APPENDIX A

MEMORANDUM – DONALD OUTFALL CHAMBER UPGRADES GEOTECHNICAL SITE INVESTIGATIONS AND HYDROGEOLOGICAL STUDY

MEMORANDUM

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DATE: July 31, 2018

PROJECT NO: 18-0107-005

RE: Donald Outfall Chamber Upgrades
Geotechnical Site Investigations and Hydrogeological Study

1.0 INTRODUCTION

This memorandum summarizes KGS Group's geotechnical site investigations, hydrogeological study, and provides recommendations for design and construction of upgrades to the Donald Outfall chamber. Detailed design drawings of the proposed works are attached to this document.

This memorandum is also suitable for submission to the City of Winnipeg in support of a Waterways Construction Permit Application, since the work will be located within 100 m (350 ft.) of the Assiniboine River in the Designated Floodway Fringe Area.

2.0 SCOPE OF WORK

The detailed scope of works for the geotechnical engineering and hydrogeological services were completed in accordance with KGS Group's proposal dated March 2018 and is detailed in the following sub-sections:

2.1 GEOTECHNICAL SCOPE OF WORK

The geotechnical engineering services completed for this assignment included the following.

Utilities Locate and Site Clearance: KGS Group completed all public utility clearances for site access, including identification and locating all public underground and overhead utilities prior to commencement of the subsurface investigation.

Geotechnical Investigation and Monitoring Program: An on-site drilling program was completed to determine the subsurface soils and groundwater conditions in the vicinity of the proposed outfall chamber upgrade. The program consisted of advancing one (1) test hole into the underlying bedrock including the installation of one (1) Casagrande tip standpipe piezometer in the bedrock. Three (3) nested pneumatic piezometers were installed in the overburden materials to monitor groundwater conditions including two (2) piezometers installed in the clay; and one (1) installed in the underlying till deposit.

Geotechnical Diagnostic Laboratory Testing Program: Diagnostic laboratory tests including moisture content, Atterberg Limits, and grain size analyses were performed on select soil samples to identify engineering properties relevant to this project.

Geotechnical Engineering Evaluation: A geotechnical evaluation of the site conditions including considerations for the proposed chamber expansion works is summarized in this memorandum and includes the following.

- Test hole logs of site stratigraphy incorporate field observations, laboratory test results and estimated elevation of the groundwater surface. A site plan showing the location of the completed test hole (TH18-01) is presented on Figure 1.

- Design parameters for the outfall chamber expansion works include Ultimate Limit States and Serviceability Limit States bearing capacity and skin friction values in accordance with the 2015 National Building Code of Canada.

- Information is provided on frost depth, potential for frost-jacking and mitigation measures, drainage requirements, active and passive earth pressure coefficients, lateral pressures for permanent and temporary walls, excavation shoring and drainage.

- A qualitative slope stability assessment of the impact that the proposed works will have on the existing stability of the riverbank and surrounding areas.

2.2 HYDROGEOLOGICAL SCOPE OF WORK

The scope of work for the hydrogeological study included the following:

Background Review: Conduct background review of previous work including drilling and construction of the original gate chamber.

Monitoring Well Drilling: The monitoring well installed in the till and bedrock as part of the geotechnical program will be used to determine on-site stratigraphy including depth of clay, depth to till and depth to bedrock. Stabilized piezometric elevations in the till and bedrock will be measured several times throughout the program.

Review of Regional Geology, Hydrogeology and Historic Groundwater Elevations: Review regional geology and hydrogeology as well as bedrock aquifer piezometric information from provincial monitors to determine typical seasonal fluctuations and record maximums that are typically related to spring melt/flood pressure rise in the aquifer. Seasonal fluctuations related to groundwater pumping will also be examined.

Local Wells: Conduct an initial overview of local well use using the GWDrill data base and initial consultation with Water Licensing. It is anticipated that a more comprehensive well inventory would be required at a later stage of the project.

Depressurization Requirements: An analysis of the potential for basal heave will be conducted in conjunction with the geotechnical program. Based on this analysis, the hydrogeological assessment will discuss preliminary depressurization targets along with implications for future investigations to support groundwater depressurization system design and licensing if required.

Report: The hydrogeological components will be incorporated with the geotechnical assessment into one memorandum/report including all materials prepared.

The scope of work did not include the provision of a depressurization program and noted that if construction depressurization were required, an additional scope of work will be developed to address the items below as part of the Construction Bid Opportunity:

- Pumping well installation and testing;
- Groundwater depressurization plan for the pumping station;
- Performance verification testing;
- Operation support; and
- Well Decommissioning

3.0 GEOTECHNICAL INVESTIGATION PROGRAM

3.1 TEST HOLE DRILLING AND SOIL SAMPLING PROGRAM

On June 7, 2018 KGS Group completed a geotechnical drilling investigation adjacent to the existing outfall chamber. The drilling program consisted of one (1) deep test hole advanced within the underlying bedrock. The test hole was advanced to power auger refusal at the base of the glacial till on bedrock at an approximate elevation of 216.1 m±. The bedrock was then cored to the final test hole elevation of 210.4 m±. The approximate location of the test hole (TH18-01) is shown on Figure 1. Drilling services were provided by Maple Leaf Drilling Ltd. under continuous KGS Group supervision. The test hole was completed using a Mobile Drill B54X track mounted rig equipped with solid stem augers for the overburden materials and HQ3 size core barrel for the bedrock.

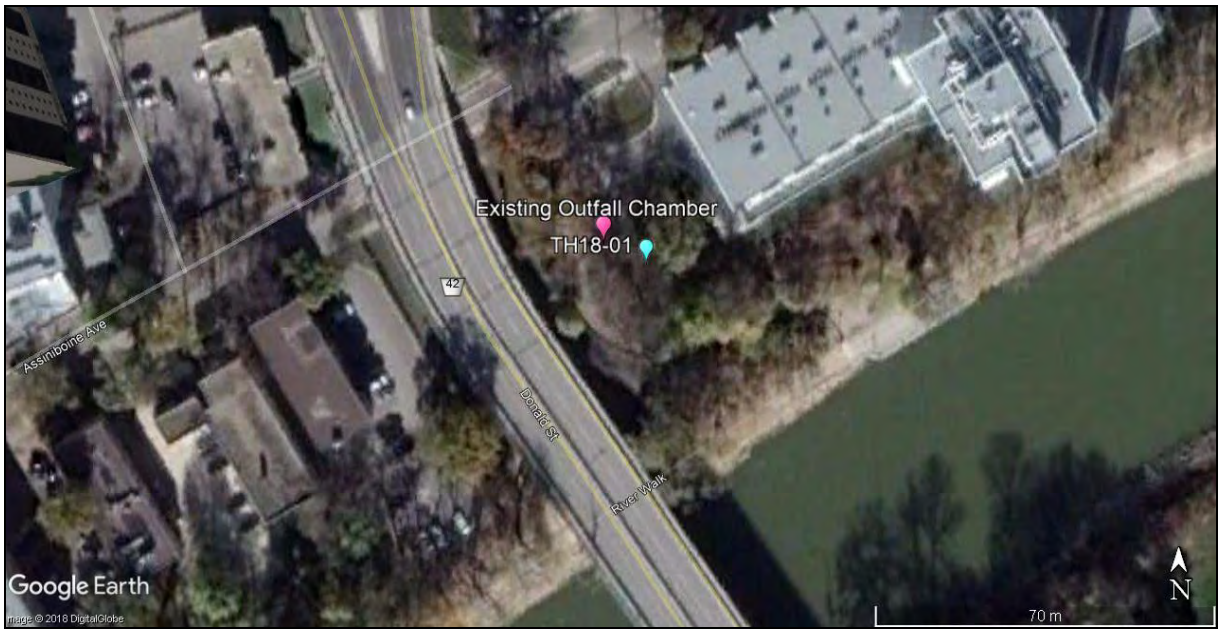


FIGURE 1: TEST HOLE LOCATION PLAN

Representative disturbed soil samples were collected directly off the auger flights at 1.5 m intervals or at changes in soil strata encountered during drilling. The soil samples were visually inspected for material type and classified according to the modified Unified Soil Classification System (USCS). All clay samples were tested with a field Torvane to evaluate consistency and to estimate undrained shear strengths. Upon reaching power auger refusal, casing was set and bedrock coring continued. A continuous bedrock core sample was obtained within the bedrock for the purposes of logging.

Upon completion of drilling and coring, the test hole was examined for indications of sloughing, squeezing and seepage. One (1) Casagrande tip standpipe piezometer zone was installed between El. 211.3 m± and 210.4 m±, and the piezometer screen was backfilled with sand within the bedrock. Three (3) nested pneumatic piezometers were installed within the overburden materials with one (1) piezometer installed within the till at El. 216.2 m± and two (2) piezometers installed within the clay at El 219.9 m± and El. 224.4 m±. The test hole was backfilled with a cement-bentonite grout mix from the top-of-bedrock to existing grade.

A detailed summary soil log incorporating all field observations and laboratory test results is provided in Appendix A.

3.2 LABORATORY TESTING

A diagnostic laboratory testing program was performed on representative soil samples to determine the relevant engineering properties of the subsurface soils. Diagnostic testing included: ten (10) moisture contents, two (2) Atterberg Limit analyses, and one (1) grain size analysis. All laboratory testing was completed at a Standards Council of Canada accredited soil testing laboratory in Winnipeg, Manitoba, in accordance with ASTM Standards. Laboratory testing results are provided in Appendix A.

4.0 GEOTECHNICAL INVESTIGATION RESULTS

4.1 SITE STRATIGRAPHY

In general, the soil stratigraphy at the site has been interpreted by KGS Group to consist of a thin layer of topsoil, fill, and silt, overlaying high plasticity silty clay, glacial silt till, underlain by limestone bedrock. The till surface was encountered at 14.0 m depth below grade (EL. 216.5 m±).

Topsoil, Fill, and Silt

Topsoil was encountered at grade in TH18-01. The topsoil, 0.3 m in thickness, was black to dark brown in colour, damp to moist, and primarily composed of amorphous peat mixed with silt.

Silty clay fill was encountered directly beneath the topsoil and extended to 0.9 m depth below grade (EL. 229.6 m±). The silty clay fill was brown to grey in colour, damp, stiff in consistency, of low plasticity, and contained gravel. The thickness of the silty clay fill layer was 0.6 m.

Silt was observed beneath the fill material and extended to 1.5 m depth below grade (EL. 229.0 m±). The silt was brown in colour, damp, and contained some organics.

Silty Clay (CH)

A deposit of high plasticity silty clay was encountered beneath the silt and extended to 14.0 m depth below grade (EL. 216.5 m±). The silty clay was brown in colour, moist, firm to stiff in

consistency, of high plasticity and contained silt inclusions. The silty clay became grey in colour and contained some fine grained sand, below 6.7 m depth (EL. 223.8 m±). The consistency of the grey silty clay remained firm to stiff throughout the stratum with a localized decrease (soft) around the assumed water table at 6.7 m depth below grade.

The undrained shear strength, estimated from the field Torvane on disturbed auger cutting samples, typically ranged from 20 kPa to 60 kPa, with localized readings of 10 kPa recorded at 6.7 m depth below grade. The moisture content of the silty clay ranged from 24% to 44%. Atterberg Limit testing was completed on two samples of silty clay and the results are summarized in Table 1.

TABLE 1
ATTERBERG LIMIT ANALYSES RESULTS

Sample Depth	Liquid Limit	Plastic Limit	Plasticity Index	Classification
2.1 m	62	21	41	CH
12.8 m	72	20	52	CH

Glacial Till
Glacial silty clay till was encountered below the silty clay at 14.0 m depth below grade (EL. 216.5 m±). The silty clay till was light brown to grey in colour, moist, compact to dense, of low plasticity, contained some fine to coarse grained sand, and trace fine grained gravel.

The moisture content of one (1) silt till sample tested was 21.5%. The material was comprised of 3% gravel, 17% sand, 56% silt, and 23% clay based on one (1) grain size analysis.

Power auger refusal was achieved on bedrock at 14.4 m depth below grade (EL. 216.1 m±).

Bedrock
The bedrock was encountered at 14.4 m depth below grade (EL. 216.1 m±). In general, the bedrock was a limestone underlain by dolomitic limestone. The limestone was light grey to tan in colour, moderate to lightly fractured, with localized mottled texture. The dolomitic limestone was separated from the limestone by trace red to brown shale zones from 16.3 m± to 16.8 m± depth below grade. The dolomitic limestone was tan to light brown in colour, fine grained, fairly massive, moderately fractured, with localized mottled texture and weak bonding.

