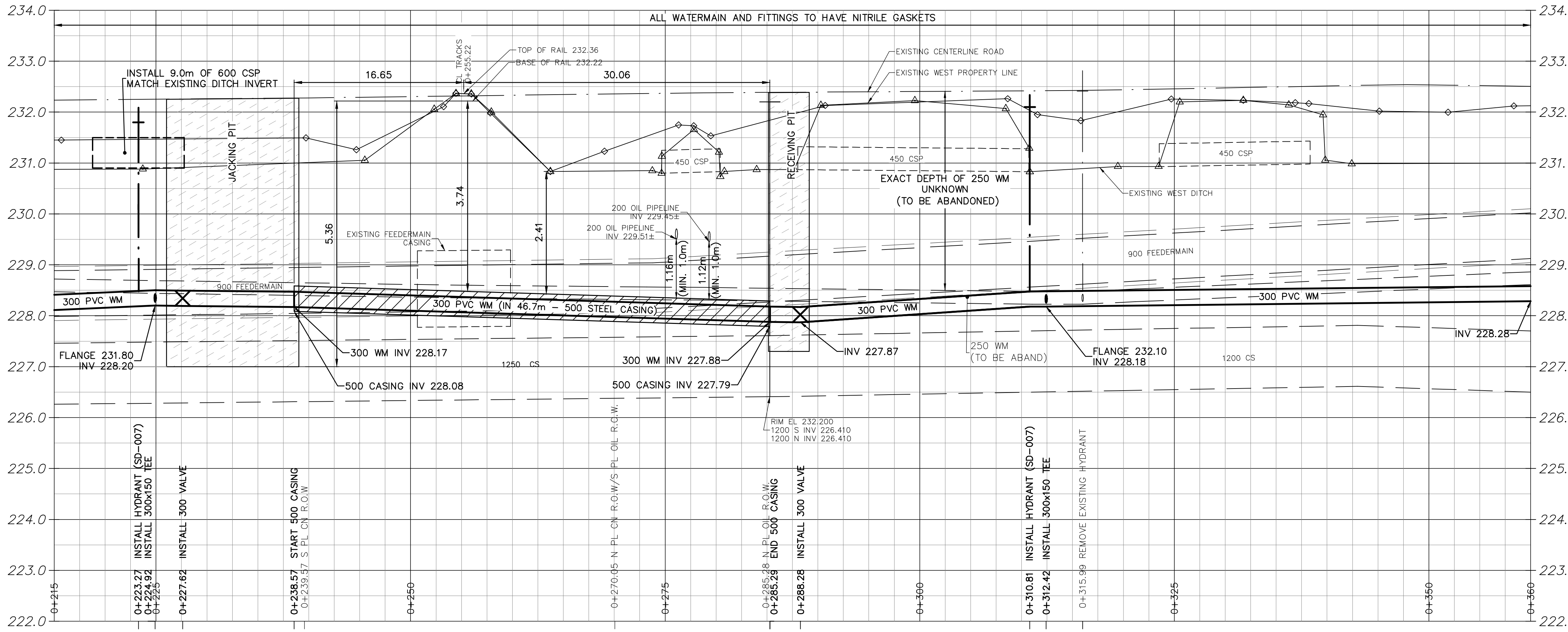
F.L.
ALOBAIDY
Member
41677

March 18, 2020

RH:rz

Appendix A

Drawings

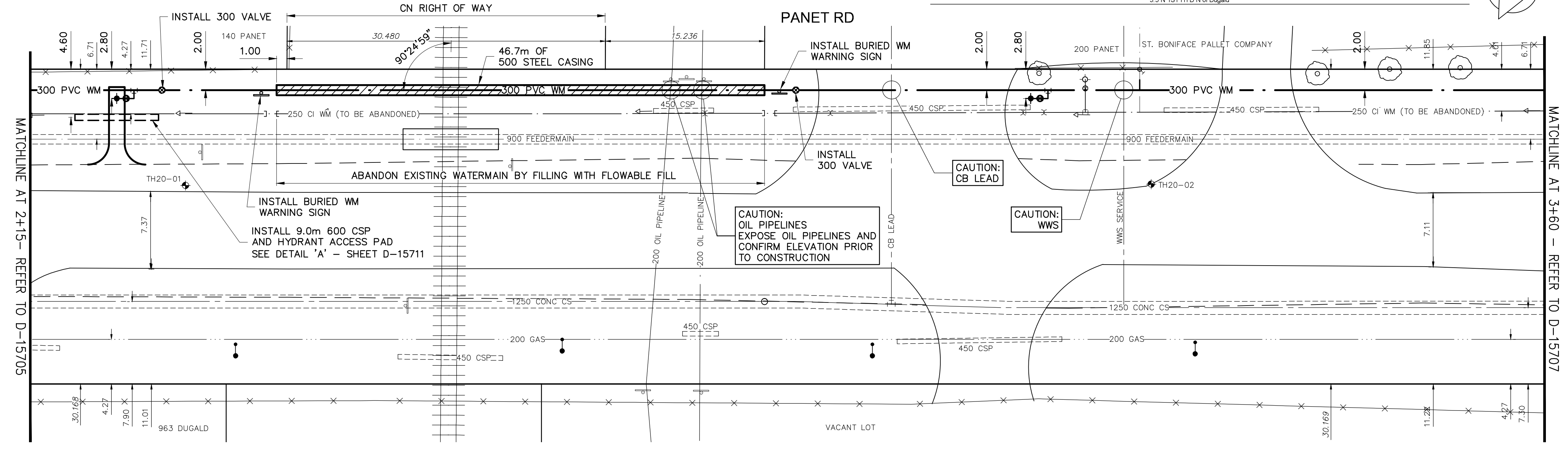


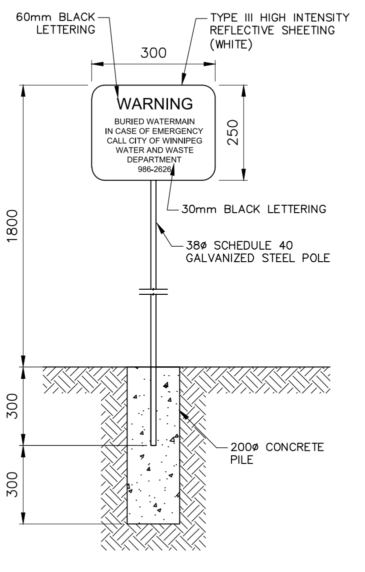
NOTE: CHAINAGES SHOWN ARE ALONG W. ℄ OF PANET RD

NOTE: NOTIFY CONSTRUCTION SERVICES COORDINATOR (CITY OF WINNIPEG) AT 986-4289, 48 HOURS PRIOR TO EXCAVATION NEAR FEEDERMAIN

WATER SERVICE INFORMATION

ADDRESS	SIZE (mm) MATERIAL (STREET)	SIZE (mm) MATERIAL (PROP.)	SHORT & LONG MEASUREMENT	CORP. LOCATION	REMARKS
200 PANET RD	25 mm	25 mm	5.5 N 1ST HYD N of Dugald		





WARNING SIGN DETAIL

NTS

RAIL CROSSING NOTES:

RAILWAY MILEAGE AND SUBDIVISION :		INDUSTRIAL SPUR - OLD BEACH LINE MILE 0.74, OFF MILE 149.63 CN SPRAGUE SUBDIVISION	
MUNICIPAL DESCRIPTION OF ADJACENT PROPERTIES:		PANET ROAD	
NAME OF PIPELINE OWNER:		CITY OF WINNIPEG, WATER AND WASTE DEPARTMENT.204-986-2626	
CONTENTS TO BE HANDLED:			POTABLE WATER
MAXIMUM OPERATING PRESSURE:			450 KPa (65 psi)
MAXIMUM SURGE AND TEST PRESSURE			1000 KPA (145 psi)
MAXIMUM OPERATING TEMPERATURE			20°C
MINIMUM OPERATING TEMPERATURE			4°C
PIPING MATERIALS		CARRIER	CASING
NOMINAL DIAMETER		300 mm	500 mm
OUTSIDE DIAMETER		335 mm	508 mm
MATERIAL		PVC	STEEL
SPECIFICATION AND GRADE		AWWA C900 DR18	MIN. YIELD STRENGTH 241 MPa
WALL THICKNESS		18.6 mm	9.5 mm MIN.
TYPE OF JOINT		RUBBER GASKET BELL AND SPIGOT	WELDED
COATING		NA	NA
LOCATION OF SHUT OFF VALVES	1. 18.2m NORTH OF NORTH LIMIT OF R.O.W. 2. 12.0m SOUTH OF SOUTH LIMIT OF R.O.W.		
METHOD OF INSTALLATION	TRENCHLESS - CASING TO BE JACKED WITH NO SOIL REMOVAL AHEAD OF PIPE		
VENTS:	NA	NUMBER:	NA
	HEIGHT ABOVE GROUND:		NA
SEALS:	BOTH ENDS	YES	
	TYPE:	PERMEABLE GEOTEXTILE FABRIC	
BURY:	BASE OF RAIL TO TOP OF CASING		3.7m
	NOT BENEATH TRACKS		NA
	ROADWAY DITCHES		2.4m
	BASE OF RAIL TO BOTTOM OF JACKING/RECEIVING PITS		5.2m (S) 4.7 (N)

