St. Charles Wastewater Sewer District Detailed Design and Contract Administration Services – Revision No. 2

Geotechnical Report

City of Winnipeg

60686223

December 2024

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December 3, 2024

Project #
60686223

Subject: **St. Charles Wastewater Sewer District Detailed Design and Contract Administration Services – Revision No. 2 Geotechnical Report**

Dear Mr. Sapiak:

AECOM Canada Ltd. is pleased to submit our Geotechnical Report for the above referenced project.

Should you have any queries, please contact German Leal directly at (204)-928-8479.

We appreciate the opportunity to provide the City of Winnipeg Water and Waste Department with our services and look forward to working together on this project and future projects.

Sincerely,
AECOM Canada Ltd.

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AECOM: 2015-04-13

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1. Introduction

The City of Winnipeg has retained AECOM Canada Ltd. (AECOM) to provide geotechnical engineering services for the detailed design for the St. Charles Wastewater Sewer District. AECOM is to develop a solution to eliminate or replace the St. Charles Lift Station (LS) while maintaining or improving the level of service provided to the West End Water Pollution and Control Centre (WEWPCC). As part of the proposal submitted to the City of Winnipeg on July 13, 2023, titled “Scope Change No. 2 – Professional Consulting Services for St. Charles Wastewater Sewer District Preliminary Design, RFP 781-2021” a geotechnical investigation was conducted by AECOM for the City of Winnipeg. The geotechnical investigation was conducted in August 2023 as part of AECOM’s preliminary design. The results of this geotechnical investigation were provided in a geotechnical data report (GDR) submitted to the City of Winnipeg on February 22, 2024.

AECOM is proposing a gravity conveyance route between the St. Charles Separated Sewer District (SSD) and the Perimeter West SSD that follows Gagnon St. and Augier Ave. The preliminary alignment travels west along Augier Avenue beneath Provincial Trunk Highway (PTH) 100. West of PTH 100 the preliminary pipe alignment would connect to the existing wastewater sewer (WWS) at Oak Forest Crescent.

PTH 100 is a major arterial highway, traveling the perimeter of Winnipeg. Due to the high traffic volume, the PTH 100 crossing will need to be trenchless. Minimal disturbance of PTH 100 is heavily considered during the preliminary design.

On July 8, 2024, AECOM submitted a proposal for the St. Charles Wastewater Sewer District Detailed Design and Contract Administration Services – Revision No. 2 and was awarded the work. This additional work required AECOM to update the previously submitted GDR, for resubmission of a Geotechnical Report (GR) that includes details regarding the PTH 100 trenchless tunneling proposed construction.

This GR documents the findings of the geotechnical investigation completed during the preliminary design phase, characterizes the subsurface and groundwater conditions, provides recommendations for excavation and shoring for open excavations and trenchless methodologies, and estimates the expected settlement due to trenchless tunneling beneath PTH 100. A testhole location plan and site photographs are found in **Appendix A**, testhole logs can be found in **Appendix B**, laboratory test results can be found in **Appendix C**, and preliminary design drawings can be found in **Appendix D**.

2. Project Site and Proposed Construction

The project site is located just west of Winnipeg, MB. The project site begins at the existing St. Charles LS located on Sansome Avenue, carries south along Gagnon Street, before heading west along Augier Avenue beneath Provincial Trunk Highway (PTH) 100. The site is primarily a residential neighborhood.

2.1 Proposed Construction

Based on an options analysis technical memorandum conducted by AECOM, it was determined that a gravity connection between the St. Charles SSD and the Perimeter West SSD would be the most advantageous option for the City of Winnipeg and was recommended for advancement to Preliminary Design.

A summary of the preliminary design is outlined below:

- A new 450 mm wastewater sewer (WWS) approximately 540 m in length is proposed to be installed from the upstream tie in point located in front of the existing St. Charles LS on Sansome Avenue to the downstream tie in point located on Oak Forest Crescent.
- The alignment of the new sewer is proposed to be below the pavement as opposed to the boulevard due to the congestion of existing utilities.
- The recommended profile consists of a uniform pipe grading of approximately 0.13% from the downstream tie-in manhole (MH) at Oxbow Bend Road and Oak Forest Crescent eastward across along Augier Avenue and then North along Gagnon Street to the upstream tie-in on Sansome Avenue.
- Based on AECOM's geotechnical investigation, till is present near the proposed pipe installation depth where it is anticipated that a significant portion of the sewer will need to be installed using open cut methods.
- The existing St. Charles LS is proposed to be decommissioned and abandoned which will involve demolishing and removing the structure. Abandoned sewer and FM pipe will also be abandoned following all relevant COW specifications.

The 450 mm WWS will be encased in a 914 mm steel casing (from here on referred to as 914 mm WWS). The PTH 100 crossing profile consists of the following details:

- PTH 100 has an approximate elevation of 238.00 m ASL.
- The invert elevation of the 450 mm carrier pipe is approximately 230.787 m ASL at the base of PTH 100. The invert depth from the base of PTH 100 is approximately 7.21 m (Elev. 230.787 m ASL).
- The invert elevation of the 914 mm steel casing is approximately 230.730 m ASL. The invert depth from the base of PTH 100 is approximately 7.27 m (Elev. 230.730 m ASL).
- Depth from the base of PTH 100 to the steel casing obvert is approximately 6.35 m (i.e., approximate obvert elev. 231.644 m ASL).
- At the time of writing this report, the exact locations of the entry and exit pits for the trenchless tunneling are not known. For writing this report, the excavated pits are assumed to be at the downstream tie in point on Oak Forest Crescent, and along Oxbow Bend near TH23-05.

3. Scope of Work

The geotechnical scope of work considered within this report involves the following:

- Update the Geotechnical Data Report
- Recommendations for excavations and shoring trench installation and shafts
- Discussion on trenchless methodologies given soil conditions and settlement profile estimate while crossing PTH 100.

As of 2024, AECOM is responsible for updating the 2023 Geotechnical Report. The groundwater scope, however, is assigned to Trek Geotechnical Inc and falls outside AECOM's responsibilities. This updated report will be included in the tender documents.

4. Geotechnical Investigation

The geotechnical program, developed under Scope Change No. 2 for the St. Charles Wastewater Sewer District Preliminary Design, was conducted from August 24 to 25, 2023. AECOM obtained underground service clearances from public utility companies through ClickBeforeYouDigMB, with final utility locates identified and marked by a private locator. Lane closure requests were processed through the City of Winnipeg's Lane Closures portal.

At the time of the investigation, the exact elevation of the gravity system was not determined. The field investigation involved drilling seven testholes (TH23-01 to TH23-07) to support the design of the new gravity system. These testholes were primarily drilled on boulevards, ditches, and city property. No testholes were drilled through asphalt or concrete pavements. A testhole location plan and photos taken during the field investigation are shown in **Appendix A**.

Drilling services were provided by Paddock Drilling Ltd. Subsurface conditions observed during testhole drilling were visually classified and documented by AECOM geotechnical personnel according to the Unified Soil Classification System (USCS). Representative soil samples were obtained directly from the auger at depth intervals ranging from 0.30 m to 1.52 m. Ten relatively undisturbed samples were retrieved in Shelby tubes at selected depth intervals in fat clay. The undrained shear strength of the cohesive soils was evaluated using a pocket torvane at depth intervals ranging from 0.30 m to 1.52 m. Seven Standard Penetration Tests (SPTs) were performed to obtain N values for poorly graded sand with silt and gravel (SP-SM) till, with six samples recovered. Groundwater and seepage conditions were recorded upon completion of drilling.

Testhole logs have been prepared for each testhole to record the descriptions and relative positions of the soil strata, locations of samples obtained, laboratory test results, and other pertinent information. Soil profiles have been prepared for representative sections. The testhole logs and soil profiles are included in **Appendix B**.

5. Laboratory Testing Program

The laboratory testing program was developed to measure index properties of the different soil types encountered. The laboratory tests consisted of geotechnical and electrochemical testing on disturbed (grab/split spoon) and relatively undisturbed (Shelby tube) samples. The geotechnical tests were conducted at AECOM's Materials Testing Laboratory in Winnipeg, Manitoba. The electrochemical tests were completed at ALS Environmental Laboratory in Winnipeg, Manitoba. A summary of tests performed is presented below and detailed laboratory test results are presented in **Appendix C**.

5.1 Geotechnical Laboratory Testing

Geotechnical laboratory testing was performed on select soil samples to evaluate the physical characteristics, evaluate the engineering properties and aid with further characterization of the subsurface soils. The geotechnical laboratory testing program included determination of moisture content, Atterberg limits, grain size distribution by hydrometer method, and unconfined compressive strength testing on samples collected during the field investigation.

A summary of the geotechnical testing that was completed is provided in **Table 5-1.**

Table 5-1: Summary of the Type and Quantity of Geotechnical Laboratory Tests

Laboratory Test	Quantity of Tests Completed	Remark
Moisture Content	41	All grab samples from each primary stratum
Atterberg Limits	10	Five tests for the gravity system, five tests specifically for the PTH 100 crossing
Grain Size Distribution (Hydrometer Analysis)	10	Five tests for the gravity system, five tests specifically for the PTH 100 crossing
Unconfined Compressive Strength Test	10	Five tests for the gravity system, five tests specifically for the PTH 100 crossing

5.2 Electrochemical Testing

Electrochemical testing was completed on select soil samples taken from the proposed gravity system to evaluate potential sulphate degradation of concrete or corrosion of buried metal. The electrochemical tests included: resistivity, conductivity, pH, and total water-soluble sulphate in soil.

A summary of the number of electrochemical tests is provided in **Table 5-2**.

Table 5-2: Summary of Type and Quantity of Electrochemical Tests

Laboratory Test	Quantity of Tests Completed
Conductivity in Soil	2
Resistivity in Soil	2
pH in Soil	2
Total & Soluble Sulphate in Soil	2

6. Subsurface Conditions

6.1 Soil Stratigraphy

The soils encountered during AECOM's investigation consisted of topsoil or fill material underlain by fat clay (CH), and poorly graded sand (SP-SM) with silt and gravel till. Each of these units are described below.

6.1.1 Topsoil

Topsoil was encountered at the ground surface in testholes TH23-01, TH23-02, TH23-03, TH23-04, and TH23-07. The thickness of the topsoil ranged from 0.08 m to 0.30 m.

6.1.2 Fill

Fat clay (CH) fill material was encountered at the surface of testholes TH23-05 and TH23-06. The thickness of the clay fill ranged from 0.61 m to 2.13 m. The clay fill was stiff in consistency. In TH23-06, 0.91 m thick of tan silty sand with gravel fill was observed below the fat clay (CH) fill.

6.1.3 Fat Clay (CH)

Fat clay (CH) was encountered below the topsoil in TH23-01 to TH23-04 and TH23-07. In TH23-05 and TH23-06, the fat clay was encountered beneath the fill material. The fat clay (CH) ranged in thickness from approximately 5.08 m (TH23-01) to 7.54 m (TH23-04). It was encountered at depths ranging from 0.07 m to 2.13 m and extended to depths ranging from 5.18 m to 8.53 m. The fat clay (CH) was classified as brown in colour and high in plasticity. The fat clay (CH) began as firm to stiff but became softer with depth. The moisture content of the fat clay ranged from 24.1% to 59.3% with an average of 39.2%.

6.1.4 Poorly Graded Sand with Silt and Gravel (SP-SM) Till

Poorly graded sand with silt and gravel (SP-SM) till was encountered below the fat clay layer in all testholes. The poorly graded sand with silt and gravel (SP-SM) till was encountered at depths ranging from 4.57 m to 8.53 m and extended to depths ranging from 6.55 m to 11.43 m. Auger refusal was met in the poorly graded sanded with silt and gravel (SP-SM) till in this range; however, the poorly graded sanded with silt and gravel (SP-SM) till layer likely extends further below ground. The poorly graded sanded with silt and gravel (SP-SM) till was light grey in colour. Standard Penetration Tests (SPT) completed within the poorly graded sand with silt and gravel till show uncorrected "N" values ranging from 14 to 50 blows per 300 mm of penetration, classifying the material as compact to very dense in relative density. The moisture content ranged from 7.1% to 16.5% with an average of 10.7%. Although not encountered during drilling, cobbles and boulders are commonly found within the poorly graded sand with silt and gravel till.

6.2 Groundwater and Sloughing Conditions

Groundwater seepage and sloughing conditions were observed in each testhole upon completion of drilling. Details of the location and nature of the sloughing, seepage, and groundwater encountered are provided in the testhole logs in **Appendix B** and presented in **Table 6-1**. Two standpipe piezometers were installed in testhole TH23-05; one standpipe piezometer was installed within the fat clay (CH) layer and the other was installed within the poorly graded sand with gravel (SP-SM) till layer. Another standpipe was installed in TH23-01 in the poorly graded sand with gravel (SP-SM) till layer.

Table 6-1: Observed Groundwater, Seepage and Sloughing Conditions

Testhole ID	Groundwater Seepage	Depth of Groundwater Seepage (m)	Groundwater Depth Upon Completion of Drilling (m)	Depth of Soil Sloughing (m)
TH23-01	Heavy	6.10	3.81	6.10
TH23-02	Heavy	6.40	3.81	8.38
TH23-03	Heavy	7.62	5.18	7.16
TH23-04	None	None	3.66	8.53
TH23-05	Heavy	9.30	3.05	8.53
TH23-06	Heavy	6.25	3.81	None
TH23-07	Heavy	7.62	2.74	5.64

Groundwater readings were taken upon completion of the testhole drilling utilizing the standpipes installed at the project site in 2023. Additional groundwater readings were recorded in the summer and fall of 2024. The readings recorded are summarized in **Table 6-2**.

Table 6-2: Groundwater Readings

Standpipe ID	Groundwater Elevations (m ASL)				
	August 25, 2023	April 30, 2024	August 27, 2024	September 23, 2024	October 4, 2024
TH23-01 (Till)	233.41	233.52	233.46	233.72	233.75
TH23-05 (Fat clay)	233.99	235.52	235.40	235.35	235.31
TH23-05 (Till)	234.49	234.12	236.50	236.58	236.50

A graphical summary of these results are provided in **Figure 6-1** which shows the groundwater elevation over time.

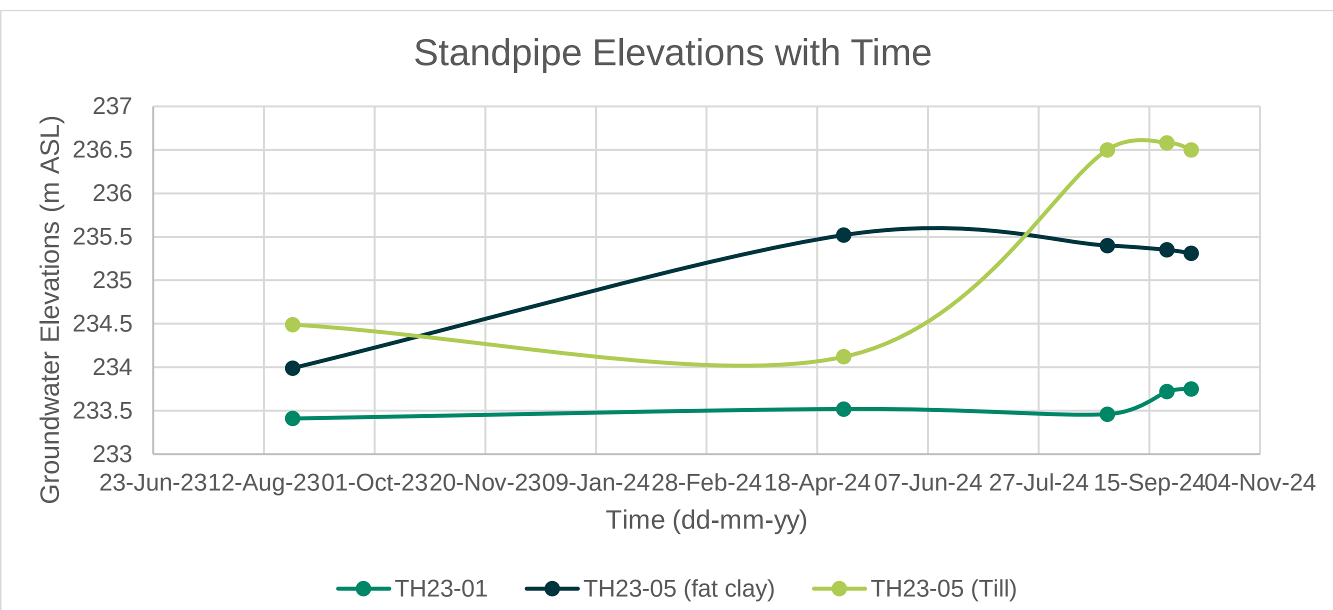


Figure 6-1: Graph of Groundwater Elevations Versus Time

Only short-term seepage and sloughing conditions were observed. It should be noted that groundwater levels (GWL) and subsequently the seepage and sloughing depths may change seasonally, annually or because of construction activities.

6.3 Laboratory Testing Results

Laboratory Testing completed by AECOM in 2023 is summarized in **Table 6-3** to **Table 6-5**. Laboratory test results are provided in **Appendix C**.

Table 6-3: Particle Size Analysis Results

Testhole ID	Sample Depth	Soil Type	Particle Size Distribution (%)			
			Gravel (4.75 to 75 mm)	Sand (0.075 to 4.75 mm)	Silt (0.002 to 0.075 mm)	Clay (<0.002 mm)
TH23-01	3.05 m – 3.20 m	CH	0.2	7.6	32.8	59.4
TH23-02	0.76 m – 0.91 m	CH	0.0	3.0	20.9	76.1
TH23-03	0.76 m – 0.91 m	CH	0.1	3.4	23.7	72.8
TH23-05	0.76 m – 0.91 m	CH	0.0	1.7	31.7	66.5
TH23-05	3.05 m – 3.20 m	CH	0.0	0.5	28.1	71.4
TH23-05	8.99 m – 9.14 m	SP-SM	2.5	30.9	45.3	21.3
TH23-06	1.52 m – 1.68 m	CH	0.2	5.7	20.6	73.6
TH23-06	4.57 m – 4.72 m	CH	0.1	3.6	25.4	70.8
TH23-07	0.76 m – 0.91 m	CH	0.1	1.2	26.0	72.8
TH23-07	4.57 m – 4.72 m	CH	0.0	3.5	34.8	61.6

Table 6-4: Atterberg Limit Test Results

Testhole ID	Sample Depth	Soil Type	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
TH23-01	3.05 m – 3.20 m	CH	62.3	16.2	46.0
TH23-02	0.76 m – 0.91 m	CH	67.1	18.2	49.0
TH23-03	0.76 m – 0.91 m	CH	69.0	17.8	51.2
TH23-05	0.76 m – 0.91 m	CH	69.0	18.2	50.7
TH23-05	3.05 m – 3.20 m	CH	78.4	19.9	58.5
TH23-05	8.99 m – 9.14 m	SP-SM	22.0	10.9	11.1
TH23-06	1.52 m – 1.68 m	CH	76.1	20.4	55.7
TH23-06	4.57 m – 4.72 m	CH	58.4	16.9	41.5
TH23-07	0.76 m – 0.91 m	CH	60.6	19.8	40.8
TH23-07	4.57 m – 4.72 m	CH	68.5	17.5	51.0

Table 6-5: Unconfined Compressive Strength Test Results

Testhole ID	Sample Depth	Soil Type	Moisture Content (%)	Bulk Unit Weight (kN/m^3)	Undrained Shear Strength (kPa)	Unconfined Compressive Strength (kPa)
TH23-01	4.57 m – 5.18 m	SP-SM	16.4	24.3	17.4	34.8
TH23-03	6.10 m – 6.71 m	CH	58.6	17.3	25.8	51.7
TH23-04	4.57 m – 5.18 m	CH	39.1	17.3	39.9	79.7
TH23-05	4.57 m – 5.18 m	CH	41.1	18.3	41.5	82.9
TH23-05	6.10 m – 6.71 m	CH	44.0	17.7	22.7	45.3
TH23-05	7.62 m – 8.23 m	CH	50.4	17.4	21.5	42.9
TH23-06	3.05 m – 3.66 m	CH	43.0	17.3	33.0	66.0
TH23-06	6.10 m – 6.71 m	SP-SM	33.8	16.9	9.5	18.9
TH23-07	3.05 m – 3.66 m	CH	40.8	17.1	45.1	90.1
TH23-07	6.10 m – 6.71 m	CH	56.1	16.8	27.1	54.2

6.3.1 Electrochemical Testing

Electrochemical tests (total and soluble sulphate, conductivity and soil resistivity, and pH) were completed on two (2) samples for the proposed wastewater sewer system. A summary of test results and expected potential for sulphate attack and degree of corrosiveness of the subsurface soils are presented in **Table 6-6.**

Table 6-6: Summary of Electrochemical Testing

Testhole ID	Sample Depth	Soil Type	Sulphate, Total, Ion Content (%)	Potential for Sulphate Attack	Resistivity (ohm · cm)	Corrosivity Rating
TH23-05	5.95	CH	0.068	Severe	510	Extremely Corrosive
TH23-06	4.57	CH	<0.050	Severe	1000	Highly Corrosive

6.4 Frost

6.4.1 Seasonal Frost Penetration

The depths of frost penetration have been estimated for a range of annual air freezing identified in **Table 6-7**. The mean annual freezing index is based on published climate normal from Environmental Canada of the year 2022 for Winnipeg, MB. The 10-year return annual freezing index is calculated using the mean annual freezing index value and recommendations outlined in the Canadian Foundation Engineering Manual (CFEM). The 50-year return annual freezing index was inferred from Figure K-5 of the National Building Code of Canada (2020) Commentary document.

Factors such as snow cover, vegetation at surface, soil type and groundwater conditions can all significantly impact the depth of frost penetration. The predominant soil type on the project site is fat clay (CH).

Table 6-7: Estimated Frost Penetration Depth

Parameter	Mean	10-Year Return Period	50-Year Return Period
Annual Air Freezing Index (°C-Days)	1825	1875	2375
Estimated Frost Penetration on Fat Clay with Gravel Surface, No Snow Cover (m)	1.9	2.0	2.5
Estimated Frost Penetration on Fat Clay with Grass with Snow cover (m)	1.7	1.9	2.2

6.4.2 Frost Susceptibility

The qualitative frost susceptibility of a soil is typically assessed using guidelines developed by Casagrande (1932) based on the percentage by weight of the soil finer than 0.02 mm, and the Plasticity Index. This classification system has been adapted by the U.S. Army Corps of Engineers and the Canadian Foundation Engineering Manual. Soils are classed as F1 through F4 in order of increasing frost susceptibility.

The soil (fat clay) encountered during the ground investigation fall mostly within the frost group F3. The F3 group has a high to very high susceptibility to frost. Frost susceptibility has been assigned to the encountered soil type and is summarized in **Table 6-8**.

Table 6-8: Project Site Frost Susceptibility

Soil Unit	USCS Soil Type	Frost Group	Frost Susceptibility
Fat Clay	CH	F3	High to very high susceptibility

7. Geotechnical Concerns

Based on our current understanding of the proposed WWS design and the results of our geotechnical investigation, the primary geotechnical concerns are the groundwater in TH23-05 was observed to be near ground surface at approximately 236.5 m ASL. The presence of the groundwater table during excavation can lead to several construction challenges:

- Water Infiltration: water can flow into the excavated site, leading to flooding or ponding;
- Soil Stability: saturated soils may lose strength, increasing risk of sloughing or collapse;
- Heaving: the buoyancy of groundwater can cause the bottom of the excavation to heave;

Another geotechnical concern is the proposed installation depth of the WWS approaches the poorly graded sand with silt and gravel (SP-SM) till layer. As the till layer is approached there is increased risk of observed cobbles and boulders. Cobbles and boulders are obstructions during tunneling and may require removal.

8. PTH 100 Crossing Design Criteria

The purpose of this geotechnical report is to ensure adequate subsurface information including geotechnical and groundwater information is provided during PTH 100 crossing application process.

Table 8-1 provides the general parameters/criteria and the proposed design based on the project drawings in **Appendix D**.

Table 8-1: Proposed Design Parameters

Parameter/Criteria	Proposed Design
Dimension Criteria	
Outside Pipe Diameter	914 mm Steel Casing
Approximate PTH 100 Elevation	238.00 m ASL
Approximate Steel Casing Obvert Elevation	231.644 m ASL
Cover Between Base of Highway and Top of Pipe	6.35 m
Carrier Pipe Approximate Invert Elevation	230.79 m ASL
Steel Casing Approximate Invert Elevation	230.73 m ASL
Adjacent Structures	None
Excavation Criteria	
Excavation Close to Highway	Approximately 80.2 m west of PTH 100 Approximately 50.0 m east of PTH 100
Crossing Angle	85.1°
Construction Method Criteria	
	Guided Auger Boring with Pipe Jacking or Guided Pipe Ramming
Other Criteria	
Settlement	According to California Department of Transportation (Caltrans), a limiting surface of settlement value of 12.7 mm (0.5 inches) is required (Caltrans, 2017).
Approximate Length of Crossing	130.2 m

9. Casing Installation

9.1 Anticipated Stratigraphy

The proposed 914 mm WWS casing passing beneath PTH 100 has an invert elevation ranging from approximately 230.637 m ASL (At the assumed excavation pit at west tie-in at Oak Forest Crescent) to approximately 230.787 m ASL (At the assumed excavation pit east of PTH 100). The fat clay (CH) layer was encountered in testholes TH23-05 to TH23-07 at elevations ranging from 234.78 m ASL to 237.26 m ASL and extended to elevations ranging from 228.38 m ASL to 230.26 m ASL. Poorly graded sand (SP-SM) with silt and gravel till was encountered in testholes TH23-05 to TH23-07 at elevations ranging from 228.38 m ASL to 230.26 m ASL. Considering these elevations the proposed 914 mm WWS will primarily reside within the fat clay (CH) layer, however, there is potential for the poorly graded sand (SP-SM) with silt and gravel till layer to be to be observed, especially when excavating the jacking and receiving pits. **Table 9-1** further provides an indication of the strata anticipated to be present at the installation depth of the proposed WWS.

Table 9-1: Anticipated Stratigraphy at the WWS Alignment

Proposed WWS	Approximate Elevation of the Proposed WWS at BOH* (m ASL)	USCS Soil Anticipated at the Proposed WWS Installation Level	USCS Soil Elevation (m ASL)
Top of Casing	231.53	Fat Clay (CH)	228.38 m ASL < TH23-05 < 234.78 m ASL 230.06 m ASL < TH23-06 < 235.25 m ASL 230.26 m ASL < TH23-07 < 237.27 m ASL
Bottom of Casing	230.61	Fat Clay (CH)	

BOH: Base of Highway (I.E., PTH 100)

As shown in **Table 9-1**, it is anticipated that the proposed WWS will be within the fat clay (CH) layer. Although, not observed during the geotechnical investigation in 2023, there is increased likelihood of cobbles and boulders in the lower strata of the fat clay as the poorly graded sand with silt and gravel (SP-SM) till is approached.

At the time of writing this report, the elevations and locations of the jacking/receiving pits are unknown. The elevations will not be known until the Contractor has confirmed the necessary equipment and methodology utilized for the installation of the WWS. Assuming an estimate of approximately 1.00 m below the casing invert, an elevation of approximately 229.787 m ASL on the east end, and 229.637 m ASL on the west end is estimated for the jacking/receiving pits. It is anticipated that the fill, fat clay (CH), and poorly graded sand with silt and gravel (SP-SM) till will be encountered during excavation of the jacking and receiving pit.

9.2 Tunnelman's Ground Classification

Table 9-2 is provided for completeness and as general information for the anticipated ground conditions along the crossing alignment. This table provides the framework for Tunnelman's Ground Classification and indicates the respective tunnel working conditions for reference as outlined by Heuer and Virgins (1987) and Brandt (1970) and others.

Table 9-2: Tunnelman's Ground Classification and Probable Work Conditions

Classification		Representative Soil Types	Tunnel Work Conditions
Hard		Very hard calcareous clay; cemented sand and gravel	Tunnel heading may be advanced without roof support.
Firm		Loess above water table; hard clay, marl, cement sand and gravel when not highly overstressed.	Tunnel heading can be advanced without initial support, and final lining can be constructed before ground starts to move.
Raveling	Slow Raveling	Residual soils or sand with small amounts of binder may be fast raveling below the water table, slow raveling above. Stiff fissured clays may be slow or fast raveling depending upon degree of overstress.	Chunks or flakes of material begin to drop out of the arch or walls sometime after the ground has been exposed, due to loosening or to overstress and “brittle” fracture (ground separates or breaks along distinct surfaces, opposed to squeezing ground). In fast raveling ground, the process starts within a few minutes, otherwise the ground is slow raveling.
	Fast Raveling		
Squeezing		Soft or medium-soft clay.	Ground slowly advances into tunnel without fracturing and without perceptible increase of water content in ground surrounding the tunnel (may not be noticed in tunnel but cause surface subsidence).
Swelling		Heavily pre-compressed clays with a plasticity index more than about 30; sedimentary formations containing anhydrite.	Like squeezing ground, moves slowly into tunnel, but movement is associated with a very considerable volume increase in the ground surrounding tunnel.
Running	Cohesive Running	Cohesive running occurs in clean, fine moist sand.	The removal of the lateral support of any surface rising at an angle of more than about 34° to the horizontal is followed by a “run” whereby the material flows like granulated sugar until the slope angle becomes equal to about 34°. If the “run” is preceded by a brief period of raveling, the ground is called cohesive raveling.
	Running	Running occurs in clean, coarse or medium sand above the GWT.	
Very Soft Squeezing		Clay and silts with high plasticity index.	Ground advances rapidly into the tunnel is plastic flow.
Flowing		Below the water table in silt, sand, or gravel without enough clay content to give significant cohesion and plasticity. May also occur in highly sensitive clay when such material is disturbed.	Flowing ground moves like a viscous liquid. It can invade the tunnel not only through the roof and the sides but also through the bottom. If the flow is not stopped, it continues until the tunnel is filled.
Bouldery		Boulder glacial till; rip-rap fill; some landslide deposits; some residual soils. The matrix between boulders may be gravel, sand, clay or combination thereof.	Problems occurred in advancing shield or in forepoling; blasting or hard mining ahead of machine possibly necessary.

For reference, soft to firm fat clay below the groundwater level is anticipated to exhibit a 'squeezing' behavior. If the poorly graded sand (SP-SM) with silt and gravel till is observed during tunnel, it is anticipated that fast raveling or flowing conditions will be observed.

9.3 Recommended Installation Options

The methods of casing installation that are considered are:

- Guided Auger Boring with Pipe Jacking (with Soil Plug) (also called Pilot Tube Guided Auger Bore)
- Guided Pipe Ramming (Also called Pilot Tube Guided Pipe Ramming)

Both methods offer similar face support at the lead end of the casing. The casing should be installed with a guided pilot tube when auger boring or pipe ramming method is used. The pilot tube method should utilize a guided pilot tube as a technique for accurately installing a pipe to line and grade. The pilot tube installation serves as the initial step in guided boring technology. Although it is recommended, it is the responsibility of the Contractor to determine the need for guided pilot tubes.

These methods have been considered based upon the known available resources, equipment, and expertise within the Manitoba market. Other factors for consideration, including the geotechnical/geological constraints are discussed in **Section 10** of this report.

9.3.1 Guided Auger Boring with Pipe Jacking Method

The guided auger boring with pipe jacking method involves several key steps. First, excavate the trench or pit to create a launching/jacking area. Next, pilot tubes are installed to control line and grade. The steel casing is connected to the installed pilot tubes and jacked into place while a soil plug is maintained to provide face stability. The auger is used inside the casing to bore through the soil, with soil cuttings removed towards the launching/jacking pit. Throughout the process, the soil plug is maintained to ensure continuous face stability and reduce the potential for ground subsidence. This method provides accurate control of line and grade and helps identify and mitigate potential for obstructions before advancing the casing.

9.3.2 Guided Pipe Ramming

Pipe ramming is a trenchless construction method whereby a pneumatic hammer is used to drive the casing through the ground, and spoils are removed from the inside of the casing. With the guidance of a pilot tube (guided pipe ramming), this method combines the line and grade accuracy of the pilot tube installation with the power of compressed air pneumatic pipe rammer affixed to the rear of the casing. Benefits of this method are that the casing can be advanced through poor soils with minimal surface effects, by maintaining a soil plug within the pipe to control caving or flowing of soils. Overcut is minimal (typically less than 25 mm) and can be used to reduce friction of the drive when used in conjunction with lubricants and a correctly specified hammer.

9.4 Trenchless Construction Risks

Each trenchless option for the PTH 100 crossing has been evaluated against the following risks:

Table 9-3: Evaluation of Trenchless Construction Risks

Trenchless Method	Perceived Risk
Guided Auger Boring with Pipe Jacking	Ground settlement and heave
	Buried obstructions
	Groundwater
	Pipe alignment/grade control
	Dense/very stiff soil conditions
Guided Pipe Ramming	Ground settlement and heave
	Buried Obstructions
	Groundwater
	Pipe alignment/grade control
	Noise Vibrations

9.4.1 Ground Settlement and Heave

The major advantage of guided auger boring and guided pipe ramming methods is the reduced ground disturbance during installation. However, ground settlement and heave can still occur during installation of the steel casing.

Heavy groundwater seepage was observed in TH23-05 in the poorly grade sand (SP-SM) with silt and gravel till layer at a depth of 9.30 m (elevation 227.62 m ASL), and in testhole TH23-06 in the poorly graded sand (SP-SM) with silt and gravel till layer at a depth of 6.25 m (elevation 230.52 m ASL). Although no soil sloughing was observed in TH23-06, TH23-05 observed sloughing at a depth of 8.53 m in the poorly graded sand (SP-SM) with silt and gravel till layer at a depth of 8.53 m (228.39 m ASL). During groundwater readings taken from the standpipes installed in TH23-05, groundwater readings as high as 236.6 m ASL were observed in the standpipe installed in the poorly graded sand (SP-SM) with silt and gravel till and groundwater readings as high as 235.4 m ASL were observed in the standpipe installed in the fat clay layer. Therefore, the proposed casing elevation will be installed below the groundwater table.

Surface heave can occur during installation using pipe jacking by auger boring if the casing is advanced through the fat clay (CH) too quickly without allowing for the auger to remove the displaced soils. Settlement can occur if flowing soils enter the casing.

9.4.2 Buried Obstructions

Buried obstructions were not encountered during AECOM's geotechnical investigation in August 2023. However, buried obstructions such as abandoned pipes, other utilities, or cobbles and boulders may be encountered during trenchless methods (pipe jacking or pipe ramming). Based on the depth of the 914 mm WWS, and the proximity to the till layer, the most likely obstruction will be cobbles and boulders from the till layer.

Encountered buried obstructions can prevent or slow down the progress of trenchless tunneling. Particularly, auger boring with pipe jacking method can have difficulty cutting and moving obstructions beyond the auger flights, potentially creating misalignment to the pipe jacking. An installation technique should be selected that can accommodate removal of potential obstructions without having to remove or expose the leading edge of the encasement pipe.

9.4.3 Groundwater

As mentioned in **Section 9.4.1**, heavy groundwater seepage was observed in TH23-05 in the poorly graded sand (SP-SM) with silt and gravel till layer at a depth of 9.30 m (elevation 227.62 m ASL), and in testhole TH23-06 in the poorly graded sand (SP-SM) with silt and gravel till layer at a depth of 6.25 m (elevation 230.52 m ASL).

Two standpipe piezometers (SP) were installed in TH23-05. One SP was installed at a depth of 5.94 m in the fat clay (CH) layer, and one SP was installed at a depth of 10.67 m in the poorly graded sand (SP-SM) with silt and gravel till layer. Groundwater levels were monitored from the SP's installed in testhole TH23-05, these values are provided in **Section 6.2**. For the SP installed in the fat clay (CH) layer, groundwater was measured at depths ranging from 1.40 m (elevation 235.52 m ASL) to 2.93 m (elevation 233.99 m ASL). The installation of the WWS casing (top of casing elevation 231.50 m ASL) is below the groundwater level recorded by the SP installed in TH23-05. Using the highest groundwater elevation observed in TH23-05 of 236.58 m ASL, the Contractor can expect up to approximately 6.79 m of pressure head at the east excavation pit, and up to 6.94 m of pressure head at the west excavation pit. During construction of the jacking and receiving pit and the installation of the casing, the contractor should be prepared to deal with groundwater originating from the poorly graded sand (SP-SM) with silt and gravel till layer. The contractor should have adequate pumping to maintain a safe excavation.

Given the potential for seasonal fluctuation of the groundwater table, it is recommended that the groundwater level in the SP's be measured again prior to construction to confirm any change arising from seasonal variation or changed conditions since the time of previous monitoring events.

Groundwater will require careful management and control throughout the casing installation process regardless of which trenchless method is adopted. Groundwater can promote instability at the face of the casing and may result in higher ground deformations (settlement/heave) at ground surface unless adequate solutions are implemented. The contractor will have to develop a method to mitigate this risk especially if auger boring with pipe jacking and pipe ramming techniques are employed. The groundwater is out of AECOM's scope. Trek's groundwater team should be consulted for any additional information regarding the groundwater.

9.4.4 Pipe Alignment and Grade Control

Pipe alignment and grade control are critical during the initial stages of installation and require careful management to achieve adequate design inverts along the drive length. In difficult ground conditions where potential obstructions may be present (i.e., abandoned pipes, other abandoned utilities, or cobbles and boulders), encountering an obstruction may result in the reduction of alignment and grade control accuracy. The casing should be installed with guided pilot tubes when auger boring or pipe ramming methods are used. The use of a guided pilot tube provides an accuracy of ±25 mm (1 inch) from the design grade and ±76 mm (3 inches) from the design alignment at any location, however, it is at the discretion of the Contractor whether to utilize the use of guided pilot tubes as they are responsible for the work described.

In the case of pipe ramming without guided pilot tubes, alignment and grade control is not readily steerable and can be significantly affected by ground conditions. Typical accuracies are in the order of 1% of the drive length, although with good initial alignment and control of the lead section, accuracies can be increased from 0.1% to 0.5%.

10. Geotechnical Assessment

10.1 Jacking Pit and Receiving Pit

At the time of writing this report, the location and depths of the jacking and receiving pit are not known. However, based on the assumption that the pits will be excavated to a depth approximately 1.00 m below the 914 mm WWS invert, it is anticipated that during the excavation of the pits that fill, fat clay (CH), and poorly graded sand (SP-SM) with silt and gravel till will be encountered. It has also been assumed that the west excavation pit for tunneling beneath PTH 100 will be located at approximately STA. 0+79.77, approximately 80 m west of the PTH 100 centerline. This excavation pit is expected to reach elevations of approximately 229.64 m ASL, where the observed soil is expected to be the poorly graded sand (SP-SM) with silt and gravel till layer.

It has also been assumed that the east excavation pit for tunneling beneath PTH 100 will be located at STA. 2+10, approximately 50 m east of the PTH 100 centerline. This excavation pit is expected to reach elevations of approximately 229.79 m ASL, where the observed soil is expected to be soft fat clay (CH).

With the above-mentioned excavated pit depths and the encompassing soil stratigraphy, the use of large excavating equipment should be considered to facilitate excavation to the intended depths. Based on the depths of the jacking and receiving pits, it is anticipated that temporary shoring will be required for the pits. Details on the temporary shoring can be found in **Section 10.3**. The pits need to be appropriately shored (in accordance with applicable regulations) because the side walls are normally cut vertically into the soil to conserve space. It is highly likely that sloughing will occur during excavation of the jacking and receiving pits if temporary shoring is not provided. Also, the excavated pits are well below the water table, increasing the risks, if proper dewatering is not implemented.

During the geotechnical investigation, public utility locates were obtained. Upon review of the locate clearance maps, it can be confirmed that these crossing areas are heavily congested with utility lines. To conduct a safe excavation, careful exposure of these lines may be required. Cobbles and boulders may increase the difficulty of the excavations.

The pits should be large enough to accommodate the backstop, jacking equipment, spacer, muck removal equipment, lubricant pumps, lines, pneumatic hammers, and augers, etc. All equipment is normally centered along the centerline of the casing pipe.

10.2 Excavation

Pipe jacking operations require the excavation of a suitable jacking and receiving pit. The Contractor should engage a competent geotechnical engineer to observe the materials excavated from the jacking and receiving pits and confirm soil conditions match those encountered during the field drilling program. The method of excavation and support of excavation sidewalls are the responsibility of the contractor and must comply with the appropriate regulations under the Manitoba Workplace Safety and Health Act. The information provided below is for use by the owner and engineer and should not be interpreted to mean that AECOM is assuming responsibility for the contractor's actions or site safety.

The Contractor should acknowledge these concerns and develop a Safe Excavation Plan accordingly. Side slopes for temporary open-cut excavation must conform to the Manitoba Guide for Excavation Work. According to Manitoba's Guide for Excavation Work, the minimum excavation side slope is 1H:1V from the base of the excavation. Services of a professional engineer is required to design support structures where a worker is required to enter any open excavation that exceeds 1.5 m in depth.

As mentioned in previous sections, groundwater seepage was observed in the fat clay (CH) and poorly graded sand (SP-SM) with silt and gravel till layers during AECOM's drilling program. Groundwater seepage should be anticipated from the poorly graded sand (SP-SM) with silt and gravel till and may be observed in the lower extents of the fat clay (CH) layer during excavation. The stability of the excavation should be monitored regularly by knowledgeable geotechnical personnel. Shoring related to temporary work is the responsibility of the Contractor, and all necessary measures should be undertaken to protect against adverse detrimental impacts.

10.3 Temporary Shoring

As mentioned in **Section 10.1**, it is anticipated that temporary shoring will be used to facilitate excavation of the jacking and receiving pits for the PTH 100 crossing, and may be required for the open cut excavation work completed along Augier Avenue, Gagnon Street and Sansome Avenue. Comments regarding the design and temporary shoring system are therefore provided as follows.

The design of the temporary shoring system should be carried out by a professional engineer specialized in shoring design. The shoring system should also be designed in accordance with the methods described in the Canadian Foundation Engineering Manual.

In consideration of the information provided in the preceding sections, it is anticipated that the elevation of the jacking and receiving pits will be excavated to is approximately 229.64 m ASL for the proposed 914 mm WWS Casing and will require open cut excavations for the remainder of the pipe installation along Augier Avenue, Gagnon Street and Sansome Avenue at elevations ranging between approximately 230.75 m ASL to 231.50 m ASL. In consideration of the conditions encountered in the testholes, it is recommended that the design of a shoring system consider the parameters provided in **Table 10-1**. **Table 10-1** provides the recommended earth pressure coefficients, and angle of internal friction and bulk unit weight of the clay fill, sand fill, fat clay (CH) and poorly graded sand (SP-SM) with silt and gravel till.

Table 10-1: Lateral Earth Pressure Design Parameters

USCS Soil Type	Soil Unit Weight (kN/m^3)	Angle of Internal Friction (°)	At-Rest Lateral Earth Pressure Coefficient (K_o)	Active Lateral Earth Pressure Coefficient (K_a)	Passive Lateral Earth Pressure Coefficient (K_p)
Fill (Clay)	18	17	0.71	0.55	1.83
Fill (Sand)	18	27	0.55	0.38	2.66
Fat Clay	17	17	0.71	0.55	1.83
Poorly Graded Sand (SP-SM) with Silt and Gravel Till	20	32	0.47	0.31	3.25

For purposes of design for the shoring system, it is recommended that the groundwater elevation be taken as 236.6 m ASL as being the highest elevation of the groundwater level recorded in the SP installed in testhole TH23-05 and in proximity to the crossing location. Construction dewatering may be expected to isolate the work zone and facilitate construction in a dry condition. The Contractor should refer to Trek Geotechnical's hydrogeology report for provisions for dewatering and groundwater control; that should be required and included in the project schedule and cost.

A perimeter ditch, associated pumping and an appropriate dewatering system should be provided to intercept surface runoff and groundwater from entering the excavation. The Contractor should submit a safe excavation plan, including dewatering measures, for engineer review.

Monitoring must be carried out during the installation/construction process and following installation/construction to confirm that movements of the temporary shoring system are within a pre-determined acceptable range.

10.3.1 Excavation Base Stability

Braced excavations will be required when excavating the jacking and receiving pits, as well as for the open cut trench excavations. Per the Canadian Foundation Engineering Manual (CFEM 5e), if the soil below the base of excavation is a soft, normally consolidated soil, it is possible that heaving can occur. In this project, there is soft, normally consolidated soil below the base of the excavation, so heaving is a concern. The soil above the base acts as a surcharge on the soil below it. This surcharge load may exceed the bearing capacity on the soil, resulting in heaving. The following equation can be used:

$$(FS)_b = N_b\left(\frac{s_u}{\sigma_z + q}\right)$$

Where:

- $(FS)_b$ = factor of safety against base heave associated with shear failure.
- N_b is a stability factor dependant upon geometry of the excavation and using Fig. 20.21 of CFEM 5e.
- s_u is undrained shear strength of soil below the base, corrected for plasticity, test method, and anisotropy as appropriate (kPa).
- σ_z is the total overburden pressures at the bottom of the excavation (kPa).
- q is surcharge pressure (kPa).

For $(FS)_{heave}$ less than 2, substantial deformations of the excavation support, base and surrounding ground may occur. If $(FS)_{heave}$ is less than 1.5, the sheeting should be extended below the base of the excavation for stability. Wall movements, strut loads, and wall moments are sensitive to $(FS)_{heave}$.

The base of the excavations for St. Charles are expected to be soft clay, or till. Groundwater seepage is expected to impact the $(FS)_b$ for these excavations and the factor of safety in the till is difficult to predict. Based on AECOM's preliminary analysis, the $(FS)_b$ will be below 1.5. Therefore, the design of the temporary shoring system should be carried out by a professional engineer specialized in shoring design.

10.3.2 Heave Due to Artesian Pressure at Depth

According to the Canadian Foundation Engineering Manual (CFEM 5e) Section 22.3.1, when an excavation is dug into a clay deposit underlain by a pervious stratum under artesian pressure, pressure and seepage may result, leading to instability of the excavation. An analysis can be prepared for the design of the temporary excavation, excavation depth and piezometric condition within the underlying fat clay.

The basal heave analysis is based on the ratio of total stresses and uplift pore water pressure.

For this approach, the FS is expressed using the equation:

$$FS = \frac{H_C \gamma_C}{H_w \gamma_w}$$

Where:

γ_c = unit weight of fat clay
H_c = thickness of the fat clay between the bottom of the excavation to the top of the glacial till
γ_w = unit weight of water = 9.81 kN/m^3
H_w = the total head in the glacial till layer

Per CFEM 5e, a minimum FS of 1.1 has been reported by Frank et al. (2005) for this failure mode. They also provide guidance on the use of load and resistance factors for this failure mode. During AECOM's preliminary analyses, the FS will be below 1.1 for some excavations, therefore, it is the duty of the Contractor to obtain services of a qualified professional engineer to develop the temporary shoring required for these excavations. The Contractor may refer to the hydrogeology report provided by Trek Geotechnical for further information regarding groundwater.

10.4 Horizontal Stresses due to Pipe Jacking of Casing Pipe

In general, the jacking force required to propel the pipe sections forward must overcome forces associated with face pressures on the cutting head, plus friction on the shield and pipeline. The frictional forces developed between the surrounding soil and the exposed outer face of the shield and installed pipe sections. The face pressure component relates to the depth of burial and can be estimated based on the soil and groundwater conditions at the site. The face pressure component of the jacking force remains theoretically constant if the depth of soil cover over the pipe is constant. However, the frictional force increases as the drive length increases. As a result, a longer drive requires greater jacking forces. Other construction issues such as pipe misalignment due to obstructions and jacking stoppage can also affect the required jacking force.

10.5 Pipe Ramming Dynamics

To drive the casing pipe horizontally along the proposed alignment, the pipe ramming force must overcome soil resistance forces (as discussed in **Section 10.4**). Wave equation analysis should be performed to optimize the hammer energy required to install the pipe without damage. The maximum energy transfer from the hammer to the pipe is dependent on the hammer type selected, hammer alignment, and the degree of tension on restraining chains. Total soil resistance generally increases with pipe length, depth of soil cover and increasing soil strength.

Wave Equation Analysis can be performed upon selection of an appropriate hammer type prior to construction. It is the responsibility of the Contractor to conduct the Wave Equation Analysis, so that an appropriate hammer type can be selected.

10.6 Face Stability

Based on the results of the 2023 AECOM geotechnical investigation and the proposed WWS profile, the proposed WWS will be installed within the fat clay (CH) layer, however, in some regions the casing may also observe the poorly graded sand (SP-SM) with silt and gravel till layer. Mitigation measures should be in place to limit the loss of ground at the face of the casing.

It is anticipated that installation of the casing will take place below the groundwater table; therefore, reduced face stability is considered likely along the WWS drive length. Utilization of a soil plug (3x the diameter of the casing) is recommended to improve face stability but is dependent upon the installation method selected.

10.7 Settlement Estimation

Like other tunnelling methods, pipe jacking/augering will result in a change in the state of stress in the ground with corresponding settlements. 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 tunnel support or linings. Based on cohesive soils tending toward a stable tunneling face, the only significant contribution to ground loss is the closure of the overcut. The overcut is the is the annular space between the tunnel boring walls and the installed pipe. Some degree of ground subsidence can be expected from tunneling although in many instances its effects, from a practical perspective, are negligible with proper technique.

10.8 Empirical Method

A conventional method for prediction of settlement that may develop due to trenchless installation is the method outlined by Schmidt (1969) and later by Thomson (1993). A ground surface deformation induced by tunnel construction is estimated using a reverse gaussian curve based on the anticipated ground loss.