Rock Quality Designation (RQD) values of the bedrock generally ranged from 72% to 90% resulting in a description of the bedrock quality as fair to good. Detailed logs of the bedrock fracture characteristics are included in Appendix A.

4.2 GROUNDWATER CONDITIONS

Groundwater infiltration from the silt till layer was observed during drilling. The water level was 6.7 m depth below grade at the completion of drilling. Squeezing of the test hole sidewall was observed at 7.6 m depth below upon completion of drilling.

One (1) Casagrande tip standpipe piezometer was installed within the limestone bedrock. The sand and screened zone for the standpipe was installed between 19.2 m to 20.1 m depth (EL.

211.3 to 210.4 m±). Three (3) nested pneumatic piezometers were installed in the overburden materials: one (1) installed in the silt till layer at 14.3 m depth (EL. 216.2 m±); and two (2) installed in the clay at 10.7 m (EL. 219.9 m±) and 6.1 m (EL. 224.4 m±) depth below grade. At the time of this memorandum, the groundwater level had been read twice, as shown in Table 2. Groundwater levels fluctuate seasonally and following precipitation events and therefore the actual water level at the time of construction may differ from those in this report.

TABLE 2
PIEZOMETRIC MONITORING RESULTS

Test Hole:		**TH18-01**			
Ground Elevation (m):		**230.54**			
Piezometer No.:		**PN 037698**	**PN 037699**	**PN 037844**	**STP-1**
Top of Pipe Elevation (m):					**231.49**
Tip Elevation (m):		**224.44**	**219.87**	**216.21**	**210.73**
Monitoring Zone:		**Silty Clay**	**Silty Clay**	**Till**	**Bedrock**
Date	**River Level (m)[1]**	**Piezometric Elevation (m)**			
18-Jun-18	223.85±	224.64	226.14	223.86	223.71
9-Jul-18	223.91	224.71	225.66	224.93	223.58
11-Jul-18	223.96	---	---	---	223.68
19-Jul-18	223.98	224.71	225.80	224.86	223.64

Notes:
1) Assiniboine River Level estimated at Osborne St. Bridge from publically available data at www.winnipeg.ca/waterandwaste

5.0 GEOTECHNICAL DESIGN CONSIDERATIONS

5.1 OUTFALL CHAMBER FOUNDATIONS

The foundation considerations described in this report follow the Limit States Design (LSD) guidelines. Limit States Design requires consideration of two (2) main loading states: Ultimate Limit States and Serviceability Limit States. For foundation design, each loading state prescribes Geotechnical Resistance Factors (Φ) that are based upon the method used to evaluate foundation capacity to obtain the Factored Serviceability Limit State (SLS) and Factored Ultimate Limit State (ULS) foundation capacity values. A Geotechnical Resistance Factor (Φ) of 0.4 was applied to the factored ULS value presented below.

The proposed outfall chamber works will be supported by a reinforced concrete base slab bearing on a lean-mix concrete working slab, bearing directly on the in-situ silty clay soil. The working and base slabs can be designed on the basis of a factored Ultimate Limit State (ULS) bearing capacity value of 70 kPa for the silty clay soil at the approximate excavation base elevation, EL. 221.5 m±.

The following is recommended for preparation of the subgrade:

- Excavate to the subgrade design elevation and proof-roll compact the subgrade. If soft spots or areas of unsuitable deflection are encountered, the subgrade should be sub-excavated an additional 300 mm and replaced with compacted granular.
- The granular should be placed in 150 mm thick lifts and compacted to 98% Standard Proctor Maximum Dry Density (SPMDD). All granular material shall conform to the City of Winnipeg Standard Material Specifications.
- Inspection of the prepared subgrade foundation should be provided by experienced geotechnical personnel prior to construction of the lean-mix working slab.

Construction depressurization requirements for the bedrock aquifer are discussed in Section 7.0.

5.2 LATERAL EARTH PRESSURE

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

TABLE 3
LATERAL EARTH PRESSURE COEFFICIENTS

Backfill Material	ϕ'	K_a	K_p	K_o
Glacial Till	25°	0.41	2.46	0.58
Silty Clay	18°	0.53	2.0	0.69
Well Graded Compacted Granular	35°	0.27	3.69	0.42

5.3 TEMPORARY EXCAVATIONS AND SHORING

Temporary excavations will be required to facilitate the construction of the proposed outfall chamber expansion. All excavation works are required to be performed in accordance with the Manitoba Workplace Safety and Health Act and Regulation.

Excavations performed adjacent to existing roadway or infrastructure, require temporary shoring or bracing. Excavations deeper than 1.5 m are required to be designed and approved prior to construction by an experienced professional engineer with an expertise in geotechnical engineering. The shoring design should account for all applicable surcharge loads. Openings and voids behind shoring lagging or sheet piles will be backfilled with free draining granular materials.

The silt and silty clay soils are known to be water bearing and are susceptible to strength loss when subjected to mechanical disturbance and sloughing from wetting. All open excavation side slopes should be covered with waterproof material to prevent saturation of the soil and all surface runoff should be directed away from the excavations. All surcharge loads such as stockpiled soil, equipment, etc., should be maintained a minimum of 10 m away from the edge of excavations.

5.4 BASAL HEAVE

The base of excavation and shoring should be designed to achieve a minimum factor of safety of 1.5 with respect to basal heave. Initial groundwater monitoring results at the test hole in the vicinity of the construction area are included in Table 2. Groundwater levels will vary seasonally and wells monitored in the vicinity have had seasonal highs of El. 226.5 m to 227.0 m since 2000. Depending on the groundwater conditions at the time of construction, groundwater depressurization may be required to achieve the specified factor of safety against basal heave. Further discussion of the depressurization requirement including an analysis of basal heave conditions is presented in Section 7.5

5.5 FROST PENETRATION

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 no insulation cover.

Well graded granular materials with less than 5% fines should be used as backfill material as they are less susceptible to the effects of frost heave than fine grained silt and clay material. Soil in contact with foundation elements can freeze to the foundations and develop adfreeze bonding, which can result in uplift forces. The 4th Edition of the Canadian Foundation Engineering Manual (CFEM 2006) recommends the following adfreeze bond stresses for soil and foundation materials:

- 65 kPa for fine grained soils frozen to wood or concrete.
- 100 kPa for fine grained soils frozen to steel.
- 150 kPa for saturated gravel frozen to steel.

6.0 SITE INSPECTION AND SLOPE STABILITY ASSESSMENT

A visual inspection and qualitative slope stability assessment of the riverbank within the Donald Outfall property (318 Assiniboine Avenue) was performed in July 2018. The section of riverbank is located along the north bank on a relatively straight section of the Assiniboine River immediately downstream of the Donald Street Bridge and approximately 680 m upstream of the confluence with the Red River. Photos from the site visit are provided as Appendix B.

The Donald Outfall site is characterized by a relatively flat upper bank area that extends from the location of the existing outfall chamber to the east property line with 300 Assiniboine Avenue as shown in Photos 1 and 2. The upper bank area is elevated from the Assiniboine Avenue roadway and slopes down uniformly at approximately 3.5H:1V to the access pathway as shown in Photo 3. Immediately downslope of the access pathway a mid-bank bench vegetated with some mature trees extends for approximately 5.8 m± as shown on Photos 4 and 5. The mid bank bench slopes down uniformly at approximately 2H:1V to the Assiniboine Riverwalk as shown in Photo 6. Rockfill riprap located along the shoulder of the Riverwalk and exposed above the river level is shown in Photo 7.

The toe of the existing slope is protected by the Riverwalk, which functions as a toe berm to improve global stability of the riverbank and has performed satisfactorily to date with no evidence of substantial slumping. Downslope of the Riverwalk extending into the river, the shoreline is lined with riprap to protect against erosion; the underlying mechanism which is a cause for a majority of riverbanks to fail.

In 2013, KGS Group was authorized by the City of Winnipeg to complete inspections, final design and contract administration for repairs to the Riverwalk berm identified following the 2011 flood. The works were completed under Waterway Permit No. 100/2013. The works included additional rockfill riprap placement along the lower toe area for over one kilometer of Assiniboine River shoreline with the objective of reconstructing the berm to achieve a geometry and stability condition similar to that following initial construction and prior to the observed flooding damage. The repairs included the shoreline at the Donald Outfall property, 318 Assiniboine Avenue. Based on inspection and surveys completed as part of the repair works scope, the berm along this property was founded primarily on granular and till soils within the river channel, where the original lower berm stability had an estimated minimum factor of safety 1.8. Following the lower berm repair works in winter 2014, the long-term stability of the riverbank at the Donald Outfall location has been maintained as no visible headscarps or tension cracks were observed during the 2018 site visit. The KGS Group Letter of Completion for Waterway Permit No. 100/2013 and the as-constructed drawing for the reach including the Donald Outfall are provided as Appendix C.

The proposed works (i.e. concrete chamber expansion and associated gate works) are to be located on the upper bank area, immediately upslope, and adjacent to the north-side of the existing outfall chamber. The top elevation of the existing chamber and proposed chamber expansion are EL. 231.13 m±, which is greater than the designated Flood Protection Level of El. 230.77 m for the property. On this basis, KGS Group concludes the proposed works will have negligible impact to critical bank stability and river hydraulics. As such, we recommend that a Waterways Construction Permit be granted provided the following is performed:

- No fill material is delivered to site to complete the work.
- All debris and excavated materials are immediately hauled off site.
- Materials are not stockpiled within 350 ft. of the Assiniboine River during the work.
- All construction equipment is chosen to limit the disturbance to mature trees and vegetation on the riverbank.

7.0 HYDROGEOLOGICAL ASSESSMENT

7.1 BACKGROUND REVIEW

A background review was conducted of previous work including drilling and construction of the original gate chamber. The main source for this review was the original as-built drawing as shown in Appendix D:

Details of Donald St. Gate Chamber and Outfall City of Winnipeg Dwg. 5615661 Revised as Constructed February 8, 1965.

This plan shows two test holes. TH2 is located close to the proposed expansion approximately 4.3 m west of the existing chamber as shown on the drawing. TH1 is located approximately 20.7 m downslope of TH2, away from the chamber expansion site. The elevation of the top of the gate chamber was determined by KGS Group to be El. 231.133 m, corresponding to local El. +31 ft on the February 8, 1965 drawing. Based on this correlation, the ground surface elevation for the 1964 test holes would be 230.706 m for TH2 and 228.938 m for TH1.

Stratigraphy consisted of brown silty clay overlying grey silty clay. The top of till (putty till) was encountered at El. 216.685 m for TH2. A higher till elevation was encountered at TH1 (217.235m) downslope of the expansion area.

7.2 MONITORING WELL DRILLING

The monitoring well TH18-01 installed in the till and bedrock is part of the geotechnical program and was described in Section 3.0 of this report with the logs (Summary log and Geological Fracture Log) presented in Appendix A. Stratigraphy consisted of topsoil, fill and silt from surface (El. 230.54 m±) to El. 229 m, underlain by silty clay to El. 216.4 m and silty clay till to El. 216.1 m. Limestone bedrock (including zone with red shale lenses) was cored from El. 216.1 m to El. 210.4 m. The rock was moderately to lightly fractured, but there was no evidence of staining on the open fractures in the core examined.

The stabilized groundwater elevation in the bedrock standpipe STP-1 are summarized in Table 2 and ranged from El. 223.71 m to El. 223.58 m. These values are representative of dry summer conditions in a dry year and are likely lower than typical summer conditions. Groundwater levels are expected to rise approximately 2 to 3 m between low summer groundwater elevations and high spring elevations based on regional water levels.

The interconnection between the river and the groundwater elevation has not been assessed in this study; however large precipitation events in the summer/fall that cause large increases in river level may also affect groundwater levels. River elevations from the closest City of Winnipeg Station 800 m upstream at the Osborne St. Bridge ranged from 223.85 m to 223.98 m on June 18 and July 9, 11, and 19, 2018.

7.3 REVIEW OF REGIONAL GEOLOGY, HYDROGEOLOGY AND HISTORIC GROUNDWATER ELEVATIONS

Regional Geology: Regional geology consists of silty clay overburden overlying till with carbonate bedrock beneath the till. Depth to till has been mapped on the east side of the Donald St. Bridge as 9.4 to 12.2 m (31 to 40 ft) and on the west side of the Donald St. Bridge as 12.5 to 15.3 m (41 to 50 ft) based on the Geological Maps and Reports for Urban Development Winnipeg, Baracos et al. 1983). Depth to till from the 1964 site test hole (TH-2) and the 2018 test hole (TH-18-01) (both 14 m) was greater than the mapped depths for the east side of the bridge.

