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May 13, 2016 File No. 15-2288-001

1x1 Architecture Inc.
Suite 103 – 120 Fort Street
Winnipeg, Manitoba
R3C 1C7

ATTENTION: Mr. Markian Yereniuk

RE: The Forks National Historic Site
Infrastructure Upgrades Geotechnical Investigation and
Foundation Assessment for Riverbank Lighting

Dear Mr. Yereniuk:

This report outlines details of the geotechnical site investigations performed by KGS Group and provides geotechnical recommendations relative to the design of the foundation systems for the proposed lighting development along the riverbank between the North Point and Amphitheatre located at the Forks National Historic Site in Winnipeg, Manitoba.

1.0 INTRODUCTION

KGS Group was authorized by 1x1 Architecture Inc. to undertake a geotechnical investigation in order to assess the subsurface conditions and provide geotechnical design recommendations for the foundation structure of the proposed development.

2.0 SCOPE OF SERVICES

The detailed scope of work for the geotechnical engineering services was completed in accordance with KGS Group's proposal dated March 8, 2016, which included the following:

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

Test hole Drilling and Soil Sampling: An on-site drilling program was completed to investigate the subsurface and groundwater conditions at the site. The drilling program consisted of advancing three (3) test holes to 12.2 m (40 ft.) or refusal, whichever was achieved first.

Laboratory Soil Testing: Diagnostic laboratory tests including moisture content, Atterberg Limits, and grain size analyses were performed on select soil samples to determine the relevant engineering properties of the foundation soils.

Summary Geotechnical Report: The following information is provided and/or discussed in this report:

- Description of site conditions including soil stratigraphy, sloughing, and seepage conditions.
- Description of the field investigation program including summary of soil sampling and insitu and laboratory testing results including field Torvane, moisture content analyses, Atterberg Limit test, and grain size analysis.
- Detailed test hole log records incorporating field observations, laboratory test results, UTM coordinates, and a drawing showing the test hole locations.
- Foundation alternatives and necessary design parameters for viable alternatives including Ultimate Limit State and Serviceability Limit State design values and resistance factors for use in the structural design.
- Information on frost depth, potential for frost-jacking, and mitigation measures.
- Considerations for cement type and concrete requirements as they relate to sulphate levels in the existing soil.
- A qualitative slope stability assessment of the impact that the proposed works will have on the existing stability of the riverbank and surrounding areas.

3.0 INVESTIGATION PROGRAM

3.1 TEST HOLE DRILLING AND SAMPLING

A drilling and sampling program consisting of three (3) test holes to 12.2 m (40 ft.) was completed on April 8, 2016. Drilling services were provided by Maple Leaf Drilling Ltd. of Winnipeg, Manitoba with continuous KGS Group supervision. Two (2) test holes were completed along the top of bank region using an Acker Renegade track-mounted drill rig and one (1) test hole was completed using a B20L skid-mounted drill rig. Both rigs were equipped with 125 mm diameter solid stem continuous flight augers. The locations of the test holes are shown on Figure 1 with the approximate UTM coordinates (Zone 14) and ground elevations for the test holes provided on Table 1.

Representative disturbed soil samples were obtained in all test holes at 1.5 m (5 ft.) intervals, or at any change in soil strata. Soil samples were collected directly off the auger flights and visually classified in the field in accordance with the modified Unified Soil Classification System (USCS). Cohesive samples were tested with a field Torvane to evaluate consistency and estimate the undrained shear strength.

Upon completion of the drilling, each test hole was examined for indications of sloughing and seepage. All test holes were backfilled with a combination of soil cuttings and bentonite chips to grade. Detailed summary soil logs incorporating all field observations are provided in Appendix A.

TABLE 1
APPROXIMATE TEST HOLE COORDINATES AND ELEVATIONS

TEST HOLE ID	APPROXIMATE UTM COORDINATES		GROUND ELEVATION (m±)
	NORTHING (m)	EASTING (m)	
TH16-01	5,528,013	634,491	229.3
TH16-02	5,527,823	634,522	227.4
TH16-03	5,527,721	634,494	229.3

The project site is located within a Federal Heritage Area and required the on-site presence of an archaeologist during the subsurface investigation to recover any artifacts encountered as a result of the investigation. Bison Historical Services Ltd. of Winnipeg, Manitoba, was on-site to provide archaeological support during the drilling program including obtaining the required Parks Canada Agency Research and Collection Permit prior to the commencement of drilling. A report detailing the results of the archaeological investigation is provided as Appendix C.

3.2 LABORATORY TESTING

A diagnostic laboratory testing program was performed on select representative soil samples to determine the relevant engineering properties of the subsurface soils relative to the foundation design. Diagnostic testing completed included ten (10) moisture content tests, one (1) Atterberg Limit test, and one (1) particle size analysis.

Laboratory testing was completed at a Standards Council of Canada accredited soil testing laboratory in Winnipeg, Manitoba in accordance with ASTM Standards. The results of the laboratory testing are included on the test hole logs in Appendix A.

4.0 INVESTIGATION RESULTS

4.1 SITE STRATIGRAPHY

In general, the stratigraphy has been interpreted by KGS Group to consist of a mixture of clay, sand and gravel fill overlying complex alluvial deposits of silty clay, clayey silt, and silty sand underlain by till. Auger refusal was encountered 11.1 m (El. 216.2 m±) below the existing ground surface within the silt till in TH16-02.

Fill

Silty to sandy clay fill was encountered at the existing ground surface within TH16-01 (El. 229.3 m±) and TH16-03 (El. 229.3 m±) and extended to a depth of 0.9 m and 2.4 m respectively. The fill was brown in colour, damp, soft to firm, of low to intermediate plasticity, and contained fine to coarse grained sand, some fine to coarse grained gravel, trace silt inclusions, trace oxidation, trace organics; and trace brick and glass fragments (TH16-03).

A 1.5 m thick layer of sand and gravel fill was encountered beneath the silty clay fill within TH16-01 and was tan in colour, damp, poorly graded, and fine to coarse grained. Some lime was encountered in the sand and gravel and an isolated thin layer of topsoil with organics was encountered below the fill.

Alluvial Silty Clay

Silty clay of alluvial origin was encountered from the existing grade within TH16-02 (El. 227.4 m±) and below the fill at a depth of 2.4 m within TH16-03. The silty clay was typically brown in colour, damp, firm to stiff, of intermediate to high plasticity, and contained trace to some fine to coarse grained sand, with silt; and trace to some oxidation, organics, rootlets, and ice lenses.

The undrained shear strength of the silty clay, as estimated by the field Torvane on disturbed samples varied from 30 kPa to 55 kPa. The moisture content of the silty clay varied from 28% to 34% across TH16-02 and TH16-03.

Clayey Silt (ML)

Clayey silt of alluvial origin was encountered in all test holes at a depth from 1.5 m to 3.1 m (El. 226.5 m± to 225.8 m±) below the existing ground surface. The deposit varied in composition both laterally and with depth between the upper bank (TH16-01, TH16-03) and mid bank (TH16-02).

In general, the clayey silt was grey with isolated black to brown colour; moist to wet, soft, of low to intermediate plasticity, and contained some fine grained sand, trace coarse grained sand, trace fine to coarse grained gravel, some clay, some organics, some oxidation pockets; and exhibited a strong organic odor. The granular content varied with depth across all test holes. Isolated sandy silt seams were noted from a depth of 6.7 m to 7.6 m below grade within TH16-03.

The undrained shear strength of the clayey silt, as estimated by the field Torvane on disturbed samples varied from 10 kPa to 35 kPa. The moisture content of the clayey silt varied from 26% to 36% across all test holes. Atterberg limit testing performed on one (1) sample from TH16-02 at 4.0 m measured a Liquid Limit of 35%, Plastic Limit of 21%, and Plasticity Index of 14%, resulting in a classification of ML.

Silty Sand

Silty sand was encountered immediately below the clayey silt layer at depths varying from 7.6 m to 9.5 m (El. 219.7 m± to 220.1 m±) in all test hole locations. The silty sand layer extended to a depth of 10.4 m within TH16-02 and to the end of hole depth of 12.2 m within TH16-01 and TH16-03. The silty sand was typically grey in colour, wet (with free water), loose, poorly graded, fine to coarse grained, and contained trace to with coarse grained sand, trace to with fine to coarse grained gravel, some silt, trace to some clay, and trace shells.

Till

Clayey silt till underlain by silt till was encountered below the alluvial silty sand at a depth of 10.4 m (El. 217.0 m±) below existing ground surface and extended to a depth of 11.1 m where power auger refusal occurred within TH16-02. The till was grey in colour, damp to moist, dense, firm, of low plasticity, and contained some fine to coarse grained sand and gravel; and trace clay.

The undrained shear strength of the clayey silt till, as determined from the field Torvane on disturbed samples was 40 kPa. The moisture content in the clayey silt till was 13% within TH16-02.

4.2 GROUNDWATER AND POTENTIAL DIFFICULT CONDITIONS

Groundwater infiltration was observed in all test holes during and after the drilling operations. The groundwater level was observed to vary from approximately 3.1 m to 5.8 m (El. 223.5 m± to 225.9 m±) below existing grade upon completion of drilling. All test holes sloughed within the alluvial deposits at depths varying from 3.1 m to 9.5 m (El. 219.8 m± to 225.6 m±). Any work completed below approximately 3.1 m (El. 225.6 m) should expect to encounter sloughing of the excavation sidewalls as well as groundwater infiltration into the excavation. These conditions will have to be controlled/mitigated during construction.

Groundwater levels can be expected to fluctuate seasonally with changing river levels and typically rise during the spring melt and after significant rainfall events.

5.0 FOUNDATION ASSESSMENT

The foundation considerations described in this report follow the Limit State Design (LSD) Guidelines. Limit State Design requires consideration of two (2) main loading states: Ultimate Limit States and Serviceability Limit States. The Ultimate Limit States (ULS) are primarily concerned with collapse mechanisms of the structure and safety, and the Serviceability Limits States (SLS) present conditions or mechanisms that restrict or constrain the intended use, function or occupancy of the structure under expected service or working loads. For pile foundation design, each loading state prescribes Geotechnical Resistance Factors (Φ) that are based upon the method used to evaluate pile capacity to obtain the Factored Serviceability Limit State (SLS) and Factored Ultimate Limit State (ULS) pile capacity values. A Geotechnical Resistance Factor of (Φ) of 0.4 has been applied to the factored ULS and SLS values presented below.

5.1 CAST-IN-PLACE CONCRETE PILES

Cast-in-place concrete piles may be used to support the proposed lighting standards. For design purposes, the upper 2.5 m of pile length below finished ground elevation of all piling should be neglected when determining pile capacities. It should be noted that this applies to piles installed in the native soils only, and the fill or organic material should be assumed to provide no support.