The empirical method is characterized as a simplified method and an upper bound solution as the method does not consider the potential for arching effects in the overlying soil mass above the borehole obvert, nor does the method consider soil layering, groundwater conditions or the shape of the void. This method does not consider the use of a 'soil plug' either.

This method assumes that the total ground loss (V_t) (or over drill) that occurs over the pipe leads to settlement at the ground surface in the shape of a reverse gaussian curve (normal probability distribution). The maximum settlement δ_{max} occurs at the ground surface above the tunnel centreline and is estimated from the following equation:

$$\delta_{max} = \frac{V_t}{2.5i}$$

Where "i" is the point inflexion for the normal distribution, and "V_t" represents the volume of ground loss during tunnel evacuation multiplied by the cross-sectional area of the drilled shaft. The method suggests the following correlation between "i", depth of tunnel centreline (Z) and settlement through parameter (K, function of soil type) for cohesive soil.

$$i = Kz$$

Based on the conditions encountered in the testholes soil stratigraphy at the proposed auger boring path is anticipated to consist of soft fat clay (CH). The highway subbase and base layers are likely comprised of granular material, and the till layer is comprised of poorly graded sand (SP-SM) with silt and gravel. However, the empirical method does not address multi-layer systems. The method suggests K values ranging from 0.4 to 0.7 for very soft to stiff clay soils, 0.5 for normally consolidated soils, and a K value of 0.25 for cohesionless soils. The smaller the K value is taken the larger will be the settlement estimate. Given the conditions in the testholes (soft to firm fat clay), a K value of 0.5 is considered for this estimation.

It can be assumed that the difference in size of auger cutter-head with a diameter up to 25 mm larger than the product pipe would create a space and that the space could potentially collapse. It is typical to assume contribution of 10% to 25% of the annular space to the ground surface deformation given the potential benefit from ground arching effects and localized ground loosening (i.e., volume change). In addition to the annular space, we can consider a ground loss of approximately 1% to 2.5% of the borehole volume to occur at bore face for boring in soft cohesive soils (i.e., fat clay). In this respect, a combination of over-drilling (V_1) and soil raveling at the bore face (V_2) is considered to contribute to ground loss (V_t).

Figure 10-1 presents the results of the settlement estimation using the empirical method for various percentages of annular space collapse and ground loss for the proposed trenchless pipeline installation under highways.

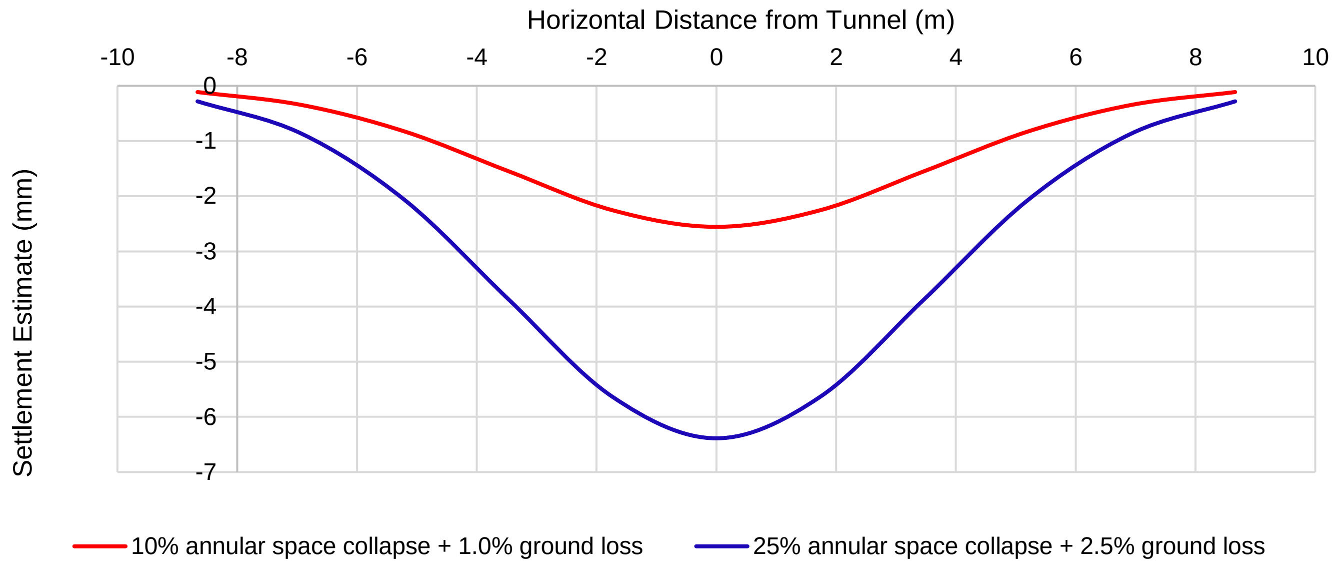


Figure 10-1: Ground Surface Settlement Using Empirical Approach

As shown in the figure above, the analysis indicates a maximum settlement of approximately 6.5 mm. This value is well within the California Department of Transportation requirement, which limits surface settlement to 12.7 mm (0.5 inches) (Caltrans, 2027).

11. Ground Monitoring Recommendations

AECOM recommends monitoring the surface of PTH 100 during the installation of the 914 mm WWS casing through trenchless tunneling. Typically, baseline readings are surveyed twice a day for two consecutive days to obtain the current elevations of PTH 100 along the alignment of the 914 mm WWS casing before conducting the installation.

12. Conclusion

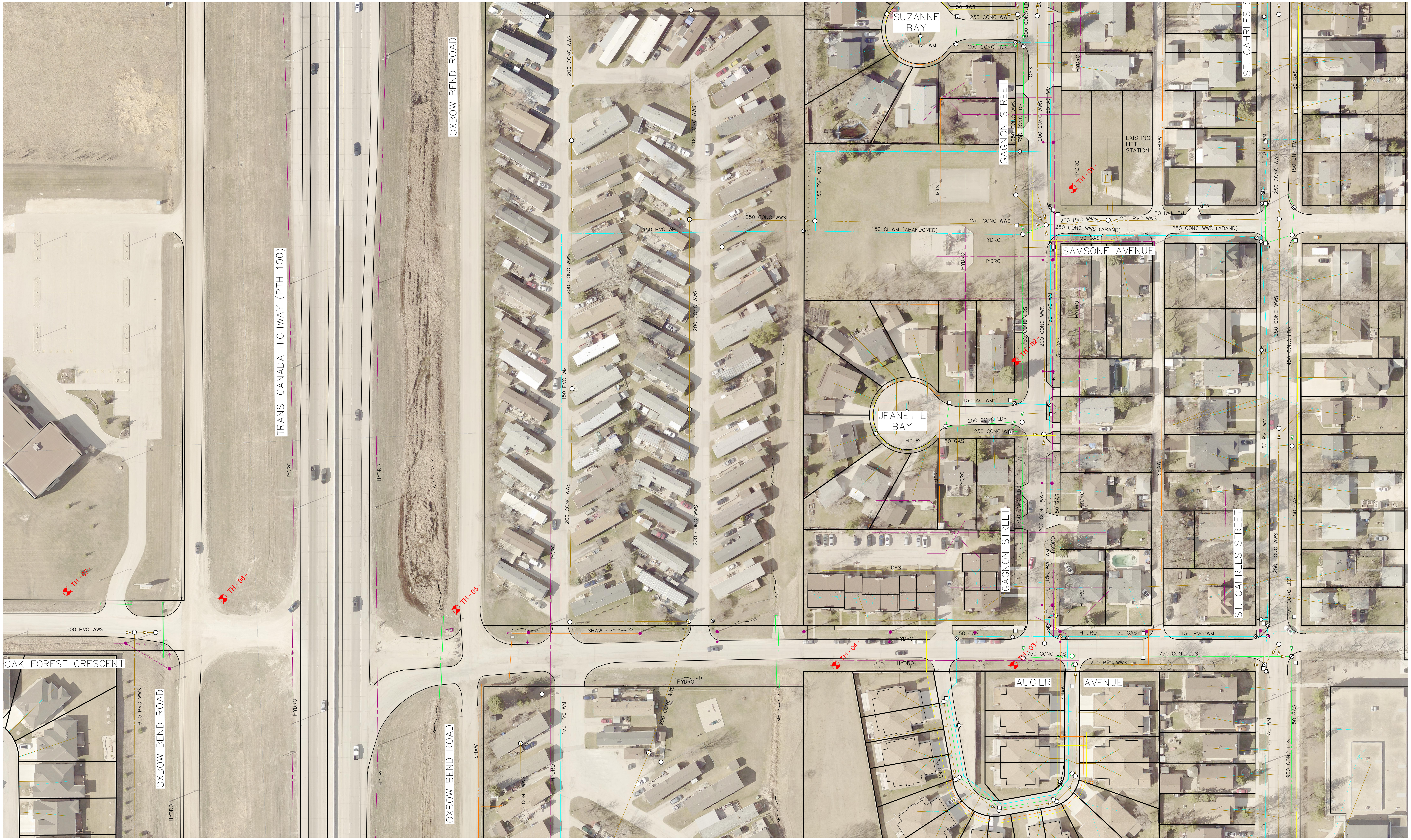
In general, and based on the available information, it is recommended that the proposed WWS be installed using trenchless methodologies. It is considered that a pipe jacking system utilizing either guided auger boring or guided pipe ramming is adopted. These methods are deemed appropriate given the required installation parameters and based upon the subsurface ground and groundwater conditions. It is thereafter the option of the Contractor to select a suitable method based on their experience and equipment.

Encountering buried obstructions such as utilities, cobbles, or boulders. An appropriate trenchless tunneling methodology should be implemented, to ease the removal of any buried obstructions encountered. Given that installation will occur near the underlying till layer; the Contractor should be prepared to mitigate potential groundwater flow around the circumference of the casing. Throughout the pipe installation process, surface monitoring should be undertaken to evaluate the impact of pipe jacking/pipe ramming beneath PTH 100.

Characterization of groundwater conditions may be required to validate dewatering quantities, methodologies and techniques prior to the onset of construction. Detailed groundwater conditions and dewatering requirements are not provided in this report, these details are provided in Trek Geotechnical’s Hydrogeology Report.

Appendix A

Testhole Location Plan and Photos



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: 23/XX/XX

REFER TO DRAWING D-XXXXX 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.
ELEV.

PRELIMINARY
NOT FOR CONSTRUCTION
Date: 2023-03-01

NO.	REVISIONS	DATE	BY
A	ISSUED FOR REVIEW	23/XX/XX	MG

AECOM

DESIGNED BY	CHECKED BY
DRAWN BY EC	APPROVED BY
SCALE: HORIZONTAL 1:750 VERTICAL	RELEASED FOR CONSTRUCTION
DATE 2023/08/01	DATE

PLOT DATE: 2023 09 14

ENGINEER'S SEAL

CONSULTANT DRAWING NUMBER
C-0001

TENDER NUMBER: XXX-2023
CONTRACT NUMBER: -

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT
ENGINEERING DIVISION

St. Charles Wastewater Sewer

BASE PLAN

SHEET 1 OF 1

CITY DRAWING NUMBER

FILE PATH: L:\DCS\Projects\WTR\60686223\900_CAD_GIS\910_CAD\20-SHEETS\SHEETS
FILE NAME: C-0001

Figure 1: View of TH23-07

Figure 2: View of TH23-05 drilling

Figure 3: View of TH23-04

Figure 4: View of TH23-01

Appendix B

Testhole Logs

EXPLANATION OF FIELD & LABORATORY TEST DATA

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

1. EXPLANATION OF SOIL

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.

1.1 Tests on Soil Samples

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

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

γ_T - Total (moist, wet, or bulk) Unit Weight. Usually expressed in kN/m^3.

C_U - Undrained Shear Strength. Usually expressed in kPa. This value can be determined by a field vane shear 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.

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 free falling of 760 mm (30 in.) which is required to drive a 50 mm (2 in.) split spoon sampler 300 mm (12 in.) into the soil.

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

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

1.2 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 to determine the soil classification.

Descriptive Term	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually in coarse-grained soils below the water table

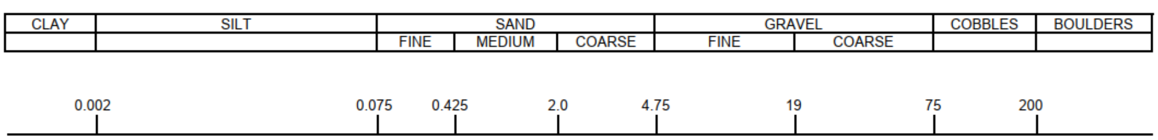
1.3 Grian Size Distrubtion

Laboratory grain size analyses provided by AECOM follow the following system. Note that, with the exception of those samples where a grain size distribution analysis has been completed, all samples have been classified by visual inspection. Visual inspection classification is not sufficient to provide exact gain sizing.

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	ADJECTIVE
	MEDIUM	2.00	0.425		
	FINE	0.425	0.075	20 – 10	SOME
SILT (non-plastic) or CLAY (plastic)		0.075		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		

ISSMFE / USCS SOIL CLASSIFICATION



EQUIVALENT GRAIN DIAMETER IN MILLIMETRES

1.4 Soil Compactness and Consistency

The standard terminology to describe cohesive soils includes consistency, which is based on undrained shear strength as measured by in-situ vane tests, penetrometer tests, unconfined compression tests, or similar field and laboratory analysis. Standard Penetration Test 'N' values can also be used to provide an approximate indication of the consistency and shear strength of fine-grained, cohesive soils.

The standard terminology to describe cohesionless soils includes the compactness condition as determined by the Standard Penetration Test 'N' value. These approximate relationships are summarized in the following tables:

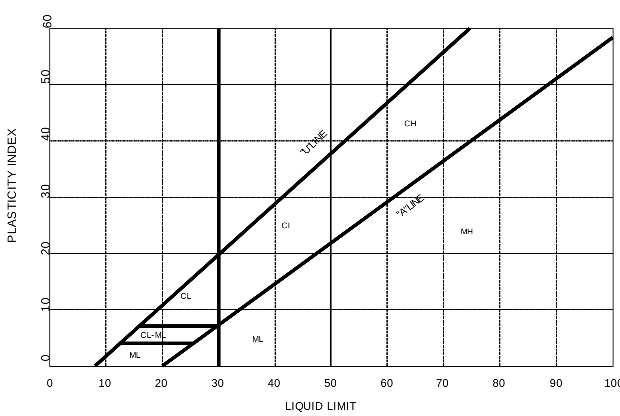
Table 1 Cohesive Soils

Consistency	SPT N (blows/0.3m)	C_u (kPa) approx.
Very Soft	<2	<12
Soft	2 - 4	12 - 25
Firm	4 - 8	25 - 50
Stiff	8 - 15	50 - 100
Very Stiff	15 - 30	100 - 200
Hard	>30	>200

Table 2 Cohesionless Soils

Compactness Condition	SPT N (blows/0.3m)
Very Loose	0 – 4
Loose	4 - 10
Compact	10 - 30
Dense	30 - 50
Very Dense	>50

MAJOR DIVISION			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	$C_u = \frac{D_{60}}{D_{10}} > 4 \quad C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
			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	$C_u = \frac{D_{60}}{D_{10}} > 6 \quad C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
			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	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	
	CLAYS (ABOVE 'A' LINE NEGLIGIBLE ORGANIC CONTENT)	$W_L < 30$	CL	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS		
		$30 < W_L < 50$	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	0.075	20 – 10	SOME
SILT (non-plastic) or CLAY (plastic)		0.075		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

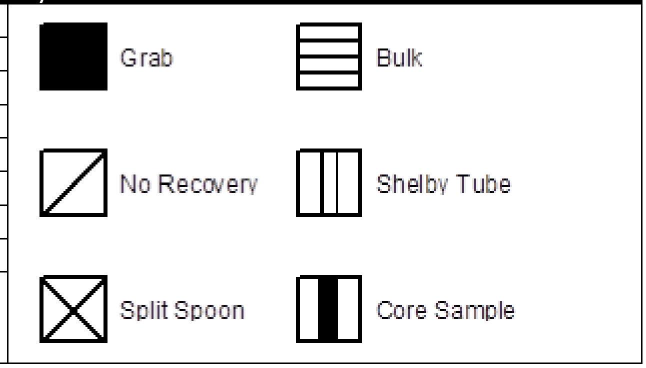
MODIFIED UNIFIED SOIL CLASSIFICATION SYSTEM

February 2022

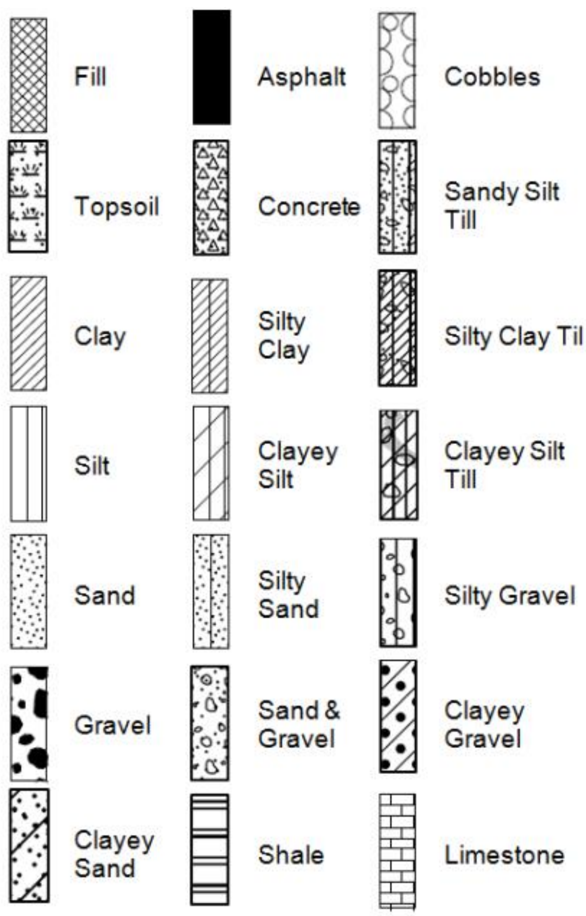
1.5 Sample Type, Symbols and Abbreviations

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

Sample abbreviations:	Symbols:
GS: Grab Sample	
BK: Bulk Sample	
NR: No Recovery	
ST: Shelby Tube	
SS: Split Spoon	
Core: Core Samples	
FV: Field Vane	
PP: Pocket Penetrometer	
DCPT: Dynamic cone penetration test	



1.6 STRATA/Graphic Plot (Shall be Changed For Different Guidelines)



2. EXPLANATION OF ENVIROMENTAL SAMPLE

2.1 Contaminant Abbreviations

Contaminant Abbreviations	
BNAE	Base/neutral/acid extractables
BTEX	Benzene, toluene, ethylbenzene, xylenes
OCP	Organochlorine pesticides
MI	Metals and inorganics
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyls
PHC	CCME petroleum hydrocarbons (fractions 1-4)
VOC	Volatile organic compounds (includes BTEX)
SO_4	Water Soluble Sulphate Content

2.2 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.

2.3 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

3. HYDROGEOLOGICAL

The groundwater table is indicated by the equilibrium level of water in a standpipe installed in a test hole 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 (▼).

4. EXPLANATION OF ROCK

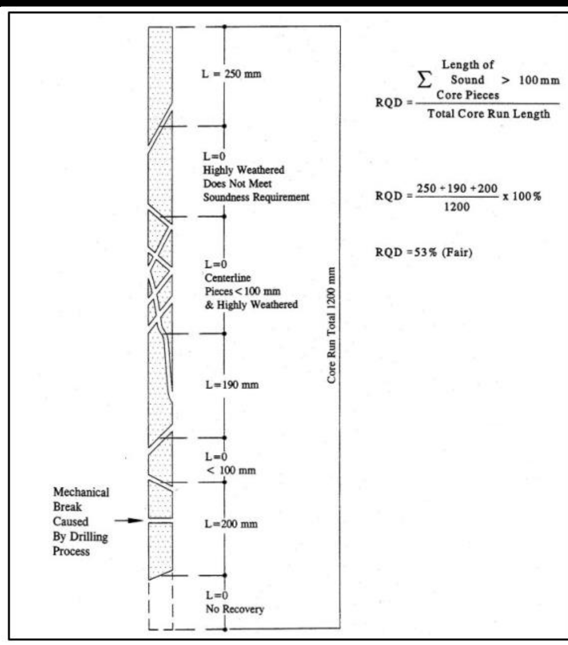
4.1 General Description and Terms

General Description of Geotechnical Unit including: Quantitative description including rock type (s), percentage of rock types, frequency and sizes of interbeds, colour, texture, weathering, strength and general joint spacing

Total Core Recovery (TCR): Total length of core recovered expressed as percentage of core run length.
Solid Core Recovery (SCR): Total length of solid full diameter core expressed as percentage of core run length.
Rock Quality Designation (RQD): Sum of lengths of solid core pieces longer than 100 mm expressed as percentage of core run length.
Fracture Index (FI): Number of fractures per meter of core.

4.2 Rock Quality Designation (RQD)

RQD(%)	RQD Classification
0 – 25	Very Poor Quality
25 – 50	Poor Quality
50 – 75	Fair Quality
75 – 90	Good Quality
90 – 100	Excellent Quality



4.3 Classification of Strength

Grade	Description	Field identification	Approximate range of Uniaxial compression strength (MPa)
R0	Extremely weak rock	Indented by thumbnail	0.25-1.0
R1	Very weak rock	Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife	1.0-5.0

R2	Weak rock	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer	5.0-25
R3	Medium strong rock	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow of geological hammer	25-50
R4	Strong rock	Specimen requires more than one blow of geological hammer to fracture it	50-100
R5	Very strong rock	Specimen requires many blows of geological hammer to fracture it	100-250
R6	Extremely strong rock	Specimen can only be chipped with geological hammer	>250

4.4 Classification of Weathering

Grade	Description	Field identification
W1	Fresh	No visible sign of rock material weathering; perhaps slight discolouration on major discontinuity surface
W2	Slightly Weathered	Discolouration indicates weathering of rock material and discontinuity surface. All the rock material may be discoloured by weathering and may be somewhat weaker externally than in its fresh condition
W3	Moderately Weathered	Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as a continuous framework or as corestones.
W4	Highly Weathered	More than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as a continuous framework or as corestones.
W5	Completely Weathered	All rock material is decomposed and/or disintegrated to a soil. The original mass structure is still largely intact. All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but soil has not been significantly transported.
W6	Residual Soil	Residual Soil

4.5 Type of discontinuity

Symbol	Description
F	Fault
J	Joint
Sh	Shear
Fo	Foliation
V	Vein
B	Bedding

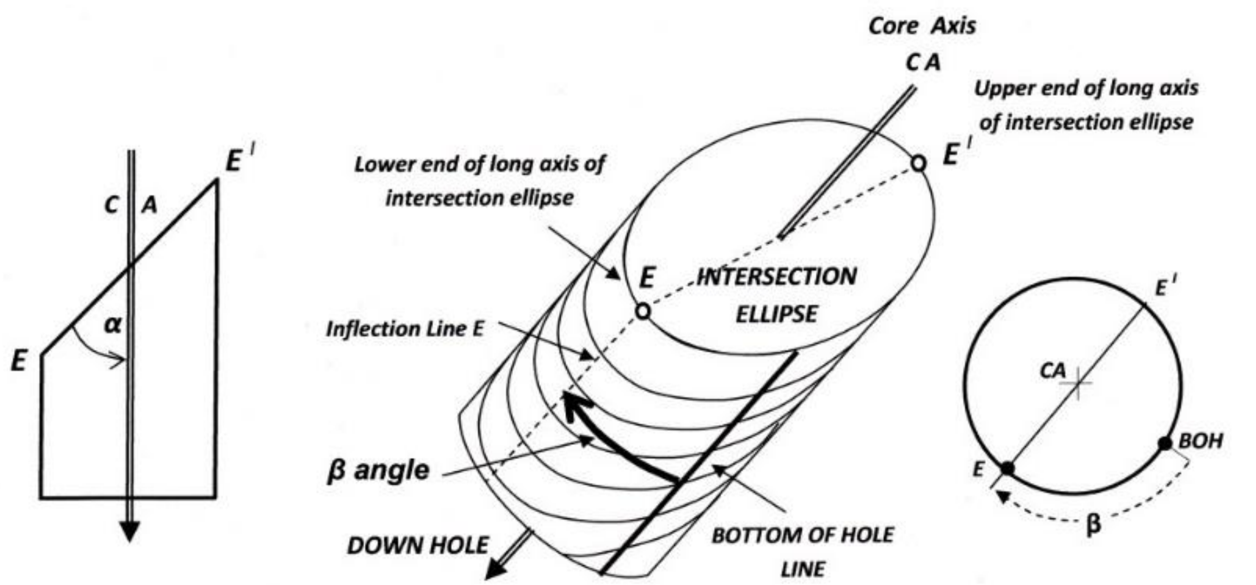
4.6 Spacing of discontinuity

Spacing Classification	Spacing width
Extremely close	<0.02m

Very close	0.02-0.06m
Close	0.06-0.2m
Moderately Close	0.2-0.6m
Wide	0.6-2.0m
Very Wide	2.0-6.0m
Extremely Wide	>6.0m

4.7 Joint Orientation

The orientation of a planar surface intersected by drill core can be defined by two angles called alpha (α) and beta (β). The definition of these angles is shown in the diagram below:



4.8 Inclination

Term	Inclination (degrees from the horizontal)
Sub-horizontal	0-5
Gently Inclined	6-15
Moderately Inclined	16-30
Steeply Inclined	31-60
Very Steeply Inclined	61-80
Sub-vertical	81-90

4.9 Stratification/foliation

Term	Spacing
Very Thickly Bedded	>2m
Thickly Bedded	600mm-2m
Medium Bedded	200mm-600mm
Thinly Bedded	60mm-200mm

Term	Spacing
Very Thinly Bedded	20mm-60mm
Laminated	6mm-20mm
Thinly Laminated	2mm-6mm
Fissile	<2mm

4.10 Grain Size

Term	Size
Very Coarse Grained	>60 mm
Coarse Grained	2mm-60mm
Medium Grained	60 microns – 2mm
Fine Grained	2 microns – 60 microns
Very Fine Grained	<2 microns

4.11 Aperture of open discontinuity

Symbol	Aperture Opening	Description	
VT	<0.1 mm	Very tight	Closed Features
T	0.1-0.25mm	Tight	
PO	0.25-0.5mm	Partly open	
O	0.5-2.5mm	Open	Gapped Features
MW	2.5-10mm	Moderately open	
W	>10mm	Wide	
VW	1-10cm	Very wide	Open Features
EW	10-100cm	Extremely wide	
C	>1m	Cavernous	

4.12 Width of filled discontinuity

Symbol	Width	Description
W	12.5-50mm	Wide
MW	2.5-12.5mm	Moderately Wide
N	1.25-2.5mm	Narrow
VN	<1.25mm	Very Narrow
T	0mm	Tight

4.13 Roughness of discontinuity

Symbol	Description
Slk	Slickenside (surface has smooth, glassy finish with visual evidence of striations)
S	Smooth (surface appears smooth and feels so to the touch)
SR	Slightly rough (asperities on the discontinuity surfaces are distinguishable and can be felt)
R	Rough (some ridges and side-angle steps are evident; asperities are clearly visible, and discontinuity surface feels very abrasive)

Symbol	Description
VR	Very rough (near-vertical steps and ridges occur on the discontinuity surface)

4.14 Shape of discontinuity

Symbol	Description
Pl	Planar
St	Stepped
Un	Undulating
Ir	Irregular

4.15 Filling amount

Symbol	Description
Su	Surface Stain
Sp	Spotty
Pa	Partially Filled
Fi	Filled
No	None

4.16 Filling Type

Symbol	Term	Hard/Soft
Ab	Albite	Hard
Ah	Anhydrite	Hard
Bt	Biotite	Soft
Bn	Bornite	Hard
Ca	Calcite	Hard
Cb	Carbonate	Hard
Ch	Chlorite	Soft
Cpy	Chalcopyrite	Hard
Cy	Clay	Soft
Do	Dolomite	Hard
Ep	Epidote	Hard
Fd	Feldspar	Hard
FeOx	Iron Oxide	Hard
Go	Gouge	Soft
Gr	Graphite	Soft
Gy	Gypsum	Soft
He	Hematite	Hard
Ka	Kaolinite	Soft
Kf	K-feldspar	Hard

Symbol	Term	Hard/Soft
Lm	Limonite/FeOx	Soft
Ms	Muscovite	Soft
Mt	Magnetite	Hard
Py	Pyrite	Hard
Qz	Quartz	Hard
Rb	Rubble	Hard
Sa	Sand	Hard
Se	Sericite/Illite	Soft
Si	Silt	Hard
Sm	Smectite	Soft
Su	Sulphide	Hard
Ta	Talc	Soft
UH	Unknown Hard	Hard
US	Unknown Soft	Soft
OTH - see comments		

PROJECT: St. Charles Wastewater Sewer Preliminary Design	CLIENT: The City of Winnipeg	TESTHOLE NO: TH23-01
LOCATION: UTM: 14U, 5526237.7 m N, 0620581.8 m E		PROJECT NO.: 60686223
CONTRACTOR: Paddock Drilling	METHOD: Solid Stem Auger/Hollow Stem Auger	ELEVATION (m): 236.90

SAMPLE TYPE: GRAB, SHELBY TUBE, SPLIT SPOON, BULK, NO RECOVERY, CORE

BACKFILL TYPE: BENTONITE, GRAVEL, SLOUGH, GROUT, CUTTINGS, SAND

PENETRATION TESTS: Becker; Dynamic Cone; SPT (Standard Pen Test) (Blows/300mm) 0 20 40 60 80 100; Total Unit Wt (kN/m³) 16 17 18 19 20 21; Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: Torvane; QU/2; Lab Vane; Pocket Pen.; Field Vane (kPa) 50 100 150 200

DEPTH (m)	USC	SOIL DESCRIPTION	SAMPLE #	SPT (N)	COMMENTS	ELEVATION
0	OR	TOPSOIL: black, moist, with organic content				
	CH	firm to stiff brown fat CLAY (CH)	G1			
1			G2			236
			G3			
2						235
3		- soft to firm below 3.05 m	G4		(G4): Liquid Limit 62.3%, Plastic Limit 16.2%, Plasticity Index 46.0%; Gravel 0.2%, Sand 7.6%, Silt 32.8%, Clay 59.4%	234
4						233
5	TILL	POORLY GRADED SAND (SP-SM) with silt and gravel (TILL) - very loose to loose light grey -moist below 3.05 m	T5			232
6			S6	50		231
7		END OF TEST HOLE - auger refusal at a depth of 6.55 m in POORLY GRADED SAND (SP-SM) with silt and gravel (TILL) - sloughing observed at a depth of 6.10 m in POORLY GRADED SAND (SP-SM) with silt and gravel (TILL) - heavy seepage observed at a depth of 6.10 m in POORLY GRADED SAND (SP-SM) with silt and gravel (TILL) - groundwater observed at a depth of 3.81 m - standpipe piezometer slotted from 5.5 to 6.1 m in POORLY GRADED SAND (SP-SM) with silt and gravel (TILL) - standpipe annulus backfilled with sand and bentonite chips				230
8						229
9						228
10						227

T5: 24.3

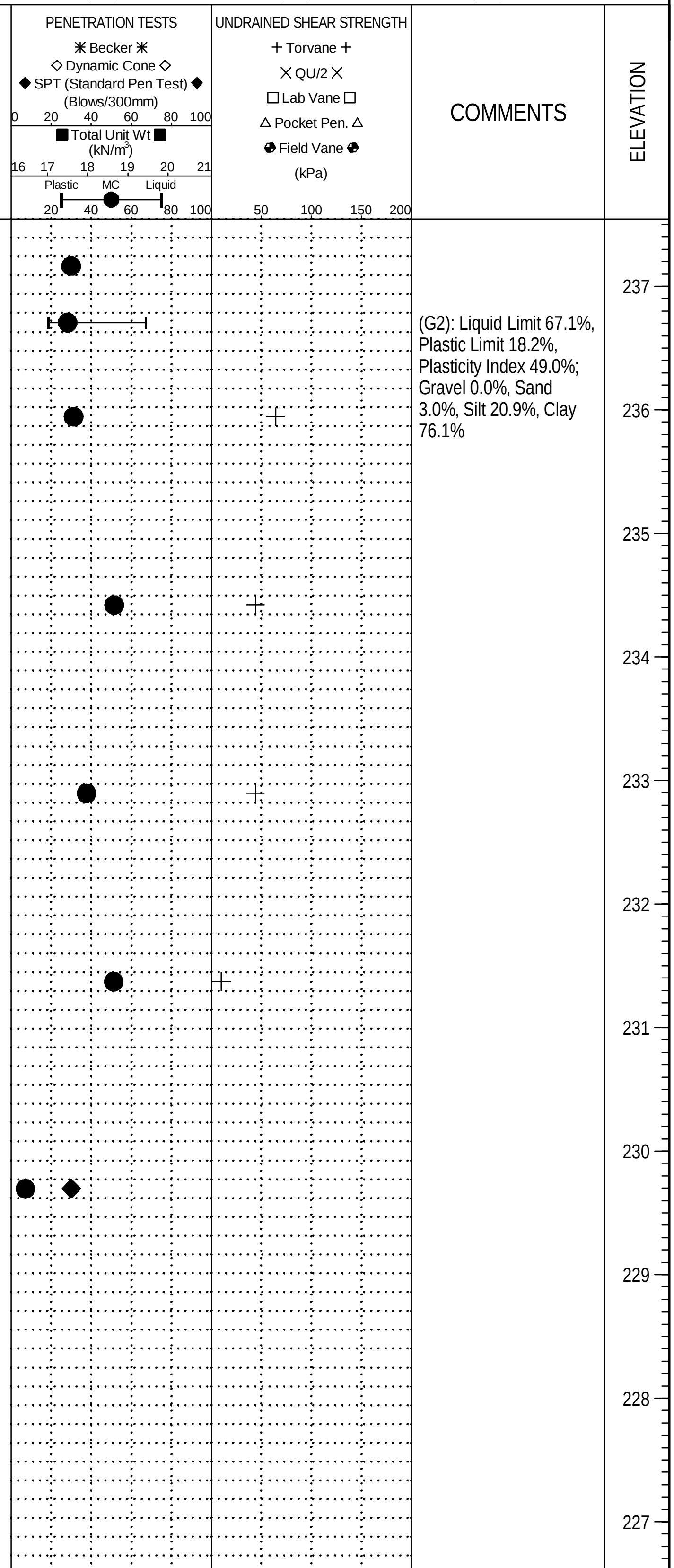
AECOM

LOGGED BY: CW	COMPLETION DEPTH: 6.55 m
REVIEWED BY: GL	COMPLETION DATE: 23-8-25
PROJECT ENGINEER: Mike Gaudreau	Page 1 of 1

PROJECT: St. Charles Wastewater Sewer Preliminary Design	CLIENT: The City of Winnipeg	TESTHOLE NO: TH23-02
LOCATION: UTM: 14U, 5526169.8 m N, 0620556.3 m E		PROJECT NO.: 60686223
CONTRACTOR: Paddock Drilling	METHOD: Solid Stem Auger	ELEVATION (m): 237.54

SAMPLE TYPE: GRAB, SHELBY TUBE, SPLIT SPOON, BULK, NO RECOVERY, CORE

DEPTH (m)	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	COMMENTS
0	OR	TOPSOIL: black, moist, with organic content				
	CH	firm to stiff brown fat CLAY (CH) - moist below 0.15 m	GRAB	G1		
			GRAB	G2		(G2): Liquid Limit 67.1%, Plastic Limit 18.2%, Plasticity Index 49.0%; Gravel 0.0%, Sand 3.0%, Silt 20.9%, Clay 76.1%
			GRAB	G3		
		- silt inclusions below 3.05 m	GRAB	G4		
			GRAB	G5		
		- very soft below 6.10 m	GRAB	G6		
	TILL	POORLY GRADED SAND (SP-SM) with silt and gravel (TILL) - very loose to loose light grey - moist below 6.40 m				
		- compact to dense below 7.62 m	SPLIT SPOON	S7	30	
		END OF TEST HOLE - auger refusal at a depth of 8.69 m in POORLY GRADED SAND (SP-SM) with silt and gravel (TILL) - heavy seepage observed at a depth of 6.40 m in POORLY GRADED SAND (SP-SM) with silt and gravel (TILL) - sloughing observed at a depth of 8.38 m in POORLY GRADED SAND (SP-SM) with silt and gravel (TILL) - ground water observed at a depth of 3.81 m				



LOGGED BY: CW	COMPLETION DEPTH: 8.69 m
REVIEWED BY: GL	COMPLETION DATE: 23-8-25
PROJECT ENGINEER: Mike Gaudreau	Page 1 of 1

AECOM

PROJECT: St. Charles Wastewater Sewer Preliminary Design	CLIENT: The City of Winnipeg	TESTHOLE NO: TH23-03
LOCATION: UTM: 14U, 5526048.8 m N, 0620550.8 m E		PROJECT NO.: 60686223
CONTRACTOR: Paddock Drilling	METHOD: Solid Stem Auger	ELEVATION (m): 237.56

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	COMMENTS
0	OR	TOPSOIL: black, moist, with organic content				
	CH	stiff brown fat CLAY (CH)	GRAB	G1		
1			GRAB	G2		(G2): Liquid Limit 69.0%, Plastic Limit 17.8%, Plasticity Index 51.2%; Gravel 0.1%, Sand 3.4%, Silt 23.7%, Clay 72.8%
			GRAB	G3		
3		- silt inclusions below 3.05 m - firm below 3.05 m	GRAB	G4		
			GRAB	G5		
6		- grey below 6.10 m - soft below 6.10 m	SHELBY TUBE	T6		
	TILL	POORLY GRADED SAND (SP-SM) with silt and gravel (TILL) - very loose to loose light grey - wet below 6.71 m				
8			SPLIT SPOON	S7	14	
			GRAB	G8		
		END OF TESTHOLE - auger refusal at a depth of 8.38 m in POORLY GRADED SAND (SP-SM) with silt and gravel (TILL) - heavy seepage observed at a depth of 7.62 m in POORLY GRADED SAND (SP-SM) with silt and gravel (TILL) - sloughing observed at a depth of 7.16 m in POORLY GRADED SAND (SP-SM) with silt and gravel (TILL) - groundwater observed at a depth of 5.18 m				

PENETRATION TESTS: Becker; Dynamic Cone; SPT (Standard Pen Test) (Blows/300mm) 0 20 40 60 80 100; Total Unit Wt (kN/m³) 16 17 18 19 20 21; Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: Torvane; QU/2; Lab Vane; Pocket Pen.; Field Vane (kPa) 50 100 150 200

ELEVATION: 237, 236, 235, 234, 233, 232, 231, 230, 229, 228, 227

DEPTH: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11

AECOM

LOGGED BY: CW	COMPLETION DEPTH: 8.38 m
REVIEWED BY: GL	COMPLETION DATE: 23-8-25
PROJECT ENGINEER: Mike Gaudreau	Page 1 of 1

PROJECT: St. Charles Wastewater Sewer Preliminary Design	CLIENT: The City of Winnipeg	TESTHOLE NO: TH23-04
LOCATION: UTM: 14U, 5526051.6 m N, 0620479.9 m E		PROJECT NO.: 60686223
CONTRACTOR: Paddock Drilling	METHOD: Solid Stem Auger	ELEVATION (m): 237.15

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

Penetration tests: Becker; Dynamic Cone; SPT (Standard Pen Test) (Blows/300mm) 0 20 40 60 80 100; Total Unit Wt (kN/m³) 16 17 18 19 20 21; Plastic MC Liquid 20 40 60 80 100

Undrained shear strength: Torvane; QU/2; Lab Vane; Pocket Pen.; Field Vane (kPa) 50 100 150 200

DEPTH (m)	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	COMMENTS	ELEVATION
0	OR	TOPSOIL: black, moist, with organic content					237
	CH	firm to stiff brown fat CLAY (CH) - moist below 0.08 m	GRAB	G1			
			GRAB	G2			
1							236
			GRAB	G3			
2		- silt inclusions below 2.13 m					235
3			GRAB	G4			234
4							233
5			SHELBY TUBE	T5			232
6		- soft below 6.10 m	GRAB	G6			231
7							230
8	TILL	POORLY GRADED SAND (SP-SM) with silt and gravel (TILL) - very loose to loose light grey - moist below 7.62 m					229
9			SPLIT SPOON	S7	23		228
10		END OF TESTHOLE - testhole was terminated at a depth of 9.60 m in POORLY GRADED SAND (SP-SM) with silt and gravel (TILL) - no seepage was observed - sloughing was observed at a depth of 8.53 m in POORLY GRADED SAND (SP-SM) with silt and gravel (TILL) - groundwater was observed at a depth 3.66 m					227
11							226
12							

AECOM

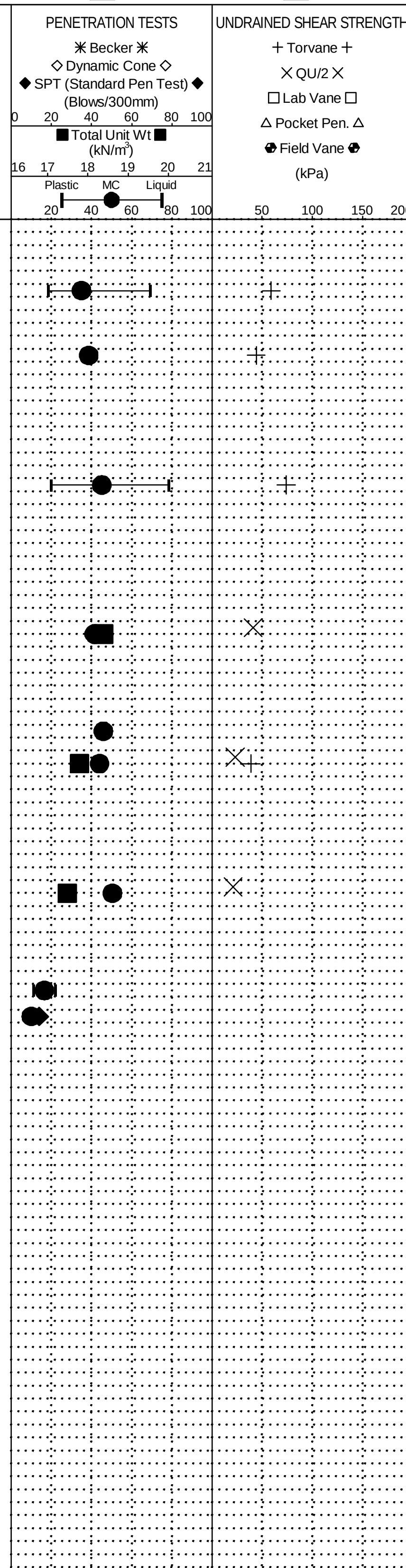
LOGGED BY: CW	COMPLETION DEPTH: 9.60 m
REVIEWED BY: GL	COMPLETION DATE: 23-8-25
PROJECT ENGINEER: Mike Gaudreau	Page 1 of 1

PROJECT: St. Charles Wastewater Sewer Preliminary Design	CLIENT: The City of Winnipeg	TESTHOLE NO: TH23-05
LOCATION: UTM: 14U, 5526080.2 m N, 0620329.6 m E		PROJECT NO.: 60686223
CONTRACTOR: Paddock Drilling	METHOD: Solid Stem Auger/Hollow Stem Auger	ELEVATION (m): 236.92

SAMPLE TYPE: ■ GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: ■ BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	USC	SOIL SYMBOL	SLOTTED PIEZOMETER	SLOTTED PIEZOMETER	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	COMMENTS	ELEVATION
0	FILL				FILL: black fat CLAY, trace gravel - moist below 0 m					
1						■	G1		(G1): Liquid Limit 69.0%, Plastic Limit 18.2%, Plasticity Index 50.7%; Gravel 0.0%, Sand 1.7%, Silt 31.7%, Clay 66.5%	236
						■	G2			235
2	CH				stiff brown fat CLAY (CH) - moist below 2.13 m					
3					- silt inclusions below 3.05 m	■	G3		(G3): Liquid Limit 78.4%, Plastic Limit 19.9%, Plasticity Index 58.5%; Gravel 0.0%, Sand 0.5%, Silt 28.1%, Clay 71.4%	234
4										233
5					- firm below 4.80 m		T4			232
6					- soft below 6.10 m	■	G5			231
							T6			
7										230
8							T7			229
9	TILL				POORLY GRADED SAND (SP-SM) with silt and gravel (TILL) - very loose to loose light grey - moist below 8.53 m - compact to dense below 9.30 m	■	G8		(G8): Liquid Limit 22.0%, Plastic Limit 10.9%, Plasticity Index 11.1%; Gravel 2.5%, Sand 30.9%, Silt 45.3%, Clay 21.3%	228
							S9	14	No Recovery	227
10										
11						■	G10			226
12					END OF TESTHOLE - auger refusal at a depth of 11.43 m in POORLY GRADED SAND (SP-SM) with silt and gravel (TILL) - heavy seepage observed at a depth of 9.30 m in POORLY GRADED SAND (SP-SM) with silt and gravel (TILL) - sloughing observed at a depth of 8.53 m in POORLY GRADED SAND (SP-SM) with silt and gravel (TILL) - Groundwater was observed at a depth of 3.05 m upon completion of drilling - Standpipe piezometer installed at a depth of 5.94 m in fat CLAY (CH) - Standpipe piezometer installed at a depth of 10.67 m in POORLY GRADED SAND (SP-SM) with silt and gravel (TILL)					225
13										224
14										223
15										222
16										

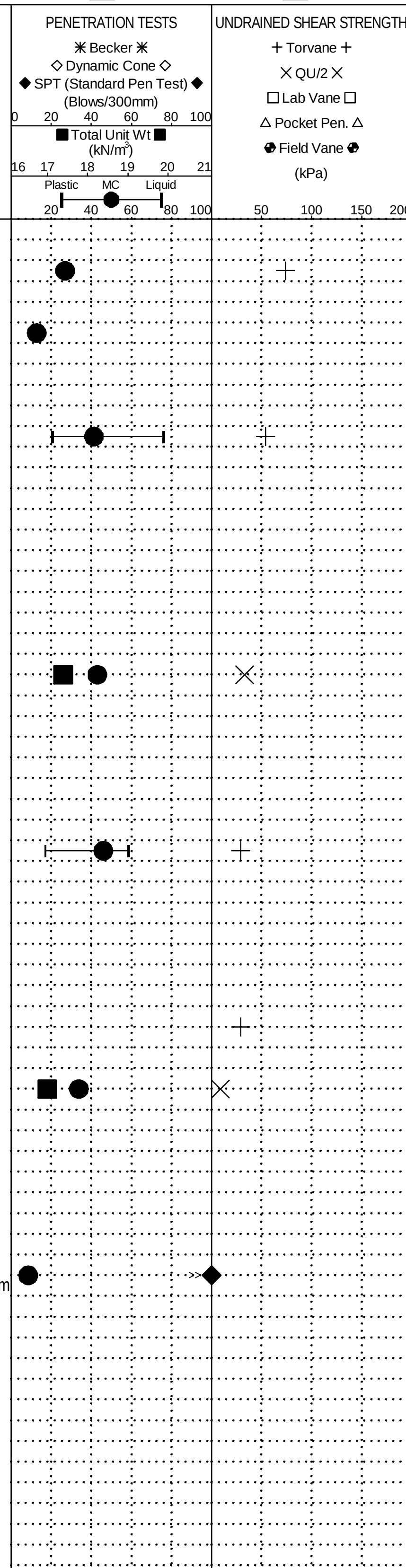


AECOM	LOGGED BY: CW	COMPLETION DEPTH: 11.43 m
	REVIEWED BY: GL	COMPLETION DATE: 23-8-24
	PROJECT ENGINEER: Mike Gaudreau	Page 1 of 1

PROJECT: St. Charles Wastewater Sewer Preliminary Design	CLIENT: The City of Winnipeg	TESTHOLE NO: TH23-06
LOCATION: UTM: 14U, 5526088.2 m N, 0620236.9 m E		PROJECT NO.: 60686223
CONTRACTOR: Paddock Drilling	METHOD: Solid Stem Auger	ELEVATION (m): 236.77

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	COMMENTS	ELEVATION
0	FILL	FILL: black fat CLAY, trace gravel - moist below 0 m	GRAB	G1			
	FILL	FILL: tan silty sand with gravel - moist below 0.61 m	GRAB	G2			236
1.52	CH	firm brown fat CLAY (CH) - moist below 1.52 m	GRAB	G3		(G3): Liquid Limit 76.1%, Plastic Limit 20.4%, Plasticity Index 55.7%; Gravel 0.2%, Sand 5.7%, Silt 20.6%, Clay 73.6%	235
			SHELBY TUBE	T4			234
		- silt inclusions below 3.96 m					233
		- very soft to soft below 4.57 m	GRAB	G5		(G5): Liquid Limit 58.4%, Plastic Limit 16.9%, Plasticity Index 41.5%; Gravel 0.1%, Sand 3.6%, Silt 25.4%, Clay 70.8%	232
		- grey below 5.18 m					231
			SHELBY TUBE	T6			
	TILL	POORLY GRADED SAND (SP-SM) with silt and gravel (TILL) - very loose to loose light grey - moist to wet below 6.25 m					230
		- dense to very dense below 7.77 m	SPLIT SPOON	S7	50/ 102mm		229
7.92		END OF TESTHOLE - auger refusal at a depth of 7.92 m in POORLY GRADED SAND (SP-SM) with silt and gravel (TILL) - heavy seepage was observed at a depth of 6.25 m in POORLY GRADED SAND (SP-SM) with silt and gravel (TILL) - no sloughing was observed - groundwater level was observed at a depth of 3.81 m upon completion of drilling					228, 227



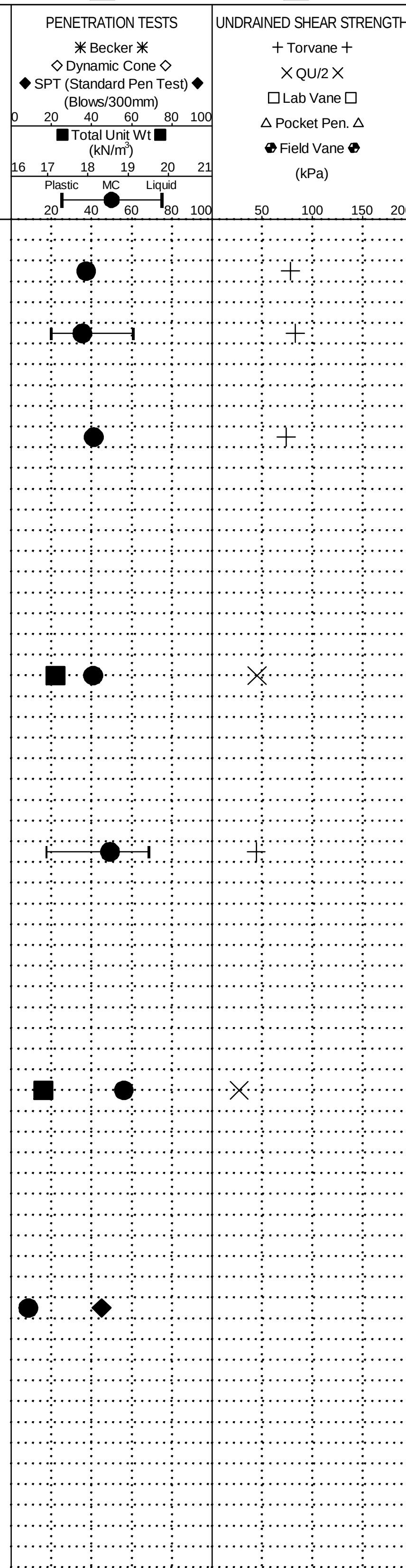
LOGGED BY: CW	COMPLETION DEPTH: 7.92 m
REVIEWED BY: GL	COMPLETION DATE: 23-8-24
PROJECT ENGINEER: Mike Gaudreau	Page 1 of 1

AECOM

PROJECT: St. Charles Wastewater Sewer Preliminary Design	CLIENT: The City of Winnipeg	TESTHOLE NO: TH23-07
LOCATION: UTM: 14U, 5526093.4 m N, 0620174.7 m E		PROJECT NO.: 60686223
CONTRACTOR: Paddock Drilling	METHOD: Solid Stem Auger	ELEVATION (m): 237.57

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	COMMENTS	ELEVATION
0	OR	TOPSOIL: black, moist, with organic content					
	CH	stiff brown fat CLAY (CH) - moist below 0.30 m	Grab	G1			237
			Grab	G2		(G2): Liquid Limit 60.6%, Plastic Limit 19.8%, Plasticity Index 40.8%; Gravel 0.1%, Sand 1.2%, Silt 26.0%, Clay 72.8%	
1			Grab	G3			236
2							235
3			Shelby Tube	T4			234
4		- firm to soft below 4.57 m	Grab	G5		(G5): Liquid Limit 68.5%, Plastic Limit 17.5%, Plasticity Index 51.0%; Gravel 0.0%, Sand 3.5%, Silt 34.8%, Clay 61.6%	233
5		- sloughing observed at a depth of 5.64 m					232
6		- silt inclusions below 6.10 m	Shelby Tube	T6			231
7	TILL	POORLY GRADED SAND (SP-SM) with silt and gravel (TILL) - compact to dense light grey - moist below 7.32 m	Split Spoon	S7	45		230
8		END OF TESTHOLE - auger refusal at a depth of 8.38 m in POORLY GRADED SAND (SP-SM) with silt and gravel (TILL) - heavy seepage observed at a depth of 7.62 m in POORLY GRADED SAND (SP-SM) with silt and gravel (TILL) - sloughing observed at a depth of 5.64 m - groundwater observed at a depth of 2.74 m					229
9							228
10							



AECOM

LOGGED BY: CW	COMPLETION DEPTH: 8.38 m
REVIEWED BY: GL	COMPLETION DATE: 23-8-24
PROJECT ENGINEER: Mike Gaudreau	Page 1 of 1

Appendix C

Laboratory Test Results

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

204 477 5381 tel
204 284 2040 fax

Memorandum

To	Colton Wooster	Page	1
CC			
Subject	St. Charles Wastewater District - Test Results		
From	Lee Boughton		
Date	September 18, 2023	Project Number	60686223.6.2

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

- Forty-two (42) Moisture Content Determination Test.
- Ten (10) Atterberg Limits (3 Points) Test.
- Ten (10) Grain Size Distribution (Hydrometer method) Test.
- Ten (10) Unconfined Compressive Strength of Cohesive Soils Test

If you have any questions, please contact the undersigned.

