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MPE Engineering Ltd.

Renfrew Outfall Gate Chamber Upgrades
Geotechnical Investigation Report

Prepared for:
Mark Baker, P.Eng.
MPE Engineering Ltd.
125 Higgins Ave
Winnipeg, MB
R3B 0B6

Project Number: 0512-013-00

Date: January 16, 2024

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January 16, 2024 Our File No. 0512-013-00

Mark Baker, P.Eng.
MPE Engineering Ltd.
125 Higgins Ave
Winnipeg, MB
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RE: Renfrew Outfall Gate Chamber Upgrades
Geotechnical Investigation Report

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

Please contact the undersigned should you have any questions.

Sincerely,

TREK Geotechnical Inc.
Per:

Michael Van Helden, Ph.D., P.Eng.
Senior Geotechnical Engineer

Encl.

Revision History

Revision No.	Author	Issue Date	Description
0	JSS	January 16, 2024	Final Report

Authorization Signatures

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Certificate of Authorization
TREK GEOTECHNICAL INC.
No. 4877

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1.0 Introduction

This report summarizes the results of the geotechnical investigation completed by TREK Geotechnical Inc. (TREK) for the proposed outfall gate chamber upgrades at Renfrew Street in Winnipeg, Manitoba. The terms of reference for the investigation are included in our proposal to Mr. Mark Baker, P.Eng. of MPE Engineering Ltd. (MPE) dated April 26, 2023. The scope of work includes a geotechnical sub-surface investigation, installation and monitoring of a standpipe piezometer, laboratory testing and the provision of geotechnical/hydrogeological recommendations for design and construction of the proposed upgrades. Other considerations such as lateral earth pressures for permanent walls and temporary shoring are also included in this report.

2.0 Background and Site Conditions

The existing chamber is located approximately 135 m south from the top of bank of the Assiniboine River as shown on Figure 01. The gate chamber is located beyond the Waterways regulated zone (105 m from the normal summer shoreline), and therefore a City of Winnipeg Waterways Permit is not required. An overhead power line is located approximately 6 m east of the existing gate chamber.

Drawings for the existing chamber and the proposed upgrades were provided by MPE, with select drawings attached in Appendix A. The proposed upgrades will include a new cell to accommodate a new flap gate, positive gate, submersible pump, and weir structure, with some modifications to the existing gate and pump out chambers. The existing chambers will be left in place and modified, with existing gate and appurtenances to be replaced. The work will involve excavation to the top of the existing lower chamber, and the construction of a new chamber extending above ground surface on top of the lower chamber. The excavation is anticipated to extend approximately 7.5m below ground surface, or slightly deeper, and temporary shoring is anticipated to be required. The presence of shoring left behind from the original construction work has not been confirmed. We understand that the works must be constructed during the winter months when the flows in the land drainage system are low.

3.0 Field Program

3.1 Sub-surface Investigation

A subsurface investigation was undertaken on September 08 and 09, 2023 under the supervision of TREK personnel to determine the soil stratigraphy and groundwater conditions at the site. One test hole (TH23-01) was drilled approximately 11.5 m north from the northwest edge of the existing gate chamber and adjacent to pedestrian walkway. The test hole was drilled to auger refusal at a depth of 14.3 m below ground surface using a B-57 track-mounted drill rig equipped with 125 mm diameter solid stem augers. The test hole was further advanced to a depth of 16 m (i.e. below the depth of auger refusal and into bedrock) with an Acker MP8 truck- mounted rig using casing and HQ coring

equipment. A 25 mm diameter PVC standpipe with Casagrande tip (SP-01) was installed in the test hole at a depth of 15.8 m below ground surface. The standpipe was backfilled with silica sand around the tip (in bedrock and silt till) followed by bentonite chips and auger cuttings to the ground surface. The top of the standpipe is 0.15 m below grade with a flush-mount protective cover installed over the standpipe. The location of the test hole is shown in Figure 01.

Subsurface soils observed during drilling were visually classified based on the Unified Soil Classification System (USCS). Samples retrieved during drilling included disturbed auger cuttings, split spoon, relatively undisturbed Shelby tube samples, and rock core samples. All samples retrieved during drilling were transported to TREK's testing laboratory in Winnipeg, Manitoba. Laboratory testing consisted of moisture contents on all samples, grain size analysis (hydrometer method) on select samples, and unconfined compressive testing on select Shelby tube samples. The bedrock core was logged and photographed. Laboratory testing results are included in Appendix B.

Test hole coordinates were recorded using a handheld GPS and the elevation was surveyed using a rod and level relative to a temporary benchmark (TBM) located on the northwest top corner of the top of the existing gate chamber. The TBM has a geodetic elevation of 223.95 m based on drawings provided by MPE. The location of the TBM is also shown in Figure 01.

3.2 Soil Stratigraphy

A brief description of the soil stratigraphy and groundwater conditions encountered during drilling is provided in the following sections. All interpretations of soil stratigraphy for the purposes of design should refer to the detailed information provided on the attached test hole log. The test hole log includes a description of the soil units encountered and other pertinent information such as groundwater, sloughing conditions, and a summary of the laboratory testing results.

The soil stratigraphy in descending order consists of 0.1 m thick of organic clay (topsoil), followed by 0.8 m of sand and gravel fill, 0.3 m of clay fill, and silty clay, silt (till) and dolomite bedrock. Silty clay was encountered at a depth of 1.2 m below ground surface and extended to 7.6 m below ground surface followed by a 0.2 m thick transition zone to silt till. The silty clay is moist, stiff becoming firm with depth, and of high plasticity.

Silt (till) was encountered at a depth of 8.7 m below grade and is approximately 6 m thick. The silt (till) is moist and loose becoming compact below 10 m (approx.) and becoming dense with depth.

Dolomite bedrock (Red River Formation, Upper Fort Garry member) was encountered at 14.8 m below ground surface and is cream to light red in colour. The bedrock is classified as strong (R4), and as good to excellent quality based on a Rock Quality Designation (RQD) of 90%, with joint spacing that is close to moderately close (0.06 to 0.6 m), and joint aperture that is closed to gapped (< 10 mm).

3.3 Power Auger Refusal

Power auger refusal was observed at a depth of 14.3 m below grade within the silt till.

3.4 Groundwater and Sloughing Conditions

Groundwater conditions described herein are based on monitoring of piezometers installed at the site. Groundwater levels were recorded with manual readings and using a down-hole water level logger. It is important to note that the measured piezometric levels are valid at the time they were recorded, and that levels may vary seasonally, annually, or as a result of construction activities.

Manual piezometer readings are summarized in Table 1, and are also displayed on Figure 02 along with down-hole water level logger readings and Assiniboine River levels at the Route 90 bridge crossing. In general, the piezometric levels in the silt (till) appear to trend relatively closely with Assiniboine River levels during the monitoring period.

Table 1. SP23-01 Groundwater Monitoring Results

Depth	Standpipe	Depth below top of pipe (m)	Groundwater Elevation (m)	River Elevation (m)
09 September,2023	SP23-01	8.52	224.83	224.7
01 November,2023	SP23-01	7.20	226.15	224.78

Squeezing of the test hole was observed at a depth of 6.4 m below ground surface. Upon completion of drilling the test hole was open to a depth of 6.4 m below ground surface and no water had accumulated in the test hole above 6.4 m.

4.0 Foundation Recommendations

A raft foundation bearing on silt till is considered the most suitable foundation alternative based on the observed sub-surface and anticipated loading conditions. The gate chamber is supported on the chamber's base slab which is bearing on compact to dense silt till approximately 2 m above the bedrock contact depth. The gate chamber upgrades will be supported on the existing structure. Recommendations to evaluate the bearing capacity for the existing foundation have been provided in accordance with the National Building Code of Canada (NBCC, 2020).

4.1 Limit States Design (NBCC, 2020)

Limit States Design recommendations for shallow and deep foundations are provided in accordance with the Manitoba Building Code (MBC, 2024) which is based on the National Building Code of

Canada (NBCC, 2020). Limit states design requires consideration of distinct loading scenarios comparing the structural loads to the foundation bearing capacity using resistance and load factors that are based on reliability criteria. Two general design scenarios are evaluated corresponding to the serviceability and ultimate capacity requirements.

The Ultimate Limit State (ULS) is concerned with ensuring that the maximum structural loads do not exceed the nominal (ultimate) capacity of the foundation units. The ULS foundation bearing

capacity is obtained by multiplying the nominal (ultimate) bearing capacity by a resistance factor (reduction factor), which is then compared to the factored (increased) structural loads. The ULS bearing capacity must be greater or equal to the maximum factored load to provide an adequate margin of safety. The resistance factors used under MBC 2011 were based on the recommended values contained in Commentary K for NBCC 2010. Since the commentaries for the NBCC 2020 are not published at this time recommended geotechnical resistance factors are not provided in the code. Table 2 summarizes the resistance factors that can be used for the design of shallow foundations as recommended in Table 6.2 of the Canadian Foundation Engineering Manual (5th Ed. 2023). These values are consistent with resistance factors provided in the commentary for the previous version of the NBCC. Different resistance factors should be applied depending upon the method of analysis and verification testing completed during construction.

The Service Limit State (SLS) is concerned with limiting deformation or settlement of the foundation under service loading conditions such that the integrity of the structure will not be impacted. The Service Limit State should generally be analysed by calculating the settlement resulting from applied service loads and comparing this to the settlement tolerance of the structure. However, the settlement tolerance of the structure is typically not yet defined at the preliminary design stage. As such, recommendations are provided for evaluating the SLS that are developed on the basis of limiting settlement to 25 mm or less. A more detailed settlement analysis should be conducted to refine the estimated settlement and/or adjust our recommendations if a more stringent settlement tolerance is required.

Table 2. ULS Resistance Factors for Shallow Foundations (NBCC, 2020)

Resistance to Vertical Loads for Shallow Foundations (Analysis Methods)	Resistance Factor
Semi-empirical analysis using laboratory and in-situ test data	0.5

4.2 Existing Foundations

Based on the design drawings provided, the proposed gate chamber upgrades will be supported by the lower chamber, which is founded at approximately El. 222 m ± 0.5 (i.e. about 11.5 m below grade) where the silt till is expected to be compact. For the existing base slab bearing on compact silt till, the

bearing capacity of the existing gate chamber base slabs can be evaluated using ULS and SLS bearing capacities of 300 kPa and 200 kPa, respectively. Settlement of the gate chamber is not expected since the weight of soil removed is anticipated to exceed the weight of structure added for the upgrades. Some minor rebound of the gate chamber could occur if the net offloading is significant. The weight of soil removed above the bearing surface can be added to the factored bearing capacities. Based on the drawings provided, the proposed chamber is expected to extend above the ground surface, however if the chamber design is modified such that it is buried, any backfill on top of the chamber should be added to the structural loads. Unit weights of 17.5 kN/m3 and 21 kN/m3 should be used for the weight of clay soils removed and granular backfill, respectively. Uplift (buoyant) forces acting against the access chamber should also be considered in design and a groundwater level at existing ground surface should be used. In this regard, there is no evidence we are aware of that would suggest uplift of the existing structure has occurred as a result of buoyancy.

4.3 Foundation Inspection Requirements

In accordance with Section *4.2.2.3 Field Review* of the NBCC (2020), the designer or other suitably qualified person shall carry out a field review on:

a) continuous basis during:
   i. the construction of all deep foundation units with all pertinent information recorded for each *foundation unit*,
   ii. during the installation and removal of retaining structures and related backfilling operations,
   iii. during the placement of engineered fills that are to be used to support the *foundation units*, and

b) as-required, unless otherwise directed by the *authority having jurisdiction*,
   i. in the construction of all *shallow foundation units,* and
   ii. in excavating, dewatering and other related works.

In accordance with Engineers and Geoscientists of Manitoba, a Professional Engineer or delegated staff responsible to them must perform site reviews for the work presented in the documents they've sealed. For conformance with the NBCC and EGM requirements, TREK should be retained on a full-time basis to observe and document the installation of all foundations, shoring or engineered fills supporting the structure, and on an as-required basis for other components such as subgrade inspections and compaction testing. TREK is familiar with the geotechnical conditions present and the underlying design assumptions of our foundation recommendations. TREK is therefore solely qualified to evaluate any design modifications deemed to be necessary should altered sub-surface conditions be encountered.

5.0 Seismic Site Classification

The Site Class for seismic site response was determined in accordance with Table 4.1.8.4.-B Site Classes, S, for Site Designation Xs of the NBCC (2020). Site Class D is recommended for this project site based on the sub-surface conditions encountered in the test hole and the depth of the existing foundations.

6.0 Excavations and Shoring

It is understood that an excavation depth of about 7.5 m (to just below the top of the lower chamber) is required to construct the gate chamber upgrades and that shoring for the excavation will likely be required. The excavation footprint is not known at this time, but is anticipated to be on the order of 5 m by 6 m. The presence of existing shoring left in place after the existing gate chamber was not investigated and if present may interfere with the installation of new shoring. Consideration should be given to further exploration around the existing gate chamber to check for the presence of shoring and backfill materials used. If available, photographs from the time of original construction may provide insight into the shoring system used.

6.1 Temporary Excavations

Excavations must be carried out in compliance with the current relevant regulations under the Manitoba Workplace Safety and Health Act to suit the planned and expected construction activities and schedule. Excavations greater than 3 m deep must be designed and sealed by a professional engineer. If space is limited or the stability of adjacent structures may be endangered by an excavation, a shoring system may be required to prevent damage to, or movement of, any part of adjacent structures, and the creation of a hazard to workers and the public.

Based on the 7.5 m excavation depth and the sensitivity of surrounding structures (e.g. walkway, poles supporting nearby overhead power line) to settlement, conventional shoring will need to be braced. Shoring will need to extend through the clay layer and into the silt till layer. Undrained soil conditions may govern design of the shoring in the short term and effective stress conditions should be considered for the long-term stability. Both undrained and drained soil conditions should be checked, and the more conservative condition used to design the shoring.

The earth pressure distribution provided in Figure 03 can be used for braced shoring design, however the shoring designer should refer to the Canadian Foundation Engineering Manual (5th Edition, 2023) and the information provided on the test hole logs for consideration of the layered soil profile in design. The apparent earth pressure distribution shown on Figure 02 can be used for temporary braced shoring design in stiff clay and is not applicable for unsupported shoring. The effect of any surcharge loads must be added to the force on the wall in addition to the calculated earth pressures. The appropriate earth pressure condition should be used to calculate the lateral earth pressure due to surcharge loads. Suggested soil parameters for use in shoring design are provided in Table 3, however it is the Contractor's responsibility to review the test hole logs and confirm the selection of soil parameters for design.

Table 2. Engineering Properties for Soil

Material	Depth Below Site Grade	Undrained Shear Strength	Effective Cohesion	Effective Friction Angle	Saturated Unit Weight	Effective Unit Weight	Earth Pressure Coefficients (Rankine[1])		
	(m)	(kPa)	(kPa)	(degrees)	(kN/m^3)	(kN/m^3)	Ko	Ka	Kp
Clay	0 – 5.5	50	5	25	17.5	7.7	0.6	0.4	2.5
Clay	5.5 – 8.5	30	5	25	17.5	7.7	0.6	0.4	2.5
Silt Till	8.5 – 14.5	n/a	5	32	22.0	12.2	0.47	0.3	3.2
Sand (fill)	-	n/a	0	30	20.0	10.2	0.5	0.3	3.0

Note 1: The effective stress earth pressure coefficients assume the magnitude of wall rotation is sufficient to develop the full earth pressure. The values should be reduced to suit the allowable wall rotation. Refer to Section 20.2.5 of the Canadian Foundation Engineering Manual (5th Edition 2023).

