CITY OF WINNIPEG

CentrePort South Regional Water & Wastewater Servicing Project
CPKC Mile 3.28 Glenboro Subdivision Crossing Geotechnical Report

Revision:
Final / Rev 0

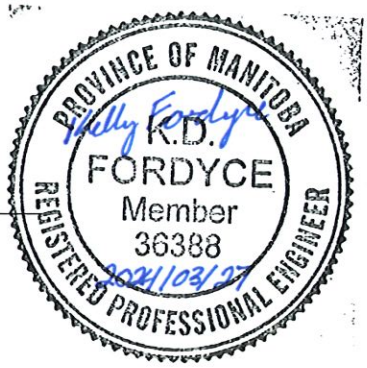
KGS Group Project:
23-0107-009

Date:
March 27, 2024

Client Project:
122-2023

PREPARED BY:

Kelly Fordyce, P.Eng.
Geotechnical Engineer



APPROVED BY:

Dami Adedapo, Ph.D., P.Eng.
Geotechnical Department Head / Principal

TABLE OF CONTENTS

1.0 INTRODUCTION 1

1.1 General 1

2.0 BACKGROUND INFORMATION 2

3.0 2023 GEOTECHNICAL INVESTIGATION PROGRAM 3

3.1 Borehole Drilling and Soil Sampling 3

3.2 Instrumentation 4

3.3 Geotechnical Laboratory Testing 4

4.0 2023 INVESTIGATION RESULTS 5

4.1 Stratigraphy 5

4.1.1 Silt 5

4.1.2 Clay (CH) 5

4.1.3 Glacial Till (ML) 5

4.1.4 Bedrock 6

4.2 Groundwater Conditions and Monitoring Results 6

4.3 Potential Difficult Ground Conditions 7

5.0 FEEDER MAIN DESIGN CRITERIA 8

6.0 DESIGN AND CONSTRUCTION CONSIDERATIONS 9

6.1 Considerations for Pipe Installation at CPKC Rail Crossing 9

6.2 Trenchless Pipe Installation Method 9

6.2.1 Considerations for Down The Hole Hammer and Microtunnelling 9

6.2.2 Settlement Analysis 10

6.2.3 Settlement and Construction Monitoring 12

6.2.4 Geotechnical Personnel 13

6.2.5 Emergency Response and Contingency Plan 13

6.2.6 Construction and Post-Installation Reporting 14

6.3 Temporary Excavations 14

6.3.1 Ground Movement 15
6.4 Base Heave 15
6.5 Care and Control of Water 15
6.6 Lateral Earth Pressures 16
6.7 Groundwater Management and Spoil Disposal 16
6.8 Frost Penetration 16
7.0 CLOSURE 17
8.0 REFERENCES 18

List of Tables

Table 4-1: Atterberg and Particle Size Analyses – Glacial Till

Table 4-2: Groundwater Monitoring Results

Table 5-1: CPKC Geotechnical Protocol Requirement and Proposed Design Parameters

Table 6-1: Estimated Surface Settlement

Table 6-2: Emergency Response Contact List

Table 6-3: Lateral Earth Pressure Coefficients

List of Figures

Figure 3-1: Borehole Location Plan

Figure 6-1: Estimated Surface Settlement

List of Appendices

Appendix A: Detailed Design Crossing Drawings

Appendix B: 2023/2024 Geotechnical Investigation Borehole and Test Pit Logs

Appendix C: 2023/2024 Select Drilling and Test Pit Photos

Appendix D: 2023 Geotechnical Laboratory Testing Results

STATEMENT OF LIMITATIONS AND CONDITIONS

Limitations

This report has been prepared for City of Winnipeg in accordance with the agreement between KGS Group and City of Winnipeg (the "Agreement"). This report represents KGS Group's professional judgment and exercising due care consistent with the preparation of similar reports. The information, data, recommendations and conclusions in this report are subject to the constraints and limitations in the Agreement and the qualifications in this report. This report must be read as a whole, and sections or parts should not be read out of context.

This report is based on information made available to KGS Group by City of Winnipeg. Unless stated otherwise, KGS Group has not verified the accuracy, completeness or validity of such information, makes no representation regarding its accuracy and hereby disclaims any liability in connection therewith. KGS Group shall not be responsible for conditions/issues it was not authorized or able to investigate or which were beyond the scope of its work. The information and conclusions provided in this report apply only as they existed at the time of KGS Group's work.

Third Party Use of Report

Any use a third party makes of this report or any reliance on or decisions made based on it, are the responsibility of such third parties. KGS Group accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions undertaken based on this report.

Geotechnical Investigation Statement of Limitations

The geotechnical investigation findings and recommendations of this report were prepared in accordance with generally accepted professional engineering principles and practice. The findings and recommendations are based on the results of field and laboratory investigations, combined with an interpolation of soil and groundwater conditions found at and within the depth of the test holes drilled by KGS Group at the site at the time of drilling. If conditions encountered during construction appear to be different from those shown by the test holes drilled by KGS Group or if the assumptions stated herein are not in keeping with the design, KGS Group should be notified in order that the recommendations can be reviewed and modified if necessary.

1.0 INTRODUCTION

1.1 General

KGS Group was retained by the City of Winnipeg Water and Waste Department to provide engineering services to facilitate the detailed design and construction of regional water and wastewater infrastructure to support future industrial and residential developments within CentrePort South. The work includes the design and construction of the proposed feeder main pipeline beneath the Canadian Pacific Kansas City (CPKC) railway at Mile 3.28 Glenboro Subdivision in Winnipeg, Manitoba. The subject CPKC railway line is a Class 3 track which runs east-west and parallel to Saskatchewan Avenue at the project site.

A geotechnical field investigation program was completed along the proposed alignment of the new feeder main pipeline to characterize the subsurface soil stratigraphy and groundwater conditions. A laboratory testing program was completed to determine relevant soil properties and were carried out on select soil samples from the investigation. This geotechnical evaluation report was prepared to summarize the finding of the geotechnical investigation and provide general design and construction recommendations for the underground trenchless installation. This report was prepared to support the CPKC utility crossing application in accordance with the requirements outlined in CPKC's Geotechnical Protocol for Pipeline and Utility Crossings under Railway Tracks (May 2022).

2.0 BACKGROUND INFORMATION

The proposed feeder main (FDM) pipeline is being constructed as part of the CentrePort South Regional Water and Wastewater Servicing project for the City of Winnipeg. The proposed FDM is planned to be installed beneath the CPKC tracks using trenchless construction methods. The new carrier pipe and required casing pipe specifications are summarized in the detailed design drawings in Appendix A. All carrier pipes were designed to meet flow capacity requirements as outlined in the hydraulic modelling analysis previously completed by KGS Group.

The proposed FDM consists of 750 mm nominal diameter PVC carrier pipe installed within a 1219 mm outside diameter (1200 mm nominal diameter) steel casing.

The crossing profile indicates the elevation of the following at the railway crossing location:

- Top of Rail (TOR) track is at elevation Elev. 240.87 m. ***Please note that only top of rail data is available and Base of Rail (BOR) was estimated. BOR data will be collected during construction and updated on the as-built drawings.***
- The invert elevation of the 750 mm PVC carrier pipe across the CPKC right-of-way is Elev. 231.99 m and 231.95 m at the north and south CPKC property limits respectively. The invert depth below the approximate BOR is 8.70 m and 8.74 m at the north and south ends respectively.
- The invert elevation of the 1200 mm steel casing pipe across the CPKC right-of-way is Elev. 231.83 m and 231.79 m at the north and south CPKC property limits respectively. The invert depth below the approximate BOR is 8.86 m and 8.90 m at the north and south ends respectively.
- Depth from the approximate BOR to the top of the pipe casing is approximately 7.70 m (i.e., obvert Elev. 232.99 m)

Assumed dimensions of the launch and receiving pits are indicated on the detailed design drawings in Appendix A; the sizing of the working pits and actual dimensions will be the responsibility of the Contractor based on their means and method and excavation support structure design. The launch pit is anticipated to be constructed on the north side of the crossing and the receiving pit is anticipated to be constructed on the south side of the crossing. The footprints of these working pits will be outside of the CPKC railway right-of-way (ROW).

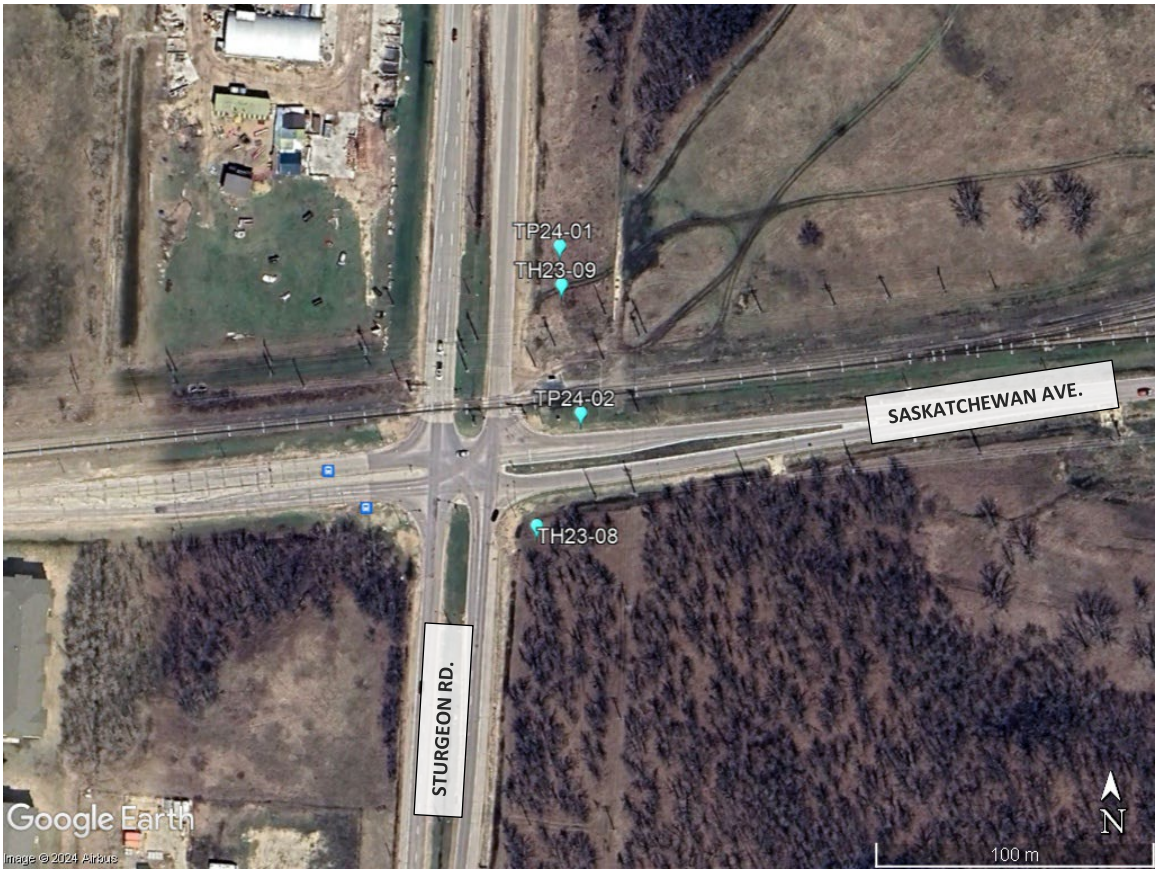
3.0 2023 GEOTECHNICAL INVESTIGATION PROGRAM

3.1 Borehole Drilling and Soil Sampling

A drilling and sampling investigation program was completed on September 24 and 25, 2023, with drilling services provided by Maple Leaf Drilling Ltd. of Winnipeg, Manitoba under KGS Group's supervision. The drilling and sampling program consisted of drilling two (2) boreholes on either side of the Saskatchewan Avenue and the CPKC ROW as shown in Figure 3-1. The boreholes were both advanced to 9.4 m (El. 230.0 m to 230.60 m) below grade using a track-mounted drill rig equipped with 125 mm diameter solid stem continuous flight augers and HQ size triple tube coring.

A supplementary test pitting program was completed on February 21 and 22, 2024, with excavation services provided by J Con Civil Ltd. of Winnipeg, Manitoba under KGS Group's supervision. The test pitting program consisted of excavating two (2) test pits on either side of the CPKC ROW as shown in Figure 3-1. Test pits TP24-01 and TP24-02 were advanced to refusal on the bedrock at 4.9 m and 5.5 m below grade, respectively, using a rubber-tire excavator. The test pits were completed to assess the composition, size, and frequency of boulders in the glacial till and to confirm the depth to bedrock at the anticipated launch and receiving pit locations.

FIGURE 3-1: BOREHOLE LOCATION PLAN



The location of the boreholes, test pits, and associated stratigraphy are also shown on the detailed design drawings in Appendix A.

Representative disturbed soil samples were obtained from each borehole at 1.5 m (5 ft) intervals, at any change in soil strata, or at the discretion of KGS Group personnel. Soil samples were collected either directly off auger flights or from a driven split spoon sampler. Collected samples were visually classified in the field in general accordance with the modified Unified Soil Classification System (USCS) and placed in resealable plastic bags. Standard Penetration Tests (SPT) were advanced at each split spoon sample depth (typically within the glacial till) to evaluate relative material density, and pocket penetrometer tests were performed on select sample to estimate unconfined compressive strength. Cohesive clay samples were tested with a field Torvane to estimate undrained shear strength.

