

## **APPENDIX C – 2018 OUTFALL RENEWAL AND REHABILITATION CONDITION ASSESSMENT - LODGE AVENUE OUTFALL**



CITY OF WINNIPEG

**2018 OUTFALL RENEWAL AND REHABILITATION  
CONDITION ASSESSMENT  
LODGE AVENUE OUTFALL**

FINAL

KGS Group 17-0107-020  
February 2019

PREPARED BY:

A handwritten signature in black ink, appearing to read "Nicole Vidal".

Nicole Vidal, C.E.T.  
Municipal Technologist

APPROVED BY:

A handwritten signature in blue ink, appearing to read "Ray Offman".

Ray Offman, P.Eng.  
Infrastructure Engineer/Project Manager

## TABLE OF CONTENTS

1.0	INTRODUCTION / BACKGROUND.....	1
2.0	INSPECTION RESULTS .....	2
2.1	LODGE AVENUE INSPECTION RESULTS.....	2
2.1.1	Lodge Physical Inspection.....	2
2.1.2	Lodge Concrete Coring and Testing.....	3
2.1.3	Lodge Geotechnical Testing Results .....	5
2.1.4	Lodge Additional Site Observations.....	7
3.0	CONDITION RATING.....	9
3.1	LODGE AVENUE OUTFALL.....	9
4.0	REHABILITATION OPTIONS .....	10
4.1	LODGE AVENUE OUTFALL REHABILITATION OPTIONS.....	10
5.0	COST ESTIMATES .....	10
5.1	LODGE AVENUE OUTFALL.....	10
5.1.1	Installation of New SPCSP Outfall.....	10
6.0	STATEMENT OF LIMITATIONS AND CONDITIONS .....	11
6.1	THIRD PARTY USE OF REPORT .....	11
6.2	GEOTECHNICAL INVESTIGATION STATEMENT OF LIMITATIONS.....	11
6.3	CAPITAL COST ESTIMATE STATEMENT OF LIMITATIONS.....	11

TABLES  
APPENDICES

## **LIST OF TABLES**

1. Compressive Strength Results for Downstream Concrete Pipe
2. ICG Rating Criteria for Concrete Sewers

## **LIST OF APPENDICIES**

- A. Lodge Concrete Core Testing Results
- B. Lodge Test Hole Logs
- C. Lodge Slope Inclinator Monitoring Results

## 1.0 INTRODUCTION / BACKGROUND

The Lodge Outfall requires replacement to address the structural defects in the Corrugated Metal Pipe (CMP) and portions of the cast in place concrete sections of the outfall. This report provides a condition assessment of the outfall to assist in the development of the capital budget and to provide information to be considered as part of the preliminary and detailed design.

The Lodge Avenue Outfall is a land drainage outfall that originates at a manhole located west of the intersection of Booth Drive and Lodge Avenue, within the south boulevard adjacent to the Grants Old Mill Park access road. The outfall initiates as an 1850 concrete cast-in-place outfall and extends 92 m where the pipe transitions to an 1800 mm SPCSP pipe for the last 27 m. The outfall outlets to Sturgeon Creek approximately 25 m from the southwest corner of the historic replica of Grants Old Mill, and falls immediately adjacent to the timbers retaining wall that supports portions of the sidewalks, patio and other landscape features associated with the Mill.

A review of the recent CCTV inspections suggests that portions of the outfall are at the end of their life, while other portions were visually in fair condition. The first 75 m of the cast in place concrete portion of the outfall appears to be in fair condition, with the exception of the invert that appears spalled (approximately 25 mm – 50 mm deep) throughout from 5:00 to 7:00; and periodic longitudinal cracking along the pipe obvert. Beginning around 70 m, the concrete pipe shows significant defects with continuous longitudinal cracking along at 12:00, 3:00, and 9:00. These pipe defects continue until the transition to the SPCSP Pipe. The SPCSP portion of the pipe is severely out of round, and has become separated at several locations (potentially from bank movements). In general, the outfall pipe from approximately 70 m to the outlet appears close to failure.

Additional investigations were carried to better understand the potential cause of the observed pipe defects, to the condition of the upstream cast in place concrete portion of the outfall, to determine if rehabilitation options were feasible for the downstream CMP portion of the outfall, and to evaluate unique site conditions that may impact the future design and construction works.

The investigations included a site reconnaissance, internal inspections, coring and compression testing of the existing cast in place concrete pipe, and a geotechnical investigation (including drilling of test holes, installation of slope inclinometers, and testing of soils).

## **2.0 INSPECTION RESULTS**

### **2.1 LODGE AVENUE INSPECTION RESULTS**

The 2017/2018 inspection of the Lodge Avenue Outfall included a physical person-entry inspection, concrete coring, test hole drilling, installation of slope inclinometers (SI's), and testing of soils.

#### **2.1.1 Lodge Physical Inspection**

KGS Group staff undertook a person-entry physical inspection of the Lodge Outfall on November 7, 2017, for the purposes of completing further structural assessment and the internal dimensions of the pipe to assess against lining options.

The inspection began at the upstream manhole (Station 100.00), located in the southwest boulevard at Booth Drive and Lodge Avenue Intersection, and concluded at the outfall outlet on Sturgeon Creek (Station 217.85). Based on the inspection, two (2) pipe types were observed (~92 m Concrete Pipe and ~27 m of CMP pipe). To address potential lining options, internal measurements were taken in each pipe segment, at approximately 5 meter intervals. A summary of the observations and defects noted in the pipe segments is provided below. One observation common to both pipe segments was the flow of water. Flowing water maintaining a depth of approximately 50 mm was observed at the time of inspection.