Prepared by:

Lee Boughton
Laboratory Manager

Reviewed by:

German Leal, M.Eng., P.Eng.
Discipline Lead, Geotechnical

Att.

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

Project Name:	St. Charles Wastewater Sewer District	Supplier:	AECOM
Project Number:	60686223	Specification:	N/A
Client:	City of Winnipeg - Water and Waste Department	Field Technician:	LTrinh/CWooster
Sample Location:	Winnipeg, Manitoba	Sample Date:	August 24-25, 2023
Sample Depth:	Varies	Lab Technician:	Ndizon
Sample Number:	Varies	Date Tested:	August 25-28, 2023

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 (%)
TH23-01	G1	0.30 - 0.46 m	**31.2%**
	G2	0.76 - 0.91 m	**35.3%**
	G3	1.52 - 1.68 m	**41.5%**
	G4	3.05 - 3.20 m	**53.1%**
	S6	6.10 - 6.55 m	**9.0%**
TH23-02	G1	0.30 - 0.46 m	**29.9%**
	G2	0.76 - 0.91 m	**28.2%**
	G3	1.52 - 1.68 m	**31.2%**
	G4	3.05 - 3.20 m	**51.4%**
	G5	4.57 - 4.72 m	**37.6%**
	G6	6.10 - 6.25 m	**51.2%**
	S7	7.62 - 8.08 m	**7.1%**
TH23-03	G1	0.30 - 0.46 m	**26.2%**
	G2	0.76 - 0.91 m	**30.4%**
	G3	1.52 - 1.68 m	**35.7%**
	G4	3.05 - 3.20 m	**59.3%**
	G5	4.57 - 4.72 m	**50.1%**
	S7	7.62 - 8.08 m	**13.9%**
	G8	8.23 - 8.38 m	**14.6%**
TH23-04	G1	0.30 - 0.46 m	**28.7%**
	G2	0.76 - 0.91 m	**24.1%**
	G3	1.52 - 1.68 m	**28.9%**
	G4	3.05 - 3.20 m	**51.2%**
	G6	6.10 - 6.25 m	**34.4%**
	S7	9.14 - 9.60 m	**8.6%**
TH23-05	G1	0.76 - 0.91 m	**35.0%**
	G2	1.52 - 1.68 m	**38.6%**
	G3	3.05 - 3.20 m	**45.1%**
	G5	5.94 - 6.10 m	**45.9%**
	G8	8.99 - 9.14 m	**16.5%**
	G9	11.28 - 11.43 m	**10.0%**
TH23-06	G1	0.30 - 0.46 m	**26.9%**
	G2	0.76 - 0.91 m	**12.7%**
	G3	1.52 - 1.68 m	**41.3%**
	G5	4.57 - 4.72 m	**46.0%**
	S7	7.92 - 8.38 m	**8.5%**
TH23-07	G1	0.30 - 0.46 m	**37.3%**
	G2	0.76 - 0.91 m	**35.4%**

Location	Sample	Depth (m)	Moisture Content (%)
	G3	1.52 - 1.68 m	**41.1%**
	G5	4.57 - 4.72 m	**49.2%**
	G7	7.62 - 7.77 m	**8.5%**

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

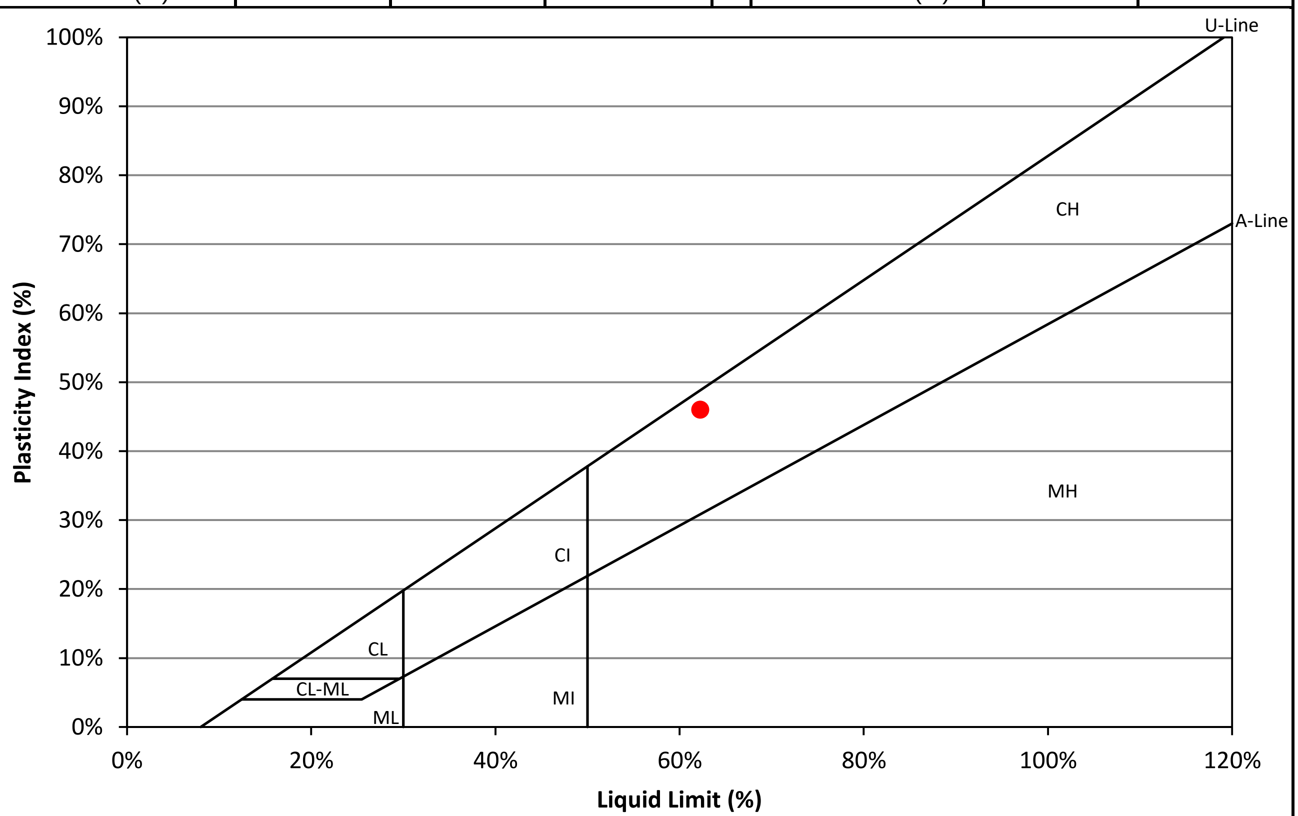
Project Name:	St. Charles WWS Preliminary Design	Supplier:	Not provided
Project Number:	60686223	Specification:	N/A
Client:	AECOM	Field Technician:	CWooster
Sample Location:	TH23-01	Sample Date:	August 25, 2023
Sample Depth:	3.05 - 3.20 m	Lab Technician:	LBoughton
Sample Number:	G4	Date Tested:	September 15, 2023

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit			
Blows	35	23	17
Wet Sample (g)	11.5	13.5	12.7
Dry Sample (g)	7.2	8.3	7.7
Water Content (%)	60.5%	62.3%	65.0%

Plastic Limit		
Trial	1	2
Wet Sample (g)	4.9	5.4
Dry Sample (g)	4.2	4.7
Water Content (%)	16.3%	16.1%



Liquid Limit (%): 62.3%	Plastic Limit (%): 16.2%	Plasticity Index (%): 46.0%

Reviewed by: Lee Boughton, Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng., Geotechnical Discipline Lead

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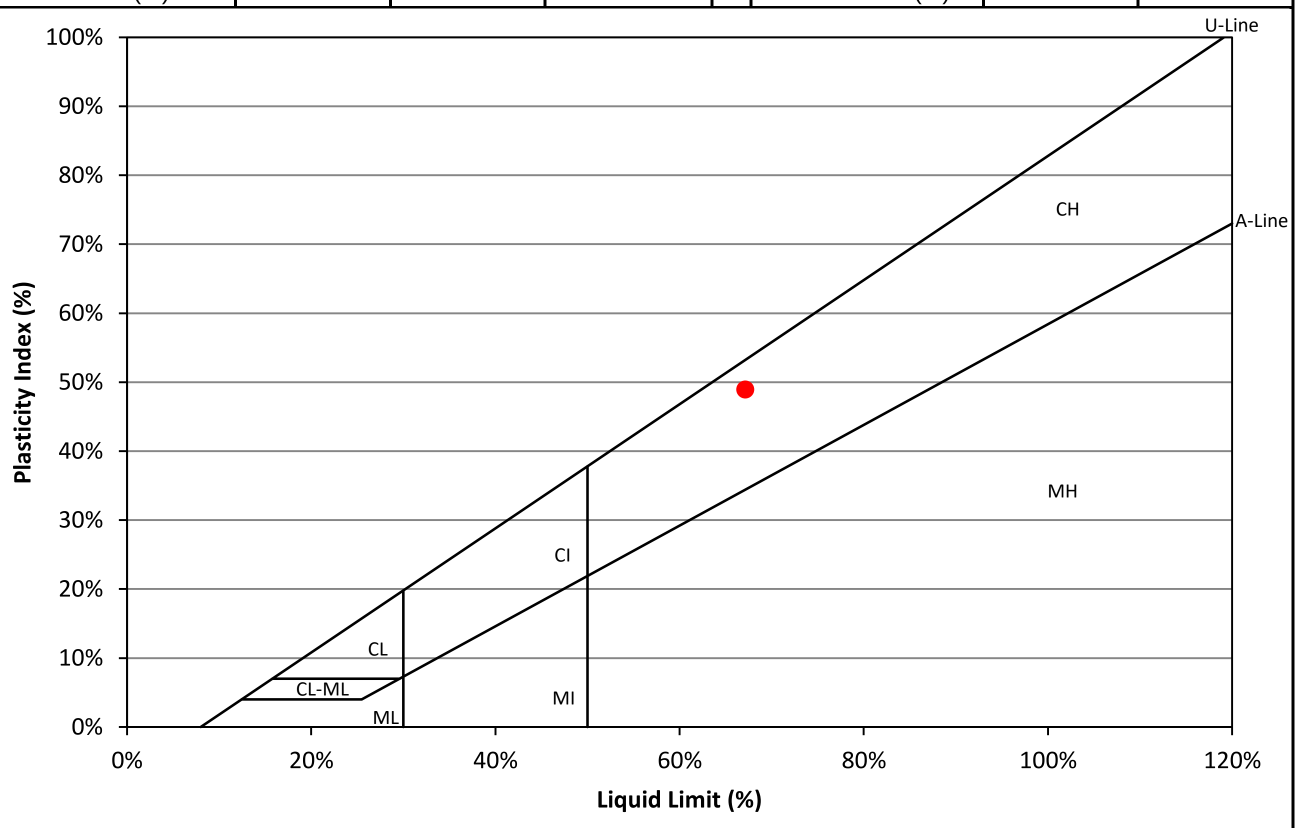
Project Name:	St. Charles WWS Preliminary Design	Supplier:	Not provided
Project Number:	60686223	Specification:	N/A
Client:	AECOM	Field Technician:	CWooster
Sample Location:	TH23-02	Sample Date:	August 25, 2023
Sample Depth:	0.76 - 0.91 m	Lab Technician:	LBoughton
Sample Number:	G2	Date Tested:	September 15, 2023

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit			
Blows	25	22	18
Wet Sample (g)	11.5	10.2	11.0
Dry Sample (g)	6.9	6.0	6.4
Water Content (%)	67.1%	68.6%	69.9%

Plastic Limit		
Trial	1	2
Wet Sample (g)	4.4	5.3
Dry Sample (g)	3.7	4.4
Water Content (%)	17.9%	18.5%



Liquid Limit (%): 67.1%	Plastic Limit (%): 18.2%	Plasticity Index (%): 49.0%

Reviewed by: Lee Boughton, Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng., Geotechnical Discipline Lead

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Winnipeg Geotechnical Laboratory
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Winnipeg, Manitoba
R3P 0Y7
Phone: 204 477 5381 Fax: 204 284 2040

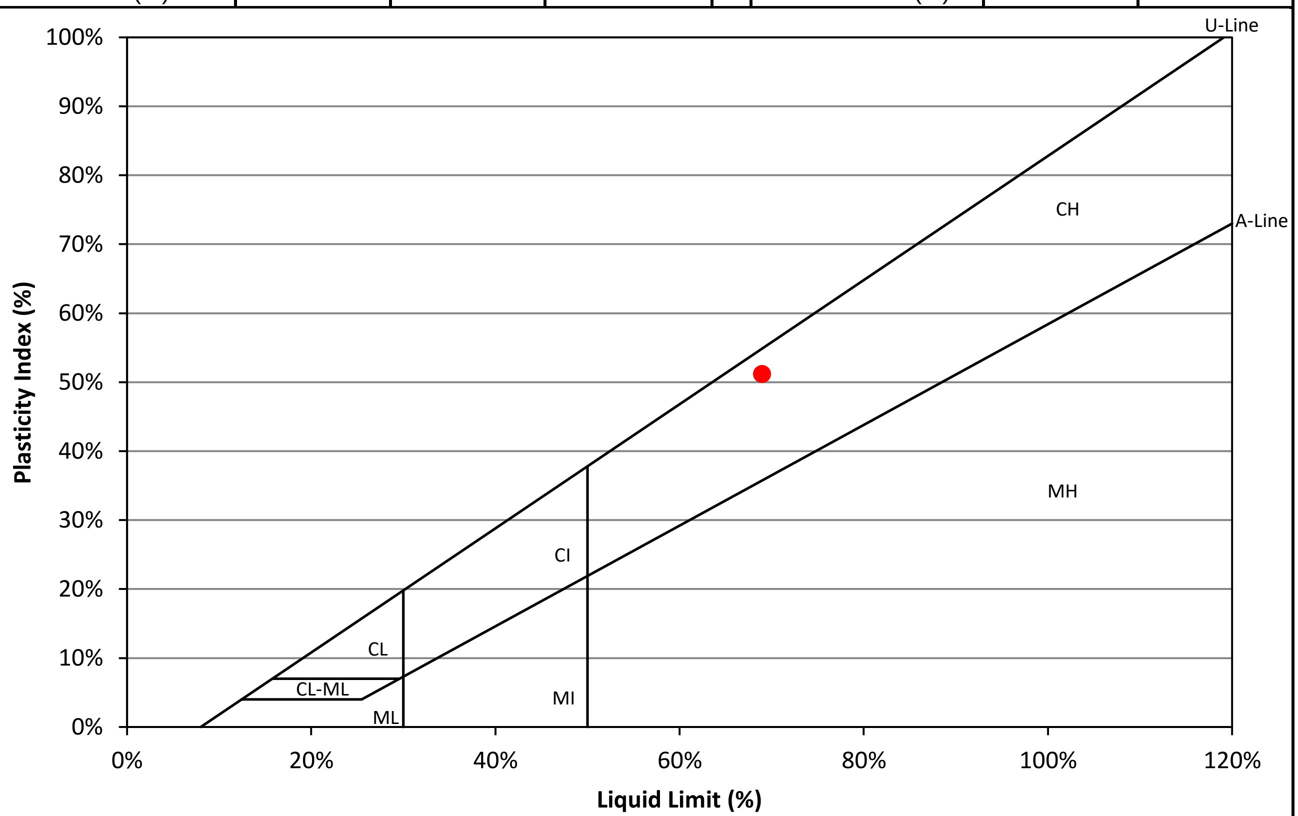
Project Name:	St. Charles WWS Preliminary Design	Supplier:	Not provided
Project Number:	60686223	Specification:	N/A
Client:	AECOM	Field Technician:	CWooster
Sample Location:	TH23-03	Sample Date:	August 25, 2023
Sample Depth:	0.76 - 0.91 m	Lab Technician:	LBoughton
Sample Number:	G2	Date Tested:	September 15, 2023

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit			
Blows	28	20	15
Wet Sample (g)	12.9	10.7	12.6
Dry Sample (g)	7.9	6.4	7.5
Water Content (%)	64.0%	67.7%	68.5%

Plastic Limit		
Trial	1	2
Wet Sample (g)	5.3	5.3
Dry Sample (g)	4.5	4.5
Water Content (%)	17.9%	17.7%



Liquid Limit (%): 69.0%	Plastic Limit (%): 17.8%	Plasticity Index (%): 51.2%

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
Geotechnical Discipline Lead

AECOM Canada Ltd.
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Phone: 204 477 5381 Fax: 204 284 2040

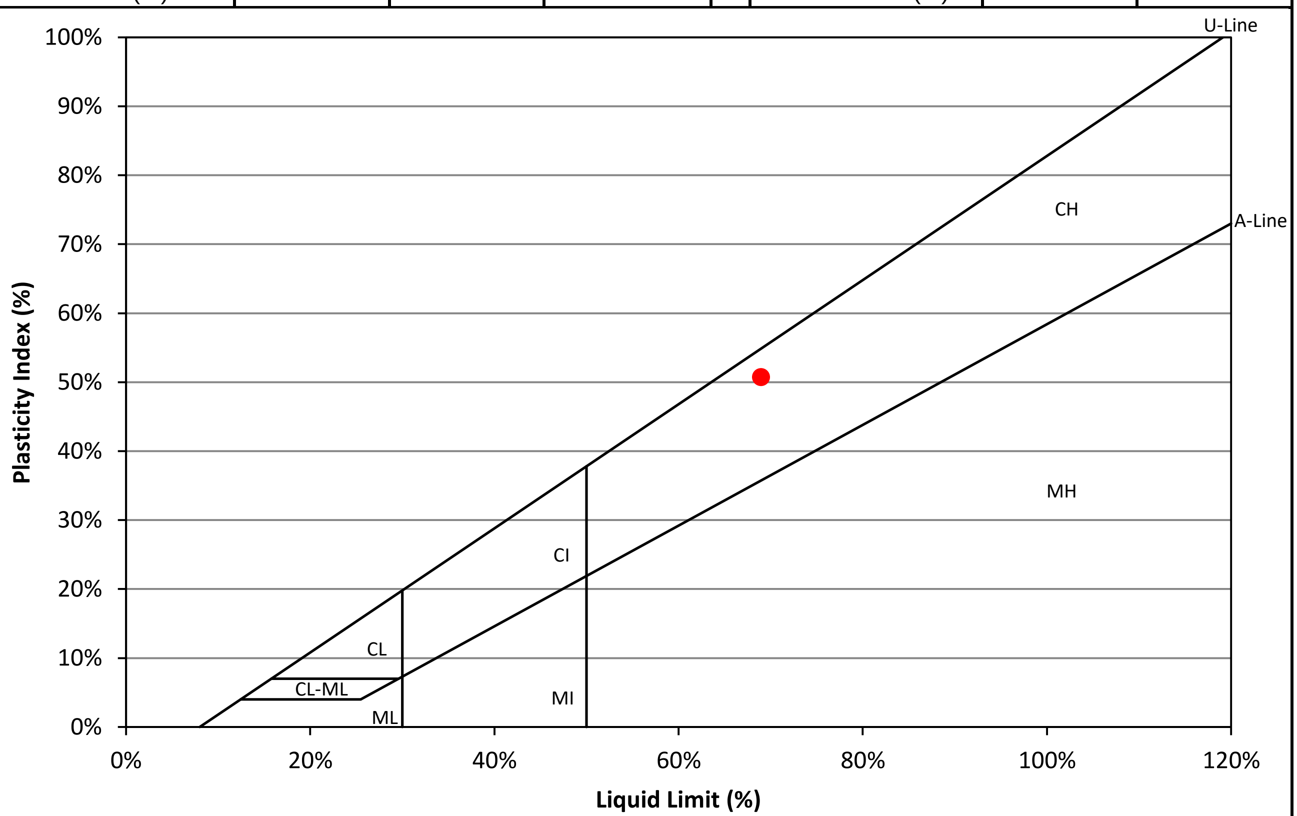
Project Name:	St. Charles WWS Preliminary Design	Supplier:	Not provided
Project Number:	60686223	Specification:	N/A
Client:	AECOM	Field Technician:	CWooster
Sample Location:	TH23-05	Sample Date:	August 25, 2023
Sample Depth:	0.76 - 0.91 m	Lab Technician:	LBoughton
Sample Number:	G1	Date Tested:	September 15, 2023

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit			
Blows	32	27	19
Wet Sample (g)	12.0	10.8	11.8
Dry Sample (g)	7.2	6.4	6.9
Water Content (%)	66.4%	68.5%	70.2%

Plastic Limit		
Trial	1	2
Wet Sample (g)	5.3	5.5
Dry Sample (g)	4.5	4.6
Water Content (%)	17.9%	18.5%



Liquid Limit (%): 69.0%	Plastic Limit (%): 18.2%	Plasticity Index (%): 50.7%

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
Geotechnical Discipline Lead

AECOM Canada Ltd.
Winnipeg Geotechnical Laboratory
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Phone: 204 477 5381 Fax: 204 284 2040

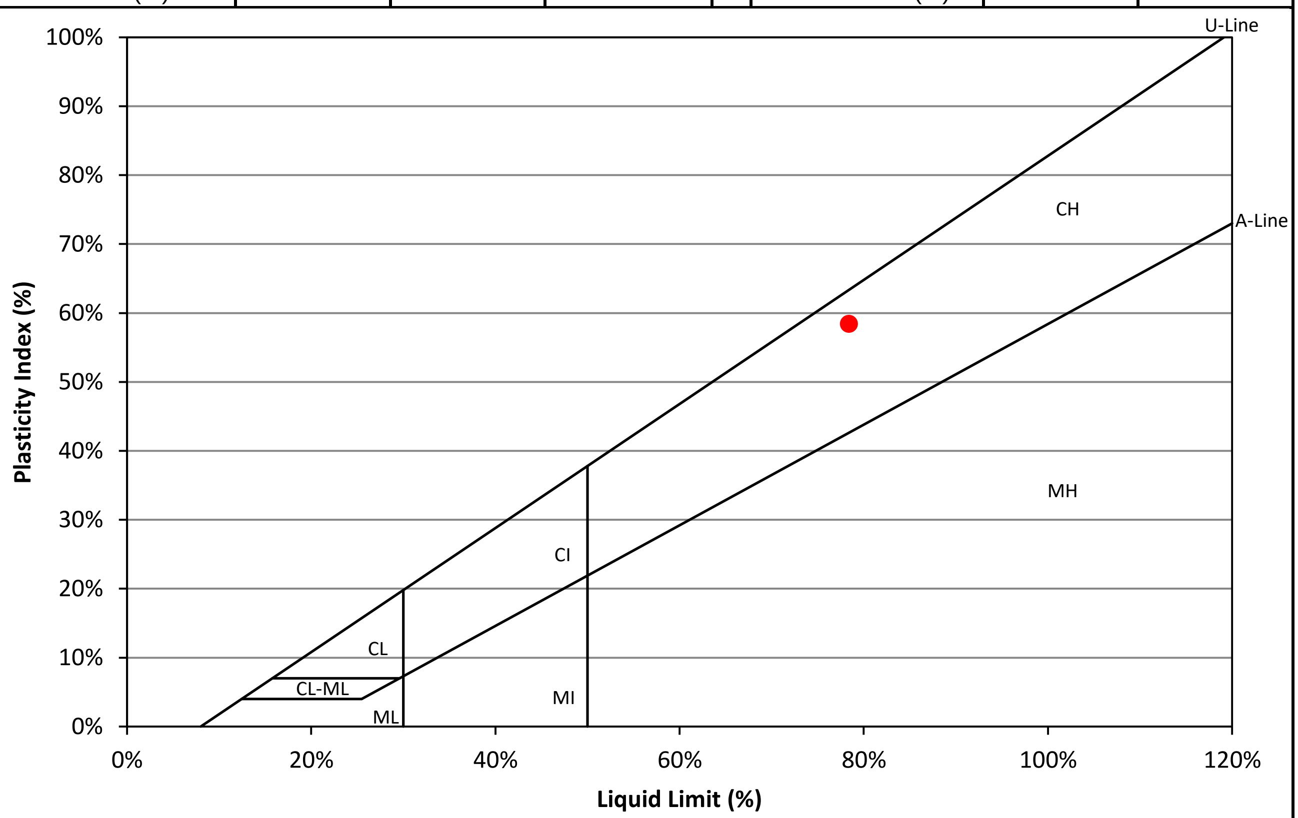
Project Name:	St. Charles WWS Preliminary Design	Supplier:	Not provided
Project Number:	60686223	Specification:	N/A
Client:	AECOM	Field Technician:	CWooster
Sample Location:	TH23-05	Sample Date:	August 25, 2023
Sample Depth:	3.05 - 3.20 m	Lab Technician:	LBoughton
Sample Number:	G3	Date Tested:	September 15, 2023

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit			
Blows	32	24	17
Wet Sample (g)	12.4	12.7	12.4
Dry Sample (g)	7.1	7.1	6.8
Water Content (%)	76.0%	78.6%	82.0%

Plastic Limit		
Trial	1	2
Wet Sample (g)	5.1	5.6
Dry Sample (g)	4.3	4.7
Water Content (%)	20.0%	19.8%



Liquid Limit (%): 78.4%	Plastic Limit (%): 19.9%	Plasticity Index (%): 58.5%

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
Geotechnical Discipline Lead

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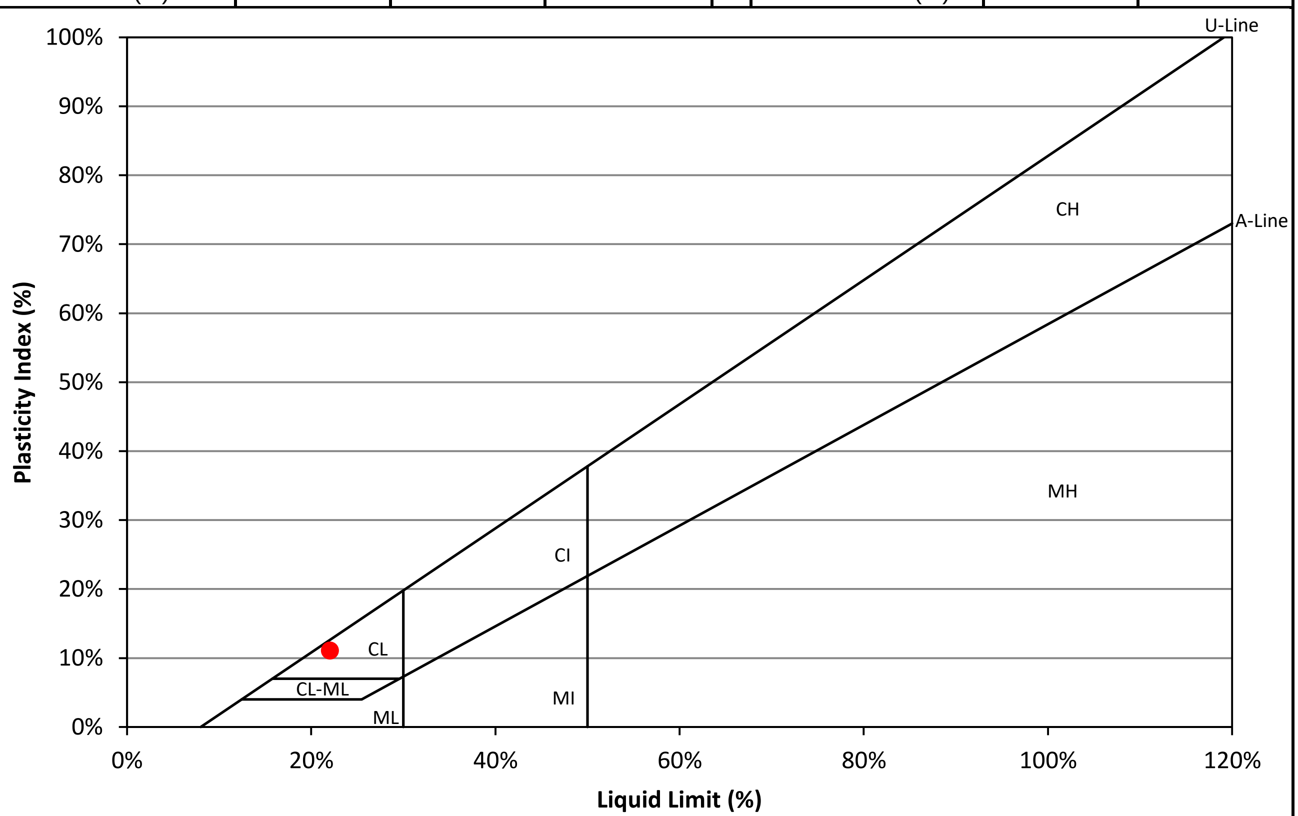
Project Name:	St. Charles WWS Preliminary Design	Supplier:	Not provided
Project Number:	60686223	Specification:	N/A
Client:	AECOM	Field Technician:	CWooster
Sample Location:	TH23-05	Sample Date:	August 25, 2023
Sample Depth:	8.99 - 9.14 m	Lab Technician:	LBoughton
Sample Number:	G8	Date Tested:	September 15, 2023

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit			
Blows	25	21	15
Wet Sample (g)	11.0	13.6	12.5
Dry Sample (g)	9.0	11.1	10.1
Water Content (%)	22.0%	22.7%	23.9%

Plastic Limit		
Trial	1	2
Wet Sample (g)	5.8	5.6
Dry Sample (g)	5.2	5.0
Water Content (%)	10.6%	11.2%



Liquid Limit (%): 22.0%	Plastic Limit (%): 10.9%	Plasticity Index (%): 11.1%

Reviewed by: Lee Boughton
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Approved by: German Leal, M.Eng., P.Eng.
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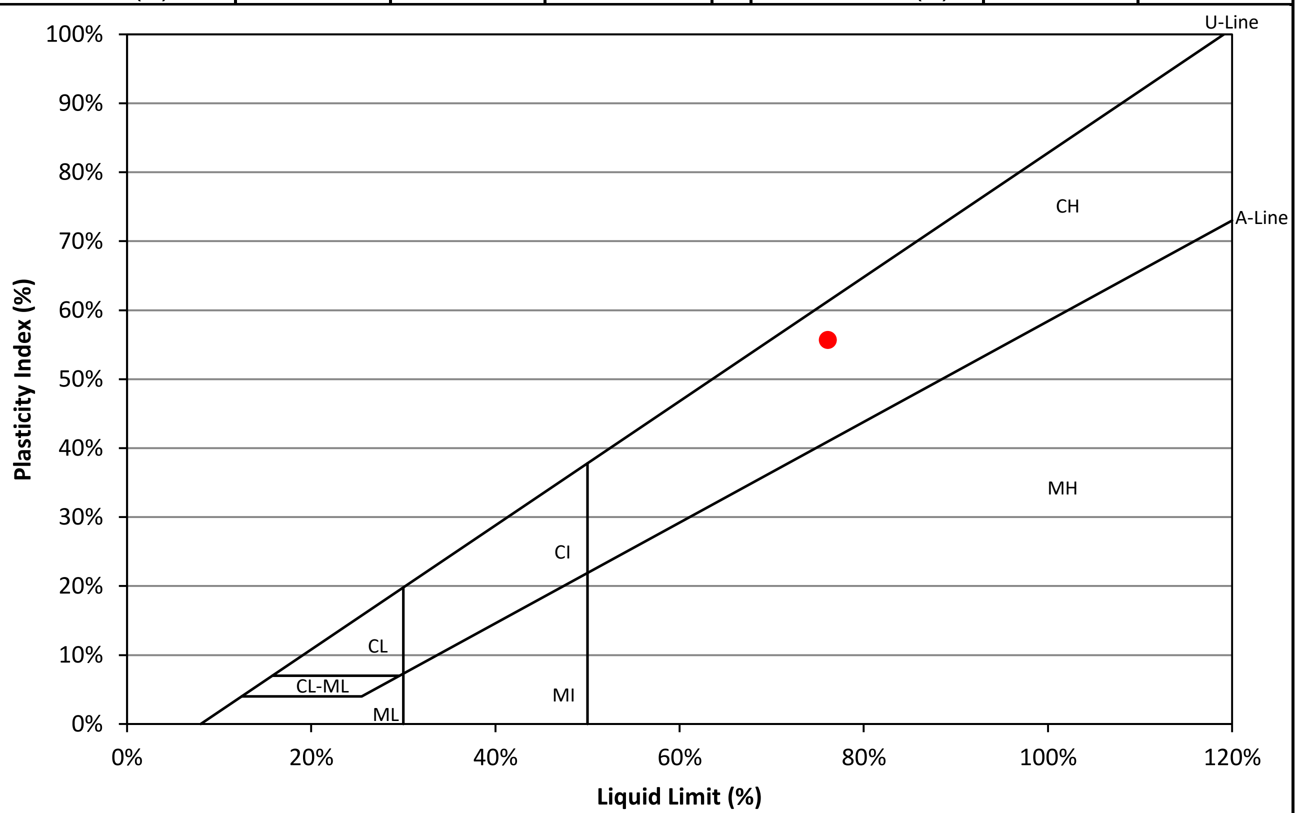
Project Name:	St. Charles WWS Preliminary Design	Supplier:	Not provided
Project Number:	60686223	Specification:	N/A
Client:	AECOM	Field Technician:	CWooster
Sample Location:	TH23-06	Sample Date:	August 25, 2023
Sample Depth:	1.52 - 1.68 m	Lab Technician:	LBoughton
Sample Number:	G3	Date Tested:	September 15, 2023

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit			
Blows	34	26	15
Wet Sample (g)	10.7	10.8	10.6
Dry Sample (g)	6.2	6.2	5.9
Water Content (%)	74.2%	75.3%	80.4%

Plastic Limit		
Trial	1	2
Wet Sample (g)	5.2	5.5
Dry Sample (g)	4.3	4.6
Water Content (%)	20.6%	20.2%



Liquid Limit (%): 76.1%	Plastic Limit (%): 20.4%	Plasticity Index (%): 55.7%

Reviewed by: Lee Boughton
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Approved by: German Leal, M.Eng., P.Eng.
Geotechnical Discipline Lead

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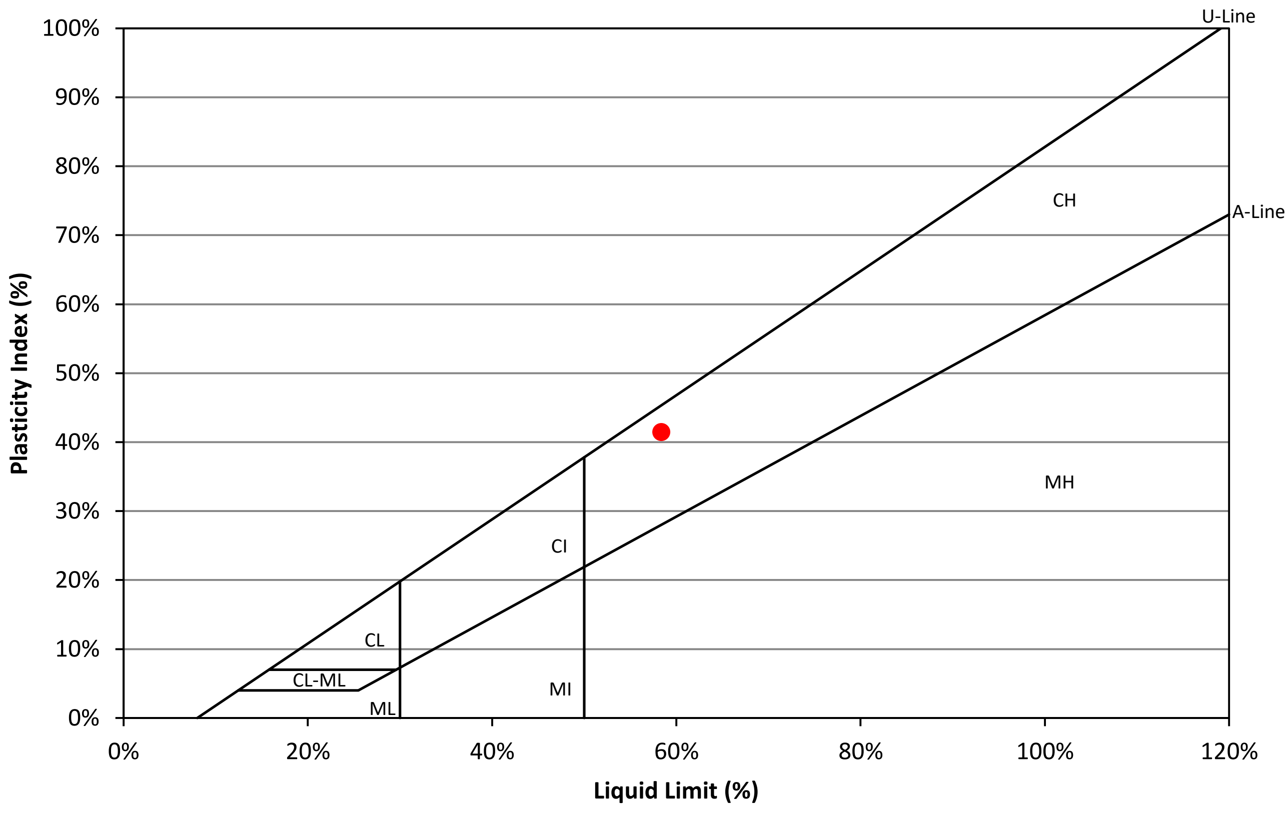
Project Name:	St. Charles WWS Preliminary Design	Supplier:	Not provided
Project Number:	60686223	Specification:	N/A
Client:	AECOM	Field Technician:	CWooster
Sample Location:	TH23-06	Sample Date:	August 25, 2023
Sample Depth:	4.57 - 4.72 m	Lab Technician:	LBoughton
Sample Number:	G5	Date Tested:	September 15, 2023

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit			
Blows	30	25	18
Wet Sample (g)	11.5	10.5	10.9
Dry Sample (g)	7.3	6.6	6.7
Water Content (%)	56.6%	58.7%	61.1%

Plastic Limit		
Trial	1	2
Wet Sample (g)	4.7	6.3
Dry Sample (g)	4.1	5.4
Water Content (%)	17.0%	16.8%



Liquid Limit (%): 58.4%	Plastic Limit (%): 16.9%	Plasticity Index (%): 41.5%

Reviewed by: Lee Boughton, Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng., Geotechnical Discipline Lead

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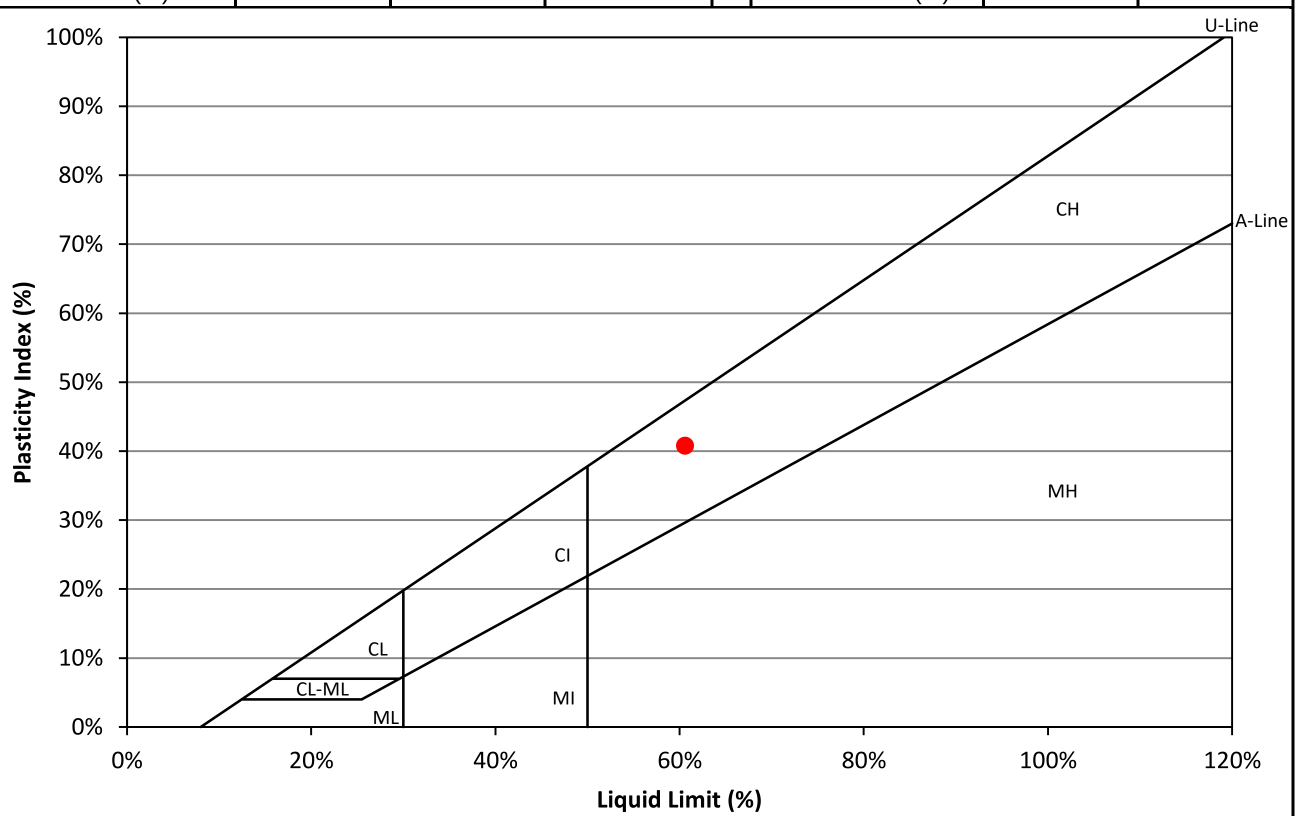
Project Name:	St. Charles WWS Preliminary Design	Supplier:	Not provided
Project Number:	60686223	Specification:	N/A
Client:	AECOM	Field Technician:	CWooster
Sample Location:	TH23-07	Sample Date:	August 25, 2023
Sample Depth:	0.76 - 0.91 m	Lab Technician:	LBoughton
Sample Number:	G2	Date Tested:	September 15, 2023

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit			
Blows	32	27	17
Wet Sample (g)	11.1	13.0	14.5
Dry Sample (g)	6.9	8.1	9.0
Water Content (%)	59.9%	60.4%	61.3%

Plastic Limit		
Trial	1	2
Wet Sample (g)	4.9	5.6
Dry Sample (g)	4.1	4.6
Water Content (%)	19.6%	19.9%



Liquid Limit (%): 60.6%	Plastic Limit (%): 19.8%	Plasticity Index (%): 40.8%

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
Geotechnical Discipline Lead

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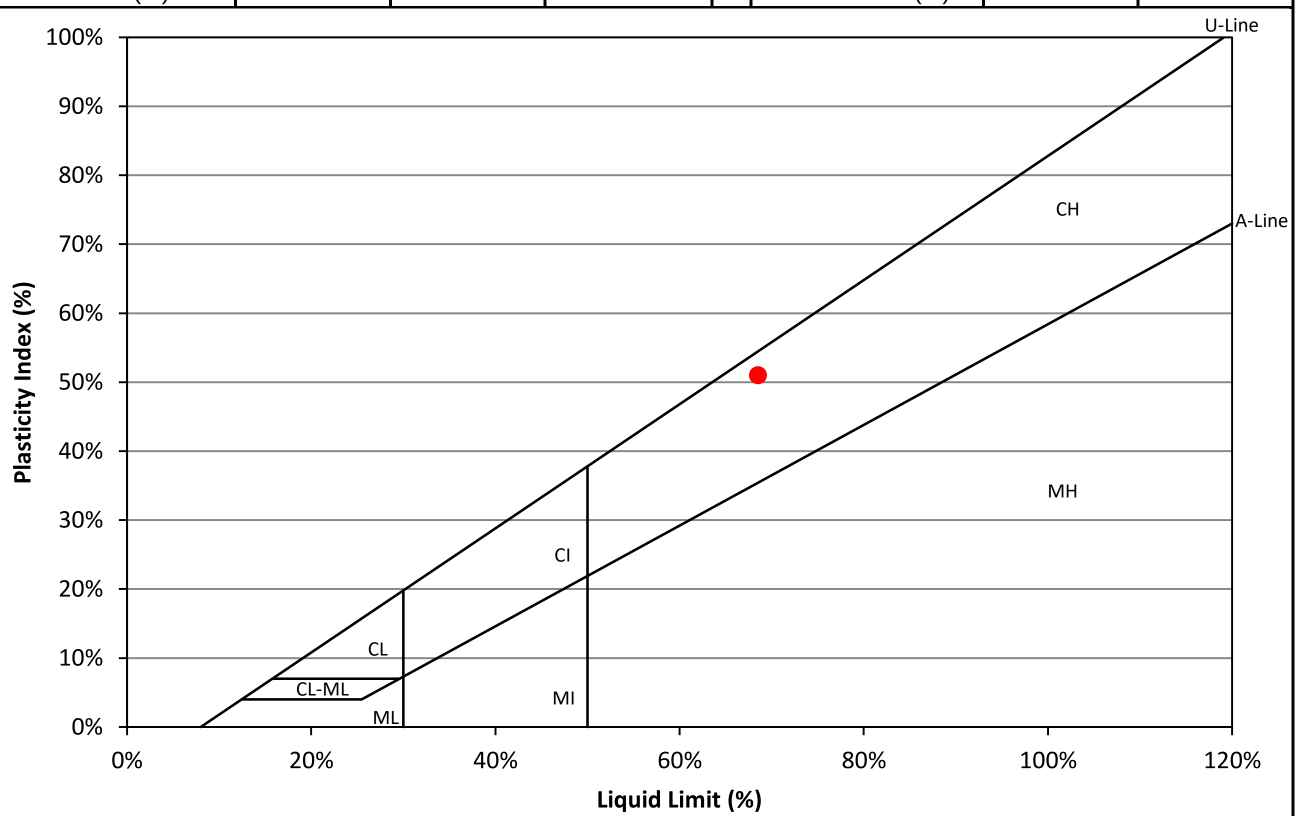
Project Name:	St. Charles WWS Preliminary Design	Supplier:	Not provided
Project Number:	60686223	Specification:	N/A
Client:	AECOM	Field Technician:	CWooster
Sample Location:	TH23-07	Sample Date:	August 25, 2023
Sample Depth:	4.57 - 4.72 m	Lab Technician:	LBoughton
Sample Number:	G5	Date Tested:	September 15, 2023