EXTENT OF CASING MEASURED PERPENDICULAR TO CENTERLINE OF TRACK 46.7m

ANGLE OF PIPE / TRACK CROSSING 90°

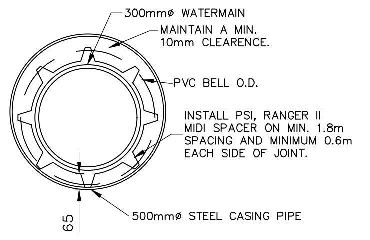
DIRECTION OF FLOW BI-DIRECTIONAL

CENTERLINE OF TRACK TO FACE OF JACKING/RECEIVING PITS 16.4m (S) 29.7m (N)

TYPE, SIZE, AND SPACING OF INSULATORS OR SUPPORTS	PSI RANGER II SPACERS WITH 65mm RUNNER HEIGHT 1.8m O.C.
CATHODIC PROTECTION	NA
GEOTECHNICAL BOREHOLES	REFER TO SOILS REPORT
SOIL TYPE	REFER TO SOILS REPORT
BASE OF RAIL TO GROUND WATER	REFER TO SOILS REPORT

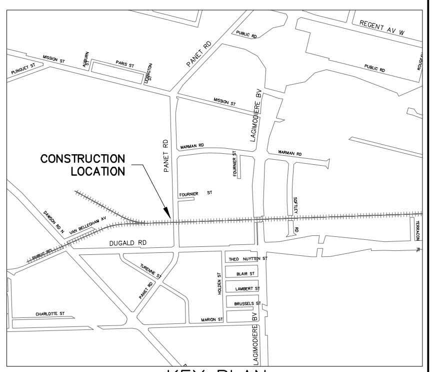
INSTALLATION AND MAINTENANCE TO BE IN ACCORDANCE WITH TC-E10 AND THE LATEST EDITION OF APPLICABLE CSA STANDARD Z662

GEOTECHNICAL ENGINEER EVALUATION HAS BEEN COMPLETED AND THE GEOTECHNICAL ENGINEER HAS DETERMINED THAT BASED ON THE SOIL CONDITIONS, THERE WILL BE NO ADVERSE EFFECTS TO CN OPERATION AND PROPERTY. ENGINEER MUST BE ON SITE DURING CONSTRUCTION.



CASING PIPE DETAIL

NTS



KEY PLAN

ALL VALVES ARE CLOCKWISE TO CLOSE (BLACK OPERATING NUT)

METRIC
WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

0.0 5.0 10.0 15.0 20.0 25.0

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
AECOM Canada Ltd.
No. 4671 Date: March 23/20

REFER TO DRAWING D-15700 FOR CONSTRUCTION NOTES

WARNING

IF POWER EQUIPMENT OR EXPLOSIVES ARE TO BE USED FOR EXCAVATION ON THIS PROJECT THE CONTRACTOR MUST:

1) NOTIFY THE GAS COMPANY OF THE PROPOSED LOCATION OF EXCAVATION.

2) TAKE PRECAUTION TO AVOID DAMAGE TO GAS COMPANY INSTALLATIONS.

SEE PROVINCIAL REGULATION 210/72 FOR DETAILS

LOCATION APPROVED
UNDERGROUND STRUCTURES

SUPV. U/G STRUCTURES COMMITTEE
DATE

NOTE:

LOCATION OF UNDERGROUND STRUCTURES AS SHOWN ARE BASED ON THE BEST INFORMATION AVAILABLE BUT NO GUARANTEE IS GIVEN THAT ALL EXISTING UTILITIES ARE SHOWN OR THAT THE GIVEN LOCATIONS ARE EXACT. CONFIRMATION OF EXISTENCE AND EXACT LOCATION OF ALL SERVICES MUST BE OBTAINED FROM THE INDIVIDUAL UTILITIES BEFORE PROCEEDING WITH CONSTRUCTION.

B.M. 33–014
ELEV. 231.421 m
360 (654360) – S.W. Cor. Mission St. & Panet Rd., Tblt. in 7.6 m Conc. pile, beneath Valve Box, 12.7 mm I.B. on N, side of pile for location purposes only.

NO.	REVISIONS	DATE	BY
D	REVISED OIL PIPELINE CROSSING	20/03/23	GSK
C	ISSUED FOR CONSTRUCTION	20/03/18	GSK
B	ISSUED FOR REVIEW	20/03/18	GSK
A	PRELIMINARY	20/02/13	GSK

AECOM

DESIGNED BY	JP	CHECKED BY	GSK
DRAWN BY	JP	APPROVED BY	KWF
SCALE: HORIZONTAL	1:250	RELEASED FOR CONSTRUCTION	
VERTICAL	1:50		
DATE	2020/03/16	DATE	

PLOT DATE: 2020 03 23

ENGINEER'S SEAL
K.W. FITCHETT
March 23/20

CONSULTANT DRAWING NUMBER
C–0006

TENDER NUMBER: 226–2020
CONTRACT NUMBER: 6

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT
ENGINEERING DIVISION

2020 WATER MAIN RENEWALS
CONTRACT 6

PANET ROAD
FROM 115m N OF DUGALD ROAD TO
7m S OF FOURNIER STREET

SHEET 8 OF 13

CITY DRAWING NUMBER
D–15706

FILE PATH: P:\60624016\900–CAD_GIS\910–CAD\20–SHEETS\C
FILE NAME: C–0005–10

Appendix B

Test Hole Logs

AECOM Canada Ltd.

GENERAL STATEMENT

NORMAL VARIABILITY OF SUBSURFACE CONDITIONS

The scope of the investigation presented herein is limited to an investigation of the subsurface conditions as to suitability for the proposed project. This report has been prepared to aid in the evaluation of the site and to assist the engineer in the design of the facilities. Our description of the project represents our understanding of the significant aspects of the project relevant to the design and construction of earth work, foundations and similar. In the event of any changes in the basic design or location of the structures as outlined in this report or plan, we should be given the opportunity to review the changes and to modify or reaffirm in writing the conclusions and recommendations of this report.

The analysis and recommendations presented in this report are based on the data obtained from the borings and test pit excavations made at the locations indicated on the site plans and from other information discussed herein. This report is based on the assumption that the subsurface conditions everywhere are not significantly different from those disclosed by the borings and excavations. However, variations in soil conditions may exist between the excavations and, also, general groundwater levels and conditions may fluctuate from time to time. The nature and extent of the variations may not become evident until construction. If subsurface conditions differ from those encountered in the exploratory borings and excavations, are observed or encountered during construction, or appear to be present beneath or beyond excavations, we should be advised at once so that we can observe and review these conditions and reconsider our recommendations where necessary.

Since it is possible for conditions to vary from those assumed in the analysis and upon which our conclusions and recommendations are based, a contingency fund should be included in the construction budget to allow for the possibility of variations which may result in modification of the design and construction procedures.

In order to observe compliance with the design concepts, specifications or recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated, we recommend that all construction operations dealing with earth work and the foundations be observed by an experienced soils engineer. We can be retained to provide these services for you during construction. In addition, we can be retained to review the plans and specifications that have been prepared to check for substantial conformance with the conclusions and recommendations contained in our report.

EXPLANATION OF FIELD & LABORATORY TEST DATA

The field and laboratory test results, as shown for each hole, are described below.

1. NATURAL MOISTURE CONTENT

The relationship between the natural moisture content and depth is significant in determining the subsurface moisture conditions. The Atterberg Limits for a sample should be compared to its natural moisture content and plotted on the Plasticity Chart in order to determine the soil classification.

2. SOIL PROFILE AND DESCRIPTION

Each soil stratum is classified and described noting any special conditions. The Modified Unified Classification System (MUCS) is used. The soil profile refers to the existing ground level at the time the hole was done. Where available, the ground elevation is shown. The soil symbols used are shown in detail on the soil classification chart.

3. TESTS ON SOIL SAMPLES

Laboratory and field tests are identified by the following and are on the logs:

N - Standard Penetration Test (SPT) Blow Count. The SPT is conducted in the field to assess the in-situ consistency of cohesive soils and the relative density of non-cohesive soils. The N value recorded is the number of blows from a 63.5 kg hammer dropped 760 mm which is required to drive a 51 mm split spoon sampler 300 mm into the soil.