Considerations for the shoring design include:

- Design should be based on local experience with similar shoring systems as well as theoretical and empirical methods,
- Length of time the excavation shoring system will be in service,
- Earth and water pressures,
- Excavation staging,
- Excavation base stability,
- Spoil material from the excavation should not be stockpiled behind the shoring,
- Surcharge loading (q) from construction equipment should be considered in the design. The surcharge loading should be confirmed based on the equipment proposed for use by the contractor,
- Provide positive surface drainage away from the excavation to minimize water infiltration behind the shoring,
- Protection from frost effects are best mitigated by providing free draining backfill behind the shoring. Insulation could also be used to minimize frost penetration into the retained soil,
- Current Manitoba Building Code (MBC 2024) requirements
- Chapter 20 of the Canadian Foundation Engineering Manual (5th Edition 2023)
- Water pressure should be included in the analysis below the water table and/or behind the portion of the shoring that is not drained. The unit weight of water is 9.8 kN/m^3. The groundwater or piezometric level in the clay soil is generally considered to be about 2 m below prairie level (i.e. existing site grade).
- A monitoring program should be established to record the performance of the shoring system from the onset of installation to removal. The monitoring program should include top of pile

surveys as a minimum to measure and track lateral movement of the shoring with time. The vertical profile of soldier piles could be monitored using slope inclinometer casing and measurement of earth pressures acting on the shoring and groundwater pressure measurements could also be considered if deemed important by the shoring designer.

Ground movements behind the shoring and associated settlement are largely unavoidable. The amount of movement cannot be predicted with a high degree of accuracy as it is as much a function of the excavation procedures and workmanship as it is of theoretical considerations. In this regard, good contact between the retaining wall or timber lagging and retained soil should be maintained throughout the construction process. Free-draining sand fill should be used to fill in any voids behind the wall.

It is anticipated that the design of excavation slopes and temporary shoring will be the responsibility of the Contractor. Shoring designs or excavations will need to be designed and sealed by a professional engineer, and shop drawings should be reviewed by TREK prior to construction for review and comment. Shoring design should account for potential base heave and the need for dewatering and/or depressurization of the till or bedrock.

6.2 Groundwater Considerations

As described in Section 3.4, it is anticipated that water levels in the till fluctuate with the level of the Assiniboine River and regional groundwater level rise during the spring and summer months, however this will require long-term monitoring to confirm. If this is the case, the groundwater levels in the till may be 2 to 3 m higher during the summer months (non-flood periods). It must also be recognized that groundwater levels are likely to be even higher during spring freshet / flooding before returning to normal summer levels. Construction of the proposed works in the winter months (November to February) will reduce the risk of higher groundwater levels and the need for more extensive dewatering measures. In the event that construction must occur during non-winter months, TREK should be contacted to re-assess conditions, and a groundwater investigation and pump test may be warranted.

The proposed excavation is anticipated to terminate at or just below the top of the lower chamber (± 7 to 7.5 m depth below ground surface), which is less than 1 m above the clay-till interface (± 7.8 m depth below ground surface). Groundwater levels in the till/bedrock during the monitoring period (November to December, 2023) were approximately 7.2 to 7.6 m below ground surface, or slightly below the top of the existing chamber and slightly above the clay-till interface. Based on the proposed excavation geometry, measured groundwater levels in the till, the thickness and compactness condition of the till, and construction occurring during the winter, seepage into the excavation can be expected and should be manageable using conventional sump pits and submersible pumping systems. Depending on the river and groundwater levels at the time of construction, more robust dewatering measures such as well point systems may be required. Upward seepage may also occur along remnant shoring piles from the original chamber construction, or through granular backfill (if used) surrounding the chamber.

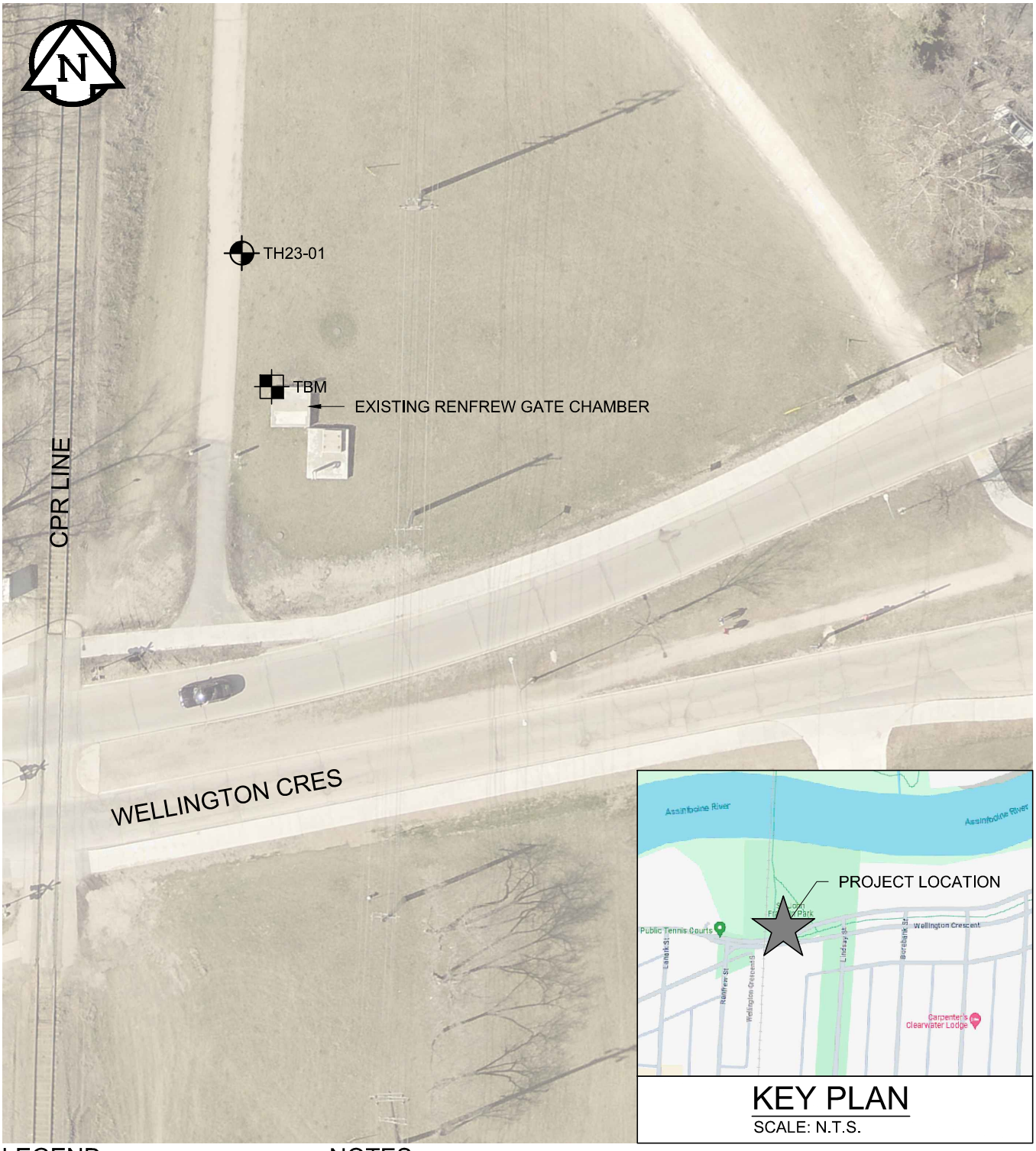
7.0 Closure

The geotechnical information provided in this report is in accordance with current engineering principles and practices (Standard of Practice). The findings of this report were based on information provided (field investigation and laboratory testing). Soil conditions are natural deposits that can be highly variable across a site. If subsurface conditions are different than the conditions previously encountered on-site or those presented here, we should be notified to adjust our findings if necessary.

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

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

Figures



KEY PLAN
SCALE: N.T.S.

LEGEND:

- TEST HOLE (TREK, 2024)
- TEMPORARY BENCHMARK

NOTES:

1. AERIAL IMAGERY FROM CITY OF WINNIPEG (2021).
2. TEST HOLE LOCATIONS WERE RECORDED USING A HANDHELD GPS UNIT.
3. TEST HOLE ELEVATIONS WERE SURVEYED RELATIVE TO A TBM (ASSIGNED ELEVATION 100.0 m) LOCATED ON TOP OF THE CONCRETE SLAB AT THE NORTHWEST CORNER OF THE EXISTING GATE CHAMBER (UTM 14U, 5526497 m N, 629737 m E).

0 5 10 15 20 25 m
SCALE = 1 : 500 (216 mm x 279 mm)

Figure 01
Test Hole Location Plan

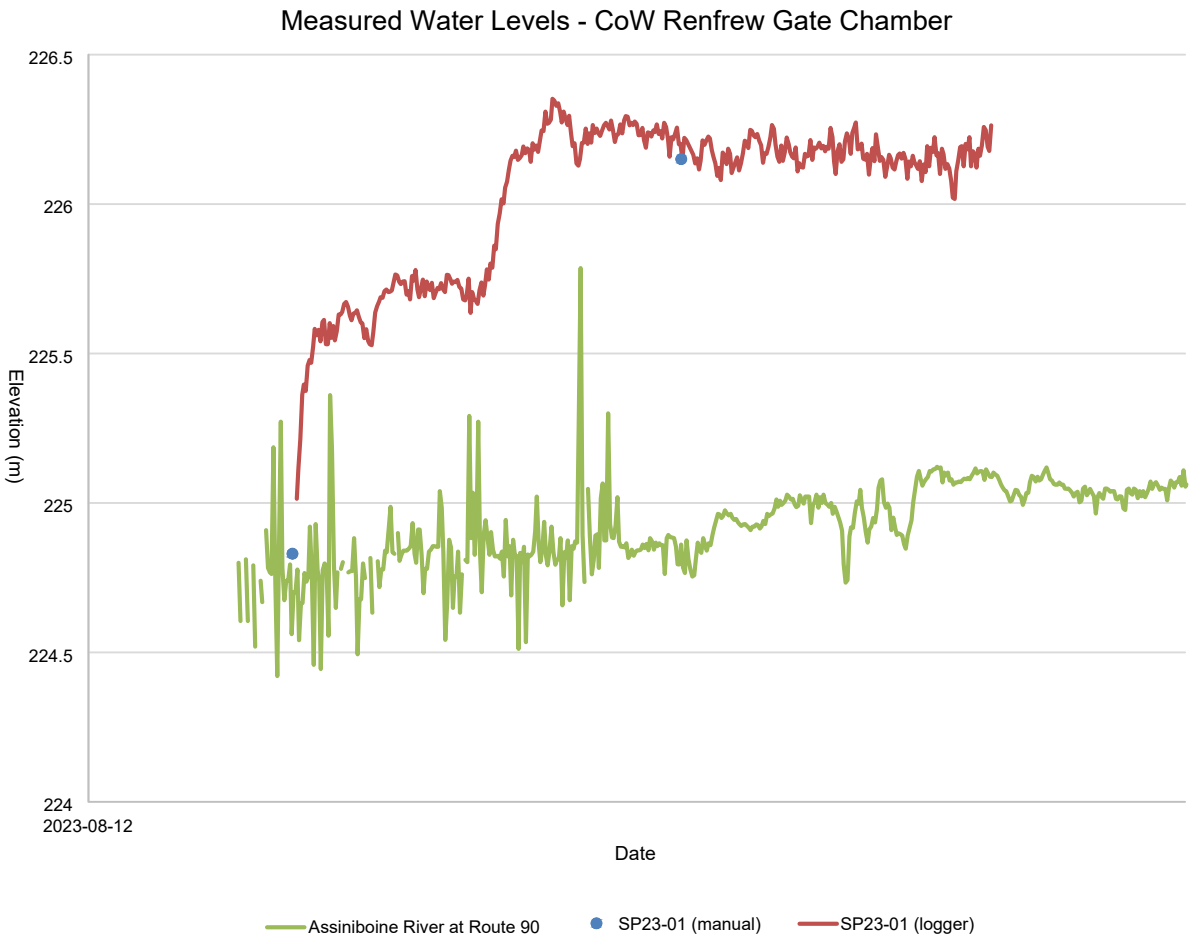
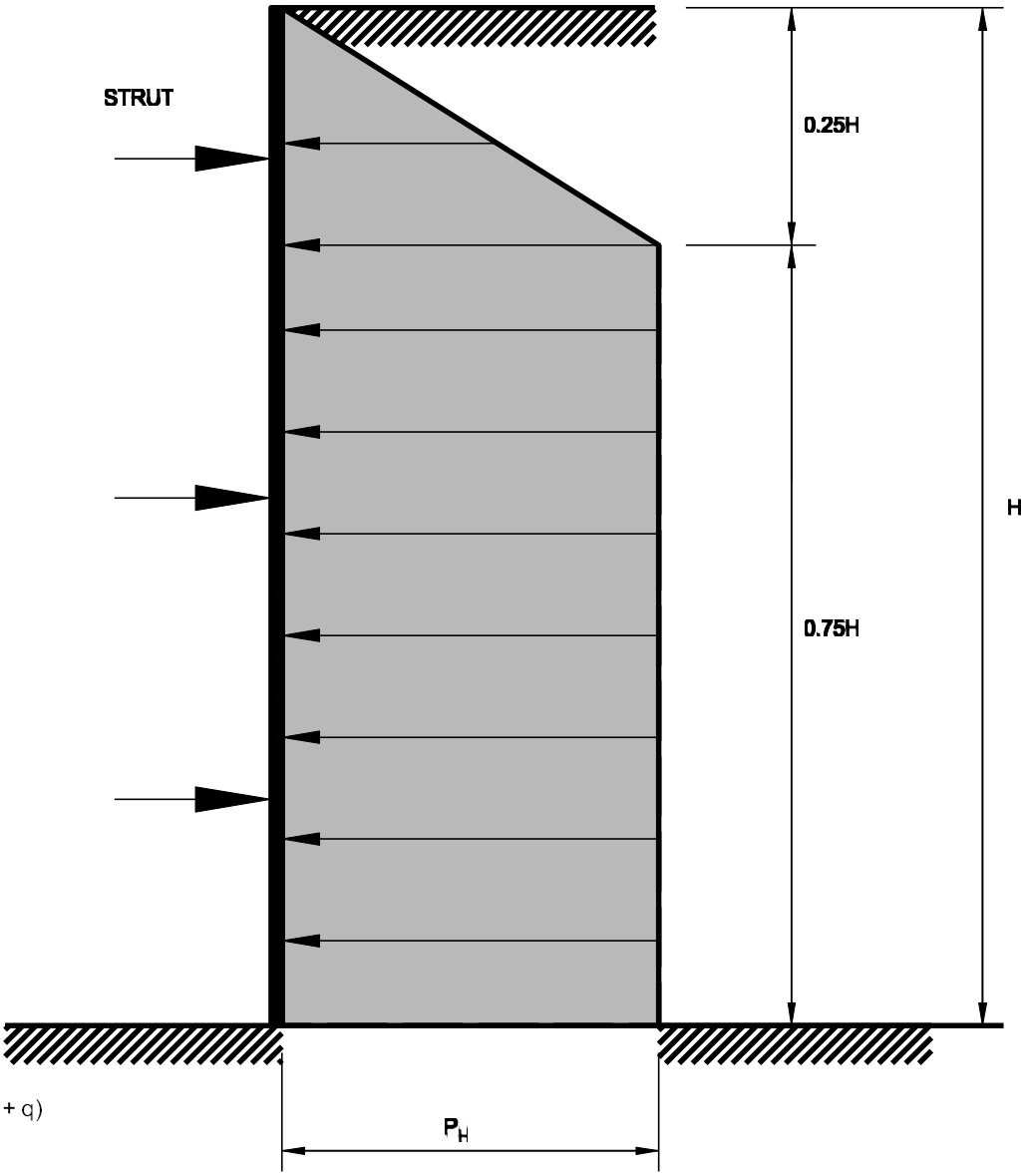