Upon completion of drilling or excavation, the boreholes and test pits were examined for indications of sloughing and seepage and subsequently backfilled to grade. Boreholes were backfilled with auger cuttings and bentonite chips. Test pits were backfilled with sand in accordance with City of Winnipeg standard specifications.

Summary borehole and test pit log records containing all field observations are provided in Appendix B. Select photos of the drilling and test pit samples are provided in Appendix C.

3.2 Instrumentation

One (1) standpipe piezometer was installed in TH23-09 as part of the geotechnical investigation program. The slotted section of the standpipe was installed within the bedrock unit between elevations El. 230.9 m and 233.9 m. A sand pack was installed around the slotted section of the standpipe, and the remainder of the borehole was backfilled with bentonite chips. A protective well cover was installed at the ground surface.

3.3 Geotechnical Laboratory Testing

Geotechnical laboratory testing was completed on select representative samples to determine relevant geotechnical engineering index properties. Laboratory testing included:

- Six (6) moisture content tests;
- One (1) Atterberg limit tests;
- Two (2) particle size analyses;
- Two (2) uniaxial compressive strength tests

All laboratory testing was completed at a Canadian Council of Independent Laboratories (CCIL) certified soil testing laboratory in Winnipeg, Manitoba. Testing was completed in general accordance with American Society for Testing and Materials (ASTM) standards. A summary of the laboratory testing has been provided in Appendix D and the borehole log records in Appendix B.

4.0 2023 INVESTIGATION RESULTS

4.1 Stratigraphy

In general, the stratigraphy at the site was interpreted by KGS Group to consist of silt and high plasticity clay deposit overlying glacial silt till and bedrock.

4.1.1 SILT

Silt up to 0.9 m thick was encountered below a thin layer of organics in TH23-09 and TP24-01, and below a 1 m layer of clay fill in TP24-02. The silt extended to approximate elevations of El. 238.8 m to 239.4 m±. The silt was light brown in colour, dry to damp, soft, non-plastic, and contained trace sand and clay. The moisture content of the silt was 12% based on one test.

4.1.2 CLAY (CH)

A deposit of low to high-plasticity clay was encountered in all boreholes and test pits at elevations ranging from El. 238.8 to 239.4 m± and extended to approximate elevations ranging from El. 237.7 and 238.5 m±. The clay was dark brown to grey in colour, dry to moist, stiff to hard, of low to high plasticity, and contained trace sand and gravel, and trace gypsum pockets. The moisture content of the high plasticity clay was 21% based on one test.

The undrained shear strength of the clay deposit was estimated to be greater than 100 kPa, as the field Torvane and pocket penetrometer measurements were maxed out.

4.1.3 GLACIAL TILL (ML)

Glacial silt till deposit was encountered below the high plasticity clay in all the boreholes and test pits and extended to elevations ranging from El. 233.5 to 236.0 m±. The thickness of the till deposit was 1.9 m and 4.2 m within TH23-08 and TH23-09, respectively. The thickness of the till deposit was 3.6 m and 1.6 m within TP24-01 and TP24-02, respectively. The silt till was light brown to light grey in colour, damp to moist, dense, and contained some gravel, some sand, and trace to with clay. Some coarse-grained gravel and trace cobbles were encountered within the till deposit in BH23-09 below El. 235.1 m±.

Cobbles and boulders were encountered in TP24-01 and TP24-02 and were comprised of sedimentary and igneous rock. The average size of the boulders observed was 300 to 380 mm (12 to 15 in), and the maximum size observed was 600 mm (24 in). The frequency of the boulders (larger than 300 mm diameter) in the test pits was estimated to be 2 to 4 boulders per cubic meter of excavated till material.

Uncorrected blow counts from Standard Penetration Tests completed in the till deposit were greater than 100 blows per 300 mm; however, the borehole logs indicate the tests prematurely refused on either the bedrock surface or a cobble/boulder. The unconfined compressive strength of the till deposit, as estimated from a pocket penetrometer, ranged between 250 and 450 kPa.

The moisture content of the till deposit ranged from 8% to 11%. Atterberg limit testing and particle size analyses were completed on one sample from each borehole as summarized in Table 4-1.

TABLE 4-1: ATTERBERG AND PARTICLE SIZE ANALYSES – GLACIAL TILL

Borehole ID	Sample Elevation	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	%Gravel	%Sand	%Silt	%Clay
BH23-08	236.7 m	--	--	--	25	30	35	10
BH23-09	235.6 m	27	14	13	17	26	42	15

4.1.4 BEDROCK

Bedrock was encountered below the glacial till at elevations of El. 236.0 m± and 233.5 m± in TH23-08 and TH23-09, respectively. The bedrock elevations encountered in TP24-01 and THP24-02 were El. 234.9 m± and El. 236.0 m± respectively.

In TH23-08, dolomite bedrock was observed between El. 236.0 and 234.4 m±. Dolomite was also observed at the bedrock surface in TP24-02 and was not rippable with the excavator bucket. The dolomite was described as mottled yellow-white, fine grained, massive, very strong, and contained trace vugs. The rock quality designation (RQD) of the dolomite was 72% (i.e. Fair). A 100 mm broken lost core zone was observed at El. 234.5 m±. One uniaxial compressive strength test was performed on the dolomite in TH23-08 at El. 235.4 m± resulting in a value of 66.1 MPa.

Argillaceous dolomite bedrock was observed in both boreholes between El. 233.5 and 234.4 m± and extended to the end of borehole depth. Argillaceous dolomite was observed at the bedrock surface in TP24-01 and appeared to be highly weathered and rippable with the excavator bucket. The argillaceous dolomite was described as mottled reddish-grey to green, fine grained, fossiliferous, and moderately strong to strong. The RQD of the material ranged from 0% to 79% (i.e. Very Poor to Good). Broken lost core zones were observed throughout the argillaceous dolomite. Increased shale content was observed in the bedrock below El. 231.9 m± and 233.5 m± in TH23-08 and TH23-09, respectively. One uniaxial compressive strength test was performed on the argillaceous dolomite in TH23-08 at El. 234.3 m± resulting in a value of 73.7 Mpa.

4.2 Groundwater Conditions and Monitoring Results

One (1) standpipe monitoring well was installed within the bedrock at TH23-09 as part of the investigation activities. Details of the well installation are provided in Table 4-2 below and on the borehole logs provided in Appendix B.

Boreholes TH23-08 and TH23-09 were observed to be dry both during drilling and immediately upon completion of drilling. Test pits TP24-01 and TP24-02 were observed to be dry upon completion of excavation. Groundwater level readings were collected four (4) times between November 2023 and January 2024, and are summarized in Table 4-2. As fluctuations can occur in response to seasonal conditions and following heavy precipitation or spring snow melt events, current groundwater levels may differ from those provided in this report. As such, water levels should be monitored both prior to and during construction activities.

TABLE 4-2: GROUNDWATER MONITORING RESULTS

Borehole ID	TH23-09
Ground Elevation (m)	240.00
Piezometer No.	Standpipe 1
Tip Elevation (m)	230.86
Monitoring Zone	Bedrock
Date	
2023-11-14	232.60
2023-11-20	232.60
2023-12-13	232.60
2023-01-17	232.57

4.3 Potential Difficult Ground Conditions

Cobbles and boulders were encountered in the glacial till deposit in borehole TH23-09, TP24-01, and TP24-02. An average boulder size of 300 to 380 mm (12 to 15 in) was observed in the test pits with maximum size up to 600 mm (24 in) observed. The boulders were sub-angular to rounded and contained sedimentary and igneous rock types. Cobbles and boulders have also been observed within the lacustrine clay near the interface with the silt till and within the silt till in a majority of the boreholes that have been completed in the larger regional project area. Based on previous works completed by the City of Winnipeg in the vicinity of this project, it is understood that installation of the new pipelines near the clay/till interface and within the till will encounter cobbles and boulders during excavation and trenchless installation.

A trenchless crossing of the railway is considered a critical crossing. The geotechnical condition of this crossing is unique in its challenges. The bedrock appears to be highly weathered at the surface and of low quality with potential for voids and a large variance in the bedrock's strength. The till is a mixture of sand, silt, clay, and gravel with the potential of larger cobbles and boulders. Due to the composition of the material and the likelihood of encountering cobbles and boulders, it is expected that the crossing will be completed via a down-the-hole hammer or micro tunnelling. These methods are able to breakdown the bedrock material, ingest it, and remove it to support continued forward progress.

Installation within the bedrock placed the depth of the invert of casing around elevation 231.8 m and the obvert of the casing around elevation 233.0 m. This elevation was selected to be entirely within the bedrock strata to provide the most clearance between the surface and the top of the casing pipe to minimize the risk of settlement.

5.0 FEEDER MAIN DESIGN CRITERIA

Table 5-1 provides the general requirements for CPKC Geotechnical Protocol Requirement for Process 2 – Intermediate and the proposed design parameters based on the detailed design drawing in Appendix A.

TABLE 5-1: CPKC GEOTECHNICAL PROTOCOL REQUIREMENT AND PROPOSED DESIGN PARAMETERS

Parameter/Criteria	CPKC Protocol Requirement	Proposed Design
Dimension Criteria		
Outside Pipe Diameter	300 mm to 1500 mm	1200 mm (nominal)
Cover between BOR and top of pipe (Note 2): measurements are from approximate BOR and BOR data will be collected during construction to update on the as-built drawings)	Greater than 1.5 m or 2 pipe diameters, whichever is greater	7.70 m (greater than 1.5 m and greater than 2 * 1200 mm)
Adjacent structures including switches and signals	Within 2.5 times, cover between BOR and top of pipe	None
Depth of pipes outside Zone of Potential Track Loading (ZPTL)	Less than 0.91 m burial within ZPTL	Approx min. depth of pipe outside ZPTL (north) = 7.70 m Approx min depth of pipe outside ZPTL (south) = 7.70 m
Excavation Criteria		
Excavation close to CPKC track(s)	Excavation or jacking/access pits within 10 m of the closest track centreline	Centreline of track to face of Launch Pit = 34.9 m Centreline of track to face of Receiving Pit = 40.7 m
Crossing Angle	More than 45 degrees off perpendicular to the track	81 degrees
Construction Method Criteria		
	Trenchless method – Auger Boring, Pipe Jacking, Pipe Ramming, HDD	Down-the-Hole Hammer or Microtunnelling
Other Criteria		
Settlement for Class 3 track	Level 1 Warning/Alert: >10 mm Level 2 Critical/Review: >19 mm	See Section 6.2.5

Notes:

1) CPKC Geotechnical Protocol for Pipeline and Utility Crossing(s) under Railway Tracks Criteria for Process 2 – Intermediate.
2) Cover measurements are from the approximate Base of Rail (BOR) data. BOR data will be collected during construction to update the as-built drawings for consistency with CPKC documentation.

6.0 DESIGN AND CONSTRUCTION CONSIDERATIONS

6.1 Considerations for Pipe Installation at CPKC Rail Crossing

Construction of the FDM pipeline that will be installed beneath the existing CPKC railway at Mile 3.28 Glenboro Subdivision will be completed using down-the-hole hammer or microtunnelling as described in Section 6.2 and will comply with the following specifications and standards.

- CPKC document "CPKC Geotechnical Protocol for Pipeline and Utility Crossing(s) under Railway Tracks" May 2022.
- Transport Canada document "Standards Respecting Pipeline Crossings Under Railways TC E-10 (June 21, 2000)".

6.2 Trenchless Pipe Installation Method

KGS Group has considered a number of trenchless methods which include down-the-hole hammer and microtunneling. Due to the bedrock being found at similar elevations in TH23-08 and TP24-02, the crossing horizon was set to be within the bedrock. Steel casing pipe will be installed within the CPKC right-of-way. The specifications for the casing and carrier pipes are provided in Section 5.0. Each proposed method is further described in the subsequent sections.

Casing installations by down the hole hammer are completed by utilizing a pneumatic hammer and hydraulic rams to generate cyclical percussive forces which break solid rock into smaller fragments which are then blown out and removed from the casing using the hydraulically powered auger. The hydraulic system also powers the advancing force of the casing. Casings and auger sections are added as the installation progresses from the working area until the reception pit is reached.

Microtunnelling is also considered a viable option because of the versatility of the machine to be outfitted with a rock-tooled cutting face and because the installation is within full face bedrock conditions. This cutting face is rotated which cuts and shears the bedrock material into small pieces which are removed by the pressurized slurry system and pumped back to the surface to be reclaimed. A jacking frame advances the steel pipe and the leading microtunnel boring machine with sections of steel pipe and supports umbilical lines as the installation advances. Once the machine reaches the reception pit, the machine is removed along with the support umbilicals, jacking frame, and surface support equipment.

6.2.1 CONSIDERATIONS FOR DOWN THE HOLE HAMMER AND MICROTUNNELLING

The installation is set within the bedrock horizon and this material is generally self-supporting and hard. Both down-the-hole hammer and microtunnelling are best suited for full face rock conditions.

Both methods allow the contractor to select the appropriate excavating face tooling. This is based on the geotechnical information which was collected in three different locations along the alignment. Tooling should not need changing due to the short length of the installation when considering microtunnelling. Down-the

hole hammer allows the hammer face to be removed back through the casing should the tooling require any repairs.