SO_4 - Water Soluble Sulphate Content. Expressed in percent. Conducted primarily to determine requirements for the use of sulphate resistant cement. Further details on the water-soluble sulphate content are given in Section 6.

γ_D - Dry Unit Weight. Usually expressed in kN/m^3.

γ_T - Total Unit Weight. Usually expressed in kN/m^3.

Q_U - Unconfined Compressive Strength. Usually expressed in kPa and may be used in determining allowable bearing capacity of the soil.

C_U - Undrained Shear Strength. Usually expressed in kPa. This value is determined by either a direct shear test or by an unconfined compression test and may also be used in determining the allowable bearing capacity of the soil.

C_{PEN} - Pocket Penetrometer Reading. Usually expressed in kPa. Estimate of the undrained shear strength as determined by a pocket penetrometer.

The following tests may also be performed on selected soil samples and the results are given on separate sheets enclosed with the logs:

- Grain Size Analysis
- Standard or Modified Proctor Compaction Test
- California Bearing Ratio Test
- Direct Shear Test
- Permeability Test
- Consolidation Test
- Triaxial Test

4. SOIL DENSITY AND CONSISTENCY

The SPT test described above may be used to estimate the consistency of cohesive soils and the density of cohesionless soils. These approximate relationships are summarized in the following tables:

Table 1 Cohesive Soils

N	Consistency	C_u (kPa) approx.
0 - 1	Very Soft	<10
1 - 4	Soft	10 - 25
4 - 8	Firm	25 - 50
8 - 15	Stiff	50 - 100
15 - 30	Very Stiff	100 - 200
30 - 60	Hard	200 - 300
>60	Very Hard	>300

Table 2 Cohesionless Soils

N	Density
0 - 5	Very Loose
5 - 10	Loose
10 - 30	Compact
30 - 50	Dense
>50	Very Dense

5. SAMPLE CONDITION AND TYPE

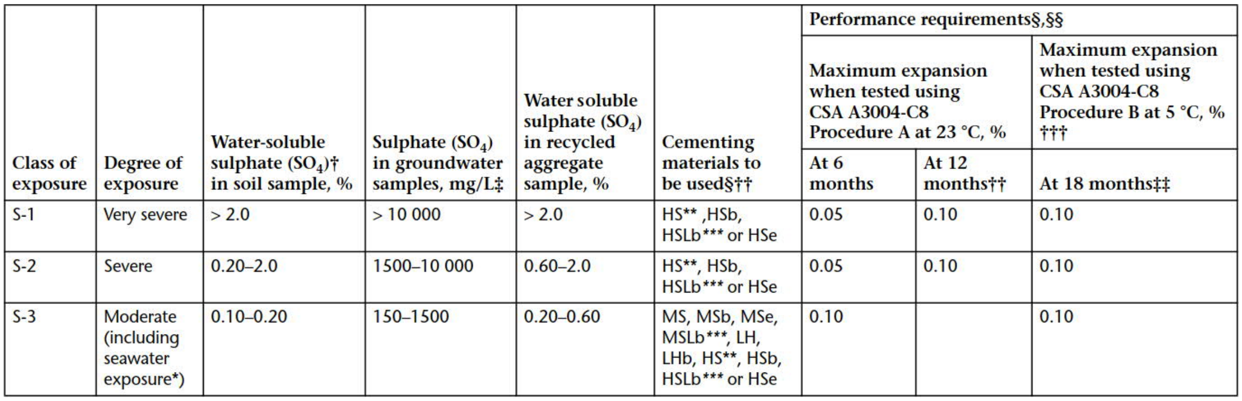
The depth, type, and condition of samples are indicated on the logs by the following symbols:

■ Grab
▤ Bulk
⧄ No Recovery
▥ Shelby Tube
☒ Split Spoon
◫ Core Sample

6. WATER SOLUBLE SULPHATE CONCENTRATION

The following table, from CSA Standard A23.1-14, indicates the requirements for concrete subjected to sulphate attack based upon the percentage of water-soluble sulphate as presented on the logs. CSA Standard A23.1-14 should be read in conjunction with the table.

Table 3 Requirements for Concrete Subjected to Sulphate Attack*



Class of exposure	Degree of exposure	Water-soluble sulphate (SO_4)† in soil sample, %	Sulphate (SO_4) in groundwater samples, mg/L‡	Water soluble sulphate (SO_4) in recycled aggregate sample, %	Cementing materials to be used§††	Performance requirements§,§§		
						Maximum expansion when tested using CSA A3004-C8 Procedure A at 23 °C, %		Maximum expansion when tested using CSA A3004-C8 Procedure B at 5 °C, % †††
						At 6 months	At 12 months††	At 18 months‡‡
S-1	Very severe	> 2.0	> 10 000	> 2.0	HS** ,HSb, HSLb*** or HSe	0.05	0.10	0.10
S-2	Severe	0.20–2.0	1500–10 000	0.60–2.0	HS**, HSb, HSLb*** or HSe	0.05	0.10	0.10
S-3	Moderate (including seawater exposure*)	0.10–0.20	150–1500	0.20–0.60	MS, MSb, MSe, MSLb***, LH, LHb, HS**, HSb, HSLb*** or HSe	0.10		0.10

*For sea water exposure, also see Clause 4.1.1.5.
†In accordance with CSA A23.2-3B.
‡In accordance with CSA A23.2-2B.
§Where combinations of supplementary cementing materials and portland or blended hydraulic cements are to be used in the concrete mix design instead of the cementing materials listed, and provided they meet the performance requirements demonstrating equivalent performance against sulphate exposure, they shall be designated as MS equivalent (MSe) or HS equivalent (HSe) in the relevant sulphate exposures (see Clauses 4.1.1.6.2, 4.2.1.1, and 4.2.1.3, and 4.2.1.4).
**Type HS cement shall not be used in reinforced concrete exposed to both chlorides and sulphates, including seawater. See Clause 4.1.1.6.3.

††The requirement for testing at 5 °C does not apply to MS, HS, MSb, HSb, and MSe and HSe combinations made without portland limestone cement.

‡‡ If the increase in expansion between 12 and 18 months exceeds 0.03%, the sulphate expansion at 24 months shall not exceed 0.10% in order for the cement to be deemed to have passed the sulphate resistance requirement.

§§For demonstrating equivalent performance, use the testing frequency in Table 1 of CSA A3004-A1 and see the applicable notes to Table A3 in A3001 with regard to re-establishing compliance if the composition of the cementing materials used to establish compliance changes.

***Where MSLb or HSLb cements are proposed for use, or where MSe or HSe combinations include Portland-limestone cement, they must also contain a minimum of 25% Type F fly ash or 40% slag or 15% metakaolin (meeting Type N pozzolan requirements) or a combination of 5% Type SF silica fume with 25% slag or a combination of 5% Type SF silica fume with 20% Type F fly ash. For some proposed MSLb, HSLb, and MSe or HSe combinations that include Portland-limestone cement, higher SCM replacement levels may be required to meet the A3004-C8 Procedure B expansion limits. Due to the 18-month test period, SCM replacements higher than the identified minimum levels should also be tested. In addition, sulphate resistance testing shall be run on MSLb and HSLb cement and MSe or HSe combinations that include Portland-limestone cement at both 23 °C and 5 °C as specified in the table.

†††If the expansion is greater than 0.05% at 6 months but less than 0.10% at 1 year, the cementing materials combination under test shall be considered to have passed.

7. SOIL CORROSIVITY

The following table, from the Handbook of Corrosion Engineering (Roberge, 1999) indicates the corrosivity rating can be obtained from the soil resistivity, presented on the logs.

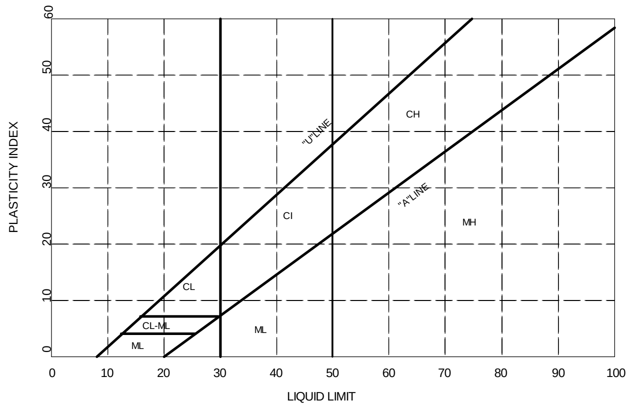
Table 4 Corrosivity Ratings Based on Soil Resistivity

Soil Resistivity (ohm-cm)	Corrosivity Rating
>20,000	Essentially non-corrosive
10,000 – 20,000	Mildly corrosive
5,000 – 10,000	Moderately corrosive
3,000 – 5,000	Corrosive
1,000 – 3,000	Highly corrosive
<1,000	Extremely corrosive

8. GROUNDWATER TABLE

The groundwater table is indicated by the equilibrium level of water in a standpipe installed in a testhole or test pit. This level is generally taken at least 24 hours after installation of the standpipe. The groundwater level is subject to seasonal variations and is usually highest in the spring. The symbol on the logs indicating the groundwater level is an inverted solid triangle (▼).