#### **Station 100.00 to 190.65m (Upstream Manhole to CMP)**

Typical defects within the concrete pipe segment included spalling and deteriorated concrete at the pipe invert, with the downstream portion being significantly worse than the upstream portion. However, aside from the deteriorated invert, from 100.0 to 184.25m, this segment appears visually round, sound and in relatively fair condition. A bend to the left exists at approximately station 184.25. Downstream from the bend, the invert spalling and deterioration is significant

with loss of concrete. The last three pipe sections upstream from the CMP pipe have significant obvert cracking (50 to 100mm) and show displacement between the joints. These three pipe segments also show large longitudinal cracking at 4:00 and 8:00.

### **Station 190.65 to 217.85 (CMP Pipe)**

The CMP portion of the outfall pipe has excessive deflection, beyond the design capacity of CMP pipe.

The 1800 mm CMP portion of the outfall is out of round beginning at the upstream connection to the concrete pipe (Sta. 190.7), and continuing to approximately Sta. 212.7. A 250mm CMP stub was observed at the pipe obvert at approximately Sta. 207.6 m. The stub connection is heavily corroded to the point of failure allowing the surrounding soil to be observed from within the pipe. The location of the stub is in close proximity to a catch basin observed at grade and it is assumed that this stub is CB lead for the catch basin. The maximum deflection of the CMP pipe was recorded at approximately Sta. 203.8 m. At stations 206.1m and 212.7m are displaced joints in the CMP, exposing the underlying soil and causing soil migration into the pipe. Sediment build up is present at the outfall invert in these locations.

The degree of deflection is based on the measured cross sections taken during the internal inspections compared against the original 1800 mm diameter round pipe. The average measurements taken from the inspections are of an indicate the pipe is now approximately 2160mm by 1395mm oval pipe. This translates into an average deflection of approximately 23%. Reverse curvature of the top of the CMP typically occurs when deflections exceed 20%, thus the pipe is considered to have exceeded the capacity of the pipe and has failed.

### **2.1.2 Lodge Concrete Coring and Testing**

Concrete coring and testing was conducted on March 15, 2018 by KGS Group and with assistance by Stantec Materials Testing. The purpose of the coring program was: to undertake a visual inspection of the pipe walls; to determine the in-situ strength of the concrete pipe walls; and to determine the extent of competent concrete along the spalled invert. Compressive strength testing was conducted by Stantec Materials Testing in accordance with CSA A23.2-14C. A copy of the Compression Testing Report can be found in Appendix D.



At the time of coring, there was approximately 600mm of ice at the pipe invert. The ice started just downstream of the upstream manhole and extended throughout the entire outfall. Core locations were chosen just upstream of the CMP pipe. To facilitate the inspections and coring, ice in test locations had to be manually chipped out. Prior to drilling, a rebar detecting device was used to scan for rebar. No steel reinforcement was picked up, nor was any encountered during drilling.

Five (5) cores were taken in total. Four (4) of the five (5) cores were suitable for compressive strength testing. Stationing for the core locations was taken from the boulevard manhole (Sta. 1+00). The location, concrete thickness, and results of the compression strength testing can be found below in Table 1.

**TABLE 1**  
**COMPRESSIVE STRENGTH RESULTS FOR DOWNSTREAM CONCRETE PIPE**

Core No.	Core Location	Concrete Thickness (mm)	Compressive Strength (MPa)	Comments
1	1+73.7 at 5:00	360	48.1	Sound Concrete
2	1+78.3 at 6:00	300	n/a	Not Testable; Conc. Rubble, two pieces intact
3	1+78.3 at 5:00	280	34.3	Visible Fractures below 80mm, rubble below 180mm, frost and rootlets visible
4	1+78.6 at 5:00	320	50.9	Sound Concrete
5	1+79.3 at 4:00	330	45.2	Sound Concrete

The compressive strength results presented above demonstrate that the core samples taken at 5:00 and 4:00 are sound competent concrete. A core at 1+78.3 was taken at the invert (6:00), in an area showing major deterioration. A competent sample was not retrieved at this location (only concrete rubble). Therefore is assumed negligible compressive strength exists at the invert in this location. The second core was taken at the same stationing but was moved over slightly across the pipe invert to an area where deterioration appeared slightly less (approximately 5:00 position), the invert appears sound for the first 80 mm, but then indicates fracturing and deterioration.



Based on this initial investigation, the cast in place concrete pipe sections tested appear to be relatively competent with the exception of the 6:00 position. Future core testing may be warranted to better address the extent of the invert pipe strengths.

Compressive strength data and photographs of the core samples can be found in Appendix A.

### **2.1.3 Lodge Geotechnical Testing Results**

#### **2.1.3.1 Test Hole Drilling and Sampling**

On February 26, 2018, KGS Group completed a geotechnical investigation at the location of the existing outfall. The drilling program consisting of two (2) test holes advanced using solid stem augers to refusal in the underlying till using a B59 track mounted rig. Drilling services were provided by Paddock Drilling Ltd. under the supervision of KGS Group. Underground utility locates were performed prior to drilling.

Representative 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. Standard Penetration Tests (SPTs) were performed in the till to determine the relative in-situ density.

Upon completion of drilling, the test holes were examined for indications of sloughing, and squeezing. A slope inclinometer and two pneumatic piezometers were installed in each test hole prior to backfilling the annulus of the test holes with grout. Test hole logs incorporating key field observations are included in Appendix B.

#### **2.1.3.2 Groundwater Conditions**

Minor groundwater infiltration was encountered in the upper silt, silty clay fill and silty clay when drilling. Moderate groundwater infiltration occurred when the hole advanced into the lower silty clay and silt till.