6.2.2 SETTLEMENT ANALYSIS

KGS Group conducted settlement analysis using O'Reilly and New (1982) to estimate the potential surface settlement of the proposed pipeline installation versus assumed % volume of ground loss. This settlement analysis model was used considering the bedrock surface at the site is undulating across the crossing location and was observed to be substantially weathered. The settlement analysis also considers the full collapse of the overcut created by the trenchless construction method. The settlements for a single tunnel installation can be estimated from the formula as shown below,

$$S_{(y,z)} = S_{(max,y,z)}\, e^{-y^2/2i^2} = \frac{V_s}{\sqrt{2\pi}\, K\, z}\, e^{-y^2/2(K\, z)^2}$$

where

$S_{(y,z)}$ = vertical displacement at a transverse distance y and a vertical distance z

V_s = % volume of ground loss

K = coefficient, typically 0.5

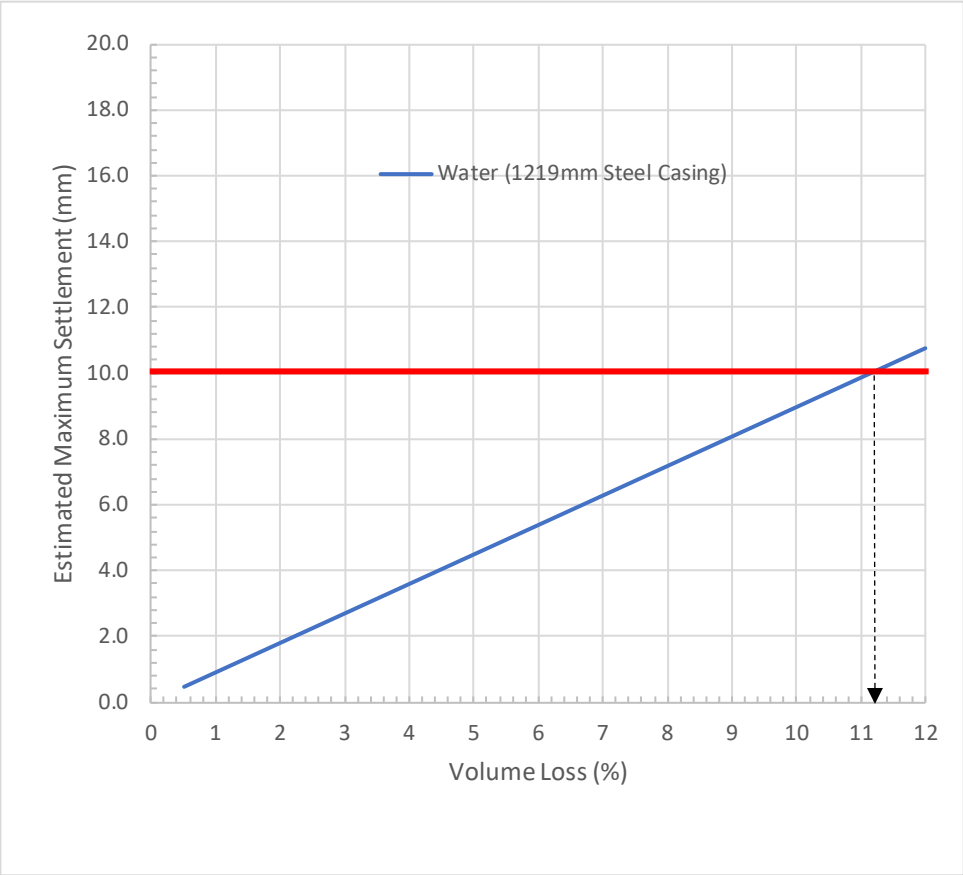
z = depth of the tunnel center

The maximum surface settlement, S_{max}, can be estimated when y = 0 (along the bore axis), which is a function of vertical distance z. For a single bore, the settlement obtained below was based on the crown of the steel casing profile located at 7.70 m below the base of the CPKC railway track. The estimated maximum settlements for the casing pipe with an assumed volume loss of the annular overcut are summarized in Table 6-1 and Figure 6-1.

TABLE 6-1: ESTIMATED SURFACE SETTLEMENT

Assumed Volume Loss (%)	Estimated Maximum Settlement (mm)
	FDM (1219mm Steel Casing)
0.5	0.4
1	0.9
2	1.8
4	3.6
6	5.4
10	9.0
12	10.7

FIGURE 6-1: ESTIMATED SURFACE SETTLEMENT



The CPKC rail line for this project is defined as a Class 3 track. Settlement thresholds of 10 mm (Warning) and 19 mm (Critical) are recommended in accordance with CPKC's Geotechnical Protocol.

Based on the results as outlined in Table 6-1 or Figure 6-1, the allowable radial overcut should be no greater than 25 mm for the FDM steel casing pipe, to ensure the potential settlement is below the Warning threshold of 10 mm. The maximum allowable overcut in the technical specifications outlines a maximum overcut of 19 mm and 25 mm for the down-the-hole hammer and microtunnelling applications respectively. It should be noted that if microtunnelling is the selected method by the contractor, the tunnel annular space will also be filled with bentonite slurry to provide lubrication for the pipe jacking string, and to mitigate collapse of the annular space.

Lowering the water table may not be required since both recommended trenchless construction methods are capable of managing groundwater flows, particularly in full face rock tunneling applications. Based on groundwater observations, groundwater will likely be encountered at the tunnel horizon. No groundwater was observed within the overburden soils above the bedrock during drilling and test pit excavation. However, groundwater levels are prone to fluctuations depending on the amount of precipitation and the time of year of the construction.

It is KGS Group's opinion that the surface settlements associated with the casing pipe installation are unlikely to impact the railway operation, provided good construction practices are followed. It is recommended to monitor ground movements during the casing installation to confirm the permissible settlement thresholds are not exceeded.

6.2.3 SETTLEMENT AND CONSTRUCTION MONITORING

Installation of the proposed pipeline and associated infrastructure using the trenchless construction methods outlined above should not result in adverse effects on CPKC operations or property. Since the proposed pipeline is greater than 300 mm (12 inches) OD, the installation falls under CPKC Process 2 – Intermediate, and a KGS Group engineer will be on-site for the entirety of the installation process to monitor construction. The ground surface above the trenchless pipe installation alignment will be monitored for movement/settlement during the installation via the following:

- Track monitoring points installed at approximate spacings of 1.18 m, 2.34 m, 4.72 m, 7.08 m, and 9.45 m extending in both directions along the track from the intersection point of the pipe alignment and railway track. The layout and details of the settlement monitoring program are shown on the sealed drawings in Appendix A.
- A minimum of two (2) sub-surface monitoring points will be installed along the alignment near the CPKC track, one (1) on either side of the track. The tip of the sub-surface settlement points will be installed to 1 m above the pipe obvert in accordance with CPKC's Geotechnical Protocol.
- A baseline survey of all survey points will be conducted and submitted to CPKC prior to the installation of the pipeline infrastructure.
- Daily surveying of all monitoring locations and submission of values to CPKC for review. The required frequency of survey monitoring and reporting will be confirmed by CPKC in writing: however, based on the Class 3 track classification, we anticipate the following in accordance with CPKC's "Track Movement Monitoring Guidelines for Trenchless Pipe Installation" (May 2022):
    - **Pre-construction:** Baseline survey monitoring will occur 2 days prior to construction for both surface and subsurface monitoring points and will be measured by means of a total station twice per day to establish reliable methodology and demonstrate accuracy.
    - **During Construction:** Daily monitoring will proceed during the duration of construction in which survey monitoring will be captured every two (2) hours or after each train passage, whichever provides the greatest number of readings while the boring operation is within the ZPTL.
    - **Post Construction:** An additional 3 days of monitoring (readings collected twice per day) will be conducted after completion of the installation.

Based on the underground utility drawings and upon KGS Group field observations of the proposed pipeline alignment option, there is no major building / infrastructure identified in the vicinity of the pipeline alignment. The risk of potential conflicts with subsurface facilities is anticipated to be very low. Should the selected trenchless installation methods encounter any obstructions or premature refusal of any kind, work should stop immediately for reassessment, and CPKC will be notified.

6.2.4 GEOTECHNICAL PERSONNEL

Mr. Dami Adedapo, Ph.D., P.Eng. will be the Geotechnical Engineer of Record for this project. He will be responsible for reviewing the shop drawings submitted by the pipeline Contractor to determine if the proposed installation method (and dewatering method, if required) could cause any track settlement.

Mr. Kelly Fordyce, P.Eng., will be the geotechnical representative responsible for day-to-day review and inspection of the work to ensure that the geotechnical requirements are satisfied during construction.

6.2.5 EMERGENCY RESPONSE AND CONTINGENCY PLAN

The railway tracks at this crossing fall under Track Class 3. Two (2) alarm levels (Level 1 Warning/Alert and Level 2 Critical/Review) have been established for the installation of the pipe under the tracks.

Level 1 Warning/Alert

Warning/Alert level indicates a measurement of 10 mm of settlement or heave has been measured at a surface/subsurface monitoring point. The contractor's work method will be reviewed at this stage and necessary adjustments will be made to mitigate any additional movements. A survey of the monitoring points will be completed prior to commencing further work and work will only proceed if the magnitude of movement has stabilized from the previous readings. If movement is observed, work will be discontinued until movement is stopped at which point the pipe installation will be authorized to proceed.

Level 2 Critical/Review

Critical/Review level indicates a measurement of 19 mm of settlement or heave has been measured at a surface/subsurface monitoring point. A survey of the monitoring points will be conducted and work will only be authorized to proceed if there is no movement between at least two readings taken 12 hours apart. If movement is recorded, survey monitoring will continue until movement has stopped and a new pipe procedure has been submitted. In all cases, CPKC will have the right to carry out maintenance of the track upon completion of the works and during any agreed warranty period to restore the track at the expense of the City of Winnipeg's contractor to the same or better condition as was established in the baseline survey.

If a critical defect is detected, an on-site meeting would be held between all parties including the Contractor, Geotechnical Engineer of Record, City of Winnipeg, and CPKC representative to determine the cause of the defect and remedial action based on the contingency plan. A contingency plan will be developed prior to the start of construction including potential local sources of ballast rock and fill materials to aid in an emergency. The contingency plan may also include pressure-injected grout to fill any potential voids to prevent further settlement. As aforementioned, the risk that such a problem will occur with the installation methodology is unlikely.

A copy of the emergency response plan will be posted on-site and will reside with key personnel including the on-site geotechnical representative. An example emergency response contact list is presented in Table 6-2 below.

TABLE 6-2: EMERGENCY RESPONSE CONTACT LIST

Department / Title	Name	Email	Phone Number
Project Manager – Overseeing Utility Installation	Tim Turzak	tturzak@winnipeg.ca	c. 204-232-2674
Geotechnical Engineer of Record for Utility Owner	Dami Adedapo, P.Eng	Dadedapo@kgsgroup.com	c. 204-770-6088
CPKC Geotechnical Engineer or Service Provider	TBD by CPKC		
CPKC Roadmaster	TBD by CPKC		
CPKC Signal & Communication Supervisor	TBD by CPKC		
CPKC Director Geotechnical Engineering	Danny Wong	Dannyj_Wong@cpkcr.com	c. 403-826-3313
CPKC Utilities Supervisor – ON, MB	Jack Carello	Jack_Carello@cpkcr.com	c. 416-992-2676
CPKC Call Before You Dig - Canada	Main Desk	call_b4udig@cpkcr.com	1-800-387-1833
CPKC 24HR Utility Owner Emergency Response			204-986-2511

Notes:

1) A complete list of contacts will be provided prior to construction and once the construction has been awarded to a Contractor.

6.2.6 CONSTRUCTION AND POST-INSTALLATION REPORTING

The Geotechnical Engineer of Record or their on-site representative will prepare daily construction inspection/monitoring reports in accordance with Section 12.0 of the CPKC's Geotechnical Protocol document. The reports will be issued to CPKC and their geotechnical service provider.

The Geotechnical Engineer of Record will compile a final memorandum to summarize the daily construction and monitoring activities and provide results of the survey monitoring data. The final memo and survey monitoring data will be submitted to CPKC. In addition, the Geotechnical Engineer of Record shall provide confirmation in writing that the work was conducted in accordance with the detailed plan reviewed and accepted by CPKC. The report shall include as-constructed drawings sealed by the Engineer of Record, and should confirm that there are no expected issues of the railway track due to the installation.

6.3 Temporary Excavations

Excavations for the trenchless installation shafts will be required to facilitate installation of the pipeline at the entry and exit locations. This will require temporary shoring or bracing to allow safe entry by workers and minimize adverse effects to any adjacent infrastructure.

All excavations must not be located within the ZPTL which is defined as the area under the track and within a 1V:1.5H soil zone extending down from a point at the level of the Base of Rail and 2 m (6.6 ft) from the centerline of the track. All excavation work should be performed in accordance with the latest version of the Manitoba Workplace Safety and Health Regulation.

Suitable options include steel piling and timber lagging or driven steel sheet piling. All excavations deeper than 1.5 m should be reviewed and designed prior to construction by an experienced professional engineer with an expertise in geotechnical engineering. Openings and voids behind shoring lagging or sheet piles should be backfilled with free draining granular material.

All open excavation side slopes should be covered to prevent saturation and raveling of the soil, and all surface runoffs should be directed away from excavations. All surcharge loads such as stockpiled soil, equipment, etc. should be kept a minimum horizontal distance of 10 m away from the edge of excavations.