MAJOR DIVISION			LOG SYMBOLS	UCS	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
COARSE GRAINED SOILS	GRAVELS (MORE THAN HALF COARSE GRAINS LARGER THAN 4.75 mm)	CLEAN GRAVELS (LITTLE OR NO FINES)	△	GW	WELL GRADED GRAVELS, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 4$ $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
			▲	GP	POORLY GRADED GRAVELS AND GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		GRAVELS WITH FINES	▥	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW 'A' LINE W_p LESS THAN 4
			▨	GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE 'A' LINE W_p MORE THAN 7
	SANDS (MORE THAN HALF COARSE GRAINS SMALLER THAN 4.75 mm)	CLEAN SANDS (LITTLE R NO FINES)	○	SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 6$ $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
			○	SP	POORLY GRADED SANDS, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		SANDS WITH FINES	▥	SM	SILTY SANDS, SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW 'A' LINE W_p LESS THAN 4
			▨	SC	CLAYEY SANDS, SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE 'A' LINE W_p MORE THAN 7
FINE GRAINED SOILS	SILTS (BELOW 'A' LINE NEGLIGIBLE ORGANIC CONTENT)	$W_L < 50$	▥	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (SEE BELOW)	
		$W_L > 50$	▥	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS		
	CLAYS (ABOVE 'A' LINE NEGLIGIBLE ORGANIC CONTENT)	$W_L < 30$	▨	CL	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS	WHENEVER THE NATURE OF THE FINE CONTENT HAS NOT BEEN DETERMINED, IT IS DESIGNATED BY THE LETTER 'F'. E.G. SF IS A MIXTURE OF SAND WITH SILT OR CLAY	
		$30 < W_L < 50$	▨	CI	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS		
		$W_L > 50$	▨	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS		
	ORGANIC SILTS & CLAYS (BELOW 'A' LINE)	$W_L < 50$	▥	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY		
		$W_L > 50$	▨	OH	ORGANIC CLAYS OF HIGH PLASTICITY		
HIGHLY ORGANIC SOILS			⋀	Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOUR OR ODOUR, AND OFTEN FIBROUS TEXTURE	
BEDROCK			▤	BR	SEE REPORT DESCRIPTION		
FILL			▩	FILL	SEE REPORT DESCRIPTION		



NOTE:

1. BOUNDARY CLASSIFICATION POSSESSING CHARACTERISTICS OF TWO GROUPS ARE GIVEN GROUP SYMBOLS, E.G. GW-GC IS A WELL GRADED GRAVEL MIXTURE WITH CLAY BINDER BETWEEN 5% AND 12%

SOIL COMPONENTS

FRACTION		SIEVE SIZE (mm)		DEFINING RANGES OF PERCENTAGE BY WEIGHT OF MINOR COMPONENTS	
		PASSING	RETAINED	PERCENT	IDENTIFIER
GRAVEL	COARSE	75	19	50 - 35	AND
	FINE	19	4.75		
SAND	COARSE	4.75	2.00	35 – 20	_____Y
	MEDIUM	2.00	0.425		
	FINE	0.425	0.080	20 – 10	SOME
SILT (non-plastic) or CLAY (plastic)		0.080		10 - 1	TRACE

OVERSIZE MATERIALS

ROUNDED OR SUB-ROUNDED COBBLES 75 mm TO 200 mm BOULDERS >200 mm	ANGULAR ROCK FRAGMENTS ROCKS > 0.75 m3 IN VOLUME

MODIFIED UNIFIED SOIL CLASSIFICATION SYSTEM

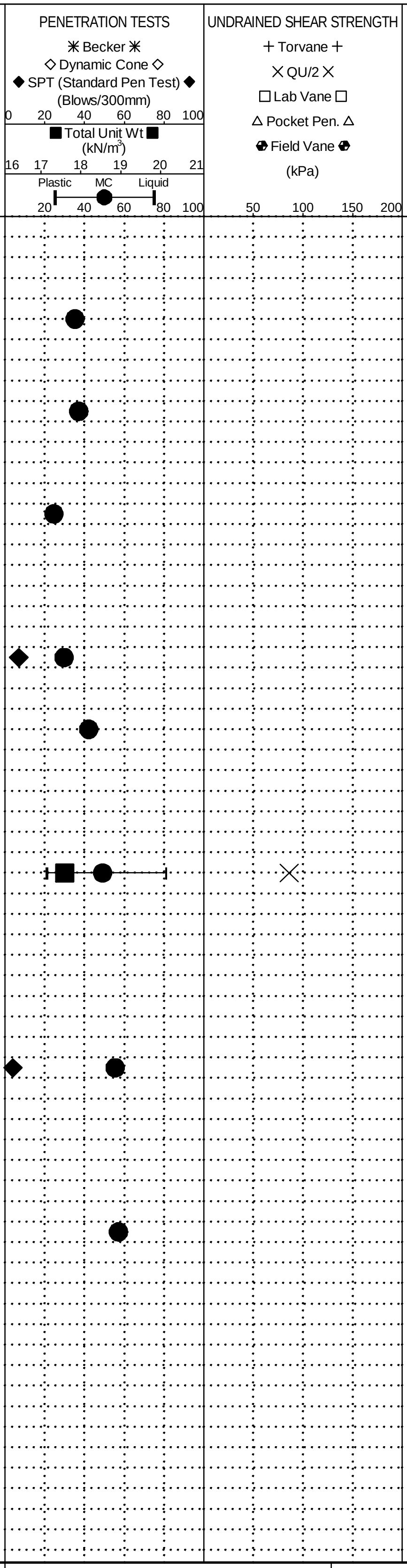
August 2015

PROJECT: 2020 Watermain Renewals - Panet Road	CLIENT: City of Winnipeg	TESTHOLE NO: TH20-01
LOCATION: UTM 14 - 5527863 m N, 637979 m E		PROJECT NO.: 60624016
CONTRACTOR: Maple Leaf Drilling	METHOD: Geoprobe - 125 mm SSA's	ELEVATION (m): 232.24

SAMPLE TYPE ■ GRAB ▥ SHELBY TUBE ☒ SPLIT SPOON ☰ BULK ▨ NO RECOVERY ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁘ GRAVEL ▥ SLOUGH ⁙ GROUT ▨ CUTTINGS ⁘ SAND

DEPTH (m)	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	COMMENTS	ELEVATION
0	FILL	GRANULAR (Fill) - dark brown, frozen					232
	FILL	CLAY (Fill) - silty, some sand, trace gravel - dark brown mottled grey, frozen	■	G1			
1	CH	CLAY - silty, trace to some sand - dark grey, firm to stiff, moist - high plasticity	■	G2			231
2	ML	SILT - some clay, trace sand - light brown, soft, moist - low plasticity	■	G3			230
	CH	CLAY - silty - brown mottled grey, firm, moist - high plasticity					
3	ML	SILT - some clay, trace sand - light brown, soft, moist - low plasticity	☒	S4	7	SPT Blows: [3/4/3], Spoon Recovery: 50%	229
	CH	CLAY - silty - brown mottled grey, firm to stiff, moist - high plasticity	■	G5			
4							228
5		- grey below 4.6 m	▥	T6		Tube Recovery: 100%, (T6): Gravel 0.0%, Sand 0.2%, Silt 26.9%, Clay 72.9%	227
6	CH	- soft to firm below 6.1 m	☒	S7	4	SPT Blows: [0/0/4], Spoon Recovery: 50%	226
7			■	G8			225
8		END OF TEST HOLE AT 7.62 m IN CLAY					224
9							223
10							



END OF TEST HOLE AT 7.62 m IN CLAY

Notes:

1. Seepage not observed during drilling.
2. Sloughing not observed during drilling.
3. Test hole backfilled with sand from 7.6 m to 6.6 m, bentonite from 6.6 m to 6.0 m, auger cuttings from 6.0 m to 0.6 m, and sand from 0.6 m to 0.3 m. Flush-mount cover installed.
7. Groundwater monitoring:
   - March 4, 2020 at elev. 226.15 m (6.09 m bgs)