Friction piles may be designed based upon the estimated Ultimate Limit State (ULS) and Serviceability Limit State (SLS) skin friction values provided on Table 2. A geotechnical resistance factor (Φ) of 0.4 has been applied to the estimated average factored resistance values.

TABLE 2
AVERAGE FACTORED SKIN FRICTION VALUES FOR C.I.P. PILES
UNDER COMPRESSIVE LOADING

DEPTH BELOW GRADE (m)	SLS SKIN FRICTION VALUE (kPa)	ULS SKIN FRICTION VALUE (kPa)
0 to 2.5	0	0
Below 2.5	4.5	6

Piles that are designed to be friction piles should be designed to resist the load by shaft resistance only. The contribution from end bearing should be ignored in pile calculation capacities. Straight shaft cast-in-place concrete piles should have a minimum embedded length of 8.0 m with reinforcing over the full pile length to protect against frost jacking.

Cast-in-place end bearing piles, bearing on undisturbed, dense till could also be used to support heavier loads. A geotechnical resistance factor (Φ) of 0.4 has been assumed for the recommended factored resistances for compressive loading. The estimated average factored end bearing values for Limit States Design of the pile are provided in Table 3.

TABLE 3
AVERAGE FACTORED END BEARING VALUES FOR C.I.P. PILES
UNDER COMPRESSIVE LOADING

DEPTH BELOW GRADE (m)	SLS BEARING CAPACITY VALUE (kPa)	ULS BEARING CAPACITY VALUE (kPa)
End Bearing on Competent Till	150	185

5.2 FOUNDATION CONSIDERATIONS

The potential exists for sloughing and squeezing of the borehole during the installation of the cast-in-place concrete piles at this site. Temporary steel sleeves would be required during pile installation in an effort to maintain the drill shaft in a clean and dry state. The concrete should be poured as soon as practical following the drilling of each shaft. Should heavy groundwater inflow be encountered, concrete placement should be completed using tremie or pump-in methods, or alternatively driven piles should be used if seepage cannot be controlled. Drilling and concrete placement for the piles should be inspected by experienced geotechnical personnel to verify the soil conditions and proper installation of the piles.

5.3 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 bare ground and no insulation cover. The clay and silt soils can heave upon freezing and must be considered in the foundation design. Well-graded granular materials should be utilized as backfill material as they are less susceptible to the effects of frost heave than fine grained silt and clay materials.

5.4 TYPE OF CEMENT FOR CONCRETE MIX

The degree of exposure of concrete in contact with soils to sulphate attack is classified in CAN/CSAA23.1-M94 (Concrete Materials and Methods of Concrete Construction) as moderate (S-3), severe (S-2), or very severe (S-1). All cast-in-place piles and pile caps should have a minimum specified 28 day compressive strength of 32 MPa and class of exposure of S-2 corresponding to severe sulphate attack. A maximum water to cement ratio of 0.45 should be specified in accordance with Table 2, CSA A23.1-09 for concrete with severe sulphate exposure (S2). Concrete which may be exposed to freezing and thawing should be adequately air entrained to improve freeze-thaw durability in accordance with Table 4, CSA A23.1-09.

6.0 SITE INSPECTION AND SLOPE STABILITY ASSESSMENT

A visual inspection and qualitative slope stability assessment of the riverbank within the Forks National Historic Site was performed. The section of riverbank is located along the west bank on an inside bend of the Red River and extends from the North Point, near the confluence of the Red and Assiniboine Rivers, approximately 400 m downstream to the Amphitheatre structure. Photos from the site visit are provided as Appendix B and approximate locations are shown on Figure 2.

At the southern project extents just upstream of North Point, the relatively flat upper bank area slopes down uniformly at approximately 3H:1V to the River Walk at the toe of the slope as shown in Photos 1 and 2. A narrow mid bank bench was observed to form downstream of the North Point and near TH16-03 as shown in Photos 3 and 4. The mid bank bench gradually widens further downstream and gently slopes down through the lower bank area towards the River Walk adjacent to the Boat Dock structure and TH16-02, as shown in Photos 5 and 6. The upper bank along this section slopes down to the mid bank bench at approximately 2H:1V. Upstream of the Amphitheatre, the mid bank bench gradually narrows to form a uniform slope at approximately 2.5H:1V, and is shown in Photos 7 and 8. The riverbank along the Amphitheatre is lined by limestone blocks along the crest and toe of the slope as shown on Photo 9. The upper bank is relatively flat and landscaped immediately downstream of the Amphitheatre near TH16-01 and the northern project extents. The riverbank is densely vegetated with large, mature trees and other riparian vegetation throughout the project extents.

The toe of the existing slope is protected by the River Walk, which functions as a toe berm to improve global stability of the riverbank and has performed satisfactory to date with no evidence of substantial slumping, as stated in KGS Group's report "Forks Promenade Extension Geotechnical and Hydraulic Assessment", dated August 1992 and provided as Appendix D. Downslope of the River Walk extending into the river, the shoreline is currently lined with riprap to protect against erosion; the underlying mechanism which is a cause for a majority of riverbanks to fail. The drilling and sampling program detailed in this report indicates that the bank consists primarily of alluvial deposits and there were no visible headscarps or tension cracks observed at the time of the site visit.

It is our understanding the proposed works (i.e. 12 new lighting standards complete with cast-in-place pile foundations) are to be located on the mid bank bench to upper bank area as shown on Figure 1 and will be located at small discrete locations on the bank. The light standard structures will represent a negligible loading to the riverbank due to the excavation of the soil for the foundations and the replacement with concrete. On this basis, KGS Group concludes that the proposed works will have negligible impact to river hydraulics and the critical bank stability. 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.
- No stockpiling of materials on site during the work.
- All foundation construction equipment is chosen to limit the disturbance to the riparian forest.

7.0 CONCLUSIONS

Based on the geotechnical field investigation and foundation assessment the following conclusions are made:

- In general, the stratigraphy at the site has been interpreted by KGS Group to consist of clay sand and gravel fill overlying complex alluvial deposits of silty clay, clayey silt, and silty sand underlain by clayey silt till and silt till. The in-situ alluvial deposits generally varied in composition both laterally across the site and with depth in each hole. Power auger refusal occurred in the silt till at approximate El. 216.2 m± within TH16-02.

- In general, groundwater levels were observed in the test holes across the site to vary from El. 223.5 m± to 225.9 m± immediately upon completion of drilling. Based on previous experience, groundwater levels will fluctuate seasonally with river levels and following precipitation events, hence the actual water level at the time of construction could differ from those reported in this report.

- Suitable foundation types for the proposed lighting works include cast-in-place friction piles and cast-in-place straight shaft end bearing piles, bearing on undisturbed, dense till.

- 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.

- The proposed works will not detrimentally impact riverbank stability or adversely impact river hydraulics. Based on a qualitative slope stability assessment, the riverbank is protected by the River Walk, riprap shoreline erosion protection, and no headscarps or tension cracks were observed at the time of the site visit.

8.0 RECOMMENDATIONS

Based on the geotechnical field investigation and foundation assessment the following recommendations are made:

- KGS Group recommends that a Waterway Construction Permit be granted in support of the work provided that: no fill material is delivered to site to complete the work; all debris and excavated materials are immediately hauled off site; no stockpiling of materials occurs on site during the work; and construction equipment is chosen to limit the disturbance to the riparian forest.

- For friction piles exposed to frost, resistance of the upper 2.5 m should be neglected throughout the depth of frost penetration.

- For end bearing piles on competent till, the base of the pile must be keyed a minimum of 500 mm into the competent till to ensure that the desired capacities can be developed.

- Since seepage and sloughing are likely to occur throughout the native soil deposits, full-length steel sleeves should be maintained on site and utilized as required during construction to maintain the pile shaft and base in a clean dry state.

- If heavy groundwater inflows are encountered in the pile excavations, concrete placement should be completed using tremie or pump-in methods.

- Cast-in-place friction or end-bearing piles should have steel reinforcement over the entire pile length to protect against frost jacking and designed by a structural engineer.

- The reinforcement and concrete should be placed as soon as possible after the subgrade or bearing surface is approved to prevent disturbance to the foundation soil during subsequent construction activity.
- All concrete foundations in contact with native soils should utilize sulfate resistance cement CSA Type HS.
- Inspection by qualified geotechnical personnel should be performed throughout the construction of foundations, and in particular for determining the quality and competency of the subgrade.

9.0 STATEMENT OF LIMITATIONS AND CONDITIONS

9.1 THIRD PARTY USE OF REPORT

This report has been prepared for 1x1 Architecture Inc. 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.

9.2 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 Group at this site. If conditions encountered during construction appear to be different from those shown by the test holes drilled by KGS Group or if the assumptions stated herein are not in keeping with the design, this office should be notified in order that the recommendations can be reviewed and modified if necessary.

Prepared By:

Kelly Fordyce, P.Eng.
Geotechnical Engineer-in-Training

Reviewed By:

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

Approved By:

Dami Adedapo, Ph.D., P.Eng.
Assistant Geotechnical Department Head

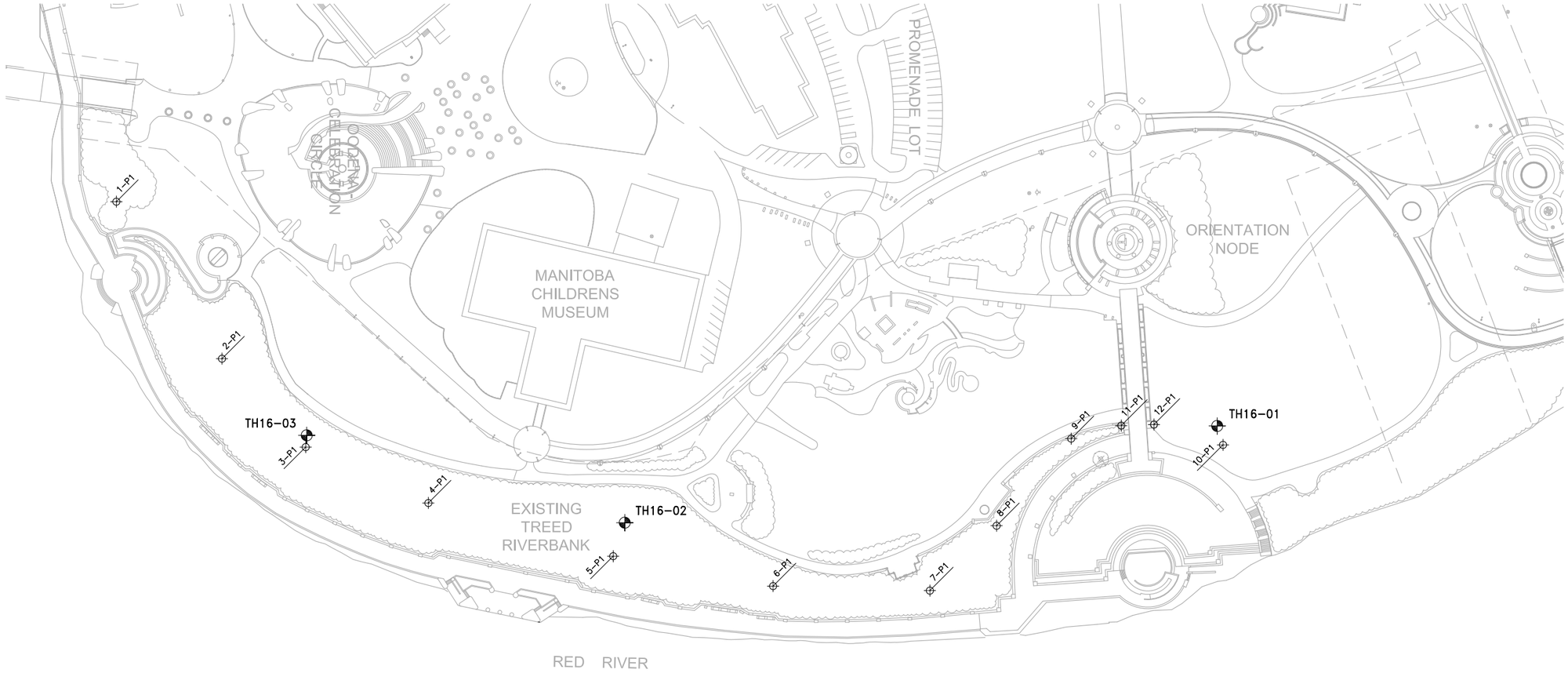
KF/DEA/nf

Attachments

cc: Patrick Gloux

FIGURE

11x17



LEGEND:

- TEST HOLE (KGS GROUP, 2016)
- PROPOSED NEW PILE

1 — TEST HOLE & NEW PILE LAYOUT
SCALE: 1:1500

PILE COORDINATES		
PILE No.	NORTHING (m)	EASTING (m)
1	5527659.965	634419.109
2	5527693.835	634469.433
3	5527720.671	634497.776
4	5527760.014	634515.688
5	5527819.287	634532.744
6	5527870.575	634542.319
7	5527920.853	634543.772
8	5527942.254	634522.979
9	5527966.181	634495.062
10	5528014.860	634497.068
11	5527982.234	634490.886
12	5527992.711	634490.543

TEST HOLE COORDINATES		
TEST HOLE No.	NORTHING (m)	EASTING (m)
TH16–01	5528013.000	634491.000
TH16–02	5527823.000	634522.000
TH16–03	5527721.000	634494.000

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
A	16/04/25	ISSUED WITH DRAFT REPORT	KF	PPG

REVISIONS / ISSUE

CLIENT:
PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

PROJECT:
THE FORKS NHS
INFRASTRUCTURE UPGRADES
WINNIPEG, MANITOBA

DWG. DESCRIPTION:
STRUCTURAL
SITE PLAN
TEST HOLE LOCATIONS

ENG. STAMP

KGS GROUP CONSULTING ENGINEERS

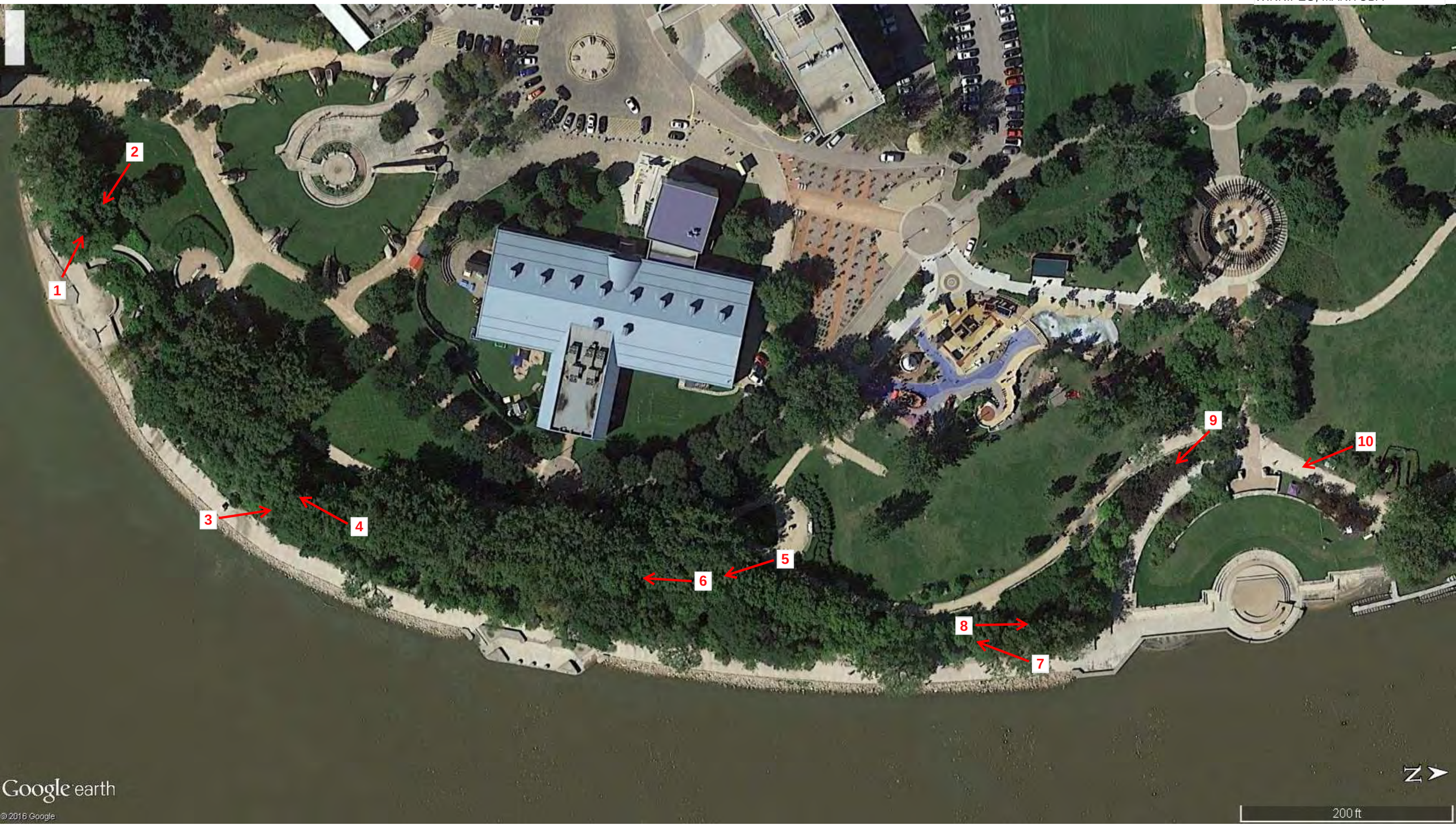
DESIGN BY: KF	DATE (YY/MM/DD): 16/04/22
DESIGN CHECK:	DATE:
DRAWN BY: JAR	DATE: 16/04/22
DWG CHECK:	DATE:

DWG. NO. 15–2288–001 FIGURE 1 | REV: A

FileName: U:\FMS\15-2288-001\15-2288-001_Fig01.dwg – Tab: LAYOUT Plotted By: jremillard 16/04/25 [Mon 9:12am]
11"x17" PLOT SCALE: 1"=2'

15-2288-001 FIGURE 2
APPROXIMATE PHOTO LOCATIONS

THE FORKS NHS
INFRASTRUCTURE UPGRADES
WINNIPEG, MANITOBA



APPENDICES

APPENDIX A

TEST HOLE LOGS AND LABORATORY TESTING DATA

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH16-01**

CLIENT 1x1 ARCHITECTURE INC.

PROJECT Forks National Historic Site - Infrastructure Upgrades

SITE Forks National Historic Site

LOCATION Top of Bank - NW of Amphitheatre

DRILLING METHOD 125 mm ø Solid Stem Auger, ACKER RENEGADE Track Mounted Rig

JOB NO. **15-2288-001**
GROUND ELEV. **229.30 m (approx.)**
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED **4/8/2016**
UTM (m) N **5,528,013**
E **634,491**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %
229				**SILTY CLAY FILL** - Brown, damp, low to intermediate plasticity, soft to firm, with fine to coarse grained sand, some fine to coarse grained gravel, trace oxidation, trace organics, trace silt nodules.			
228.4	1	5		**SAND & GRAVEL FILL** - Tan, damp, compact, fine to coarse grained.		S01	
228				- Increased fines content below 1.8 m.			
227	2			- With lime (white, damp, firm, low plasticity) below 2.1 m.			
226.9				**TOPSOIL** - Black, damp, firm, with fine to coarse grained sand, with organics, with wood fragments.		S02	
226.6				**CLAYEY SILT (ML)** - Black to grey, moist, soft to firm, low to intermediate plasticity, some to with clay, trace coarse grained sand.		S03	
226	3	10		- With fine to coarse grained sand, trace fine to coarse grained gravel, some organics, trace coal fragments, occasional brick fragments below 3.1 m.			
				- Some clay below 3.7 m.		S04	
225	4	15		- Wet, some fine to coarse grained gravel, with organics, some to with clay, no coal, no brick below 4.6 m.			
224	5			- Soft, low plasticity, increased coarse grained gravel below 5.2 m.		S05	
223	6	20		- Grey, moist to wet, low plasticity, some fine grained sand, no gravel below 6.1 m.			
						S06	
222	7			- Firm below 7.3 m.			

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

CONTRACTOR **Maple Leaf Enterprises**
INSPECTOR **K. FORDYCE**
APPROVED DRAFT
DATE 4/22/16

GEOTECHNICAL-SOIL LOG U:\FMS\15-2288-001\FORKS NHS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH16-01**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	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 %
	8			- Wet (free water), soft, with fine to coarse grained sand, some clay below 7.9 m.					
221						S07			
220.2	9	30		**SILTY SAND** - Grey, wet, very loose, fine to coarse grained, some silt, some clay, trace fine grained gravel.					
220				- No recovery from 9.1 m to 10.7 m.					
	10								
219		35		- No recovery from 10.7 m to 12.2 m.					
	11			- Fine to medium grained sand, trace coarse grained sand, trace fine to coarse grained gravel below 10.7 m.					
218									
	12								
217.1		40		**END OF TEST HOLE AT 12.2 m.**					
217				Notes: 1. Test hole open to 3.7 m upon completion of drilling. 2. Water level at 3.4 m below grade upon completion of drilling. 3. Test hole backfilled with bentonite chips and cuttings to grade.					
	13								
216		45							
	14								
215									
	15	50							
214									
	16								
213									

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	K. FORDYCE	DRAFT	4/22/16

GEOTECHNICAL-SOIL LOG U:\FMS\15-2288-001\FORKS NHS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH16-02**

CLIENT 1x1 ARCHITECTURE INC.