During the site investigation, silt was encountered in TH23-09 near ground surface and above the clay and can potentially be water bearing depending on seasonal groundwater fluctuations. As such, there may be the potential of localized groundwater inflows into the excavations from the cohesionless overburden layers as well as below the water table, which may require temporary pumping as well as potential shoring. Additionally, groundwater levels will fluctuate seasonally and following precipitation events and should be monitored regularly prior to, and during construction. Design of the above measures depends on the size, depth, and extent of excavation during construction.

6.3.1 GROUND MOVEMENT

Excavation support systems should be designed to control ground movement / subsidence around the perimeter of the excavation. The magnitude of ground movement could be affected by the procedure and workmanship applied during construction. Potential settlement of the ground surface adjacent to temporary shoring systems should be recognized and accounted for. Any resulting movement / settlement around the perimeter of the excavation must be kept within acceptable limits as specified in the contract document.

The excavation and shoring system should be designed by a professional engineer with extensive relevant experience and the works must be inspected and certified by the same professional engineer to verify that the temporary structure has been installed according to the design.

6.4 Base Heave

The base of excavation and shoring is recommended to be designed to achieve a minimum factor of safety of 1.5 with respect to basal heave.

6.5 Care and Control of Water

To maintain safe working conditions in excavations/shafts and to protect against instability of the excavation base, water should not be allowed to accumulate anywhere within excavations or to within 0.5 m below the lowest point within the excavation. It will be important to have an effective drainage and sump pump system below the base of excavation and to maintain a firm, dry working surface.

The drainage system should be designed to efficiently collect potential groundwater seepage and surface water drainage within the excavation so it can be pumped out and treated before being released into the environment. Surface run-off resulting from rainfall should be controlled and prevent ed from entering the excavation.

6.6 Lateral Earth Pressures

For design purposes, the soils may be assigned active, passive and at-rest lateral earth pressure coefficients as shown in Table 6-3.

TABLE 6-3: LATERAL EARTH PRESSURE COEFFICIENTS

Material	Bulk Unit Weight	Φ'	K_a	K_p	K_o
Well-Graded Granular Fill	20 kN/m^3	35°	0.27	3.69	0.43
Clay (CH)	18 kN/m^3	18°	0.49	2.04	0.66
Glacial Till	22 kN/m^3	23°	0.43	2.28	0.61

6.7 Groundwater Management and Spoil Disposal

The Contractor is expected to be familiar with, and follow, all local spoil disposal regulations including all monitoring, analysis, permits, and treatment required by the City of Winnipeg. Transportation and disposal of the spoil material is required to comply with all applicable laws and regulations. The Contractor will be required to obtain any and all necessary permits/approvals for the discharge of groundwater. Routine monitoring of groundwater discharge quality by the Contractor may be required during construction.

6.8 Frost Penetration

The depth of frost penetration will vary depending on air temperature, ground cover, the type of fill material used during development and other factors. The expected depth of frost penetration has been estimated assuming a design freezing index of 2680°C days, taken as the coldest winter over a ten (10) year period. The estimated maximum depth of frost penetration is 2.5 m assuming bare ground and no insulation cover.

7.0 CLOSURE

The geotechnical investigation conducted by KGS Group describes the underlying soil and groundwater conditions along the proposed alignment of the feeder main pipeline beneath the CPKC railway tracks at Mile 3.28 Glenboro Subdivision. This report presents the geotechnical engineer's best judgement of the subsurface and ground conditions anticipated to be encountered at the project site during construction. To develop this report, it was necessary to interpolate between the boreholes that were drilled at the site.

While the actual conditions encountered in the field are expected to be within the range of conditions discussed in this document, the spatial variability of subsurface and groundwater conditions that would be encountered at the site may be more complex than the simplified interpretation presented in this report.

To facilitate project design, certain assumptions were made with respect to the construction method and on the level of workmanship that can be reasonably expected for the installation of the pipelines. It should be noted that the Contractor's selected equipment, means and methods, and workmanship will influence the behaviour and performance of the subsurface soils encountered at the site.

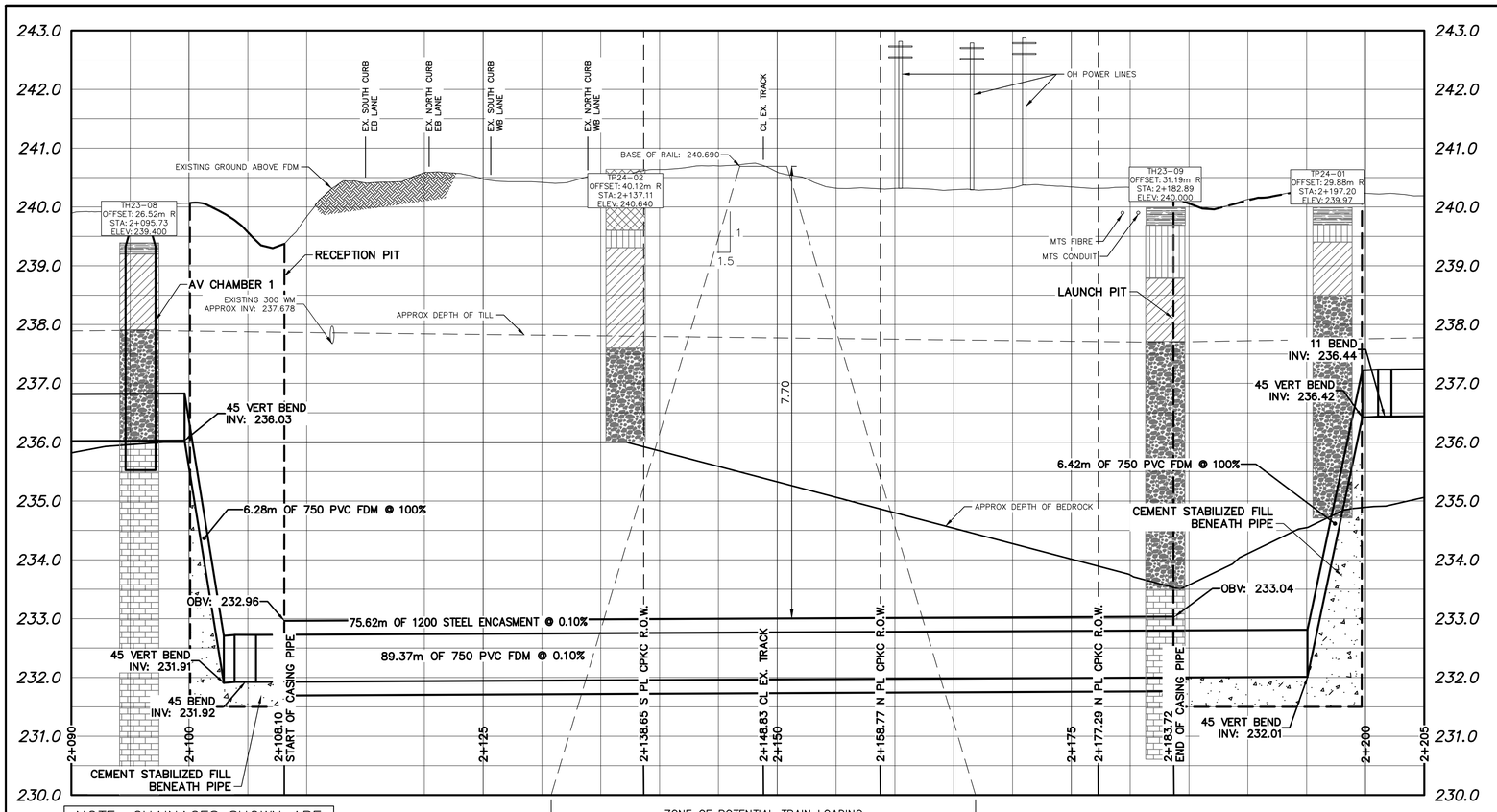
In accordance with CPKC's Geotechnical Protocol, full time inspection by qualified geotechnical personnel is recommended during construction to ensure that design intent is achieved, and to address any issues that may arise due to variability in soil conditions.

8.0 REFERENCES

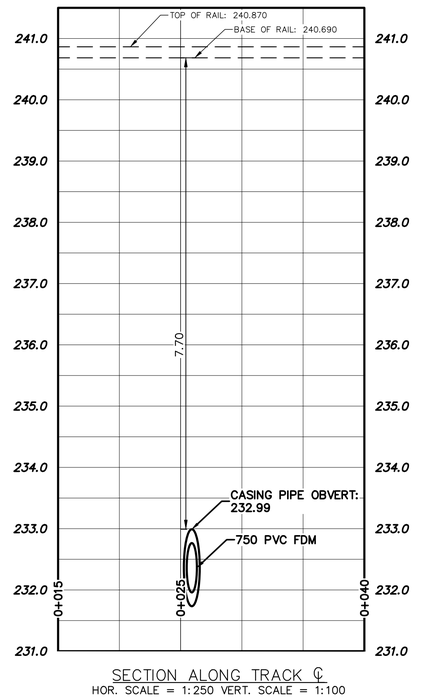
1. KGS Group, March 2024. CentrePort South Regional Water & Wastewater Servicing – Geotechnical Data Report – Final Rev 0.
2. KGS Group (2020). Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering, 2019/2020 Preliminary Geotechnical Investigation Report, Final Version 02. March 2020.
3. Department of Geological Engineering, the University of Manitoba, (1983). Geological Engineering Report for Urban Development of Winnipeg.

APPENDIX A

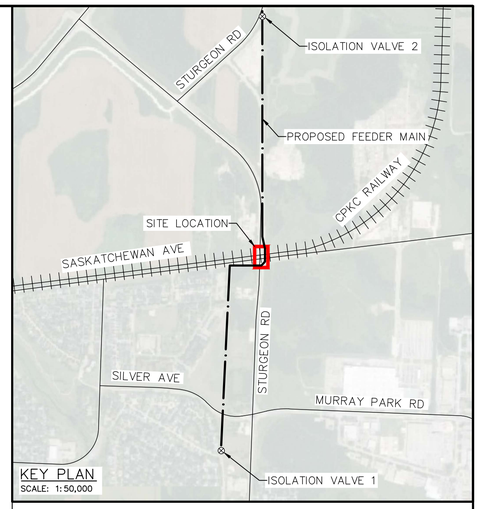
Detailed Design Crossing Drawings



NOTE: CHAINAGES SHOWN ARE ALONG STURGEON ROAD ℄



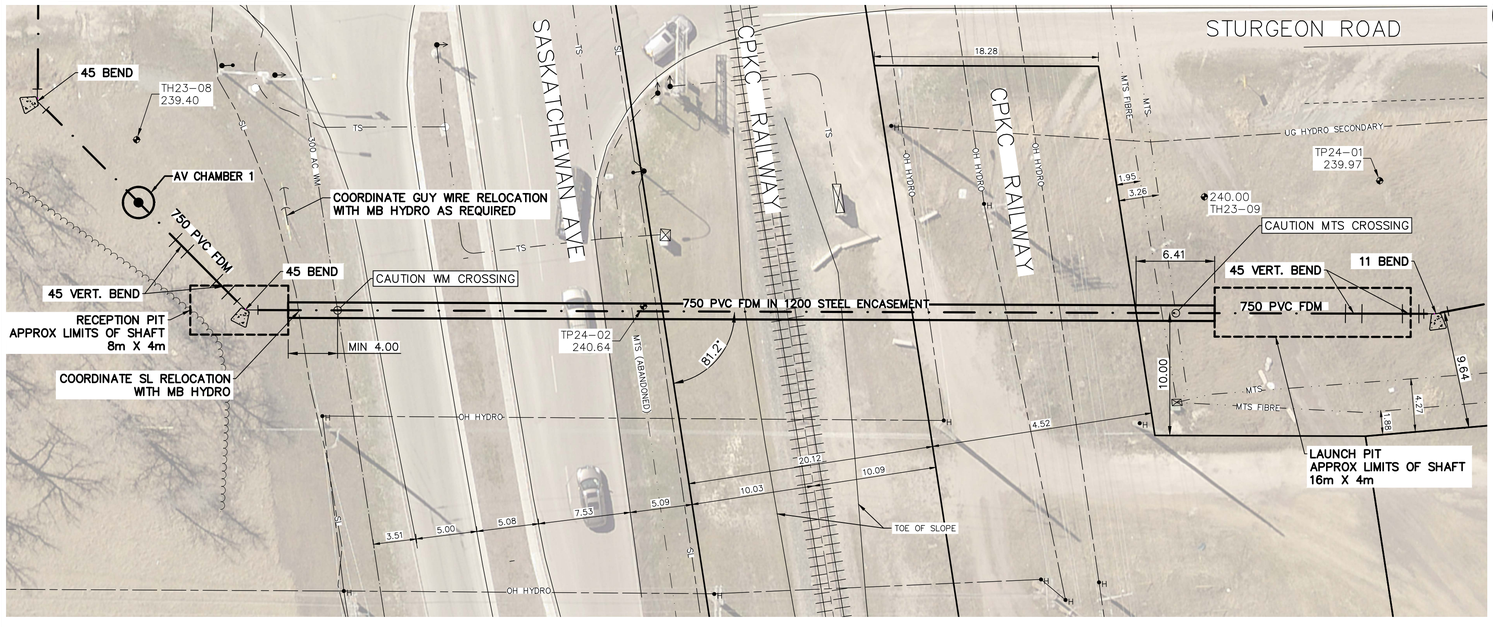
SECTION ALONG TRACK ℄
HOR. SCALE = 1:250 VERT. SCALE = 1:100



TEST HOLE LEGEND:

- ORGANICS
- CLAY
- FILL (MADE GROUND)
- TILL
- SILT
- BEDROCK

ISOLATION VALVE LOCATIONS		
DESCRIPTION	NORTHING	EASTING
ISOLATION VALVE 1	5528180.349	623562.266
ISOLATION VALVE 2	5530352.922	623769.632



GENERAL NOTES:
- ALL UTILITIES SHOWN ARE APPROXIMATE ONLY. LOCATIONS OF ALL UTILITIES TO BE CONFIRMED IN FIELD BY THE CONTRACTOR.
- THIS DRAWING DEPICTS THE DESIGN OF THE CASED CROSSING. FEEDER MAIN DESIGN ELEMENTS ARE SHOWN FOR INFORMATION ONLY.
- RAILWAY MILEAGE AND SUBDIVISION: MILE 3.28 GLENBORO SUBDIVISION.
- APPROXIMATE TILL AND BEDROCK PROFILES ARE INTERPOLATED FROM THE TEST HOLE DATA PROVIDED WITHIN THE GEOTECHNICAL REPORT.
- GEOTECHNICAL REPORT: CENTREPORT SOUTH REGIONAL WATER & WASTEWATER SERVICING PROJECT CPKC MILE 3.28 GLENBORO SUBDIVISION CROSSING GEOTECHNICAL REPORT (KGS GROUP MARCH 2024).
- CONTRACTOR TO CONFIRM BASE OF RAIL ELEVATION UPON LAYOUT OF THE WORKS.