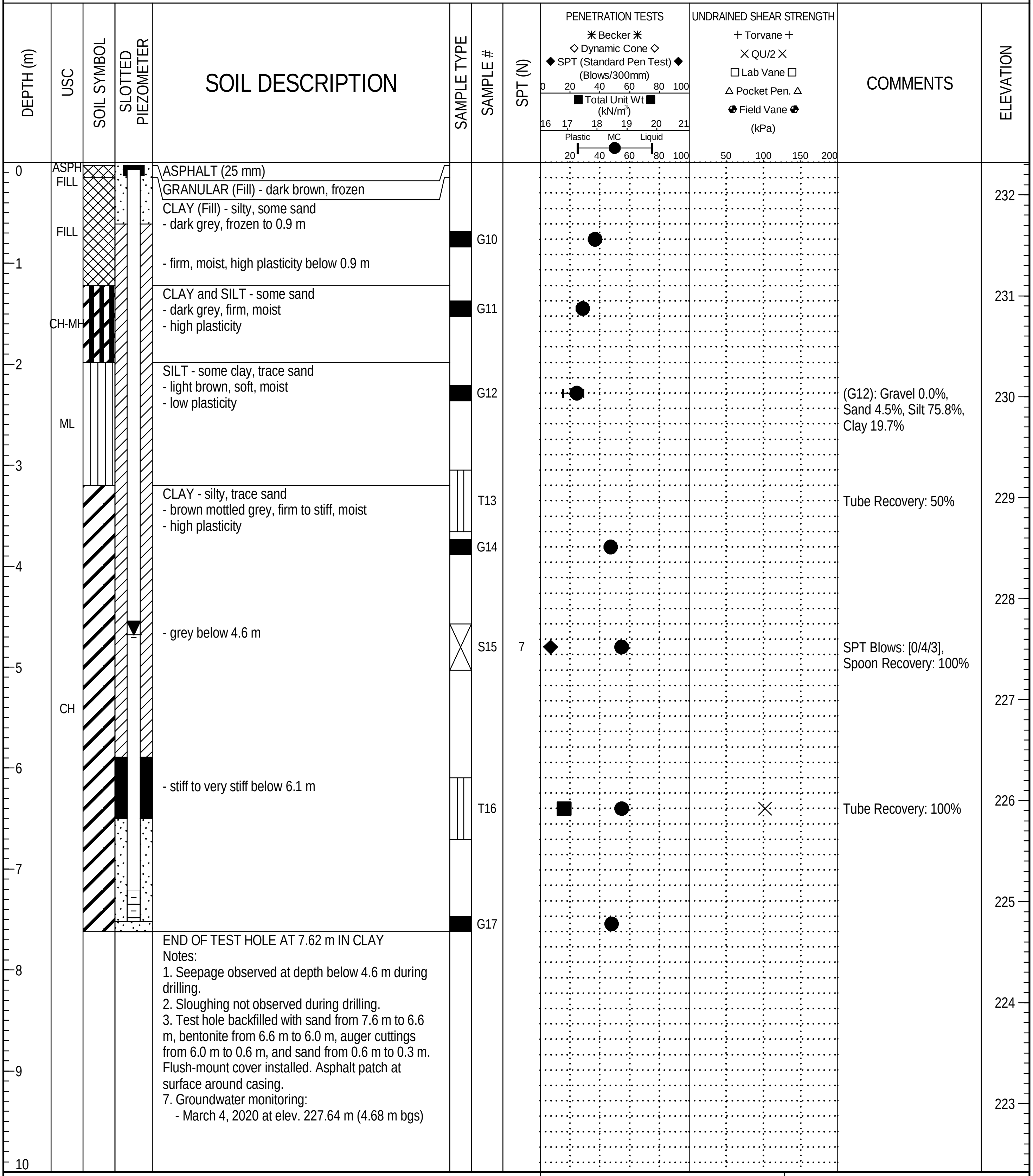
LOGGED BY: Ryan Harras	COMPLETION DEPTH: 7.62 m
REVIEWED BY: Faris Alobaidy	COMPLETION DATE: 2/14/20
PROJECT ENGINEER: Greg Karman	Page 1 of 1

AECOM

PROJECT: 2020 Watermain Renewals - Panet Road	CLIENT: City of Winnipeg	TESTHOLE NO: TH20-02
LOCATION: UTM 14 - 5527954 m N, 637976 m E		PROJECT NO.: 60624016
CONTRACTOR: Maple Leaf Drilling	METHOD: Geoprobe - 125 mm SSA's	ELEVATION (m): 232.32

SAMPLE TYPE ■ GRAB ▥ SHELBY TUBE ☒ SPLIT SPOON ☰ BULK ◿ NO RECOVERY ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁘ GRAVEL ▥ SLOUGH ▨ GROUT ◿ CUTTINGS ⁘ SAND



ASPHALT (25 mm)

GRANULAR (Fill) - dark brown, frozen

CLAY (Fill) - silty, some sand
- dark grey, frozen to 0.9 m
- firm, moist, high plasticity below 0.9 m

CLAY and SILT - some sand
- dark grey, firm, moist
- high plasticity

SILT - some clay, trace sand
- light brown, soft, moist
- low plasticity

CLAY - silty, trace sand
- brown mottled grey, firm to stiff, moist
- high plasticity
- grey below 4.6 m
- stiff to very stiff below 6.1 m

END OF TEST HOLE AT 7.62 m IN CLAY
Notes:
1. Seepage observed at depth below 4.6 m during drilling.
2. Sloughing not observed during drilling.
3. Test hole backfilled with sand from 7.6 m to 6.6 m, bentonite from 6.6 m to 6.0 m, auger cuttings from 6.0 m to 0.6 m, and sand from 0.6 m to 0.3 m. Flush-mount cover installed. Asphalt patch at surface around casing.
7. Groundwater monitoring:
- March 4, 2020 at elev. 227.64 m (4.68 m bgs)

■	G10		
■	G11		
■	G12		(G12): Gravel 0.0%, Sand 4.5%, Silt 75.8%, Clay 19.7%
▥	T13		Tube Recovery: 50%
■	G14		
☒	S15	7	SPT Blows: [0/4/3], Spoon Recovery: 100%
▥	T16		Tube Recovery: 100%
■	G17		

LOGGED BY: Ryan Harras	COMPLETION DEPTH: 7.62 m
REVIEWED BY: Faris Alobaidy	COMPLETION DATE: 2/14/20
PROJECT ENGINEER: Greg Karman	Page 1 of 1

Appendix C

Laboratory Testing Results

AECOM
99 Commerce Drive
Winnipeg, MB, Canada R3P 0Y7
www.aecom.com

204 477 5381 tel
204 284 2040 fax

Memorandum

To	Ryan Harras	Page	1
CC			
Subject	2020 Watermain Renewals C6 – City of Winnipeg –Test Results		
From	Elliott E. Drumright		
Date	March 03, 2020	Project Number	60624016.10

Please find attached the following material test result(s) on sample(s) submitted to the Winnipeg Geotechnical Laboratory:

- Twelve (12) Moisture Content Determination test.

If you have any questions, please contact the undersigned.

Sincerely,

Elliott E. Drumright

Elliott E. Drumright, Ph.D.
Associate Geotechnical Engineer

Att.

AECOM Canada Ltd.
Winnipeg Geotechnical Laboratory
99 Commerce Drive
Winnipeg, Manitoba
R3P 0Y7
Phone: 204 477 5381 Fax: 204 284 2040

Project Name:	2020 Watermain Renewals C6	Supplier:	AECOM
Project Number:	60624016	Specification:	N/A
Client:	City of Winnipeg	Field Technician:	RHarras
Sample Location:	Varies	Sample Date:	February 14, 2020
Sample Depth:	Varies	Lab Technician:	EManimbao
Sample Number:	Varies	Date Tested:	February 18, 2020

Moisture Content (ASTM D2216-10)

Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

Location	Sample	Depth (m)	**Moisture Content (%)**
TH20-01	G1	0.76 - 0.91 m	**35.2%**
	G2	1.52 - 1.68 m	**37.1%**
	G3	2.29 - 2.44 m	**24.6%**
	S4	3.05 - 3.51 m	**29.7%**
	G5	3.81 - 3.96 m	**42.1%**
	T6	4.57 - 5.18 m	**-**
	S7	6.10 - 6.55 m	**55.4%**
	G8	7.62 - 7.77 m	**57.1%**
TH20-02	G10	0.76 - 0.91 m	**36.8%**
	G11	1.52 - 1.68 m	**28.5%**
	G12	2.29 - 2.44 m	**-**
	T13	3.05 - 3.66 m	**-**
	G14	3.81 - 3.96 m	**47.3%**
	S15	4.57 - 5.03 m	**54.6%**
	T16	6.10 - 6.71 m	**-**
	G17	7.62 - 7.77 m	**47.9%**

Location	Sample	Depth (m)	**Moisture Content (%)**

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CONSULTING LTD.