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit			
Blows	35	22	15
Wet Sample (g)	11.3	12.1	12.0
Dry Sample (g)	6.8	7.2	7.0
Water Content (%)	66.7%	68.6%	72.8%

Plastic Limit		
Trial	1	2
Wet Sample (g)	5.2	5.1
Dry Sample (g)	4.5	4.3
Water Content (%)	17.7%	17.3%



Liquid Limit (%): 68.5%	Plastic Limit (%): 17.5%	Plasticity Index (%): 51.0%

Reviewed by: Lee Boughton, Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng., Geotechnical Discipline Lead

GRAIN SIZE DISTRIBUTION
(ASTM D422-63)

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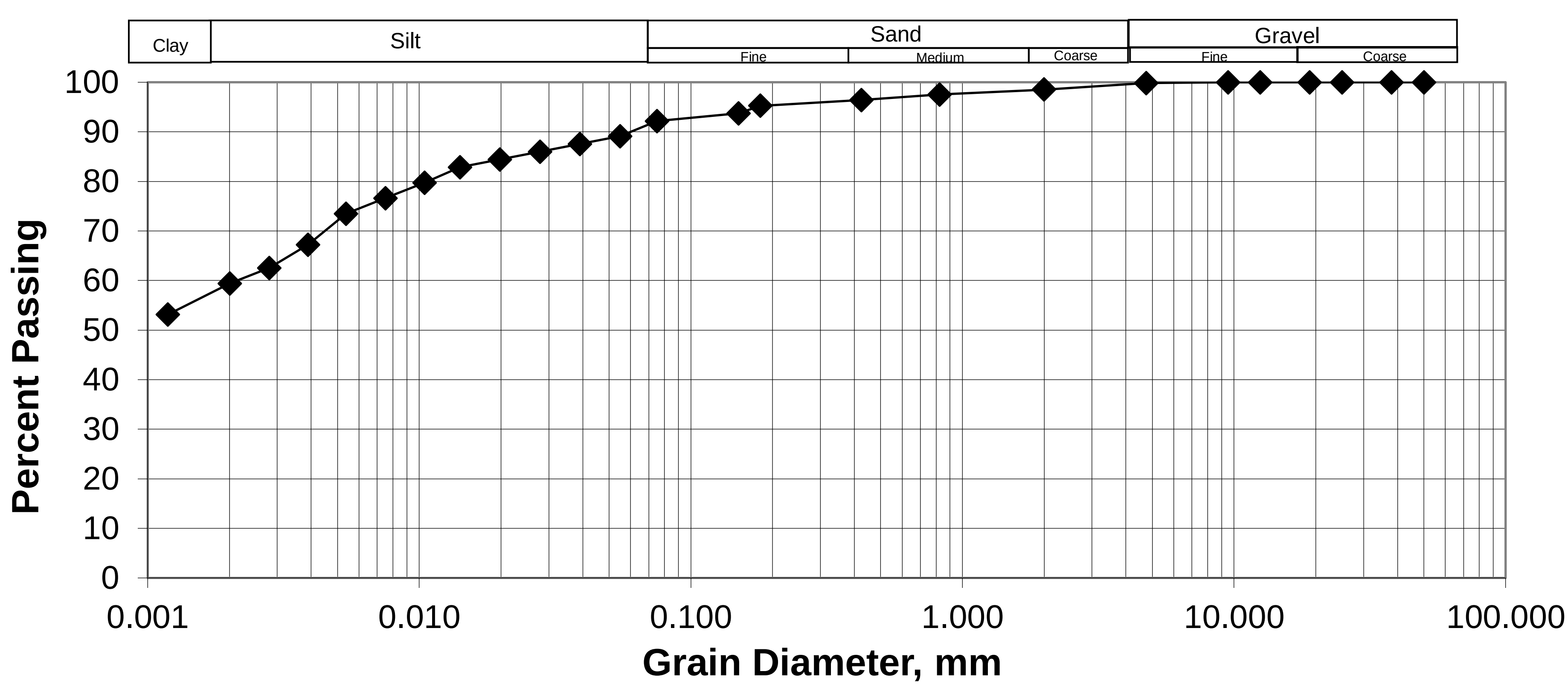
Job No.:	60686223	Hole No.:	TH23-01
Client:	AECOM	Sample No.:	G4
Project :	St. Charles Wastewater District	Depth:	3.05 - 3.20 m
Date Tested:	07-Sep-23	Date Sampled:	25-Aug-23
Tested By:	NDizon	Sampled By:	AECOM

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	4.75	99.8	0.0750	92.2
38.0	100.0	2.00	98.5	0.0548	89.1
25.0	100.0	0.825	97.5	0.0391	87.6
19.0	100.0	0.425	96.4	0.0278	86.0
12.5	100.0	0.18	95.3	0.0198	84.4
9.5	100.0	0.15	93.7	0.0141	82.9
4.75	99.8	0.075	92.2	0.0105	79.7
				0.0075	76.6
				0.0054	73.5
				0.0039	67.2
				0.0028	62.5
				0.0020	59.4
				0.0012	53.1

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**0.2%**	**Silt**	**32.8%**
Sand	**7.6%**	**Clay**	**59.4%**

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
Geotechnical Discipline Lead

GRAIN SIZE DISTRIBUTION
(ASTM D422-63)

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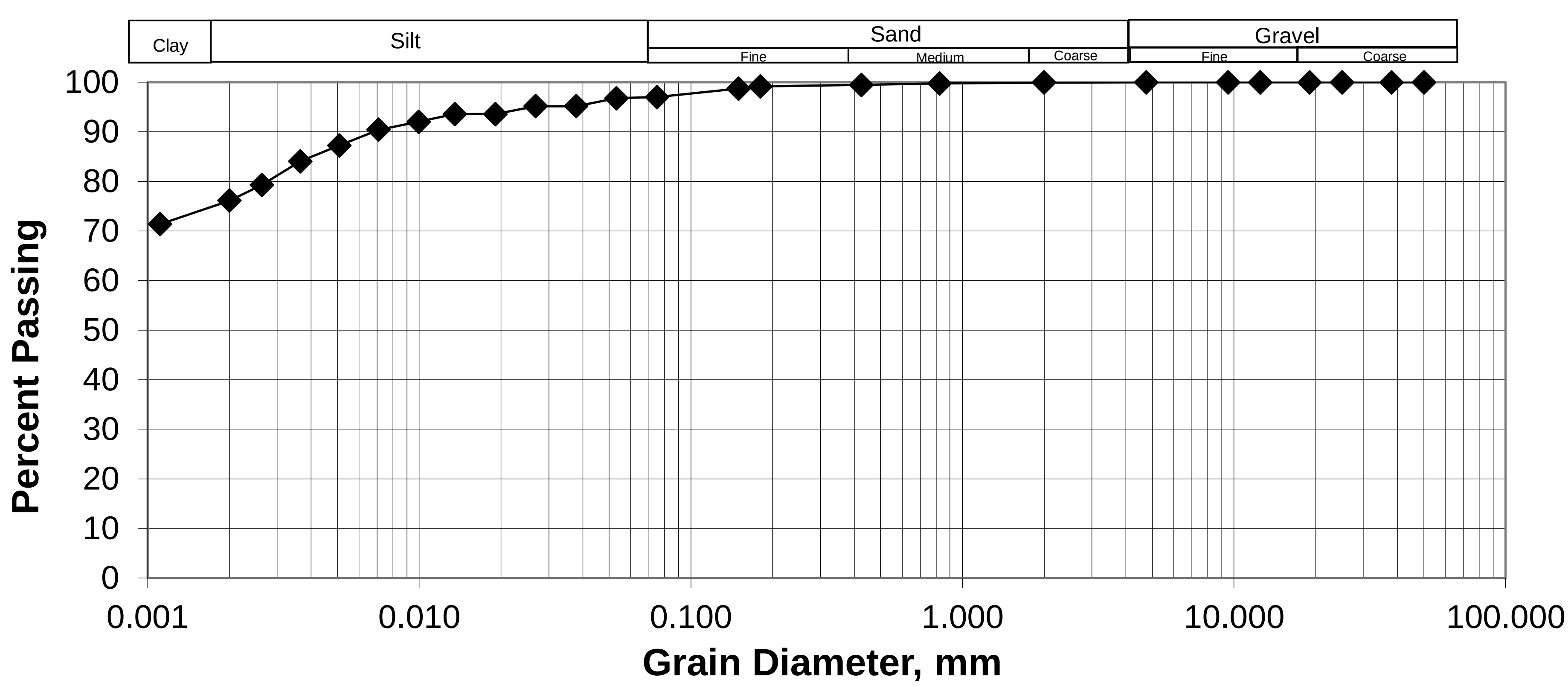
Job No.:	60686223	Hole No.:	TH23-02
Client:	AECOM	Sample No.:	G2
Project :	St. Charles Wastewater District	Depth:	0.76 - 0.91 m
Date Tested:	07-Sep-23	Date Sampled:	25-Aug-23
Tested By:	NDizon	Sampled By:	AECOM

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	4.75	100.0	0.0750	97.0
38.0	100.0	2.00	99.9	0.0532	96.8
25.0	100.0	0.825	99.8	0.0379	95.2
19.0	100.0	0.425	99.5	0.0268	95.2
12.5	100.0	0.18	99.2	0.0191	93.6
9.5	100.0	0.15	98.7	0.0135	93.6
4.75	100.0	0.075	97.0	0.0099	92.0
				0.0071	90.4
				0.0051	87.2
				0.0036	84.1
				0.0026	79.3
				0.0020	76.1
				0.0011	71.4

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**0.0%**	**Silt**	**20.9%**
Sand	**3.0%**	**Clay**	**76.1%**

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
Geotechnical Discipline Lead

GRAIN SIZE DISTRIBUTION
(ASTM D422-63)

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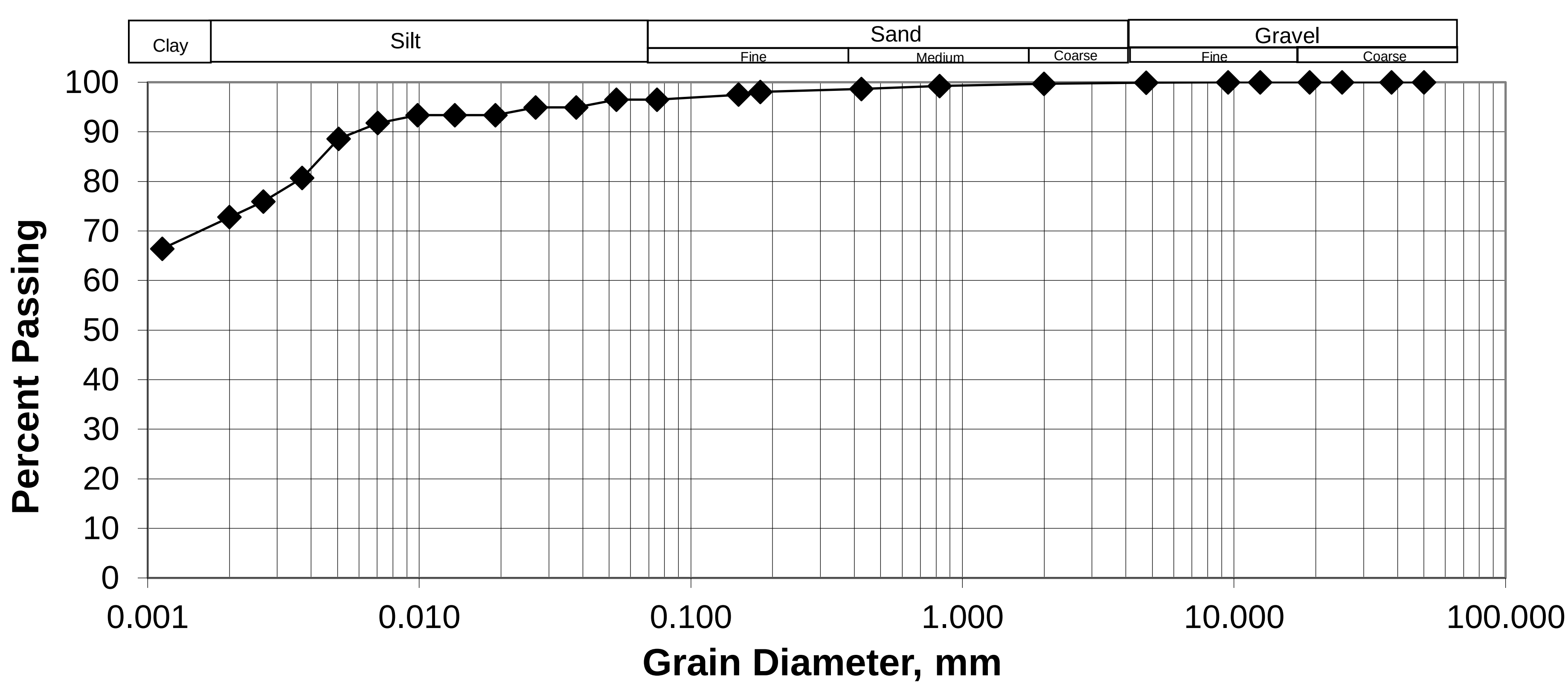
99 Commerce Dr., Winnipeg, MB R3P 0Y7 Canada
tel (204) 477-5381 **fax** (431) 800-1210

Job No.:	60686223	Hole No.:	TH23-03
Client:	AECOM	Sample No.:	G2
Project :	St. Charles Wastewater District	Depth:	0.76 - 0.91 m
Date Tested:	07-Sep-23	Date Sampled:	25-Aug-23
Tested By:	NDizon	Sampled By:	AECOM

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	4.75	99.9	0.0750	96.5
38.0	100.0	2.00	99.7	0.0532	96.5
25.0	100.0	0.825	99.2	0.0379	94.9
19.0	100.0	0.425	98.7	0.0268	94.9
12.5	100.0	0.18	98.0	0.0191	93.3
9.5	100.0	0.15	97.5	0.0135	93.3
4.75	99.9	0.075	96.5	0.0099	93.3
				0.0070	91.8
				0.0050	88.6
				0.0037	80.7
				0.0027	75.9
				0.0020	72.8
				0.0011	66.4

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**0.1%**	**Silt**	**23.7%**
Sand	**3.4%**	**Clay**	**72.8%**

Reviewed by: Lee Boughton, Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng., Geotechnical Discipline Lead

GRAIN SIZE DISTRIBUTION
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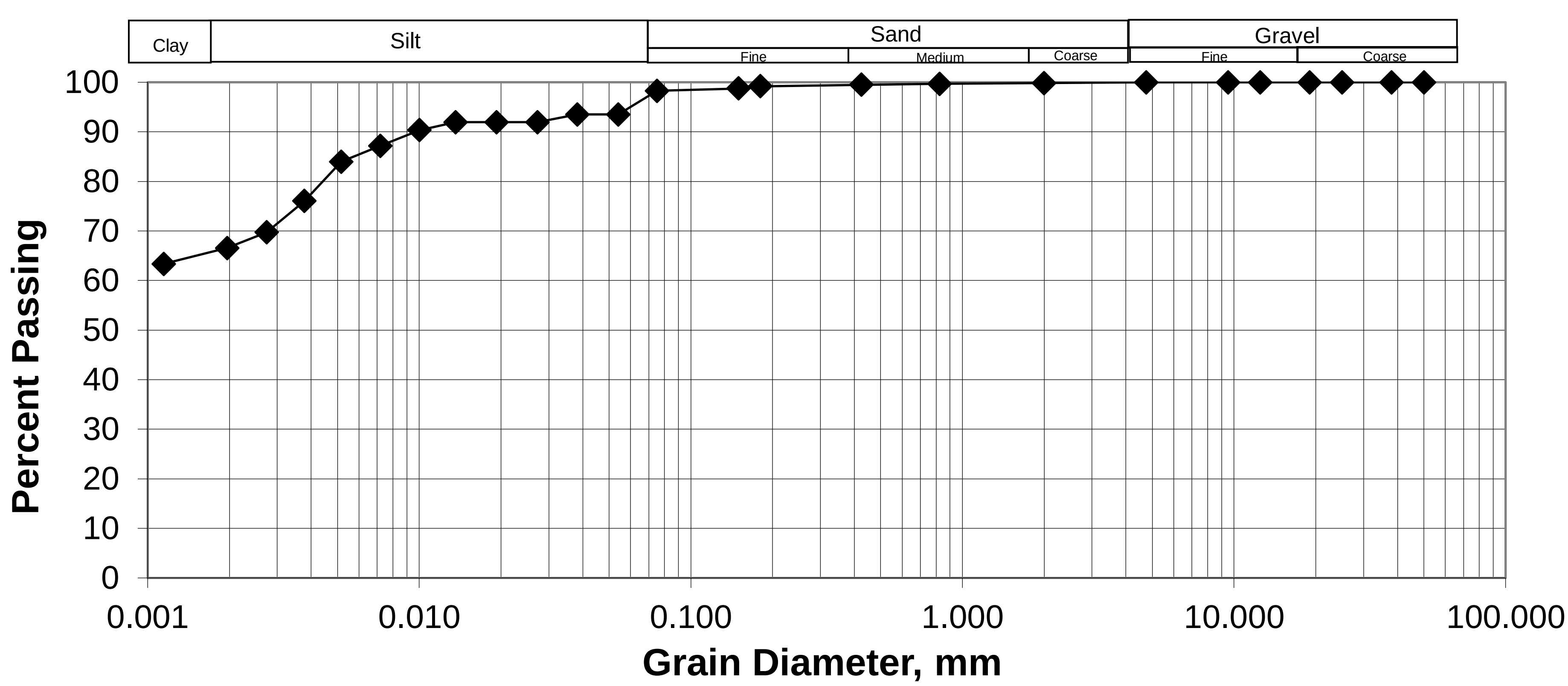
Job No.:	60686223	Hole No.:	TH23-05
Client:	AECOM	Sample No.:	G1
Project :	St. Charles Wastewater District	Depth:	0.76 - 0.91 m
Date Tested:	07-Sep-23	Date Sampled:	25-Aug-23
Tested By:	NDizon	Sampled By:	AECOM

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	4.75	100.0	0.0750	98.3
38.0	100.0	2.00	99.8	0.0540	93.5
25.0	100.0	0.825	99.7	0.0382	93.5
19.0	100.0	0.425	99.5	0.0272	91.9
12.5	100.0	0.18	99.2	0.0192	91.9
9.5	100.0	0.15	98.8	0.0136	91.9
4.75	100.0	0.075	98.3	0.0100	90.3
				0.0072	87.2
				0.0052	84.0
				0.0038	76.1
				0.0027	69.7
				0.0020	66.5
				0.0011	63.4

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**0.0%**	**Silt**	**31.7%**
Sand	**1.7%**	**Clay**	**66.5%**

Reviewed by: Lee Boughton, Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng., Geotechnical Discipline Lead

GRAIN SIZE DISTRIBUTION
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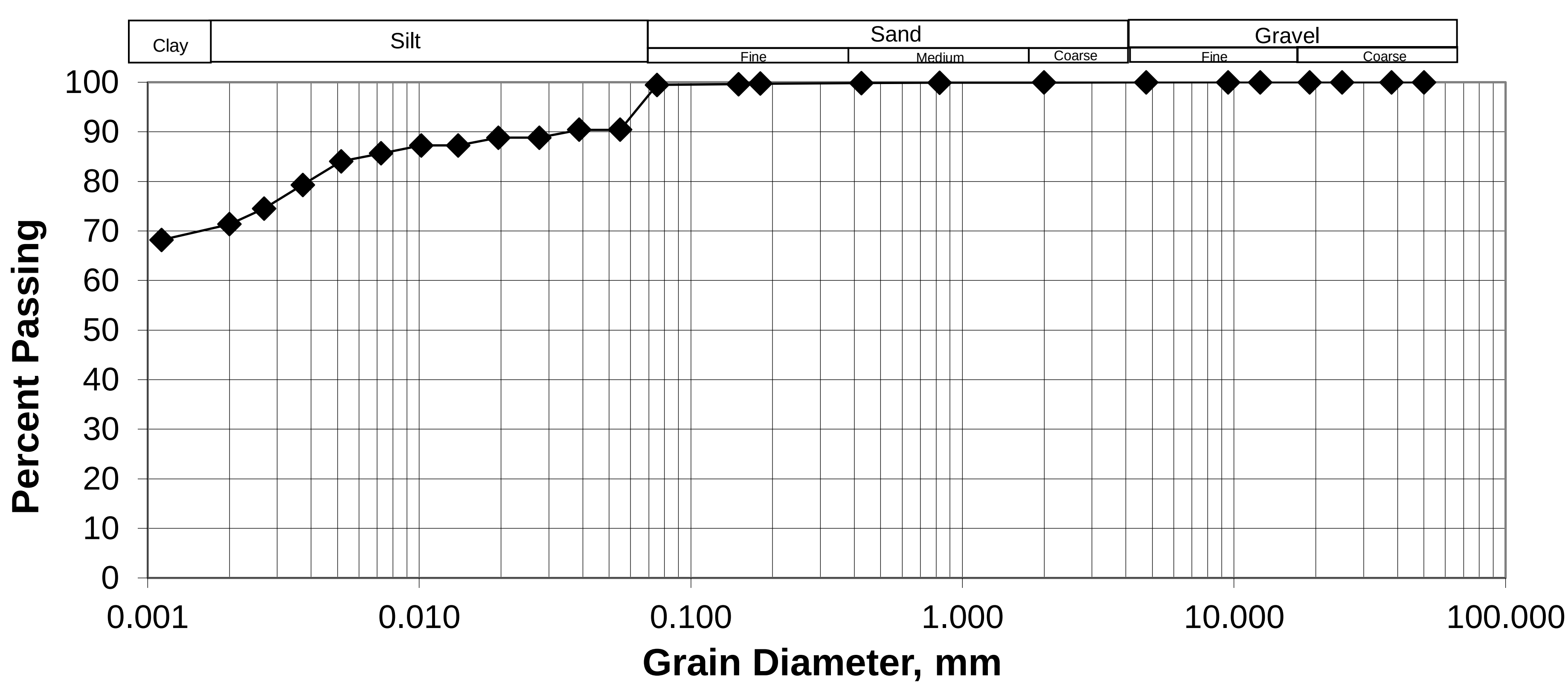
Job No.:	60686223	Hole No.:	TH23-05
Client:	AECOM	Sample No.:	G3
Project :	St. Charles Wastewater District	Depth:	3.05 - 3.20 m
Date Tested:	07-Sep-23	Date Sampled:	25-Aug-23
Tested By:	NDizon	Sampled By:	AECOM

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	4.75	100.0	0.0750	99.4
38.0	100.0	2.00	99.9	0.0548	90.4
25.0	100.0	0.825	99.9	0.0388	90.4
19.0	100.0	0.425	99.8	0.0276	88.8
12.5	100.0	0.18	99.7	0.0195	88.8
9.5	100.0	0.15	99.6	0.0139	87.2
4.75	100.0	0.075	99.4	0.0102	87.2
				0.0072	85.7
				0.0052	84.1
				0.0037	79.3
				0.0027	74.5
				0.0020	71.4
				0.0011	68.2

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**0.0%**	**Silt**	**28.1%**
Sand	**0.5%**	**Clay**	**71.4%**

Reviewed by: Lee Boughton, Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng., Geotechnical Discipline Lead

GRAIN SIZE DISTRIBUTION
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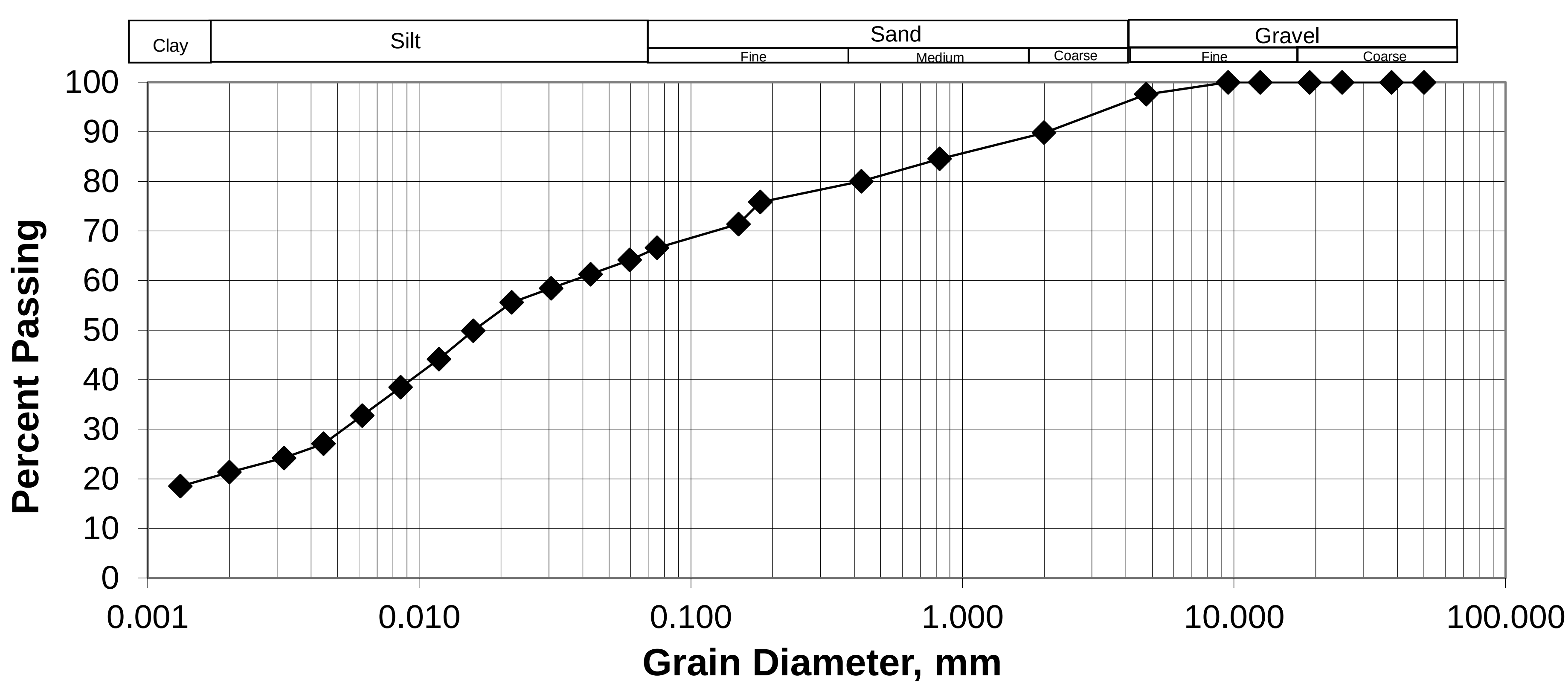
Job No.:	60686223	Hole No.:	TH23-05
Client:	AECOM	Sample No.:	G8
Project :	St. Charles Wastewater District	Depth:	8.99 - 9.14 m
Date Tested:	08-Sep-23	Date Sampled:	25-Aug-23
Tested By:	NDizon	Sampled By:	AECOM

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	4.75	97.5	0.0750	66.6
38.0	100.0	2.00	89.8	0.0596	64.1
25.0	100.0	0.825	84.5	0.0427	61.3
19.0	100.0	0.425	80.0	0.0306	58.4
12.5	100.0	0.18	75.8	0.0219	55.6
9.5	100.0	0.15	71.4	0.0158	49.9
4.75	97.5	0.075	66.6	0.0118	44.2
				0.0085	38.5
				0.0062	32.8
				0.0044	27.0
				0.0032	24.2
				0.0020	21.3
				0.0013	18.5

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**2.5%**	**Silt**	**45.3%**
Sand	**30.9%**	**Clay**	**21.3%**

Reviewed by: Lee Boughton, Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng., Geotechnical Discipline Lead

GRAIN SIZE DISTRIBUTION
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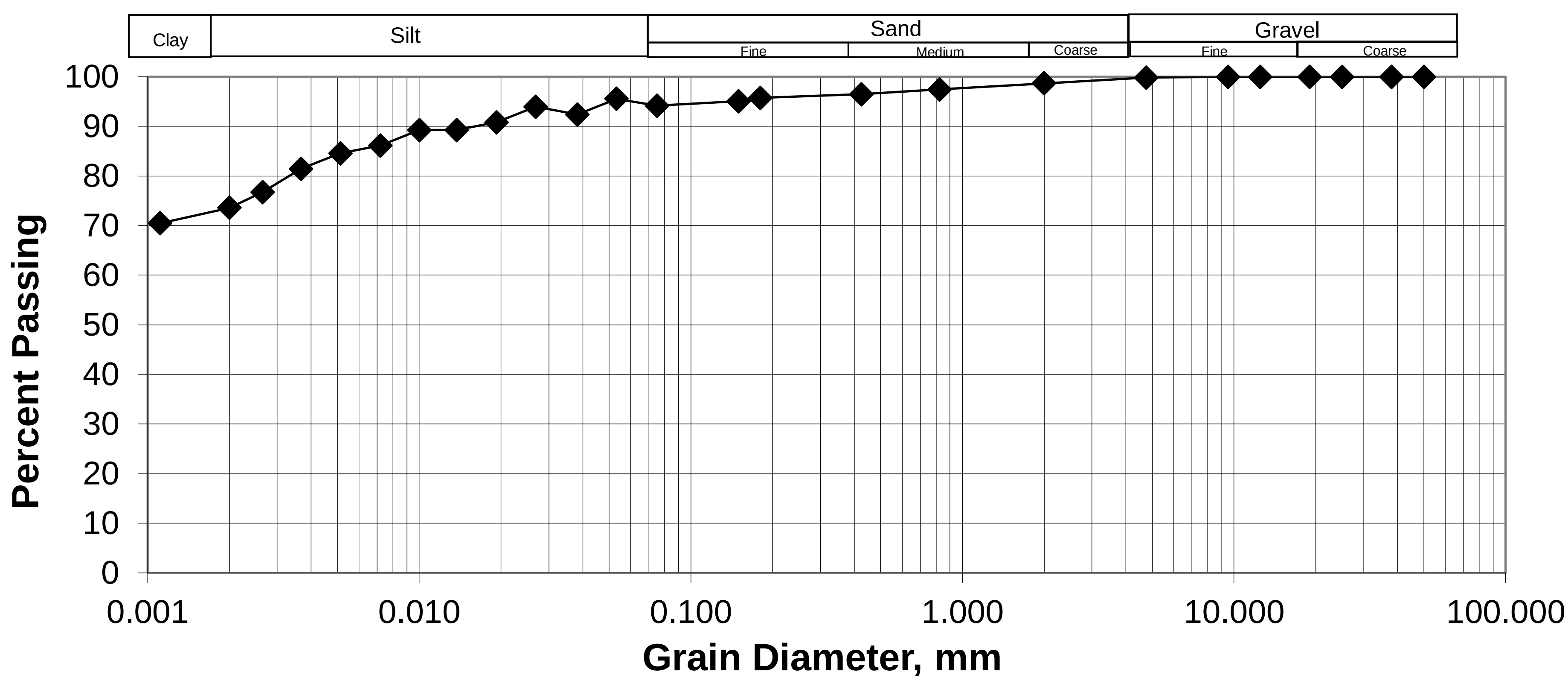
Job No.:	60686223	Hole No.:	TH23-06
Client:	AECOM	Sample No.:	G3
Project :	St. Charles Wastewater District	Depth:	1.52 - 1.68 m
Date Tested:	08-Sep-23	Date Sampled:	25-Aug-23
Tested By:	NDizon	Sampled By:	AECOM

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	4.75	99.8	0.0750	94.2
38.0	100.0	2.00	98.7	0.0532	95.5
25.0	100.0	0.825	97.4	0.0382	92.4
19.0	100.0	0.425	96.5	0.0268	94.0
12.5	100.0	0.18	95.7	0.0192	90.8
9.5	100.0	0.15	95.1	0.0137	89.3
4.75	99.8	0.075	94.2	0.0100	89.3
				0.0072	86.1
				0.0051	84.6
				0.0037	81.4
				0.0027	76.7
				0.0020	73.6
				0.0011	70.5

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**0.2%**	**Silt**	**20.6%**
Sand	**5.7%**	**Clay**	**73.6%**

Reviewed by: Lee Boughton, Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng., Geotechnical Discipline Lead

GRAIN SIZE DISTRIBUTION
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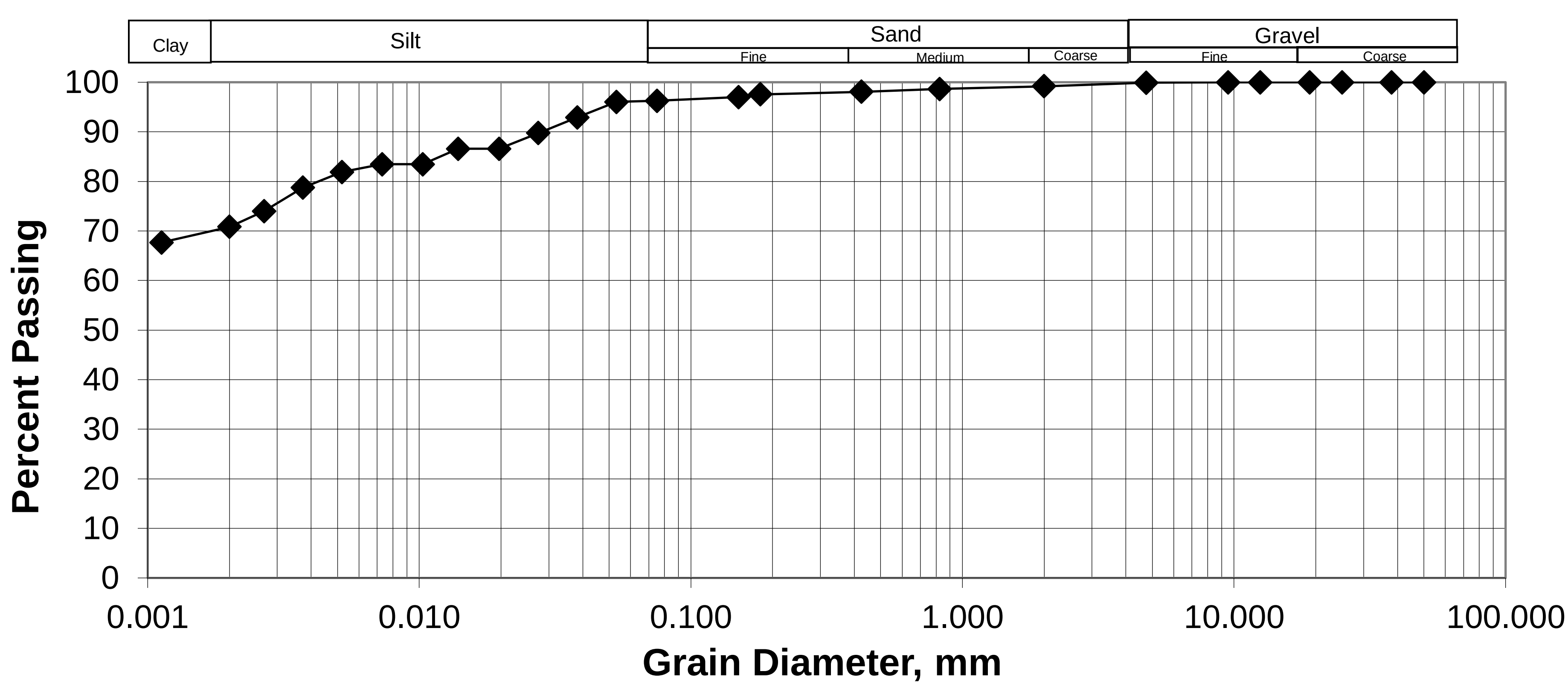
Job No.:	60686223	Hole No.:	TH23-06
Client:	AECOM	Sample No.:	G5
Project :	St. Charles Wastewater District	Depth:	4.57 - 4.72 m
Date Tested:	08-Sep-23	Date Sampled:	25-Aug-23
Tested By:	NDizon	Sampled By:	AECOM

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	4.75	99.9	0.0750	96.3
38.0	100.0	2.00	99.2	0.0532	96.1
25.0	100.0	0.825	98.6	0.0382	92.9
19.0	100.0	0.425	98.1	0.0274	89.7
12.5	100.0	0.18	97.6	0.0197	86.6
9.5	100.0	0.15	97.0	0.0139	86.6
4.75	99.9	0.075	96.3	0.0103	83.4
				0.0073	83.4
				0.0052	81.9
				0.0037	78.7
				0.0027	74.0
				0.0020	70.8
				0.0011	67.7

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**0.1%**	**Silt**	**25.4%**
Sand	**3.6%**	**Clay**	**70.8%**

Reviewed by: Lee Boughton, Laboratory Manager

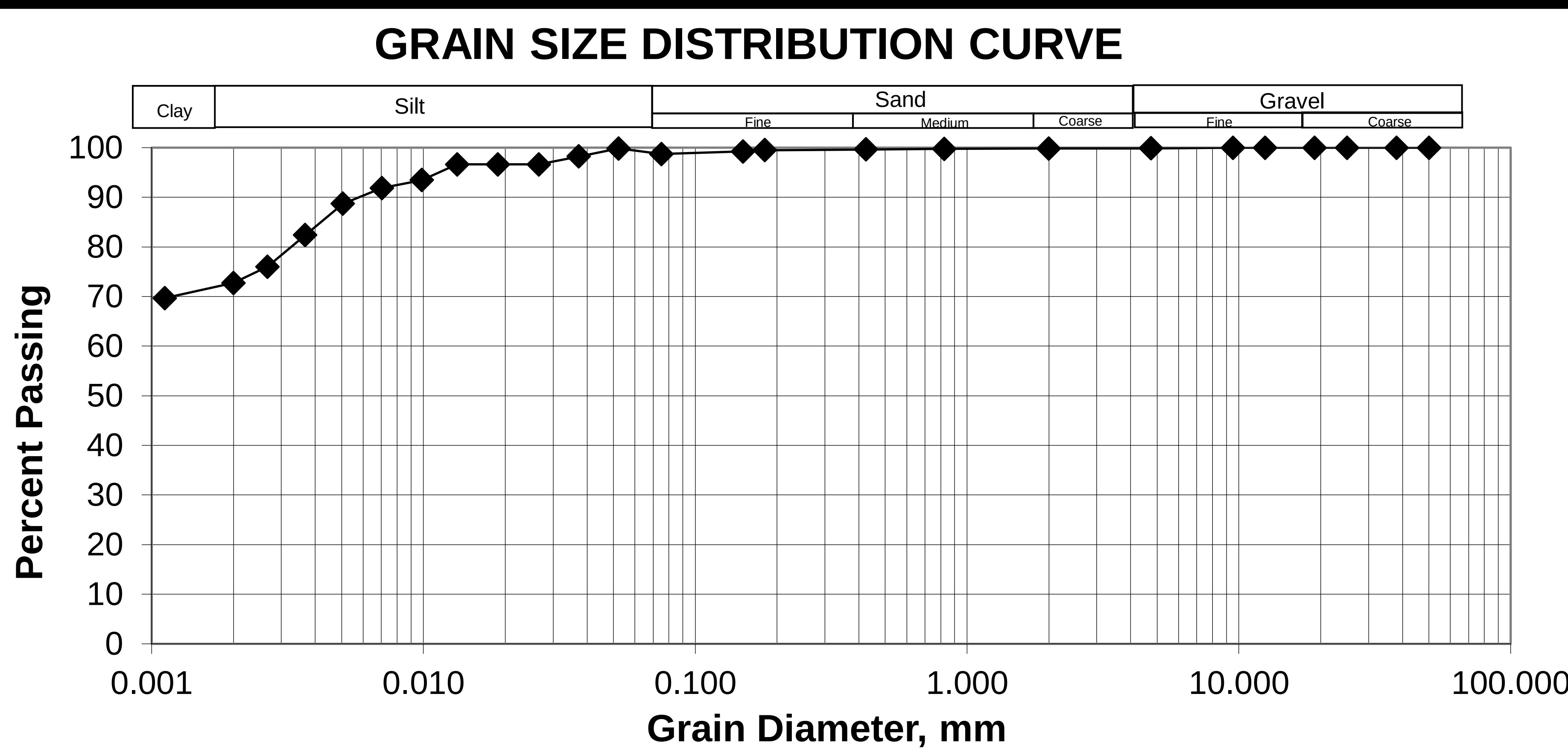
Approved by: German Leal, M.Eng., P.Eng., Geotechnical Discipline Lead

GRAIN SIZE DISTRIBUTION
(ASTM D422-63)

AECOM
WINNIPEG GEOTECHNICAL LABORATORY
99 Commerce Dr., Winnipeg, MB R3P 0Y7 Canada
tel (204) 477-5381 **fax** (431) 800-1210

Job No.:	60686223	Hole No.:	TH23-07
Client:	AECOM	Sample No.:	G2
Project :	St. Charles Wastewater District	Depth:	0.76 - 0.91 m
Date Tested:	08-Sep-23	Date Sampled:	25-Aug-23
Tested By:	NDizon	Sampled By:	AECOM

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	4.75	99.9	0.0750	98.7
38.0	100.0	2.00	99.8	0.0523	99.8
25.0	100.0	0.825	99.7	0.0373	98.2
19.0	100.0	0.425	99.6	0.0266	96.6
12.5	100.0	0.18	99.5	0.0188	96.6
9.5	100.0	0.15	99.2	0.0133	96.6
4.75	99.9	0.075	98.7	0.0099	93.5
				0.0070	91.9
				0.0050	88.7
				0.0037	82.4
				0.0027	76.0
				0.0020	72.8
				0.0011	69.7



Gravel	**0.1%**	**Silt**	**26.0%**
Sand	**1.2%**	**Clay**	**72.8%**

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
Geotechnical Discipline Lead

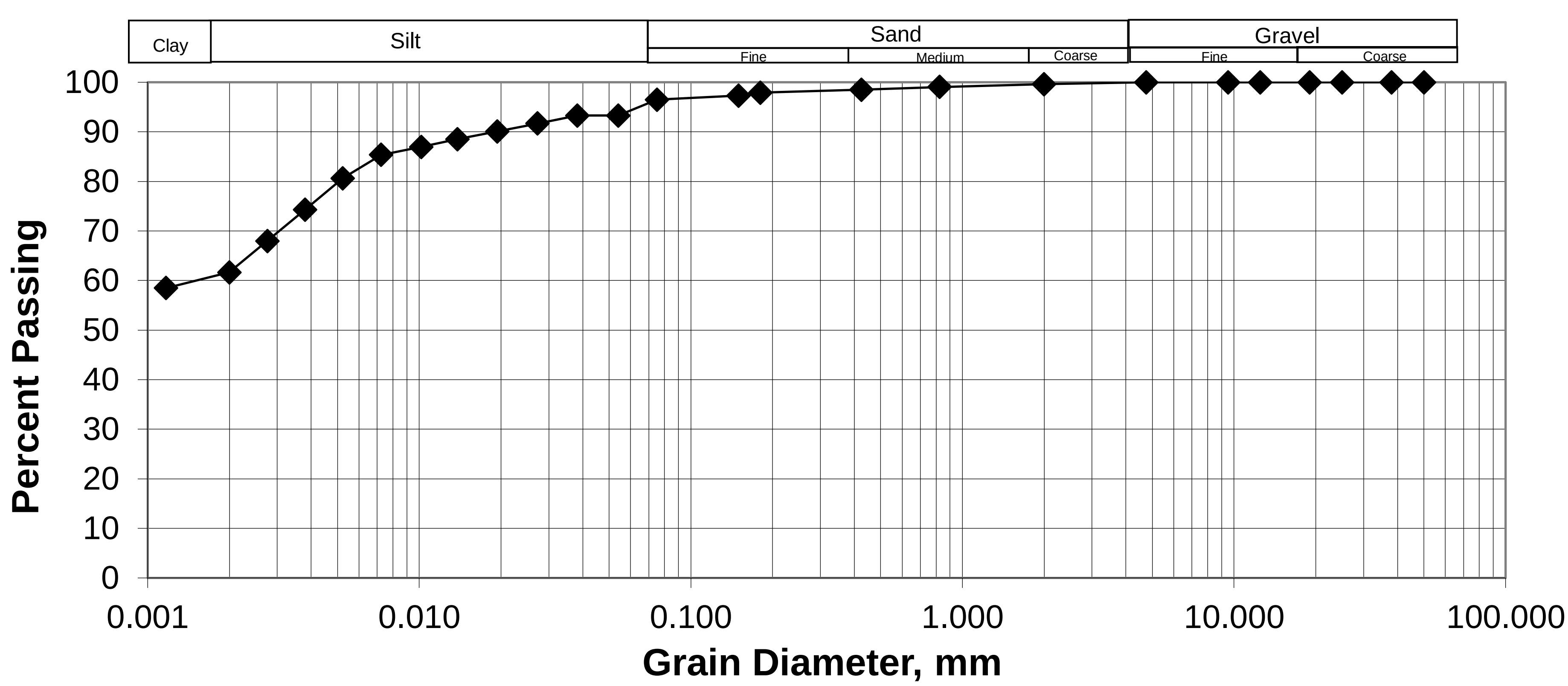
GRAIN SIZE DISTRIBUTION
(ASTM D422-63)

AECOM
WINNIPEG GEOTECHNICAL LABORATORY
99 Commerce Dr., Winnipeg, MB R3P 0Y7 Canada
tel (204) 477-5381 **fax** (431) 800-1210

Job No.:	60686223	Hole No.:	TH23-07
Client:	AECOM	Sample No.:	G5
Project :	St. Charles Wastewater District	Depth:	4.57 - 4.72 m
Date Tested:	08-Sep-23	Date Sampled:	25-Aug-23
Tested By:	NDizon	Sampled By:	AECOM

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	4.75	100.0	0.0750	96.5
38.0	100.0	2.00	99.6	0.0540	93.3
25.0	100.0	0.825	99.1	0.0382	93.3
19.0	100.0	0.425	98.5	0.0272	91.7
12.5	100.0	0.18	97.9	0.0194	90.1
9.5	100.0	0.15	97.3	0.0138	88.5
4.75	100.0	0.075	96.5	0.0102	86.9
				0.0072	85.4
				0.0052	80.6
				0.0038	74.3
				0.0028	68.0
				0.0020	61.6
				0.0012	58.5

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**0.0%**	**Silt**	**34.8%**
Sand	**3.5%**	**Clay**	**61.6%**

Reviewed by: Lee Boughton, Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng., Geotechnical Discipline Lead

AECOM - SOILS LABORATORY
SHEAR STRENGTH, MOISTURE CONTENT & DENSITY CALCULATIONS

AECOM

CLIENT: City of Winnipeg
PROJECT: St. Charles Wastewater Sewer District
JOB NO.: 60686223

TEST HOLE NO.:	**TH23-01**
SAMPLE NO.:	**T5**
SAMPLE DEPTH:	4.57 - 5.18 m
DATE TESTED:	1-Sep-23
SHEAR STRENGTH TESTS	
TORVANE	
Reading	0.20
Vane Size (S, M, L)	M
Undrained Shear Strength (kPa)	**19.6**
Undrained Shear Strength (ksf)	0.41
POCKET PENETROMETER	
Reading - Qu (tsf)	0.25
Undrained Shear Strength (kPa)	**12.0**
Reading - Qu (tsf)	0.25
Undrained Shear Strength (kPa)	**12.0**
Reading - Qu (tsf)	0.25
Undrained Shear Strength (kPa)	**12.0**
UNCONFINED COMPRESSIVE STRENGTH TEST	
Unconfined compressive strength (kPa)	**34.8**
Unconfined compressive strength (ksf)	**0.7**
Undrained Shear Strength (kPa)	**17.4**
Undrained Shear Strength (ksf)	**0.363**
MOISTURE CONTENT	
Tare Number	E-24
Wt. Sample wet + tare (g)	449.7
Wt. Sample dry + tare (g)	387.7
Wt. Tare (g)	9.8
Moisture Content %	**16.4**
BULK DENSITY	
Sample Wt. (g)	1457.9
Diameter 1 (cm)	7.25
Diameter 2 (cm)	7.33
Diameter 3 (cm)	7.32
Avg. Diameter (cm)	**7.30**
Length 1 (cm)	14.06
Length 2 (cm)	14.10
Length 3 (cm)	14.11
Avg. Length (cm)	**14.09**
Volume (cm^3)	589.4
Moisture content (%)	16.4
Bulk Density (g/cm^3)	2.474
Bulk Unit Weight (kN/m^3)	**24.3**
Bulk Unit Weight (pcf)	**154.4**
Dry Unit Weight (kN/m^3)	**20.84**