TRENCHLESS NOTES:
- CASING WALL THICKNESS DESIGN BASED ON COOPER E90 TRACK LOADING.
- CARRIER PIPE TO BE SUPPORTED BY MANUFACTURED CASING SPACERS. CASING ENDS TO BE SEALED WITH MANUFACTURED NEOPRENE RUBBER END SEALS. REFER TO CIVIL DETAILS AND SPECIFICATIONS.
- CROSSING TO BE CONSTRUCTED, MAINTAINED AND OPERATED IN ACCORDANCE WITH TRANSPORT CANADA STANDARD TC E-10 AND THE LATEST EDITION OF CSA STANDARD Z662.
- WORKING PIT DIMENSIONS ARE APPROXIMATE. SUPPORT STRUCTURE DESIGNS ARE THE CONTRACTOR'S RESPONSIBILITY.
- SUPPORT STRUCTURES SHALL BE DESIGNED AND CERTIFIED BY A PROFESSIONAL ENGINEER LICENSED TO PRACTICE IN THE PROVINCE OF MANITOBA.
- SUPPORT STRUCTURES SHALL BE DESIGNED BASED ON THE SITE CONDITIONS, ANTICIPATED GROUND AND GROUNDWATER CONDITIONS, TRENCHLESS INSTALLATION EQUIPMENT AND THE RECOMMENDATIONS IN THE GEOTECHNICAL REPORT.

ENCASEMENT PIPE SPECIFICATION:
- OUTSIDE DIAMETER: 1219 mm
- PIPE MATERIAL: STEEL
- SPECIFICATION AND GRADE: ASTM A252 GR2 (241 MPa SMYS)
- WALL THICKNESS: 19.1 mm
- PROTECTION: N/A
- JOINT: WELDED (CJP GROOVE WELDS)
- INSTALLATION METHOD: DOWN THE HOLE HAMMER (DTH) OR MICROTUNNELLING

CARRIER PIPE SPECIFICATION:
- CONTENTS: POTABLE WATER
- NOMINAL DIAMETER: 750 mm
- PIPE MATERIAL: PVC
- SPECIFICATION: AWWA C900
- DIMENSION RATIO: DR 18
- OPERATING PRESSURE: 483 kPa (70 PSI)
- SURGE/TEST PRESSURE: 1000 kPa (145 PSI)
- JOINT: RESTRAINED (EXTERNAL BELL HARNESS)

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Associated Engineering (Sask) Ltd.
No. 396 Date: 03/26/2024

METRIC
WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

0 5.0 10.0 15.0 20.0m
SCALE: 1:250

PROPERTY LIMITS DELINEATION

DELINEATION OF PROPERTY LIMITS AS SHOWN ON THIS DWG DOES NOT REPRESENT A "LEGAL SURVEY". KGS GROUP AND ASSOCIATED ENGINEERING MAKES NO REPRESENTATION OR WARRANTY AS TO THE ACCURACY OF PROPERTY LIMITS DELINEATED ON THIS DWG, NOR ON THE DIMENSIONAL ACCURACY OF DWG FEATURES RELATIVE TO THOSE PROPERTY LIMITS.

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.

VERTICAL DATUM: CGVD28 (HT2.0 Geoid)
HORIZONTAL DATUM: NAD83 (June 1990), Zone 14

NO.	REVISIONS	DATE (YYYY/MM/DD)	BY
A	ISSUED FOR CPKC APPROVAL	24/03/25	GH

KGS GROUP | Associated Engineering

DESIGNED BY	CL	CHECKED BY	RBO
DRAWN BY	GTH	APPROVED BY	JL
SCALE: HORIZONTAL	1:250	RELEASED FOR CONSTRUCTION	
VERTICAL	1:100		
DATE	2024 03 25	DATE	

PLOT DATE: 2024 03 25

ENGINEER'S SEAL
PROVINCE OF MANITOBA
J. S. LOEKE
Member
36827
REGISTERED PROFESSIONAL ENGINEER
2024-Mar-26

CONSULTANT DRAWING NUMBER
C-4A-115

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT
ENGINEERING DIVISION

CENTREPORT SOUTH REGIONAL WATER AND WASTEWATER SERVICING – PHASE 1A CONTRACT 4A – FEEDER MAIN

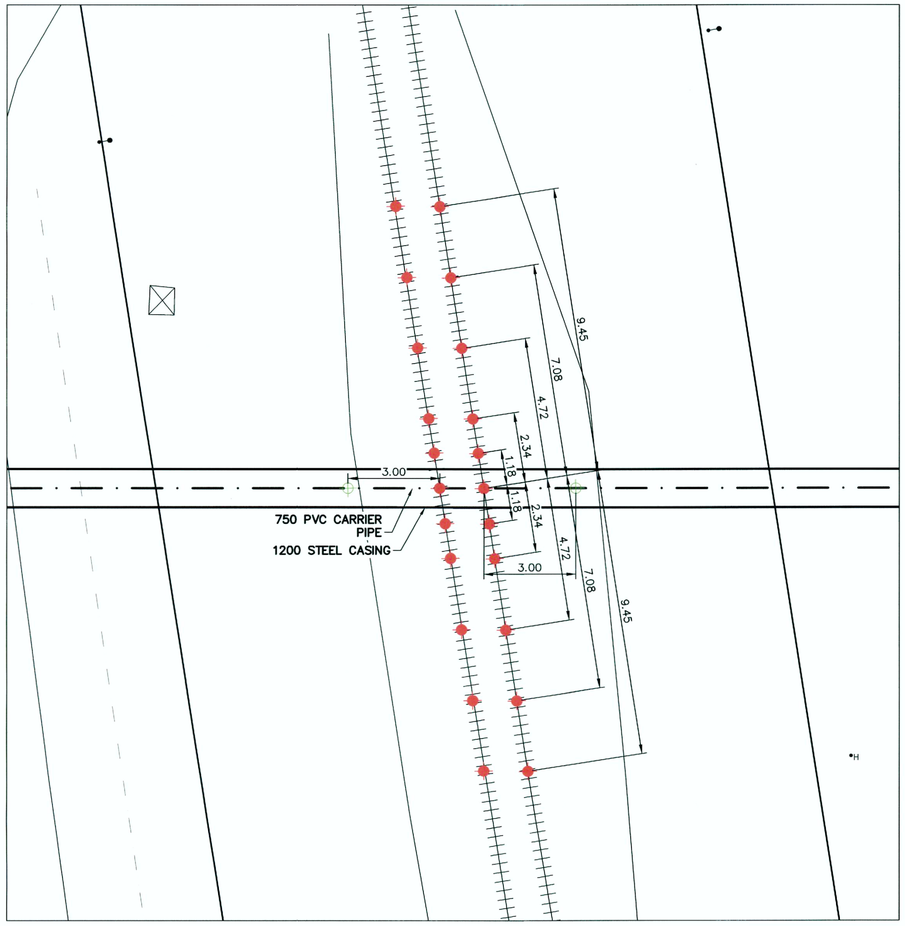
STURGEON ROAD SOUTH
CPKC RAILWAY MILE 3.28 GLENBORO SUBDIVISION CROSSING

SHEET 18 OF 30

CITY DRAWING NUMBER
1-0798C-C0001-001

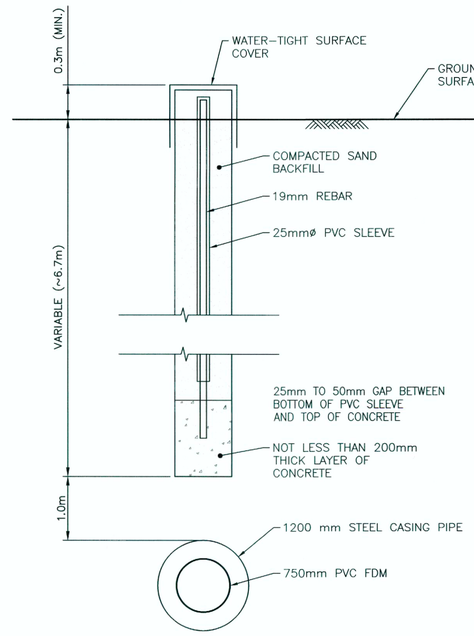
BID OPP: 220-2024
CONTRACT NUMBER: 4A

FILE PATH: U:\FMS\23-0107-009\
FILE NAME: 23-0107-009_C4A_Feedermain_CALL.dwg



SUB-SURFACE MONITORING POINTS TO BE INSTALLED TO 1m ABOVE CASING OBVERT IN ACCORDANCE WITH CPKC GEOTECHNICAL PROTOCAL FIGURE B.

TRACK MONITORING PLAN
SCALE = 1:100



SUB-SURFACE MONITORING POINT INSTALLATION DETAIL
SCALE = NTS

TRACK MONITORING:
- MONITOR RAIL TRACK IN ACCORDANCE WITH TRACK MONITORING PLAN, SEE SPECIFICATIONS.
- SETTLEMENT MONITORING THRESHOLDS:
  CRITICAL/REVIEW THRESHOLD: >19 mm
  ALERT/WARNING THRESHOLD: >10 mm
- SETTLEMENT MONITORING OF THE RAIL TRACK SHALL COMMENCE A MINIMUM OF 2 DAYS PRIOR TO CONSTRUCTION/EXCAVATION TO ESTABLISH BASELINE COORDINATES AND ELEVATIONS.
- MONITORING POINTS SHOULD BE SURVEYED AT LEAST TWICE PER DAY DURING THE DURATION OF CONSTRUCTION AND AT LEAST 3 DAYS AFTER THE COMPLETION OF CONSTRUCTION.
- SURVEY RESULTS SHALL BE SUBMITTED DAILY TO GEOTECHNICAL ENGINEER AND CPKC FOR REVIEW.

LEGEND:
- SURFACE MONITORING LOCATION
- SUB-SURFACE MONITORING LOCATION

METRIC
WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

PROPERTY LIMITS DELINEATION
DELINEATION OF PROPERTY LIMITS AS SHOWN ON THIS DWG DOES NOT REPRESENT A "LEGAL SURVEY". KGS GROUP MAKES NO REPRESENTATION OR WARRANTY AS TO THE ACCURACY OF PROPERTY LIMITS DELINEATED ON THIS DWG, NOR ON THE DIMENSIONAL ACCURACY OF DWG FEATURES RELATIVE TO THOSE PROPERTY LIMITS.

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.