Two (2) pneumatic piezometer were installed at depths of 4.4 m and 7.5 m in TH18-01 and at 4 m and 8.5 m in TH18-02. Groundwater levels appear to be equivalent to the water level in Sturgeon Creek in the silt till and silty clay

**TABLE 2**  
**GROUNDWATER MONITORING DATA**

Test Hole/Well:	TH18-01		TH18-02	
Ground Surface Elevation (m):	232.5		235.1	
Serial Number:	PN07760	PN37758	PN37761	PN37757
Monitoring Depth (m):	4.4	7.5	4.0	8.5
Monitoring Elevation (m):	228.1	225.0	231.1	226.6
Monitoring Zone:	Silt Till	Silt Till	Silty Clay	Silt Till
Date	Piezometric Elevation (m)			
6-Mar-18	230.6	230.7	231.3	231.3
28-Mar-18	230.6	230.7	231.1 [Note 1]	231.1
5-Dec-18	230.7	230.6	231.1 [Note 1]	230.8

**Note:**

1. Measured groundwater level is at or below the tip of the pneumatic piezometer.

Groundwater levels will fluctuate seasonally and following precipitation events; hence, the actual water level at the time of construction could differ from those reported in this report.

### 2.1.3.3 Slope Incliner Monitoring

Two slope inclinometers were installed by KGS Group on February 26, 2018. The first slope inclinometer was installed on the mid bank in TH18-01, with the second slope inclinometer installed on the upper slope in TH18-02.

A stability analysis should be undertaken as part of the preliminary stage of the future project to determine if mechanical stabilization is required as part of the design and construction works.

#### 2.1.4 Lodge Additional Site Observations

The outfall exists within a park area dedicated to the replica 1829 flour mill operated by Metis Leader Cuthbert Grant. A multi-level timber retaining wall structure exists above the pipe in close proximity to the alignment (consisting of vertical timber poles). The vertical timbers show evidence of movement and have been restrained using metal cable running through eyelets bolted into each timber pole. The metal cable is temporarily supported to the base of the existing hydro transformer pad.

The future design and construction must address these site issues.

**PHOTO 1**  
**LODGE AVENUE OUTFALL – EXISTING RETAINING WALL STRUCTURE**





**PHOTO 2**  
**CABLE INSTALLED AROUND TRANSFORMER CONCRETE PAD TO SUPPORT TIMBER STRUCTURE**



**PHOTO 3**  
**CABLE CONNECTED TO TIMBER STRUCTURE**



### 3.0 CONDITION RATING

The criterion for categorizing the Archibald Street Outfall and Lodge Avenue Outfall is based on the 2001 Sewer Management Study: Technical Memorandum for *Sewer Condition Assessment, Sewer Rehabilitation Design, and Sewer Maintenance Management for the City of Winnipeg*.

The Internal Condition Grade was evaluated by reviewing the CCTV inspections and the person-entry physical inspections. Table 2 indicates the classification of Internal Condition Grades for concrete sewers.

**TABLE 2**  
**ICG RATING CRITERIA FOR CONCRETE SEWERS**

Grade	Implication
5	Collapsed or collapse imminent
4	Collapse likely in the near future
3	Collapse unlikely in the near future but further deterioration likely
2	Minimal collapse risk in the short term but potential for further deterioration
1	Acceptable structural condition

#### 3.1 LODGE AVENUE OUTFALL

The Lodge Avenue Outfall is one asset consisting of two different pipe types. Sections of both the concrete and CMP pipe are given an ICG rating of 4 and 5, respectively. While the condition of the invert throughout the entire concrete portion of the outfall shows spalling and deterioration, the overall integrity of the pipe does not appear to be compromised as no signs of failure, such as deformation or excessive cracking is evident. However, the last 3 concrete segments of pipe are near collapse, and therefore is given an ICG of 4. The CMP portion of the outfall shows significant deflection exceeding 20%, with 2 joints showing significant displacement and exposing the surrounding soil, allowing for erosion. Collapse of the CMP pipe can be considered imminent and the pipe section is rated with an ICG of 5.

## 4.0 REHABILITATION OPTIONS

### 4.1 LODGE AVENUE OUTFALL REHABILITATION OPTIONS

The degradation of the concrete pipe and deflection of the CMP pipe restrict rehabilitation options. The existing pipe deflection of the CMP pipe is greater than 20%, and as such a high likelihood exists that pipe deflection will continue. Therefore, there is a high risk that any planned rehabilitation may not be viable at the time of construction (i.e. pipe lining). Further, a significant safety hazard exists for working within the CMP pipe as it has deflected beyond the design pipe tolerances. As such, replacement of the CMP pipe is recommended.

## 5.0 COST ESTIMATES

### 5.1 LODGE AVENUE OUTFALL

For budgeting purposes a cost estimate was prepared with the following assumptions: Replacement of the CMP pipe; lining of the first 3 sections of concrete pipe; concrete repairs to pipe invert of approximately 15m cast in place outfall; relocation of the hydro transformer; landscaping (included in Site Development and Restorations); and geotechnical stabilization for the site.

#### 5.1.1 Installation of New SPCSP Outfall

ITEM	DESCRIPTION	UNIT	APPROX. QUANTITY	UNIT PRICE	TOTAL
1.0	Site Development and Restoration	lump sum	1	\$100,000.00	\$100,000.00
2.0	Hydro Transformer Utility Box Relocation	lump sum	1	\$70,000.00	\$70,000.00
3.0	Excavation and Shoring	lump sum	1	\$398,000.00	\$398,000.00
4.0	Supply and Install 1970mm SPCSP c/w copolymer coat	m	27	\$7,570.00	\$204,390.00
5.0	Line 15 m of concrete pipe	m	15	\$2,000.00	\$30,000.00
6.0	Concrete Repairs to U/S Conc outfall	m	15	\$1,000.00	\$15,000.00
7.0	Install reinforced angled concrete collar	lump sum	1	\$25,000.00	\$25,000.00
8.0	Geotech. shear key	lump sum	1	\$75,000.00	\$75,000.00
Sub-Total					<b>\$917,390.00</b>
Class 3/Class 4 Estimate Contingency (30%)					\$275,217.00
Engineering Services (15%)					\$137,608.50
Total - Online Replacement Option (GST extra)					<b>\$1,330,215.50</b>

## **6.0 STATEMENT OF LIMITATIONS AND CONDITIONS**

### **6.1 THIRD PARTY USE OF REPORT**

This report has been prepared for the City of Winnipeg to whom this report has been addressed and any use a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties. KGS Group accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions undertaken based on this report.