Figure 02
Monitoring Results for Piezometers



$P_H = 0.4 (\gamma H + q)$

WHERE:
P_H = LATERAL EARTH PRESSURE (kPa)
H = DEPTH OF EXCAVATION (m)
γ = BULK SOIL UNIT WEIGHT (17.0 kN/m^3)
q = SURFACE SURCHARGE LOAD (kPa)

Figure 03
Apparent Temporary Lateral Earth Pressure Distribution
Braced Excavation in Stiff Clay

Test Hole Logs

Sub-Surface Log

Test Hole TH23-01

Client:	MPE Engineering	**Project Number:**	0512-013-00
Project Name:	Renfrew Outfall Gate Chamber Upgrades	**Location:**	UTM-14U, 5526506N, 629735E
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	233.50 m Geodetic
Method:	125 mm solid stem auger & HQ Coring B-57 drill rig and Acker MP8 drill Rig	**Date Drilled:**	8 September 2023

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

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

Backfill Legend: Bentonite | Cement | Drill Cuttings | Filter Pack Sand | Grout | Slough

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number	Recovery % (RQD %)	SPT (N)
233.4	0	ORGANIC CLAY (TOPSOIL) - silty, trace rootlets, black, moist, firm to stiff, intermediate plasticity		G1		
	0.5	SAND AND GRAVEL (FILL) - some gravel (<20 mm diam.), trace to some silt, trace clay, trace rootlets, brown, dry, loose, poorly graded, fine to medium grained sand				
232.6	1.0	CLAY (FILL) - silty, trace sand, trace gravel (< 10 mm diam.) - black , moist, stiff, high plasticity		G2		
232.3	1.5	CLAY - silty, trace sand, trace silt inclusions (<5 mm diam.) - mottled brown dark grey - moist, stiff - high plasticity		G3		
	2.0			G4		
	2.5					
	3.0			T5		
	3.5					
	4.0					
	4.5			T6		
	5.0					
	5.5	- dark grey, firm below 5.5 m				
	6.0			G7		
	6.5					
	7.0			G8		
225.9	7.5	(TRANSITION LAYER FROM CLAY TO SILT TILL) - trace gravel (< 30 mm diam.), trace to some silt till inclusions (< 50 mm diam.) below 8.2 m		T9		
224.8	8.5	SILT (TILL) - some sand, trace to some gravel (< 15 mm diam.), trace clay - light grey - moist, loose - no to low plasticity		G10		
	9.0			SS11		7
	9.5					

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100 — PL MC LL

Undrained Shear Strength (kPa): 0 50 100 150 200 250

Test Type: △ Torvane △ ✿ Pocket Pen. ✿ ☒ Qu ☒ ○ Field Vane ○

Logged By: Jagdeep Sidhu **Reviewed By:** Gil Robinson **Project Engineer:** Michael Van Helden

SUB-SURFACE LOG LOGS 2023-09-08 RENFREW OUTFALL CHAMBER UPGRADE 0_A_JSS 0512-013-00.GPJ TREK.GDT 16/1/24

Sub-Surface Log

Test Hole TH23-01

Elevation (m)	Depth (m)	Soil Symbol	SP23-01	MATERIAL DESCRIPTION	Sample Type	Sample Number	Recovery % (RQD %)	SPT (N)
	10.5			- compact below 10.0 m		G12		
	11.0					SS13		19
	11.5							
	12.0			- trace gravel (< 30 mm diam.) below 11.9 m		G14		
	12.5					SS15		26
	13.0							
	13.5			- dense below 13.5 m				
	14.0					SS16		33
	14.5			- some gravel (< 75 mm diam.) below 14.3 m		C1		
218.7				DOLOMITE (BEDROCK) - Red River Formation, Upper Fort Garry member, cream to light red colour, strong (R4), good to excellent quality, horizontal and vertical fractures, close to moderately close discontinuity spacing, joint aperture closed to gapped, evidence of water flow (rust staining) in vertical fracture at 15.3 m depth.		C2	95 (90)	
217.5	15.0							
	15.5							
	16.0							

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL

0 20 40 60 80 100

Undrained Shear Strength (kPa)

Test Type

△ Torvane △

✤ Pocket Pen. ✤

☒ Qu ☒

○ Field Vane ○

0 50 100 150 200 250

END OF TEST HOLE AT 16.0 m IN BEDROCK

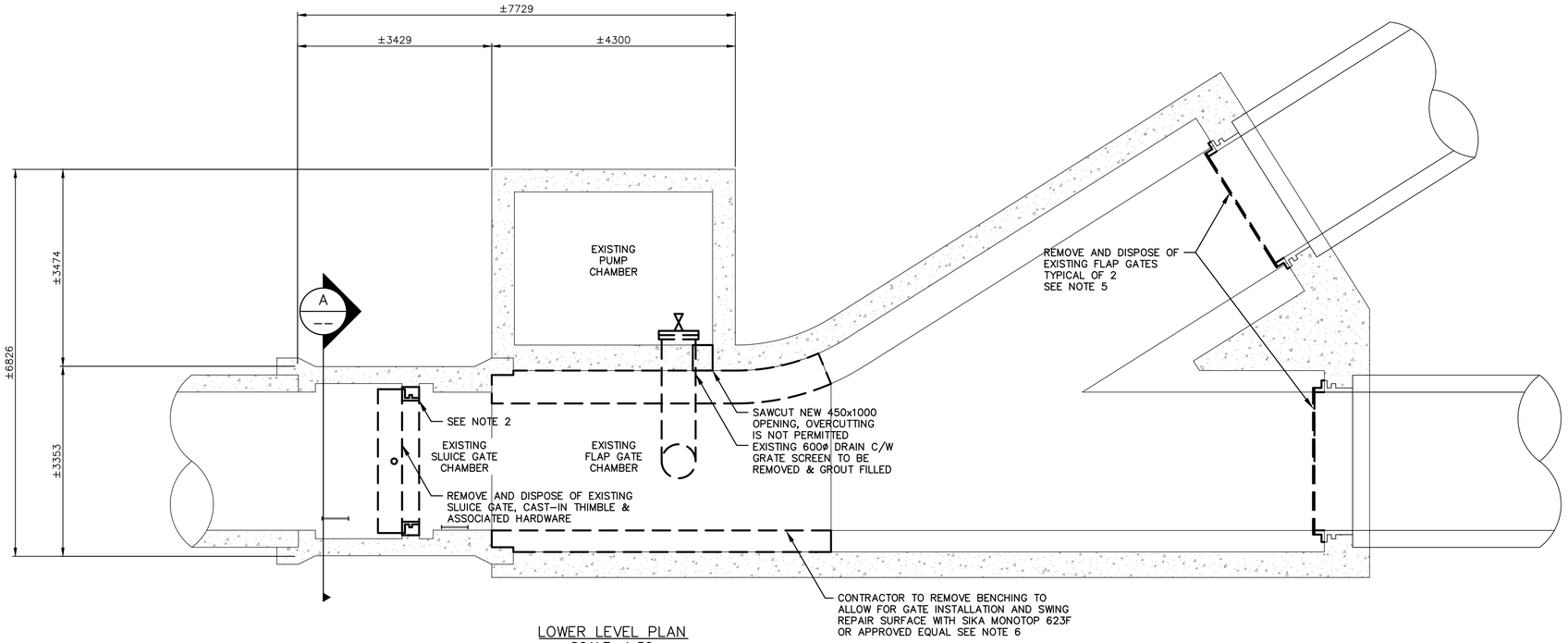
Notes:

1. Power auger refusal observed at 14.3 m depth and drill method switched to HQ coring.
2. Seepage observed at 12.2 m depth.
3. Squeezing observed below 6.4 m depth.
4. Test hole open to 6.4 m depth immediately after drilling.
5. No water accumulated in test hole immediately after drilling.
6. Standpipe Piezometer SP23-01 installed at 15.8 m depth with water level logger suspended inside at 14.2 m depth from top of standpipe. Top of standpipe 0.15 m below ground surface and capped with flush-mount well cover.
7. Water level measured to be at 8.52 m depth below top of standpipe SP23-01 immediately after install.

Logged By: Jagdeep Sidhu **Reviewed By:** Gil Robinson **Project Engineer:** Michael Van Helden

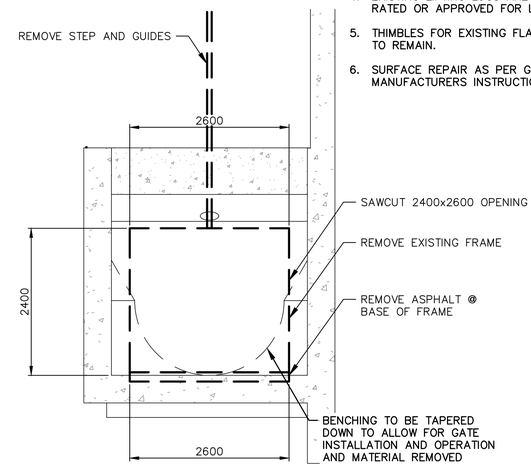
Appendix A

Existing and Proposed Gate Chamber Drawings

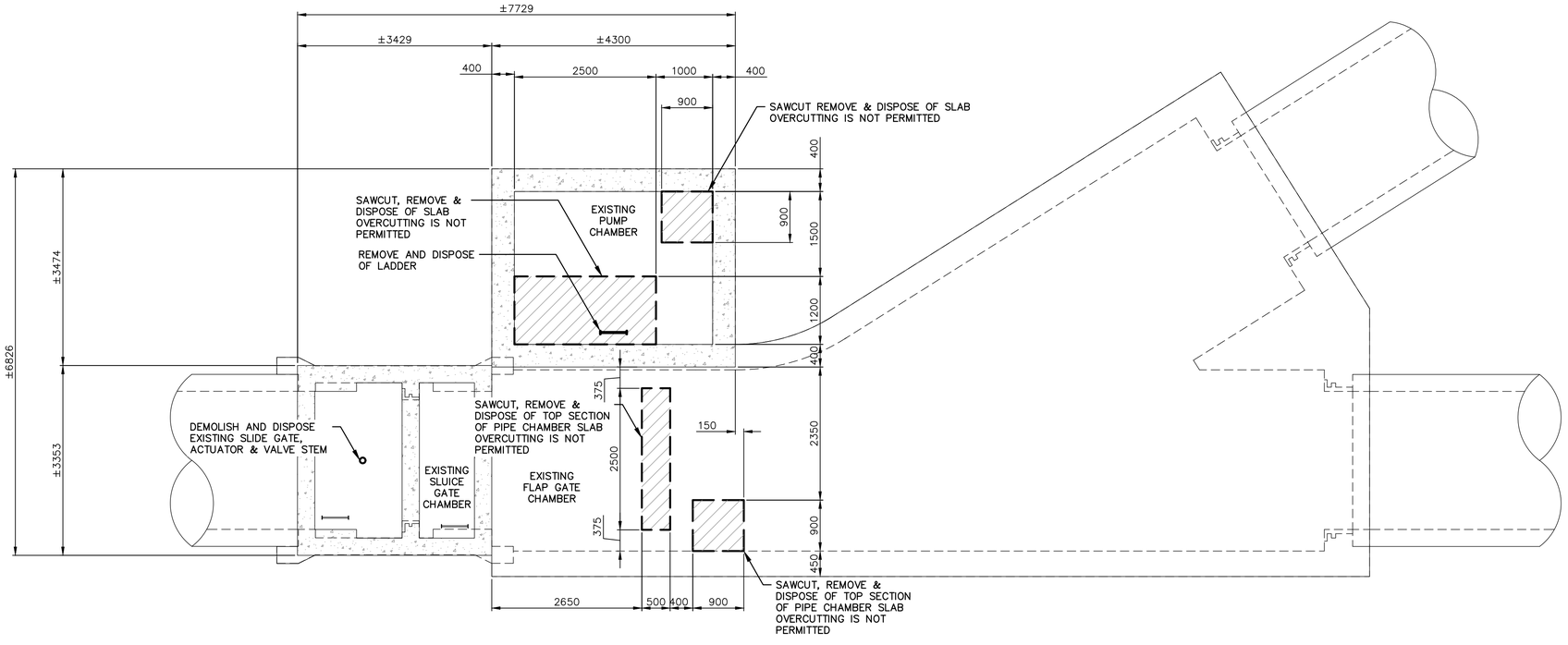


LOWER LEVEL PLAN
SCALE: 1:50

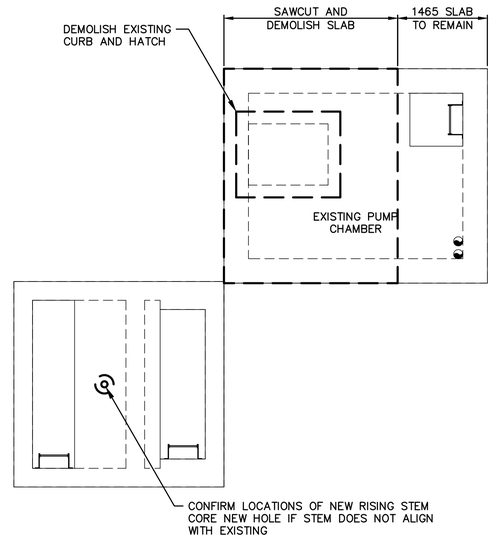
NOTES:
1. FOR CONSTRUCTION OF VAULT EXCAVATE & DISPOSE OF EXCESS SOIL OVER CHAMBER.
2. CONTRACTOR TO SAWCUT CONCRETE AND ROMOVE F-THIMBLE.
3. CONTRACTOR TO PROTECT EXISTING CONCRETE STRUCTURE.
4. EXISTING LIFTING LUGS ARE NOT RATED OR APPROVED FOR LOADING.
5. THIMBLES FOR EXISTING FLAP GATES TO REMAIN.
6. SURFACE REPAIR AS PER GROUT MANUFACTURERS INSTRUCTIONS.