PROJECT Forks National Historic Site - Infrastructure Upgrades

SITE Forks National Historic Site

LOCATION Middle Bank Bench - NW of Boat Dock

DRILLING METHOD 125 mm ø Solid Stem Auger, B20 Portable Drill Rig

JOB NO. **15-2288-001**
GROUND ELEV. **227.40 m (approx.)**
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED **4/8/2016**
UTM (m) N **5,527,823**
E **634,522**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %
227				**SILTY CLAY** - Brown, damp, stiff, intermediate plasticity, with silt, trace fine to medium grained sand, trace silt inclusions, trace oxidation, trace organics, trace rootlets, trace ice lenses.			
	1					S01	
226.2				**SILT & SAND** - Grey, moist, loose, fine to coarse grained, trace fine grained gravel, odorous (possible ash).			
226							
225.9		5		**CLAYEY SILT (ML)** - Brown, damp, very soft, low plasticity, some clay, some fine to medium grained sand. with organics.			
	2			- Damp to moist below 1.8 m.			
225				- Moist, soft, trace rootlets below 2.4 m.		S02	
	3	10					
224				- Grey, wet, very soft, some to with clay, some fine grained sand, odorous below 3.7 m.			
	4			- Grain Size Distribution at 4.0 m: Gravel (0%), Sand (16.6%), Silt (62.5%), Clay (20.9%).		S03	
223		15		- Free water on augers below 4.6 m.			
	5			- Soft silt and organic pockets from 5.2 m to 5.5 m.		S04	
222				- Very soft silt pocket at 5.8 m.			
	6	20					
221				- Sand seam encountered from 6.4 m to 6.7 m - brown, wet, loose, poorly graded, fine to coarse grained, with silt, trace clay.		S05	
	7						
220				- Loose, some coarse grained sand, trace fine grained gravel, trace clay below 7.3 m.			
219.8							

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

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	K. FORDYCE	DRAFT	4/22/16

GEOTECHNICAL - SOIL LOG U:\FMS\15-2288-001\FORKS NHS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH16-02**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	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)
	8			**SILTY SAND** - Grey, wet (free water), loose, poorly graded, fine to coarse grained, some fine to coarse grained gravel, some silt, trace clay, trace shells, poor recovery.					
219						S06			
				- With fine to coarse grained gravel below 8.5 m.					
	9	30							
218									
	10			- some clay content below 10.1 m.					
217.0									
217				**CLAYEY SILT TILL** - Grey, damp, firm, low plasticity, some fine to coarse grained sand, some fine to coarse grained gravel, some clay.		S07			
		35							
216.4						S08			
216.3	11			**SILT TILL** - Grey, damp, dense, soft to firm, low plasticity, some fine to coarse grained sand, some fine to coarse grained gravel, trace clay.					
216				**POWER AUGER REFUSAL AT 11.1 m.**					
				Notes: 1. Test hole sloughed in to 3.1 m upon completion of drilling. 2. Water level at 3.1 m below grade upon completion of drilling. 3. Test hole backfilled with bentonite chips and cuttings to grade.					
	12	40							
215									
	13								
214									
		45							
	14								
213									
	15	50							
212									
	16								
211									

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	K. FORDYCE	DRAFT	4/22/16

GEOTECHNICAL-SOIL LOG U:\FMS\15-2288-001\FORKS NHS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH16-03**

CLIENT 1x1 ARCHITECTURE INC.

PROJECT Forks National Historic Site - Infrastructure Upgrades

SITE Forks National Historic Site

LOCATION Top of Bank - Between North Point and Boat Dock

DRILLING METHOD 125 mm ø Solid Stem Auger, ACKER RENEGADE Track Mounted Rig

JOB NO. **15-2288-001**
GROUND ELEV. **229.30 m (approx.)**
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED **4/8/2016**
UTM (m) N **5,527,721**
E **634,494**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	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 %
229				**SANDY CLAY FILL** - Brown, damp, firm, low plasticity, with fine to coarse grained sand, some fine grained gravel.				
	1			- Dry to damp, loose, trace brick fragments, trace glass fragments below 0.9 m.				
228		5		- Decreased granular, trace oxidation below 1.4 m. - Clay nodules encountered below 1.5 m.				
	2			- Some oxidation below 1.8 m.	S01			
227				- Decreased granular below 2.1 m.				
226.9				**SILTY CLAY** - Brown, damp, firm, intermediate plasticity, some fine to coarse grained sand, some oxidation, some organics, laminated.				
				- Organic pocket encountered at 2.7 m.	S02			
226.3	3	10		- Concrete chunk below 2.7 m.				
226				**CLAYEY SILT (ML)** - Grey, moist, soft, low plasticity, some to with clay, some organic pockets, odorous.	S03			
	4							
225		15						
	5				S04			
224				- Some fine grained sand below 5.8 m.				
	6	20						
223				- Brown below 6.7 m.				
	7			- Silty sand seam encountered from 7.0 m to 7.2 m. - brown, moist to wet, compact, poorly graded fine to medium grained, with silt, trace clay.	S05			
222				- Soft to firm, intermediate plasticity, trace fine grained sand, with clay, some oxidation pockets, trace silt pockets below 7.3 m.				

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	K. FORDYCE	DRAFT	4/22/16

GEOTECHNICAL-SOIL LOG U:\FMS\15-2288-001\FORKS NHS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH16-03**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	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)
	8			- Grey, wet, with fine grained sand below 7.6 m.					
221				- Firm, some fine grained sand, some clay below 8.2 m.		S06			
	9	30		- Soft, some fine to coarse grained sand below 9.0 m.					
220									
219.9				**SILTY SAND** - Grey, wet, loose to compact, poorly graded, fine to coarse grained, some fine grained gravel, with silt, some clay.					
	10					S07			
219		35		- Loose, poor recovery through anticipated silty, fine grained sand below 10.7 m.					
	11								
218									
	12								
217.1		40		**END OF TEST HOLE AT 12.2 m.**					
217				Notes: 1. Test hole open to 9.5 m upon completion of drilling. 2. Water level at 5.8 m below grade upon completion of drilling. 3. Test hole backfilled with bentonite chips and cuttings to grade.					
	13								
216									
		45							
	14								
215									
	15								
214		50							
	16								
213									

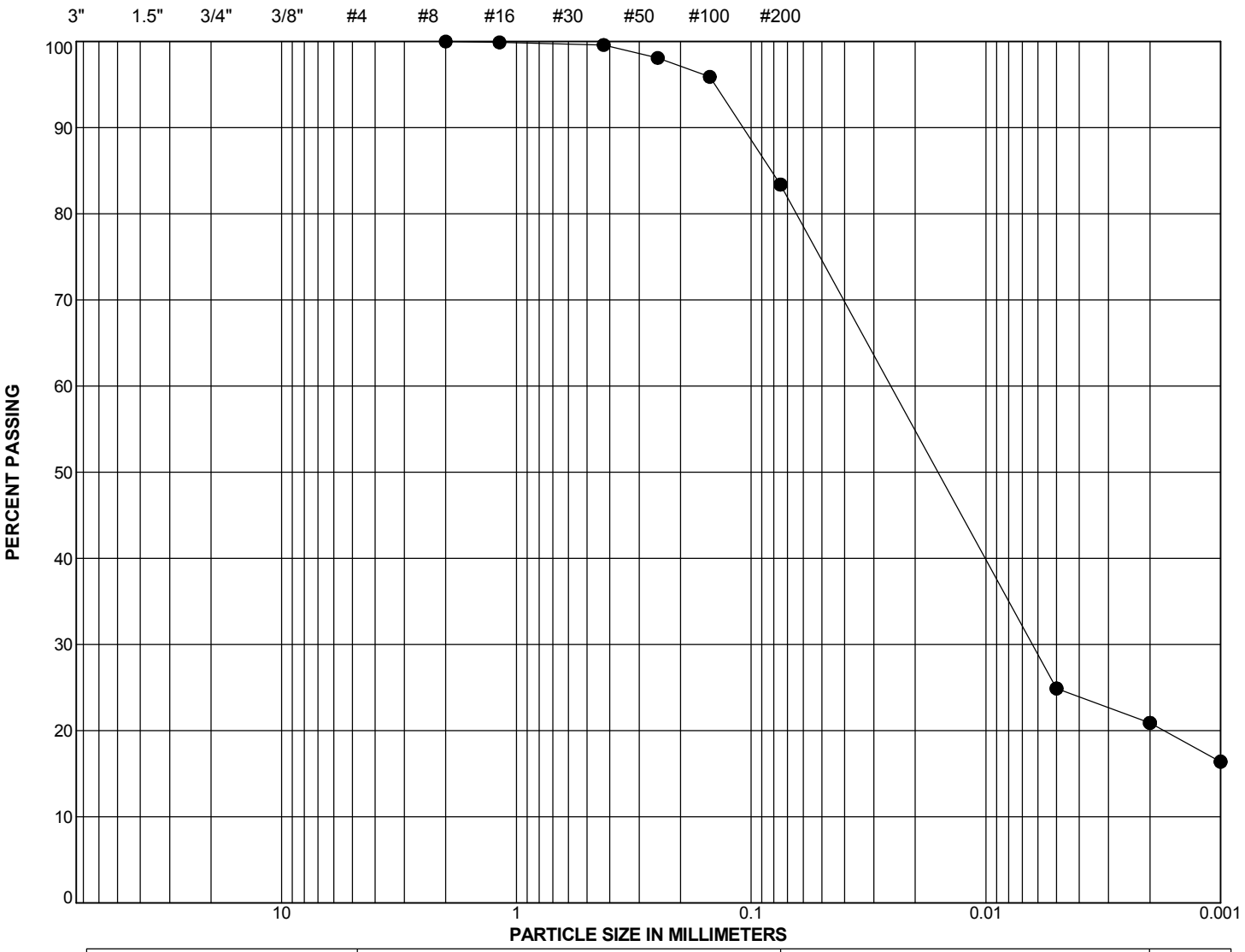
SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	K. FORDYCE	DRAFT	4/22/16