### **6.2 GEOTECHNICAL INVESTIGATION STATEMENT OF LIMITATIONS**

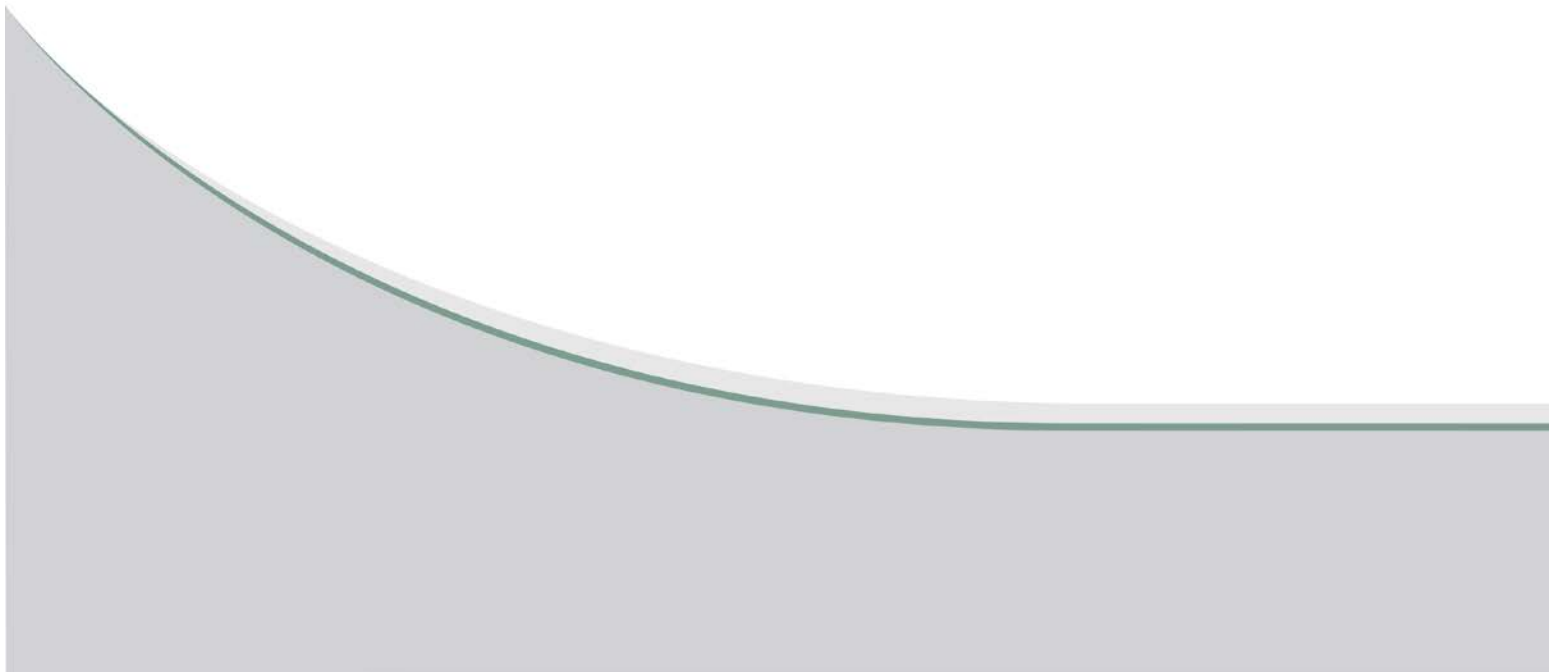
The geotechnical investigation findings and recommendations of this report were prepared in accordance with generally accepted professional engineering principles and practice. The findings and recommendations are based on the results of field and laboratory investigations, combined with an interpolation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

### **6.3 CAPITAL COST ESTIMATE STATEMENT OF LIMITATIONS**

The cost estimates included with this report have been prepared by KGS Group using its professional judgment and exercising due care consistent with the level of detail required for the stage of the project for which the estimate has been developed. These estimates represent KGS Group's opinion of the probable costs and are based on factors over which KGS has no control. These factors include, without limitation, site conditions, availability of qualified labour and materials, present workload of the Bidders at the time of tendering and overall market conditions. KGS does not assume any responsibility to the Client, in contract, tort or otherwise in connection with such estimates and shall not be liable to the Client if such estimates prove to be inaccurate or incorrect.



**APPENDIX A**  
**LODGE AVENUE CONCRETE CORE TESTING REPORT**





**Stantec Consulting Ltd.**  
199 Henlow Bay, Winnipeg MB R3Y 1G4

March 20, 2018  
File: 123313608

**Attention: Ms. Nicole Vidal**  
KGS Group Inc.  
3<sup>rd</sup> Floor – 865 Waverley St.  
Winnipeg, MB R3T 5P4

Good day Nicole,

**Reference: Lodge Avenue Outfall**

On March 15, 2018, Stantec Consulting was retained to recover five (5) core samples from the outfall pipe located at Lodge Avenue at Booth Drive in Winnipeg, Manitoba. The purpose of the coring program was to determine the in-situ strength of the concrete pile walls.

Four (4) of the five (5) concrete core samples were suitable for compressive strength testing in accordance with *CSA A23.2-14C, Obtaining and Testing Drilled Cores for Compressive Strength*. Prior to testing, the core samples were conditioned in water at room temperature for 48 hours. The compressive strength results are summarized in the attached Table 1. Photographs of the core samples are attached to this report.