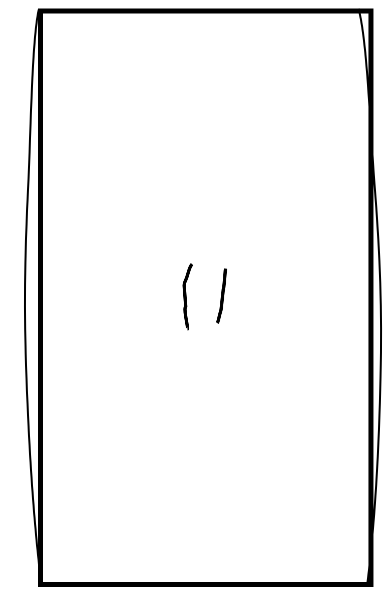
AECOM - SOILS LABORATORY
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS (ASTM D2166)

AECOM

CLIENT:	City of Winnipeg
PROJECT:	St. Charles Wastewater Sewer District
JOB NO.:	60686223

TEST HOLE NO.:	TH23-01	**SOIL DESCRIPTION:**	
SAMPLE NO.:	T5	CLAY - Tan, moist, soft, silty, some silt inclusion, trace gravel inclusion	
SAMPLE DEPTH:	4.57 - 5.18 m	intermediate plasticity	
SAMPLE DATE:	25-Aug-23		
TEST DATE:	01-Sep-23	**MOISTURE CONTENT:**	16.4

SAMPLE DIAM.(Do):	72.99	**(mm)**	**INITIAL AREA, Ao:**	4183.9	**(mm^2)**
SAMPLE LENGTH, (Lo):	140.86	**(mm)**	**PISTON RATE:**	0.0500	**(inches / minute)**
L / D RATIO:	1.93	**(2 < L/D < 2.5)**	**AXIAL STRAIN RATE, R:**	0.90	**(0.5<R<2 % / minute)**



FAILURE SKETCH

TEST DATA - DIAL READINGS							
AXIAL COMPRESSION	**PROVING RING**	**TOTAL AXIAL STRAIN, E_1**	**AVERAGE CROSS-SECTIONAL AREA, A**	**APPLIED AXIAL LOAD, P**	**COMPRESSIVE STRESS, σ_C**		
(inches)	(inches)	(%)	(inches2)	(lbs)	(psi)	(ksf)	(kPa)
0.01	0.0001	0.00	6.48	0.66	0.10	0.015	0.7
0.02	0.0001	0.15	6.49	1.22	0.19	0.027	1.3
0.03	0.0002	0.30	6.50	1.87	0.29	0.041	2.0
0.03	0.0003	0.45	6.51	2.44	0.37	0.054	2.6
0.04	0.0003	0.60	6.52	3.09	0.47	0.068	3.3
0.05	0.0004	0.75	6.53	3.75	0.57	0.083	4.0
0.06	0.0005	0.90	6.54	4.31	0.66	0.095	4.5
0.07	0.0005	1.05	6.55	4.97	0.76	0.109	5.2
0.08	0.0006	1.20	6.56	5.53	0.84	0.121	5.8
0.08	0.0007	1.35	6.57	6.47	0.98	0.142	6.8
0.09	0.0007	1.50	6.58	6.84	1.04	0.150	7.2
0.10	0.0008	1.65	6.59	7.40	1.12	0.162	7.7
0.11	0.0009	1.80	6.60	8.34	1.26	0.182	8.7
0.12	0.0010	1.95	6.61	9.00	1.36	0.196	9.4
0.13	0.0010	2.10	6.62	9.56	1.44	0.208	9.9
0.13	0.0011	2.25	6.63	10.21	1.54	0.222	10.6
0.14	0.0012	2.40	6.64	10.87	1.64	0.236	11.3
0.15	0.0012	2.55	6.65	11.43	1.72	0.247	11.8
0.16	0.0014	2.70	6.67	12.65	1.90	0.273	13.1
0.17	0.0014	2.86	6.68	12.65	1.89	0.273	13.1
0.18	0.0015	3.01	6.69	13.96	2.09	0.301	14.4
0.18	0.0015	3.16	6.70	14.24	2.13	0.306	14.7
0.19	0.0016	3.31	6.71	14.52	2.17	0.312	14.9
0.20	0.0016	3.46	6.72	14.90	2.22	0.319	15.3
0.21	0.0017	3.61	6.73	15.84	2.35	0.339	16.2
0.22	0.0017	3.76	6.74	16.12	2.39	0.344	16.5
0.23	0.0018	3.91	6.75	16.68	2.47	0.356	17.0
0.23	0.0019	4.06	6.76	17.33	2.56	0.369	17.7
0.24	0.0019	4.21	6.77	17.99	2.66	0.383	18.3
0.25	0.0020	4.36	6.78	18.55	2.74	0.394	18.9
0.26	0.0020	4.51	6.79	18.93	2.79	0.401	19.2
0.27	0.0021	4.66	6.80	19.49	2.87	0.413	19.8
0.28	0.0022	4.81	6.81	20.15	2.96	0.426	20.4
0.28	0.0022	4.96	6.82	20.43	2.99	0.431	20.6
0.29	0.0023	5.11	6.83	21.08	3.08	0.444	21.3
0.30	0.0023	5.26	6.84	21.64	3.16	0.455	21.8
0.31	0.0024	5.41	6.86	22.02	3.21	0.462	22.1
0.32	0.0024	5.56	6.87	22.58	3.29	0.474	22.7
0.33	0.0025	5.71	6.88	22.96	3.34	0.481	23.0
0.33	0.0025	5.86	6.89	23.52	3.41	0.492	23.5
0.34	0.0025	6.01	6.90	23.80	3.45	0.497	23.8
0.35	0.0026	6.16	6.91	24.46	3.54	0.510	24.4
0.36	0.0026	6.31	6.92	24.74	3.57	0.515	24.6
0.37	0.0027	6.46	6.93	25.39	3.66	0.527	25.3
0.38	0.0027	6.61	6.94	25.67	3.70	0.532	25.5
0.38	0.0028	6.76	6.96	26.33	3.79	0.545	26.1
0.39	0.0028	6.91	6.97	26.61	3.82	0.550	26.3

TEST DATA - DIAL READINGS							
AXIAL COMPRESSION	PROVING RING	TOTAL AXIAL STRAIN, E_1	AVERAGE CROSS-SECTIONAL AREA, A	APPLIED AXIAL LOAD, P	COMPRESSIVE STRESS, σ_C		
(inches)	(inches)	(%)	(inches2)	(lbs)	(psi)	(ksf)	(kPa)
0.40	0.0029	7.06	6.98	26.89	3.85	0.555	26.6
0.41	0.0030	7.21	6.99	28.20	4.04	0.581	27.8
0.42	0.0031	7.36	7.00	29.42	4.20	0.605	29.0
0.43	0.0032	7.51	7.01	30.36	4.33	0.623	29.9
0.43	0.0034	7.66	7.02	31.58	4.50	0.647	31.0
0.44	0.0034	7.81	7.03	32.23	4.58	0.660	31.6
0.45	0.0035	7.96	7.05	32.80	4.65	0.670	32.1
0.50	0.0036	8.87	7.12	33.45	4.70	0.677	32.4
0.55	0.0037	9.77	7.19	34.67	4.82	0.695	33.3
0.60	0.0038	10.67	7.26	35.32	4.87	0.701	33.6
0.65	0.0038	11.57	7.33	35.89	4.89	0.705	33.7
0.70	0.0039	12.47	7.41	36.82	4.97	0.716	34.3
0.75	0.0040	13.37	7.49	37.76	5.04	0.726	34.8

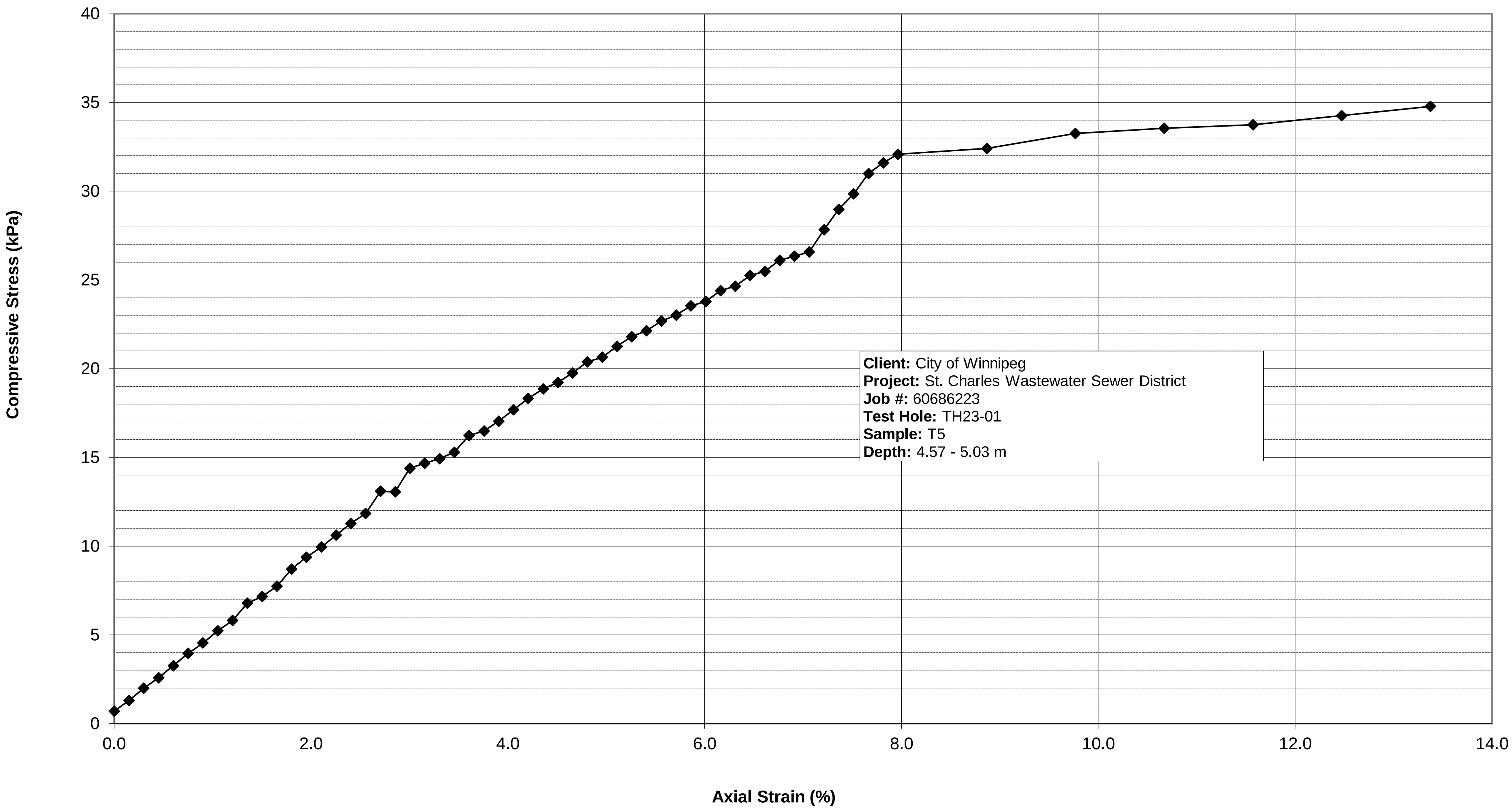
UNCONFINED COMPRESSIVE STRENGTH, q_u:	34.78	kPa
(based on maximum q_u value)	0.726	ksf
UNDRAINED SHEAR STRENGTH, S_u:	17.39	kPa
(based on maximum q_u value)	0.363	ksf

NOTES:

Reviewed by: Lee Boughton, Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng., Geotechnical Discipline Lead

AECOM
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS
(ASTM D2166)



AECOM - SOILS LABORATORY
SHEAR STRENGTH, MOISTURE CONTENT & DENSITY CALCULATIONS

AECOM

CLIENT: City of Winnipeg
PROJECT: St. Charles Wastewater Sewer District
JOB NO.: 60686223

TEST HOLE NO.:	**TH23-03**
SAMPLE NO.:	**T6**
SAMPLE DEPTH:	6.10 - 6.71 m
DATE TESTED:	1-Sep-23
SHEAR STRENGTH TESTS	
TORVANE	
Reading	0.25
Vane Size (S, M, L)	M
Undrained Shear Strength (kPa)	**24.5**
Undrained Shear Strength (ksf)	0.51
POCKET PENETROMETER	
Reading - Qu (tsf)	0.10
Undrained Shear Strength (kPa)	**4.8**
Reading - Qu (tsf)	0.15
Undrained Shear Strength (kPa)	**7.2**
Reading - Qu (tsf)	0.15
Undrained Shear Strength (kPa)	**7.2**
UNCONFINED COMPRESSIVE STRENGTH TEST	
Unconfined compressive strength (kPa)	**51.7**
Unconfined compressive strength (ksf)	**1.1**
Undrained Shear Strength (kPa)	**25.8**
Undrained Shear Strength (ksf)	**0.540**
MOISTURE CONTENT	
Tare Number	M30
Wt. Sample wet + tare (g)	318.3
Wt. Sample dry + tare (g)	203.9
Wt. Tare (g)	8.7
Moisture Content %	**58.6**
BULK DENSITY	
Sample Wt. (g)	1076
Diameter 1 (cm)	7.15
Diameter 2 (cm)	7.15
Diameter 3 (cm)	7.20
Avg. Diameter (cm)	**7.17**
Length 1 (cm)	15.16
Length 2 (cm)	15.19
Length 3 (cm)	15.15
Avg. Length (cm)	**15.17**
Volume (cm^3)	611.5
Moisture content (%)	58.6
Bulk Density (g/cm^3)	1.760
Bulk Unit Weight (kN/m^3)	**17.3**
Bulk Unit Weight (pcf)	**109.9**
Dry Unit Weight (kN/m^3)	**10.88**

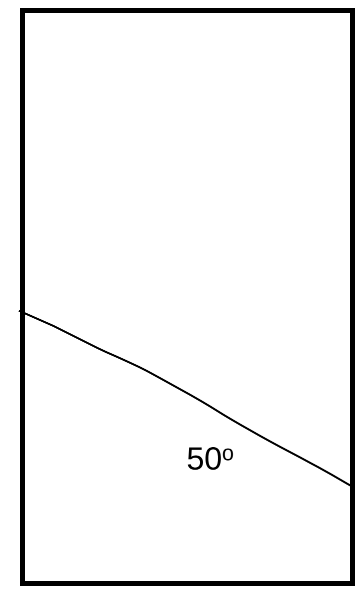
AECOM - SOILS LABORATORY
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS (ASTM D2166)

AECOM

CLIENT:	City of Winnipeg
PROJECT:	St. Charles Wastewater Sewer District
JOB NO.:	60686223

TEST HOLE NO.:	TH23-03
SAMPLE NO.:	T6
SAMPLE DEPTH:	6.10 - 6.71 m
SAMPLE DATE:	25-Aug-23
TEST DATE:	01-Sep-23

SOIL DESCRIPTION:	
CLAY - grey, moist, soft, silty, trace silt inclusion, trace oxidation inclusion	
High plasticity	
MOISTURE CONTENT:	58.6



FAILURE SKETCH

SAMPLE DIAM.(Do):	71.65	**(mm)**	**INITIAL AREA, Ao:**	4032.0	**(mm^2)**
SAMPLE LENGTH, (Lo):	151.65	**(mm)**	**PISTON RATE:**	0.0500	**(inches / minute)**
L / D RATIO:	2.12	**(2 < L/D < 2.5)**	**AXIAL STRAIN RATE, R:**	0.84	**(0.5<R<2 % / minute)**

TEST DATA - DIAL READINGS

AXIAL COMPRESSION	**PROVING RING**	**TOTAL AXIAL STRAIN, E_1**	**AVERAGE CROSS-SECTIONAL AREA, A**	**APPLIED AXIAL LOAD, P**	**COMPRESSIVE STRESS, σ_C**		
(inches)	(inches)	(%)	(inches2)	(lbs)	(psi)	(ksf)	(kPa)
0.01	0.0006	0.00	6.25	5.53	0.88	0.127	6.1
0.02	0.0011	0.14	6.26	10.21	1.63	0.235	11.3
0.03	0.0016	0.28	6.27	14.52	2.32	0.334	16.0
0.03	0.0021	0.42	6.28	19.21	3.06	0.441	21.1
0.04	0.0025	0.56	6.28	22.96	3.65	0.526	25.2
0.05	0.0028	0.70	6.29	26.33	4.18	0.602	28.8
0.06	0.0032	0.84	6.30	29.70	4.71	0.679	32.5
0.07	0.0035	0.98	6.31	32.80	5.20	0.748	35.8
0.08	0.0037	1.12	6.32	34.67	5.49	0.790	37.8
0.08	0.0038	1.26	6.33	35.32	5.58	0.804	38.5
0.09	0.0038	1.40	6.34	35.61	5.62	0.809	38.7
0.10	0.0042	1.54	6.35	39.64	6.24	0.899	43.1
0.11	0.0044	1.67	6.36	41.13	6.47	0.932	44.6
0.12	0.0046	1.81	6.37	43.01	6.76	0.973	46.6
0.13	0.0048	1.95	6.37	44.88	7.04	1.014	48.5
0.13	0.0050	2.09	6.38	46.48	7.28	1.048	50.2
0.14	0.0051	2.23	6.39	47.41	7.42	1.068	51.1
0.15	0.0051	2.37	6.40	47.97	7.49	1.079	51.7
0.16	0.0051	2.51	6.41	47.97	7.48	1.078	51.6
0.17	0.0051	2.65	6.42	47.69	7.43	1.070	51.2
0.18	0.0050	2.79	6.43	47.04	7.32	1.054	50.4
0.18	0.0049	2.93	6.44	45.82	7.12	1.025	49.1

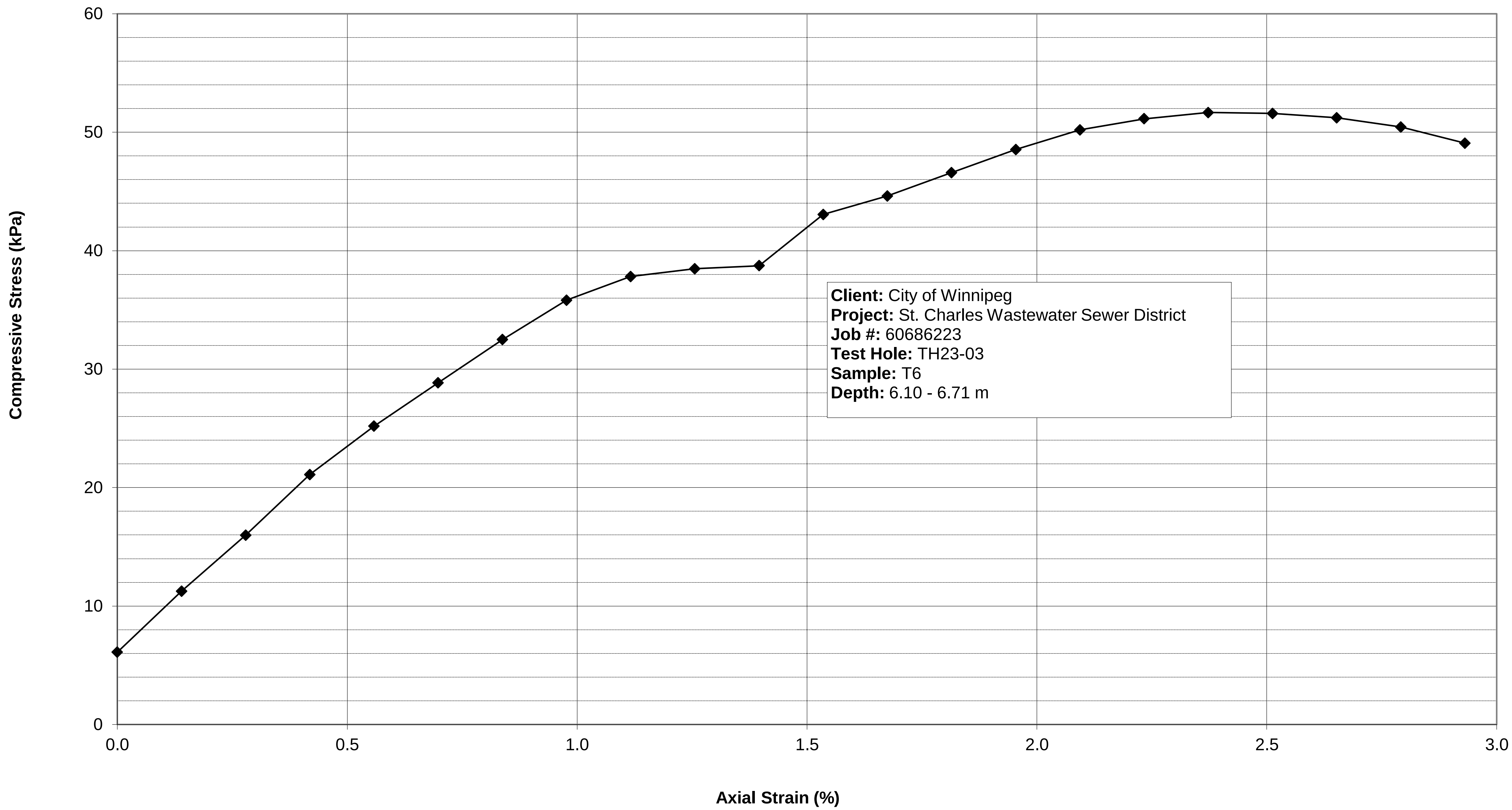
UNCONFINED COMPRESSIVE STRENGTH, q_u:	51.67	kPa
(based on maximum q_u value)	1.079	ksf
UNDRAINED SHEAR STRENGTH, S_u:	25.84	kPa
(based on maximum q_u value)	0.540	ksf

NOTES:

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
Geotechnical Discipline Lead

AECOM
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS
(ASTM D2166)



AECOM - SOILS LABORATORY
SHEAR STRENGTH, MOISTURE CONTENT & DENSITY CALCULATIONS

AECOM

CLIENT: City of Winnipeg
PROJECT: St. Charles Wastewater Sewer District
JOB NO.: 60686223

TEST HOLE NO.:	**TH23-04**
SAMPLE NO.:	**T5**
SAMPLE DEPTH:	4.57 - 5.18 m
DATE TESTED:	1-Sep-23
SHEAR STRENGTH TESTS	
TORVANE	
Reading	0.30
Vane Size (S, M, L)	M
Undrained Shear Strength (kPa)	**29.4**
Undrained Shear Strength (ksf)	0.61
POCKET PENETROMETER	
Reading - Qu (tsf)	0.25
Undrained Shear Strength (kPa)	**12.0**
Reading - Qu (tsf)	0.35
Undrained Shear Strength (kPa)	**16.8**
Reading - Qu (tsf)	0.50
Undrained Shear Strength (kPa)	**23.9**
UNCONFINED COMPRESSIVE STRENGTH TEST	
Unconfined compressive strength (kPa)	**79.7**
Unconfined compressive strength (ksf)	**1.7**
Undrained Shear Strength (kPa)	**39.9**
Undrained Shear Strength (ksf)	**0.833**
MOISTURE CONTENT	
Tare Number	XS0
Wt. Sample wet + tare (g)	307.4
Wt. Sample dry + tare (g)	223.6
Wt. Tare (g)	9.1
Moisture Content %	**39.1**
BULK DENSITY	
Sample Wt. (g)	1121.8
Diameter 1 (cm)	7.21
Diameter 2 (cm)	7.24
Diameter 3 (cm)	7.26
Avg. Diameter (cm)	**7.24**
Length 1 (cm)	15.50
Length 2 (cm)	15.50
Length 3 (cm)	15.50
Avg. Length (cm)	**15.50**
Volume (cm^3)	637.7
Moisture content (%)	39.1
Bulk Density (g/cm^3)	1.759
Bulk Unit Weight (kN/m^3)	**17.3**
Bulk Unit Weight (pcf)	**109.8**
Dry Unit Weight (kN/m^3)	**12.41**

AECOM - SOILS LABORATORY
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS (ASTM D2166)

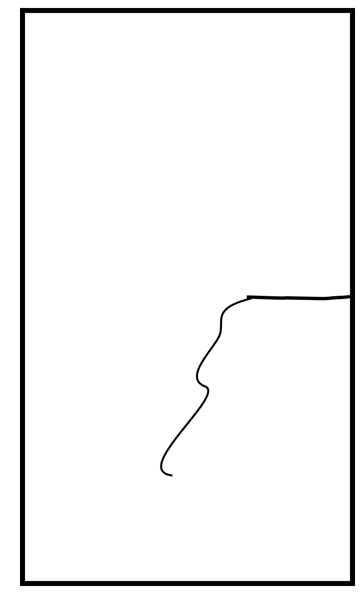
AECOM

CLIENT:	City of Winnipeg
PROJECT:	St. Charles Wastewater Sewer District
JOB NO.:	60686223

TEST HOLE NO.:	TH23-04
SAMPLE NO.:	T5
SAMPLE DEPTH:	4.57 - 5.18 m
SAMPLE DATE:	25-Aug-23
TEST DATE:	01-Sep-23

SOIL DESCRIPTION:	
CLAY - brown, moist, firm, silty, trace silt inclusion	
High plasticity	
MOISTURE CONTENT:	39.1

SAMPLE DIAM.(Do):	72.37	**(mm)**	**INITIAL AREA, Ao:**	4113.5	**(mm^2)**
SAMPLE LENGTH, (Lo):	155.02	**(mm)**	**PISTON RATE:**	0.0500	**(inches / minute)**
L / D RATIO:	2.14	**(2 < L/D < 2.5)**	**AXIAL STRAIN RATE, R:**	0.82	**(0.5<R<2 % / minute)**



FAILURE SKETCH

TEST DATA - DIAL READINGS							
AXIAL COMPRESSION	**PROVING RING**	**TOTAL AXIAL STRAIN, E_1**	**AVERAGE CROSS-SECTIONAL AREA, A**	**APPLIED AXIAL LOAD, P**	**COMPRESSIVE STRESS, σ_C**		
(inches)	(inches)	(%)	(inches2)	(lbs)	(psi)	(ksf)	(kPa)
0.01	0.0003	0.00	6.38	2.44	0.38	0.055	2.6
0.02	0.0006	0.14	6.38	5.53	0.87	0.125	6.0
0.03	0.0011	0.27	6.39	9.93	1.55	0.224	10.7
0.03	0.0015	0.41	6.40	14.24	2.22	0.320	15.3
0.04	0.0020	0.55	6.41	18.55	2.89	0.417	20.0
0.05	0.0025	0.68	6.42	22.96	3.58	0.515	24.7
0.06	0.0028	0.82	6.43	26.33	4.10	0.590	28.2
0.07	0.0035	0.96	6.44	32.51	5.05	0.727	34.8
0.08	0.0036	1.09	6.45	34.01	5.28	0.760	36.4
0.08	0.0038	1.23	6.46	35.61	5.52	0.794	38.0
0.09	0.0041	1.37	6.46	38.04	5.89	0.847	40.6
0.10	0.0045	1.50	6.47	41.79	6.46	0.930	44.5
0.11	0.0047	1.64	6.48	43.66	6.74	0.970	46.4
0.12	0.0050	1.78	6.49	46.76	7.20	1.037	49.7
0.13	0.0053	1.91	6.50	49.57	7.63	1.098	52.6
0.13	0.0056	2.05	6.51	52.00	7.99	1.150	55.1
0.14	0.0059	2.18	6.52	54.81	8.41	1.211	58.0
0.15	0.0061	2.32	6.53	56.97	8.73	1.257	60.2
0.16	0.0063	2.46	6.54	59.12	9.05	1.303	62.4
0.17	0.0065	2.59	6.55	61.28	9.36	1.348	64.5
0.18	0.0068	2.73	6.55	63.43	9.68	1.394	66.7
0.18	0.0070	2.87	6.56	65.31	9.95	1.433	68.6
0.19	0.0071	3.00	6.57	66.90	10.18	1.466	70.2
0.20	0.0073	3.14	6.58	68.40	10.39	1.496	71.6
0.21	0.0075	3.28	6.59	69.99	10.62	1.529	73.2
0.22	0.0077	3.41	6.60	71.87	10.89	1.568	75.1
0.23	0.0078	3.55	6.61	73.09	11.06	1.592	76.2
0.23	0.0079	3.69	6.62	74.30	11.22	1.616	77.4
0.24	0.0080	3.82	6.63	75.24	11.35	1.634	78.3
0.25	0.0081	3.96	6.64	75.90	11.43	1.646	78.8
0.26	0.0082	4.10	6.65	76.46	11.50	1.656	79.3
0.27	0.0082	4.23	6.66	76.74	11.53	1.660	79.5
0.28	0.0082	4.37	6.67	77.12	11.57	1.666	79.7
0.28	0.0082	4.51	6.68	77.12	11.55	1.663	79.6
0.29	0.0082	4.64	6.69	76.74	11.48	1.653	79.1
0.30	0.0082	4.78	6.70	76.46	11.42	1.644	78.7
0.31	0.0081	4.92	6.71	75.90	11.32	1.630	78.0

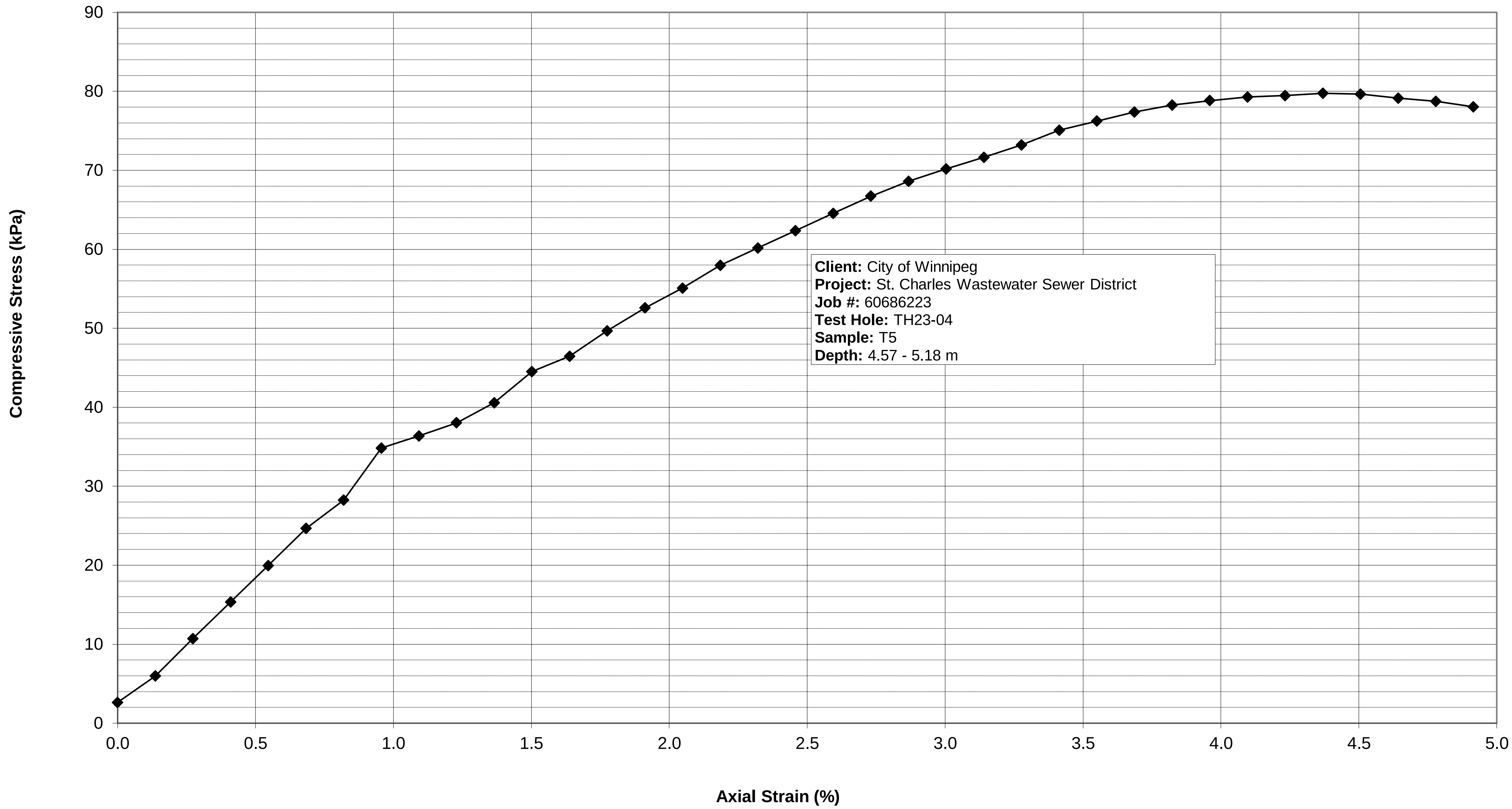
UNCONFINED COMPRESSIVE STRENGTH, q_u:	79.75	kPa
(based on maximum q_u value)	1.666	ksf
UNDRAINED SHEAR STRENGTH, S_u:	39.87	kPa
(based on maximum q_u value)	0.833	ksf

NOTES:

Reviewed by: Lee Boughton, Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng., Geotechnical Discipline Lead

AECOM
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS
(ASTM D2166)



AECOM - SOILS LABORATORY
SHEAR STRENGTH, MOISTURE CONTENT & DENSITY CALCULATIONS

CLIENT: City of Winnipeg
PROJECT: St. Charles Wastewater Sewer District
JOB NO.: 60686223

TEST HOLE NO.:	**TH23-05**
SAMPLE NO.:	**T4**
SAMPLE DEPTH:	4.57 - 5.18 m
DATE TESTED:	1-Sep-23
SHEAR STRENGTH TESTS	
TORVANE	
Reading	0.39
Vane Size (S, M, L)	M
Undrained Shear Strength (kPa)	**38.3**
Undrained Shear Strength (ksf)	0.80
POCKET PENETROMETER	
Reading - Qu (tsf)	0.85
Undrained Shear Strength (kPa)	**40.7**
Reading - Qu (tsf)	0.75
Undrained Shear Strength (kPa)	**35.9**
Reading - Qu (tsf)	1.00
Undrained Shear Strength (kPa)	**47.9**
UNCONFINED COMPRESSIVE STRENGTH TEST	
Unconfined compressive strength (kPa)	**82.9**
Unconfined compressive strength (ksf)	**1.7**
Undrained Shear Strength (kPa)	**41.5**
Undrained Shear Strength (ksf)	**0.866**
MOISTURE CONTENT	
Tare Number	AT-70
Wt. Sample wet + tare (g)	379.0
Wt. Sample dry + tare (g)	271.0
Wt. Tare (g)	8.5
Moisture Content %	**41.1**
BULK DENSITY	
Sample Wt. (g)	1173.4
Diameter 1 (cm)	7.14
Diameter 2 (cm)	7.19
Diameter 3 (cm)	7.25
Avg. Diameter (cm)	**7.19**
Length 1 (cm)	15.51
Length 2 (cm)	15.50
Length 3 (cm)	15.50
Avg. Length (cm)	**15.50**
Volume (cm^3)	629.5
Moisture content (%)	41.1
Bulk Density (g/cm^3)	1.864
Bulk Unit Weight (kN/m^3)	**18.3**
Bulk Unit Weight (pcf)	**116.4**
Dry Unit Weight (kN/m^3)	**12.95**

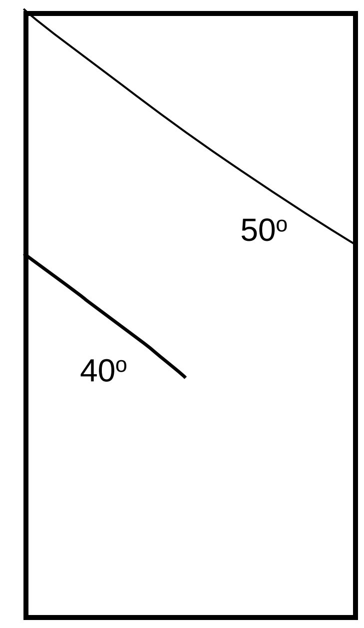
AECOM - SOILS LABORATORY
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS (ASTM D2166)

AECOM

CLIENT:	City of Winnipeg
PROJECT:	St. Charles Wastewater Sewer District
JOB NO.:	60686223

TEST HOLE NO.:	TH23-05
SAMPLE NO.:	T4
SAMPLE DEPTH:	4.57 - 5.18 m
SAMPLE DATE:	25-Aug-23
TEST DATE:	01-Sep-23

SOIL DESCRIPTION:	
CLAY - grey, moist, firm, silty, trace silt inclusion, trace oxidation inclusion, trace gravel inclusion, trace roots inclusion	
High plasticity	
MOISTURE CONTENT:	41.1



FAILURE SKETCH

SAMPLE DIAM.(Do):	71.90	**(mm)**	**INITIAL AREA, Ao:**	4060.6	**(mm^2)**
SAMPLE LENGTH, (Lo):	155.03	**(mm)**	**PISTON RATE:**	0.0500	**(inches / minute)**
L / D RATIO:	2.16	**(2 < L/D < 2.5)**	**AXIAL STRAIN RATE, R:**	0.82	**(0.5<R<2 % / minute)**

TEST DATA - DIAL READINGS							
AXIAL COMPRESSION	**PROVING RING**	**TOTAL AXIAL STRAIN, E_1**	**AVERAGE CROSS-SECTIONAL AREA, A**	**APPLIED AXIAL LOAD, P**	**COMPRESSIVE STRESS, σ_C**		
(inches)	(inches)	(%)	(inches2)	(lbs)	(psi)	(ksf)	(kPa)
0.01	0.0005	0.00	6.29	4.69	0.74	0.107	5.1
0.02	0.0006	0.14	6.30	5.90	0.94	0.135	6.5
0.03	0.0008	0.27	6.31	7.12	1.13	0.162	7.8
0.03	0.0009	0.41	6.32	8.34	1.32	0.190	9.1
0.04	0.0010	0.55	6.33	9.56	1.51	0.217	10.4
0.05	0.0012	0.68	6.34	11.43	1.80	0.260	12.4
0.06	0.0015	0.82	6.35	13.59	2.14	0.308	14.8
0.07	0.0018	0.96	6.35	16.68	2.62	0.378	18.1
0.08	0.0022	1.09	6.36	20.15	3.17	0.456	21.8
0.08	0.0025	1.23	6.37	23.52	3.69	0.531	25.4
0.09	0.0028	1.37	6.38	26.61	4.17	0.601	28.8
0.10	0.0032	1.50	6.39	29.70	4.65	0.669	32.0
0.11	0.0034	1.64	6.40	31.58	4.93	0.711	34.0
0.12	0.0035	1.77	6.41	33.17	5.18	0.745	35.7
0.13	0.0037	1.91	6.42	34.39	5.36	0.772	37.0
0.13	0.0038	2.05	6.43	35.61	5.54	0.798	38.2
0.14	0.0043	2.18	6.43	39.92	6.20	0.893	42.8
0.15	0.0046	2.32	6.44	43.01	6.67	0.961	46.0
0.16	0.0049	2.46	6.45	46.10	7.14	1.029	49.3
0.17	0.0052	2.59	6.46	48.91	7.57	1.090	52.2
0.18	0.0056	2.73	6.47	52.00	8.04	1.157	55.4
0.18	0.0059	2.87	6.48	54.81	8.46	1.218	58.3
0.19	0.0061	3.00	6.49	57.25	8.82	1.271	60.8
0.20	0.0064	3.14	6.50	59.78	9.20	1.325	63.4
0.21	0.0066	3.28	6.51	62.22	9.56	1.377	65.9
0.22	0.0069	3.41	6.52	64.37	9.88	1.423	68.1
0.23	0.0071	3.55	6.53	66.25	10.15	1.462	70.0
0.23	0.0073	3.69	6.53	68.12	10.42	1.501	71.9
0.24	0.0074	3.82	6.54	69.62	10.64	1.532	73.3
0.25	0.0076	3.96	6.55	71.21	10.87	1.565	74.9
0.26	0.0078	4.10	6.56	72.71	11.08	1.595	76.4
0.27	0.0079	4.23	6.57	74.02	11.26	1.622	77.7
0.28	0.0080	4.37	6.58	75.24	11.43	1.646	78.8
0.28	0.0081	4.51	6.59	76.18	11.56	1.664	79.7
0.29	0.0082	4.64	6.60	76.74	11.63	1.674	80.2
0.30	0.0083	4.78	6.61	77.68	11.75	1.692	81.0
0.31	0.0083	4.92	6.62	78.05	11.79	1.698	81.3
0.32	0.0084	5.05	6.63	78.33	11.82	1.702	81.5
0.33	0.0084	5.19	6.64	78.61	11.84	1.705	81.7
0.33	0.0084	5.32	6.65	78.99	11.88	1.711	81.9
0.34	0.0085	5.46	6.66	79.27	11.91	1.715	82.1
0.35	0.0085	5.60	6.67	79.55	11.93	1.718	82.3
0.36	0.0085	5.73	6.68	79.83	11.96	1.722	82.4
0.37	0.0086	5.87	6.69	80.21	12.00	1.727	82.7
0.38	0.0086	6.01	6.70	80.49	12.02	1.731	82.9
0.38	0.0086	6.14	6.71	80.49	12.00	1.728	82.8

TEST DATA - DIAL READINGS							
AXIAL COMPRESSION	**PROVING RING**	**TOTAL AXIAL STRAIN, E_1**	**AVERAGE CROSS-SECTIONAL AREA, A**	**APPLIED AXIAL LOAD, P**	**COMPRESSIVE STRESS, σ_C**		
(inches)	(inches)	(%)	(inches2)	(lbs)	(psi)	(ksf)	(kPa)
0.39	0.0086	6.28	6.72	80.77	12.03	1.732	82.9
0.40	0.0086	6.42	6.73	80.77	12.01	1.729	82.8
0.41	0.0086	6.55	6.74	80.21	11.91	1.715	82.1

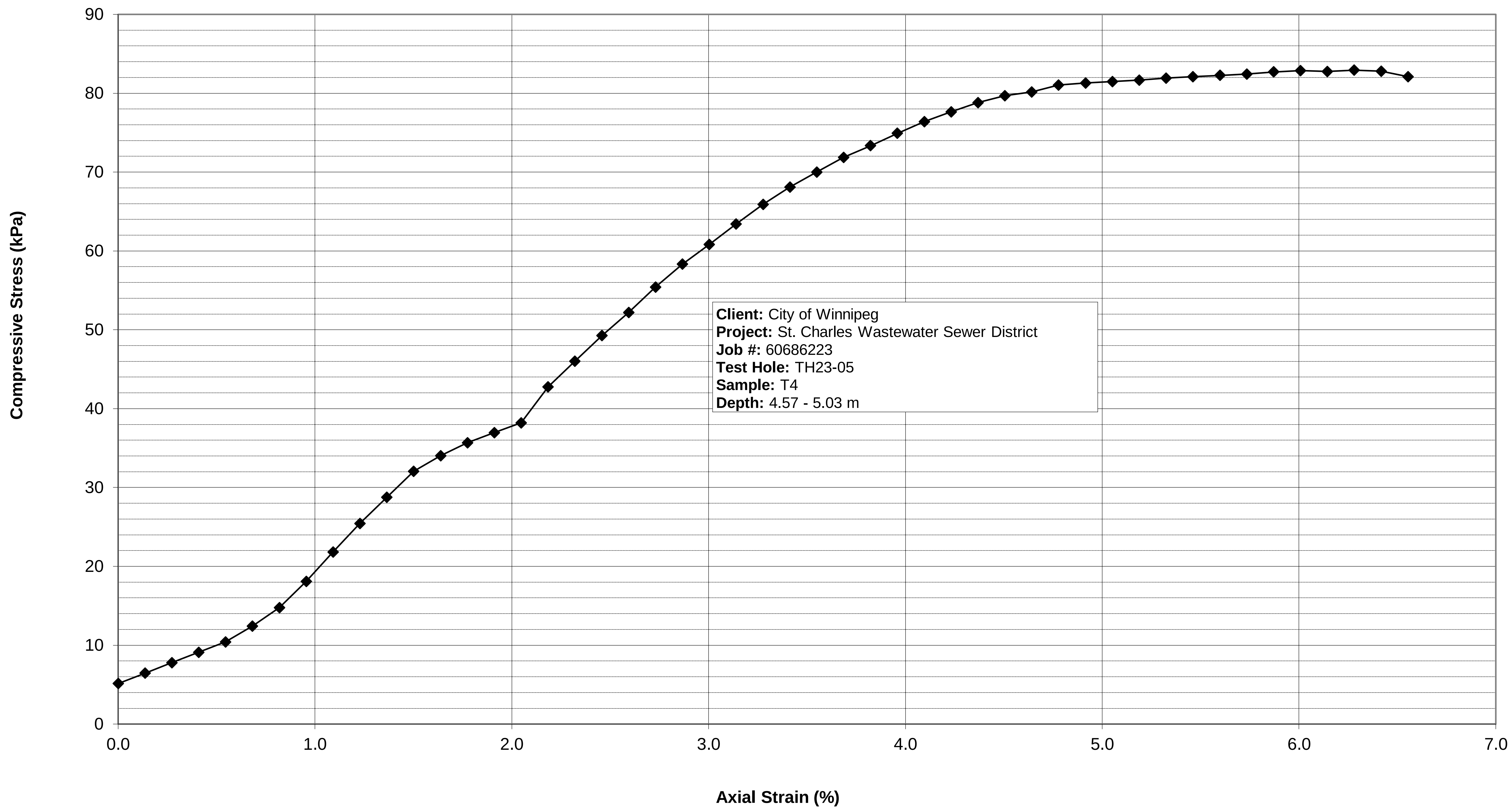
UNCONFINED COMPRESSIVE STRENGTH, q_u:	82.92	kPa
(based on maximum q_u value)	1.732	ksf
UNDRAINED SHEAR STRENGTH, S_u:	41.46	kPa
(based on maximum q_u value)	0.866	ksf

NOTES:

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
Geotechnical Discipline Lead

AECOM
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS
(ASTM D2166)



AECOM - SOILS LABORATORY
SHEAR STRENGTH, MOISTURE CONTENT & DENSITY CALCULATIONS

AECOM

CLIENT: City of Winnipeg
PROJECT: St. Charles Wastewater Sewer District
JOB NO.: 60686223

TEST HOLE NO.:	**TH23-05**
SAMPLE NO.:	**T6**
SAMPLE DEPTH:	6.10 - 6.71 m
DATE TESTED:	5-Sep-23
SHEAR STRENGTH TESTS	
TORVANE	
Reading	0.30
Vane Size (S, M, L)	M
Undrained Shear Strength (kPa)	**29.4**
Undrained Shear Strength (ksf)	0.61
POCKET PENETROMETER	
Reading - Qu (tsf)	0.15
Undrained Shear Strength (kPa)	**7.2**
Reading - Qu (tsf)	0.55
Undrained Shear Strength (kPa)	**26.3**
Reading - Qu (tsf)	0.65
Undrained Shear Strength (kPa)	**31.1**
UNCONFINED COMPRESSIVE STRENGTH TEST	
Unconfined compressive strength (kPa)	**45.3**
Unconfined compressive strength (ksf)	**0.9**
Undrained Shear Strength (kPa)	**22.7**
Undrained Shear Strength (ksf)	**0.474**
MOISTURE CONTENT	
Tare Number	A6
Wt. Sample wet + tare (g)	332.8
Wt. Sample dry + tare (g)	233.6
Wt. Tare (g)	8.3
Moisture Content %	**44.0**
BULK DENSITY	
Sample Wt. (g)	1153.1
Diameter 1 (cm)	7.26
Diameter 2 (cm)	7.26
Diameter 3 (cm)	7.26
Avg. Diameter (cm)	**7.26**
Length 1 (cm)	15.42
Length 2 (cm)	15.43
Length 3 (cm)	15.48
Avg. Length (cm)	**15.44**
Volume (cm^3)	639.3
Moisture content (%)	44.0
Bulk Density (g/cm^3)	1.804
Bulk Unit Weight (kN/m^3)	**17.7**
Bulk Unit Weight (pcf)	**112.6**
Dry Unit Weight (kN/m^3)	**12.28**

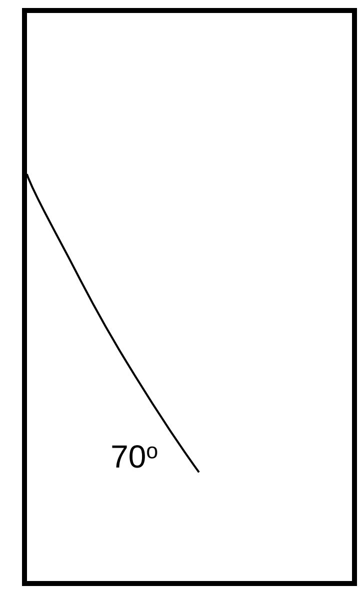
AECOM - SOILS LABORATORY
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS (ASTM D2166)