GEOTECHNICAL-SOIL LOG U:\FMS\15-2288-001\FORKS NHS.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
●	*TH16-02*	*4.0*	*S03*	*0.0*	*16.6*	*62.5*	*20.9*	*83.4*			*ML*

SIEVE ANALYSIS U:\FMS\15-2288-001\FORKS NHS.GPJ

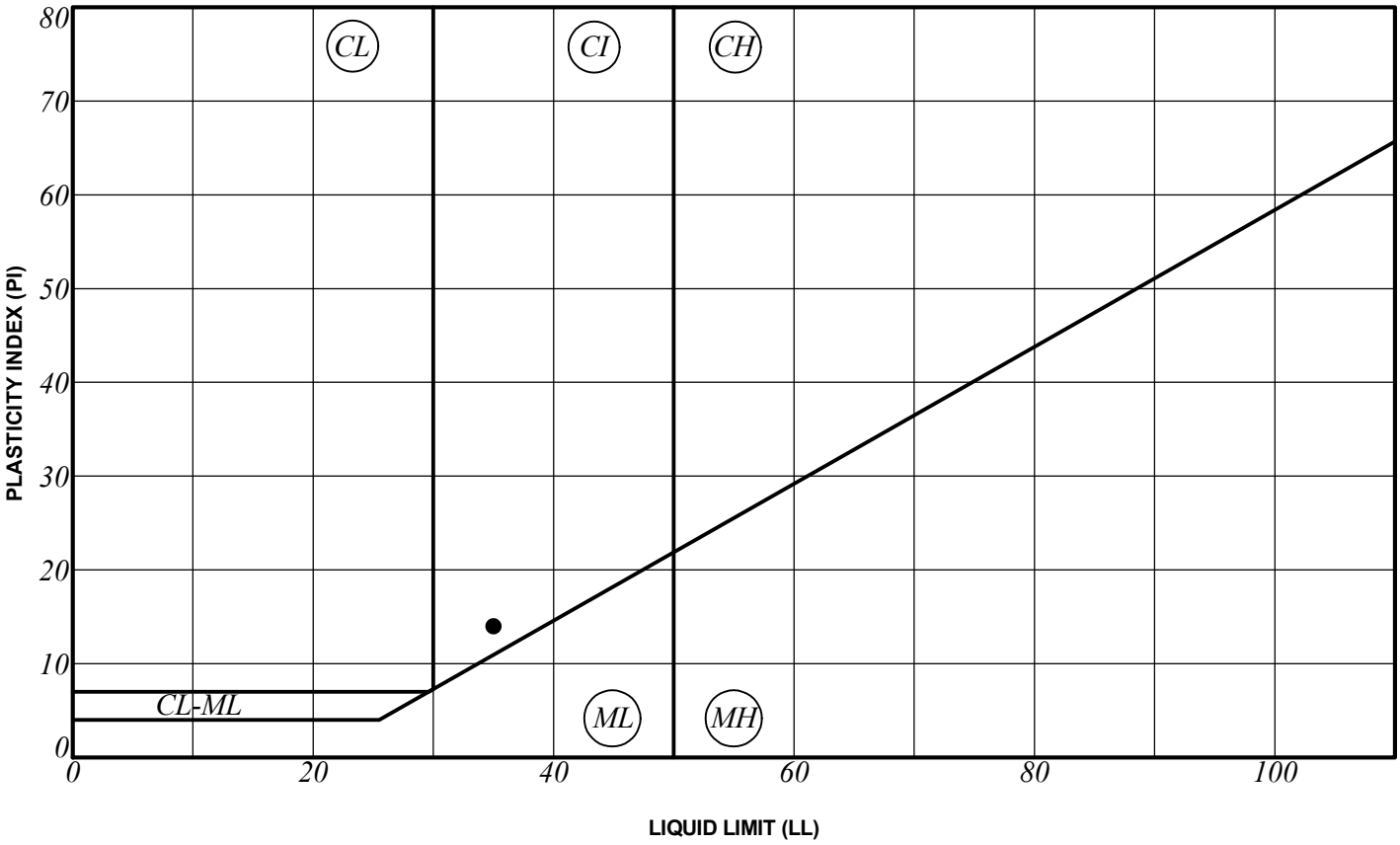
KGS GROUP

1x1 ARCHITECTURE INC.

Forks National Historic Site - Infrastructure Upgrades

GRAIN SIZE ANALYSES

10/08/2004	Figure A	Page 1 of 1



SYMBOL	HOLE	DEPTH (m)	SAMPLE #	LL	PL	PI	% SAND	% SILT	% CLAY	% MC	CLASSIFICATION
●	TH16-02	4.0	S03	35	21	14	16.6	62.5	20.9	36.4	ML

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

1x1 ARCHITECTURE INC.

Forks National Historic Site - Infrastructure Upgrades

A-LINE PLOT

April 2016	Figure B	Page 1 of 1

A-LINE PLOT U:\FMS\15-2288-001\FORKS NHS.GPJ

APPENDIX B

FORKS NATIONAL HISTORIC SITE PHOTOS

Photo 1 – Looking upslope at uniform slope from River Walk located upstream of North Point near the southern project extent.

Photo 2 – Looking downslope at uniform slope from upper bank area located upstream of North Point.

Photo 3 – Looking upslope from River Walk at upstream extent of mid bank bench located downstream of North Point.

Photo 4 – Looking upstream at the narrowing mid bank bench area located downstream of North Point.

Photo 5 – Looking upstream and downslope from upper bank area located just downstream of the Boat Dock. Note the slope from the upper bank to mid bank bench areas and numerous trees.

Photo 6 – Looking upstream at flat mid bank bench area located downstream of the Boat Dock and near TH16-02.

Photo 7 – Looking upstream from River Walk at downstream extent of mid bank bench area located upstream of the Amphitheatre.

Photo 8 – Looking downstream at the narrowing mid bank bench area located upstream of the Amphitheatre.

Photo 9 – Looking upstream from upper bank area located at the Amphitheatre. Note the proposed lighting location is within the vegetated area encompassed by the limestone blocks.

Photo 10 – Looking upstream from upper bank area located just downstream of the Amphitheatre and near the northern project extent.

APPENDIX C

ARCHAEOLOGICAL REPORT

Archaeological Monitoring of The Forks Riverwalk Geotechnical Drilling Program Final Report; Winnipeg, MB Parks Canada Permit Number: FRK-2016-21320

Submitted to:

KGS Group
Kelly Fordyce, EIT Geotechnical Engineer-in-Training
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Tel: (204) 896-1209 Ext. 281 Fax: (204) 896-0754
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Prepared by:

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Bison Historical Services Ltd.
6-1555 Dublin Ave, Winnipeg, MB, R3E 3M
Tel: (204) 202-3808; Cell: (204) 805-6841
Email: ed@bisonhistorical.com

April 27, 2016

Executive Summary

Bison Historical Services Ltd. (Bison) was contracted by KGS Group to conduct archaeological monitoring of geotechnical drilling tests at three locations along The Forks Riverwalk in order to determine soil consistency for proposed installation of lampposts. The Forks Riverwalk is located at the confluence between the Red and Assiniboine Rivers in Winnipeg, MB. Bison staff conducted the monitoring of the geotechnical drilling on April 8, 2016 under Parks Canada Agency Research and Collection Permit FRK-2016-21320.

The geotechnical drilling was conducted at three select locations along either the uppermost terrace or (one location) the secondary terrace above the existing Riverwalk. Due to the paucity of heritage resources within the footprint of the proposed well site and access road, Bison can confidently recommend that there are no further heritage concerns at these locations and that the construction of the well sites and access road can proceed as planned.

The archaeological recommendations are based on the background historic research, examination of maps and aerial photos, registered site database and indicators of archaeological potential as well as the HRIA.

Table of Contents

Table of Figures

Project Personnel

Project Manager:
Ed Fread, M.A., RPA

Project Fieldwork:
Ed Fread, M.A., RPA

GIS:
Sean Pickering, M.A.

Report Research and Preparation:
Ed Fread, M.A., RPA

Archaeological Monitoring of The Forks Riverwalk Geotechnical Drilling Program Final Report; Winnipeg, MB Parks Canada Permit Number: FRK-2016-21320

1.0 Introduction

Bison Historical Services Ltd. (Bison) was contracted by KGS Group to conduct archaeological monitoring of geotechnical drilling tests at three locations along The Forks Riverwalk. The proponent is intending to conduct geotechnical drilling adjacent to the Riverwalk at The Forks to determine soil characteristics for foundation design of the proposed above-ground lighting structures located on the riverbank. The drill rig is a B20L power rig (pulled by a quad ATV) capable of reaching limited access locations. The drill size is a 5-inch diameter solid stem auger. Three test holes (each to a 12m (40ft) depth or auger refusal) will be drilled. The Forks Riverwalk is located at the confluence between the Red and Assiniboine Rivers in Winnipeg, MB.

The proposed geotechnical drill sites were located within Parks Canada land and were identified as having the potential to impact heritage resources. Therefore under National Parks General Regulations: Sections 7(5); 11(1); and 14(2) as well as National Historic Parks General Regulations: Sections 3(2); 4(2); and 12(3) the developer is required to have a qualified archaeologist monitoring soil removal activities.

Bison staff conducted the monitoring of the geotechnical drilling on April 8, 2016 under Parks Canada Agency Research and Collection Permit FRK-2016-21320.

2.0 Background Setting

The Forks is located at the confluence of the Red and Assiniboine Rivers in Winnipeg, MB (Figure 1). Over the last 6000 years, the two rivers were utilized as highways for First Nation and European populations. Where these rivers merged at The Forks had been long used by First Nations as campsites, trade centre, meeting sites and subsistence procurement locations. More recently, Europeans settled the area and utilized The Forks as a series of Forts and encampments, an experimental farm, rail yard and meeting area (Kroker et al. 1991).