A / S1.1 SECTION
SCALE: 1:50



MID-LEVEL PLAN
SCALE: 1:50



UPPER LEVEL PLAN
SCALE: 1:50

NO.	DRAWING NUMBER	REFERENCE DRAWING TITLE
10		
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REFERENCE DRAWINGS

METRIC
WHOLE NUMBERS INDICATE MILLIMETRES
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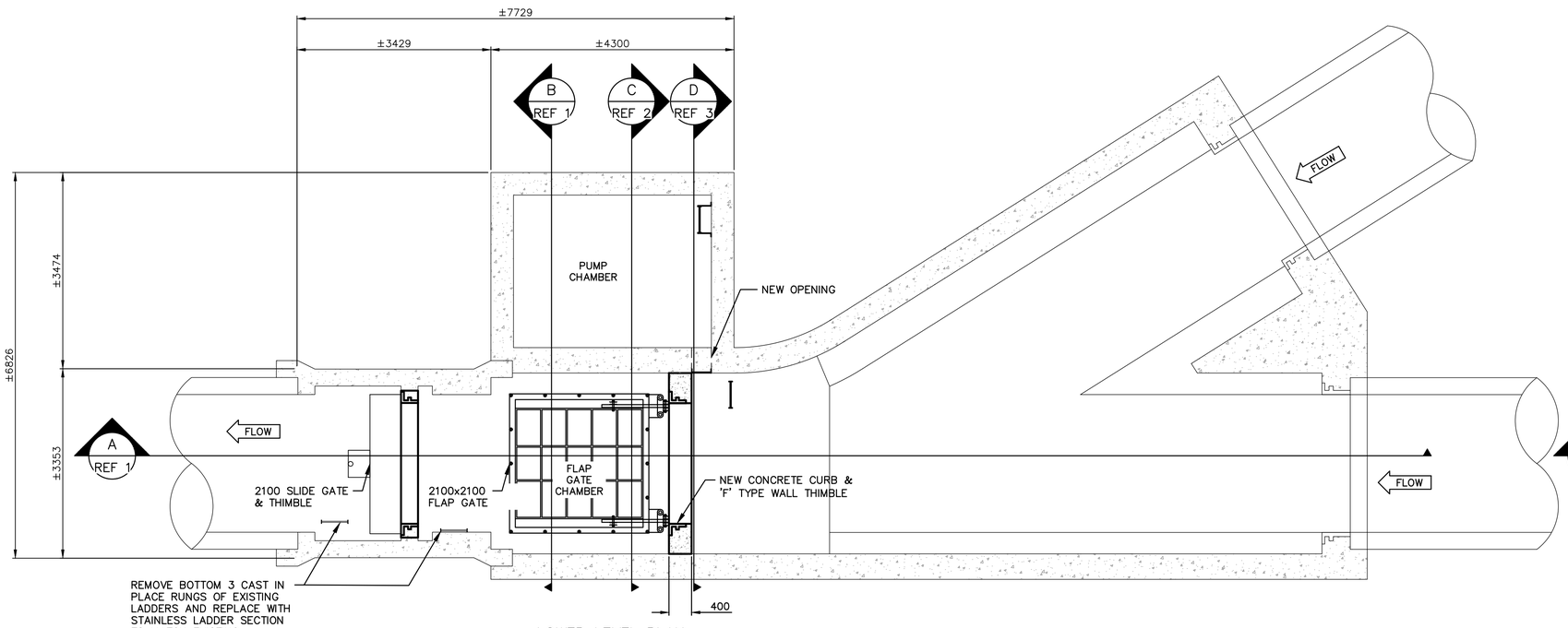
2024 UPGRADES

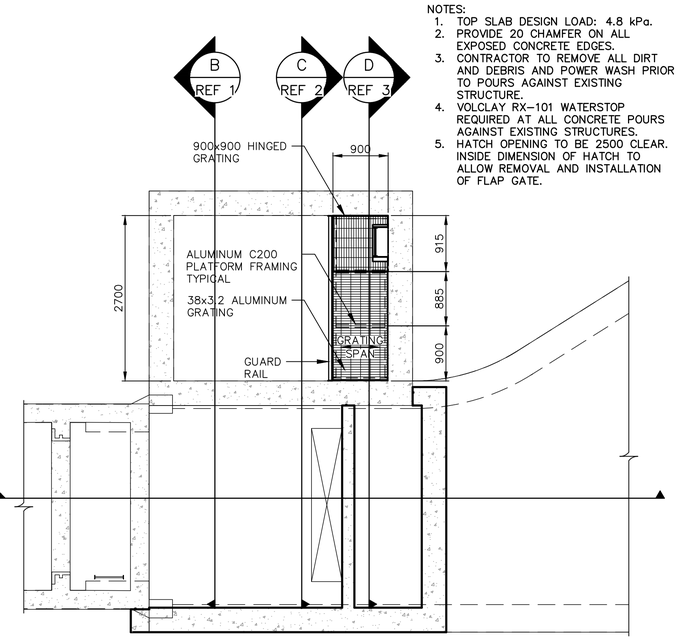
STRUCTURAL DEMOLITION PLAN

CITY DRAWING NUMBER 1-0240-XXXX-L1XX-XXX | SHEET 1 OF 3

FILE PATH: M:\N-Data\84\00 City of Winnipeg\006 - Renfrew Outfall Gate Chamber Upgrades\AutoDesk\ACAD\
FILE NAME: S2.1 Demo.dwg

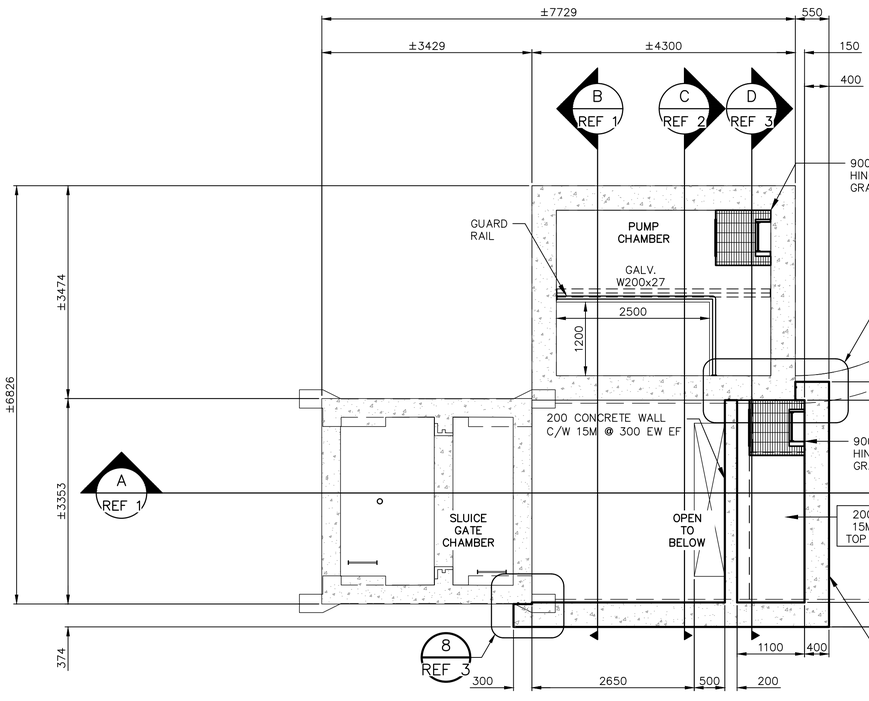


LOWER LEVEL PLAN
SCALE: 1:50



NOTES:
1. TOP SLAB DESIGN LOAD: 4.8 kPa.
2. PROVIDE 20 CHAMFER ON ALL EXPOSED CONCRETE EDGES.
3. CONTRACTOR TO REMOVE ALL DIRT AND DEBRIS AND POWER WASH PRIOR TO POURS AGAINST EXISTING STRUCTURE.
4. VOLCLAY RX-101 WATERSTOP REQUIRED AT ALL CONCRETE POURS AGAINST EXISTING STRUCTURES.
5. HATCH OPENING TO BE 2500 CLEAR. INSIDE DIMENSION OF HATCH TO ALLOW REMOVAL AND INSTALLATION OF FLAP GATE.

SUB-FLOOR PLAN
SCALE: 1:50



MID-LEVEL PLAN
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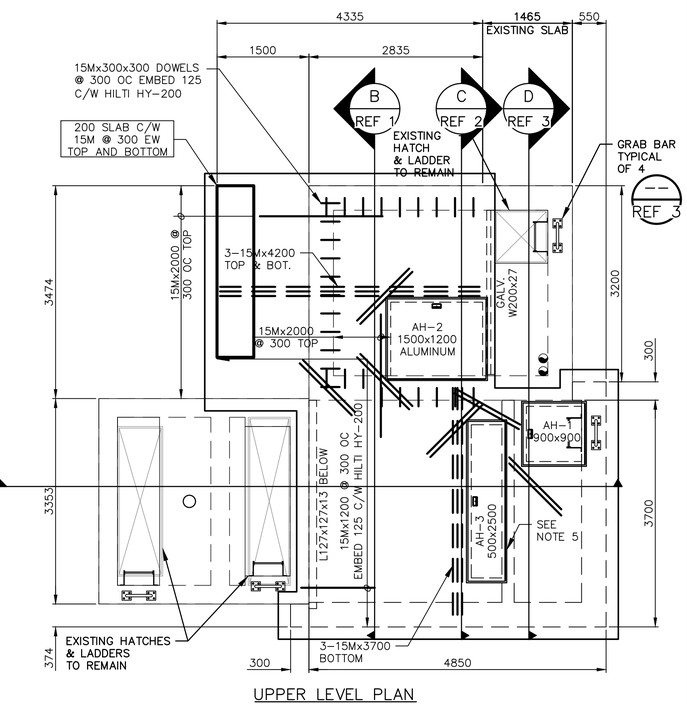

UPPER LEVEL PLAN
SCALE: 1:50

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2	S3.2	STRUCTURAL SECTIONS
1	S3.1	STRUCTURAL SECTIONS

REFERENCE DRAWINGS

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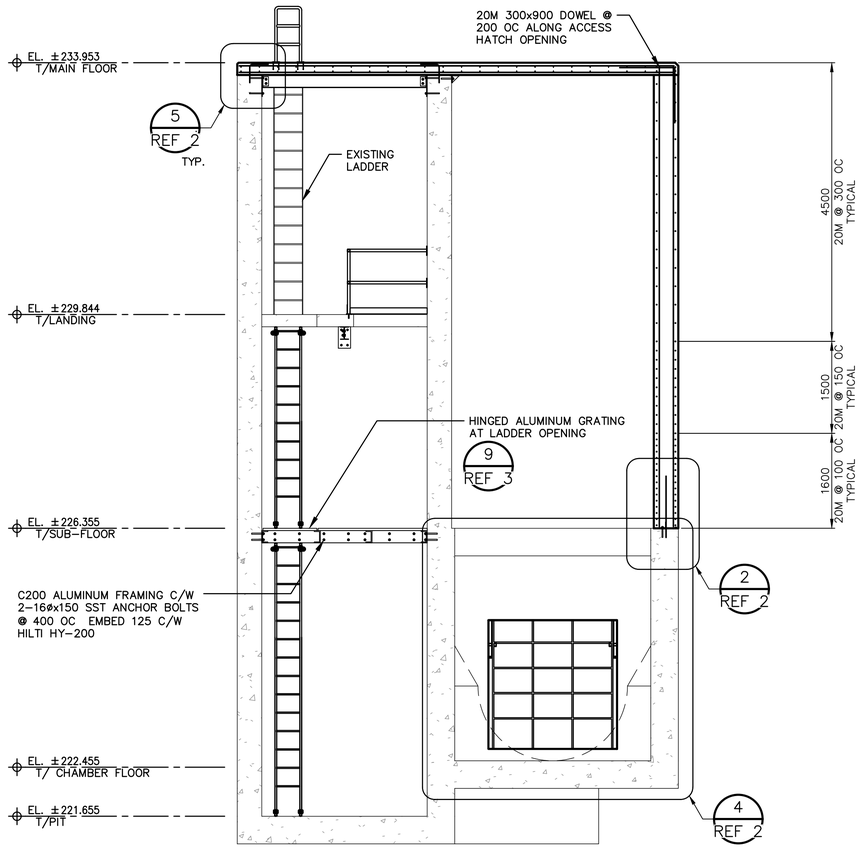
2024 UPGRADES
STRUCTURAL PLANS

CITY DRAWING NUMBER 1-0240-XXXX-L1XX-XXX | SHEET X OF X

FILE PATH: M:\N-Data\84\00 City of Winnipeg\006 - Renfrew Outfall Gate Chamber Upgrades\AutoDesk\ACAD\
FILE NAME: S2.2 - S2.3 Plans.dwg



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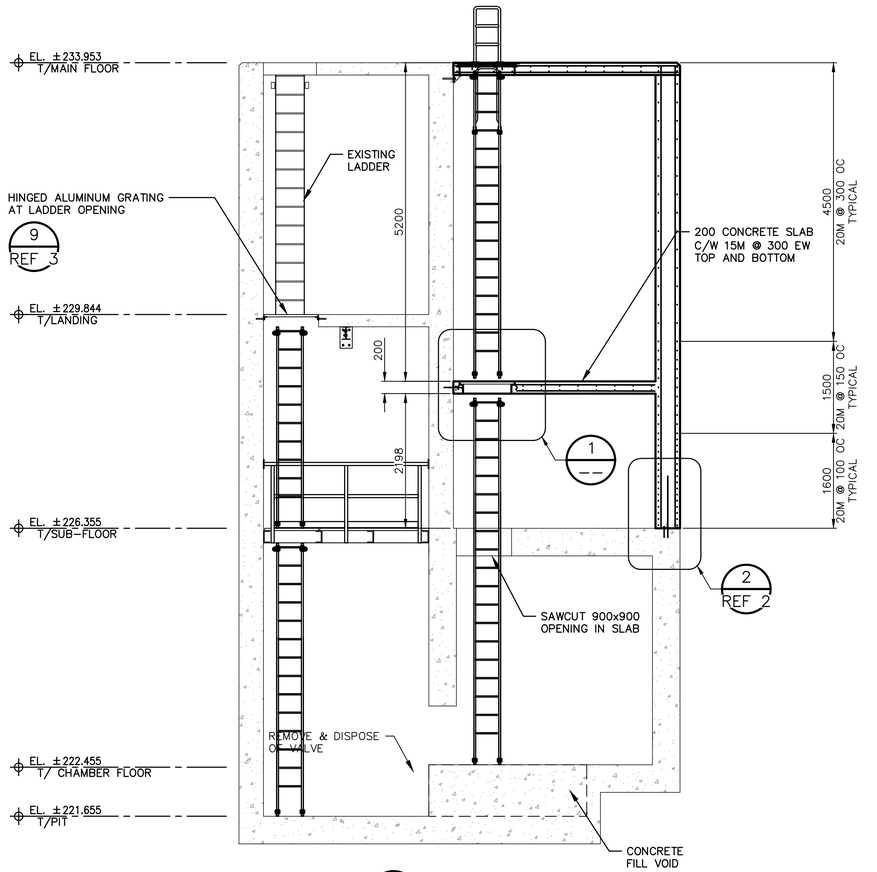