Regional Hydrogeology: The carbonate aquifer is confined by the low permeability silty clay. The initial measured piezometric surface of the carbonate aquifer at El. 223.83 m is 6.7 m below ground surface. Although the permeability of the till is much lower than the bedrock, it is hydraulically connected to the bedrock. Confined conditions in the bedrock are transmitted to the till with resulting piezometric pressures above the top of till surface.

Regional groundwater flow is east south east discharging to the Assiniboine River and Red River. Local variations in groundwater flow are produced by the proximity of the Assiniboine River and by any consumptive use of groundwater in the local area.

Seasonal fluctuations in the piezometric surface are important to examine when designing deep excavations. A confined aquifer is very sensitive to changes in hydraulic pressure. An increase or decrease in pressure is also transmitted a long distance. The rise and fall of the Red and Assiniboine River systems with flood events exerts pressure on the aquifer and can result in rapid changes in piezometric pressure over a short period of time. Pumping of wells for consumptive use within the region also has an additive effect that is seen throughout the area. Examining the long term hydrographs of Provincial monitoring wells close to the project was done to establish the potential

range of aquifer pressures that may be encountered through the duration of planned excavation.

Historic Groundwater Elevations

The following vicinity Provincial well locations are shown on Figure 2:

- G050J021 M0-1 (PID 6909) located 624 m northwest of the site (observation well);
- G05OC004 (PID 8238/8239) located 500 m southeast of the site on the north side of Main St. Bridge and Red River (observation well); and
- G05OJ128 M15 (PID 101613) located 624 m northwest of the site at Main St. and Broadway (production well).

Provincial hydrographs of groundwater elevation versus time from 1965 to 2014 are provided in Appendix E. Updated data to 2018 can be requested from Manitoba Water Stewardship in the next phase of the project if necessary. The period of record is sufficient for the present analysis since it does include record floods (1997, 2009 and 2011). The more recent data may be helpful to determine if there are any changes in regional or local pumping in the 2014 to 2018 period.

Groundwater elevations for March 15 for recent years were used to approximate winter construction conditions, however only G050C004 is close to a river (Red River) with the other locations are likely hydraulically upgradient of the site and possibly less representative.

- G050J021 El. 225.5 m to El. 225.9 m March 15, 2011, 2012, and 2013;
- G05OC004 El. 222.8 m to El. 223.9 m March 15, 2011, 2012, 2013 and 2014; and
- G05OJ128 El.222.9 m to El. 225.2 m March 15, 2014, 2012 and 2011.

Although construction of the chamber is scheduled to be complete by March 15, spring elevations were evaluated to assess the risk if the excavation is not completed before the spring melt.

Maximum spring elevation of these wells was as follows:

- G050J021 approximately El. 227 m in 2009;
- G05OC004 approximately El. 226.4 m in 2011; and
- G05OJ128 approximately El. 226.3 m 2009.

7.4 LOCAL WELLS

An inventory of third party wells has been conducted within approximately 1.6 km of the existing outfall chamber, as shown in Figure 2. It is anticipated that a more comprehensive well inventory would be required at a later stage of the project.
The well inventory was completed based on the 2016 GWDrill data base produced by Manitoba Sustainable Development (MSD) Groundwater Management Section. This data base is in Microsoft Access format and has been used to locate well records in the area current to the end of 2016. Only those records with accurate (50-350 m), very accurate (<50 m), and exact (<5 m)

GPS locations are shown. Sealed wells are not shown. Well use (as defined in the database) includes observation wells, production wells, recharge wells and test wells, however only active production or recharge wells are pertinent to this evaluation. There are also a large number of wells categorized as unknown. They are also shown and may or may not be active.

Approximately 64 third party wells have been located within 1.6 km of the existing outfall chamber including: four (4) wells located east of the Red River, 21 wells located south of the Assiniboine River, and 39 wells located north of the Assiniboine River.

Groundwater within the City of Winnipeg is typically not used as potable water. Many well logs in this area may be associated with groundwater heating/cooling systems; however an individual inventory has not be done at this stage of the project.

A summary of the 54 active or unknown status well locations by distance includes:

- ***Wells within 500 m of the existing outfall chamber (two (2) wells identified):***
    - Status is active: two (2) production wells
- ***Wells within 1000 m of the existing outfall chamber (23 wells identified):***
    - Status is active: nine (9) production and four (4) recharge wells
    - Status unknown: ten (10) wells
- ***Wells within 1600 m of the existing outfall chamber (29 wells identified):***
    - Status is active: 15 production wells and four (4) recharge wells
    - Status unknown: ten (10) wells

The closest wells are located 215 m northwest and 456 m northeast of the existing outfall chamber. The well nearest the site holds a groundwater licence as indicated by MSD's Department of Water Use Licensing. According to the owner Timbercreek Asset Management Inc., the well is used to supply geothermal heating and cooling to 33 Hargrave Street, an apartment block. Further information should be acquired during the next phase of the project regarding 33 Hargrave Street and other wells located within the 1.6 km radius of the site, to determine well usage and water quantity.

Information also provided by MSD Department of Water Use Licensing identified four other wells with water rights licenses within the 1.6 km radius of the site. One of the users is located north of the Assiniboine River and three (3) are located south of the Assiniboine River and west of the Red River.

Typical water quality parameters in the vicinity are expected to be at the following approximate levels based on local wells:

- Conductivity 2500 µmhos/cm;
- Total dissolved solids 1500 mg/L;
- Chloride 400 mg/L; and
- Sodium 300 mg/L.

Brackish or saline water is not expected in this area therefore there should be no issues with groundwater discharge during a potential depressurization program.

7.5 DEPRESSURIZATION REQUIREMENTS

Construction depressurization, or dewatering is required to ensure basal heave or blow out does not occur during excavation. In addition, it is prudent to lower the groundwater piezometric surface below the excavation invert to decrease the possibility of groundwater seepage impacting the construction work.

Factor of Safety Calculations

Factor of Safety calculations were conducted to assess the potential for basal heave. An excavation invert of El. 221.2 m was used which includes the 75 mm working slab and a potential 300 mm excavation for backfill. The analysis was conducted for the new test hole TH18-01, with till El. 216.5 m. An analysis for the historic test hole TH2 which has a similar till elevation was also conducted. A third evaluation at TH1, downslope, with a higher till elevation EL. 217.2 m, was also included but may not be representative. The current July 2018 bedrock piezometric level at TH18-01 is approximately El. 223.7 m based on recent monitoring at vicinity wells, but the spring maximum elevation could be El. 226.5 m to 227.0 m, based on historic hydrographs.

The estimated maximum allowable groundwater level to maintain an estimated Factor of Safety of 1.5 is approximately El. 222.0 m for both the new test hole TH18-01 and the 1964 test hole TH2. The estimated maximum allowable groundwater elevation for TH1 downslope would be slightly less.

A sensitivity analysis was also conducted to maintain a Factor of Safety of 1.3, requiring an estimated allowable maximum groundwater level of approximately El. 223 m at TH18-01 and TH2.

Anticipated Drawdown - Construction Dewatering

Construction dewatering will be required to lower the groundwater level in the bedrock aquifer during shaft excavation and construction. Estimated drawdown required for a Factor of Safety of 1.5 based on current groundwater elevations (El. 223.7 m) at TH18-01 and the shaft would be at least 1.6 m; however greater drawdown would be required to maintain operating levels at least 1 m below the shaft base during pumping.

Excavation is scheduled to be completed prior to March 15, 2019. However if excavation were conducted during spring high water levels, additional pumping would be necessary to achieve an additional 3 m or more of drawdown, assuming record high spring levels. Additional drawdown may be required to prevent seepage into the shaft base during construction.

Seepage Considerations

Construction dewatering drawdown to El. 220 m (1 m below El. 221.2 m, the excavation invert) should be maintained to keep the groundwater level below the excavation and avoid seepage inflow problems. If seepage is not a concern during construction, the dewatering drawdown level could be maintained at El. 222 m to achieve an estimated Factor of Safety of 1.5 against

blowout, or to approximately El. 223 m at an estimated Factor of Safety of 1.3.

Because the outfall chamber is located close to the Assiniboine River, the pumping requirements may be higher if there is connection between the bedrock and the base of the river. The degree of influence may be assessed by a bathymetric survey in the area confirmed by pumping tests at the chamber location.

Recommendations

1. An exploration permit should be submitted for a test drilling program.
2. A test well should be drilled and a pump test should be conducted at the construction chamber to determine the aquifer properties and associated drawdown in the area of work and with distance. This may include installation of both a pumping well as well as an observation well between the site and the closest groundwater user.
3. Based on the test pumping a groundwater depressurization plan for the chamber excavation should be designed including the following:
    - Specifications for construction;
    - Performance verification testing;
    - Operation support; and
    - Well Decommissioning.

Prepared By:

for David Anderson, M.Sc., P.Eng.
Senior Geotechnical Engineer

Prepared By:

Marci Friedman Hamm, M.Sc., P.Geo.
Senior Hydrogeologist

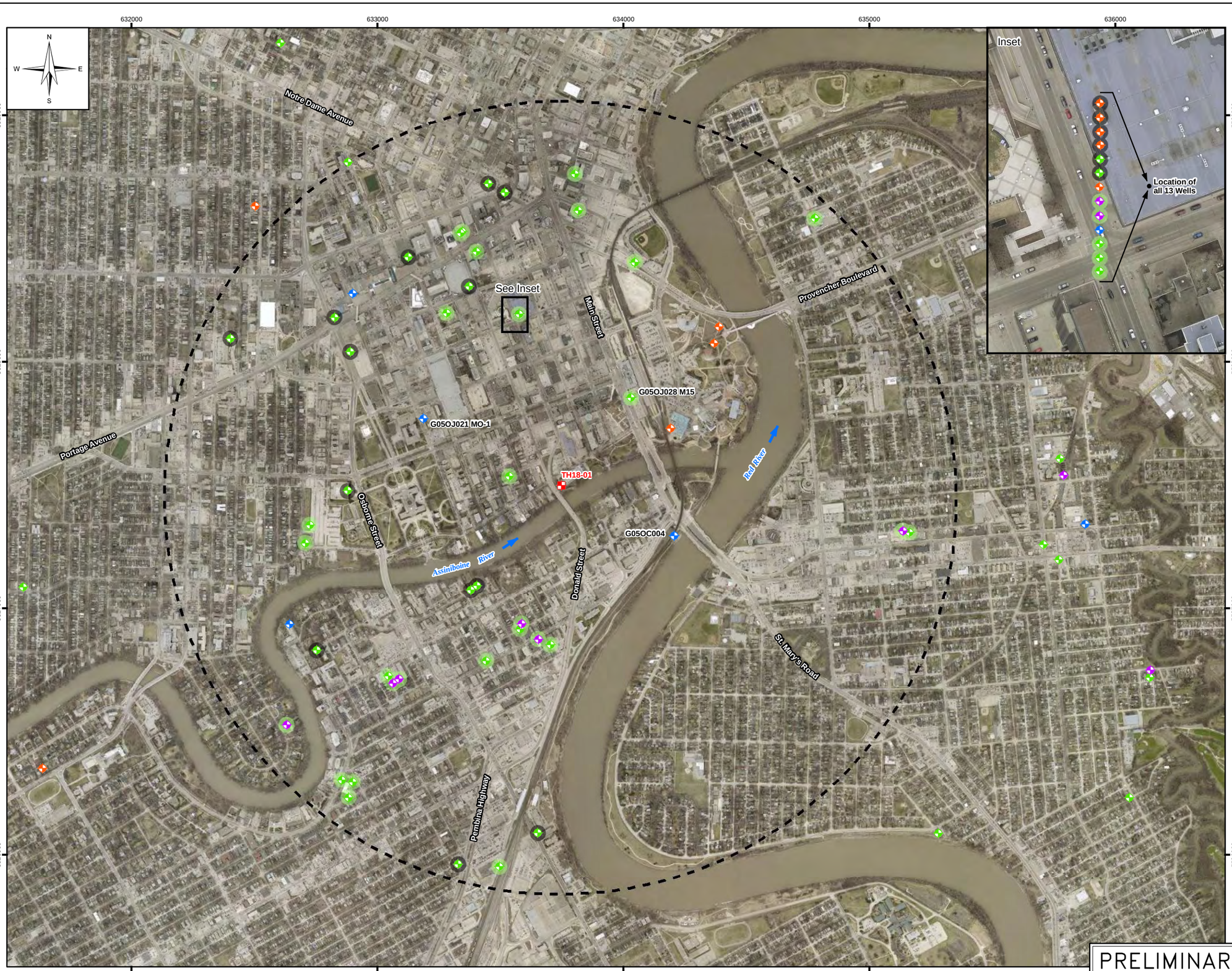
Approved By:

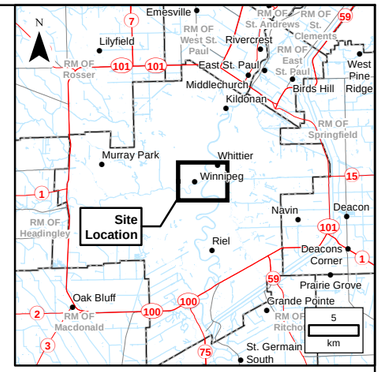
J. Bert Smith, P.Eng.
Principal – Geotechnical/Environmental

KF/LSA/slw
Attachments

FIGURE 02

GW DRILL LOCATIONS PLAN





LEGEND:

- Proposed Pumping Well

GW DRILL (2016)

G05OJ021 MO-1 Well Name

Well Use

- Observation
- Production
- Recharge
- Test Well

Well Status

- Active Production or Recharge (Count = 34)
- Unknown (Count = 20)
- 1.6 Kilometre Buffer

NOTES:

1. Imagery is supplied by ESRI/DigitalGlobe and dated as 2016.
2. All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD 1983, Zone 14. Elevations are in metres above sea level (MSL).