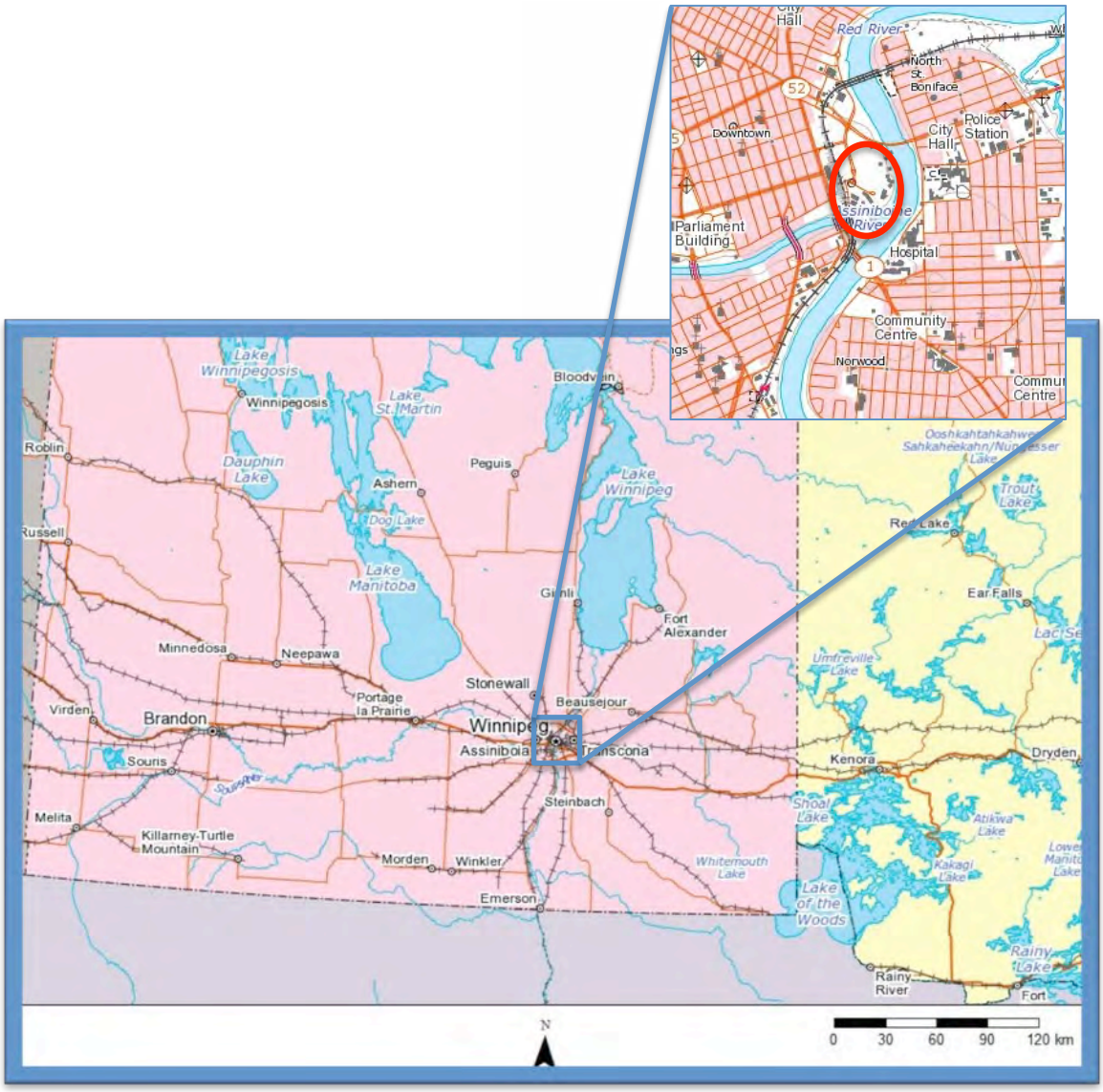


Figure 1. Map of southern Manitoba with Winnipeg in square and The Forks (inset) with study area in red oval.

2.1 KGS Test 01 (14-634492E / 5528006N – 236m asl)

KGS Test 01 is the northern-most drill site situated approximately 350m south of the Provencher Bridge and 400m southeast of the Canadian Museum for Human Rights (Figures 2 and 4). The test location was on the upper terrace from the river on a flat short grass field (Figure 2) west of the gravel-walking path.

Figure 2. Geotechnical drilling at KGS Test 01 with Canadian Museum for Human Rights (left) and Provencher Bridge (right) in background.

2.2 KGS Test 02 (14-634536E / 5527825N – 232m asl)

KGS Test 02 was located on the middle (of three) terrace within a dense copse of trees (Figures 3 and 4), and east of The Children's Museum. The drill site Test 02 was nearest of the tests to the river and adjacent as well as east of a clay walking/cycling path that followed along the terrace bisecting the narrow forest (Figure 3).

Figure 3. KGS Test 02 location on second terrace in forest.

2.3 KGS Test 03 (14-634494E / 5527717N – 236m asl)

KGS Test 03 was located on the top terrace along the northern bend of the river, in flat short grassed landscape, on the edge of a treeline (Figure 4). The site is immediately east of a gravel-walking path and south of the Children's Museum.

Figure 4. Locations of the three drill sites (green stars) along The Forks Riverwalk.

3.0 Objectives

The objectives for Bison were to closely monitor the geotechnical drilling (Figure 5) at three locations to: (1) determine the presence or absence of heritage resources at the drill sites; and (2) reduce impact to heritage resources that may be exposed during drilling. If heritage resources are identified, the objects will be examined to determine significance; then further mitigation strategies (ranging from halting drilling and selection of new location to further intensive testing and recovery of artifacts, to full excavation of test location) would be implemented.

Figure 5. Monitoring soil disruption during geotechnical drilling operations.

4.0 Archaeological Methods

The archaeological methods for monitoring the geotechnical drilling consisted of (1) brief pedestrian survey around drill site to identify any heritage resources located on the ground surface; and (2) monitoring of drilling process with halts and drill removal every 30cm for top 2m to examine back dirt and drill bit for evidence of heritage resources (Figure 6).

If heritage resources were identified, the drilling would be halted, the artifacts would then be examined to establish type, age and significance and decision to proceed at that location would be determined. Intensive visual inspection of the surrounding area would also be conducted. Prior to recovery of any surface heritage resources, all flagged artifacts would be waypointed with GPS in UTM NAD 83, all provenience would be recorded and the artifacts bagged separately or in concentrated groups.

Figure 6. Examining soils from drill at 30cm increments for top 2m+.

5.0 Results of Archaeological Investigations

Each drill site was examined by pedestrian survey prior to drilling. All soil attached to the drill bit was examined in 30cm increments within the top 2m of soil for presence and absence of heritage resources. Close inspection of the lower soils was also conducted at 5m increments.

The average stratigraphic type and depths consisted of the thin root mat/ sod of 8cm. The following level entailed a clean gravel fill for an average depth of 1m to 1.2m above a .5m lens of older fill containing Late Historic to Modern architectural debris (brick fragments, window glass, gravel, etc). Alluvial clays were identified approximately 2m+ in depth that ranged in colour from brown, to green to blue/gray near the 8m depths. Glacial til consisting of large gravels and rock was encountered at or near the termination depths of 12m. The water table was encountered between 8 – 12m dbs.

5.1 Results of KGS Test 01 (14-634492E / 5528006N – 236m asl)

As the ground surface was covered in short grass, visibility of pedestrian survey was greatly reduced. No evidence of heritage resources were noted during the pedestrian survey.

During the drilling process, it was noted that the clean fill was deeper than anticipated and terminated at approximately 2m depth, followed by wet dark silt to 2.5m. Wood fibres and sand (Figure 7) was identified between 2.5 to 3m; likely due to railroad activities a century ago (Kroker et al. 1991; The Forks Public Archaeological Association Inc. 1993; The Forks Renewal Corporation 1993).

Figure 7. Wood fibres and sand identified in drill KGS Test 01 at approximately 2.5m – 3m depth.

A thin lens of black organic (original top soil) was noted below 3m with a small mix of Late Historic architectural debris including two wire nails (ca.1900- present), one machine cut nail (ca.1860-1900) and brick fragments. Also recovered were a thin strip of cut leather, a fragment of slag (from metal working) and a fragment of coal (Figure 8).

Figure 8. Artifacts recovered from KGS Test 1. Top row (L – R) machine cut nail, two wire nails and brick fragment. Second row – coal fragment and slag. Bottom – cut leather fragment.

The artifacts reflect Late Historic architectural and possible blacksmithing activities. The heritage resources may have been recovered from a disturbed lens due to rail construction activities or modification of the area for newer development. The artifacts did not represent a significant site and geotechnical drilling at activities at KGS Test 1 continued without any further finds.

5.2 Results of KGS Test 02 (14-634536E / 5527825N – 232m asl)

KGS Test 2 located on the lower terrace within an old stand of trees contained a more natural soil matrix (no fill) below the series of flood plain clays deposited for centuries (Figures 3 and 5).

The ground surface was covered with dry, frozen clays with little to no vegetation cover. No evidence of heritage resources was noted during the pedestrian survey.

Monitoring of the drilling activities at test 2 identified a single layer of interest. Some charcoal flecks and thin white ashy soil was identified at 1.2m depth. The lens was thin with no heritage resources present. The charcoal and possible ash may represent a natural fire or associated with past human presence. No other concerns were noted and the drilling continued to termination at glacial till near the 10 - 12m depth.

5.3 Results of KGS Test 03 (14-634494E / 5527717N – 236m asl)

KGS Test 3 was located on the river edge of the upper terrace. The area was covered in manicured grass on the edge of pristine forest (west of the river). Pedestrian survey was limited due to lack of visual access to the ground surface. No evidence of heritage resources was noted during the pedestrian survey.

The top portion of the stratigraphy of KGS Test 3 consisted of 1.25m of clean fill above a .5m lens of fill containing Late Historic to Modern architectural debris. The debris included brick fragments, window glass shards, wire, round nails and metal fragments. It appeared that the debris represented a secondary deposition (brought in from another location and deposited as fill at that site). There was no heritage concerns with the debris brought to the surface by the drilling activities at site 3, the geotechnical testing continued without any other recoveries.

6.0 Summary and Recommendations

On April 8, 2016, Bison staff conducted the monitoring of geotechnical drilling to determine soil characteristics for foundation design of the proposed above-ground lighting structures located on the riverbank. The archaeological monitoring was conducted under Parks Canada Agency Research and Collection Permit FRK-2016-21320.

The geotechnical drilling was conducted at three tests sites along the riverwalk. Each location was first examined by pedestrian survey prior to drilling. During the monitoring process, the soils attached to the drill bit were inspected at 30cm intervals for the first 2m, then approximately 2m intervals for the remainder of the test.

No heritage resources were identified during the pedestrian survey of all three sites. Late Historic artifacts were recovered at 2.5m to 3m depth at Test 1 (nails, leather, brick, coal and slag). The finds were immediately below wood fibres and sand that were affiliated with historic railway activities. The artifacts were recovered and determined to be of little heritage concern and the drilling continued.

Due to the paucity of heritage resources within the proposed drill site locations, Bison can confidently recommend that there are no further heritage concerns at these three test sites.

It is recommended that a qualified archaeologist be on site to closely monitor during lamp post installations as the locations are within an exceptionally high potential area for the presence of heritage resources.

In the event that heritage resources or human remains become unearthed during any subsurface activities, any work in that area should stop and an archaeologist be contacted.