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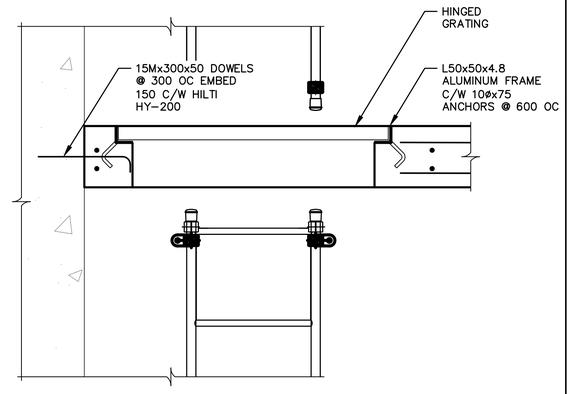

NOTE: PROVIDE 2-COATS OF BITUMEN PAINT ON ALL ALUMINUM SURFACES IN CONTACT WITH CONCRETE

1 -- REMOVABLE GRATING DETAIL
SCALE: 1:20

NO.	DRAWING NUMBER	REFERENCE DRAWING TITLE
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1	S2.2	STRUCTURAL PLANS

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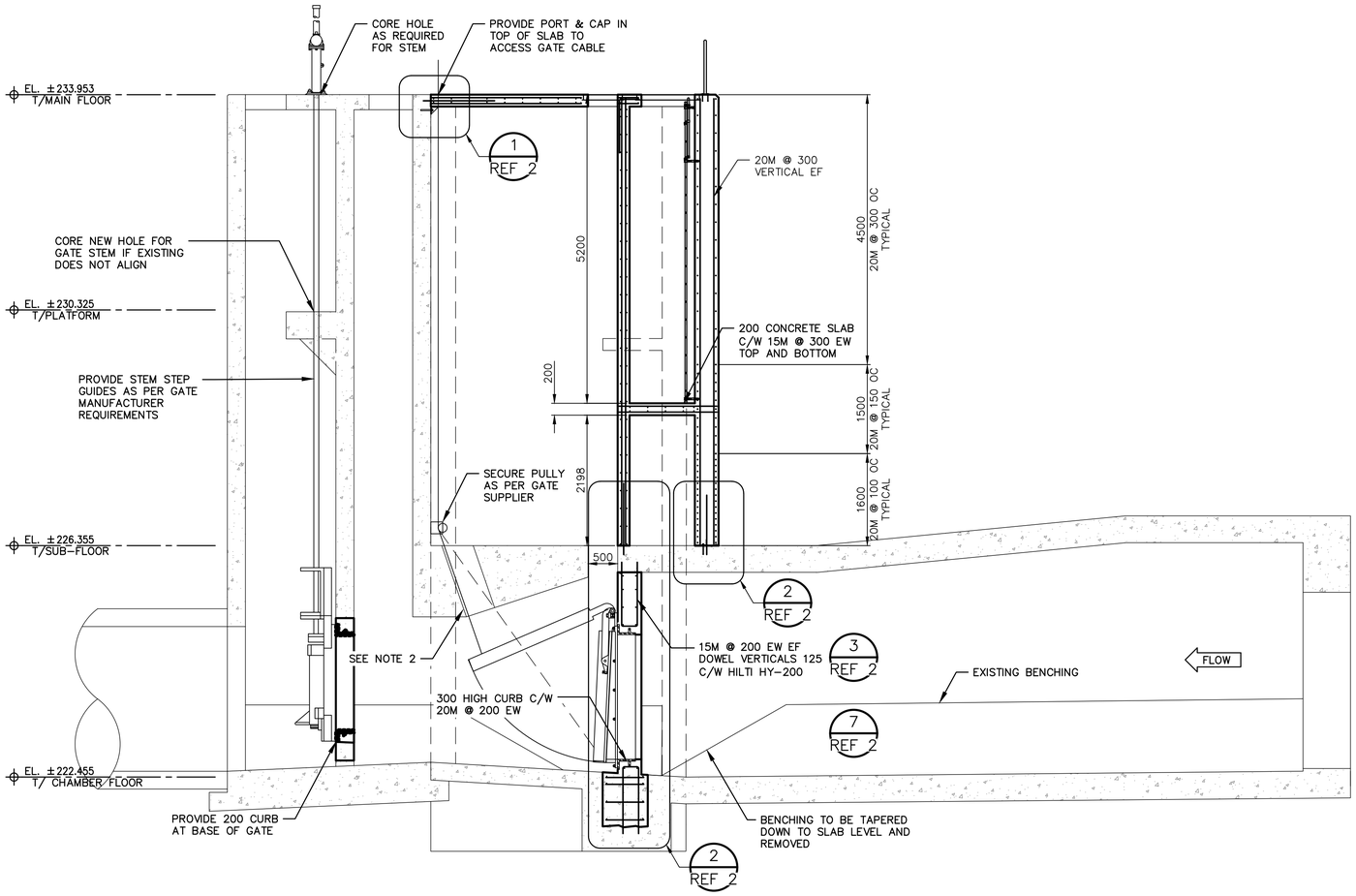
RENFREW OUTFALL GATE CHAMBER
2024 UPGRADES
STRUCTURAL SECTIONS

CITY DRAWING NUMBER 1-0240-XXXX-L1XX-XXX | SHEET X OF X

FILE PATH: M:\N-Data\84\00 City of Winnipeg\006 - Renfrew Outfall Gate Chamber Upgrades\AutoDesk\ACAD\
FILE NAME: S3.1 - S3.2 Sections.dwg

NOTES:
1. CORE 100ø x 400 SLOT HOLE ON ANGLE TO ALLOW FOR CABLE. CONFIRM ALIGNMENT WITH ENGINEER AND GATE SUPPLIER.
2. FILL VOID FROM ASPHALT REMOVAL. INFILL CONTINUOUS WITH CURB POUR.



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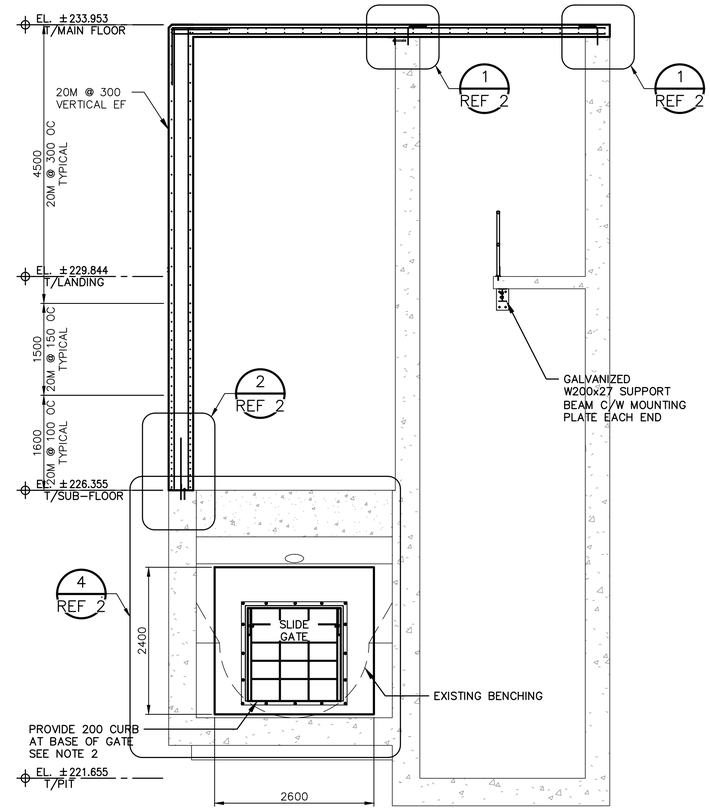

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1	S2.2	STRUCTURAL PLANS

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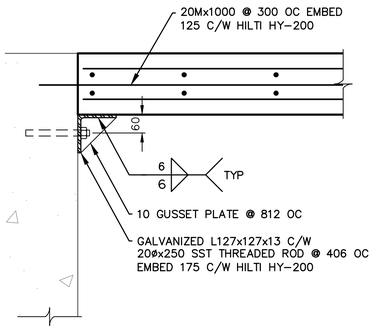
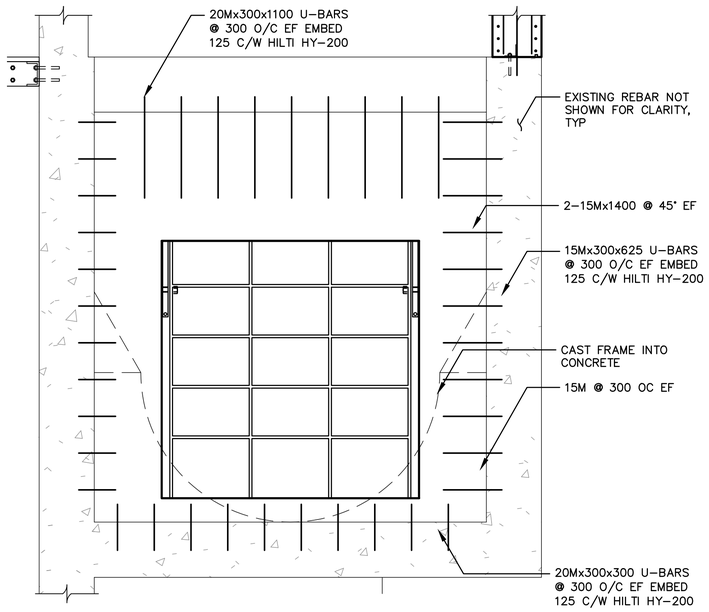
CITY DRAWING NUMBER 1-0240-XXXX-L1XX-XXX | SHEET X OF X

FILE PATH: M:\N-Data\84\00 City of Winnipeg\006 - Renfrew Outfall Gate Chamber Upgrades\AutoDesk\ACAD\
FILE NAME: S3.1 - S3.2 Sections.dwg

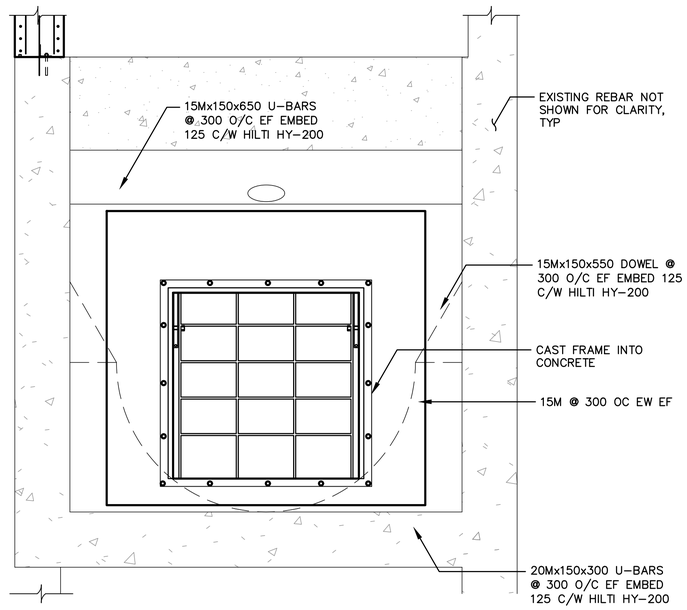
NOTES:
1. COAT ALL ALUMINUM IN CONTACT WITH CONCRETE WITH 2-COATS BITUMEN PAINT.



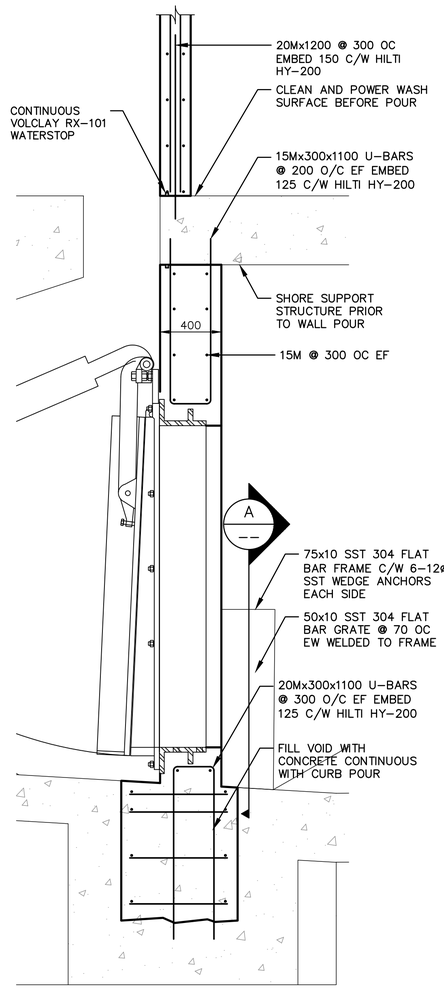
1 NEW SLAB INTO EXISTING
REF 2 SLAB SUPPORT
1:10



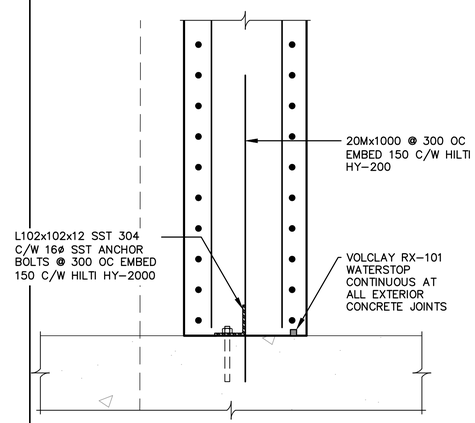
3 FLAP GATE WALL REINFORCING
REF 3 1:25



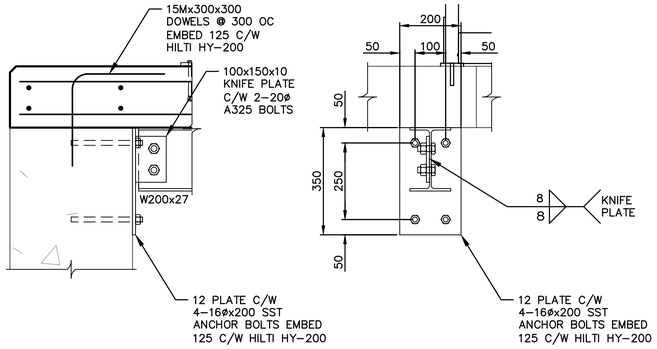
4 SLIDE GATE WALL REINFORCING
REF 2 1:25