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Email: hmanalo@mts.net

MOISTURE CONTENT OF SOIL (ASTM D2216)

CLIENT:	AECOM	TEST NO:	20- 001	PROJECT NO:	112-2004
PROJECT:	2020 WM Renewals	DATE SAMPLED:	14-Feb-2020	SAMPLED BY:	Client
PROJECT CONTACT:	Ryan Harras	DATE TESTED:	19-Feb-2020	TESTED BY:	Reynand Coronel
TEST LOCATION:	Panet Road				

Description	20-01				
Sample	T6 - 15'				
Wt Wet Sample + Tare	1,830.20				
Wt Dry Sample + Tare	1,356.40				
Wt Water	473.80				
Wt Tare	392.10				
Wt Dry Sample	964.30				
Moisture Content (%)	**49.1**				

Description	20-02	20-02			
Sample	G12 - 7.5'	T16 - 20'			
Wt Wet Sample + Tare	1,983.90	1,143.60			
Wt Dry Sample + Tare	1,671.30	962.20			
Wt Water	312.60	181.40			
Wt Tare	393.00	630.80			
Wt Dry Sample	1,278.30	331.40			
Moisture Content (%)	**24.5**	**54.7**			

Description					
Sample					
Wt Wet Sample + Tare					
Wt Dry Sample + Tare					
Wt Water					
Wt Tare					
Wt Dry Sample					
Moisture Content (%)					

Description					
Sample					
Wt Wet Sample + Tare					
Wt Dry Sample + Tare					
Wt Water					
Wt Tare					
Wt Dry Sample					
Moisture Content (%)					

MTR/Disptach No: MTR 1531

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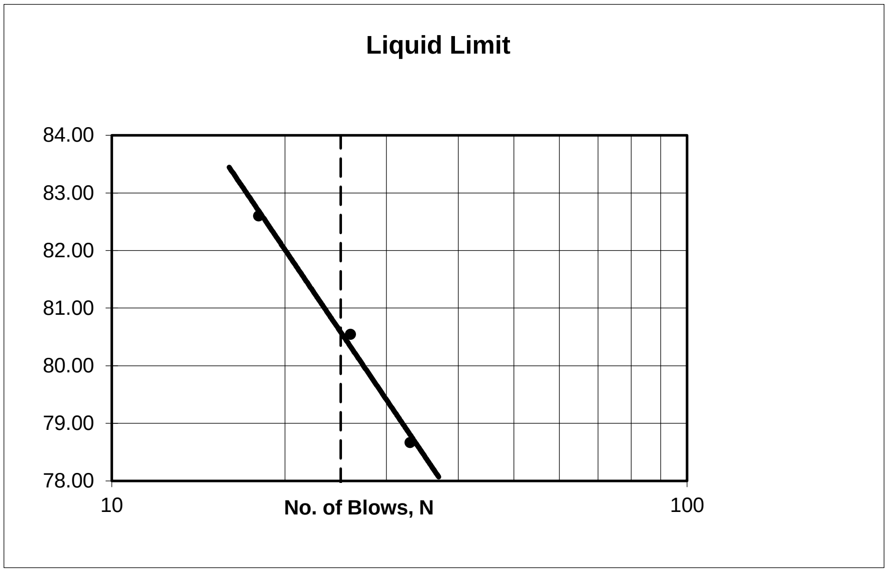
Atterberg Limits (ASTM D4318)

Client: AECOM
99 Commerce Drive
Winnipeg MB R3P 0Y7
Attention.: Ryan Harras
Project: 2020 WM Renewals (60624016)
Panet Rd, Winnipeg, MB

PROJECT No.: 112-2004
PI Test No.: 1
LAB No.: HM 39
Date Received: 18-Feb-20
Date Tested / By: 3-Mar-20 / RC

Liquid Limit Determination

Dish No.:	1	2	3		Liquid Limit 25 Blows
Wet Soil + Dish:	59.06	58.53	59.84		
Dry Soil + Dish:	50.94	50.62	51.43		
Moisture:	8.12	7.91	8.41		
Dish:	41.11	40.80	40.74		
Dry Soil:	9.83	9.82	10.69		
% Moisture:	82.60	80.55	78.67		
No. of Blows:	18	26	33		
Liquid Limits:					**81**



Material Identification:

T.H./B.H. No. **20-01 (T6)**

Depth: **15.0'**

Liquid Limit, %: **81**
Plastic Limit, %: **21**
Plasticity Index: **60**
(LL-PL)

Plastic Limit Determination

Dish No.:	1	2	3		
Wet Soil + Dish:	46.49	46.69	47.03		
Dry Soil + Dish:	45.46	45.67	46.01		
Moisture:	1.03	1.02	1.02		
Dish:	40.57	40.85	41.17		
Dry Soil:	4.89	4.82	4.84		
% Moisture:	21.06	21.16	21.07		
Average:					**21**

Test Method : ASTM: D4318, D2216

P. Bevel

Reviewed by: Paul Bevel

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1402 Notre Dame Avenue, Winnipeg, MB R3E
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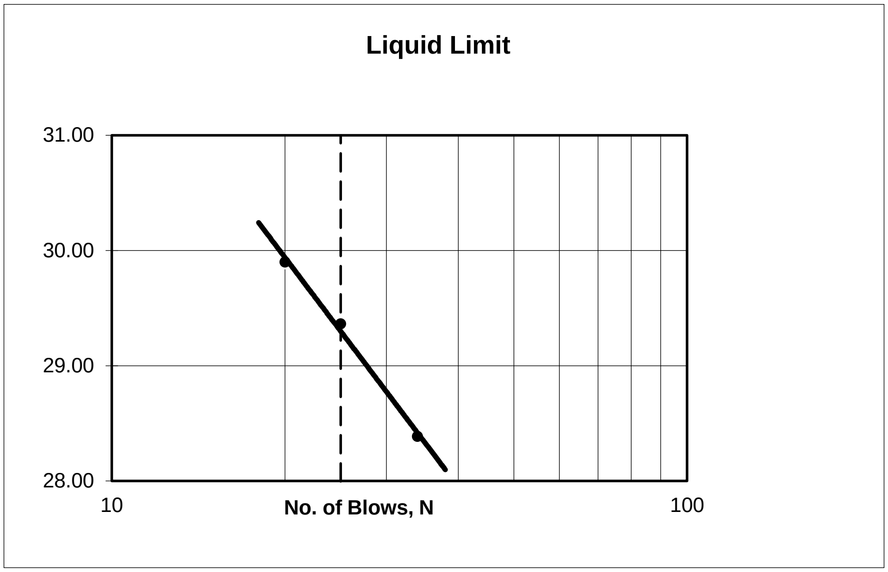
hmanalo@mts.net

Atterberg Limits (ASTM D4318)

Client:	AECOM 99 Commerce Drive Winnipeg MB R3P 0Y7	PROJECT No.:	112-2004
		PI Test No.:	2
		LAB No.:	HM 39
Attention.:	Ryan Harras	Date Received:	18-Feb-20
Project:	2020 WM Renewals (60624016) Panet Rd, Winnipeg, MB	Date Tested / By:	3-Mar-20 / RC

Liquid Limit Determination

Dish No.:	1	2	3		Liquid Limit 25 Blows
Wet Soil + Dish:	52.52	50.80	52.16		
Dry Soil + Dish:	49.79	48.58	49.71		
Moisture:	2.73	2.22	2.45		
Dish:	40.66	41.02	41.08		
Dry Soil:	9.13	7.56	8.63		
% Moisture:	29.90	29.37	28.39		
No. of Blows:	20	25	34		
Liquid Limits:					**29**



Material Identification:

T.H./B.H. No.	**20-02 (G12)**
Depth:	**7.5'**
Liquid Limit, %:	**29**
Plastic Limit, %:	**15**
Plasticity Index: (LL-PL)	**14**

Plastic Limit Determination

Dish No.:	1	2	3		
Wet Soil + Dish:	48.65	49.87	49.01		
Dry Soil + Dish:	47.68	48.71	48.01		
Moisture:	0.97	1.16	1.00		
Dish:	41.04	40.76	41.19		
Dry Soil:	6.64	7.95	6.82		
% Moisture:	14.61	14.59	14.66		
Average:					**15**