AECOM

CLIENT:	City of Winnipeg
PROJECT:	St. Charles Wastewater Sewer District
JOB NO.:	60686223

TEST HOLE NO.:	TH23-05
SAMPLE NO.:	T6
SAMPLE DEPTH:	6.10 - 6.71 m
SAMPLE DATE:	25-Aug-23
TEST DATE:	05-Sep-23

SOIL DESCRIPTION:	
CLAY - grey, moist, firm, silty, trace silt inclusion, trace oxidation inclusion	
High plasticity	
MOISTURE CONTENT:	44.0



FAILURE SKETCH

SAMPLE DIAM.(Do):	72.60	**(mm)**	**INITIAL AREA, Ao:**	4139.3	**(mm^2)**
SAMPLE LENGTH, (Lo):	154.45	**(mm)**	**PISTON RATE:**	0.0500	**(inches / minute)**
L / D RATIO:	2.13	**(2 < L/D < 2.5)**	**AXIAL STRAIN RATE, R:**	0.82	**(0.5<R<2 % / minute)**

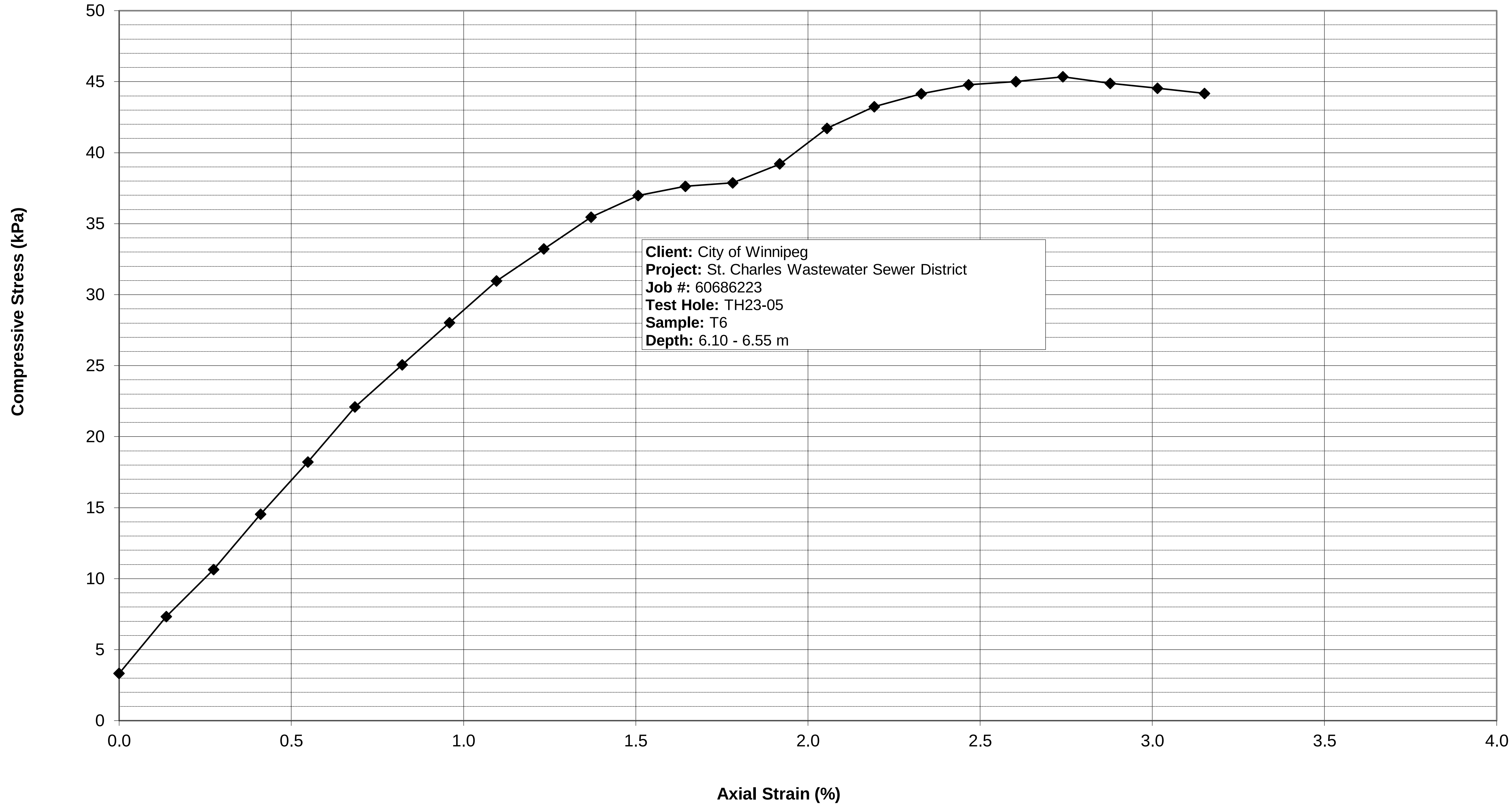
TEST DATA - DIAL READINGS							
AXIAL COMPRESSION	**PROVING RING**	**TOTAL AXIAL STRAIN, E_1**	**AVERAGE CROSS-SECTIONAL AREA, A**	**APPLIED AXIAL LOAD, P**	**COMPRESSIVE STRESS, σ_C**		
(inches)	(inches)	(%)	(inches2)	(lbs)	(psi)	(ksf)	(kPa)
0.01	0.0003	0.00	6.42	3.09	0.48	0.069	3.3
0.02	0.0007	0.14	6.42	6.84	1.06	0.153	7.3
0.03	0.0011	0.27	6.43	9.93	1.54	0.222	10.6
0.03	0.0015	0.41	6.44	13.59	2.11	0.304	14.5
0.04	0.0018	0.55	6.45	17.05	2.64	0.381	18.2
0.05	0.0022	0.69	6.46	20.71	3.21	0.462	22.1
0.06	0.0025	0.82	6.47	23.52	3.64	0.524	25.1
0.07	0.0028	0.96	6.48	26.33	4.06	0.585	28.0
0.08	0.0031	1.10	6.49	29.14	4.49	0.647	31.0
0.08	0.0033	1.23	6.50	31.30	4.82	0.694	33.2
0.09	0.0036	1.37	6.51	33.45	5.14	0.740	35.5
0.10	0.0037	1.51	6.51	34.95	5.37	0.773	37.0
0.11	0.0038	1.64	6.52	35.61	5.46	0.786	37.6
0.12	0.0038	1.78	6.53	35.89	5.49	0.791	37.9
0.13	0.0040	1.92	6.54	37.20	5.69	0.819	39.2
0.13	0.0042	2.06	6.55	39.64	6.05	0.871	41.7
0.14	0.0044	2.19	6.56	41.13	6.27	0.903	43.2
0.15	0.0045	2.33	6.57	42.07	6.40	0.922	44.2
0.16	0.0046	2.47	6.58	42.73	6.50	0.935	44.8
0.17	0.0046	2.60	6.59	43.01	6.53	0.940	45.0
0.18	0.0046	2.74	6.60	43.38	6.58	0.947	45.3
0.18	0.0046	2.88	6.61	43.01	6.51	0.938	44.9
0.19	0.0046	3.02	6.62	42.73	6.46	0.930	44.5
0.20	0.0045	3.15	6.62	42.45	6.41	0.923	44.2

UNCONFINED COMPRESSIVE STRENGTH, q_u:	45.34	kPa
(based on maximum q_u value)	0.947	ksf
UNDRAINED SHEAR STRENGTH, S_u:	22.67	kPa
(based on maximum q_u value)	0.474	ksf

NOTES:

Reviewed by:	Lee Boughton	Approved by:	German Leal, M.Eng., P.Eng.
	Laboratory Manager		Geotechnical Discipline Lead

AECOM
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS
(ASTM D2166)



AECOM - SOILS LABORATORY
SHEAR STRENGTH, MOISTURE CONTENT & DENSITY CALCULATIONS

CLIENT: City of Winnipeg
PROJECT: St. Charles Wastewater Sewer District
JOB NO.: 60686223

TEST HOLE NO.:	**TH23-05**
SAMPLE NO.:	**T7**
SAMPLE DEPTH:	7.62 - 8.23 m
DATE TESTED:	1-Sep-23
SHEAR STRENGTH TESTS	
TORVANE	
Reading	0.35
Vane Size (S, M, L)	M
Undrained Shear Strength (kPa)	**34.3**
Undrained Shear Strength (ksf)	0.72
POCKET PENETROMETER	
Reading - Qu (tsf)	0.25
Undrained Shear Strength (kPa)	**12.0**
Reading - Qu (tsf)	0.25
Undrained Shear Strength (kPa)	**12.0**
Reading - Qu (tsf)	0.15
Undrained Shear Strength (kPa)	**7.2**
UNCONFINED COMPRESSIVE STRENGTH TEST	
Unconfined compressive strength (kPa)	**42.9**
Unconfined compressive strength (ksf)	**0.9**
Undrained Shear Strength (kPa)	**21.5**
Undrained Shear Strength (ksf)	**0.448**
MOISTURE CONTENT	
Tare Number	F30
Wt. Sample wet + tare (g)	319.9
Wt. Sample dry + tare (g)	215.5
Wt. Tare (g)	8.3
Moisture Content %	**50.4**
BULK DENSITY	
Sample Wt. (g)	1101.9
Diameter 1 (cm)	7.21
Diameter 2 (cm)	7.20
Diameter 3 (cm)	7.21
Avg. Diameter (cm)	**7.20**
Length 1 (cm)	15.31
Length 2 (cm)	15.25
Length 3 (cm)	15.20
Avg. Length (cm)	**15.25**
Volume (cm^3)	621.6
Moisture content (%)	50.4
Bulk Density (g/cm^3)	1.773
Bulk Unit Weight (kN/m^3)	**17.4**
Bulk Unit Weight (pcf)	**110.7**
Dry Unit Weight (kN/m^3)	**11.56**

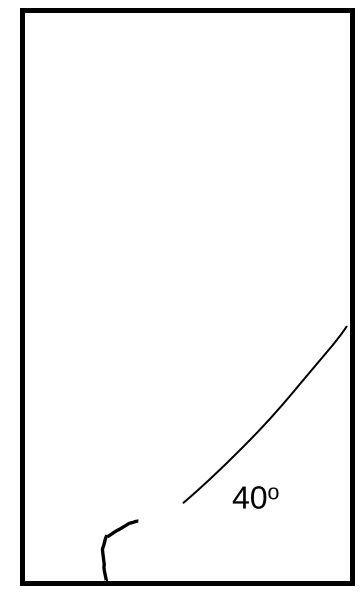
AECOM - SOILS LABORATORY
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS (ASTM D2166)

AECOM

CLIENT:	City of Winnipeg
PROJECT:	St. Charles Wastewater Sewer District
JOB NO.:	60686223

TEST HOLE NO.:	TH23-05
SAMPLE NO.:	T6
SAMPLE DEPTH:	7.62 - 8.23 m
SAMPLE DATE:	25-Aug-23
TEST DATE:	01-Sep-23

SOIL DESCRIPTION:	
CLAY - grey, moist, firm, silty, trace silt inclusion	
High plasticity	
MOISTURE CONTENT:	50.4



FAILURE SKETCH

SAMPLE DIAM.(Do):	72.03	**(mm)**	**INITIAL AREA, Ao:**	4075.3	**(mm^2)**
SAMPLE LENGTH, (Lo):	152.54	**(mm)**	**PISTON RATE:**	0.0500	**(inches / minute)**
L / D RATIO:	2.12	**(2 < L/D < 2.5)**	**AXIAL STRAIN RATE, R:**	0.83	**(0.5<R<2 % / minute)**

TEST DATA - DIAL READINGS

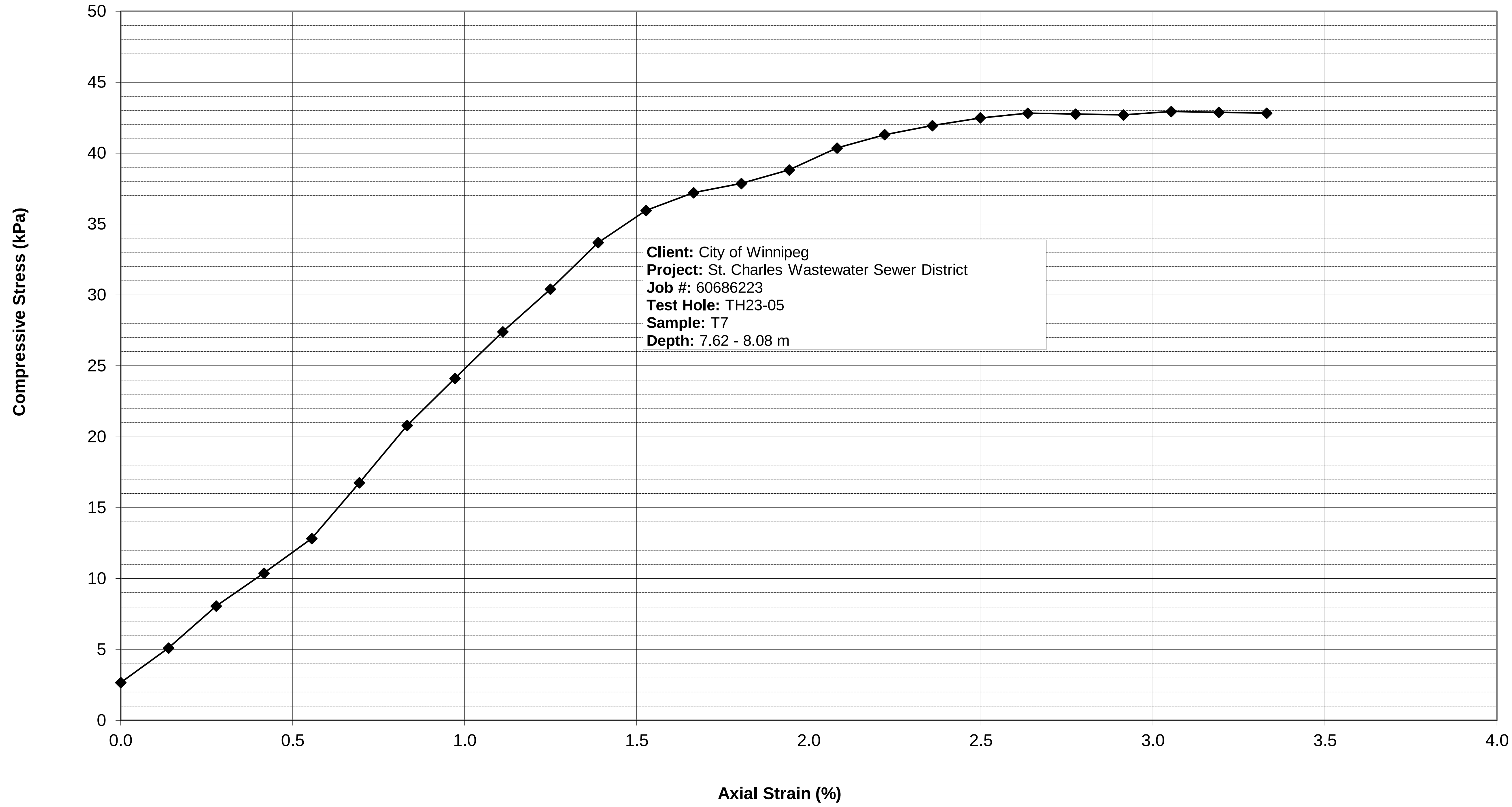
AXIAL COMPRESSION	**PROVING RING**	**TOTAL AXIAL STRAIN, E_1**	**AVERAGE CROSS-SECTIONAL AREA, A**	**APPLIED AXIAL LOAD, P**	**COMPRESSIVE STRESS, σ_C**		
(inches)	(inches)	(%)	(inches2)	(lbs)	(psi)	(ksf)	(kPa)
0.01	0.0003	0.00	6.32	2.44	0.39	0.056	2.7
0.02	0.0005	0.14	6.33	4.69	0.74	0.107	5.1
0.03	0.0008	0.28	6.33	7.40	1.17	0.168	8.1
0.03	0.0010	0.42	6.34	9.56	1.51	0.217	10.4
0.04	0.0013	0.56	6.35	11.81	1.86	0.268	12.8
0.05	0.0017	0.69	6.36	15.46	2.43	0.350	16.8
0.06	0.0021	0.83	6.37	19.21	3.02	0.434	20.8
0.07	0.0024	0.97	6.38	22.30	3.50	0.503	24.1
0.08	0.0027	1.11	6.39	25.39	3.98	0.572	27.4
0.08	0.0030	1.25	6.40	28.20	4.41	0.635	30.4
0.09	0.0033	1.39	6.41	31.30	4.89	0.704	33.7
0.10	0.0036	1.53	6.41	33.45	5.21	0.751	36.0
0.11	0.0037	1.67	6.42	34.67	5.40	0.777	37.2
0.12	0.0038	1.80	6.43	35.32	5.49	0.791	37.9
0.13	0.0039	1.94	6.44	36.26	5.63	0.811	38.8
0.13	0.0040	2.08	6.45	37.76	5.85	0.843	40.4
0.14	0.0041	2.22	6.46	38.70	5.99	0.863	41.3
0.15	0.0042	2.36	6.47	39.35	6.08	0.876	41.9
0.16	0.0043	2.50	6.48	39.92	6.16	0.887	42.5
0.17	0.0043	2.64	6.49	40.29	6.21	0.894	42.8
0.18	0.0043	2.78	6.50	40.29	6.20	0.893	42.8
0.18	0.0043	2.91	6.51	40.29	6.19	0.892	42.7
0.19	0.0043	3.05	6.52	40.57	6.23	0.897	42.9
0.20	0.0043	3.19	6.52	40.57	6.22	0.895	42.9
0.21	0.0043	3.33	6.53	40.57	6.21	0.894	42.8

UNCONFINED COMPRESSIVE STRENGTH, q_u:	42.93	kPa
(based on maximum q_u value)	0.897	ksf
UNDRAINED SHEAR STRENGTH, S_u:	21.47	kPa
(based on maximum q_u value)	0.448	ksf

NOTES:

Reviewed by:	Lee Boughton	Approved by:	German Leal, M.Eng., P.Eng.
	Laboratory Manager		Geotechnical Discipline Lead

AECOM
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS
(ASTM D2166)



AECOM - SOILS LABORATORY
SHEAR STRENGTH, MOISTURE CONTENT & DENSITY CALCULATIONS

CLIENT: City of Winnipeg
PROJECT: St. Charles Wastewater Sewer District
JOB NO.: 60686223

TEST HOLE NO.:	**TH23-06**
SAMPLE NO.:	**T4**
SAMPLE DEPTH:	3.05 - 3.66 m
DATE TESTED:	5-Sep-23
SHEAR STRENGTH TESTS	
TORVANE	
Reading	0.60
Vane Size (S, M, L)	M
Undrained Shear Strength (kPa)	**58.8**
Undrained Shear Strength (ksf)	1.23
POCKET PENETROMETER	
Reading - Qu (tsf)	2.60
Undrained Shear Strength (kPa)	**124.5**
Reading - Qu (tsf)	2.10
Undrained Shear Strength (kPa)	**100.5**
Reading - Qu (tsf)	1.00
Undrained Shear Strength (kPa)	**47.9**
UNCONFINED COMPRESSIVE STRENGTH TEST	
Unconfined compressive strength (kPa)	**66.0**
Unconfined compressive strength (ksf)	**1.4**
Undrained Shear Strength (kPa)	**33.0**
Undrained Shear Strength (ksf)	**0.689**
MOISTURE CONTENT	
Tare Number	Mac-8
Wt. Sample wet + tare (g)	233.8
Wt. Sample dry + tare (g)	166.0
Wt. Tare (g)	8.4
Moisture Content %	**43.0**
BULK DENSITY	
Sample Wt. (g)	1108.4
Diameter 1 (cm)	7.26
Diameter 2 (cm)	7.25
Diameter 3 (cm)	7.28
Avg. Diameter (cm)	**7.26**
Length 1 (cm)	15.18
Length 2 (cm)	15.13
Length 3 (cm)	15.14
Avg. Length (cm)	**15.15**
Volume (cm^3)	627.5
Moisture content (%)	43.0
Bulk Density (g/cm^3)	1.766
Bulk Unit Weight (kN/m^3)	**17.3**
Bulk Unit Weight (pcf)	**110.3**
Dry Unit Weight (kN/m^3)	**12.11**

AECOM - SOILS LABORATORY
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS (ASTM D2166)

AECOM

CLIENT:	City of Winnipeg
PROJECT:	St. Charles Wastewater Sewer District
JOB NO.:	60686223

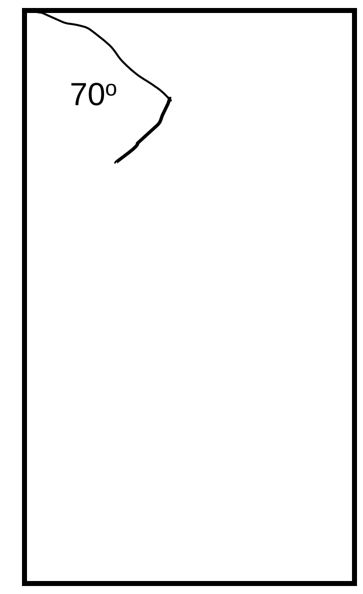
TEST HOLE NO.:	TH23-06
SAMPLE NO.:	T4
SAMPLE DEPTH:	3.05 - 3.66 m
SAMPLE DATE:	25-Aug-23
TEST DATE:	05-Sep-23

SOIL DESCRIPTION:

CLAY - brown, moist, stiff, silty, sandy silt inclusion
Low plasticity

MOISTURE CONTENT: 43.0

SAMPLE DIAM.(Do):	72.62	**(mm)**	**INITIAL AREA, Ao:**	4141.5	**(mm^2)**
SAMPLE LENGTH, (Lo):	151.51	**(mm)**	**PISTON RATE:**	0.0500	**(inches / minute)**
L / D RATIO:	2.09	**(2 < L/D < 2.5)**	**AXIAL STRAIN RATE, R:**	0.84	**(0.5<R<2 % / minute)**



FAILURE SKETCH

TEST DATA - DIAL READINGS							
AXIAL COMPRESSION	**PROVING RING**	**TOTAL AXIAL STRAIN, E_1**	**AVERAGE CROSS-SECTIONAL AREA, A**	**APPLIED AXIAL LOAD, P**	**COMPRESSIVE STRESS, σ_C**		
(inches)	(inches)	(%)	(inches2)	(lbs)	(psi)	(ksf)	(kPa)
0.01	0.0003	0.00	6.42	2.81	0.44	0.063	3.0
0.02	0.0006	0.14	6.43	5.90	0.92	0.132	6.3
0.03	0.0010	0.28	6.44	9.00	1.40	0.201	9.6
0.03	0.0013	0.42	6.45	12.09	1.88	0.270	12.9
0.04	0.0016	0.56	6.46	14.52	2.25	0.324	15.5
0.05	0.0018	0.70	6.46	17.05	2.64	0.380	18.2
0.06	0.0021	0.84	6.47	19.49	3.01	0.434	20.8
0.07	0.0024	0.98	6.48	22.02	3.40	0.489	23.4
0.08	0.0026	1.12	6.49	24.46	3.77	0.542	26.0
0.08	0.0029	1.26	6.50	26.89	4.14	0.596	28.5
0.09	0.0031	1.40	6.51	29.42	4.52	0.651	31.2
0.10	0.0033	1.54	6.52	31.30	4.80	0.691	33.1
0.11	0.0035	1.68	6.53	33.17	5.08	0.732	35.0
0.12	0.0037	1.82	6.54	34.39	5.26	0.757	36.3
0.13	0.0038	1.96	6.55	35.61	5.44	0.783	37.5
0.13	0.0039	2.10	6.56	36.54	5.57	0.803	38.4
0.14	0.0040	2.24	6.57	37.76	5.75	0.828	39.7
0.15	0.0043	2.37	6.58	40.57	6.17	0.888	42.5
0.16	0.0045	2.51	6.59	41.79	6.35	0.914	43.8
0.17	0.0046	2.65	6.59	43.01	6.52	0.939	45.0
0.18	0.0049	2.79	6.60	45.54	6.90	0.993	47.5
0.18	0.0051	2.93	6.61	47.41	7.17	1.032	49.4
0.19	0.0052	3.07	6.62	48.91	7.39	1.063	50.9
0.20	0.0054	3.21	6.63	50.79	7.66	1.103	52.8
0.21	0.0056	3.35	6.64	52.66	7.93	1.142	54.7
0.22	0.0058	3.49	6.65	54.16	8.14	1.172	56.1
0.23	0.0060	3.63	6.66	55.75	8.37	1.205	57.7
0.23	0.0062	3.77	6.67	57.63	8.64	1.244	59.6
0.24	0.0063	3.91	6.68	59.12	8.85	1.274	61.0
0.25	0.0065	4.05	6.69	60.72	9.08	1.307	62.6
0.26	0.0066	4.19	6.70	62.22	9.29	1.337	64.0
0.27	0.0067	4.33	6.71	63.15	9.41	1.355	64.9
0.28	0.0068	4.47	6.72	63.81	9.50	1.367	65.5
0.28	0.0069	4.61	6.73	64.37	9.57	1.377	66.0
0.29	0.0069	4.75	6.74	64.37	9.55	1.375	65.9
0.30	0.0068	4.89	6.75	63.43	9.40	1.353	64.8
0.31	0.0066	5.03	6.76	61.94	9.16	1.319	63.2

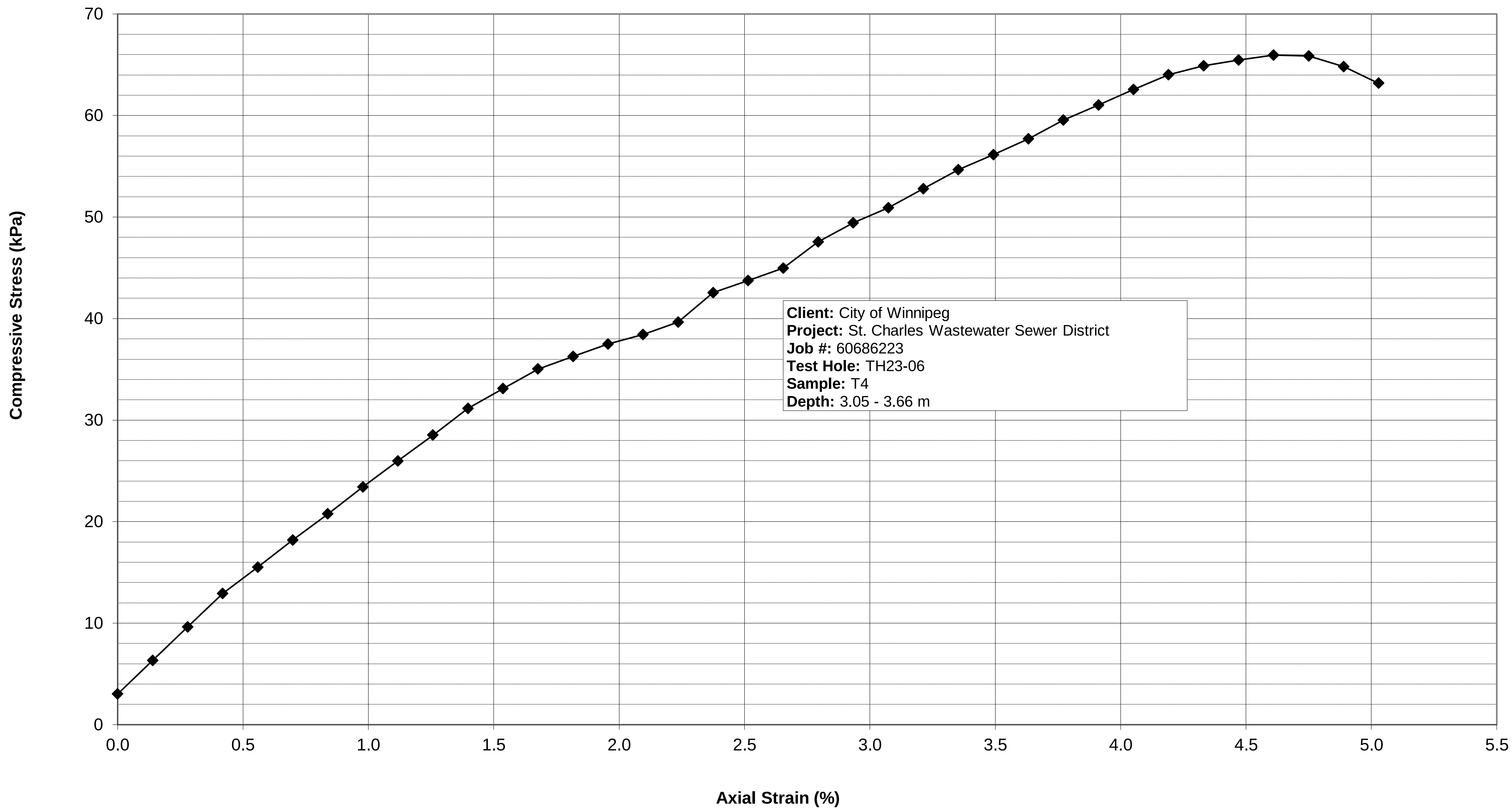
UNCONFINED COMPRESSIVE STRENGTH, q_u:	65.95	kPa
(based on maximum q_u value)	1.377	ksf
UNDRAINED SHEAR STRENGTH, S_u:	32.98	kPa
(based on maximum q_u value)	0.689	ksf

NOTES:

Reviewed by: Lee Boughton, Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng., Geotechnical Discipline Lead

AECOM
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS
(ASTM D2166)



AECOM - SOILS LABORATORY
SHEAR STRENGTH, MOISTURE CONTENT & DENSITY CALCULATIONS

AECOM

CLIENT: City of Winnipeg
PROJECT: St. Charles Wastewater Sewer District
JOB NO.: 60686223

TEST HOLE NO.:	**TH23-06**
SAMPLE NO.:	**T6**
SAMPLE DEPTH:	6.10 - 6.71 m
DATE TESTED:	6-Sep-23
SHEAR STRENGTH TESTS	
TORVANE	
Reading	0.19
Vane Size (S, M, L)	M
Undrained Shear Strength (kPa)	**18.6**
Undrained Shear Strength (ksf)	0.39
POCKET PENETROMETER	
Reading - Qu (tsf)	0.10
Undrained Shear Strength (kPa)	**4.8**
Reading - Qu (tsf)	0.15
Undrained Shear Strength (kPa)	**7.2**
Reading - Qu (tsf)	0.15
Undrained Shear Strength (kPa)	**7.2**
UNCONFINED COMPRESSIVE STRENGTH TEST	
Unconfined compressive strength (kPa)	**18.9**
Unconfined compressive strength (ksf)	**0.4**
Undrained Shear Strength (kPa)	**9.5**
Undrained Shear Strength (ksf)	**0.198**
MOISTURE CONTENT	
Tare Number	AT-56
Wt. Sample wet + tare (g)	279.3
Wt. Sample dry + tare (g)	210.8
Wt. Tare (g)	8.4
Moisture Content %	**33.8**
BULK DENSITY	
Sample Wt. (g)	1062
Diameter 1 (cm)	7.20
Diameter 2 (cm)	7.18
Diameter 3 (cm)	7.13
Avg. Diameter (cm)	**7.17**
Length 1 (cm)	15.25
Length 2 (cm)	15.21
Length 3 (cm)	15.21
Avg. Length (cm)	**15.22**
Volume (cm^3)	614.8
Moisture content (%)	33.8
Bulk Density (g/cm^3)	1.727
Bulk Unit Weight (kN/m^3)	**16.9**
Bulk Unit Weight (pcf)	**107.8**
Dry Unit Weight (kN/m^3)	**12.66**

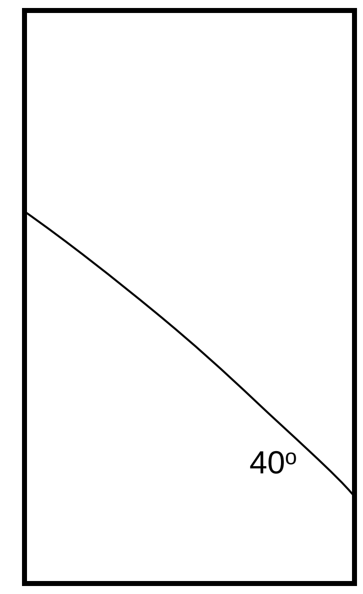
AECOM - SOILS LABORATORY
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS (ASTM D2166)

AECOM

CLIENT:	City of Winnipeg
PROJECT:	St. Charles Wastewater Sewer District
JOB NO.:	60686223

TEST HOLE NO.:	TH23-06
SAMPLE NO.:	T6
SAMPLE DEPTH:	6.10 - 6.71 m
SAMPLE DATE:	25-Aug-23
TEST DATE:	06-Sep-23

SOIL DESCRIPTION:	
CLAY - grey, moist, soft, silty, trace silt inclusion	
High plasticity	
MOISTURE CONTENT:	33.8



FAILURE SKETCH

SAMPLE DIAM.(Do):	71.71	**(mm)**	**INITIAL AREA, Ao:**	4038.8	**(mm^2)**
SAMPLE LENGTH, (Lo):	152.23	**(mm)**	**PISTON RATE:**	0.0500	**(inches / minute)**
L / D RATIO:	2.12	**(2 < L/D < 2.5)**	**AXIAL STRAIN RATE, R:**	0.83	**(0.5<R<2 % / minute)**

TEST DATA - DIAL READINGS							
AXIAL COMPRESSION	**PROVING RING**	**TOTAL AXIAL STRAIN, E_1**	**AVERAGE CROSS-SECTIONAL AREA, A**	**APPLIED AXIAL LOAD, P**	**COMPRESSIVE STRESS, σ_C**		
(inches)	(inches)	(%)	(inches2)	(lbs)	(psi)	(ksf)	(kPa)
0.01	0.0004	0.00	6.26	3.75	0.60	0.086	4.1
0.02	0.0007	0.14	6.27	6.84	1.09	0.157	7.5
0.03	0.0011	0.28	6.28	9.93	1.58	0.228	10.9
0.03	0.0014	0.42	6.29	12.65	2.01	0.290	13.9
0.04	0.0016	0.56	6.30	14.90	2.37	0.341	16.3
0.05	0.0018	0.70	6.30	16.40	2.60	0.375	17.9
0.06	0.0019	0.83	6.31	17.33	2.75	0.395	18.9
0.07	0.0018	0.97	6.32	17.05	2.70	0.388	18.6
0.08	0.0018	1.11	6.33	16.40	2.59	0.373	17.9
0.08	0.0016	1.25	6.34	14.90	2.35	0.338	16.2

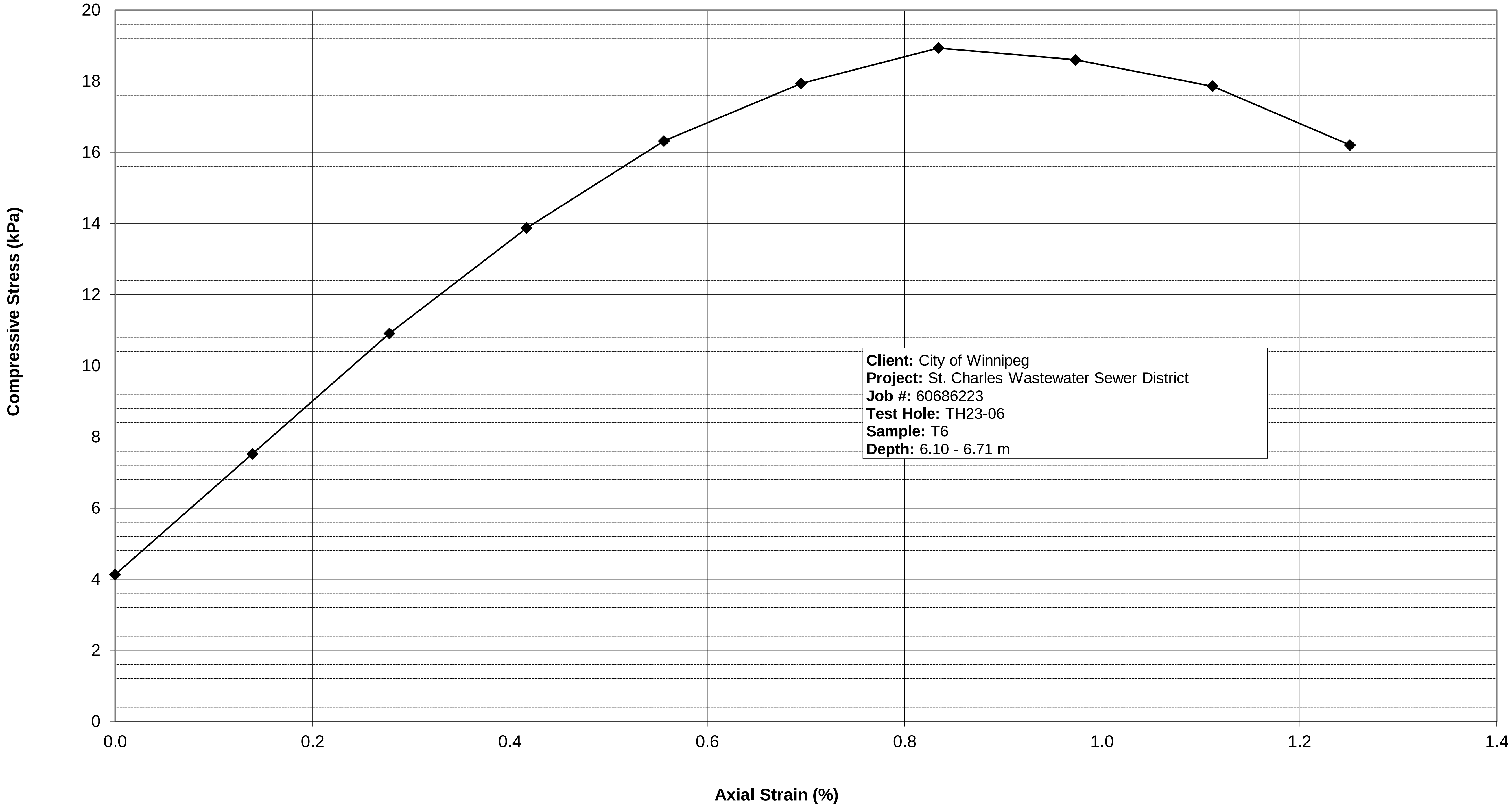
UNCONFINED COMPRESSIVE STRENGTH, q_u:	18.93	kPa
(based on maximum q_u value)	0.395	ksf
UNDRAINED SHEAR STRENGTH, S_u:	9.47	kPa
(based on maximum q_u value)	0.198	ksf

NOTES:

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
Geotechnical Discipline Lead

AECOM
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS
(ASTM D2166)



AECOM - SOILS LABORATORY
SHEAR STRENGTH, MOISTURE CONTENT & DENSITY CALCULATIONS

AECOM

CLIENT: City of Winnipeg
PROJECT: St. Charles Wastewater Sewer District
JOB NO.: 60686223

TEST HOLE NO.:	**TH23-07**
SAMPLE NO.:	**T6**
SAMPLE DEPTH:	6.10 - 6.71 m
DATE TESTED:	6-Sep-23
SHEAR STRENGTH TESTS	
TORVANE	
Reading	0.68
Vane Size (S, M, L)	M
Undrained Shear Strength (kPa)	**66.2**
Undrained Shear Strength (ksf)	1.38
POCKET PENETROMETER	
Reading - Qu (tsf)	1.80
Undrained Shear Strength (kPa)	**86.2**
Reading - Qu (tsf)	1.75
Undrained Shear Strength (kPa)	**83.8**
Reading - Qu (tsf)	2.50
Undrained Shear Strength (kPa)	**119.7**
UNCONFINED COMPRESSIVE STRENGTH TEST	
Unconfined compressive strength (kPa)	**54.2**
Unconfined compressive strength (ksf)	**1.1**
Undrained Shear Strength (kPa)	**27.1**
Undrained Shear Strength (ksf)	**0.566**
MOISTURE CONTENT	
Tare Number	T-18
Wt. Sample wet + tare (g)	197.6
Wt. Sample dry + tare (g)	129.7
Wt. Tare (g)	8.6
Moisture Content %	**56.1**
BULK DENSITY	
Sample Wt. (g)	1037.3
Diameter 1 (cm)	7.08
Diameter 2 (cm)	7.06
Diameter 3 (cm)	7.14
Avg. Diameter (cm)	**7.09**
Length 1 (cm)	15.31
Length 2 (cm)	15.34
Length 3 (cm)	15.38
Avg. Length (cm)	**15.34**
Volume (cm^3)	606.0
Moisture content (%)	56.1
Bulk Density (g/cm^3)	1.712
Bulk Unit Weight (kN/m^3)	**16.8**
Bulk Unit Weight (pcf)	**106.9**
Dry Unit Weight (kN/m^3)	**10.76**

AECOM - SOILS LABORATORY
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS (ASTM D2166)

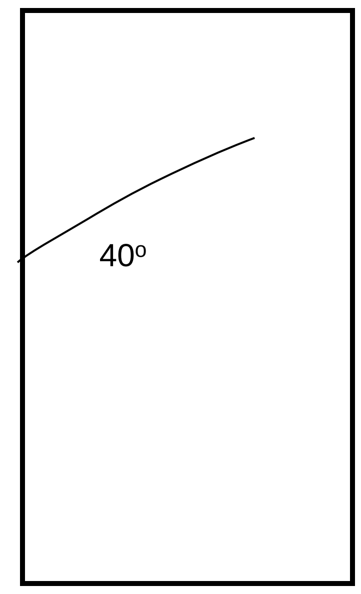
AECOM

CLIENT:	City of Winnipeg
PROJECT:	St. Charles Wastewater Sewer District
JOB NO.:	60686223

TEST HOLE NO.:	TH23-07
SAMPLE NO.:	T6
SAMPLE DEPTH:	6.10 - 6.71 m
SAMPLE DATE:	25-Aug-23
TEST DATE:	06-Sep-23

SOIL DESCRIPTION:	
CLAY - brown, moist, stiff, silty, trace silt inclusion, some organic inclusion	
Low plasticity	
MOISTURE CONTENT:	56.1

SAMPLE DIAM.(Do):	70.92	**(mm)**	**INITIAL AREA, Ao:**	3950.6	**(mm^2)**
SAMPLE LENGTH, (Lo):	153.40	**(mm)**	**PISTON RATE:**	0.0500	**(inches / minute)**
L / D RATIO:	2.16	**(2 < L/D < 2.5)**	**AXIAL STRAIN RATE, R:**	0.83	**(0.5<R<2 % / minute)**



FAILURE SKETCH

TEST DATA - DIAL READINGS							
AXIAL COMPRESSION	**PROVING RING**	**TOTAL AXIAL STRAIN, E_1**	**AVERAGE CROSS-SECTIONAL AREA, A**	**APPLIED AXIAL LOAD, P**	**COMPRESSIVE STRESS, σ_C**		
(inches)	(inches)	(%)	(inches2)	(lbs)	(psi)	(ksf)	(kPa)
0.01	0.0004	0.00	6.12	3.37	0.55	0.079	3.8
0.02	0.0007	0.14	6.13	6.47	1.05	0.152	7.3
0.03	0.0010	0.28	6.14	9.56	1.56	0.224	10.7
0.03	0.0014	0.41	6.15	13.02	2.12	0.305	14.6
0.04	0.0017	0.55	6.16	15.84	2.57	0.370	17.7
0.05	0.0020	0.69	6.17	18.55	3.01	0.433	20.7
0.06	0.0023	0.83	6.17	21.08	3.41	0.492	23.5
0.07	0.0025	0.97	6.18	23.52	3.80	0.548	26.2
0.08	0.0028	1.10	6.19	26.05	4.21	0.606	29.0
0.08	0.0030	1.24	6.20	27.83	4.49	0.646	30.9
0.09	0.0032	1.38	6.21	30.08	4.84	0.698	33.4
0.10	0.0034	1.52	6.22	31.58	5.08	0.731	35.0
0.11	0.0036	1.66	6.23	33.45	5.37	0.774	37.0
0.12	0.0037	1.79	6.24	34.67	5.56	0.801	38.3
0.13	0.0038	1.93	6.24	35.32	5.66	0.815	39.0
0.13	0.0038	2.07	6.25	35.89	5.74	0.826	39.6
0.14	0.0039	2.21	6.26	36.54	5.84	0.840	40.2
0.15	0.0040	2.35	6.27	37.48	5.98	0.861	41.2
0.16	0.0042	2.48	6.28	39.35	6.27	0.902	43.2
0.17	0.0043	2.62	6.29	40.29	6.41	0.923	44.2
0.18	0.0044	2.76	6.30	41.51	6.59	0.949	45.4
0.18	0.0045	2.90	6.31	42.45	6.73	0.969	46.4
0.19	0.0046	3.04	6.32	43.38	6.87	0.989	47.4
0.20	0.0047	3.17	6.32	43.95	6.95	1.001	47.9
0.21	0.0048	3.31	6.33	44.88	7.09	1.020	48.9
0.22	0.0049	3.45	6.34	45.54	7.18	1.034	49.5
0.23	0.0050	3.59	6.35	46.48	7.32	1.054	50.5
0.23	0.0050	3.73	6.36	47.04	7.40	1.065	51.0
0.24	0.0051	3.86	6.37	47.69	7.49	1.078	51.6
0.25	0.0051	4.00	6.38	47.97	7.52	1.083	51.9
0.26	0.0052	4.14	6.39	48.63	7.61	1.096	52.5
0.27	0.0052	4.28	6.40	48.91	7.65	1.101	52.7
0.28	0.0053	4.42	6.41	49.57	7.74	1.114	53.3
0.28	0.0053	4.55	6.42	49.85	7.77	1.119	53.6
0.29	0.0054	4.69	6.42	50.13	7.80	1.124	53.8
0.30	0.0054	4.83	6.43	50.50	7.85	1.130	54.1
0.31	0.0054	4.97	6.44	50.50	7.84	1.129	54.0
0.32	0.0054	5.11	6.45	50.50	7.83	1.127	54.0
0.33	0.0054	5.24	6.46	50.79	7.86	1.132	54.2
0.33	0.0054	5.38	6.47	50.79	7.85	1.130	54.1
0.34	0.0054	5.52	6.48	50.79	7.84	1.128	54.0
0.35	0.0054	5.66	6.49	50.79	7.82	1.127	53.9
0.36	0.0054	5.80	6.50	50.50	7.77	1.119	53.6

TEST DATA - DIAL READINGS							
AXIAL COMPRESSION	**PROVING RING**	**TOTAL AXIAL STRAIN, E_1**	**AVERAGE CROSS-SECTIONAL AREA, A**	**APPLIED AXIAL LOAD, P**	**COMPRESSIVE STRESS, σ_C**		
(inches)	(inches)	(%)	(inches2)	(lbs)	(psi)	(ksf)	(kPa)

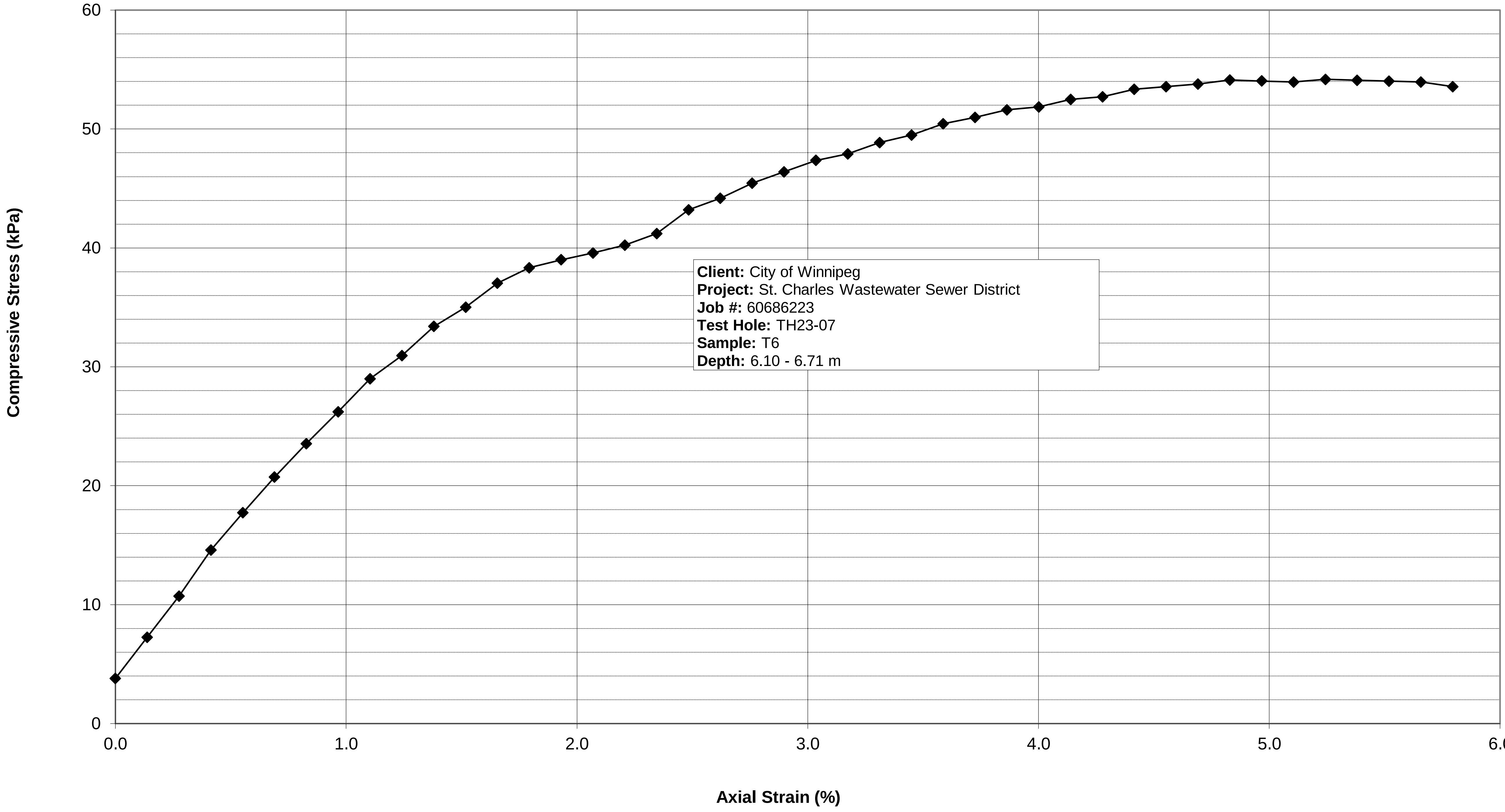
UNCONFINED COMPRESSIVE STRENGTH, q_u:	54.18	kPa
(based on maximum q_u value)	1.132	ksf
UNDRAINED SHEAR STRENGTH, S_u:	27.09	kPa
(based on maximum q_u value)	0.566	ksf