Should burials or bones thought to be human remains be encountered during any subsurface activity under National Parks General Regulations: Sections 7(5); 11(1); and 14(2) as well as National Historic Parks General Regulations: Sections 3(2); 4(2); and 12(3) will take effect. Therefore, Parks Canada representatives be contacted to assess and discuss mitigation.

7.0 References

Kroker, S.; Greco, B. and Thomson, S.
1991 *1990 Investigations at Fort Gibraltar I: The Forks Public Archaeology Project*. The Forks Renewal Corporation.

The Forks Renewal Corporation.
1993 *Archaeological Monitoring and Mitigation of the Assiniboine Riverfront Quay*. Sid Kroker & Pamela Goundry. The Forks Renewal Corporation.

The Forks Public Archaeological Association, Inc.
1993 *A 3000 Year Old Native Campsite and Trade Centre at the Forks.* Sid Kroker & Pamela Goundry. The Forks Renewal Corporation.

8.0 Appendix 1: Parks Canada Agency Research and Collection Permit (FRK-2016-21310)

PARKS CANADA AGENCY
RESEARCH AND COLLECTION PERMIT
(NOT TRANSFERABLE)

PERMIT No.: FRK-2016-21320

START DATE: 2016-04-04 **EXPIRY DATE** 2016-04-05 New end date 2016-04-09

Project Title: Forks Riverwalk Geotech Drilling Program

Principal Investigator Name: Ed Fread, Regional Manager and Senior Project Archaeologist

Address: 268 Lynbrook Drive Winnipeg, Manitoba R3R 0S7

Telephone: 204 805 6841

Email: ed@bisonhistorical.com

Affiliation: Ed Fread is the Regional Manager and Senior Project Archaeologist for Bison Historical Services Ltd (an archaeological consulting company). He has created and managed the Winnipeg, MB office since 2012.

Is hereby authorized to conduct the research project entitled "Forks Riverwalk Geotech Drilling Program" , Research and Collection Permit Application Number 26140, In The Forks National Historic Site of Canada, subject to the terms and conditions set out below and/or attached to and forming part of this Research and Collection Permit.

Members of Research Team:

Ed Fread is the sole investigator and supervisor of this project. Chris Whaley - a Bison Historical employee is the assistant and may be on site. Chris Whaley 43 Pilgrim Avenue, Winnipeg, Manitoba, Canada R2M 0L3 (204) 783 - 5319 cwhaley07@gmail.com

Additional PHA's involved

Parks Canada

Issuing Authorities and Terms and Conditions:

Permit issued pursuant to:

National Parks General Regulations: Section(s) __7(5),__11(1); __14(2)

National Historic Parks General Regulations: Section(s) __3(2); __4(2); __12(3)

National Parks Wildlife Regulations: Section __15(1)(a)

National Historic Parks Wildlife and Domestic Animals Regulations: Section __5(1)

Federal Real Property Regulations: __Section 4(2)

Historic Canals Regulations: __Section 11(3)

Parks Canada Parcs Canada

Canada

Saguenay-St. Lawrence Marine Park Act: __Section 10

(Other applicable Act(s) or Regulations)

National General Conditions:

Failure to comply with applicable Heritage Area regulations or the conditions of the permit may constitute grounds to cancel or suspend the permit, refuse to issue future permits, and may be considered as grounds for prosecution under the applicable Act(s) or Regulation(s).

All permit holders must be in possession of a valid permit before the fieldwork commences and at other periods as stated on the permit.

Permits are not transferable and each member of the field work team must have a copy of the valid permit in their possession.

The permit is valid only for the geographic location, the time period, the activities, and under the terms and conditions described on the permit, unless amended and revalidated by the Superintendent.

Restrictions:

The Superintendent may suspend, cancel, or restrict the scope of the permit.

The permit shall cease to be valid if the fieldwork is not started within six months of the date of issue.

Other Acts and Regulations:

The Principal Investigator must abide by applicable regulations and all other federal, provincial, territorial or municipal regulations applying to the Heritage Area.

If requested by the Superintendent, an authorized Heritage Area staff member, or police constable, the Principal Investigator or any team member will identify themselves and show the permit.

Principal Investigator Responsibilities :

A site, or site component(s) that has been excavated or disturbed shall be restored or conserved by the Principal Investigator to the satisfaction of the Superintendent.

The Principal Investigator must advise the Research Coordinator of any adjustments in work location, research plan and methodology, implementation schedule, or main personnel, etc., during the course of the research.

Unless otherwise negotiated, Researchers working in a Heritage Area are required, as a condition of their permit, to submit:

a) A report of progress sixty (60) days following the completion of the field season, unless otherwise agreed with the Research Coordinator;

b) A final report, one (1) electronic copy and three (3) hard copies, no later than eight (8) months following the completion of the field season, unless otherwise agreed with the Research Coordinator;

c) Submission of an online Investigator's Annual Report (IAR) within one year of signing the permit. In the case of a multi-year permits, the principal investigator will submit an IAR for each year of the research.

The reporting requirements above do not replace any reporting requirements set out in any contract between Parks Canada and the Principal Investigator.

Parks Canada Parcs Canada

Canada

The Principal Investigator will be responsible for all members of their party. All field assistants must observe any general or specific conditions of the permit.

The Principal Investigator shall at all times indemnify and save harmless the Crown from and against all claims, demands, loss, costs, damages, actions, suits, or other proceedings, by whosoever made, sustained, brought or prosecuted, in any manner based upon, occasioned by, or attributable to, anything done or omitted by the Principal Investigator or the project personnel in the fulfillment or purported fulfillment of any of the conditions of the Permit.

General Conditions Governing Archaeological Research:

The Principal Investigator must participate in or directly supervise a minimum of 75% of the archaeological research project's field operations.

The Principal Investigator must ensure that the latest Parks Canada archaeological site and object numbers are used for recording purposes, as specified in the Parks Canada Archaeological Recording Manual: Excavations and Surveys.

The Principal Investigator shall use archival quality recording materials (e.g., paper, ink, pencil, film) for all field recording.

Following completion of the archaeological research project, the Principal Investigator must submit to the Superintendent:

a) The originals of all Archaeological Records: Any written, graphic, visual and electronic record that is prepared and assembled that relates to the identification, evaluation, documentation, study, preservation, or excavation of an archaeological site or resource.

Moreover, all data submitted must comply with Parks Canada's archaeological data and metadata requirements.

The Principal Investigator and his or her crew shall use the Parks Canada Archaeological Recording Manual: Excavations and Surveys in the conducting of archaeological research activities.

Archaeological Objects:

All Archaeological Objects:

Remain the custodial responsibility of the of the Crown unless specified otherwise within a final comprehensive land claim agreement;

Are considered to be on loan to the Principal Investigator until the research on the site assemblage and final archaeological research report(s) are completed in accordance with the allotted time period specified on the approved Archaeological Research Permit Application and on the Archaeological Research Permit;

While in the possession of the Principal Investigator, the archaeological objects will be made available to Parks Canada for research and display purposes; and,

All excavation units, archaeological objects and records will be recorded and identified using the Parks Canada archaeological provenience system, and according to Parks Canada standards and procedures.

Where an Archaeological Resource requires special treatment (e.g., unique, sacred, fragile, requiring immediate conservation assistance), the Superintendent shall be immediately informed for direction on how to proceed.

Conditions regarding the management, conservation, and the disposition of the collections(s) into a mutually agreed upon Parks Canada repository may be changed as circumstances warrant by the applicable Superintendent, on the advice of the appropriate Service Centre Director.

Parks Canada Parcs Canada

Canada

Human Remains:

Where human remains and/or funerary objects are accidentally encountered, the activities in progress at the site must be suspended immediately and the Superintendent notified. The Principal Investigator will await further direction from the Superintendent.

Human remains and funerary objects recovered from an archaeological context should be treated separately from archaeological objects. Human remains cannot be the subject of property. When human remains are found on federal Crown land administered by Parks Canada, the Agency has a custodial responsibility. The human remains are in the care and custody of the Crown.

Special Conditions:

Principal Investigator Signature

I, Ed Fread, Regional Manager and Senior Project Archaeologist, the Project Principal Investigator, accept all the stated Research and Collection Permit terms and conditions.

Ed Fread

Signature

2016/04/05

Date (yyyy/mm/dd)

Approval:

Permit issued/approved by:

Marilyn K Packett

Superintendent, Manitoba Field Unit

Marilyn K Packett

Superintendent Signature

2016/04/01

Date (yyyy/mm/dd)

Parks Canada Contact

Sandra Hollender
Manitoba Field Unit Office
145 McDermot Avenue
Winnipeg, Manitoba, R3B 0R9
204-983-2918 Sandra.Hollender@pc.gc.ca

Parks Canada / Parcs Canada

Canada

APPENDIX D

KGS GROUP REPORT

FORKS PROMENADE EXTENSION GEOTECHNICAL AND HYDRAULIC ASSESSMENT

DATED AUGUST, 1992

PARKS CANADA
FORKS NATIONAL HISTORIC PARK

FORKS PROMENADE EXTENSION

GEOTECHNICAL AND

HYDRAULIC ASSESSMENT

AUGUST, 1992

KGS GROUP

KONTZAMANIS ▪ GRAUMANN ▪ SMITH ▪ MACMILLAN INC.
CONSULTING ENGINEERS & PROJECT MANAGERS

KGS GROUP

KONTZAMANIS ▪ GRAUMANN ▪ SMITH ▪ MACMILLAN INC.
CONSULTING ENGINEERS & PROJECT MANAGERS

August 27, 1991 File No. 91-0147-01

Hilderman, Witty, Crosby, Hanna and Associates
500-115 Bannatyne Avenue East
Winnipeg, Manitoba
R3B 0R3

ATTENTION: Mr. Jeffrey Frank
Partner

RE: Forks
Promenade Extension
Geotechnical and Hydraulic Assessment

Dear Mr. Frank:

Please find enclosed three (3) copies of the KGS Group report on the geotechnical and hydraulic assessment of the proposed Forks Promenade Extension.

The quantity estimate for the corresponding promenade extension is as follows:

rockfill	2500 m^3
granular beach surfacing	400 m^3
geotextile	2500 m^3

Also enclosed for your information is three (3) prints of the site survey, existing conditions, Drawings 91-147-0101, Revision 0.

Please call of you have any questions regarding the above information.

Yours very truly,

PROVINCE OF MANITOBA
J. B. SMITH
27/08/92
REGISTERED ENGINEER

J. Bert Smith, P.Eng.
Chief Geotechnical Engineer

JBS/pc
Enclosure

TABLE OF CONTENTS

LIST OF FIGURES

1.0 INTRODUCTION

The KGS Group were authorized by Hilderman Witty Crosby Hanna and Associates, Landscape Architects and Planners, to provide geotechnical and hydraulic services for the extension of the existing Forks Promenade.