Test Method : ASTM: D4318, D2216

P. Bevel

Reviewed by: Paul Bevel

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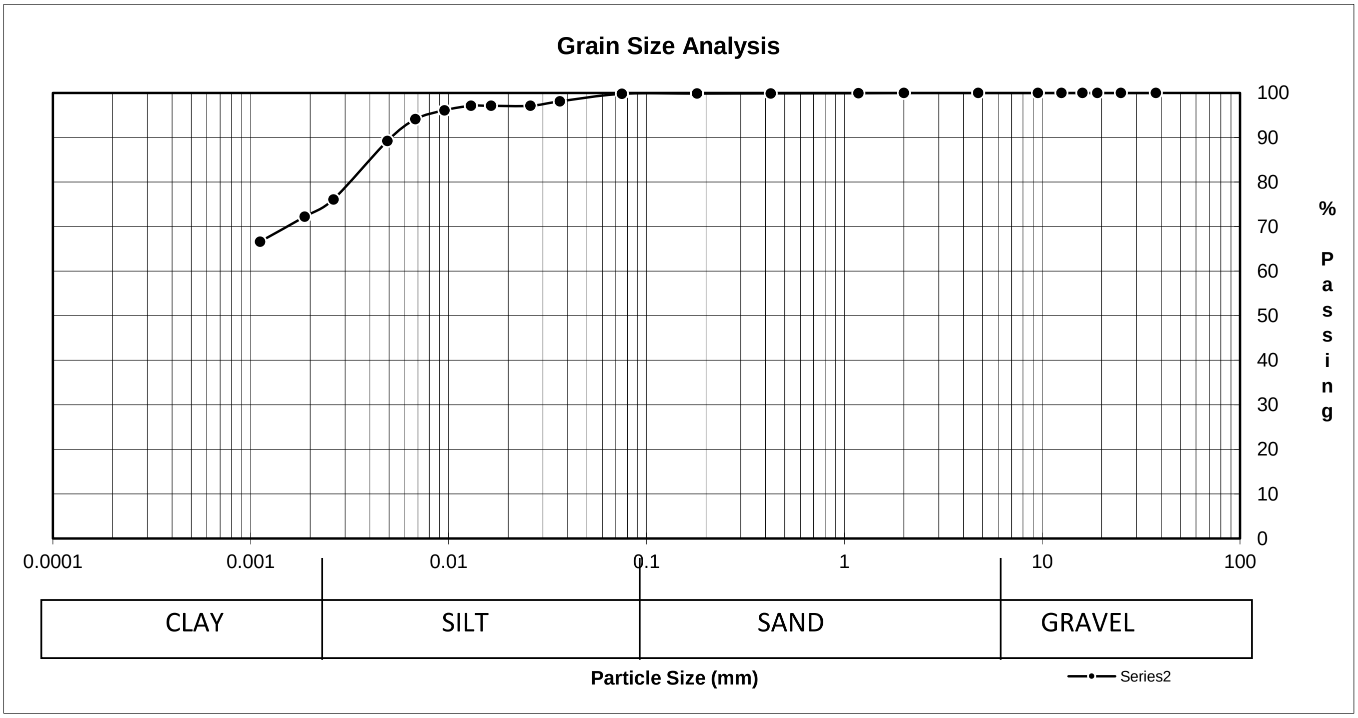
PARTICLE SIZE ANALYSIS OF SOILS TEST REPORT

CLIENT:	AECOM 99 Commerce Drive Winnipeg MB R3P 0Y7	PROJECT No.: PSA Test No.: LAB No.:	112-2004 1 HM 39
ATTENTION:	Ryan Harras		
PROJECT:	2020 WM Renewals (60624016) Panet Rd, Winnipeg, MB		
Date Sampled:	14-Feb-20	Date Received:	18-Feb-20
Sampled By:	Client	Date Tested:	3-Mar-20

Material Identification
B.H./T.H. No.: 20-01
Sample No.: **T6**
Sample Source: Winnipeg, MB
Specific Gravity of Material: 2.65

Sieve Analysis		Hydrometer Analysis	
Sieve (mm)	% Passing	Diameter	% Finer
50.00	100.0		
37.50	100.0		
25.00	100.0		
19.00	100.0		
16.00	100.0		
12.50	100.0	0.0365	98.1
9.50	100.0	0.0259	97.1
4.75	100.0	0.0164	97.1
2.00	100.0	0.0130	97.1
1.18	99.9	0.0095	96.1
0.425	99.9	0.0068	94.1
0.180	99.9	0.0049	89.2
0.075	99.8	0.0011	66.6



SOIL DESCRIPTION	% Composition		
		Gravel	D10
	0.2	Sand	D30
	26.9	Silt	D60
	72.9	Clay	Cu
			Cc

Remarks: Test Method: ASTM D7928, D2216, D4318

Technician: RC

P. Bevel

Reviewed by: Paul Bevel

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1402 Notre Dame Avenue, Winnipeg, MB R3E 3G5
Phone: 204 697 3854 Cell: 204 997-1355
hmanalo@mts.net

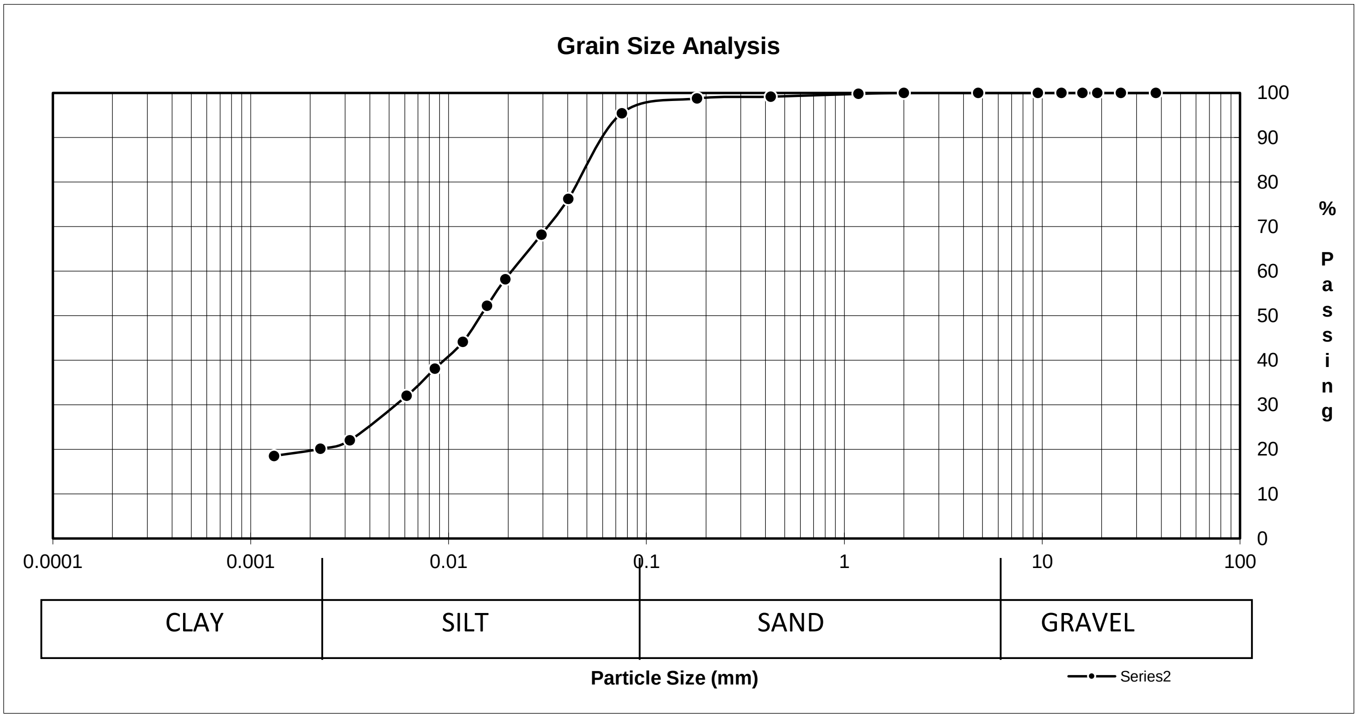
PARTICLE SIZE ANALYSIS OF SOILS TEST REPORT

CLIENT:	AECOM 99 Commerce Drive Winnipeg MB R3P 0Y7	PROJECT No.:	112-2004
		PSA Test No.:	2
		LAB No.:	HM 39
ATTENTION:	Ryan Harras		
PROJECT:	2020 WM Renewals (60624016) Panet Rd, Winnipeg, MB		

Date Sampled:	14-Feb-20	Date Received:	18-Feb-20
Sampled By:	Client	Date Tested:	3-Mar-20

Material Identification
B.H./T.H. No.: 20-02
Sample No.: **G12**
Sample Source: Winnipeg, MB
Specific Gravity of Material: 2.65