NOTES:

Reviewed by: Lee Boughton, Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng., Geotechnical Discipline Lead

AECOM
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS
(ASTM D2166)



AECOM - SOILS LABORATORY
SHEAR STRENGTH, MOISTURE CONTENT & DENSITY CALCULATIONS

AECOM

CLIENT: City of Winnipeg
PROJECT: St. Charles Wastewater Sewer District
JOB NO.: 60686223

TEST HOLE NO.:	**TH23-07**
SAMPLE NO.:	**T4**
SAMPLE DEPTH:	3.05 - 3.66 m
DATE TESTED:	6-Sep-23
SHEAR STRENGTH TESTS	
TORVANE	
Reading	0.56
Vane Size (S, M, L)	M
Undrained Shear Strength (kPa)	**54.9**
Undrained Shear Strength (ksf)	1.15
POCKET PENETROMETER	
Reading - Qu (tsf)	1.35
Undrained Shear Strength (kPa)	**64.6**
Reading - Qu (tsf)	1.25
Undrained Shear Strength (kPa)	**59.9**
Reading - Qu (tsf)	1.40
Undrained Shear Strength (kPa)	**67.0**
UNCONFINED COMPRESSIVE STRENGTH TEST	
Unconfined compressive strength (kPa)	**90.1**
Unconfined compressive strength (ksf)	**1.9**
Undrained Shear Strength (kPa)	**45.1**
Undrained Shear Strength (ksf)	**0.941**
MOISTURE CONTENT	
Tare Number	SG-40
Wt. Sample wet + tare (g)	241.6
Wt. Sample dry + tare (g)	174.0
Wt. Tare (g)	8.4
Moisture Content %	**40.8**
BULK DENSITY	
Sample Wt. (g)	1107.5
Diameter 1 (cm)	7.24
Diameter 2 (cm)	7.25
Diameter 3 (cm)	7.24
Avg. Diameter (cm)	**7.24**
Length 1 (cm)	15.40
Length 2 (cm)	15.43
Length 3 (cm)	15.47
Avg. Length (cm)	**15.43**
Volume (cm^3)	636.2
Moisture content (%)	40.8
Bulk Density (g/cm^3)	1.741
Bulk Unit Weight (kN/m^3)	**17.1**
Bulk Unit Weight (pcf)	**108.7**
Dry Unit Weight (kN/m^3)	**12.12**

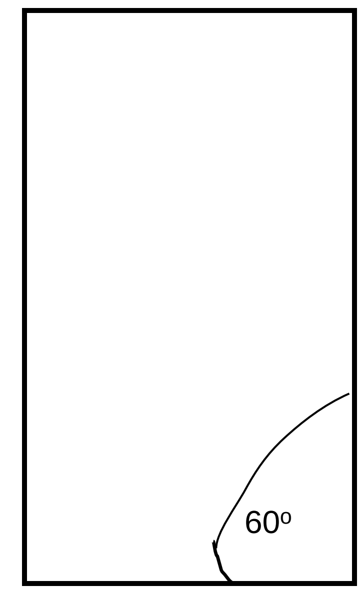
AECOM - SOILS LABORATORY
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS (ASTM D2166)

AECOM

CLIENT:	City of Winnipeg
PROJECT:	St. Charles Wastewater Sewer District
JOB NO.:	60686223

TEST HOLE NO.:	TH23-07
SAMPLE NO.:	T4
SAMPLE DEPTH:	3.05 - 3.66 m
SAMPLE DATE:	25-Aug-23
TEST DATE:	06-Sep-23

SOIL DESCRIPTION:	
CLAY - brown, moist, stiff, silty, trace silt inclusion, trace organic inclusion	
Intermediate plasticity	
MOISTURE CONTENT:	40.8



FAILURE SKETCH

SAMPLE DIAM.(Do):	72.44	**(mm)**	**INITIAL AREA, Ao:**	4121.8	**(mm^2)**
SAMPLE LENGTH, (Lo):	154.35	**(mm)**	**PISTON RATE:**	0.0500	**(inches / minute)**
L / D RATIO:	2.13	**(2 < L/D < 2.5)**	**AXIAL STRAIN RATE, R:**	0.82	**(0.5<R<2 % / minute)**

TEST DATA - DIAL READINGS							
AXIAL COMPRESSION	**PROVING RING**	**TOTAL AXIAL STRAIN, E_1**	**AVERAGE CROSS-SECTIONAL AREA, A**	**APPLIED AXIAL LOAD, P**	**COMPRESSIVE STRESS, σ_C**		
(inches)	(inches)	(%)	(inches2)	(lbs)	(psi)	(ksf)	(kPa)
0.01	0.0006	0.00	6.39	5.90	0.92	0.133	6.4
0.02	0.0012	0.14	6.40	11.43	1.79	0.257	12.3
0.03	0.0017	0.27	6.41	16.12	2.52	0.362	17.3
0.03	0.0023	0.41	6.42	21.08	3.29	0.473	22.7
0.04	0.0028	0.55	6.42	26.05	4.05	0.584	28.0
0.05	0.0033	0.69	6.43	30.92	4.81	0.692	33.1
0.06	0.0036	0.82	6.44	34.01	5.28	0.760	36.4
0.07	0.0037	0.96	6.45	34.67	5.37	0.774	37.1
0.08	0.0039	1.10	6.46	36.54	5.66	0.815	39.0
0.08	0.0045	1.23	6.47	42.45	6.56	0.945	45.2
0.09	0.0051	1.37	6.48	47.41	7.32	1.054	50.5
0.10	0.0055	1.51	6.49	51.35	7.92	1.140	54.6
0.11	0.0058	1.65	6.50	54.53	8.40	1.209	57.9
0.12	0.0062	1.78	6.50	58.47	8.99	1.294	62.0
0.13	0.0066	1.92	6.51	62.22	9.55	1.375	65.9
0.13	0.0070	2.06	6.52	65.59	10.06	1.448	69.3
0.14	0.0073	2.19	6.53	68.78	10.53	1.516	72.6
0.15	0.0077	2.33	6.54	71.87	10.99	1.582	75.8
0.16	0.0079	2.47	6.55	74.30	11.34	1.633	78.2
0.17	0.0082	2.61	6.56	76.74	11.70	1.685	80.7
0.18	0.0084	2.74	6.57	78.61	11.97	1.723	82.5
0.18	0.0086	2.88	6.58	80.21	12.19	1.756	84.1
0.19	0.0087	3.02	6.59	81.43	12.36	1.780	85.2
0.20	0.0088	3.15	6.60	82.64	12.53	1.804	86.4
0.21	0.0090	3.29	6.61	84.24	12.75	1.836	87.9
0.22	0.0091	3.43	6.62	85.17	12.87	1.854	88.8
0.23	0.0092	3.57	6.63	86.11	13.00	1.872	89.6
0.23	0.0092	3.70	6.63	86.39	13.02	1.875	89.8
0.24	0.0093	3.84	6.64	86.67	13.05	1.879	89.9
0.25	0.0093	3.98	6.65	86.95	13.07	1.882	90.1
0.26	0.0093	4.11	6.66	86.95	13.05	1.879	90.0
0.27	0.0092	4.25	6.67	86.39	12.95	1.864	89.3
0.28	0.0092	4.39	6.68	85.74	12.83	1.848	88.5

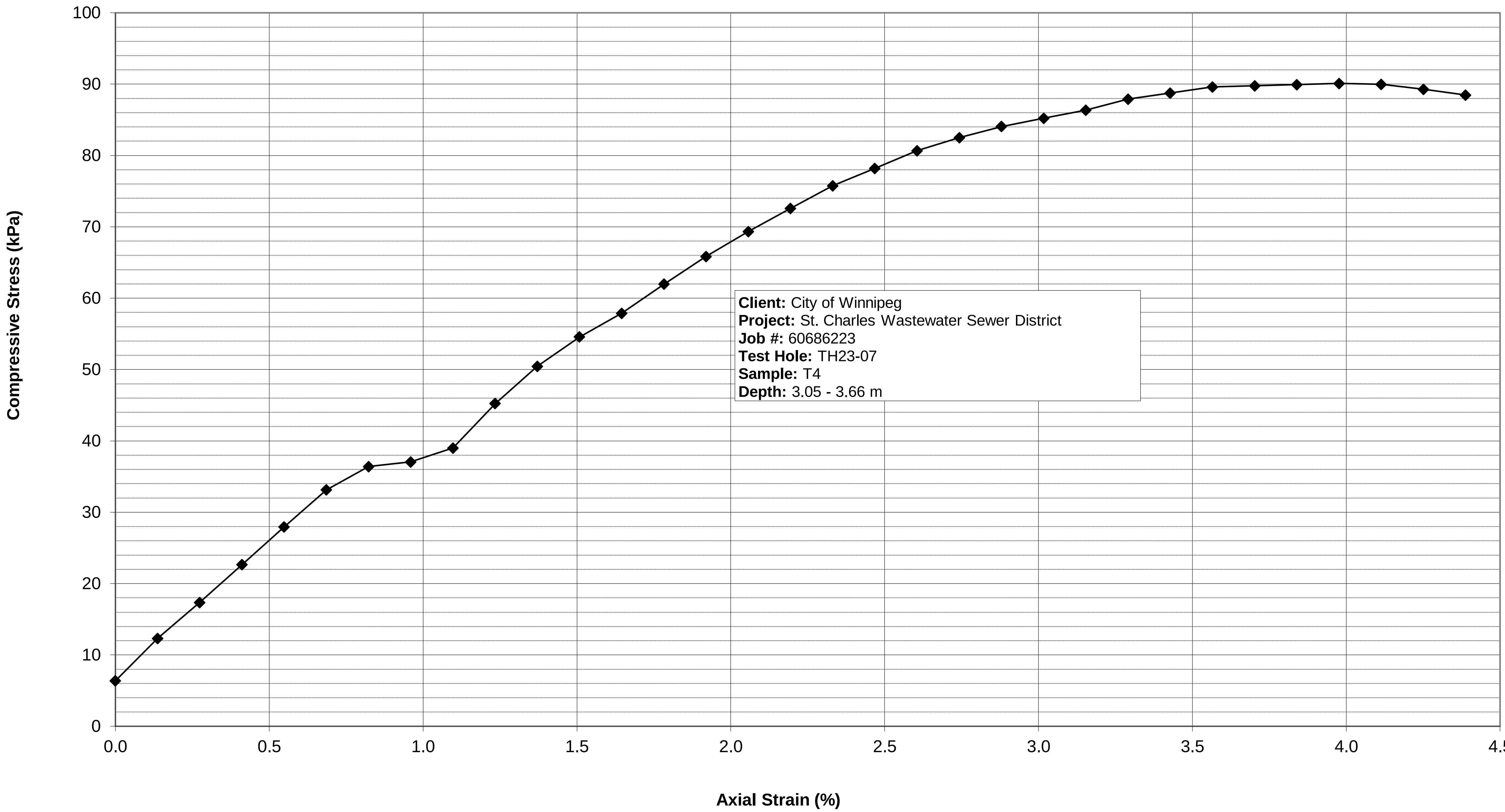
UNCONFINED COMPRESSIVE STRENGTH, q_u:	90.11	kPa
(based on maximum q_u value)	1.882	ksf
UNDRAINED SHEAR STRENGTH, S_u:	45.05	kPa
(based on maximum q_u value)	0.941	ksf

NOTES:

Reviewed by: Lee Boughton, Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng., Geotechnical Discipline Lead

AECOM
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS
(ASTM D2166)



ALS Canada Ltd.

CERTIFICATE OF ANALYSIS

Work Order	: **WP2322386**	Page	: 1 of 3
Amendment	: **1**		
Client	: **AECOM Canada Ltd.**	Laboratory	: ALS Environmental - Winnipeg
Contact	: Colton Wooster	Account Manager	: Craig Riddell
Address	: 99 Commerce Drive Winnipeg MB Canada R3P 0Y7	Address	: 1329 Niakwa Road East, Unit 12 Winnipeg MB Canada R2J 3T4
Telephone	: ----	Telephone	: +1 204 255 9720
Project	: 60686223	Date Samples Received	: 07-Sep-2023 11:48
PO	: 60686223	Date Analysis Commenced	: 12-Sep-2023
C-O-C number	: ----	Issue Date	: 18-Sep-2023 11:54
Sampler	: ----		
Site	: ----		
Quote number	: AECOM , ph, Cond, Resist, Tot & Sol Sulphate CSA		
No. of samples received	: 2		
No. of samples analysed	: 2		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
George Huang	Supervisor - Inorganic	Inorganics, Calgary, Alberta
Kevin Baxter	Team Leader - Inorganics	Inorganics, Calgary, Alberta
Nik Perkio	Inorganics Analyst	Inorganics, Waterloo, Ontario

General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances

LOR: Limit of Reporting (detection limit).

Unit	*Description*
%	percent
mS/cm	millisiemens per centimetre
ohm cm	ohm centimetres (resistivity)
pH units	pH units

<: less than.

>: greater than.

Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical Results

Sub-Matrix: **Soil/Solid**
(Matrix: **Soil/Solid**)

					Client sample ID	TH23-05 ; 65 19.5'	TH-23-06 ; 65 15'	----	----	----
					Client sampling date / time	07-Sep-2023 00:00	07-Sep-2023 00:00	----	----	----
Analyte	CAS Number	Method/Lab	LOR	Unit		WP2322386-001	WP2322386-002	--------	--------	--------
						Result	Result	----	----	----
Physical Tests										
Conductivity (1:2 leachate)	----	E100-L/WT	0.00500	mS/cm		1.95	1.00	----	----	----
pH (1:2 soil:CaCl2-aq)	----	E108A/WT	0.10	pH units		7.89	7.82	----	----	----
Resistivity	----	EC100R/WT	100	ohm cm		510	1000	----	----	----
Inorganics										
Sulfate, total, ion content	14808-79-8	E246.SO4/CG	0.050	%		0.068	<0.050	----	----	----
Sulfate, soluble ion content	14808-79-8	E246A.SO4/CG	0.05	%		NR	NR	----	----	----

Please refer to the General Comments section for an explanation of any result qualifiers detected.

Please refer to the Accreditation section for an explanation of analyte accreditations.

ALS Canada Ltd.

right solutions.
right partner.

QUALITY CONTROL INTERPRETIVE REPORT

Work Order	: **WP2322386**	Page	: 1 of 7
Amendment	: **1**		
Client	: **AECOM Canada Ltd.**	Laboratory	: ALS Environmental - Winnipeg
Contact	: Colton Wooster	Account Manager	: Craig Riddell
Address	: 99 Commerce Drive Winnipeg MB Canada R3P 0Y7	Address	: 1329 Niakwa Road East, Unit 12 Winnipeg, Manitoba Canada R2J 3T4
Telephone	: ----	Telephone	: +1 204 255 9720
Project	: 60686223	Date Samples Received	: 07-Sep-2023 11:48
PO	: 60686223	Issue Date	: 18-Sep-2023 11:55
C-O-C number	: ----		
Sampler	: ----		
Site	: ----		
Quote number	: AECOM , ph, Cond, Resist, Tot & Sol Sulphate CSA		
No. of samples received	: 2		
No. of samples analysed	: 2		

This report is automatically generated by the ALS LIMS (Laboratory Information Management System) through evaluation of Quality Control (QC) results and other QA parameters associated with this submission, and is intended to facilitate rapid data validation by auditors or reviewers. The report highlights any exceptions and outliers to ALS Data Quality Objectives, provides holding time details and exceptions, summarizes QC sample frequencies, and lists applicable methodology references and summaries.

Key

Anonymous: Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number: Chemical Abstracts Service number is a unique identifier assigned to discrete substances.
DQO: Data Quality Objective.
LOR: Limit of Reporting (detection limit).
RPD: Relative Percent Difference.

Workorder Comments

Holding times are displayed as "---" if no guidance exists from CCME, Canadian provinces, or broadly recognized international references.

Summary of Outliers

Outliers : Quality Control Samples

- No Method Blank value outliers occur.
- No Duplicate outliers occur.
- No Laboratory Control Sample (LCS) outliers occur
- No Test sample Surrogate recovery outliers exist.

Outliers: Reference Material (RM) Samples

- No Reference Material (RM) Sample outliers occur.

Outliers : Analysis Holding Time Compliance (Breaches)

- No Analysis Holding Time Outliers exist.

Outliers : Frequency of Quality Control Samples

- Quality Control Sample Frequency Outliers occur - please see following pages for full details.

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times, which are selected to meet known provincial and /or federal requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by organizations such as CCME, US EPA, APHA Standard Methods, ASTM, or Environment Canada (where available). Dates and holding times reported below represent the first dates of extraction or analysis. If subsequent tests or dilutions exceeded holding times, qualifiers are added (refer to COA).

If samples are identified below as having been analyzed or extracted outside of recommended holding times, measurement uncertainties may be increased, and this should be taken into consideration when interpreting results.

Where actual sampling date is not provided on the chain of custody, the date of receipt with time at 00:00 is used for calculation purposes.

Where only the sample date without time is provided on the chain of custody, the sampling date at 00:00 is used for calculation purposes.

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation: Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis: Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Inorganics : Soluble Sulfate ion in soil by boiling water extraction, IC.										
LDPE bag TH23-05 ; 65 19.5'	E246A.SO4	07-Sep-2023	16-Sep-2023	180 days	9 days	✓	17-Sep-2023	28 days	1 days	✓
Inorganics : Soluble Sulfate ion in soil by boiling water extraction, IC.										
LDPE bag TH-23-06 ; 65 15'	E246A.SO4	07-Sep-2023	16-Sep-2023	180 days	9 days	✓	17-Sep-2023	28 days	1 days	✓
Inorganics : Total Sulfate ion in soil by acidic boiling water extraction, IC										
LDPE bag TH23-05 ; 65 19.5'	E246.SO4	07-Sep-2023	15-Sep-2023	180 days	9 days	✓	15-Sep-2023	28 days	0 days	✓
Inorganics : Total Sulfate ion in soil by acidic boiling water extraction, IC										
LDPE bag TH-23-06 ; 65 15'	E246.SO4	07-Sep-2023	15-Sep-2023	180 days	9 days	✓	15-Sep-2023	28 days	0 days	✓
Physical Tests : Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)										
LDPE bag TH23-05 ; 65 19.5'	E100-L	07-Sep-2023	15-Sep-2023	30 days	8 days	✓	15-Sep-2023	30 days	9 days	✓
Physical Tests : Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)										
LDPE bag TH-23-06 ; 65 15'	E100-L	07-Sep-2023	15-Sep-2023	30 days	8 days	✓	15-Sep-2023	30 days	9 days	✓
Physical Tests : pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received										
LDPE bag TH23-05 ; 65 19.5'	E108A	07-Sep-2023	12-Sep-2023	30 days	5 days	✓	12-Sep-2023	30 days	6 days	✓

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Physical Tests : pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received										
LDPE bag TH-23-06 ; 65 15'	E108A	07-Sep-2023	12-Sep-2023	30 days	5 days	✓	12-Sep-2023	30 days	6 days	✓

Legend & Qualifier Definitions

Rec. HT: ALS recommended hold time (see units).

Quality Control Parameter Frequency Compliance

The following report summarizes the frequency of laboratory QC samples analyzed within the analytical batches (QC lots) in which the submitted samples were processed. The actual frequency should be greater than or equal to the expected frequency.

Matrix: **Soil/Solid**

Evaluation: × = *QC frequency outside specification*; ✓ = *QC frequency within specification.*

Quality Control Sample Type			Count		Frequency (%)		
Analytical Methods	*Method*	*QC Lot #*	*QC*	*Regular*	*Actual*	*Expected*	*Evaluation*
Laboratory Duplicates (DUP)							
Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)	E100-L	1131363	1	15	6.6	5.0	✓
pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received	E108A	1128819	1	9	11.1	5.0	✓
Soluble Sulfate ion in soil by boiling water extraction, IC.	E246A.SO4	1137570	0	18	0.0	5.0	×
Total Sulfate ion in soil by acidic boiling water extraction, IC	E246.SO4	1136190	1	18	5.5	5.0	✓
Laboratory Control Samples (LCS)							
Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)	E100-L	1131363	2	15	13.3	10.0	✓
pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received	E108A	1128819	1	9	11.1	5.0	✓
Soluble Sulfate ion in soil by boiling water extraction, IC.	E246A.SO4	1137570	2	18	11.1	10.0	✓
Total Sulfate ion in soil by acidic boiling water extraction, IC	E246.SO4	1136190	2	18	11.1	10.0	✓
Method Blanks (MB)							
Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)	E100-L	1131363	1	15	6.6	5.0	✓
Soluble Sulfate ion in soil by boiling water extraction, IC.	E246A.SO4	1137570	1	18	5.5	5.0	✓
Total Sulfate ion in soil by acidic boiling water extraction, IC	E246.SO4	1136190	1	18	5.5	5.0	✓

Methodology References and Summaries

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Reference methods may incorporate modifications to improve performance (indicated by "mod").

Analytical Methods	*Method / Lab*	*Matrix*	*Method Reference*	*Method Descriptions*
Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)	E100-L ALS Environmental - Waterloo	Soil/Solid	CSSS Ch. 15 (mod)/APHA 2510 (mod)	Conductivity, also known as Electrical Conductivity (EC) or Specific Conductance, is measured by immersion of a conductivity cell with platinum electrodes into a soil sample that has been added in a defined ratio of soil to deionized water, then shaken well and allowed to settle. Conductance is measured in the fluid that is observed in the upper layer.
pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received	E108A ALS Environmental - Waterloo	Soil/Solid	MECP E3137A	pH is determined by potentiometric measurement with a pH electrode, and is conducted at ambient laboratory temperature (normally 20 ± 5°C) and is carried out in accordance with procedures described in the Analytical Protocol (prescriptive method). A minimum 10g portion of the sample, as received, is extracted with 20mL of 0.01M calcium chloride solution by shaking for at least 30 minutes. The aqueous layer is separated from the soil by centrifuging, settling, or decanting and then analyzed using a pH meter and electrode.
Total Sulfate ion in soil by acidic boiling water extraction, IC	E246.SO4 ALS Environmental - Calgary	Soil/Solid	CSA-A23.2-3B	The dried solid is mixed with water and acid then heated. After filtration the liquid is ready for analysis by IC with conductivity detector.
Soluble Sulfate ion in soil by boiling water extraction, IC.	E246A.SO4 ALS Environmental - Calgary	Soil/Solid	CSA-A23.2-3B	The dried solid is mixed with water at a specified ratio then heated. After filtration the liquid is ready for analysis by IC with conductivity detector. A result of "NR" indicates that the total sulfate analysis was <0.2% and based on CSA-A23.2-3B no analysis for soluble sulfate is required.
Resistivity Calculation for Soil Using E100-L	EC100R ALS Environmental - Waterloo	Soil/Solid	APHA 2510 B	Soil Resistivity (calculated) is determined as the inverse of the conductivity of a 2:1 water:soil leachate (dry weight). This method is intended as a rapid approximation for Soil Resistivity. Where high accuracy results are required, direct measurement of Soil Resistivity by the Wenner Four-Electrode Method (ASTM G57) is recommended.

Preparation Methods	*Method / Lab*	*Matrix*	*Method Reference*	*Method Descriptions*
Leach 1:2 Soil:Water for pH/EC	EP108 ALS Environmental - Waterloo	Soil/Solid	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL	The procedure involves mixing the dried (at <60°C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water.
Leach 1:2 Soil : 0.01CaCl2 - As Received for pH	EP108A ALS Environmental - Waterloo	Soil/Solid	MOEE E3137A	A minimum 10g portion of the sample, as received, is extracted with 20mL of 0.01M calcium chloride solution by shaking for at least 30 minutes. The aqueous layer is separated from the soil by centrifuging, settling or decanting and then analyzed using a pH meter and electrode.
Soluble ion Sulfate in soil or concrete preparation.	EP246.S ALS Environmental - Calgary	Soil/Solid	CSA-A23.2B	The dried solid is mixed with water then heated. After filtration the liquid is ready for analysis.

Preparation Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Total ion Sulfate in soil or concrete preparation	EP246.T ALS Environmental - Calgary	Soil/Solid	CSA-A23.2B	The dried solid is mixed with water and acid then heated. After filtration the liquid is ready for analysis.

ALS Canada Ltd.

right solutions. right partner.

QUALITY CONTROL REPORT

Work Order	: **WP2322386**	Page	: 1 of 4
Amendment	: **1**		
Client	: AECOM Canada Ltd.	Laboratory	: ALS Environmental - Winnipeg
Contact	: Colton Wooster	Account Manager	: Craig Riddell
Address	: 99 Commerce Drive Winnipeg MB Canada R3P 0Y7	Address	: 1329 Niakwa Road East, Unit 12 Winnipeg, Manitoba Canada R2J 3T4
Telephone	:	Telephone	: +1 204 255 9720
Project	: 60686223	Date Samples Received	: 07-Sep-2023 11:48
PO	: 60686223	Date Analysis Commenced	: 12-Sep-2023
C-O-C number	: ----	Issue Date	: 18-Sep-2023 11:55
Sampler	: ---- ----		
Site	: ----		
Quote number	: AECOM , ph, Cond, Resist, Tot & Sol Sulphate CSA		
No. of samples received	: 2		
No. of samples analysed	: 2		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percent Difference (RPD) and Data Quality Objectives
- Reference Material (RM) Report; Recovery and Data Quality Objectives
- Method Blank (MB) Report; Recovery and Data Quality Objectives
- Laboratory Control Sample (LCS) Report; Recovery and Data Quality Objectives

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
George Huang	Supervisor - Inorganic	Calgary Inorganics, Calgary, Alberta
Kevin Baxter	Team Leader - Inorganics	Calgary Inorganics, Calgary, Alberta
Nik Perkio	Inorganics Analyst	Waterloo Inorganics, Waterloo, Ontario

General Comments

The ALS Quality Control (QC) report is optionally provided to ALS clients upon request. ALS test methods include comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against predetermined Data Quality Objectives (DQOs) to provide confidence in the accuracy of associated test results. This report contains detailed results for all QC results applicable to this sample submission. Please refer to the ALS Quality Control Interpretation report (QCI) for applicable method references and methodology summaries.

Key :

Anonymous = Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number = Chemical Abstracts Service number is a unique identifier assigned to discrete substances.
DQO = Data Quality Objective.
LOR = Limit of Reporting (detection limit).
RPD = Relative Percent Difference
\# = Indicates a QC result that did not meet the ALS DQO.

Workorder Comments

Holding times are displayed as "---" if no guidance exists from CCME, Canadian provinces, or broadly recognized international references.

Laboratory Duplicate (DUP) Report

A Laboratory Duplicate (DUP) is a randomly selected intralaboratory replicate sample. Laboratory Duplicates provide information regarding method precision and sample heterogeneity. ALS DQOs for Laboratory Duplicates are expressed as test-specific limits for Relative Percent Difference (RPD), or as an absolute difference limit of 2 times the LOR for low concentration duplicates within ~ 4-10 times the LOR (cut-off is test-specific).

Sub-Matrix: **Soil/Solid**

					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	*Client sample ID*	*Analyte*	*CAS Number*	*Method*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD(%) or Difference*	*Duplicate Limits*	*Qualifier*
Physical Tests (QC Lot: 1128819)											
WP2322386-001	TH23-05 ; 65 19.5'	pH (1:2 soil:CaCl2-aq)	----	E108A	0.10	pH units	7.89	7.81	1.02%	5%	----
Physical Tests (QC Lot: 1131363)											
WT2329025-001	Anonymous	Conductivity (1:2 leachate)	----	E100-L	5.00	µS/cm	0.111 mS/cm	110	0.723%	20%	----
Inorganics (QC Lot: 1136190)											
CG2312329-001	Anonymous	Sulfate, total, ion content	14808-79-8	E246.SO4	500	mg/kg	<0.050 %	<500	0	Diff <2x LOR	----

Method Blank (MB) Report

A Method Blank is an analyte-free matrix that undergoes sample processing identical to that carried out for test samples. Method Blank results are used to monitor and control for potential contamination from the laboratory environment and reagents. For most tests, the DQO for Method Blanks is for the result to be < LOR.

Sub-Matrix: **Soil/Solid**

Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Physical Tests (QCLot: 1131363)						
Conductivity (1:2 leachate)	----	E100-L	5	µS/cm	<5.00	----
Inorganics (QCLot: 1136190)						
Sulfate, total, ion content	14808-79-8	E246.SO4	500	mg/kg	<500	----
Inorganics (QCLot: 1137570)						
Sulfate, soluble ion content	14808-79-8	E246A.SO4	500	mg/kg	NR	----

Laboratory Control Sample (LCS) Report

A Laboratory Control Sample (LCS) is an analyte-free matrix that has been fortified (spiked) with test analytes at known concentration and processed in an identical manner to test samples. LCS results are expressed as percent recovery, and are used to monitor and control test method accuracy and precision, independent of test sample matrix.

Sub-Matrix: **Soil/Solid**

					Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
Analyte	CAS Number	Method	LOR	Unit	Concentration	LCS	Low	High	Qualifier
Physical Tests (QCLot: 1128819)									
pH (1:2 soil:CaCl2-aq)	----	E108A	----	pH units	7 pH units	99.7	98.0	102	----
Physical Tests (QCLot: 1131363)									
Conductivity (1:2 leachate)	----	E100-L	5	µS/cm	1409 µS/cm	99.4	90.0	110	----
Inorganics (QCLot: 1136190)									
Sulfate, total, ion content	14808-79-8	E246.SO4	500	mg/kg	10000 mg/kg	97.5	90.0	110	----

Reference Material (RM) Report

A Reference Material (RM) is a homogenous material with known and well-established analyte concentrations. RMs are processed in an identical manner to test samples, and are used to monitor and control the accuracy and precision of a test method for a typical sample matrix. RM results are expressed as percent recovery of the target analyte concentration. RM targets may be certified target concentrations provided by the RM supplier, or may be ALS long-term mean values (for empirical test methods).

Sub-Matrix:

					Reference Material (RM) Report				
					RM Target	Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Reference Material ID	Analyte	CAS Number	Method	Concentration	RM	Low	High	Qualifier
Physical Tests (QCLot: 1131363)									
	RM	Conductivity (1:2 leachate)	----	E100-L	1725.6 µS/cm	108	70.0	130	----
Inorganics (QCLot: 1136190)									
	RM	Sulfate, total, ion content	14808-79-8	E246.SO4	33400 mg/kg	94.8	80.0	120	----

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

Affix ALS barcode label here (lab use only)

COC Number: 17 - 743904

Page 1 of 1

Report To	Contact and company name below will appear on the final report
Company:	AECOM Canada Ltd.
Contact:	COLTON WOOSTER
Phone:	204-583-8797
	Company address below will appear on the final report
Street:	99 Commerce Dr
City/Province:	Winnipeg, MB
Postal Code:	R3P 0Y7

Invoice To	
Same as Report To	☑ YES ☐ NO
Copy of Invoice with Report	☑ YES ☐ NO
Company:	
Contact:	

Report Format / Distribution

Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)

Quality Control (QC) Report with Report ☐ YES ☐ NO

☐ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax: colton.wooster@aecom.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax

Email 2

Select Service Level Below - Contact your AM to confirm all E&P TATs (surcharges may apply)

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4-20%] ☐ 3 day [P3-25%] ☐ 2 day [P2-50%] ☐

EMERGENCY: 1 Business day [E - 100%] ☐ Same Day, Weekend or Statutory holiday [E2 -200% (Laboratory opening fees may apply)] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:	
Job #:	60686223
PO / AFE:	
LSD:	
ALS Lab Work Order # (lab use only):	

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	
ALS Contact:	Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	E106-L Cond in Soil	E108A pH in soil	EC100R Resistivity Calc.	E246-SO4 / E246A-SO4 total + soluble sulfate by ~~LA-MS~~ method	SAMPLES ON HOLD	SUSPECTED HAZARD (see Special Instructions)
	TH23-05 ; GS 19.5'					✓	✓	✓	✓		
	TH23-06 ; GS 15'					✓	✓	✓	✓		

Environmental Division
Winnipeg
Work Order Reference
WP2322386
Telephone : +1 204 255 9720

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☐ NO

Are samples for human consumption/ use? ☐ YES ☐ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C

FINAL COOLER TEMPERATURES °C: 22.1

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by: FC	Date: SEP 07 2023	Time: 1148	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

JUNE 2018 FRONT

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

Appendix D

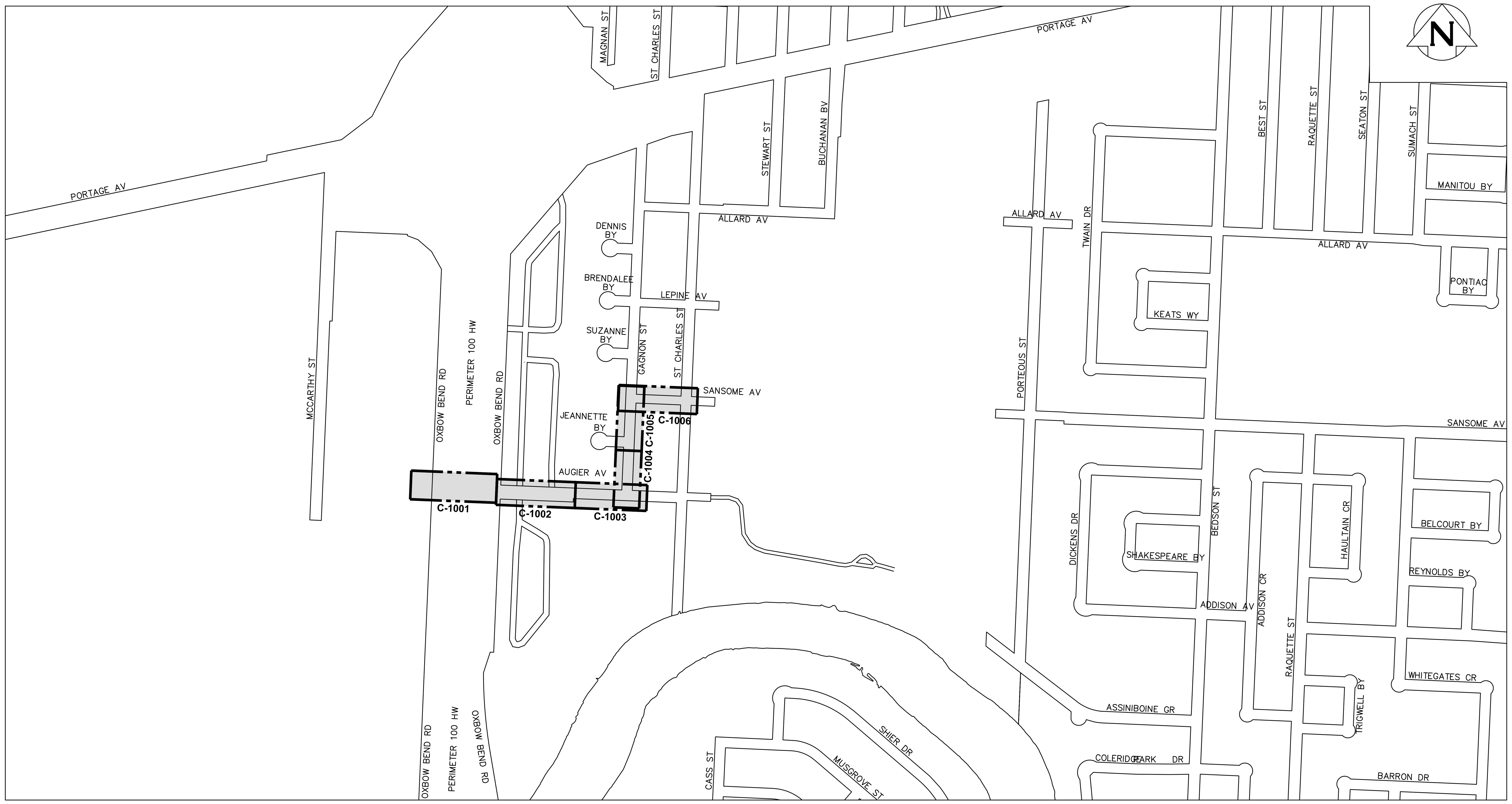
Preliminary Design Drawings

THE CITY OF WINNIPEG

WATER AND WASTE DEPARTMENT
ENGINEERING DIVISION

ST. CHARLES SEWER DISTRICT
PRELIMINARY DESIGN

CONTRACT NO: ___
TENDER: _____-______



KEY MAP

DRAFT
09/24/2024

SHEET 1 OF __
CITY DRAWING NUMBER

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FILE NAME: 60686223-SHT-00-StC WWS-G-1000.dwg

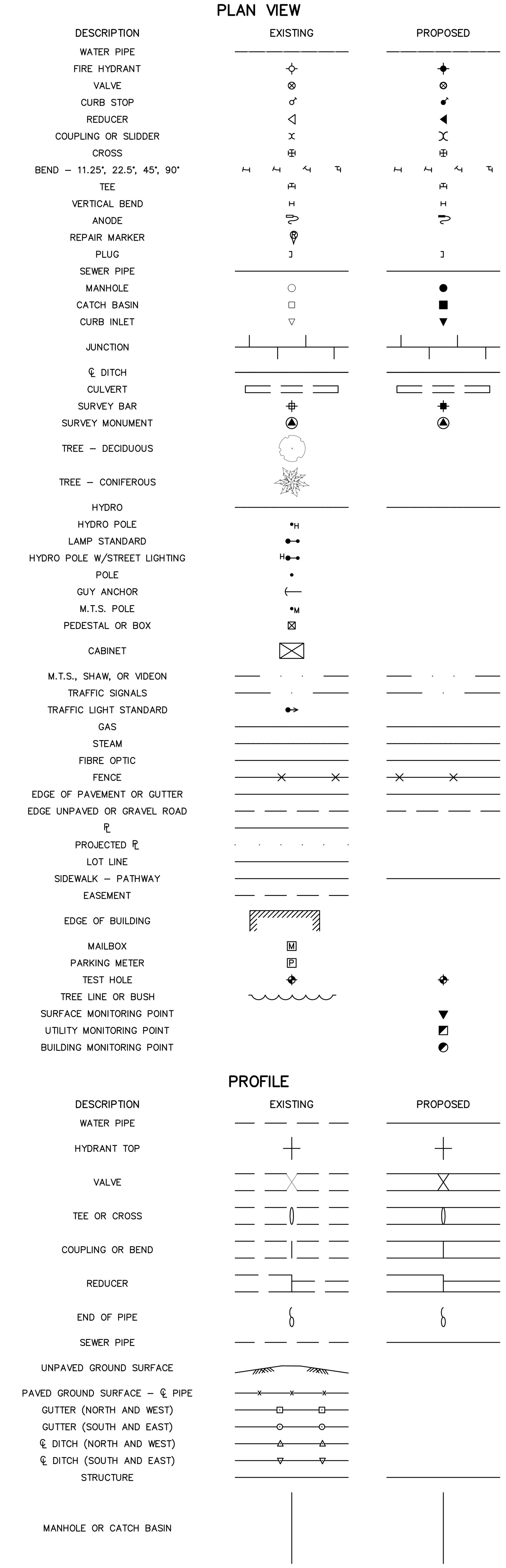
DRAWING INDEX

SHEET NUMBER	CITY OF WINNIPEG DRAWING NUMBER	DRAWING TITLE
1	_____	COVER
2	_____	DRAWING INDEX, DESIGN NOTES, LEGEND, & ABBREVIATIONS
3	_____	AUGIER AVENUE – PERIMETER 100 HIGHWAY CROSSING
4	_____	AUGIER AVENUE – 218m WEST OF GAGNON STREET TO 80m WEST OF GAGNON STREET
5	_____	AUGIER AVENUE – 130m EAST OF PERIMETER 100 HIGHWAY TO GAGNON STREET
6	_____	GAGNON STREET – AUGIER AVENUE TO 83m SOUTH OF SANSOME AVENUE
7	_____	GAGNON STREET – 69m NORTH OF AUGIER AVENUE TO SANSOME AVENUE
8	_____	SANSOME AVENUE – GAGNON STREET TO ST CHARLES STREET

ABBREVIATIONS

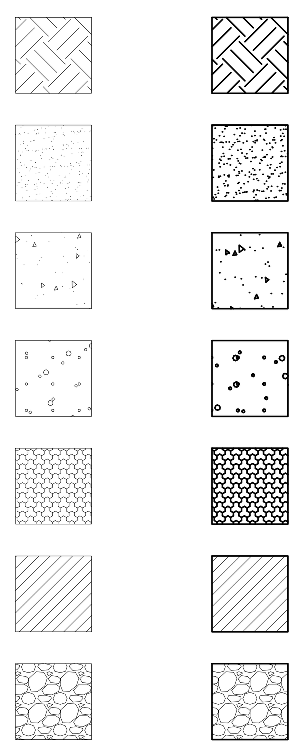
WWS	WASTE WATER SEWER
CS	COMBINED SEWER
LDS	LAND DRAINAGE SEWER
℘	PROPERTY LINE
℄	CENTER LINE
G.I.S.	GEOGRAPHIC INFORMATION SYSTEM
B.M.	BENCH MARK
TH	TEST HOLE
ELEV	ELEVATION
INV	INVERT
MIN	MINIMUM
MAX	MAXIMUM
SL	STREET LIGHTING
TS	TRAFFIC SIGNALS
ABAND	ABANDONED
BLDG	BUILDING
HSE	HOUSE
CRN	CORNER
OPP	OPPOSITE
C/S OR S/C	CURB STOP
MTS	MANITOBA TELEPHONE SYSTEM
R.O.W.	RIGHT-OF-WAY
WM	WATERMAIN
CULV	CULVERT
MH	MANHOLE
CB	CATCH BASIN
CI	CURB INLET
VERT.	VERTICAL
HORZ.	HORIZONTAL
I.B.	IRON BAR
FIBRE	FIBRE OPTIC
TYP	TYPICAL
X-ING	CROSSING
HYD	HYDRANT
EXIST	EXISTING
N	NORTH
E	EAST
S	SOUTH
W	WEST
W/	WITH
C/W	CONSTRUCTED WITH
CONC	CONCRETE
AC	ASBESTOS CEMENT
VC OR CLAY	VITRIFIED CLAY
CI	CAST IRON
DI	DUCTILE IRON
PVC	POLYVINYL CHLORIDE
HDPE	HIGH DENSITY POLYETHYLENE
PCCP	PRESTRESSED CONCRETE CYLINDER PIPE
FRPMP	FIBRE REINFORCED POLYMER MORTAR PIPE

LEGEND



CONSTRUCTION NOTES

HATCH PATTERNS



EXISTING	PROPOSED	DESCRIPTION
		EARTH OR GROUND ABOVE PIPE
		SAND OR OTHER FINE MATERIAL
		CONCRETE
		WASHED STONE OR GRANULAR MATERIAL
		INTERLOCKING STONE
		METAL
		GRAVEL OR STONE

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
AECOM Canada Ltd.
No. 4671 Date:____________

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. 83R472
ELEV. 237.928m
S.E. Cor. Bedson St. & Addison Ave., Tblt. on top of 0.05m dia. x 2.4m iron pipe, 10.1m E. of C.L. Conc. Pav't. of Bedson St. & 6.4m S. of C. L. Conc. Pav't. Addison Ave., or 2.6m N. of S.L. Addison Ave. & on E. property line.

DRAFT
09/24/2024

NO.	REVISIONS	DATE	BY

AECOM

DESIGNED BY AD	CHECKED BY
DRAWN BY ADL	APPROVED BY
SCALE: HORIZONTAL VERTICAL	RELEASED FOR CONSTRUCTION
DATE 2024 09 24	DATE

PLOT DATE: 2024 09 24

ENGINEER'S SEAL

CONSULTANT DRAWING NUMBER
G-1001

Tender No: ___-2024
CONTRACT NUMBER: X

Winnipeg
THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT
ENGINEERING DIVISION

ST. CHARLES SEWER DISTRICT
PRELIMINARY DESIGN
INDEX PAGE

SHEET 2 OF XX
CITY DRAWING NUMBER
_____

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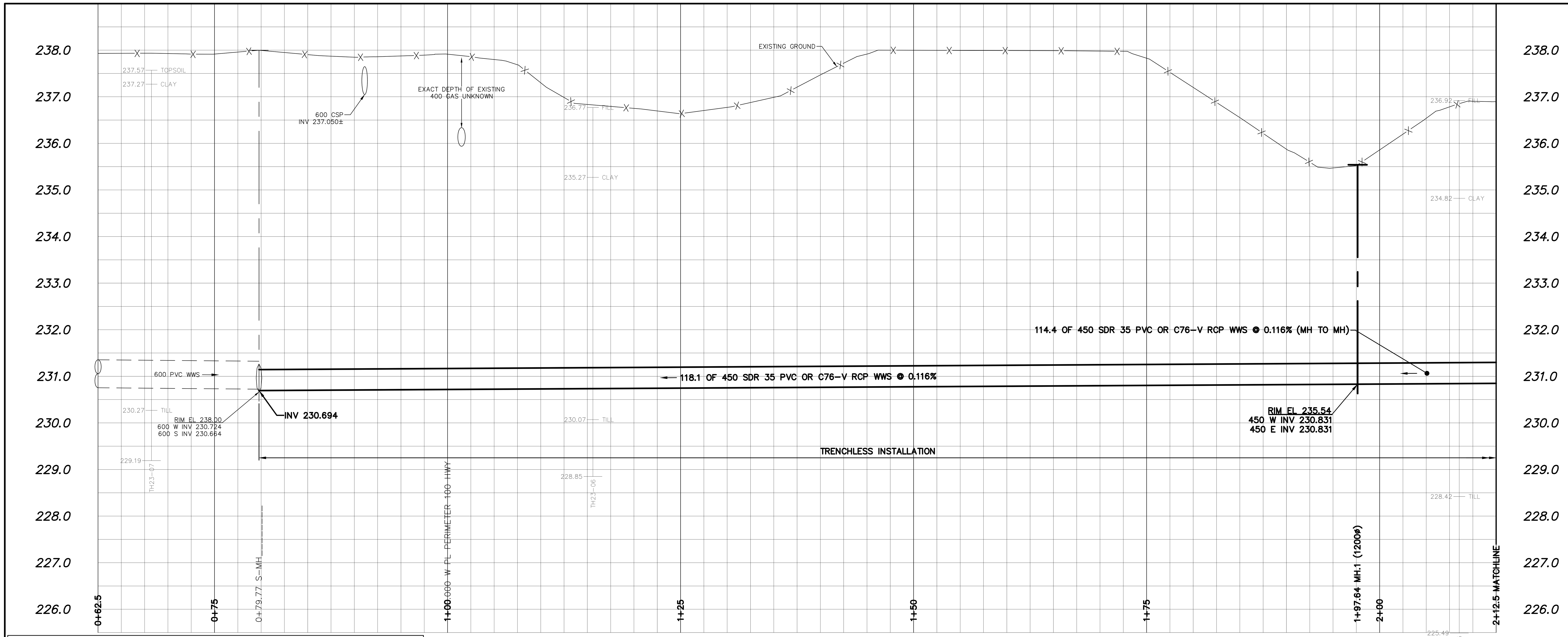
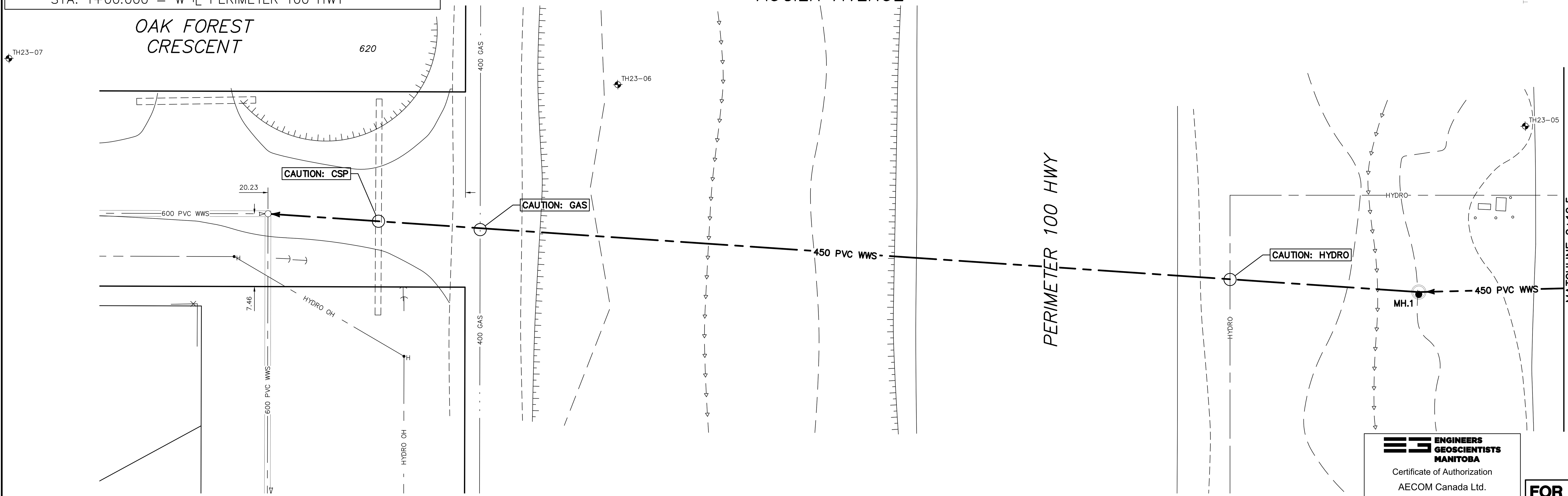
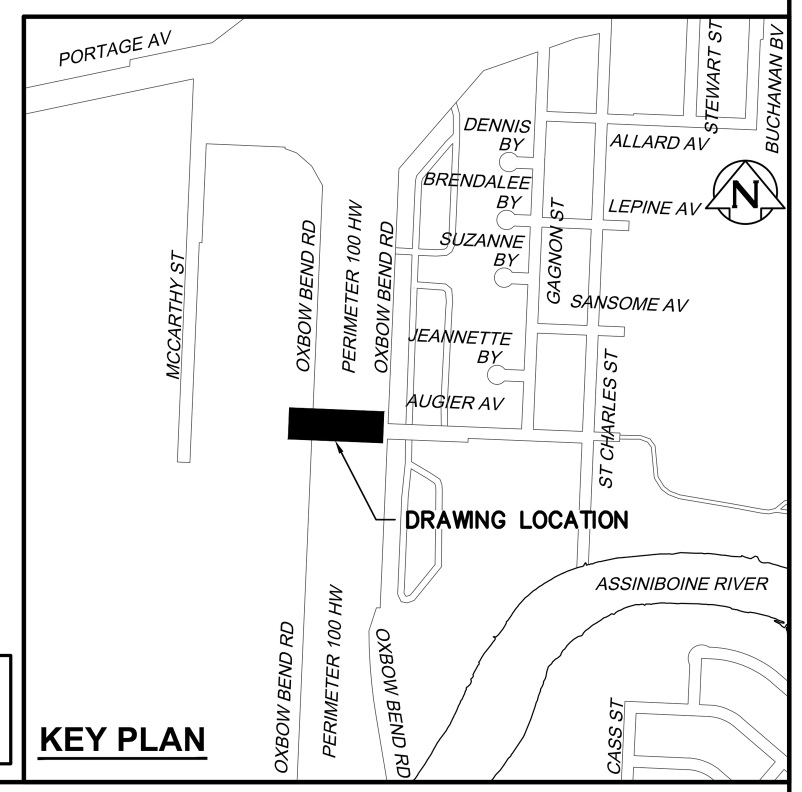


NOTE: CHAINAGES SHOWN ARE ALONG N. ℄ OF AUGIER AVENUE
STA. 1+00.000 = W ℄ PERIMETER 100 HWY



ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
AECOM Canada Ltd.
No. 4671 Date:

FOR INDEX SEE G-1001



KEY PLAN

METRIC
WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

0.0 5.0 10.0 15.0 20.0 25.0

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.