100 0 100 200 300 400 500

Metres

SCALE: 1:15,000 METRIC 11"x17"

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	18/07/31	ISSUED WITH MEMO	LSA	MFH

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Winnipeg

DETAILED DESIGN AND CONSTRUCTION ADMINISTRATION SERVICES FOR THE DONALD OUTFALL CHAMBER UPGRADES

GW DRILL LOCATIONS PLAN

JULY 2018 | FIGURE 02 | REV: 0

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

FileName: P:\Projects\2018\18-0107-005\Dwg\GIS\MXD\Memo\RevA\18-0107-005_Fig02.mxd
11"x17" PLOT SCALE 1:1

APPENDIX A

2018 TEST HOLE LOGS AND LABORATORY TEST RESULTS

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH18-01**

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT

PROJECT Detailed Design and CA Services for Donald Outfall Chamber Upgrades

SITE 318 Assiniboine Ave.

LOCATION East of Existing Donald Outfall Chamber

DRILLING METHOD 125 mm ø Solid Stem Auger, HQ3 Core Barrel, Mobile Drill B54X Track Mounted Rig

JOB NO. **18-0107-005**
GROUND ELEV. **230.54 m±**
TOP OF CASING ELEV.
WATER ELEV.
DATE DRILLED **6/7/2018**
UTM (m) N **633,748**
E **5,527,497**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZO. LOG	DEPTH (m)	SAMPLE TYPE / NUMBER	RECOVERY %
230.2				**TOPSOIL** - Black to dark brown, damp to moist, amorphous peat mixed with silt.				
230				**SILTY CLAY FILL** - Brown to grey, damp, low plasticity, with gravel.				
229.6	1			**SILT** - Brown, damp, no plasticity, with organics.				
229.0		5		**SILTY CLAY (CH)** - Brown, damp to moist, stiff, high plasticity, some silt, some organics.				
229	2						S01	
228								
227	3	10		- Moist, high plasticity, trace oxidation pockets, trace organics below 3.1 m.				
226	4						S02	
225	5	15		- Firm, trace silt inclusions below 4.6 m.			S03	
224	6	20		- Stiff, some silt inclusions below 6.1 m.	PN	5.9 6.1	S04	
223	7	25		- Grey, soft, some fine grained sand, trace silt inclusions below 6.7 m. - Groundwater table observed (free water on augers) at 6.7 m. - Sqeezing observed at 7.6 m.			S05	
222	8			- Firm below 8.1 m.			S06	
221	9	30		- Firm to stiff, trace fine grained sand below 9.1 m.				
220	10	35			PN	10.5 10.7	S07	
219	11						S08	

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE Auger Grab Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	M. Ahmeduzzaman	DEA	7/31/18

GEOTECHNICAL-SOIL LOG U:\FMS\18-0107-005\18-0107-005 DONALD OUTFALL EXPANSION.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH18-01**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZO. LOG	DEPTH (m)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY %
				- Stiff, some silt pockets, no sand below 12.2 m.					
218	13	40					S09		
217		45							
216.5	14			**SILTY CLAY TILL** - Light brown to grey, moist, low plasticity, with fine grained sand, trace fine to coarse grained gravel.		14.2	S10		
216.1				- Grain Size Analysis at 14.2 m: Gravel (3.1%), Sand (17.2%), Silt (56.4%), Clay (23.3%).	PN	14.3			
216						14.6			
	15	50		**POWER AUGER REFUSAL at 14.4 m.** **SWITCHED TO HQ3 CORING**		15.2		R1	100
215				**LIMESTONE** - Light grey and tan, slightly mottled texture locally, moderate to lightly fractured. Grades into zone with red shale. - RQD = 90% from 14.40 m to 15.54 m.					
	16							R2	100
214.2				- RQD = 83% from 15.54 m to 17.07 m.					
214		55		**DOLOMITIC LIMESTONE** - Tan to light brown with red-brown shale zones. Majority of red shale occurs from 16.34 m to 16.75 m. Some red shale from 18.58 m to 18.78 m.		16.8			
	17			- RQD = 72% from 17.07 m to 18.59 m.					
213								R3	100
	18	60							
212				- RQD = 80% from 18.59 m to 20.12 m. - Tan, fine grained, locally mottled texture, otherwise fairly massive with weak bonding/remnant bedding below 18.80 m.					
	19					19.2		R4	100
211						19.5			
		65				19.8			
210.4	20					20.1			
210				**END OF TEST HOLE AT 20.12 m**					
	21	70		Notes: 1) Groundwater observed at 6.7 m below grade immediately upon completion of drilling. 2) Test hole squeezing at 7.6 m below grade immediately upon completion of drilling. 3) Installed three (3) pneumatic piezometers: - PN37698 at 6.10 m below grade - PN37699 at 10.67 m below grade - PN37844 at 14.33 m beow grade 4) Installed one (1) Casagrande tip standpipe piezometer at 19.81 m below grade (stickup of 0.95 m) 5) Test hole backfilled with: - Silica sand from 20.1 m to 19.2 m - Bentonite chips from 19.2 m to 16.8 m - Silica sand from 16.8 m to 15.2 m - Bentonite chips from 15.2 m to 14.6 m - Cement-Bentonite grout mix from 14.6 m to grade 6) Installed above-ground protective casing. 7) Test hole ground elevation estimated from KGS 2018 topographic survey.					
209									
	22								
208									
	23	75							
207									
	24								
		80							
206									
	25								
205									
	26	85							

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE Auger Grab Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	M. Ahmeduzzaman	DEA	7/31/18

GEOTECHNICAL-SOIL LOG U:\FMS\18-0107-005\18-0107-005 DONALD OUTFALL EXPANSION.GPJ

GEOLOGICAL DETAIL FRACTURE LOG

HOLE NO……TH18-01……
SHEET……1…..OF…2……

KGS GROUP CONSULTING ENGINEERS

SITE/LOCATION	Donald Outfall	CLIENT	City of Winnipeg
CONTRACTOR	Maple Leaf Drilling	PROJECT	Donald Outfall Chamber Expansions
CORE DIA.	HQ	PROJECT NO.	
METHOD	Triple Tube	LOGGED BY	J. Burns DATE June 15/ 2018
BEARING OF HOLE		WATER TABLE	
ANGLE FROM HORIZ.		DATE	
ROCK SURFACE			

DEPTH	DISCONTINUITY JOINT, FOLIATION BEDDING PLANE FAULT, SHEARING ZONE ETC.	ANGLE WITH CORE AXIS	DESCRIPTION										JOINT FILLING									
			HAIRLINE	TIGHT	OPEN (IN)	SMOOTH	ROUGH	SLICKENSIDED	PLANOR	CURVED	WEATHERED	STAINED(IRON)	CLAY / SILT	CHLORIDE	RUST	GYPSUM	TALC	QUARTZ	SERPENTINE	CARBONATE	EPIDOTE	OTHER(STATE)
14.4	Top of Rock	55			X		SR						silt									
14.5	Jt	85		X					SP				tr									
14.6	Jt	80			X		SR		SP				tr									
14.7	Jt	70			X		R		1R				x									
14.9	Jt	20		X					P													
15.0	Jt	85			X		R		1R													
15.0	Jt	85			X		SR		SP													
15.1	Jt	85		X			SR		SP													
15.1	Jt	90		X			SR		SP													
15.4	Jt	85			X		SR			X			X									
15.7	Jt	85			X	X			P													
15.8	Jt	90			X		SR		SP				tr									
15.8	Jt	90			X		SR		SP				X									
15.9	Jt	85			X		SR		P				tr									
16.0	Jt	85			X		SR		SP													
16.0	Jt	85			X		SR		SP				X									
16.1	Jt	25		X			SR		P				tr									
16.3	Jt	85			X		SR		SP						tr							
16.3	Jt	10		X			R		1R													
16.5	Jt	85			X		R		SP				X									
17.1	EOR														SPUN BY DRILL ACTION							
17.2	Jt	75			X		SR		SP				X									
17.2	Jt	90			X		SR		P						tr	Shale Zone						
17.2	Jt	1			X		SR		P						tr	Shale Zone						
17.3	Jt	85			X		SR		P						tr	Shale Zone						
17.4	BCZ on Jts	90+20		X			SR		P				tr		tr	Shale Zone						
17.6-17.7	Jt	80			X		SR		SP				tr		tr	Multiple tight jts in BCZ						
17.7	Jt	3		X		X			P						Black Oxidation							
17.9	Jt	7		X			R		SP						Black Oxidation							
18.0	Jt	88			X		SR		SP				tr		tr							
18.2	Jt	10		X		X			P				tr									

SHIFT DATE

KGS GROUP CONSULTING ENGINEERS

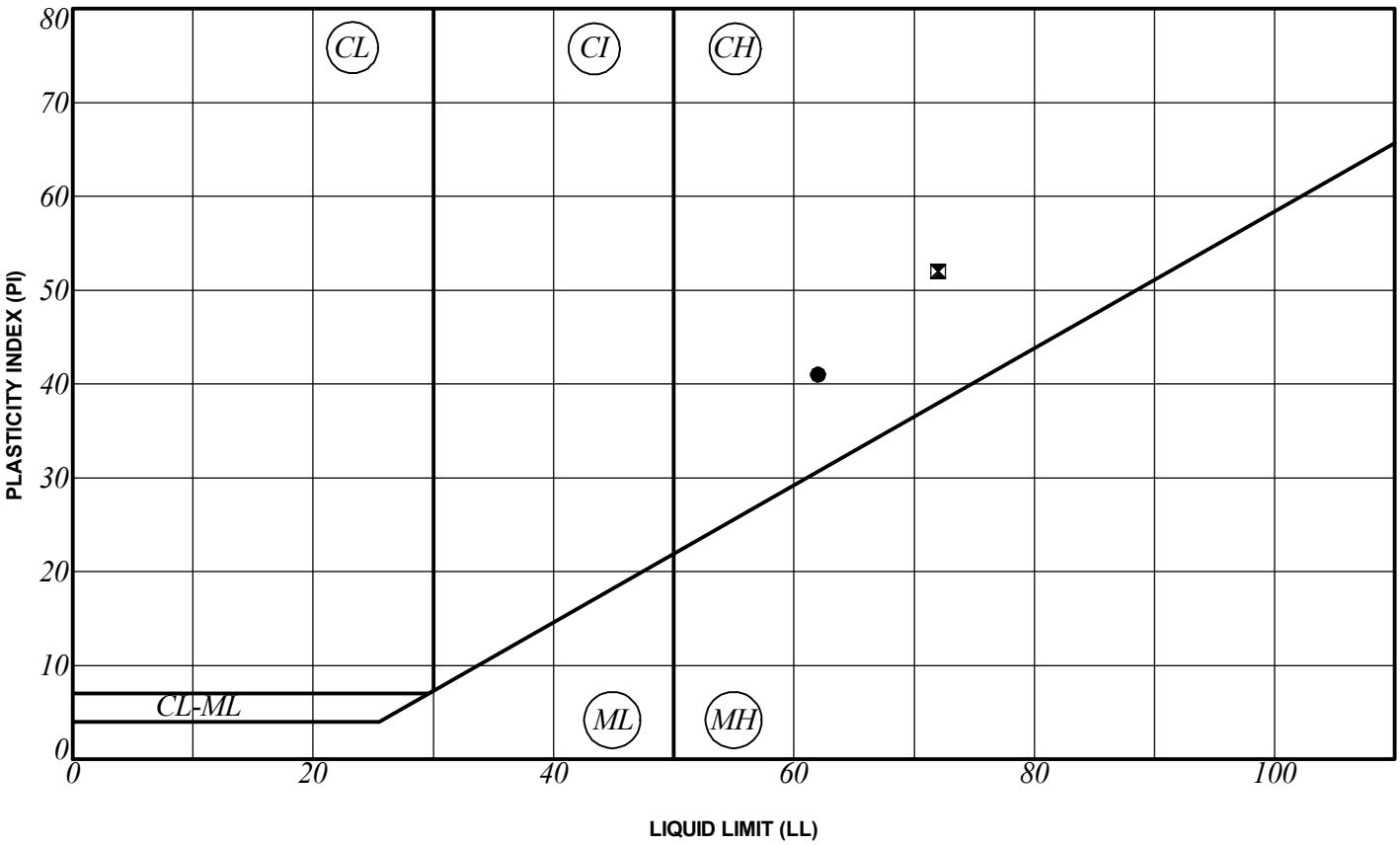
GEOLOGICAL DETAIL FRACTURE LOG

HOLE NO……TH18-01……
SHEET……2…..OF…2……

SITE/LOCATION	Donald Outfall	CLIENT	City of Winnipeg
CONTRACTOR	Maple Leaf Drilling	PROJECT	Donald Outfall Chamber Expansions
CORE DIA.	HQ	PROJECT NO.	
METHOD	Triple Tube	LOGGED BY	J. Burns DATE June 15/ 2018
BEARING OF HOLE		WATER TABLE	
ANGLE FROM HORIZ.		DATE	
ROCK SURFACE			