Sieve Analysis		Hydrometer Analysis	
Sieve (mm)	% Passing	Diameter	% Finer
50.00	100.0		
37.50	100.0		
25.00	100.0		
19.00	100.0		
16.00	100.0		
12.50	100.0	0.0403	76.2
9.50	100.0	0.0294	68.2
4.75	100.0	0.0194	58.2
2.00	100.0	0.0156	52.2
1.18	99.8	0.0118	44.1
0.425	99.2	0.0085	38.1
0.180	98.8	0.0061	32.0
0.075	95.5	0.0013	18.5



SOIL DESCRIPTION	% Composition		
		Gravel	D10
	4.5	Sand	D30
	75.8	Silt	D60
	19.7	Clay	Cu
			Cc

Remarks: Test Method: ASTM D7928, D2216, D4318

Technician: RC

P. Bevel

Reviewed by: Paul Bevel

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UNCONFINED COMPRESSIVE STRENGTH TEST REPORT

CLIENT: AECOM
99 Commerce Drive
Winnipeg MB R3P 0Y7
ATTENTION: Ryan Harras
PROJECT: 2020 WM Renewals - Panet Road (60624016)

PROJECT NO.: 112-2004
Qu Test No.: 1
Lab No.: HM 39

Date Sampled: 14-Feb-20
Sampled By: Client
Date Received: 18-Feb-20
Date Tested: 5-Mar-20
Sample ID: TH 20-01 T6 (15')

Test Result: **Unconfined Compressive Strength 171.8 kPa**

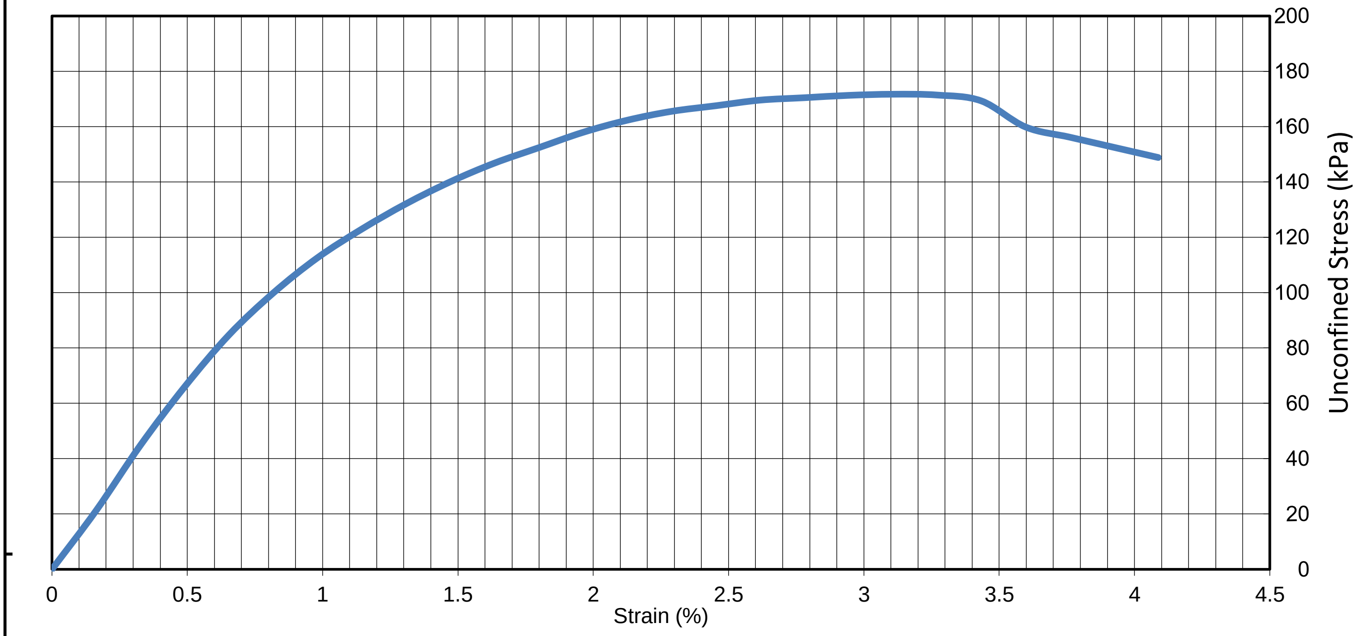
Test Sample Data

Sample Mass (g)	Average Height (m)	Average Diameter (m)	Moisture Content %	Wet Density (kg/m3)	Dry Density (kg/m3)	Strain rate (%/min)
1126.0	0.1553	0.0720	49.1	1781	1194	1.0

Test Sample Visual Description

CLAY, silty, trace silt laminations, brown

Unconfined Stress (kPa) vs Strain (%)



Remarks: Test Method: ASTM D2166
Technician: RC

P. Bevel

Reviewed by: Paul Bevel

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UNCONFINED COMPRESSIVE STRENGTH TEST REPORT

CLIENT: AECOM
99 Commerce Drive
Winnipeg MB R3P 0Y7
ATTENTION: Ryan Harras
PROJECT: 2020 WM Renewals - Panet Road (60624016)

PROJECT NO.: 112-2004
Qu Test No.: 2
Lab No.: HM 39

Date Sampled: 14-Feb-20
Sampled By: Client
Date Received: 18-Feb-20
Date Tested: 5-Mar-20
Sample ID: TH 20-02 T16 (20')

Test Result: **Unconfined Compressive Strength 203.5 kPa**

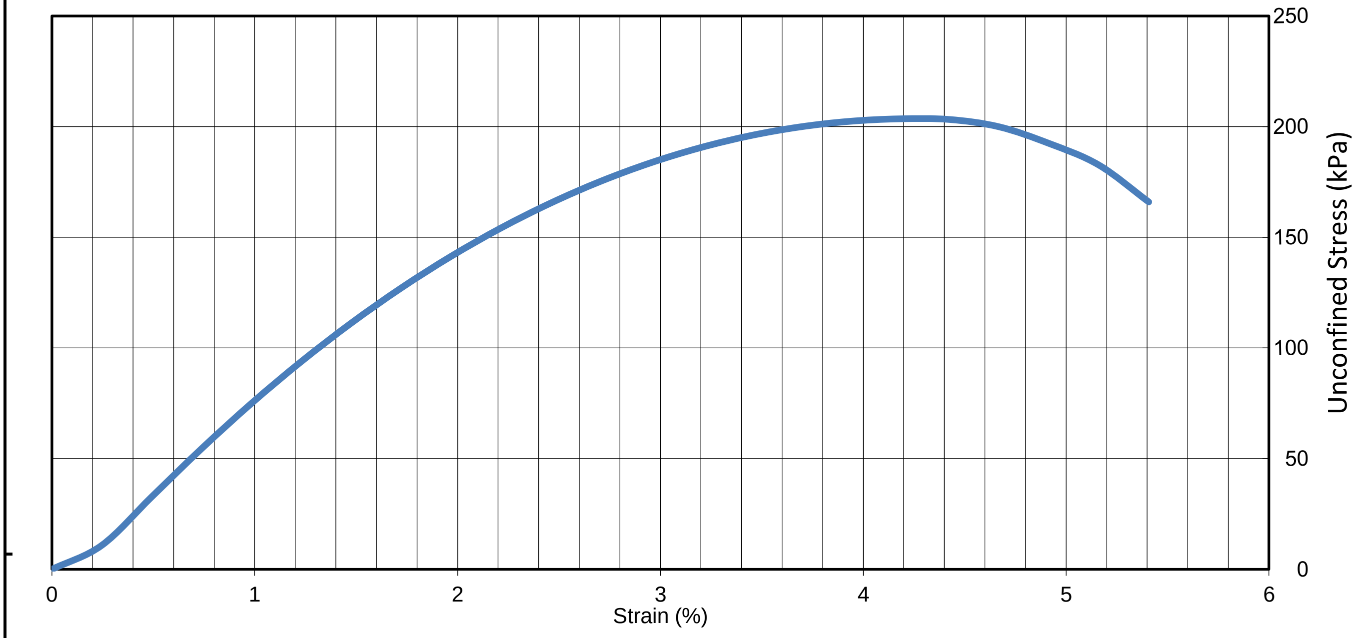
Test Sample Data

Sample Mass (g)	Average Height (m)	Average Diameter (m)	Moisture Content %	Wet Density (kg/m3)	Dry Density (kg/m3)	Strain rate (%/min)
995.6	0.1447	0.0715	54.7	1714	1108	1.0

Test Sample Visual Description

CLAY, silty, dark grey/brown

Unconfined Stress (kPa) vs Strain (%)



Remarks: Test Method: ASTM D2166
Technician: RC

P. Bevel

Reviewed by: Paul Bevel