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CONSTRUCTION COMPLETION DATE: YYYY MM DD

DRAFT
09/24/2024

NO.	REVISIONS	DATE	BY

AECOM

DESIGNED BY	AD	CHECKED BY	
DRAWN BY	ADL	APPROVED BY	
SCALE: HORIZONTAL 1:250 VERTICAL 1:50		RELEASED FOR CONSTRUCTION	
DATE	2024 09 24	DATE	

ENGINEER'S SEAL

CONSULTANT DRAWING NUMBER
C–1001

Winnipeg
THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT
ENGINEERING DIVISION

ST. CHARLES SEWER DISTRICT
PRELIMINARY DESIGN
AUGIER AVENUE
PERIMETER 100 HIGHWAY CROSSING

SHEET 3 OF XX
CITY DRAWING NUMBER
C–1001

PLOT DATE: 2024 09 24
Tender No: XXX–XXXX
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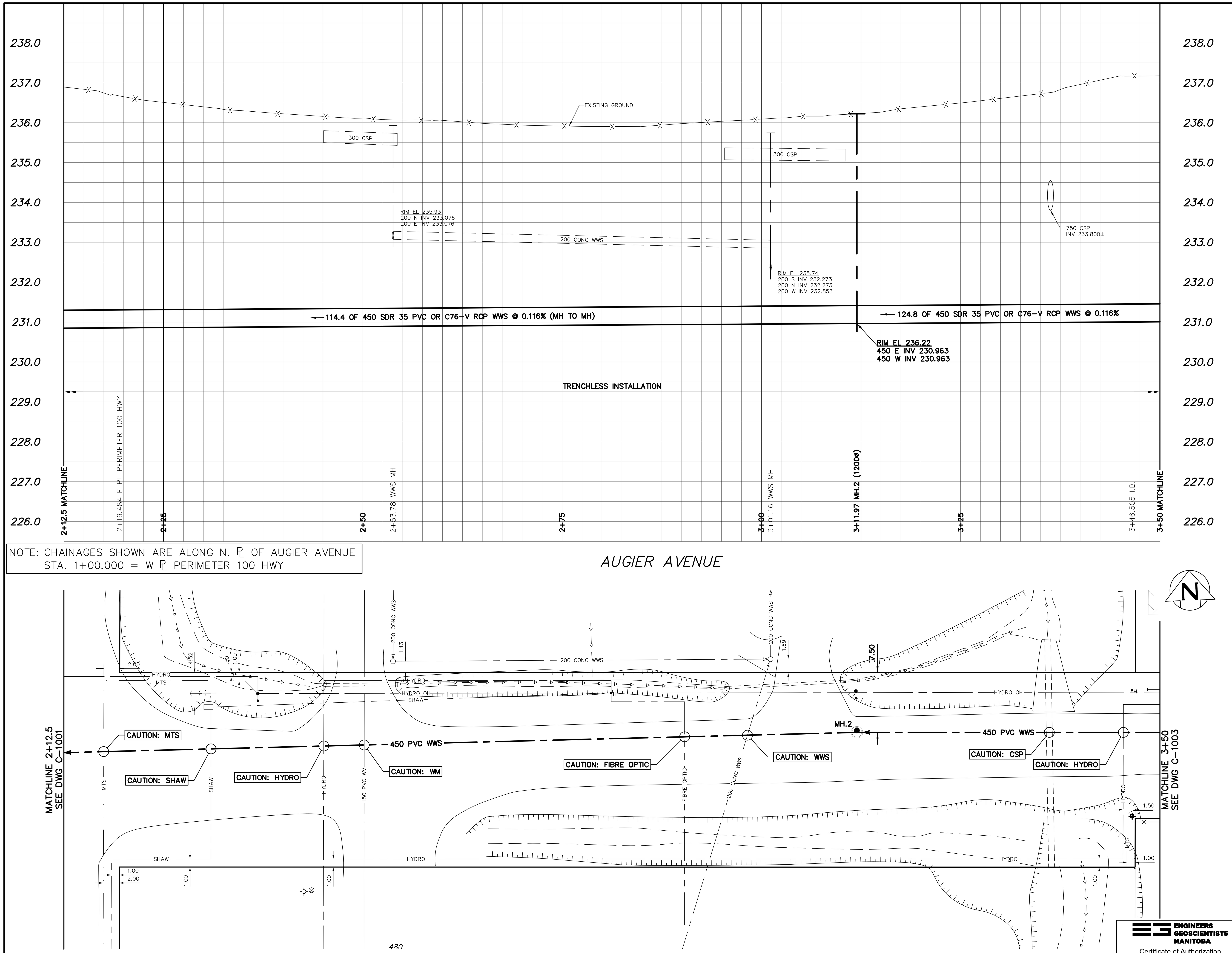
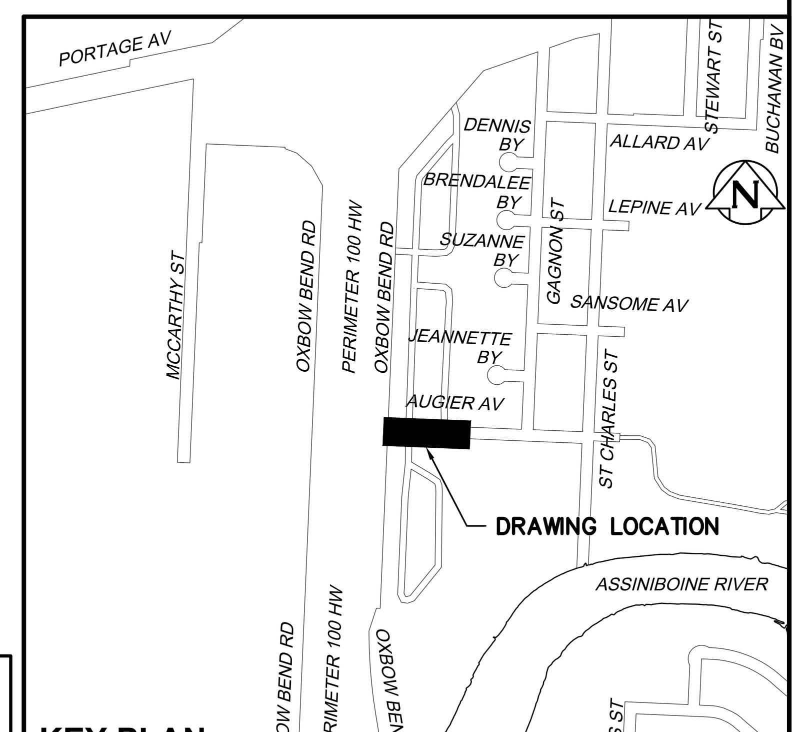


ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
AECOM Canada Ltd.
No. 4671 Date:

FOR INDEX SEE G-1001



KEY PLAN

METRIC
WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

0.0 5.0 10.0 15.0 20.0 25.0

LOCATION APPROVED
UNDERGROUND STRUCTURES

SUPV. U/G STRUCTURES COMMITTEE DATE

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ELEV. 237.928m
S.E. Cor. Bedson St. & Addison Ave., Tblt. on top of 0.05m dia. x 2.4m iron pipe, 10.1m E. of C.L. Conc. Pav't. of Bedson St. & 6.4m S. of C. L. Conc. Pav't. Addison Ave., or 2.6m N. of S.L. Addison Ave. & on E. property line.

CONSTRUCTION COMPLETION DATE: YYYY MM DD

DRAFT
09/24/2024

NO.	REVISIONS	DATE	BY

AECOM

DESIGNED BY	AD	CHECKED BY	
DRAWN BY	ADL	APPROVED BY	
SCALE: HORIZONTAL	1:250	RELEASED FOR CONSTRUCTION	
VERTICAL	1:50		
DATE	2024 09 24	DATE	

ENGINEER'S SEAL

CONSULTANT DRAWING NUMBER
C-1002

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT
ENGINEERING DIVISION

ST. CHARLES SEWER DISTRICT
PRELIMINARY DESIGN

AUGIER AVENUE
218m WEST OF GAGNON STREET
TO 80m WEST OF GAGNON STREET

SHEET 4 OF XX
CITY DRAWING NUMBER
C-1002

PLOT DATE: 2024 09 24
Tender No: XXX-XXXX
CONTRACT NUMBER:
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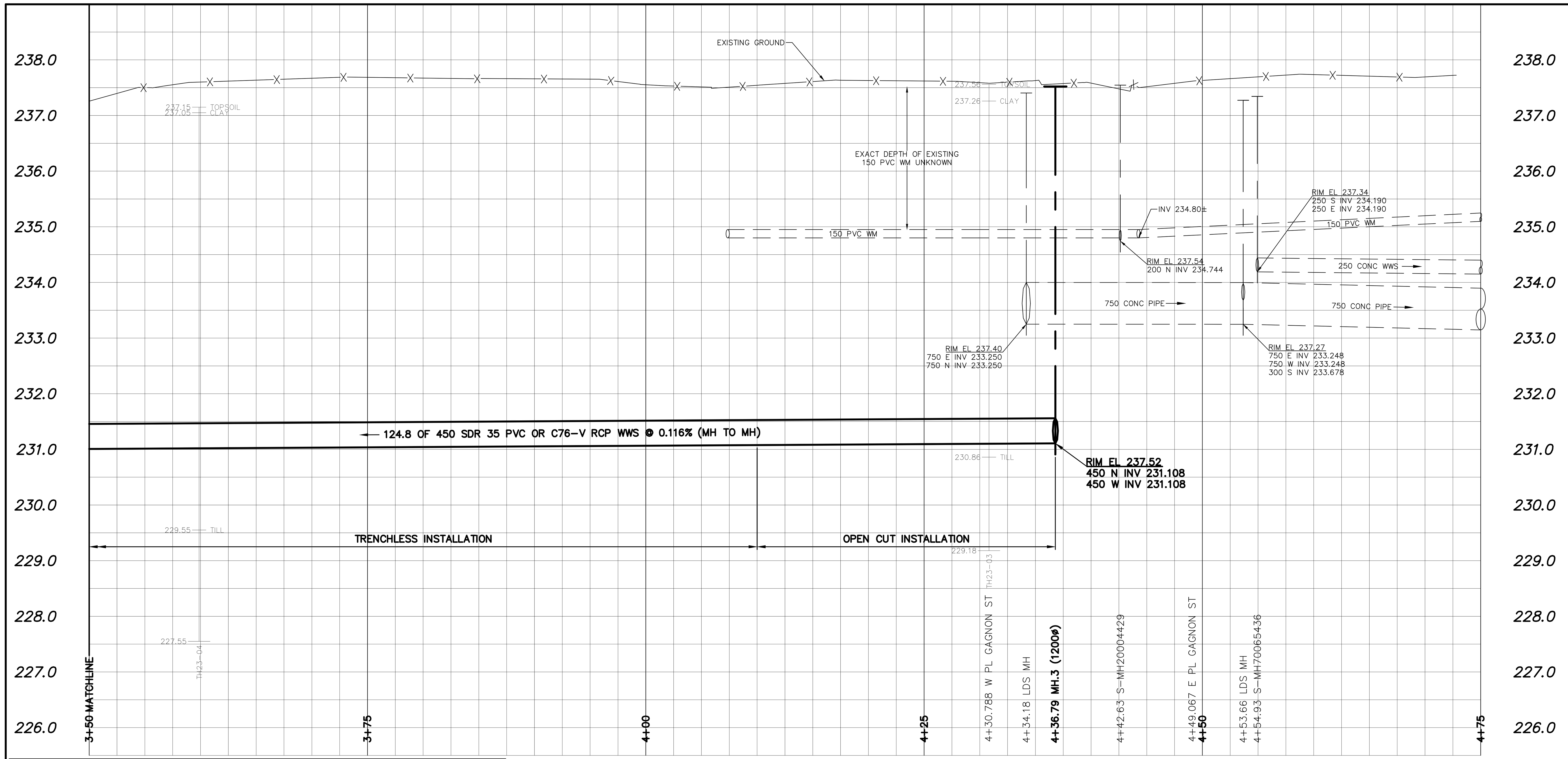
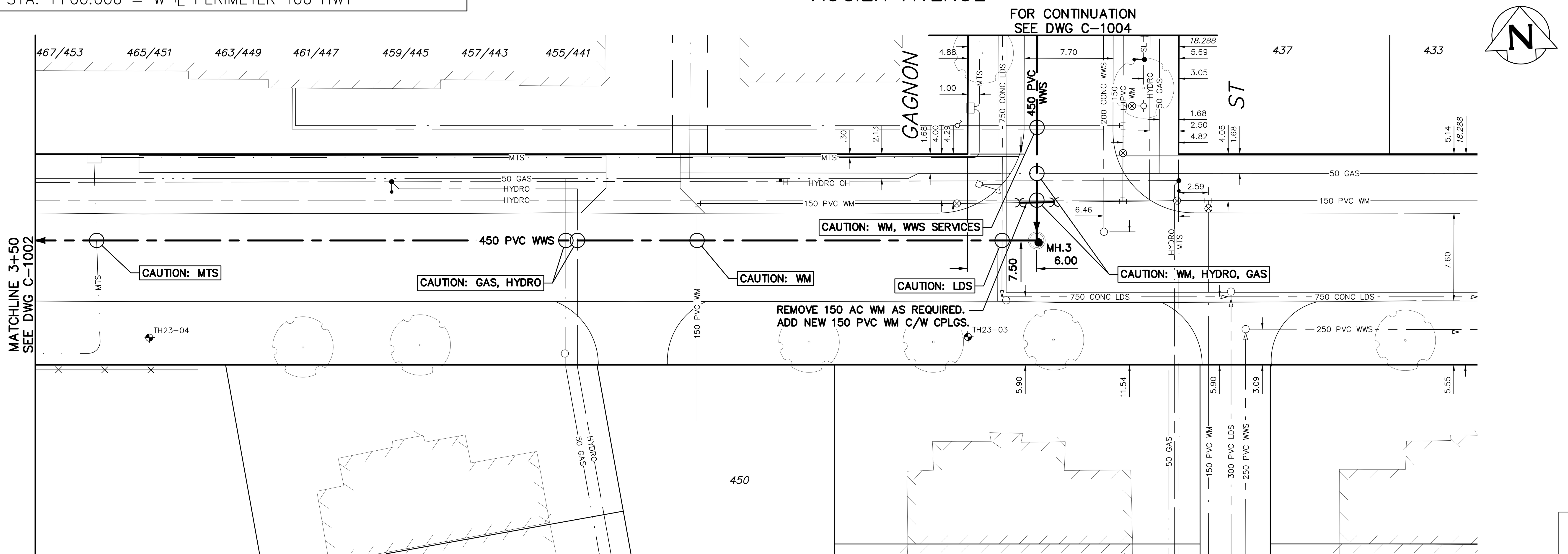
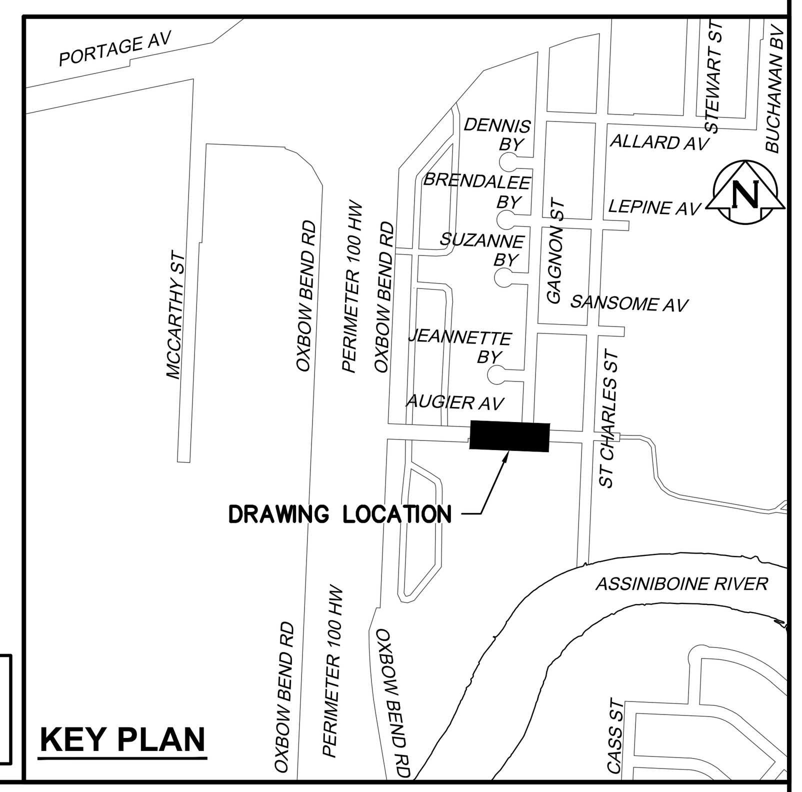


NOTE: CHAINAGES SHOWN ARE ALONG N. ℄ OF AUGIER AVENUE
STA. 1+00.000 = W ℄ PERIMETER 100 HWY





KEY PLAN

FOR INDEX SEE G-1001

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
AECOM Canada Ltd.
No. 4671 Date:

METRIC
WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

0.0 5.0 10.0 15.0 20.0 25.0

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. 83R472
ELEV. 237.928m
S.E. Cor. Bedson St. & Addison Ave., Tblt. on top of 0.05m dia. x 2.4m iron pipe, 10.1m E. of C.L. Conc. Pav't. of Bedson St. & 6.4m S. of C. L. Conc. Pav't. Addison Ave., or 2.6m N. of S.L. Addison Ave. & on E. property line.

CONSTRUCTION COMPLETION DATE: YYYY MM DD

DRAFT
09/24/2024

NO.	REVISIONS	DATE	BY

AECOM

DESIGNED BY	AD	CHECKED BY	
DRAWN BY	ADL	APPROVED BY	
SCALE: HORIZONTAL 1:250 VERTICAL 1:50		RELEASED FOR CONSTRUCTION	
DATE	2024 09 24	DATE	

PLOT DATE: 2024 09 24
Tender No: XXX-XXXX
CONTRACT NUMBER:

ENGINEER'S SEAL

CONSULTANT DRAWING NUMBER
C-1003

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT
ENGINEERING DIVISION

ST. CHARLES SEWER DISTRICT
PRELIMINARY DESIGN

AUGIER AVENUE
130m EAST OF PERIMETER 100 HWY
TO GAGNON STREET

SHEET 5 OF XX
CITY DRAWING NUMBER
C-1003

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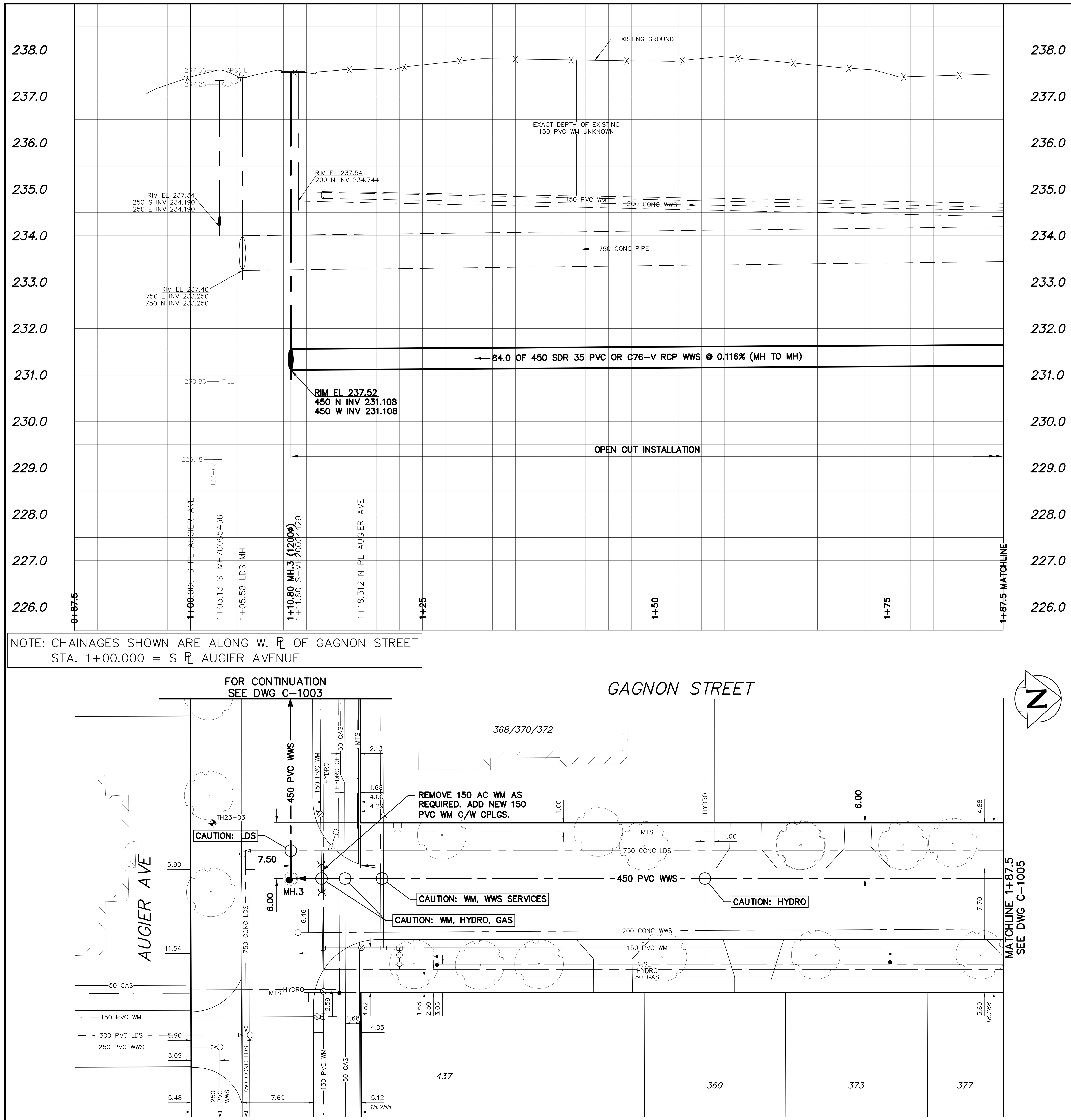
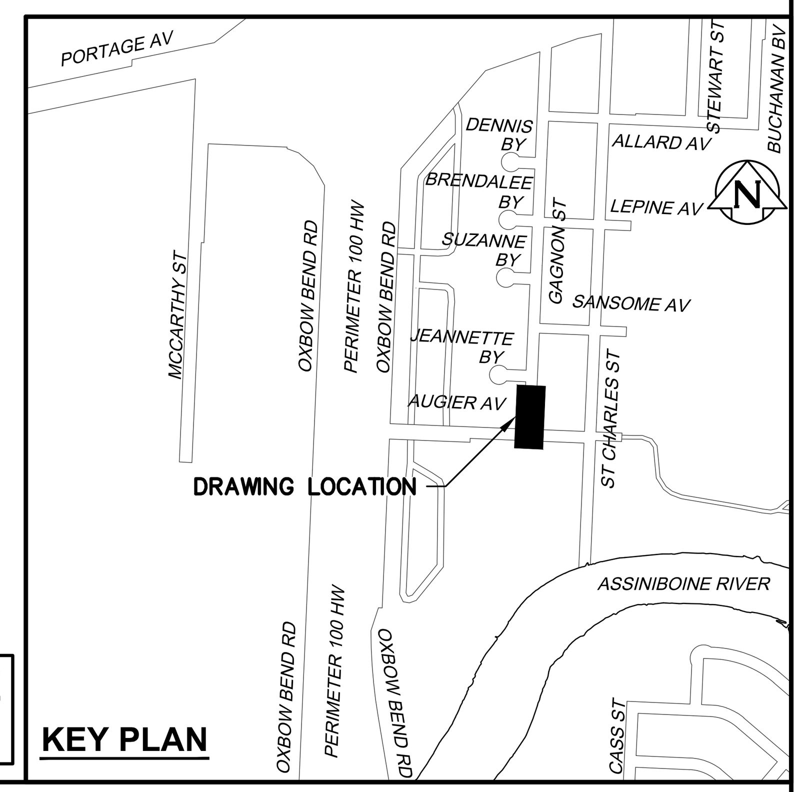
FILE NAME: 60686223-SHT-00-StC WWS-C-1001_C-1003.dwg





KEY PLAN

FOR INDEX SEE G-1001

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:

LOCATION APPROVED
UNDERGROUND STRUCTURES

SUPV. U/G STRUCTURES COMMITTEE — DATE

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CONSTRUCTION COMPLETION DATE: YYYY MM DD

DRAFT
09/24/2024

NO.	REVISIONS	DATE	BY

AECOM

DESIGNED BY	AD	CHECKED BY	
DRAWN BY	ADL	APPROVED BY	
SCALE: HORIZONTAL	1:250	RELEASED FOR CONSTRUCTION	
VERTICAL	1:50		
DATE	2024 09 24	DATE	

PLOT DATE: 2024 09 24
Tender No: XXX-XXXX
CONTRACT NUMBER:

ENGINEER'S SEAL

CONSULTANT DRAWING NUMBER
C-1004

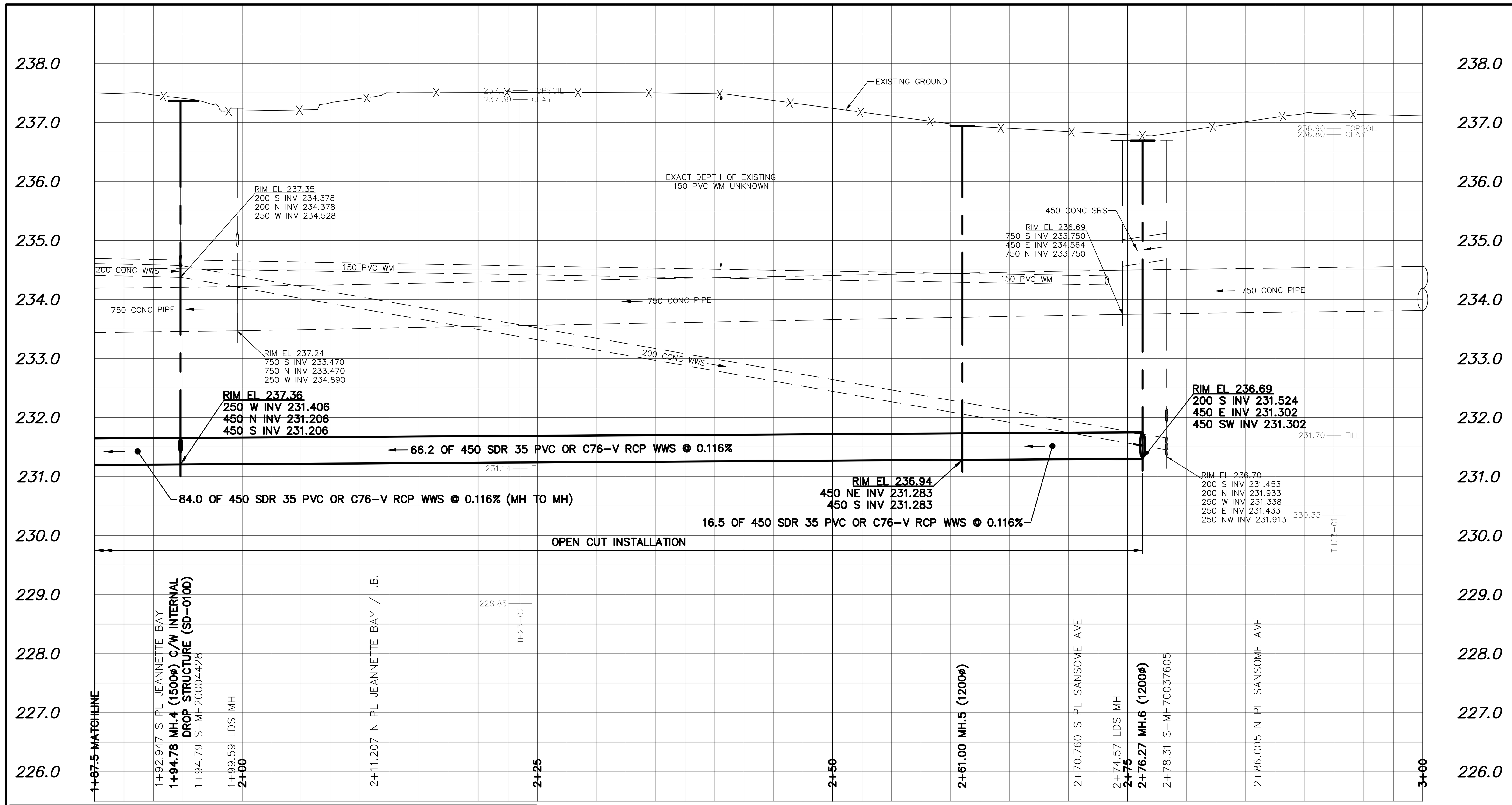
FILE PATH: C:\Users\leippla\appdata\local\temp\AcPublish_24152\
FILE NAME: 60686223-SHT-00-StC WWS-C-1004_C-1005.dwg

Winnipeg
THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT
ENGINEERING DIVISION

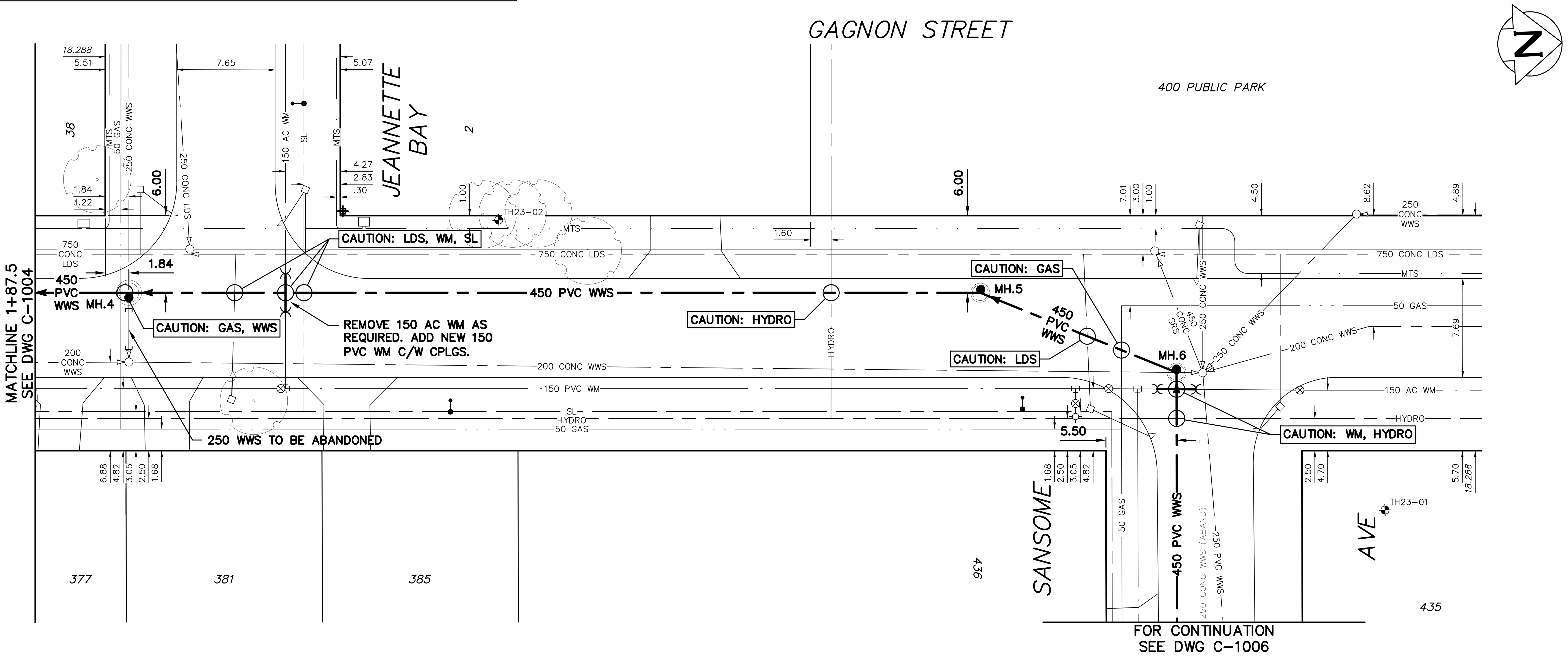
ST. CHARLES SEWER DISTRICT
PRELIMINARY DESIGN

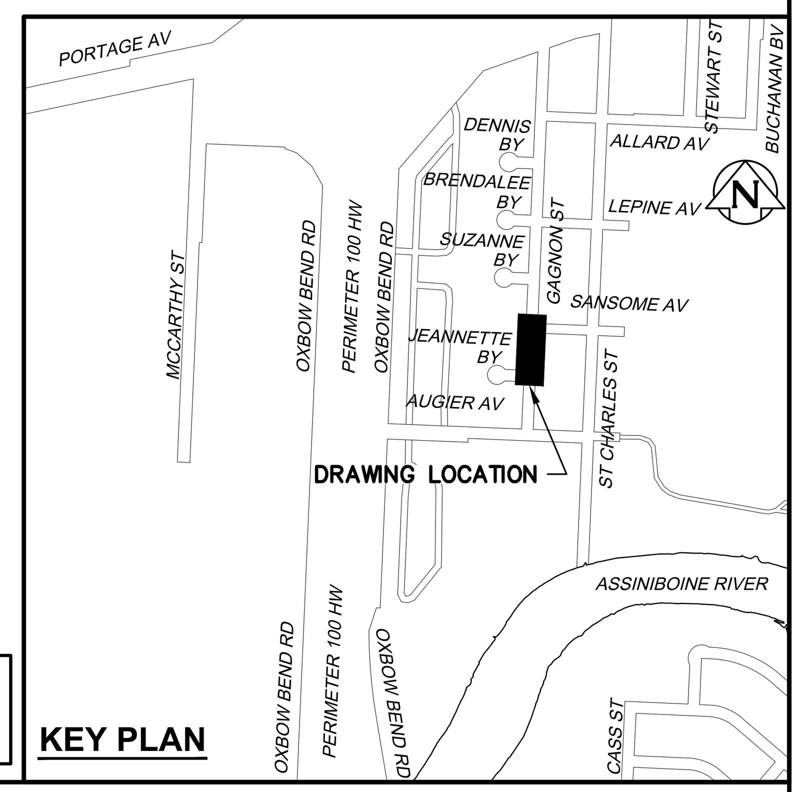
GAGNON STREET
AUGIER AVENUE
TO 83m SOUTH OF SANSOME AVENUE

SHEET 6 OF XX
CITY DRAWING NUMBER
C-1004



NOTE: CHAINAGES SHOWN ARE ALONG W. ℄ OF GAGNON STREET
STA. 1+00.000 = S ℄ AUGIER AVENUE





FOR INDEX SEE G-1001

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
AECOM Canada Ltd.
No. 4671 Date:

METRIC
WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES
0.0 5.0 10.0 15.0 20.0 25.0

LOCATION APPROVED
UNDERGROUND STRUCTURES

SUPV. U/G STRUCTURES COMMITTEE — DATE

NOTE:
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CONSTRUCTION COMPLETION DATE: YYYY MM DD

DRAFT
09/24/2024

NO.	REVISIONS	DATE	BY

AECOM

DESIGNED BY	AD	CHECKED BY	
DRAWN BY	ADL	APPROVED BY	
SCALE: HORIZONTAL	1:250	RELEASED FOR CONSTRUCTION	
VERTICAL	1:50		
DATE	2024 09 24	DATE	

PLOT DATE: 2024 09 24
Tender No: XXX-XXXX
CONTRACT NUMBER:

ENGINEER'S SEAL

CONSULTANT DRAWING NUMBER
C-1005

FILE PATH: C:\Users\leippla\appdata\local\temp\AcPublish_24152\
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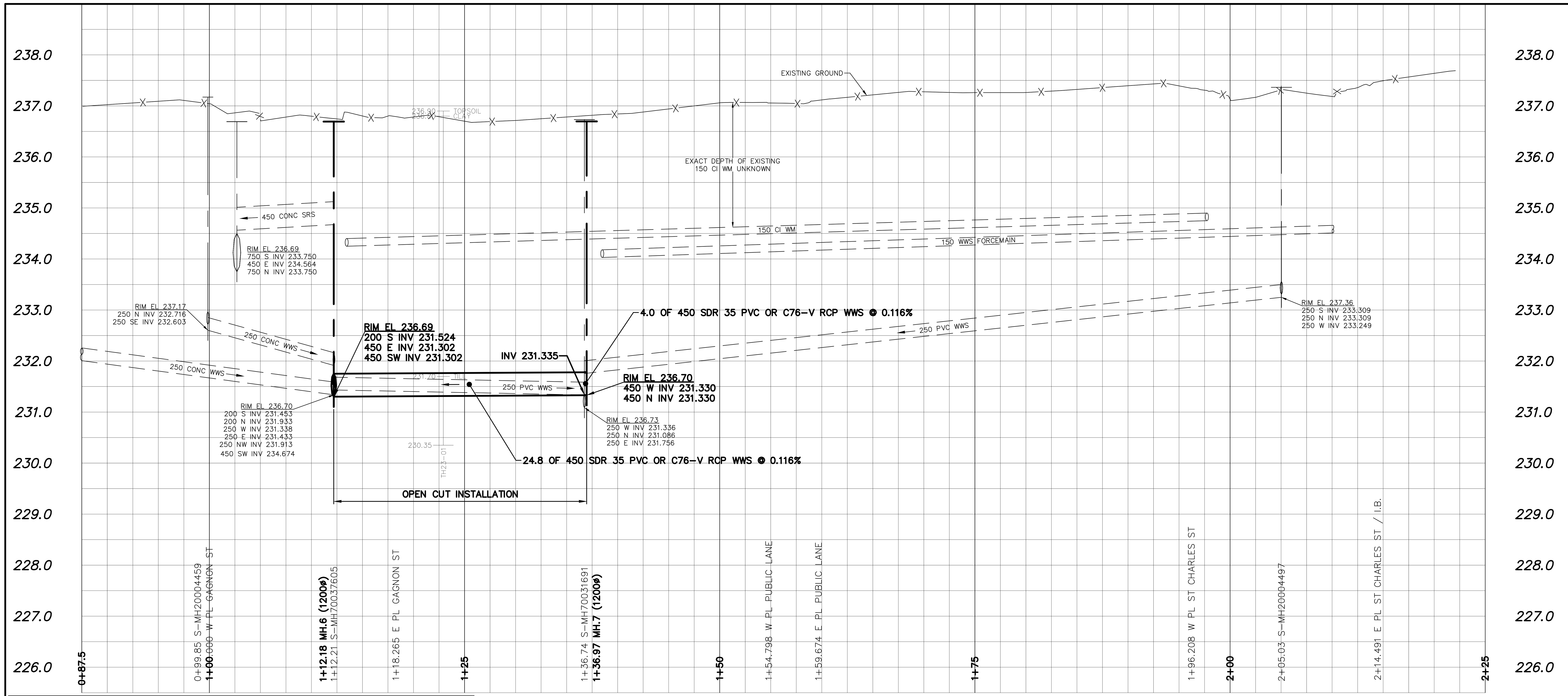
Winnipeg
THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT
ENGINEERING DIVISION

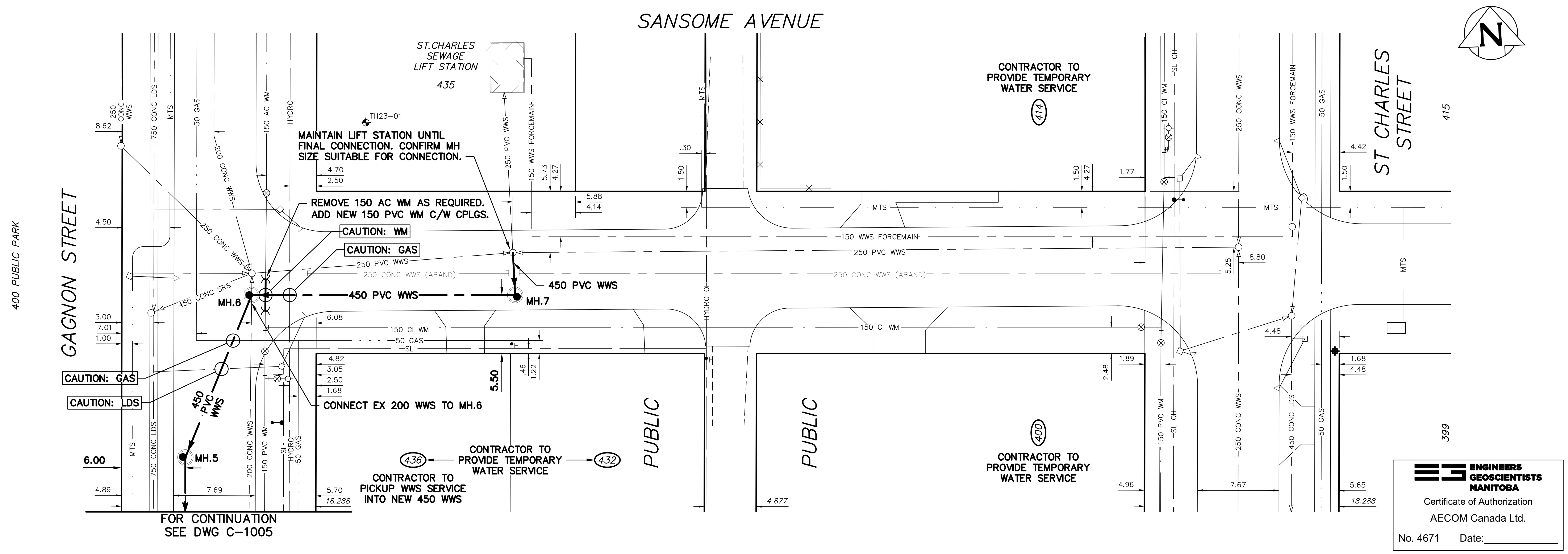
ST. CHARLES SEWER DISTRICT
PRELIMINARY DESIGN

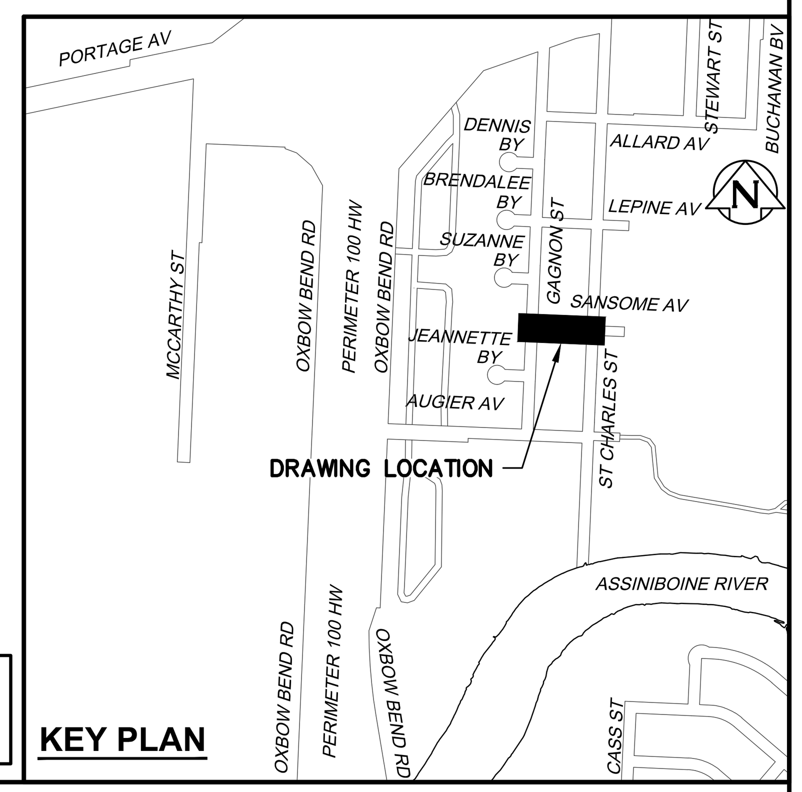
GAGNON STREET
69m NORTH OF AUGIER AVENUE
TO SANSOME AVENUE

SHEET 7 OF XX
CITY DRAWING NUMBER
C-1005



NOTE: CHAINAGES SHOWN ARE ALONG N. ℄ OF SANSOME AVENUE
STA. 1+00.000 = W ℄ GAGNON STREET





KEY PLAN

FOR INDEX SEE G-1001

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
AECOM Canada Ltd.
No. 4671 Date:

METRIC
WHOLE NUMBERS INDICATE MILLIMETRES
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0.0 5.0 10.0 15.0 20.0 25.0

LOCATION APPROVED
UNDERGROUND STRUCTURES

SUPV. U/G STRUCTURES COMMITTEE | DATE

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CONSTRUCTION COMPLETION DATE: YYYY MM DD

DRAFT
09/24/2024

NO.	REVISIONS	DATE	BY

AECOM

DESIGNED BY	AD	CHECKED BY	
DRAWN BY	ADL	APPROVED BY	
SCALE: HORIZONTAL	1:250	RELEASED FOR CONSTRUCTION	
VERTICAL	1:50		
DATE	2024 09 23	DATE	

ENGINEER'S SEAL

CONSULTANT DRAWING NUMBER
C-1006

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT
ENGINEERING DIVISION

ST. CHARLES SEWER DISTRICT
PRELIMINARY DESIGN
SANSOME AVENUE
GAGNON STREET
TO ST CHARLES STREET

SHEET 8 OF XX
CITY DRAWING NUMBER
C-1006

PLOT DATE: 2024 09 23
Tender No: XXX-XXXX
CONTRACT NUMBER:
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AECOM Canada Ltd.
99 Commerce Drive
Winnipeg, MB R3P 0Y7
Canada

T: 204.477.5381
F: 431.800.1210
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