We appreciate the opportunity to assist you in this project. Please contact the undersigned if you have any questions regarding this report.

Regards,

**STANTEC CONSULTING LTD.**

A handwritten signature in black ink, appearing to read "Jason Thompson".

**Jason Thompson, C.E.T.**  
Principal - Manager of Materials Testing Services  
Phone: (204) 928-4004  
Fax: (204) 488-6947  
jason.thompson@stantec.com

Attachments: Table 1 – Compressive Strength Test Data  
Photographs of Core Samples



Reference: Lodge Avenue Outfall

**Table 1 – Compressive Strength Test Data**

<b>Core No.</b>	<b>Core Locations</b>	<b>Concrete Thickness (mm)</b>	<b>Compressive Strength (MPa)</b>	<b>Comments</b>
1	Sta 1+737 at 5:00	360	48.1	Sound concrete
2	Sta 1+783 at invert	300	n/a	Not testable; Concrete rubble, two pieces intact
3	Sta 1+783 at invert	280	34.3	Visible fractures below 80 mm, rubble below 180 mm, frost and rootlets visible
4	Sta 1+786 at 5:00	320	50.9	Sound concrete
5	Sta 1+793 at 4:00	330	45.2	Sound Concrete



Reference: Lodge Avenue Outfall



Figure 1 - Core no. 1



Figure 2 - Core no. 2 (pieces)



Figure 3 - Core no. 3



Figure 4 - Core no. 3 (frost/rootlets)



March 20, 2018  
Ms. Nicole Vidal  
Page 4 of 4

**Reference: Lodge Avenue Outfall**

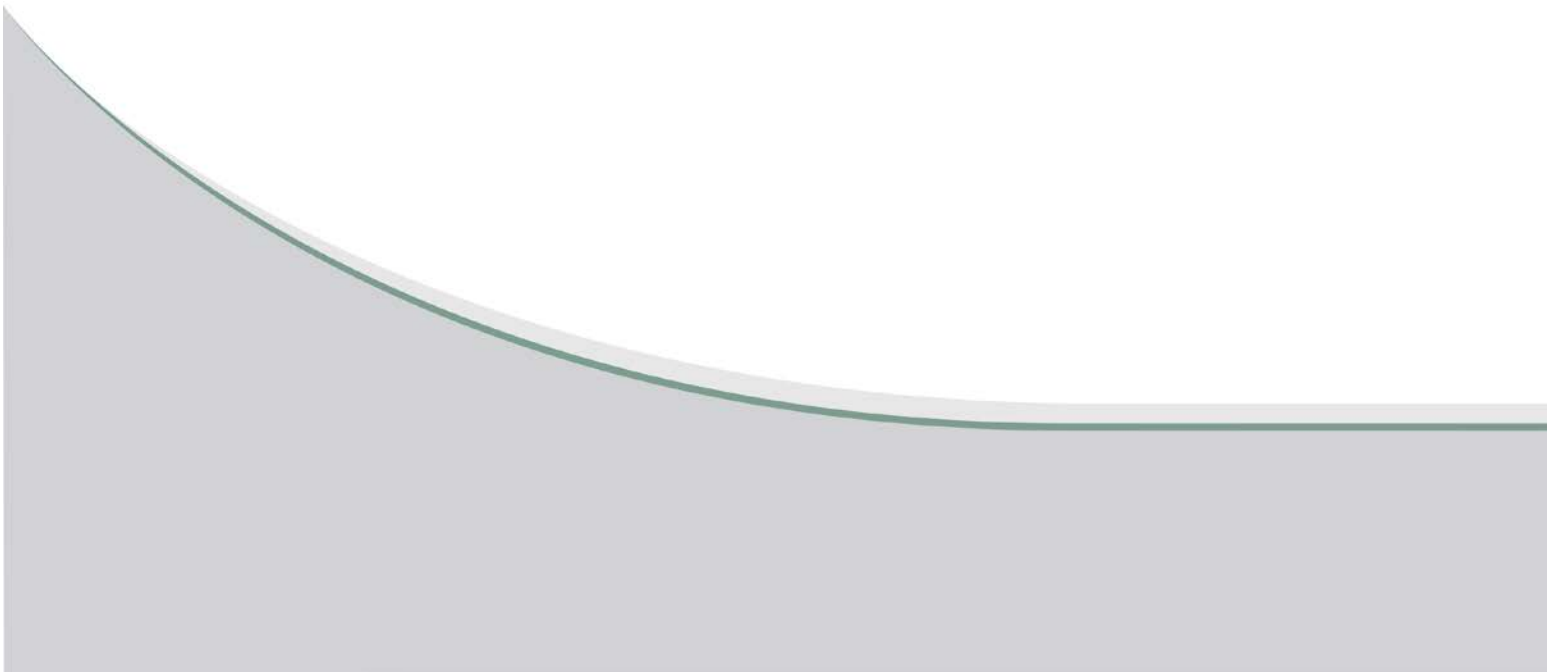


Figure 5 - Core no. 4



Figure 6 - Core no. 5

**APPENDIX B**  
**LODGE TEST HOLE LOGS**







**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** 2018 OUTFALL RENEWAL AND REHABILITATION  
**SITE** Lodge Outfall  
**LOCATION** ~Xm East of the Outfall on Lower Bank  
**DRILLING METHOD** 125 mm ø Solid Stem Auger, Mobile B59

**JOB NO.** 17-0107-020  
**GROUND ELEV.** 232.50  
**TOP OF CASING ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 2/26/2018  
**UTM (m)** N 5,526,615  
 E 623,925