DEPTH	DISCONTINUITY JOINT, FOLIATION BEDDING PLANE FAULT, SHEARING ZONE ETC.	ANGLE WITH CORE AXIS	DESCRIPTION										JOINT FILLING									
			HAIRLINE	TIGHT	OPEN (IN)	SMOOTH	ROUGH	SLICKENSIDED	PLANOR	CURVED	WEATHERED	STAINED(IRON)	CLAY / SILT	CHLORIDE	RUST	GYPSUM	TALC	QUARTZ	SERPENTINE	CARBONATE	EPIDOTE	OTHER(STATE)
18.4	Jt	85		X			SR		ST						tr							
18.6	Jt/EOR	85			X		R		SP				X		1 mm Shale Seam							
18.7	Jt				X		SR		P				X									
18.8	Jt			X			SR		P						X							
18.77-18.8	BCZ				X																	
18.8	Jt			X			R		SP				X		END OF BCZ							
19.3	Jt			X			R		SP				X									
19.3	Jt			X			R		IR						Brown Oxidation							
19.4	Jt				X		SR		P				X		SPUN/Ground by drill action							
19.5	Jt			X			NOT BROKEN						X		Clay filled jts							
19.6	Jt			X			NOT BROKEN						X		Clay filled jts							
19.6	Jt			X			R		1R						Brown Oxidation							
19.8	Jt			X			SR		SP				X		Lt Brown Oxidation							
19.9	Jt			X			SR		SP				X									
20.1	MB/EOH																					

APPROVED SHIFT DATE



SYMBOL	HOLE	DEPTH (m)	SAMPLE #	LL	PL	PI	% SAND	% SILT	% CLAY	% MC	CLASSIFICATION
●	TH18-01	2.3	S01	62	21	41				24.2	CH
⊠	TH18-01	13.0	S09	72	20	52				44.2	CH

Notes:
ML - Low Plasticity Silt
MH - High Plasticity Silt
CL-ML - Silty Clay
CL - Low Plasticity Clay
CI - Intermediate Plasticity Clay
CH - High Plasticity Clay
LL - Liquid Limit
PL - Plastic Limit
PI - Plasticity Index
MC - Moisture Content
NP - Non-Plastic

KGS GROUP

CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT

Detailed Design and CA Services for Donald Outfall Chamber Upgrades

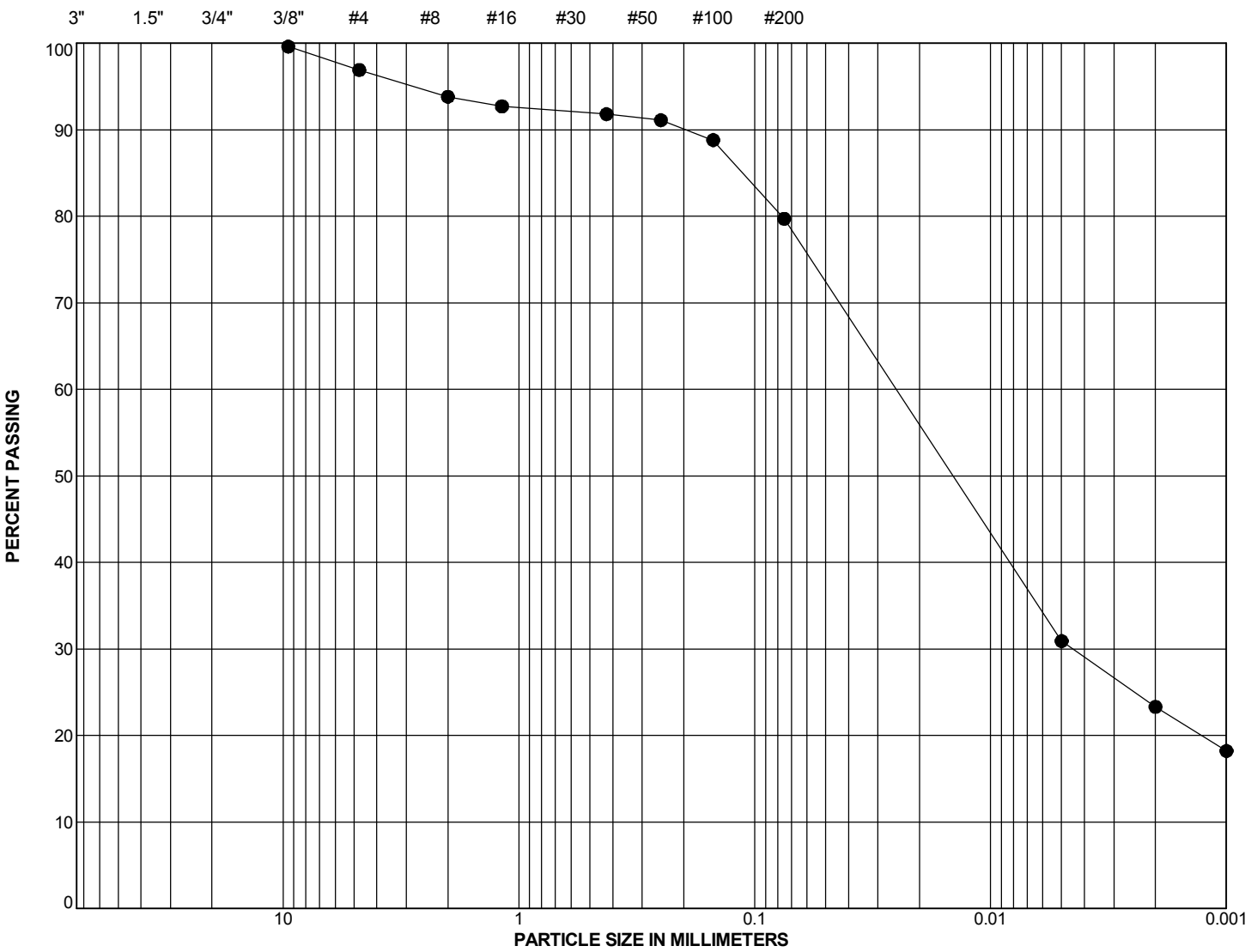
A-LINE PLOT

July 2018	Figure A-1	Page 1 of 1

A-LINE PLOT U:\PMS\18-0107-005 DONALD OUTFALL EXPANSION.GPJ

SIEVE ANALYSIS

HYDROMETER ANALYSIS



GRAVEL		SAND			SILT	CLAY
coarse	fine	coarse	medium	fine		

SYMBOL	HOLE	DEPTH (m)	SAMPLE #	% GRAVEL	% SAND	% SILT	% CLAY	% SILT & CLAY	Cu	Cc	CLASSIFICATION
●	*TH18-01*	*14.0*	*S10*	*2.7*	*17.2*			*79.7*			*ML*

SIEVE ANALYSIS U:\FMS\18-0107-005\18-0107-005 DONALD OUTFALL EXPANSION.GPJ

KGS GROUP

CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT

Detailed Design and CA Services for Donald Outfall Chamber Upgrades

GRAIN SIZE ANALYSES

July 2018	Figure A-2	Page 1 of 1

APPENDIX B

SITE PHOTOS

Photo 1 – Looking downslope (SE) from street side of Assiniboine Avenue to elevated upper bank area and existing Donald Outfall chamber. TH18-01 is highlighted.

Photo 2 – Looking downstream (NE) along relatively flat upper bank area extending to the neighbouring property at 300 Assiniboine Avenue.

Photo 3 – Looking downstream (NE) from access pathway towards upper bank slope. Note the numerous mature trees and vegetation on the slope.

Photo 4 – Looking E and downslope of the access pathway along the mid-bank bench.

Photo 5 – Looking upstream (SW) along the mid-bank bench. Note the gradual slope transition from the mid-bank bench to the lower bank.

Photo 6 – Looking upstream (W) from the River Walk towards the lower bank area at the approximate alignment of the Donald Outfall.

Photo 7 – Looking downstream (NE) at exposed riprap protection along the River Walk lower berm shoulder at the approximate alignment of the Donald Outfall.

APPENDIX C

2014 KGS GROUP LETTER OF COMPLETION FOR ASSINIBOINE RIVER WALK REPAIRS (WATERWAY PERMIT NO. 100/2013)

Kontzamanis Graumann Smith MacMillan Inc.

KGS GROUP CONSULTING ENGINEERS

3rd Floor
865 Waverley Street
Winnipeg,
Manitoba
R3T 5P4
204.896.1209
fax: 204.896.0754
www.kgsgroup.com

December 3, 2014

File No. 13-0107-023

The City of Winnipeg
Planning, Property and Development
Unit 15 – 30 Fort Street
Winnipeg, Manitoba
R3C 4X5

ATTENTION: Kendall Thiessen, P.Eng.
Riverbank Management Engineer

RE: Letter of Completion
Flood Damage Repairs to the Assiniboine Riverwalk
Waterway Permit No. 100/2013

Dear Mr. Thiessen:

As per Condition No. 9 of Waterway Permit No. 100/2013, this letter has been prepared to inform you that repairs to the Assiniboine Riverwalk were completed in November 2014 in accordance with the respective permit conditions and to the satisfaction of KGS Group. Site photos taken by KGS Group in February and October of 2014 are attached to this letter along with a copy of the as-constructed drawings.

In total, approximately 8,825 metric tonnes of rockfill riprap (D_{50} = 300 mm) erosion protection was placed along 1,021 m of shoreline and extended to the walkway shoulder. The rockfill riprap was placed directly overtop the channel bottom and extended approximately 7 m± beyond the Unregulated Winter River Level (UWRL, El. 222.0 m±). All riprap deposited above the UWRL was placed over top of the existing riprap to restore the original design geometry and extended to the walkway shoulder. The rockfill riprap blanket was appropriately tapered at all docks and bridge crossings to provide a smooth hydraulic transition and to best match the existing grades along the neighbouring properties.

Resetting of existing limestone landscaping blocks and replacing missing or damaged limestone landscaping blocks was also completed as part of the work. In total along the Riverwalk, approximately 175 m of limestone landscaping blocks were reset and approximately 250 m of limestone landscaping blocks were replaced as shown on drawing 13-0107-023_02.

A temporary structural support over the existing hollow core deck of the dock located east of the Donald Street Bridge was constructed and maintained throughout the construction works. The temporary structural support over the dock structure was removed once all works had been completed. Following removal of the deck structure there was no visible damage noted to the deck structure.

All areas disturbed during the repairs to the Assiniboine Riverwalk works were restored and revegetated to the satisfaction of KGS Group. Topsoil and seed was placed in the laydown area.

Please contact the undersigned at (204) 896-1209 with any questions or comments.

Prepared by:

Bruno Pierre Arpin, P.Eng.
Geotechnical Engineer

Approved by:

Dr. Robert Kenyon, Ph.D., P.Eng.
Manager, Geotechnical Services

cc: Rob Zanewich, City of Winnipeg

BPA/jr

WATERWAY PERMIT 100/2013

Winnipeg

Planning, Property & Development Department • Service de l'urbanisme, des biens et de l'aménagement
Urban Design Division • Division de l'aménagement urbain

In reply please refer to / Référence à rappeler :

Kendall Thiessen
(204) 986-5159
Fax / Téléc. : (204) 986-3684

November 27, 2013

The City of Winnipeg
Planning, Property and Development
Unit 15-30 Fort Street
Winnipeg, Manitoba
R3C 4X5

Attention: Mr. Rob Zanewich

Dear Sir:

RE: WATERWAY PERMIT NO. 100/2013
ASSINIBOINE RIVERWALK FROM THE FORKS TO THE MANITOBA LEGISLATIVE BUILDING
FLOOD DAMAGE REPAIRS TO THE ASSINIBOINE RIVERWALK

Please find enclosed Waterway Permit No. 100/2013, with conditions, pursuant to Waterway By-law No. 5888/92.