VERTICAL DATUM: CGVD28 (HT2.0 Geoid)
HORIZONTAL DATUM: NAD83 (June 1990), Zone 14

NO.	REVISIONS	DATE (YYYY/MM/DD)	BY
A	ISSUED FOR CPKC APPROVAL	24/03/25	GH

KGS GROUP

DESIGNED BY	KF	CHECKED BY	DAA
DRAWN BY	GTH	APPROVED BY	KF
SCALE: HORIZONTAL	AS NOTED	RELEASED FOR CONSTRUCTION	
VERTICAL	AS NOTED		
DATE	2024 03 26	DATE	

PLOT DATE: 2024 03 26

ENGINEER'S SEAL
PROVINCE OF MANITOBA
A.B. FORDYCE
Member
38388
2024/03/26
REGISTERED PROFESSIONAL ENGINEER

CONSULTANT DRAWING NUMBER
C-4A-116

BID OPP: 220-2024
CONTRACT NUMBER: 4A

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
KGS Group
No. 245

Winnipeg
THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT
ENGINEERING DIVISION

CENTREPORT SOUTH REGIONAL WATER AND WASTEWATER SERVICING – PHASE 1A CONTRACT 4A – FEEDER MAIN
STURGEON ROAD SOUTH
CPKC RAILWAY MILE 3.28 GLENBORO SUBDIVISION CROSSING – SETTLEMENT MONITORING

SHEET 19 OF 30
CITY DRAWING NUMBER
1-0798C-C0002-001

FILE PATH: U:\FMS\23-0107-009\
FILE NAME: 23-0107-009_C4A_Feedermain_CALL.dwg

APPENDIX B

2023/2024 Geotechnical Investigation Borehole and Test Pit Logs

KGS GROUP

TEST HOLE LOG

HOLE NO.
TH23-08

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-009
PROJECT	**CentrePort Regional S&W Servicing**	**SURFACE ELEV.**	239.40 m
LOCATION	Winnipeg, Manitoba	**START DATE**	9-26-2023
DESCRIPTION	South side Saskatchewan Ave Rail Crossing	**UTM (m)**	N 5,529,096
DRILL RIG / HAMMER	GeoProbe 3230 Track Mounted Drill Rig with Auto-Hammer		E 623,757 Zone 14
METHOD(S)	0.0 m to 3.0 m: 125 mm ø SSA		
	3.0 m to 9.4 m: Water Rotary HQ Core - switched due to encountering suspected bedrock		

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	SAMPLE TYPE	NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)	BLOWS/0.15 m	N-VALUE	PL MC LL; Cu TORVANE (kPa) ◆; qu POCKET PEN (kPa) ★; SPT (N) BLOWS/0.30 m ▲ (20 40 60 80)
239				**TOPSOIL/ORGANICS** - 152 mm, Grey and black, dry, trace to some organics.	239.2								
	1.0			**CLAY (CH)** - Grey, dry, hard, high plasticity, trace silt and gypsum pockets, trace fine gravel.									★ 450
238		5			237.9			S1					★ 450
	2.0			**SILT TILL (ML)** - Light grey, dry to damp, dense, with fine to coarse grained sand, with fine grained gravel, trace to some clay.									★ 450
237				- PSA: 25% gravel, 30% sand, 35% silt, 10% clay at 2.7 m.				S2					●
	3.0	10		- Very dense below 3.0 m.	236.0			S3	67		8 50/ 80mm	+100	>> ▲
236				**DOLOMITE** - Mottled yellow-white, fine grained, massive, trace vugs, very strong.									
	4.0			- Fair quality from 3.4 m to 4.9 m. - UCS: 66.1 MPa at 4.0 m.				R1	65	72 (8)			
235		15		- No water return at 4.3 m.									
	5.0			- Good quality from 4.9 m to 6.4 m. - Highly fractured and broken lost core zone from 4.9 m to 5.0 m.	234.4								
234				**ARGILLACEOUS DOLOMITE** - Mottled reddish-gray to green, fine grained, fossiliferous, moderately strong. - UCS: 73.7 MPa at 5.1 m.				R2	70	79 (2)			
	6.0	20		- Lost core zone from 6.4 m to 7.5 m. - Poor quality from 6.4 m to 7.9 m.									
233								R3	38	27 (3)			
	7.0			- Increased shale content from 7.5 m to 8.5 m.									
232		25		- Good quality below 7.9 m. - ~ 30 mm thick soft shale seam at 8.0 m.									
	8.0			- Decreased shale content, increased porosity, very strong below 8.5 m. - Increased joint frequency below 8.5 m.				R4	95	79 (12)			
231													
	9.0	30			230.0								
230				Notes: 1. End of test hole at 9.4 m. 2. Refusal encountered on suspected bedrock at a depth of 3.0 m. 3. Test hole backfilled with auger cuttings and bentonite chips.									
	10.0												
229		35											
	11.0												
228													

WATER LEVELS
- ▽ **During Drilling/Digging** — on 9-27-2023 None Encountered
- ▼ **Upon Completion** — on 9-27-2023 None Encountered

CONTRACTOR: **Maple Leaf Drilling Ltd.**
INSPECTOR: **M. RODRIGUEZ**
APPROVED: K. FORDYCE
DATE: 1-22-2024

KGS_LOG_C:\USERS\KFORDYCE\DESKTOP\FMS\23-0107-009\23-0107-009_CENTREPORT_SEPT 26 TO 29_2023.GPJ

KGS GROUP

TEST HOLE LOG

HOLE NO.
TH23-09

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-009
PROJECT	**CentrePort Regional S&W Servicing**	**SURFACE ELEV.**	240.00 m
LOCATION	Winnipeg, Manitoba	**TOC STICK-UP / ELEV.**	0.91 m / 240.91 m (Standpipe)
DESCRIPTION	North side Saskatchewan Ave Rail Crossing	**START DATE**	9-25-2023
DRILL RIG / HAMMER	GeoProbe 3230 Track Mounted Drill Rig with Auto-Hammer	**UTM (m)**	N 5,529,183
METHOD(S)	0.0 m to 5.3 m: 125 mm ø SSA		E 623,764 Zone 14
	5.3 m to 9.8 m: Water Rotary HQ Core - switched due to encountering suspected bedrock		

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)
				TOPSOIL/ORGANICS - 305 mm, Black, damp, with organics and roots.	239.7
				SILT (ML) - Light brown, dry to damp, firm, non-plastic, trace sand.	238.8
239	1.0			**CLAY (CH)** - Dark brown, moist, stiff, high plasticity, some silt pockets, trace fine to coarse grained gravel.	
		5		- Hard drilling below 2.0 m.	237.7
238	2.0			**SILT TILL (CL)** - Light brown, moist, dense, low plasticity, with fine to coarse grained sand, some fine grained gravel, some clay.	
237	3.0	10			
236	4.0				
		15		- LL=27, PL=14, PI=13 at 4.4 m. - PSA: 17% gravel, 26% sand, 42% silt, 15% clay at 4.4 m.	
235	5.0			- Some coarse grained gravel, trace cobbles below 4.9 m. - Loss of return water, 15 cm granite boulder in sampler at 5.3 m.	
234	6.0	20			233.5
233	7.0			**ARGILLACEOUS DOLOMITE** - Mottled green-red, fine grained, fossiliferous, strong. - Very poor quality from 6.5 m to 9.4 m. - Increased shale content on joint faces below 6.5 m. - Highly fractured and broken lost core zones below 6.6 m. - No water return during run at 7.9 m.	
		25			
232	8.0				
		30			
231	9.0			- Reddish-purple, increased fossils, strong below 9.1 m.	230.6
230	10.0	35			
229	11.0				

LOG OF INSTALLS

DIAGRAM	DEPTH (m)
	5.79
	6.10
	9.14
	9.45

SAMPLE TYPE	NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)	BLOWS/0.15 m	N-VALUE
	S1				
	S2				
	S3				
	S4	77		19 34 50/ 130mm	+100
	S5				
	S6				
	R1	37	14 (10)		
	R2	42	0 (10)		
	R3	43	18 (2)		

PL MC LL

Cu TORVANE (kPa) ◆

qu POCKET PEN (kPa) ★

SPT (N) BLOWS/0.30 m ▲

20 40 60 80

250 ★

>> ▲

300 ★

425 ★

425 ★

Notes:
1. End of test hole at 9.8 m.
2. Refusal encountered on boulder or bedrock at a depth of 5.3 m.
3. Protective well cover installed at surface.
4. 25.4 mm or one (1) inch diameter standpipe installed.

WATER LEVELS

▽	**During Drilling/Digging**	on 9-27-2023 None Encountered
▼	**Upon Completion**	on 9-27-2023 None Encountered

CONTRACTOR **Maple Leaf Drilling Ltd.**

INSPECTOR **G. GITZEL**

APPROVED K. FORDYCE

DATE 1-22-2024

KGS_LOG_C:\USERS\KFORDYCE\DESKTOP\FMS\23-0107-009\23-0107-009_CENTREPORT_SEPT 26 TO 29_2023.GPJ

KGS GROUP

TEST PIT LOG

HOLE NO.
TP24-01

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-009
PROJECT	**CentrePort Regional S&W Servicing**	**SURFACE ELEV.**	239.97 m
LOCATION	Winnipeg, Manitoba	**START DATE**	2-21-2024
DESCRIPTION	Approx 15 m North of TH23-09	**UTM (m)**	N 5,529,197.34
EXCAVATOR	CAT 320 Excavator		E 623,763.07 Zone 14
METHOD(S)			

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	SAMPLE TYPE	NUMBER
				TOPSOIL - Black, frozen, with grass and rootlets.	239.7			
				SILT - Light brown, non-plastic, frozen.	239.4			S1
239	1.0			**CLAY** - Brown, damp, stiff, low plasticity, some silt.				S2
		5			238.5			S3
238	2.0			**SILT TILL** - Light brownish grey, dry, dense, low plasticity, some gravel, some sand, some clay, trace cobbles/boulders. - Increased gravel, cobbles/boulders. Average boulder size of 380 mm and maximum size of 560 mm below 2.0 m.				S4
237	3.0	10						S5
236	4.0							S6
		15						
235	5.0			- Silt till mixed with weathered bedrock at 4.9 m.	234.9	▼		
				BEDROCK - Reddish brown, argillaceous, brittle.	234.7			S7
234	6.0	20		Notes: 1. End of test pit at 5.3 m. 2. Refusal encountered on boulder or bedrock at a depth of 5.1 m. 3. Test pit backfilled with excavated material.				
233	7.0							
		25						
232	8.0							
231	9.0	30						
230	10.0							

PL MC LL
Cu TORVANE (kPa) ◆
qu POCKET PEN (kPa) ★
SPT (N) BLOWS/0.30 m ▲
20 40 60 80

WATER LEVELS ▼ **Upon Completion** 5.10 m Dry

CONTRACTOR **J CON Civil**	INSPECTOR **L. PROVEN**
APPROVED K. FORDYCE	DATE 2-29-2024

KGS_LOG_C:\USERS\KFORDYCE\DESKTOP\FMS\23-0107-009\CENTREPORT TESTPITS.GPJ

KGS GROUP

TEST PIT LOG

HOLE NO.
TP24-02

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-009
PROJECT	**CentrePort Regional S&W Servicing**	**SURFACE ELEV.**	240.64 m
LOCATION	Winnipeg, Manitoba	**START DATE**	2-22-2024
DESCRIPTION	North Shoulder of Saskatchewan Ave outside CPKC ROW	**UTM (m)**	N 5,529,137.29
EXCAVATOR	CAT 320 Excavator		E 623,771.87 Zone 14
METHOD(S)			

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	SAMPLE TYPE	NUMBER
240				**CLAY FILL** - Black, topsoil at ground surface, frozen, trace rootlets.				
	1.0				239.6			
				SILT - Light brown, dry, low plasticity, some clay.	239.3			S1
239		5		**CLAY** - Brown, damp, hard, low plasticity, with silt.				
	2.0							S2
238								
	3.0	10			237.6			
				SILT TILL - Light grey, damp, dense, low plasticity, and clay, some gravel, some sand, trace cobbles/boulders.				S3
237				- Trace clay. Sedimentary/Igneous boulders (maximum size of 600 mm) encountered below 3.5 m.				S4
	4.0							
236		15			236.0	▼		
				BEDROCK - Mottled yellow grey dolomite, hard, strong.				S5
	5.0				235.6			
235								
	6.0	20						
234								
	7.0							
233		25						
	8.0							
232								
	9.0	30						
231								
	10.0							

PL MC LL
Cu TORVANE (kPa) ◆
qu POCKET PEN (kPa) ★
SPT (N) BLOWS/0.30 m ▲
20 40 60 80

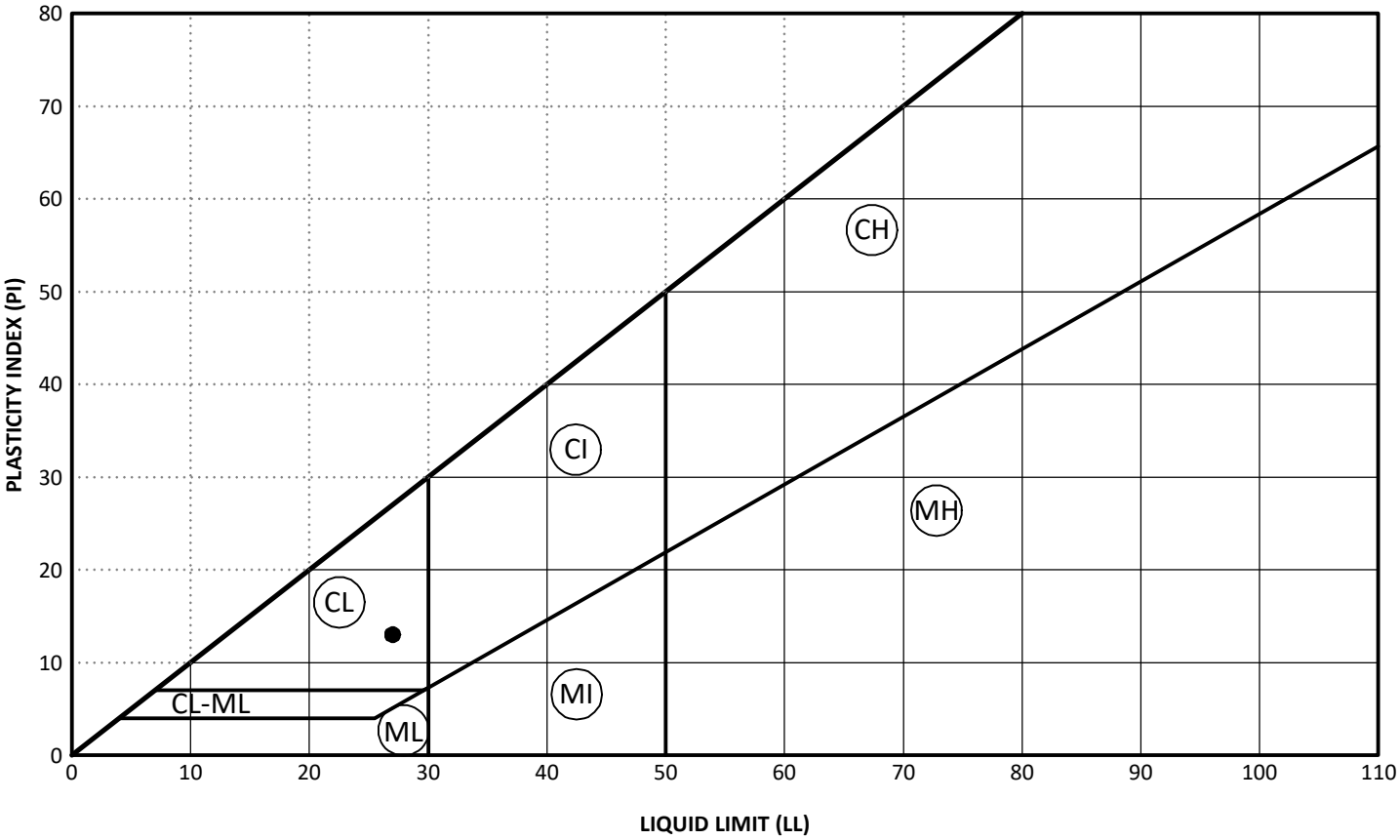
Notes:
1. End of test pit at 5.0 m.
2. Refusal encountered on boulder or bedrock at a depth of 4.6 m.
3. Test pit backfilled with excavated material.