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ DYNAMIC CONE (N) blows/ft △	Soil Properties					
	(m)	(ft)								Cu POCKET PEN (kPa) ★ Cu TORVANE (kPa) ◆	PL %	MC %	LL %		
232.4				<b>TOPSOIL</b> - Black, frozen, rootlets.		0.3									
232	1			<b>SILTY CLAY FILL</b> - Dark brown to black, frozen, loose/crumblly, intermediate to high plasticity, trace fine to coarse grained sand, trace rootlets/roots. - Damp, stiff below 0.6 m.			S01								
231.0	5			<b>SILTY CLAY</b> - Brown, damp, stiff, high plasticity, trace silt inclusion.  - Dark brown, moist, soft below 2.4 m.			S02								
230	2						S03								
229.5	3	10		<b>SILT TILL</b> - Tan, moist, loose, some fine to coarse grained sand, trace fine grained gravel, occasional coarse grained gravel.			S04								
229	4														
228	15			- Compact, with fine to coarse grained sand, trace to some fine grained gravel below 4.6 m.		4.3									
227	5			- Grey, and fine to coarse grained sand, trace fine grained gravel below 5.5 m.		4.5		S05							
226	6	20		- Redish brown, some fine to coarse grained sand below 6.1 m, difficult drilling.			S06	100	18						
225	7						S07	100	13						
224.5	8	25					S08	100	14						
224	8			<b>AUGER REFUSAL AT 8 m</b>		7.4									
223	9	30				7.5									
222	10					7.8									
221	11	35				8.0		S09	100	50					

**Notes:**  
 1. Test hole remained open to 7.8 m after drilling.  
 2. Installed pneumatic piezometers at 4.4 m (07760) and 7.5 m (037758) below grade.  
 3. Installed a slope inclinometer to 7.8 m below grade with a stick-up of 1.02 m.

SAMPLE TYPE Auger Grab Split Spoon

CONTRACTOR **Paddock Drilling Ltd.** INSPECTOR **K. HAMILTON** APPROVED **DRAFT** DATE **4/5/18**

GEO-TECHNICAL-SOIL LOG U:\FMS\17-0107-020\2018 OUTFALL RENEWAL AND REHABILITATION.GPJ

**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** 2018 OUTFALL RENEWAL AND REHABILITATION  
**SITE** Lodge Outfall  
**LOCATION** ~Xm East of Outfall on Upper Bank  
**DRILLING METHOD** 125 mm ø Solid Stem Auger, Mobile B59

**JOB NO.** 17-0107-020  
**GROUND ELEV.** 235.10  
**TOP OF CASING ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 2/26/2018  
**UTM (m)** N 5,526,625  
 E 623,937

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ Cu TORVANE (kPa) ◆		
									PL	MC	LL
235			<b>TOPSOIL</b> - Black, frozen, rootlets.		0.3						
234.8			<b>SILT</b> - Tan, dry to damp, loose to compact.			S01					
233.9	1		<b>SILTY CLAY</b> - Dark brown, dry to damp, stiff, high plasticity, some fine to coarse grained sand.			S02					
233	2		- Damp, trace fine to coarse grained sand, trace silt inclusions below 3 m.			S03					
232	3				3.9						
231	4		- Damp to moist, firm below 4.6 m. - Moist, dark grey below 4.9 m.		4.0	S04					
230	5					S05					
229.6			<b>SILT TILL</b> - Tan, damp to moist, loose, some fine to coarse grained sand, trace fine grained gravel, occasional coarse grained gravel.			S06					
229	6										
228	7		- Compact, with fine to coarse grained sand, trace to some fine grained gravel below 4.6 m.								
227	8		- Grey, and fine to coarse grained sand, trace fine grained gravel below 5.5 m.								
226	9		- Redish brown, some fine to coarse grained sand below 6.1 m, difficult drilling.								
225.2			<b>AUGER REFUSAL AT 9.9 m</b>		9.9						
225	10										
224	11		Notes: 1. Test hole remained open to 7.8 m after drilling. 2. Installed pneumatic piezometers at 4 m (07761) and 8.5 m (037757) below grade. 3. Installed a slope inclinometer to 9.4 m below grade with a stick up of 1.06 m.								