Yours truly,

Kendall Thiessen
Riverbank Management Engineer

KT/sl

Enclosure

cc: KGS Group, 3rd Floor – 865 Waverley Street, Winnipeg, Manitoba R3C 4X5
Attn.: Bruno Arpin

wa-permit- 100-2013

Winnipeg

Planning, Property and Development Department
Service de l'urbanisme, des biens et de l'aménagement
Unit 15 – 30 Fort Street • 30, rue Fort, unité 15 • Winnipeg • Manitoba R3C 4X5

WATERWAY PERMIT

PERMIT NO: **100/2013**

Under and by virtue of the powers vested in it under the provisions of The City of Winnipeg Charter Act, The City of Winnipeg hereby authorizes (subject to the conditions hereinafter specified):

APPLICANT: KGS Group, Attention: Bruno Arpin
3rd Floor, 865 Waverley Street
Winnipeg, MB R3T 5P4
(on behalf of The City of Winnipeg Planning, Property and Development, Attention: Rob Zanewich, Unit 15-30 Fort Street, Winnipeg, Manitoba, R3C 4X5)

to undertake work on the following described lands, contained within the regulated area of The City of Winnipeg Waterway By-law namely:

LEGAL DESCRIPTION:

MUNICIPAL LOCATION: **and commonly known as:**

Assiniboine Riverwalk from the Forks to The Manitoba Legislative Building

SUBJECT: **the following work namely:**

Repair Flood Damage Repairs to an approximately 1,021 m length of the Assiniboine Riverwalk from the Forks to The Manitoba Legislative Building as follows:

Permanent Works:

1. Place approximately 6,500 t of rockfill riprap below the Unregulated Winter River Level (UWRL) so that the original design geometry along the subject section of the Assiniboine Riverwalk is restored.

2. Place approximately 2,500 t of rockfill riprap above the Unregulated Winter River Level (UWRL) and below the walkway shoulder so that the original design geometry along the subject section of the Assiniboine Riverwalk is restored.

3. Reset existing limestone landscaping blocks on the downslope side of the Riverwalk, including placement of geotextile, limestone gravel and then resetting the existing blocks and curbs, along approximately 175 m of the Riverwalk site, location as shown on the submitted drawings.

4. Replace missing or damaged limestone landscaping blocks on the downslope side of the Riverwalk, including placement of geotextile, limestone gravel and limestone curbs and blocks, along approximately 250 m of the Riverwalk site, location as shown on the submitted drawings.

Temporary Works:

5. Construct a temporary structural support over the existing hollow core deck of the dock east of the Donald Street Bridge, as shown on the submitted drawings, for equipment and material access during construction.

6. Construct four temporary in-water equipment turnarounds using rockfill riprap, locations as shown on the submitted drawings. Materials used for the turnarounds will be incorporated into the Riverwalk in subsequent stages of work.

7. Installation of temporary silt fence downslope of limestone curbs, temporary ice fence along the length of the Riverwalk, and temporary safety fence upslope of the Riverwalk.

All of the above as per Engineer's Report by KGS Group, "Flood Damage Repairs to the Assiniboine Riverwalk, Waterways Construction Permit Application" dated October 23, 2013.

City of Winnipeg Bid Opportunity No. 815-2013, Repair of the Assiniboine Riverwalk, submitted in support of application.

All of the above as per plans and correspondence submitted and date stamped October 23, 28, and 31 and November 26, 2013.

The proposed works will be located along the bank of the Assiniboine River.

CONDITIONS:

1. Subject to Engineer's Report by KGS Group, "Flood Damage Repairs to the Assiniboine Riverwalk, Waterways Construction Permit Application" dated October 23, 2013, particularly:

    a) At upstream limits of work, riprap shall be placed around dock area such that boat draft shall not be compromised.
    b) Riprap placement around outfalls shall ensure that pipes are not damaged and the openings are not compromised to restrict flow.
    c) Riprap around bridge piers shall require special attention and direction in the field from the Engineer.

2. Subject to City of Winnipeg Bid Opportunity No. 815-2013, "Repair of the Assiniboine Riverwalk."

3. All in-water works, and riprap placement is to be performed under the full-time engineering supervision of KGS Group.

4. The placement of rockfill riprap shall be performed under the constant supervision of the Engineer. Recognizing that the project purpose is to repair the damaged Riverwalk, including the rockfill berm, appropriate care and controls shall be in place to ensure that the completed works are consistent with the original design cross section of the Riverwalk. In particular, the repaired berm cross-section shall not extend beyond the design cross-section so that the subject works will not restrict or impede flows in the Assiniboine River to a greater degree than the as-constructed condition of the Riverwalk. In particular,

    a) Quantities of rockfill riprap used to repair the Riverwalk berm are to be closely monitored by the Engineer to ensure that the amount of rip-rip placed is consistent with the design requirements based on the surveyed bathymetry.
    b) To the extent that is reasonably achievable, the Engineer shall establish an inspection and measurement system to verify the geometry of the final riprap configuration and to ensure that the riprap does not extend into the river channel beyond the design section.
    c) The lines and grades of the approved riprap are to provide a uniform shoreline and are to be feathered at transition areas to smoothly blend with the existing bank contours and not adversely impact on the erosion or stability of adjacent sections of riverbank.

5. Any excavated material shall be removed from site, and not deposited within the Regulated Area as per City of Winnipeg Waterway By-law 5888/92.

6. Areas for storage or stockpiling of materials, construction supplies and equipment are to be approved by the Engineer, and situated so as not to adversely impact bank stability.

7. Any areas damaged as a result of access or construction activity are to be restored to a condition, at minimum, equivalent to that which existed prior to initiation of the approved works.

8. All heavy construction activities shall be carried out during the winter months when the ground is frozen.

9. Upon completion of the proposed works, as-constructed drawings including a letter certifying that the works have been completed to the satisfaction of the Engineer and in compliance with this permit are to be submitted to the City of Winnipeg, Waterways Section, Unit 15-30 Fort Street, Winnipeg MB, R3C 4X5.

EXPIRATION:

This permit shall expire and the right of the owner under the permit shall terminate if the work authorized by the permit is not commenced within one (1) year from the date of issuance of the permit and reasonably continued without interruption thereafter.

IMPORTANT NOTICE:

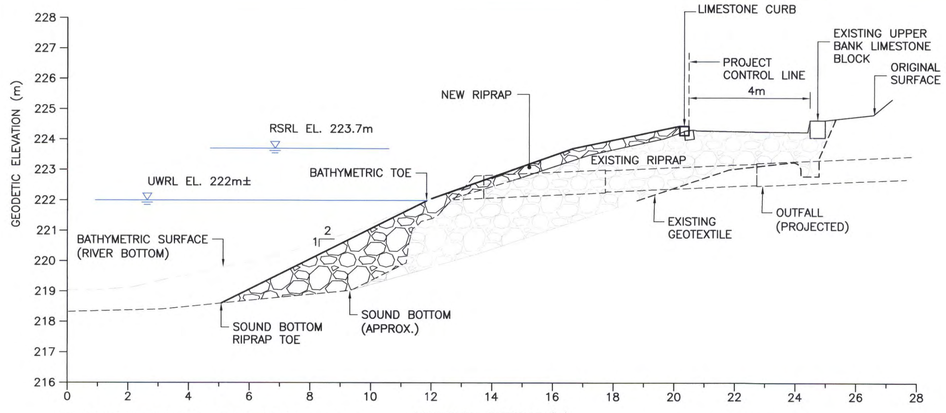
The permit holder is reminded that this permit is issued in pursuance of The City of Winnipeg Waterway By-law only, and does not constitute authority for any particular use of the land designated therein which may be within the regulatory powers of the Government of Canada, the Government of Manitoba, or The City of Winnipeg within which the land is situate.

Dated in The City of Winnipeg, in the Province of Manitoba this 26th day of November 2013 A.D.

Estimated Cost:	$730,625.00
Permit Fee:	$2714.18 (after 10% Downtown Development Fee Reduction)
Receipt Number:	JE# 287304

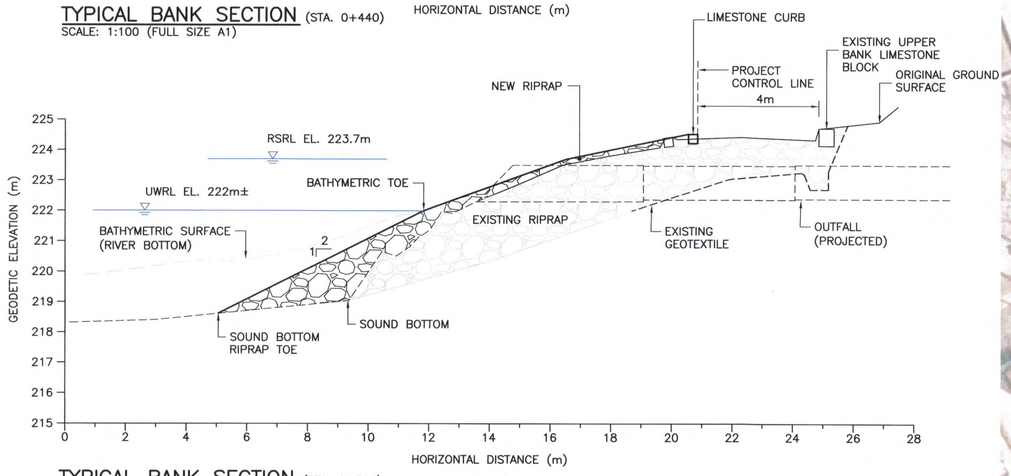
Designated Employee, The City of Winnipeg

AS-CONSTRUCTED DRAWINGS



TYPICAL BANK SECTION (STA. 0+440)

SCALE: 1:100 (FULL SIZE A1)



TYPICAL BANK SECTION (STA. 0+560)

SCALE: 1:100 (FULL SIZE A1)

DETAILED PLAN

SCALE: 1: 500 (FULL SIZE A1)

NOTES: (ALL WORK COMPLETED AS SPECIFIED BELOW AND APPROVED BY THE CONTRACT ADMINISTRATOR)

1. RIPRAP AROUND BRIDGE PIERS SHALL REQUIRE SPECIAL ATTENTION AND DIRECTION IN THE FIELD FROM THE CONTRACT ADMINISTRATOR.
2. RIPRAP SHALL BE PLACED AROUND DOCK AREA SUCH THAT BOAT DRAFT SHALL NOT BE COMPROMISED AS APPROVED BY THE CONTRACT ADMINISTRATOR.

UTILITIES

EXISTING SERVICES AND UTILITIES SHALL BE LOCATED BY THE CONTRACTOR PRIOR TO THE START OF CONSTRUCTION. THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR MAINTAINING THE STRUCTURAL INTEGRITY OF THE SERVICES AND UTILITIES.

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

1. NOTIFY THE GAS COMPANY OF THE PROPOSED LOCATION OF EXCAVATION.
2. TAKE PRECAUTION TO AVOID DAMAGE TO GAS COMPANY INSTALLATIONS.
3. SEE PROVINCIAL REGULATION 210/72 FOR DETAILS.