WATER LEVELS ▼ **Upon Completion** 4.60 m Dry

CONTRACTOR **J CON Civil**	INSPECTOR **L. PROVEN**
APPROVED K. FORDYCE	DATE 2-29-2024

KGS_LOG_C:\USERS\KFORDYCE\DESKTOP\FMS\23-0107-009\CENTREPORT TESTPITS.GPJ

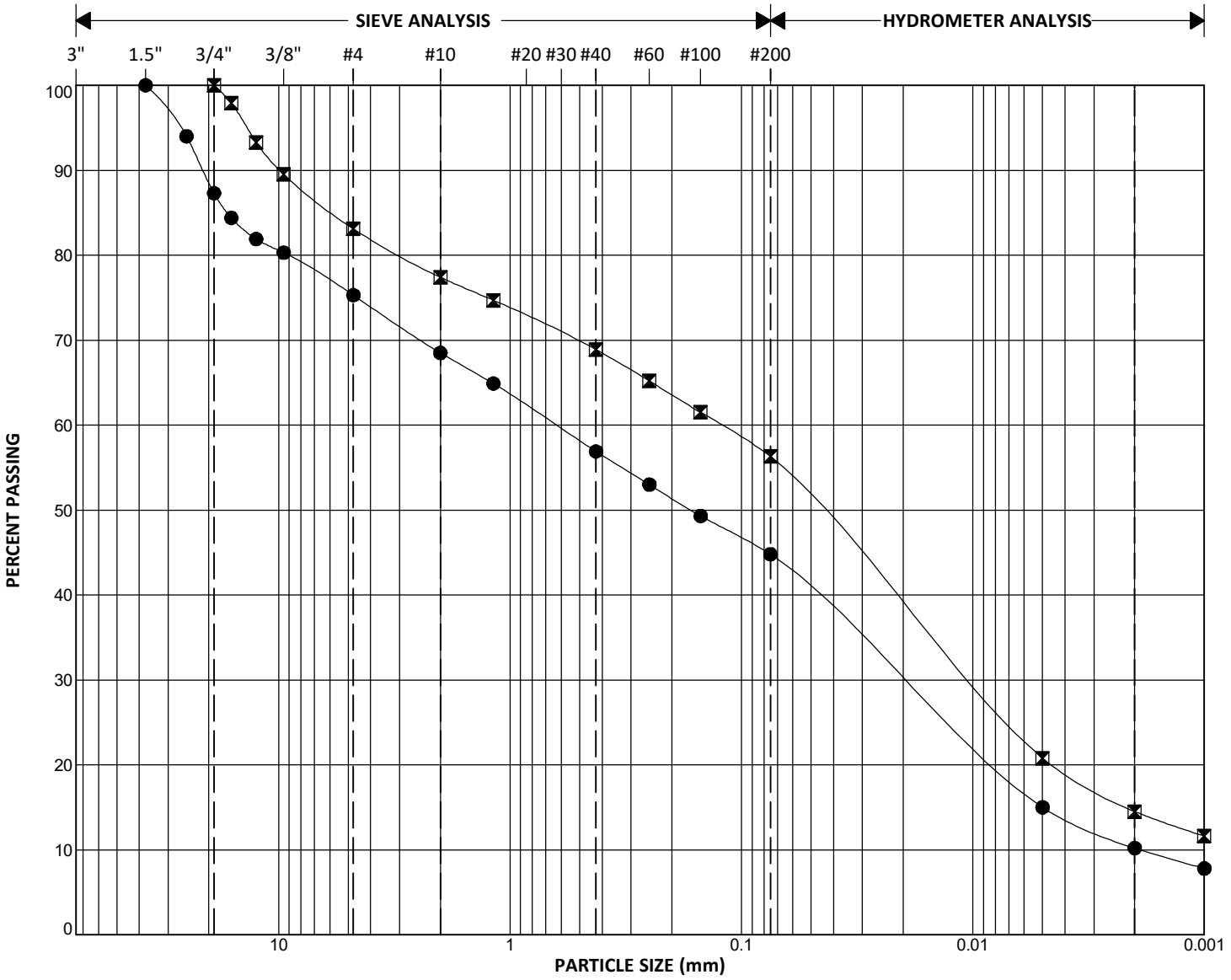
ATTERBERG LIMITS



	HOLE	DEPTH (m)	SAMPLE #	LL	PL	PI	SAND (%)	SILT (%)	CLAY (%)	SILT & CLAY (%)	MC (%)	CLASSIFICATION
●	TH23-09	4.4		27	14	13	27	42	15	56	11	CL

KGS GROUP	**CLIENT**	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-009
	PROJECT NAME	CentrePort Regional S&W Servicing	**LOCATION**	Winnipeg, Manitoba
	TESTED BY	Stantec	**DATE TESTED**	10/24/2023

GRAIN SIZE DISTRIBUTION



GRAVEL		SAND			SILT	CLAY
coarse	fine	coarse	medium	fine		

	HOLE	DEPTH (m)	SAMPLE #	GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	SILT & CLAY (%)	Cu	Cc	CLASSIFICATION
●	TH23-08	2.7		25	30	35	10	45	334.42	0.32	
⊠	TH23-09	4.4		17	27	42	15	56			CL

SIEVE ANALYSIS C:\USERS\KFORDYCE\DESKTOP\FMS\23-0107-009\23-0107-009_CENTREPORT_SEPT 26 TO 29, 2023.GPJ

KGS GROUP

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-009
PROJECT NAME	CentrePort Regional S&W Servicing	**LOCATION**	Winnipeg, Manitoba
TESTED BY	Stantec	**DATE TESTED**	10/26/2023

KEY TO SYMBOLS

LITHOLOGIC SYMBOLS


Clay (CH, high plasticity)


Dolomite


Dolomite Shaley


Fill


Limestone


Silt (MH)


Silt (ML)


Silt Till


No Recovery


Organics


Silt Till


Topsoil

SAMPLER SYMBOLS


Auger Grab


Core Barrel


SPT Split Spoon

WELL CONSTRUCTION SYMBOLS


Sand Backfill


Standpipe (bentonite pellets)


Standpipe (cement/bentonite grout)


Standpipe (filter sand)


Screen (filter sand)

ABBREVIATIONS

LL - Liquid Limit
PL - Plastic Limit
PI - Plastic Index
MC - Moisture Content
DD - Dry Density
NP - Non-Plastic
-200 - Percent Passing No. 200 Sieve
TV - Torvane (kPa)
PP - Pocket Penetrometer (kPa)
PSA - Particle Size Analysis
TOC - Top Of Casing

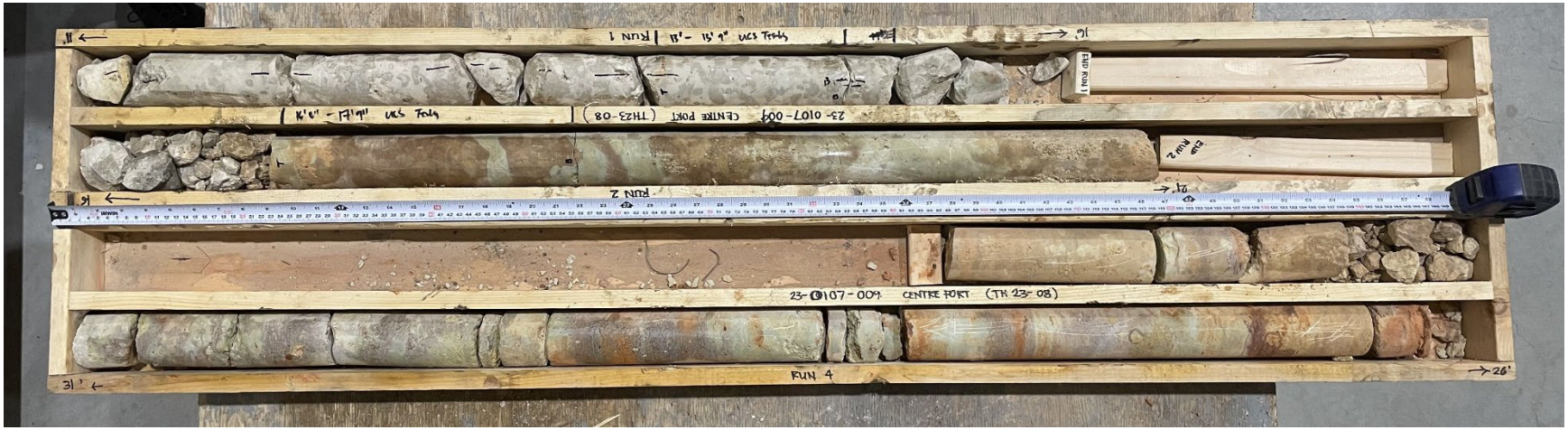
PN - Pneumatic Piezometer
VW - Vibrating Wire Piezometer
PID - Photoionization Detector
ppm - Parts Per Million
▽ Water Level During Drilling
▼ Water Level Upon Completion of Drilling
▼ Water Level Remeasured/Static

KGS GROUP

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT **PROJECT NO.** 23-0107-009
PROJECT NAME CentrePort Regional S&W Servicing **LOCATION** Winnipeg, Manitoba

APPENDIX C

2023/2024 Select Drilling and Test Pit Photos



TH23-08 Photo 1: Bedrock Core, 5 m to 9.45 m (16 ft-5 in to 31 ft)

TH23-09 Photo 1: 0 to 1.5 m (0 to 5 ft)

TH23-09 Photo 2: 1.5 m to 3.0 m (5 ft to 10 ft)

TH23-09 Photo 3: SPT at 3.0 m (10 ft)

TH23-09 Photo 4: 3.0 m to 4.5 m (10 ft to 15 ft)

TH23-09 Photo 5: 4.5 m to 5.25 m (15 ft to 17 ft-3 in)

TH23-09 Photo 6: Bedrock Core, 6.45 m to 9.75 m (21 ft-3 in to 32 ft)

TP24-01 Photo 1: Completed test pit to 5.1 m

TP24-01 Photo 2: Clay -rich Silt Till

TP24-01 Photo 3: Silt Till with Higher Gravel Content

TP24-01 Photo 4: Boulders from Silt Till

TP24-01 Photo 5: Sedimentary Boulder (22 inches)

TP24-01 Photo 6: Igneous Boulder (22 inches)

TP24-01 Photo 7: Sedimentary Boulder

TP24-01 Photo 8: Reddish Brown Argillaceous Bedrock at 5.1 m.

TP24-02 Photo 1: Top of bedrock encountered at 4.6 m

TP24-02 Photo 2: Cobbles and Boulders from silt till

TP24-02 Photo 3: Boulder from silt till (22 inches)

TP24-02 Photo 4: Boulders from silt till (16 inches)

TP24-02 Photo 5: Boulder from silt till (24 inches)

TP24-02 Photo 6: Igneous boulder in silt till

APPENDIX D

2023 Geotechnical Laboratory Testing Results

Stantec Consulting Ltd.
199 Henlow Bay, Winnipeg, MB R3Y 1G4
Tel: (204) 488-6999

ASTM D2216 - LABORATORY DETERMINATION OF WATER (MOISTURE) CONTENT OF SOIL AND ROCK BY MASS

TO KGS Group Inc.
3rd Floor - 865 Waverley Street
Winnipeg, Manitoba
R3T 5P4

ATTN: Grace Gitzel

PROJECT CentrePort AAW Regional S&W Servicing (23-0107-009)

PROJECT NO. 123316822

REPORT NO. 1

DATE SAMPLED: 2023.Sep.25
SAMPLED BY: KGS Group Inc.

DATE RECEIVED: 2023.Oct.20
SUBMITTED BY: KGS Group Inc.