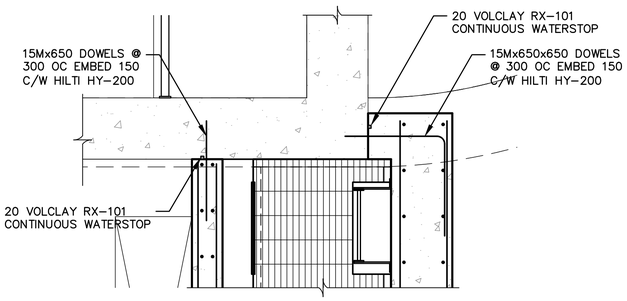
7 REINFORCING DETAIL
REF 1 1:20



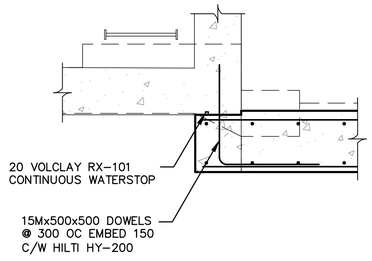
2 NEW WALL INTO EXISTING
REF 2 REINFORCEMENT DETAIL
1:10



5 SLAB SUPPORT DETAIL
REF 3 1:10



6 REINFORCING DETAIL
REF 1 1:20



8 REINFORCING DETAIL
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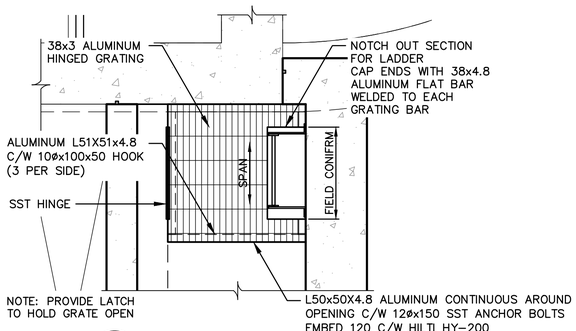
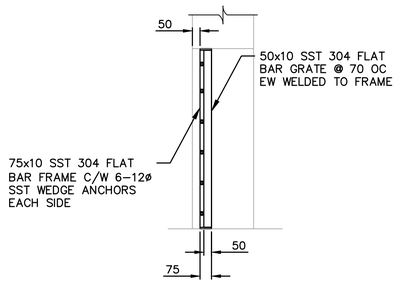


9 GRATING HATCH DETAIL
REF 1 1:20



A REINFORCING DETAIL
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9		
8		
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3	S3.2	STRUCTURAL SECTIONS
2	S3.1	STRUCTURAL SECTIONS
1	S2.2	STRUCTURAL PLANS

METRIC
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THE CITY OF WINNIPEG
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ENGINEERING DIVISION

RENFREW OUTFALL GATE CHAMBER
2024 UPGRADES
STRUCTURAL DETAILS

CITY DRAWING NUMBER 1-0240-XXXX-L1XX-XXX | SHEET X OF X

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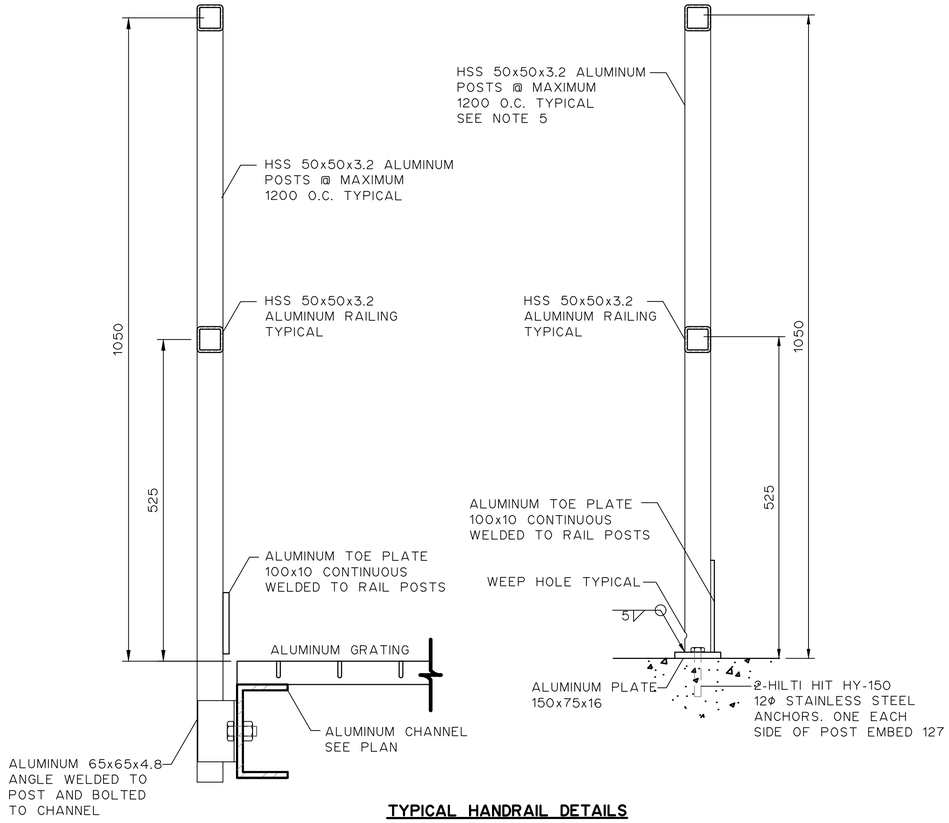
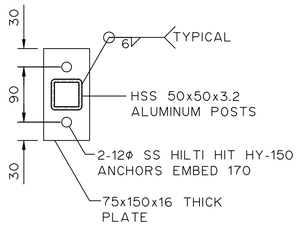
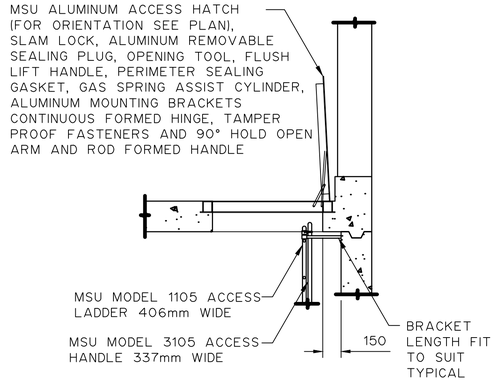
FILE NAME: S4.1 - S4.3 Details.dwg



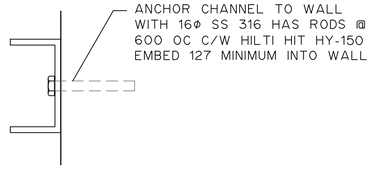
TYPICAL HANDRAIL DETAILS



TYPICAL HANDRAIL BASE PLATE/ WALL CONNECTION PLATE

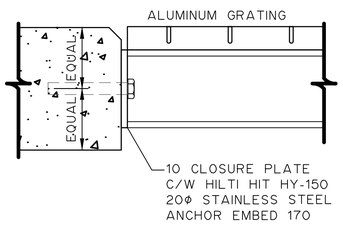


TYPICAL MSU HATCH
1:50

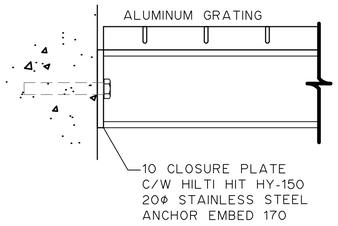


TYPICAL LANDING CHANNEL TO WALL CONNECTION

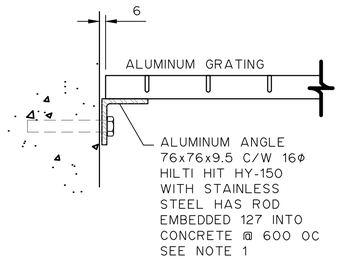
NOTES:
1. SERRATED ALUMINUM GRATING C/W 6063–T6 BEARING BARS AND 6063–T5 CROSS BARS. ALL ALUMINUM GRATING IS TO BE CLIPPED TO SUPPORTING MEMBERS.
2. ALL INTERIOR MEMBERS TO BE STRUCTURAL ALUMINUM ALLOY 6061–T6. EXTERIOR TO BE STEEL UNLESS NOTED OTHERWISE.
3. COORDINATE SIZE AND LOCATION OF OPENINGS THROUGH SLAB AND GRATING WITH MECHANICAL AND PROCESS PLANS.
4. ANCHOR END POST TO ADJACENT WALL WHERE RAILING ENDS AT WALL.



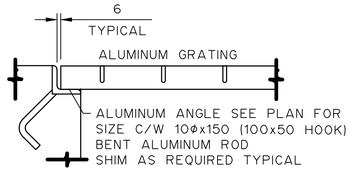
TYPICAL GRATING CHANNEL SUPPORT AT SLAB



TYPICAL GRATING CHANNEL SUPPORT



TYPICAL GRATING SUPPORT



TYPICAL EMBEDDED GRATING SUPPORT

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DRAWN BY: D.A.M. | APPROVED BY:
SCALE: HORIZONTAL: AS SHOWN | VERTICAL: | RELEASED FOR CONSTRUCTION
DATE: 2023–06–14 | DATE:
PLOT DATE: 2023 11 22

MONTH DATE, YEAR
CONSULTANT DRAWING NUMBER: S4.2
BID OPPORTUNITY: --

THE CITY OF WINNIPEG
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ENGINEERING DIVISION

RENFREW OUTFALL GATE CHAMBER
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STRUCTURAL DETAILS

CITY DRAWING NUMBER: 1–0240–XXXX–L1XX–XXX | SHEET X OF X

FILE PATH: M:\N-Data\84\00 City of Winnipeg\006 – Renfrew Outfall Gate Chamber Upgrades\AutoDesk\ACAD\
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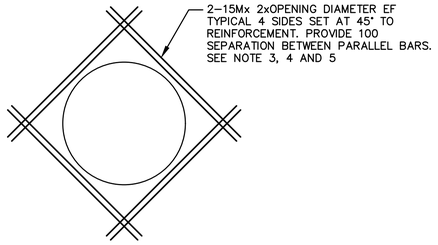
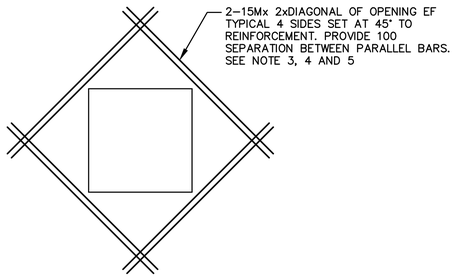


TYPICAL ROUND OPENING REINFORCING
NTS



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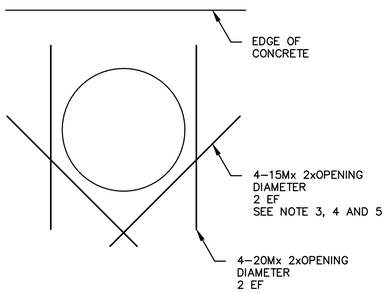

TYPICAL ROUND OPENING REINFORCING FOR EDGE CONDITIONS
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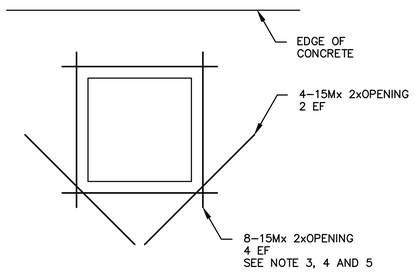

TYPICAL SQUARE OPENING REINFORCING FOR EDGE CONDITIONS
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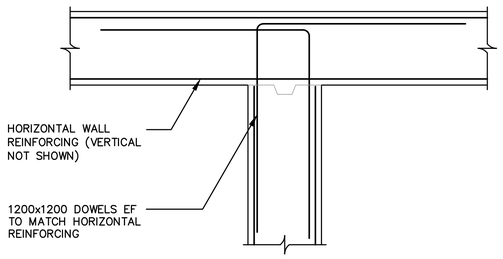
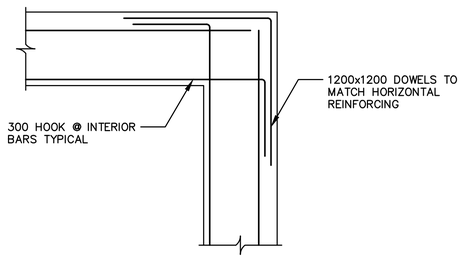
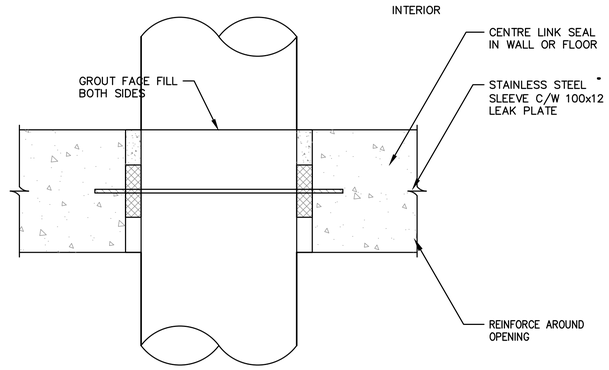


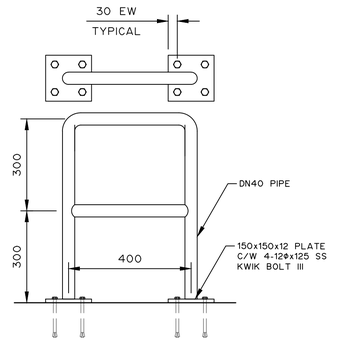
TYPICAL WALL INTERSECTION
NTS



TYPICAL CORNER DETAIL
NTS



TYPICAL PIPE PENETRATION
1:20



TYPICAL GRAB BAR
1:20

NOTES:
1. ALL ELEVATIONS ARE IN METERS AND ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. ALL ALUMINUM IN CONTACT WITH CONCRETE TO HAVE 2–COATS BITUMEN.
3. FOR EACH BAR INTERRUPTED BY OPENING, IN THE PRIMARY REBAR DIRECTION ADD BAR TO EITHER SIDE OF OPENING. EXTEND BAR TO MINIMUM 900 PAST EACH EDGE OF OPENING. TYPICAL TOP AND BOTTOM. ALLOW MINIMUM 40 SPACING BETWEEN BARS TYPICAL FOR ALL OPENINGS.
4. TYPICAL REINFORCING DETAILS FOR OPENINGS APPLY TO ALL OPENINGS GREATER OR EQUAL TO 200ø FOR SLAB, 100ø FOR WALLS. UNLESS NOTED OTHERWISE IN NOTE 5.
5. FOR OPENINGS THAT ARE SPACED CLOSER THAN OR EQUAL TO 600 PROVIDE OPENING REINFORCING AS IF IT IS ONE PENETRATION.
6. SERRATED ALUMINUM GRATING C/W 6063–T6 BEARING BARS AND 6063–T5 CROSS BARS. ALL ALUMINUM GRATING IS TO BE CLIPPED TO SUPPORTING MEMBERS.
7. ALL INTERIOR MEMBERS TO BE STRUCTURAL ALUMINUM ALLOY 6061–T6. EXTERIOR TO BE STEEL UNLESS NOTED OTHERWISE.
8. COORDINATE SIZE AND LOCATION OF OPENINGS THROUGH SLAB AND GRATING WITH MECHANICAL AND PROCESS PLANS.
9. ANCHOR END POST TO ADJACENT WALL WHERE RAILING ENDS AT WALL.

NO.	DRAWING NUMBER	REFERENCE DRAWING TITLE
10		
9		
8		
7		
6		
5		
4		
3		
2		
1		

REFERENCE DRAWINGS

METRIC
WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES
UNLESS OTHERWISE NOTED

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
MPE, A DIVISION OF ENGLOBE CORP.
No. 4968

B.M.
ELEV.

NO.	REVISIONS	DATE	BY
A	FOR 66% REVIEW	2023–11–20	D.A.M.