METRIC

WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

APEGM
Certificate of Authorization
KGS Group
No. 245

EXISTING	LEGEND—PLAN	EXISTING	LEGEND—PLAN	PROPOSED	EXISTING	LEGEND—PROFILE	PROPOSED
	BRIDGE CLEARANCE EL. 3.0m ±						
	PINCH POINT (WIDTH LESS THAN 4m)						
	TA—1 TEMPORARY TURNAROUND AREA 1						
	CONSTRUCTION ACCESS						
	(91) CITY OF WINNIPEG OUTFALL						
	223 AS CONSTRUCTED CONTOUR						
	221 BATHYMETRIC CONTOUR						

COWLEGEND

LOCATION APPROVED
UNDERGROUND STRUCTURES

SUPV. U/G STRUCTURES COMMITTEE — DATE

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

B.M. KGS BASE ELEV. —
DRAWINGS BASED ON C.S.R.S NAD 83 SYSTEM, UTM GRID

NO.	REVISIONS	DATE	BY
2	ISSUED AS—CONSTRUCTED	28/11/14	BPA
1	ISSUED FOR CONSTRUCTION	31/10/13	BPA
0	ISSUED FOR TENDER	25/10/13	BPA

KGS GROUP CONSULTING ENGINEERS

DESIGNED BY BPA — CHECKED BY MRJ
DRAWN BY PwD — APPROVED BY
HOR. SCALE: AS NOTED
VERTICAL: AS NOTED
DATE 23/09/2013 — RELEASED FOR CONSTRUCTION: DATE

ENGINEER'S SEAL

THE ORIGINAL ISSUE REV. 1 WAS STAMPED, DATED AND SIGNED
BY B.P. ARPIN
ON OCT. 31 2013 D/M/Y

CONSULTANT DRAWING NO.
13—0107—023_04

Winnipeg
THE CITY OF WINNIPEG
URBAN DESIGN DIVISION
PLANNING, PROPERTY & DEVELOPMENT DEPARTMENT

PROJECT TITLE
REPAIR OF THE ASSINIBOINE RIVERWALK
DETAILED PLAN AND SECTIONS (SHEET 2 OF 3)

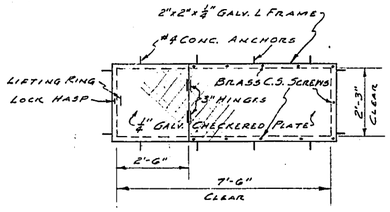
SHEET 05 OF 08
COMPUTER FILE NAME 13—0107—023_04
CITY DRAWING NUMBER 815—2013_0004_01—01

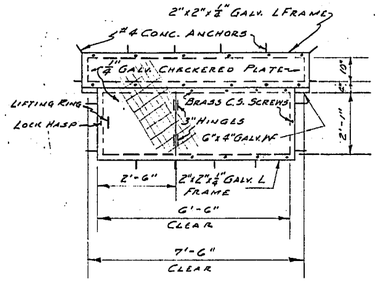
APPENDIX D

1964 DONALD OUTFALL RECORD DRAWING

APPENDIX A – DONALD OUTFALL GATE CHAMBER HISTORICAL RECORD DRAWINGS

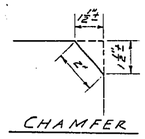
- **DRAWINGS:**
  - Drawing SC-15661



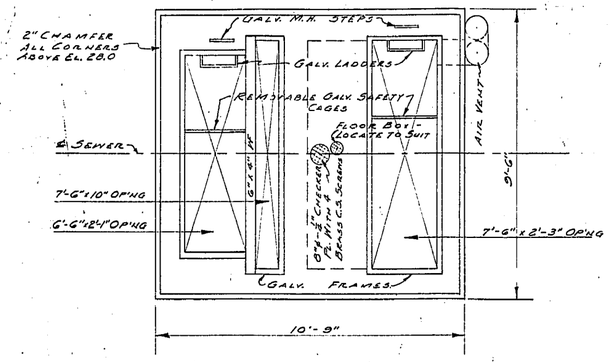


HATCH COVERS & FRAMES

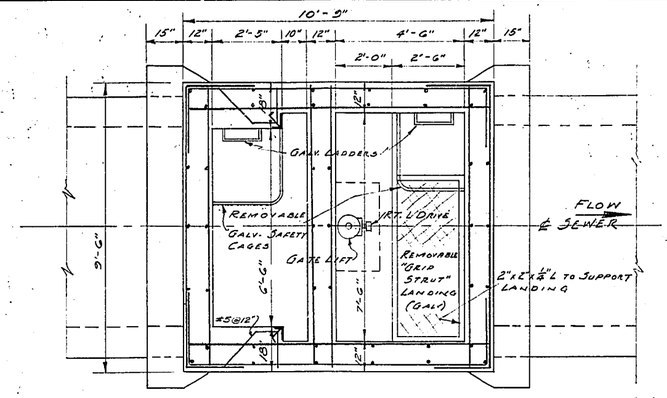
NOTE: ALL COVERS TO BE FLUSH WITH TOP OF CONCRETE AT EL. 31.00



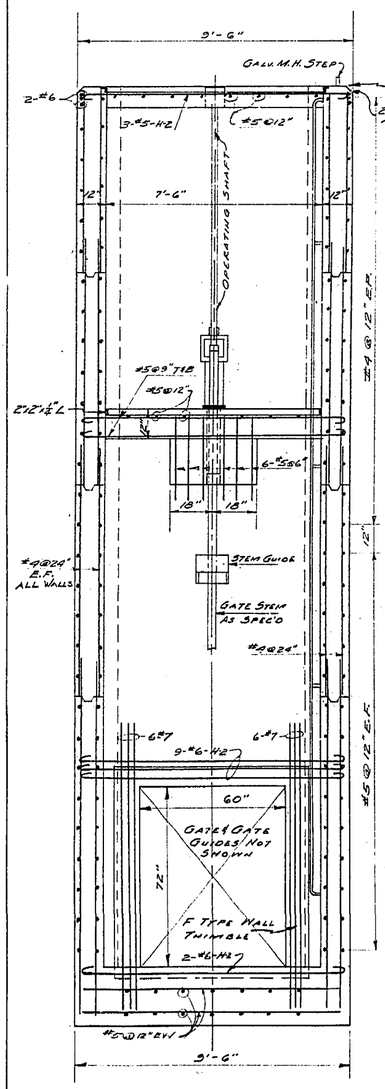
CHAMFER



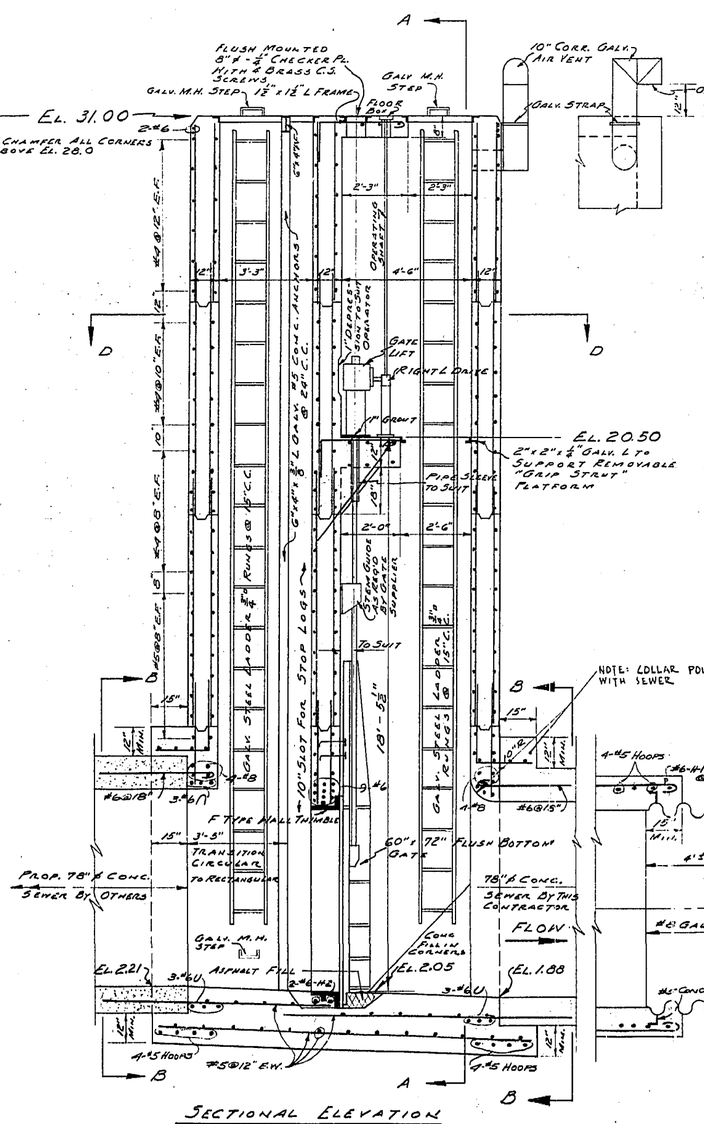
TOP PLAN



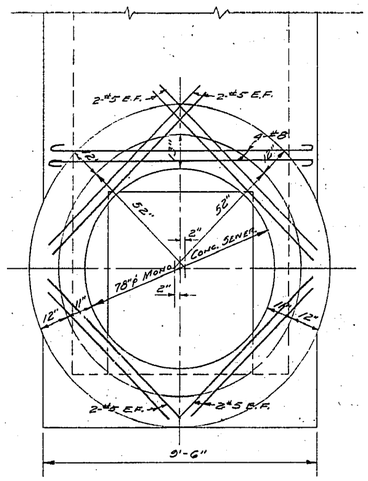
SECTION 'D-D'



SECTION 'A-A'

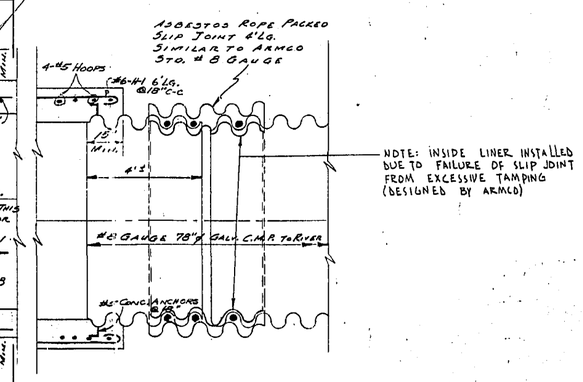


SECTIONAL ELEVATION

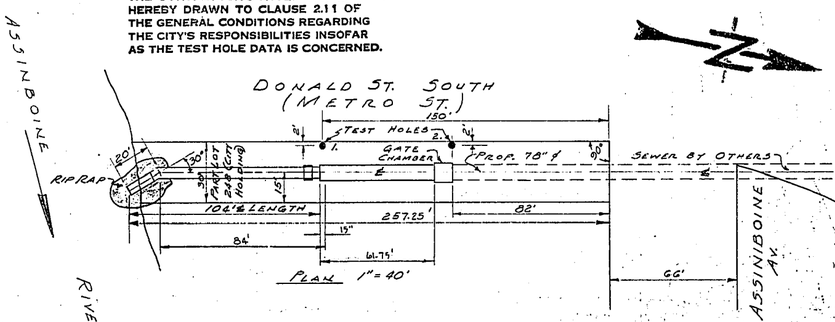


SECTION 'B-B'

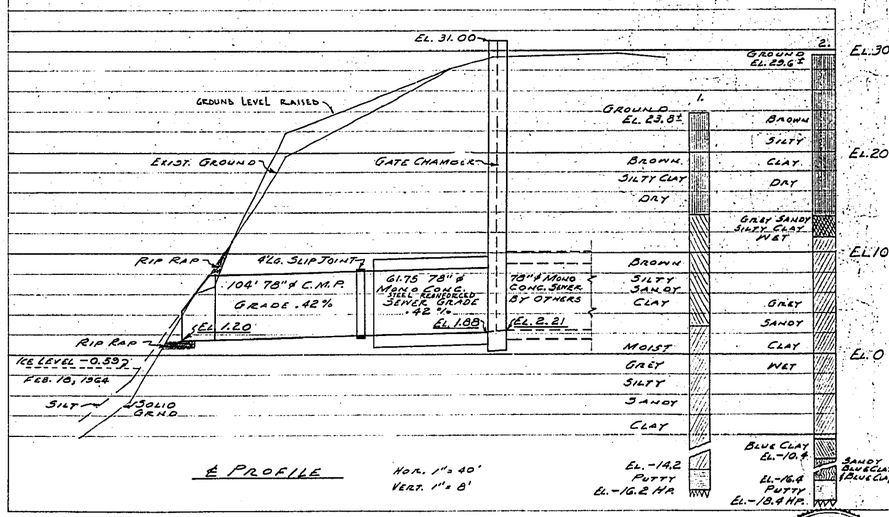
NOTE: ALL STEEL 2½" CLEAR



THE CONTRACTOR'S ATTENTION IS HEREBY DRAWN TO CLAUSE 2.11 OF THE GENERAL CONDITIONS REGARDING THE CITY'S RESPONSIBILITIES INSOFAR AS THE TEST HOLE DATA IS CONCERNED.