SAMPLE TYPE  Auger Grab  Split Spoon

CONTRACTOR **Paddock Drilling Ltd.**

INSPECTOR **K. HAMILTON**

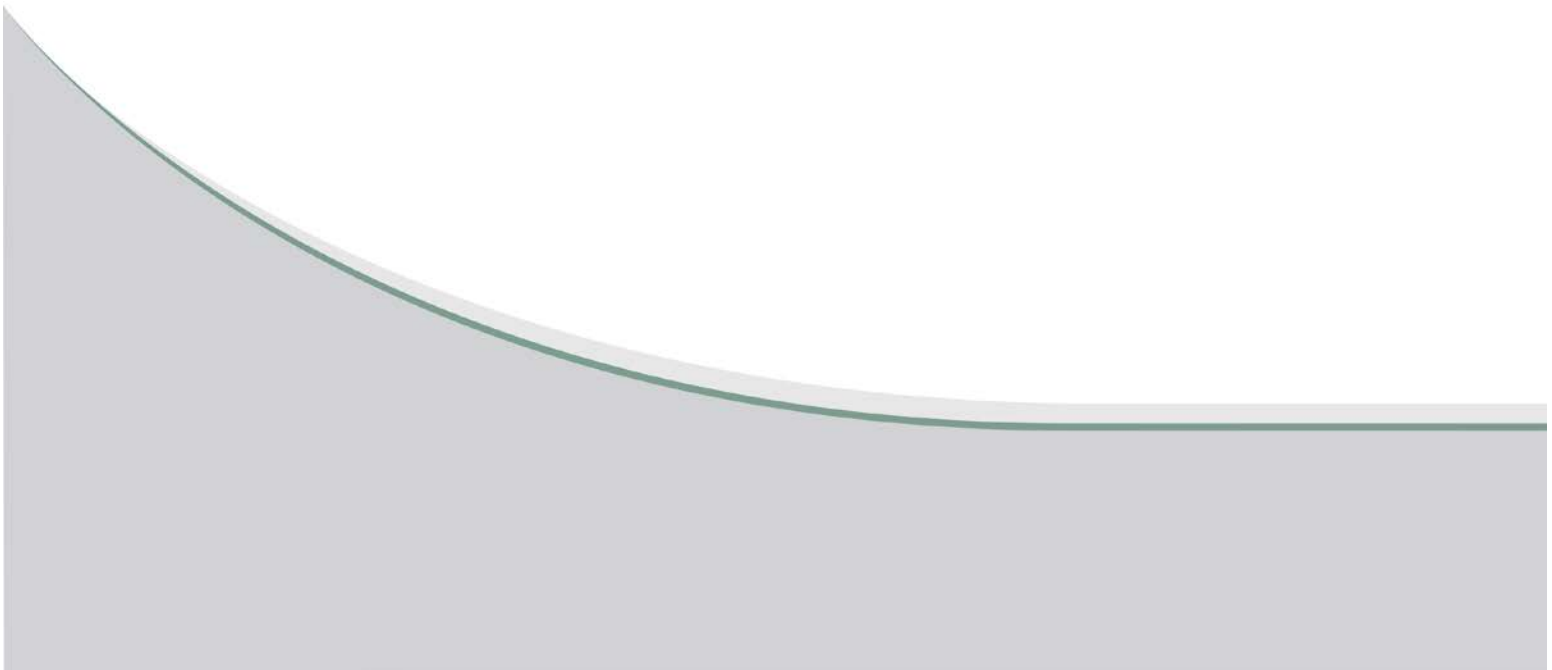
APPROVED **DRAFT**

DATE **4/5/18**

GEO-TECHNICAL-SOIL LOG U:\FMS\17-0107-020\2018 OUTFALL RENEWAL AND REHABILITATION.GPJ

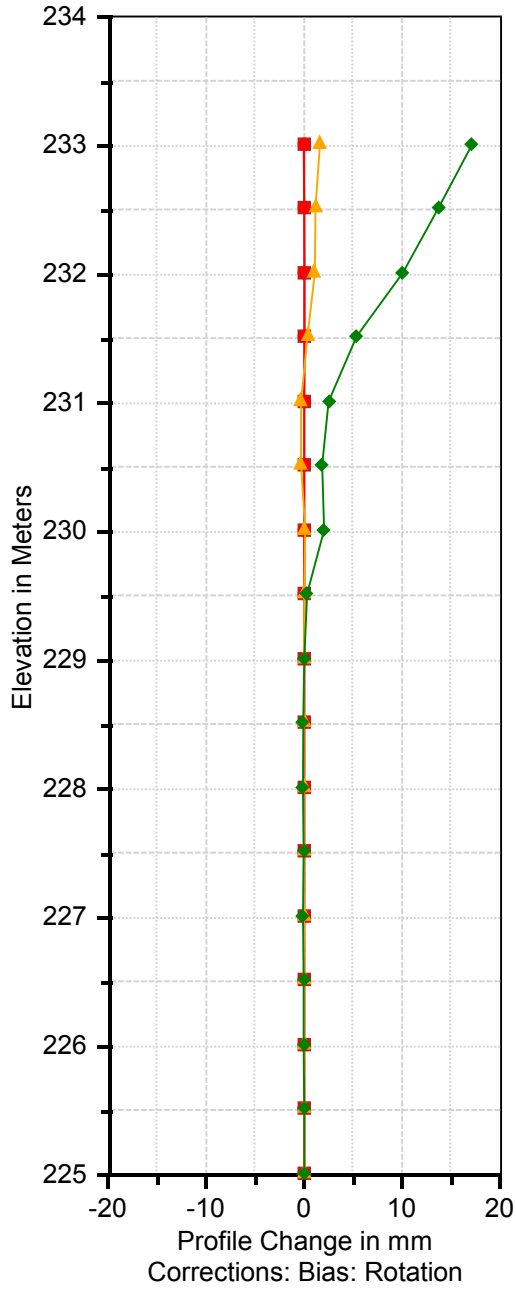
## APPENDIX C

### LODGE SLOPE INCLINOMETER MONITORING RESULTS



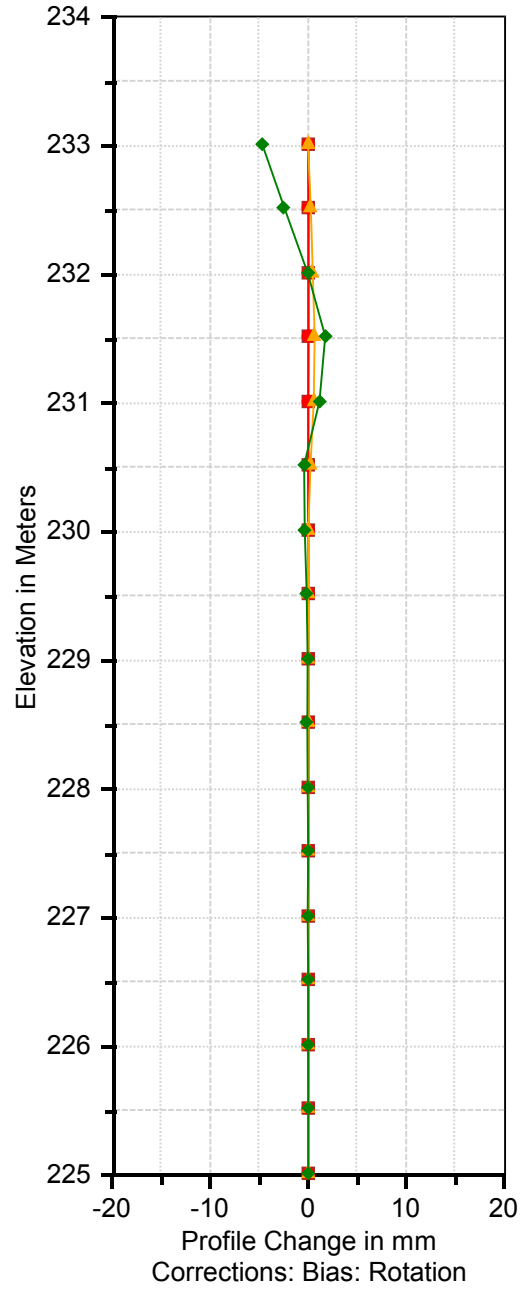
17-0107-020 TH18-01 A