MPE a division of Englobe

DESIGNED BY	B.B.	CHECKED BY	
DRAWN BY	D.A.M.	APPROVED BY	
SCALE: HORIZONTAL	AS SHOWN	RELEASED FOR CONSTRUCTION	
VERTICAL			
DATE	2023–06–14	DATE	

PLOT DATE: 2023 11 22

MONTH DATE, YEAR
CONSULTANT DRAWING NUMBER
S4.3

BID OPPORTUNITY: --

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT
ENGINEERING DIVISION

RENFREW OUTFALL GATE CHAMBER
2024 UPGRADES
STRUCTURAL DETAILS

CITY DRAWING NUMBER 1–0240–XXXX–L1XX–XXX | SHEET X OF X

FILE PATH: M:\N–Data\84\00 City of Winnipeg\006 – Renfrew Outfall Gate Chamber Upgrades\AutoDesk\ACAD\
FILE NAME: S4.1 – S4.3 Details.dwg

Appendix B

Laboratory Testing Results

MEMORANDUM

TREK GEOTECHNICAL Quality Engineering | Valued Relationships

Date	September 21, 2023
To	Jagdeep Sidhu, TREK Geotechnical
From	Angela Fidler-Kliewer, TREK Geotechnical
Project No.	0512-013-00
Project	Renfrew Outfall Gate Chamber Upgrades
Subject	Laboratory Testing Results – Lab Req. R23-446
Distribution	Michael Van Helden

Attached are the laboratory testing results for the above noted project. The testing included moisture content determinations, Atterberg Limits, particle size distribution (Hydrometer method) and Shelby Tube visual classification and related testing.

Regards,

Angela Fidler-Kliewer, C.Tech.

Attach.

Review Control:

Prepared By: TN	*Reviewed By:* AFK	*Checked By:* NJF

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TREK GEOTECHNICAL

LABORATORY REQUISITION

BMH/DS

Bulk unit weight

CLIENT MPE Architects **PROJECT NO:** 0512-013-00

PROJECT NAME Renfrew Outfall Gate Chamber Upgrades **FIELD TECHNICIAN:** Jagdeep Sidhu

TEST HOLE NUMBER	SAMPLE NUMBER	DEPTH OF SAMPLE (ft)	TARE NUMBER (LAB USE ONLY)	MOISTURE	VISUAL CLASS.	ATTERBERG LIMITS	HYDROMETER	GRADATION	STD. PROCTOR	UNCONFINED AND AUXILLARY TESTS					Soil Description/Comments
TH23-01	G1	0.0 - 0.5		X											
TH23-01	G2	3.0 - 3.5		X											
TH23-01	G3	4.5 - 5.0		X											
TH23-01	G4	7.0 - 7.5		X											
TH23-01	T5	10.0 - 12.0		X	X	X				X					
TH23-01	T6	15.0 - 17.0		X	X	X				X					
TH23-01	G7	19.0 - 20.0		X											
TH23-01	G8	22.0 - 23.0		X											
TH23-01	T9	25.0 - 27.0		X	X	X				X					
TH23-01	G10	29.0 - 30.0		X											
TH23-01	SS11	30.0 - 31.5		X											
TH23-01	G12	33.0 - 34.0		X			X								
TH23-01	SS13	35.0 - 36.5		X											
TH23-01	G14	39.0 - 40.0		X											
TH23-01	SS15	40.0 - 41.5		X											
TH23-01	SS16	45.0 - 46.5		X											

REQUESTED BY: Jagdeep Sidhu **REPORT TO:** JSS/MVH

REQUISITION DATE: 1st Sept. **DATE REQUIRED:** ASAP

COMMENTS:

REQUISITION NO. R23-446

PAGE 1 OF 1

TREK LABORATORY REQUISITION LOGS 2023-09-08 RENFREW OUTFALL CHAMBER UPGRADE 0_A_JSS 0512-013-00.GPJ TREK GEOTECHNICAL.GDT 8/9/23

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Moisture Content Report
ASTM D2216-98

Project No. 0512-013-00
Client MPE Engineering
Project Renfrew Outfall Gate Chamber Upgrades

Sample Date 08-Sep-23
Test Date 14-Sep-23
Technician DS

Test Hole	TH23-01	TH23-01	TH23-01	TH23-01	TH23-01	TH23-01
Depth (m)	0.0 - 0.2	0.9 - 1.1	1.4 - 1.5	2.1 - 2.3	5.8 - 6.1	6.7 - 7.0
Sample #	G01	G02	G03	G04	G07	G08
Tare ID	E80	M35	F13	M65	E52	N28
Mass of tare	6.8	7.0	6.8	6.9	6.9	6.9
Mass wet + tare	216.3	216.1	207.4	233.4	249.7	219.0
Mass dry + tare	197.1	169.2	154.4	168.2	169.7	148.2
Mass water	19.2	46.9	53.0	65.2	80.0	70.8
Mass dry soil	190.3	162.2	147.6	161.3	162.8	141.3
Moisture %	10.1%	28.9%	35.9%	40.4%	49.1%	50.1%

Test Hole	TH23-01	TH23-01	TH23-01	TH23-01	TH23-01	TH23-01
Depth (m)	8.8 - 9.1	9.1 - 9.6	10.1 - 10.4	10.7 - 11.1	11.9 - 12.2	12.2 - 12.6
Sample #	G10	SS11	G12	SS13	G14	SS15
Tare ID	H69	M19	E96	M08	M48	M37
Mass of tare	6.8	7.0	7.0	6.8	6.9	6.8
Mass wet + tare	285.9	268.8	411.2	190.6	331.0	277.8
Mass dry + tare	256.0	240.2	374.2	174.3	305.2	258.3
Mass water	29.9	28.6	37.0	16.3	25.8	19.5
Mass dry soil	249.2	233.2	367.2	167.5	298.3	251.5
Moisture %	12.0%	12.3%	10.1%	9.7%	8.6%	7.8%

Test Hole	TH23-01					
Depth (m)	13.7 - 14.2					
Sample #	SS16					
Tare ID	E48					
Mass of tare	6.7					
Mass wet + tare	228.9					
Mass dry + tare	211.7					
Mass water	17.2					
Mass dry soil	205.0					
Moisture %	8.4%					

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Atterberg Limits
ASTM D4318-10e1

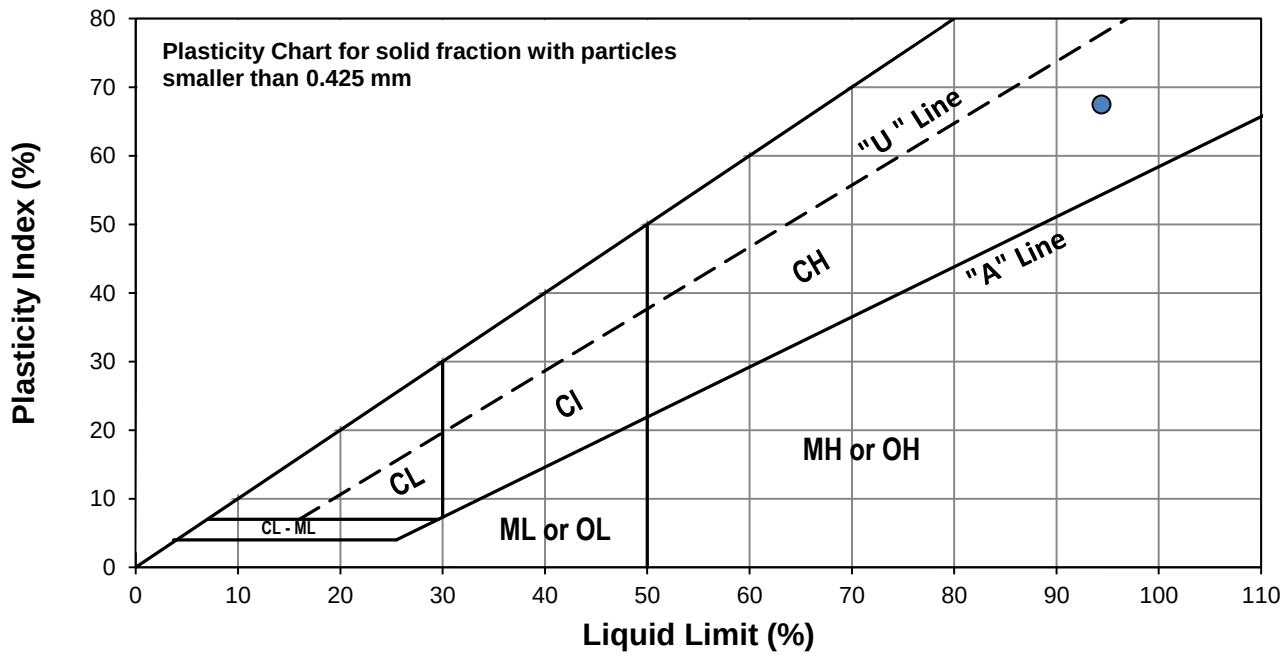
CERTIFIED BY CCIL Canadian Council of Independent Laboratories For specific tests as listed on www.ccil.com

Project No.	0512-013-00
Client	MPE Engineering
Project	Renfrew Outfall Gate Chamber Upgrades
Test Hole	TH23-01
Sample #	T05
Depth (m)	3.0 - 3.7
Sample Date	08-Sep-23
Test Date	18-Sep-23
Technician	TN

Liquid Limit	94
Plastic Limit	27
Plasticity Index	67

Liquid Limit

Trial #	1	2	3		
Number of Blows (N)	15	20	33		
Mass Tare (g)	14.007	13.982	14.205		
Mass Wet Soil + Tare (g)	24.116	24.216	24.319		
Mass Dry Soil + Tare (g)	19.051	19.173	19.498		
Mass Water (g)	5.065	5.043	4.821		
Mass Dry Soil (g)	5.044	5.191	5.293		
Moisture Content (%)	100.416	97.149	91.083		



Plastic Limit

Trial #	1	2	3	4	5
Mass Tare (g)	13.954	13.967			
Mass Wet Soil + Tare (g)	26.875	25.548			
Mass Dry Soil + Tare (g)	24.124	23.092			
Mass Water (g)	2.751	2.456			
Mass Dry Soil (g)	10.170	9.125			
Moisture Content (%)	27.050	26.915			

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

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Shelby Tube Visual

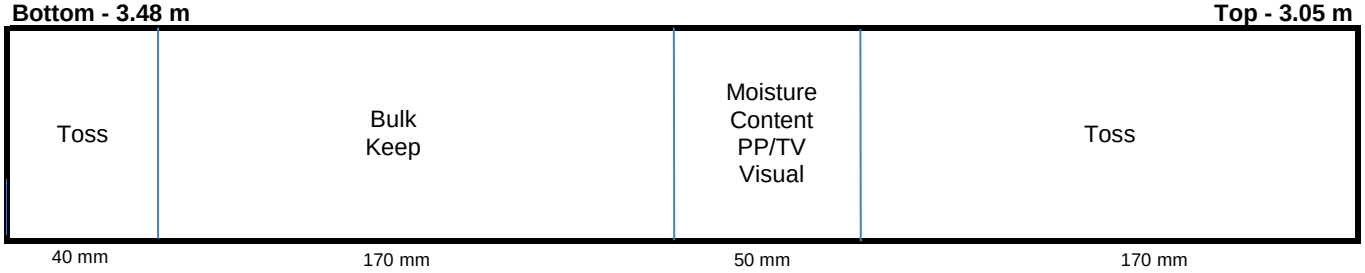
Project No.	0512-013-00
Client	MPE Engineering
Project	Renfrew Outfall Gate Chamber Upgrades
Test Hole	TH23-01
Sample #	T05
Depth (m)	3.0 - 3.7
Sample Date	08-Sep-23
Test Date	14-Sep-23
Technician	BMH

Tube Extraction

Recovery (mm) 430

3.44 m | 3.27 m | 3.22 m

Bottom - 3.48 m **Top - 3.05 m**



Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<5 mm diam.)	
trace precipitates (sulphates)	
trace oxidation	
Color	brown and gray
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	laminated (alternating layers, brown and gray, <5mm)
Gradation	-

Torvane

Reading	0.60
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	58.8

Pocket Penetrometer

Reading	**1**	1.30
	2	1.20
	3	1.20
	Average	1.23
Undrained Shear Strength (kPa)		60.5

Moisture Content

Tare ID	D5
Mass tare (g)	8.3
Mass wet + tare (g)	426.3
Mass dry + tare (g)	290.3
Moisture %	48.2%

Unit Weight

Bulk Weight (g)		1056.0
Length (mm)	**1**	151.10
	2	151.02
	3	156.23
	4	149.90
Average Length (m)		0.152
Diam. (mm)	**1**	72.31
	2	71.69
	3	72.42
	4	71.99
Average Diameter (m)		0.072
Volume (m^3)		6.21E-04
Bulk Unit Weight (kN/m^3)		16.7
Bulk Unit Weight (pcf)		106.2
Dry Unit Weight (kN/m^3)		11.3
Dry Unit Weight (pcf)		71.6

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Atterberg Limits
ASTM D4318-10e1

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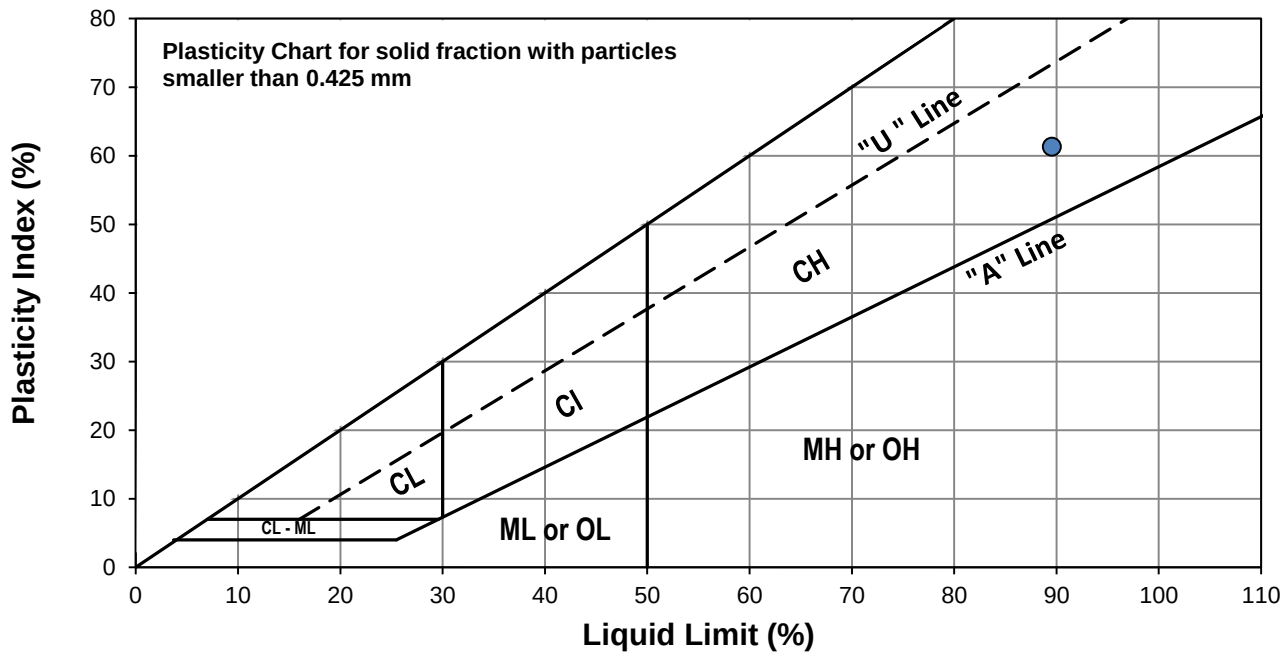
Project No.	0512-013-00
Client	MPE Engineering
Project	Renfrew Outfall Gate Chamber Upgrades
Test Hole	TH23-01
Sample #	T06
Depth (m)	4.6 - 5.2
Sample Date	08-Sep-23
Test Date	18-Sep-23
Technician	TN