PLAN 1"=40'



℄ PROFILE

HOR. 1"=40'
VERT. 1"=8'

RIVERS & STREAMS PROTECTION. APPROVAL REC'D
R.C.G. DATE June 9/64

PROVINCIAL DYKING BOARD APPROVAL REC'D
R.C.G. DATE June 23/64

METRO APPROVAL REC'D.
N.R. JUNE 16 DATE 16/6/64

LICENCE No. 201130 16/6/64

PROVINCE OF MANITOBA — REGISTERED ENGINEER

REVISED AS CONSTRUCTED
BY D.G. DATE 2-6-65
CHECKED BY N.R. DATE 2-6-65

DETAILS OF DONALD ST. GATE CHAMBER AND OUTFALL

CITY OF WINNIPEG
ENGINEERING DEPARTMENT
W. D. HURST, CITY ENGINEER
J. B. STRIOWSKI, DEPUTY CITY ENGINEER

DRAWN BY N.R. DATE 5/5/64
TRACED BY
CHECKED BY R.C.G. DATE 5/5/64
APPROVED BY J.B. Striowski

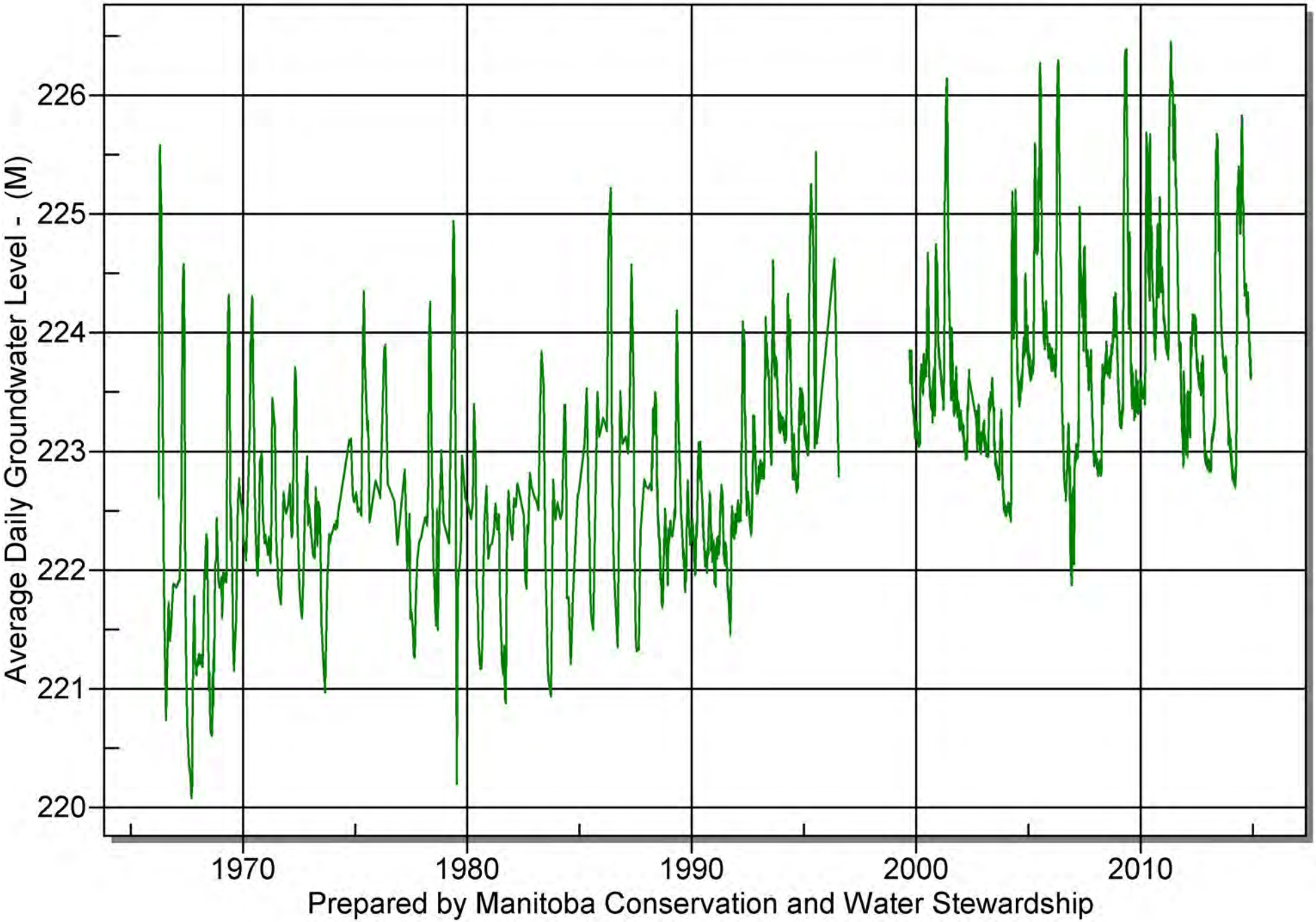
SCALE ⅜"=1'-0"
DRAWING No. SC15661

APPENDIX E

HISTORICAL GROUNDWATER LEVELS AT LOCAL WELLS

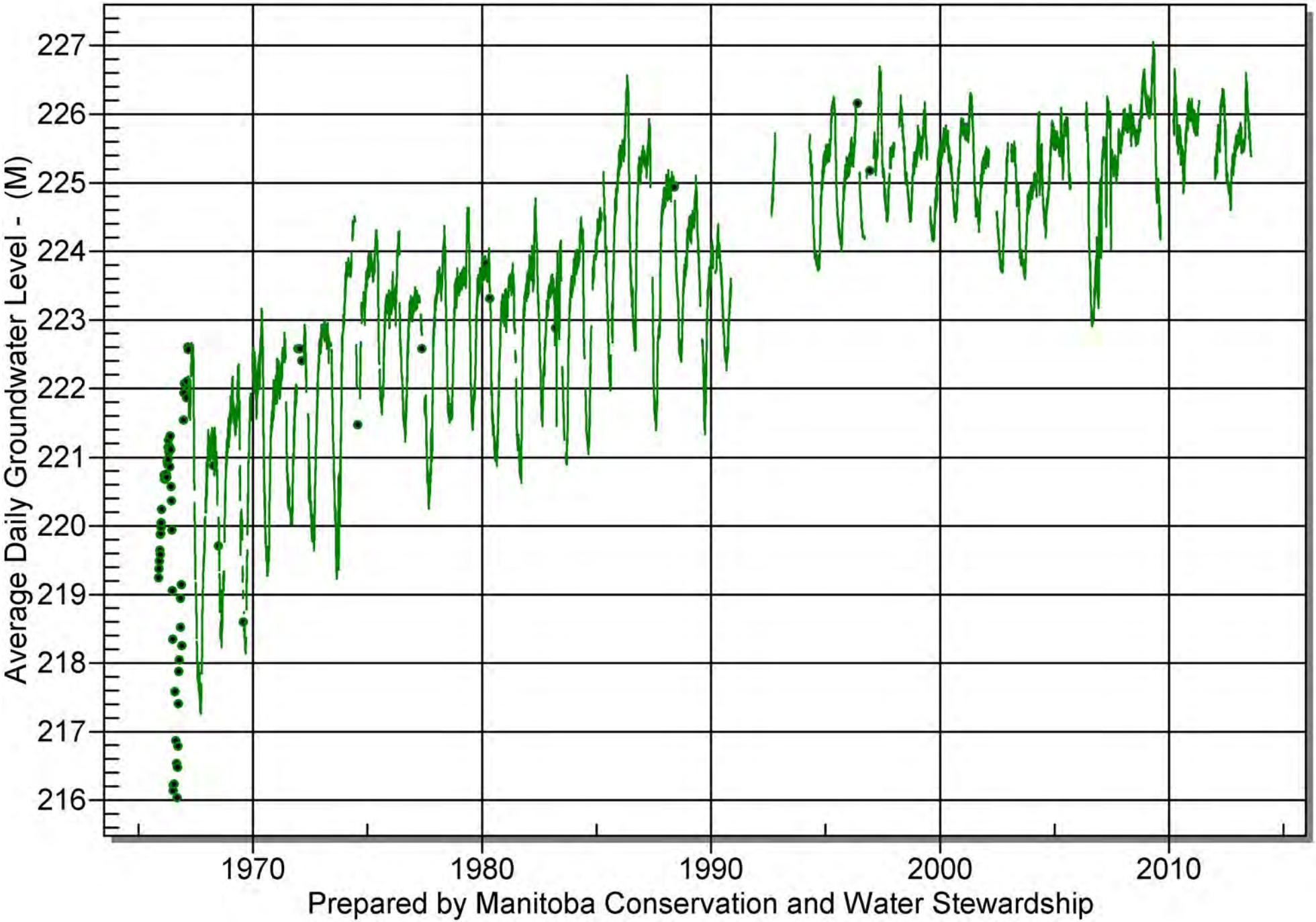
G05OC004 WINNIPEG MO-10 37ST BONIFACE

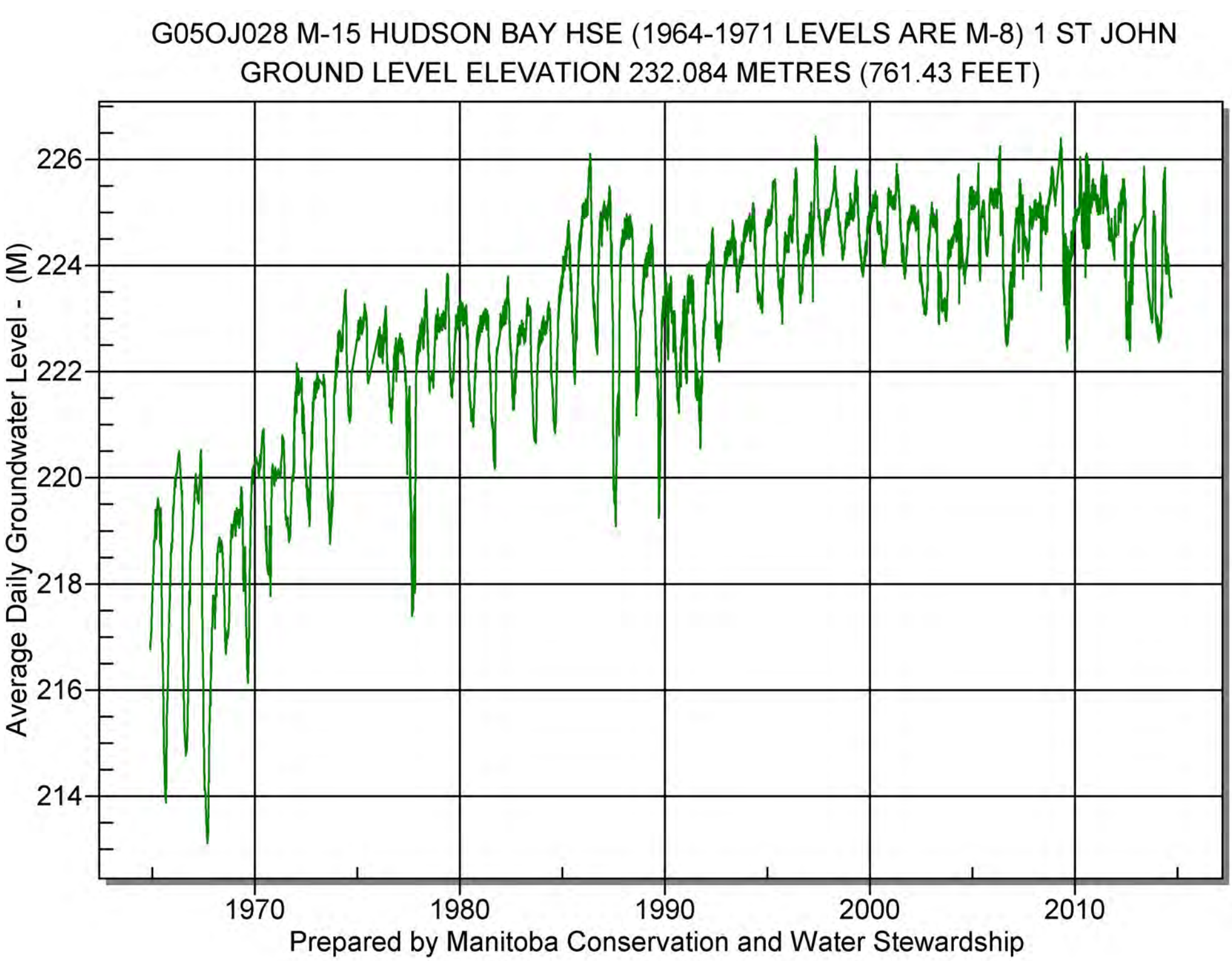
GROUND LEVEL ELEVATION 230.629 METRES (756.66 FEET)



G05OJ021 WINNIPEG MO-1 1 ST JOHN

GROUND LEVEL ELEVATION 234.053 METRES (767.89 FEET)




G05OJ028 M-15 HUDSON BAY HSE (1964-1971 LEVELS ARE M-8) 1 ST JOHN
GROUND LEVEL ELEVATION 232.084 METRES (761.43 FEET)
Average Daily Groundwater Level - (M)
226
224
222
220
218
216
214
1970
1980
1990
2000
2010
Prepared by Manitoba Conservation and Water Stewardship