■ 3/6/2018    ● 3/6/2018  
▲ 3/28/2018    ◆ 12/5/2018



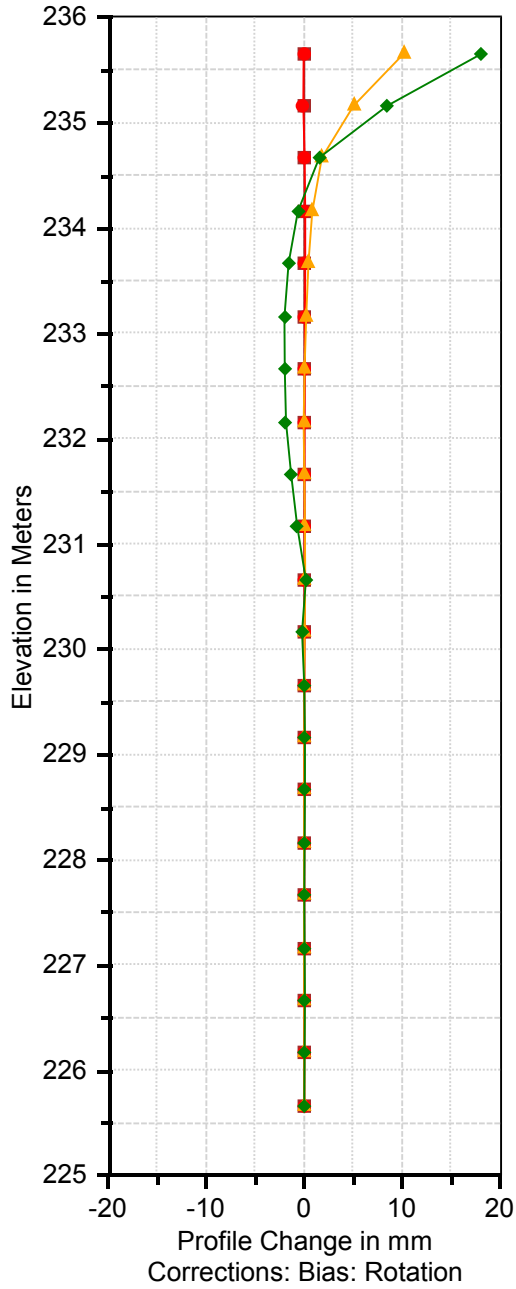
17-0107-020 TH18-01 B

■ 3/6/2018    ● 3/6/2018  
▲ 3/28/2018    ◆ 12/5/2018



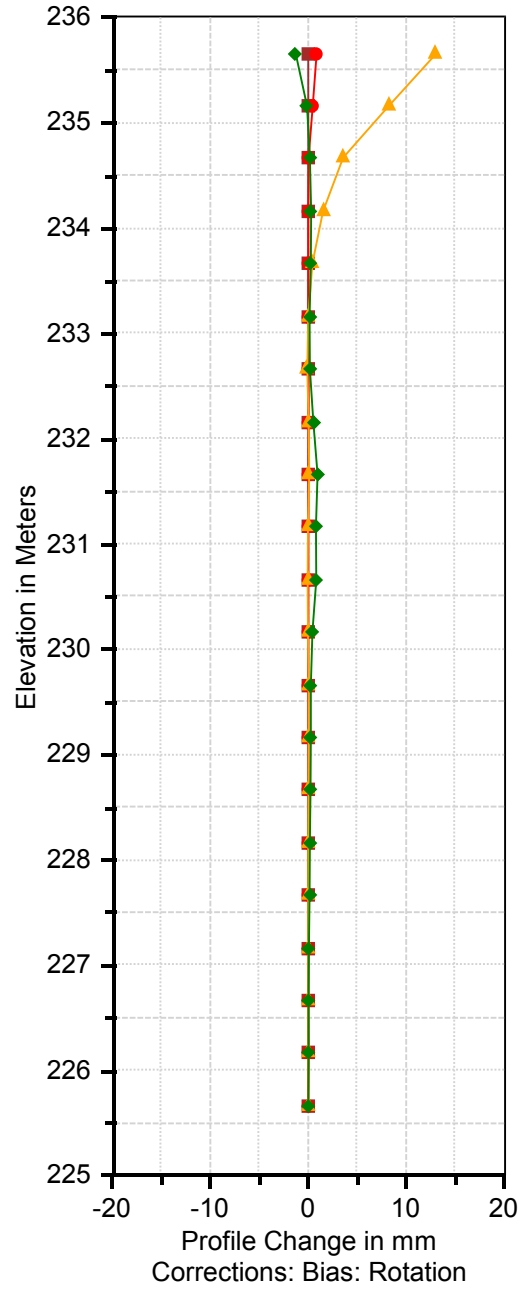
17-0107-020 TH18-02 A

■ 3/6/2018    ● 3/6/2018  
▲ 3/28/2018    ◆ 12/5/2018



17-0107-020 TH18-02 B

■ 3/6/2018    ● 3/6/2018  
▲ 3/28/2018    ◆ 12/5/2018



**KGS**  
GROUP  
CONSULTING  
ENGINEERS