DATE TESTED: 2023.Oct.20
TESTED BY: Larry Presado

TESTHOLE	SAMPLE	MC %
TH23-01	S3	45.5
	S5	29.5
	S6	9.3
	S8	9.3
	S10	8.3
TH23-08	S1	20.8
	S2	7.9
TH23-09	S1	11.9
	S3	9.8
	S4	9.2
	S5	10.7
TH23-20	S3	20.0
	S5	45.6
	S6	29.3
	S8	42.9

REPORT DATE 2023.Oct.27

REVIEWED BY Guillaume Beauce, P.Eng.
Geotechnical Engineer - Materials Testing Services

Stantec Consulting Ltd.
199 Henlow Bay, Winnipeg, MB R3Y 1G4
Tel: (204) 488-6999

ASTM D4318 - LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS (LL METHOD A - MULTIPOINT)

TO KGS Group Inc.
3rd Floor - 865 Waverley Street
Winnipeg, Manitoba
R3T 5P4

ATTN: Grace Gitzel

PROJECT CentrePort AAW Regional S&W Servicing (23-0107-009)

PROJECT NO. 123316822

REPORT NO. 2

DATE SAMPLED: 2023.Sep.25
SAMPLED BY: KGS Group Inc.

DATE RECEIVED: 2023.Oct.20
SUBMITTED BY: KGS Group Inc.

DATE TESTED: 2023.Oct.26
TESTED BY: Larry Presado

SAMPLE ID: TH23-09, S5, 14.5'-15'

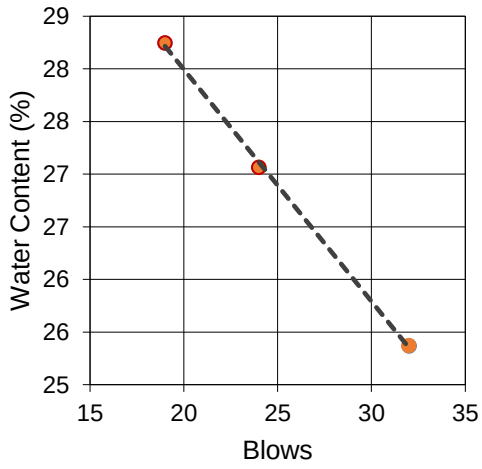
LIQUID LIMIT

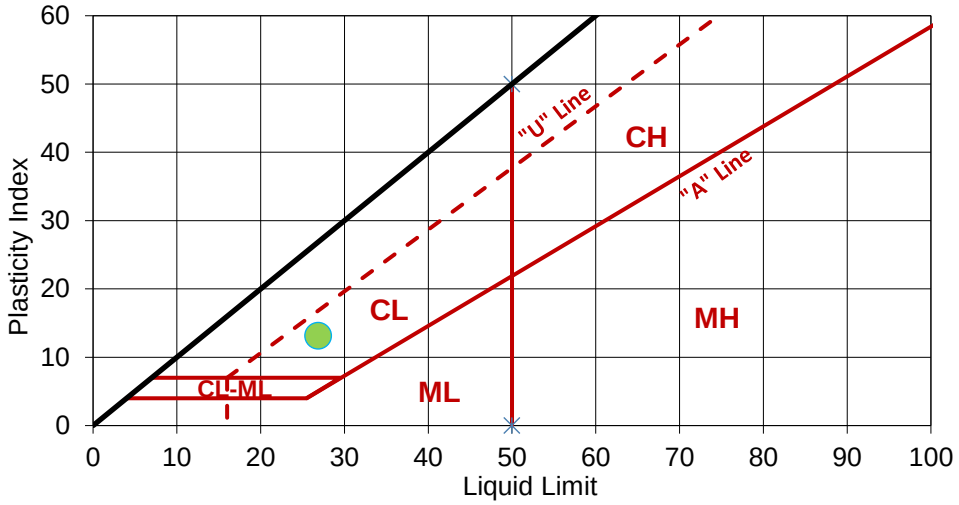
TRIAL	1	2	3
BLOWS	32	24	19
MC (%)	25	27	28

PLASTIC LIMIT

TRIAL	1	2
MC (%)	14	14

LIQUID LIMIT, LL	27
PLASTIC LIMIT, PL	14
PLASTICITY INDEX, PI	13
AS REC'D MC (%)	10.7





COMMENTS:

REPORT DATE 2023.Oct.27

REVIEWED BY Guillaume Beauce, P.Eng.
Geotechnical Engineer - Materials Testing Services

Stantec Consulting Ltd.
199 Henlow Bay, Winnipeg, MB R3Y 1G4
Tel: (204) 488-6999

AASHTO T88 (ASTM D422) - PARTICLE-SIZE ANALYSIS OF SOILS

TO KGS Group Inc.
3rd Floor - 865 Waverley Street
Winnipeg, Manitoba
R3T 5P4

ATTN: Grace Gitzel

PROJECT CentrePort AAW Regional S&W Servicing (23-0107-009)

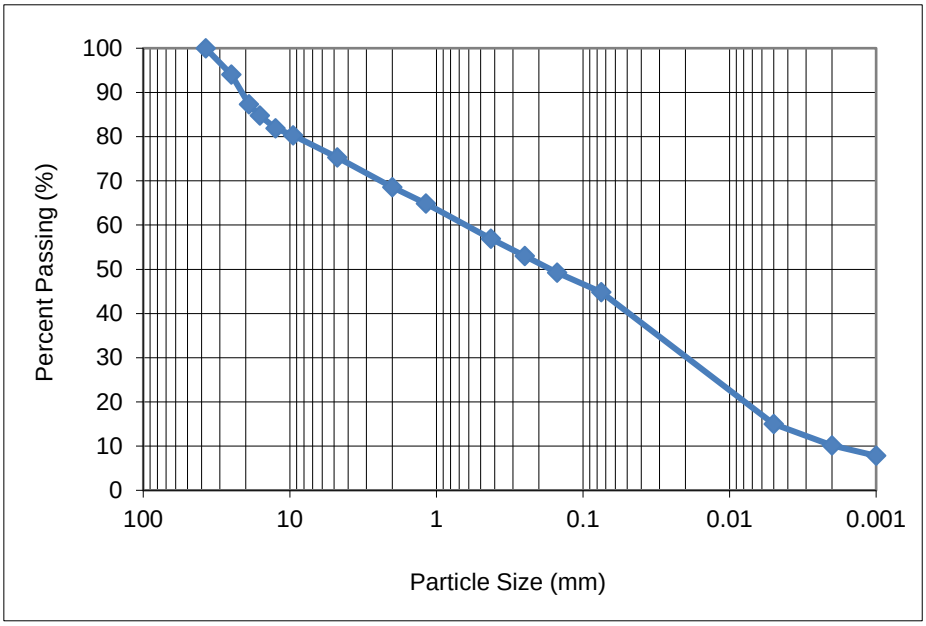
PROJECT NO. 123316822

REPORT NO. 2

DATE SAMPLED: 2023.Sep.26
SAMPLED BY: KGS Group Inc.

DATE RECEIVED: 2023.Oct.20
SUBMITTED BY: KGS Group Inc.

DATE TESTED: 2023.Oct.24
TESTED BY: Larry Presado



SIEVE SIZE (mm)	% PASSING
37.5	100.0
25.0	94.0
19.0	87.3
16.0	84.8
12.5	81.9
9.5	80.3
4.75	75.3
2.00	68.5
1.18	64.9
0.425	56.9
0.250	53.0
0.150	49.3
0.075	44.8
0.005	15.0
0.002	10.2
0.001	7.8

Gravel	Sand			Silt	Clay	Colloids
	Coarse	Medium	Fine			
24.7	6.8	11.6	12.1	34.6	10.2	7.8

COMMENTS:
Material tested was identified as TH23-08, S2, 10'-11'.

REPORT DATE 2023.Oct.27

REVIEWED BY Guillaume Beauce, P.Eng.
Geotechnical Engineer - Materials Testing Services

Stantec Consulting Ltd.
199 Henlow Bay, Winnipeg, MB R3Y 1G4
Tel: (204) 488-6999

AASHTO T88 (ASTM D422) - PARTICLE-SIZE ANALYSIS OF SOILS

TO KGS Group Inc.
3rd Floor - 865 Waverley Street
Winnipeg, Manitoba
R3T 5P4

ATTN: Grace Gitzel

PROJECT CentrePort AAW Regional S&W Servicing (23-0107-009)

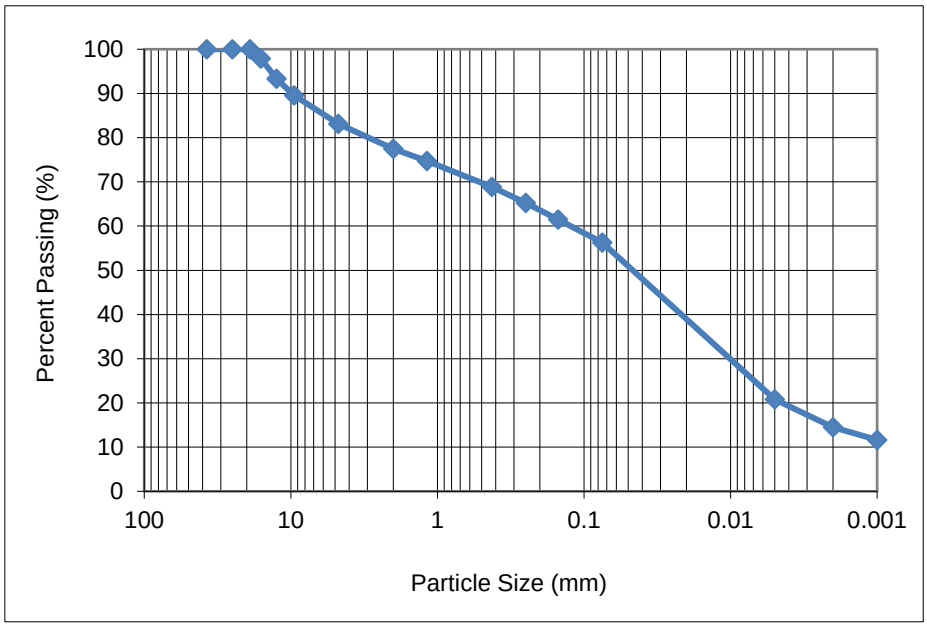
PROJECT NO. 123316822

REPORT NO. 3

DATE SAMPLED: 2023.Sep.25
SAMPLED BY: KGS Group Inc.

DATE RECEIVED: 2023.Oct.20
SUBMITTED BY: KGS Group Inc.

DATE TESTED: 2023.Oct.24
TESTED BY: Larry Presado



SIEVE SIZE (mm)	% PASSING
37.5	100.0
25.0	100.0
19.0	100.0
16.0	97.9
12.5	93.3
9.5	89.5
4.75	83.1
2.00	77.4
1.18	74.7
0.425	68.9
0.250	65.2
0.150	61.5
0.075	56.3
0.005	20.8
0.002	14.5
0.001	11.6

Gravel	Sand			Silt	Clay	Colloids
	Coarse	Medium	Fine			
16.9	5.7	8.5	12.6	41.8	14.5	11.6

COMMENTS:
Material tested was identified as TH23-09, S5, 14.5'-15'.

REPORT DATE 2023.Oct.27

REVIEWED BY Guillaume Beauce, P.Eng.
Geotechnical Engineer - Materials Testing Services

Stantec

Compressive Strength & Elastic Moduli of Intact Rock Core Speciments under Varying States of Stress and Temperatures

Method C

ASTM D7012 & D4543

Client:	KGS Group Inc.	Project No.:	123316822
Project:	CentrePort AAW Regional S&W Servicing		
Material Type:	Rock Core	Date Received:	October 26, 2023
Date Sampled:	October 25, 2023	Tested By:	Sagar Khatri
Sampled By:	Stantec	Date Tested:	November 6, 2023

Sample Information				
Borehole Location	**TH23-01**	**TH23-01**	**TH23-08**	**TH23-08**
Sample Number	2697	2698	2699	2700
Sample Depth	42'4"-42'11"	55'6"-56'0"	13'0"-13'9"	16'8"-17'9"
Compressive Strength Test Data				
Physical Description	As per Geotechnical Report	As per Geotechnical Report	As per Geotechnical Report	As per Geotechnical Report
Average Diameter (mm) (≥63.0)	60.63	60.71	60.65	60.63
Average Sample Length (mm)	144.07	127.32	149.05	150.93
Density (kg/m^3)	2500.81	2428.47	2484.85	2558.87
Unit Weight (kN/m^3)	24.53	23.82	24.38	25.10
L/D Ratio (2.0-2.5)	2.38	2.10	2.46	2.49
Failure Load (lbs)	15610	11430	42960	47810
Compressive Strength (MPa)	**24.1**	**17.6**	**66.1**	**73.7**
Straightness by Procedure S1 (≤0.02inch)	<0.02	<0.02	<0.02	<0.02
Flatness by Procedure FP2 (≤0.001inch)	<0.001	<0.001	<0.001	<0.001
Parallelism by Procedure FP2 (≤0.25°)	-0.073	0.037	0.011	0.036
Perpendicularity by Procedure P2 (≤0.0043)	<0.0043	<0.0043	<0.0043	<0.0043
Moisture Condition	As-Received	As-Received	As-Received	As-Received
Description of Break D7012/11.1.13	Diagonal cracking from one end.	Diagonal fracture with cracking through ends.	Reasonbly well formed cones on both ends.	Reasonbly well formed cones on both ends.
Note				

Remarks:

Reviewed by: Brian Prewer

Date: November 7, 2023

KGS GROUP

Experience in Action