Liquid Limit	90
Plastic Limit	28
Plasticity Index	61

Liquid Limit

Trial #	1	2	3		
Number of Blows (N)	17	26	34		
Mass Tare (g)	14.088	14.036	14.055		
Mass Wet Soil + Tare (g)	23.336	23.658	25.192		
Mass Dry Soil + Tare (g)	18.854	19.119	20.050		
Mass Water (g)	4.482	4.539	5.142		
Mass Dry Soil (g)	4.766	5.083	5.995		
Moisture Content (%)	94.041	89.298	85.771		



Plastic Limit

Trial #	1	2	3	4	5
Mass Tare (g)	14.185	14.022			
Mass Wet Soil + Tare (g)	24.513	22.015			
Mass Dry Soil + Tare (g)	22.264	20.233			
Mass Water (g)	2.249	1.782			
Mass Dry Soil (g)	8.079	6.211			
Moisture Content (%)	27.838	28.691			

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

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Shelby Tube Visual

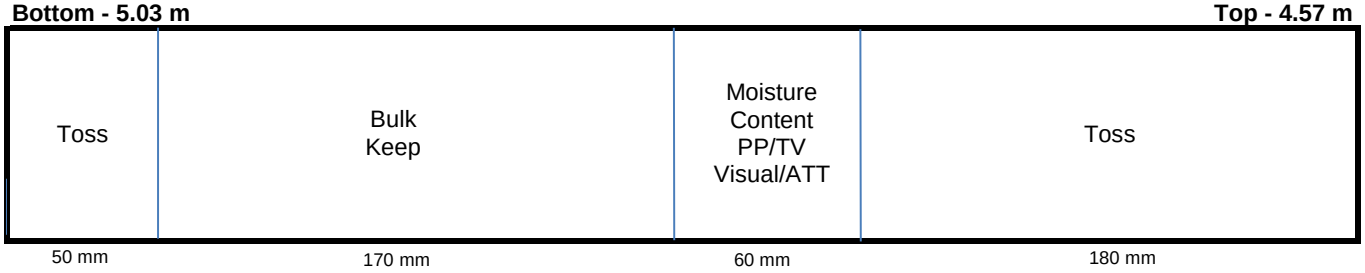
Project No.	0512-013-00
Client	MPE Engineering
Project	Renfrew Outfall Gate Chamber Upgrades
Test Hole	TH23-01
Sample #	T06
Depth (m)	4.6 - 5.2
Sample Date	08-Sep-23
Test Date	14-Sep-23
Technician	BMH

Tube Extraction

Recovery (mm) 460

4.98 m 4.81 m 4.75 m

Bottom - 5.03 m **Top - 4.57 m**



Visual Classification

Material	CLAY
Composition	silty
trace sand, trace gravel (<20 mm diam.)	
trace silt inclusions (<20 mm diam.)	
trace oxidation	
Color	greenish brown
Moisture	moist
Consistency	firm to stiff
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.50
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	49.0

Pocket Penetrometer

Reading	**1**	1.30
	2	1.20
	3	1.40
	Average	1.30
Undrained Shear Strength (kPa)		63.7

Moisture Content

Tare ID	Z71
Mass tare (g)	8.5
Mass wet + tare (g)	391.4
Mass dry + tare (g)	261.4
Moisture %	51.4%

Unit Weight

Bulk Weight (g)		1073.8
Length (mm)	**1**	151.37
	2	151.09
	3	151.06
	4	152.07
Average Length (m)		0.151
Diam. (mm)	**1**	71.52
	2	71.82
	3	71.26
	4	72.56
Average Diameter (m)		0.072
Volume (m^3)		6.13E-04
Bulk Unit Weight (kN/m^3)		17.2
Bulk Unit Weight (pcf)		109.4
Dry Unit Weight (kN/m^3)		11.3
Dry Unit Weight (pcf)		72.3

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Atterberg Limits
ASTM D4318-10e1

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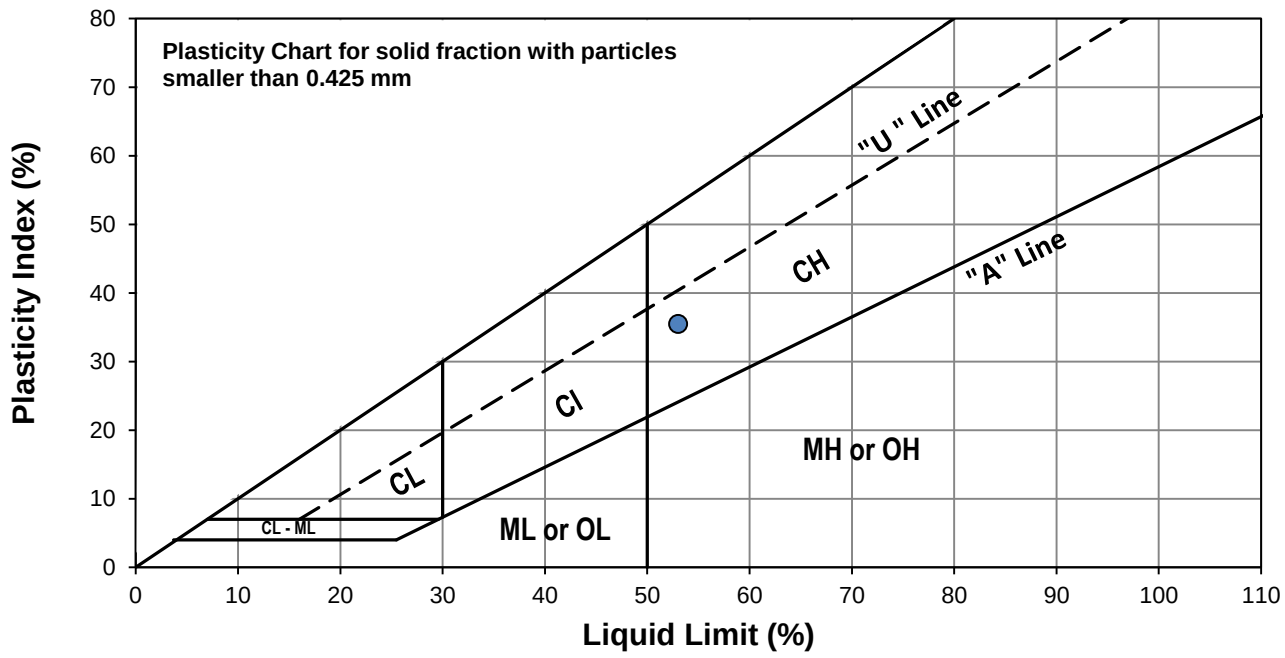
Project No.	0512-013-00
Client	MPE Engineering
Project	Renfrew Outfall Gate Chamber Upgrades
Test Hole	TH23-01
Sample #	T09
Depth (m)	7.6 - 8.2
Sample Date	09-Sep-23
Test Date	18-Sep-23
Technician	TN

Liquid Limit	53
Plastic Limit	18
Plasticity Index	35

Liquid Limit

Trial #	1	2	3		
Number of Blows (N)	18	22	28		
Mass Tare (g)	14.199	14.197	13.184		
Mass Wet Soil + Tare (g)	24.104	24.336	24.520		
Mass Dry Soil + Tare (g)	20.467	20.712	20.694		
Mass Water (g)	3.637	3.624	3.826		
Mass Dry Soil (g)	6.268	6.515	7.510		
Moisture Content (%)	58.025	55.625	50.945		



Plastic Limit

Trial #	1	2	3	4	5
Mass Tare (g)	14.099	14.217			
Mass Wet Soil + Tare (g)	22.417	26.157			
Mass Dry Soil + Tare (g)	21.153	24.403			
Mass Water (g)	1.264	1.754			
Mass Dry Soil (g)	7.054	10.186			
Moisture Content (%)	17.919	17.220			

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

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Shelby Tube Visual

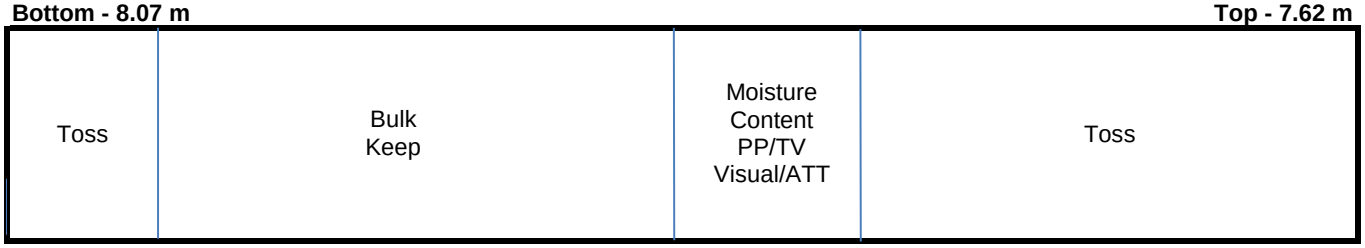
Project No.	0512-013-00
Client	MPE Engineering
Project	Renfrew Outfall Gate Chamber Upgrades
Test Hole	TH23-01
Sample #	T09
Depth (m)	7.6 - 8.2
Sample Date	08-Sep-23
Test Date	14-Sep-23
Technician	BMH

Tube Extraction

Recovery (mm) 450

8.02 m 7.85 m 7.79 m

Bottom - 8.07 m **Top - 7.62 m**



Visual Classification

Material	CLAY
Composition	silty
trace sand	
trace gravel (< 30mm diam.)	
trace to some silt till inclusions (<50 mm diam.)	
Color	dark gray
Moisture	moist
Consistency	firm
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

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

Pocket Penetrometer

Reading	**1**	0.60
	2	0.70
	3	0.70
	Average	0.67
Undrained Shear Strength (kPa)		32.7

Moisture Content

Tare ID	E01
Mass tare (g)	6.8
Mass wet + tare (g)	468.7
Mass dry + tare (g)	340.7
Moisture %	38.3%

Unit Weight

Bulk Weight (g)		1116.7
Length (mm)	**1**	144.48
	2	143.88
	3	144.60
	4	146.09
Average Length (m)		0.145
Diam. (mm)	**1**	71.74
	2	71.14
	3	71.74
	4	71.68
Average Diameter (m)		0.072
Volume (m^3)		5.82E-04
Bulk Unit Weight (kN/m^3)		18.8
Bulk Unit Weight (pcf)		119.7
Dry Unit Weight (kN/m^3)		13.6
Dry Unit Weight (pcf)		86.5

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

Grain Size Analysis (Hydrometer Method)
AASHTO T 88

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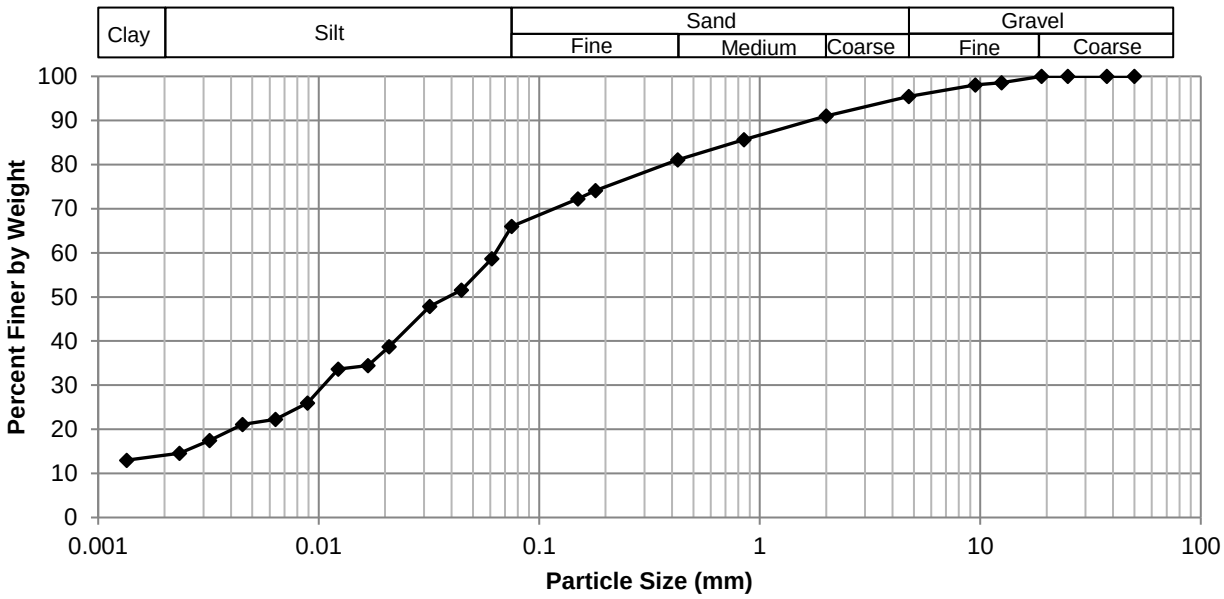
Project No.	0512-013-00
Client	MPE Engineering
Project	Renfrew Outfall Gate Chamber Upgrades
Test Hole	TH23-01
Sample #	G12
Depth (m)	10.1 - 10.4
Sample Date	06-Sep-23
Test Date	18-Sep-23
Technician	TG/AD

Gravel	4.6%
Sand	29.4%
Silt	51.5%
Clay	14.5%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	95.44	0.0750	66.00
37.5	100.00	2.00	91.05	0.0610	58.65
25.0	100.00	0.850	85.66	0.0444	51.54
19.0	100.00	0.425	81.07	0.0319	47.84
12.5	98.57	0.180	74.10	0.0209	38.73
9.50	98.07	0.150	72.23	0.0168	34.47
4.75	95.44	0.075	66.00	0.0123	33.61
				0.0089	25.93
				0.0064	22.26
				0.0045	21.12
				0.0032	17.49
				0.0023	14.55
				0.0013	13.00

Appendix C

Rock Core Photos


Top
47'
Bottom
49'
Renfrew Outfall Gate Chamber Upgrades 0512-013-00
EIT JSidhu TH23-01 C1 47-49' 14U 629743 5526505
Friday September8, 2023 5:23:31 PM


Bottom
52.5'
Top
49'
Renfrew Outfall Gate Chamber Upgrades 0512-013-00
EIT JSidhu TH23-01 C2 49-52.5' 14U 629742 5526509
Friday September8, 2023 5:52:03 PM