The proposed development consists of a rockfill walkway berm similar to the existing Forks Promenade, to extend from the north edge of the Amphitheatre to the Paddlewheel Dock on the west bank of the Red River immediately south of the Provencher Street Bridge. A beach area for boat access will be provided along the north half of the amphitheatre. Riprap will be placed along the south half of the Amphitheatre connecting the rockfill toe of the existing promenade to the beach area, to minimize the potential for hydraulic turbulence and scour.

2.0 BACKGROUND INFORMATION

Two previous geotechnical investigations were performed by Independent Test Lab Ltd., of Winnipeg as part of the Forks National Historic Park Developments. The investigations, including drilling programs plus soil testing, are summarized in ITL reports dated July 22, 1987 and July 6, 1988. These reports, made available to KGS Group for data review, were used as part of the geotechnical data base. Other pertinent data provided included:

- The Forks National Historic Park Design Summary, Hydrology and Geotechnical Report on the Red River, 1987.
- The Forks National Historic Park as-built drawings, 1989 from Parks Canada, including riverbank contours.
- Paddlewheel Dock Design drawings, 1989, from Cohlmeyer Hansen Architect - Designer.

The relevant drill hole locations are shown in Figure 1. The drill logs are included in Appendix A. Relevant index and direct shear testing performed as part of the earlier geotechnical investigations has also been included in Appendix A. No ground water monitoring was available for the upper bank.

3.0 EXISTING SITE CONDITIONS

The project is part of the Fork's National Historic Park development along the west bank of the Red River, approximately 150 m south of the Provencher Street Bridge. The main existing structures along the riverbank in the vicinity of the proposed development include the Paddlewheel Dock, structural Amphitheatre, and the Promenade rockfill berm, as shown on Figure 1.

Paddlewheel Dock

The dock consists of a 30 m long by 7 m wide rockfill berm, located approximately 130 m south of the Provencher Street Bridge. The top of the dock is at elevation 224.3 m with a face slope of approximately 1H:1V. The boats dock perpendicular to the edge of the dock, with the use of a gangplank to offset the need for a vertical face and corresponding deeper draft.

Amphitheatre

The Amphitheatre is a concrete structure located approximately 210 m south of Provencher Street Bridge. The structure is supported on end bearing piles driven to refusal. The front face is rip-rapped, extending from summer river level down to the river bed at approximately 1:5H:1V.

Promenade

The existing promenade is a rockfill berm extending south from the Amphitheatre along the west bank of the Red River towards the Assiniboine River. The rockfill section consists of a 6 m wide top at Elev. 224.5 with a 1.5H:1V face slope. A 6 m wide by 1 m thick toe berm has also been placed.

The riverbank along the proposed promenade extension is in a natural state, with no excavation work or rockfill placement. The upper bank is steep, approximately 2 to 3H:1V with extensive tree and brush growth. The lower bank slopes at 4H to 5H:1V, extend from summer river level to the near horizontal riverbed at approximate elevation 220 m.

Stratigraphy

The soil stratigraphy shown on Figure 2 is based on ITL drill holes 1F, TH-13 and TH-20, which are all adjacent to the site. The other drill holes in the area show similar strata.

The upper bank consists of 8 to 10 m of fill, including mixtures of sand and gravel, clay and silt, wood and concrete rubble. This fill is underlain by 4 to 6 m of soft to firm very clayey silt to silty clay, overlying silt till at approximately elevation 215 m. Upper bank drill holes at the amphitheatre location (TH-1, 2, 9 and 10) indicate a gravelly to clayey sand layer, approximately 3.5 m thick beginning at about elevation 217.5 to 221 m. The riverbed drill holes, 1F, 2F, and TH-20 show an apparently continuous fine sand layer 1.5 to 2 m thick below winter riverbed (el 221 to 218).

This is underlain by 3 to 4 m of soft to stiff silty clay overlying the silt till. Slickensides were not detected in these clays in the TH series of holes by ITL (limited shelby and spoon samples) at the amphitheatre (TH1,2,9,10,20) and 50 m downstream (TH13). Evidence of slickensided surfaces were observed in the lower 2 m of the silty clay in drill holes 1F and 2F at the existing Paddle Wheel dock 65 m downstream and further from the amphitheatre (Figure 1).

Bank Stability

The existing bank between the amphitheatre and the Paddlewheel Dock is covered with mature trees and bushes, demonstrating overall stable conditions, with no evidence of any major deep seated movements. Minor lower bank scouring and erosion is ongoing. Slickensides within the lower clay below the granular zone, approximately el 218 to el 216 m, (ITL Hole 1F, 2F) are indicative of historical movement and shearing, with the resultant strengths of the clay at residual values.

4.0 STABILITY ANALYSIS

The stability analysis consisted of a back analysis of the existing bank conditions, with a sensitivity assessment of the groundwater level in the upper bank. The proposed promenade berm and beach section were then superimposed on the cross section to determine the relative impact on bank stability. All stability analyses were performed using the computer model PCSTABL4 developed at Purdue University. Both circular and composite block failure surfaces were analyzed to establish the potential critical slip surfaces.

4.1 Back Analysis

The location and bank geometry of the cross section analyzed are shown on Figures 1 and 3. The strength values assumed in the analysis, as taken from the ITL Geotechnical Reports of 1987 and 1988, based on direct shear testing and back analyses, are shown on Table 1 and Figure 3.

A plot of the direct shear test data by Independent Test Lab (ITL) is shown in Appendix A, Figure A-1. Testing was done on 5 samples (Hole TH6; F1,5,13 & 16) for peak, post peak and residual strengths. The envelop of residual strengths ranged from $Ø'_r = 9°$ $c'_r = 2$ kPa to $Ø'_r = 26°$, $c'_r = 8$ kPa, with the average value approximately $Ø'_r = 17°$, $c'_r = 5$ kPa. This average value was assumed for the lower clay strength by ITL in their 1987 study. A slightly lower residual strength of $Ø'_r = 14$ to $16.5°$, $c'_r = 1$ to 2 kPa was used for the lower clay from the amphitheatre north to Provencher Bridge in their 1988 study, with the former value of $Ø' = 17°$ $c' = 5$ kPa assumed to be the post peak strength of the clay.

The back analysis of the current study for overall bank slip surface 1 was determined for a factor of safety of unity (FS = 1.0), assuming material strengths in the silty clay of Ø' = 17.5° and c' = 5 kpa, winter river level and a calculated groundwater level in the bank (GWL A) at a depth of approximately 4 m. The groundwater level assumed reflects some drainage of the upper bank, consistent with the presence of the semiprevious random fill (sand, gravel, silt, clay) and the underlying sands. The existing banks have remained stable under drawdown conditions, consistent with the groundwater level assumed and some drainage of the upper bank. An extreme condition with an assumption of saturated groundwater conditions, is not reasonable since much higher foundation strength values would be required based on the back analysis, to satisfy the observed bank stability (FS $\geq$ 1.0). The lower foundation strengths (Ø' = 17.5°, c' = 5 kPa) were chosen as being more representative, in particular for analysis of the lower bank stability.

4.2 Proposed Rockfill Berm

Two sections were analyzed, one through the walkway and the other through the beach, as shown on Figure 3, with the potential critical slip surfaces. The results of the stability analysis are summarized on Table 1. The 0.6 m thick riprap zone in front of the south half of the amphitheatre is considered to have a minimal impact on stability and as such was not analyzed.

Promenade Section

The proposed promenade berm geometry is shown on Figure 3. This geometry is similar to that of the Forks Promenade berm, with a 6 m wide by 1 m thick toe berm for added lower toe

stability. The overall Slip Surface 1 with the rockfill section, increased by 19% to FS = 1.19, assuming the same strength and water conditions as for the back analysis. The lower bank stability, potential slip surface 2, decreased by approximately 17% from FS = 1.72 to 1.43, with the addition of the rockfill berm.

The existing Forks Promenade section, similar to the proposed berm, has performed satisfactory to date with no evidence of substantial slumping. The proposed berm is similar to the existing Forks Promenade section with a shallower upper berm slope (2H:1V, respectively). There has been some minor sloughing of the upper section of the existing Promenade observed since its construction, but this may be related to construction deficiencies and not failure of underlying foundation material. Based on the apparently uniform nature of the stratigraphy, the proposed rockfill section is anticipated to perform in a similar acceptable nature.

Beach Section

The geometry of the beach area is shown on Figure 3, including the upper bank slope flattening (minimum 1V:3H) for the amphitheatre and existing 3.5 m thick granular zone in foundation, plus the larger rockfill cross section.

The overall bank safety factor for critical conditions will be significantly higher than that for the promenade section (FS = 1.19), with the added rockfill enhancing the original Forks design, and the upper bank excavation, such that this section is considered to be stable.

The toe berm has been included, in part for added stability of the lower toe and, in part to help streamline the edge of the rockfill for hydraulic considerations. The 3 m wide by 1 m thick toe berm, improves stability, such that shallow slip surface 3 through the rockfill berm has a safety factor of FS = 1.50.

5.0 HYDRAULIC CONSIDERATIONS

The extension of the Forks Promenade from the Amphitheatre to the Paddlewheel Dock will essentially be a continuation of the riverbank conditions imposed by the construction of the original Forks Promenade (1988, 250 m long). As shown on Figure 1, the rockfill berm and riprap will help streamline the bank between the existing Promenade and the Paddlewheel dock. This can be expected to slightly reduce turbulence in this area. The riverbed will be protected from any turbulence induced by the addition of the rockfill. As such, no additional erosion related impact would be anticipated.

The hydraulic assessment of the original promenade and amphitheatre development conducted in 1987 (The Forks National Historic Park Design Summary, Hydrology Report) indicated minor changes in the total head loss along the impacted reach. Total increases in the head loss for the 10 and 160 year floods were found to be 0.47 and 0.41 mm, respectively. These impacts are not significant and all related approvals were obtained. Approximately 75% of that increase was attributed to the Amphitheatre structure. Therefore, the addition of the Promenade extension will not significantly alter the increase in head loss calculated in the 1987 assessment. On the basis of the previous analytical results, an additional head loss of less than 0.1 mm would be expected. This is an insignificant additional impact.

Increased velocities were addressed in the original submission and calculated to be 3 to 4% of the average flow velocities. These values would not change as a result of the proposed works and do not represent a significant impact.

6.0 RECOMMENDATIONS

On the basis of the geotechnical and hydraulic considerations investigated, as well as the satisfactory performance of the existing Forks Promenade, it is recommended that the construction of the Forks Promenade Extension be allowed to proceed in accordance with the work proposed in this investigation.

TABLE

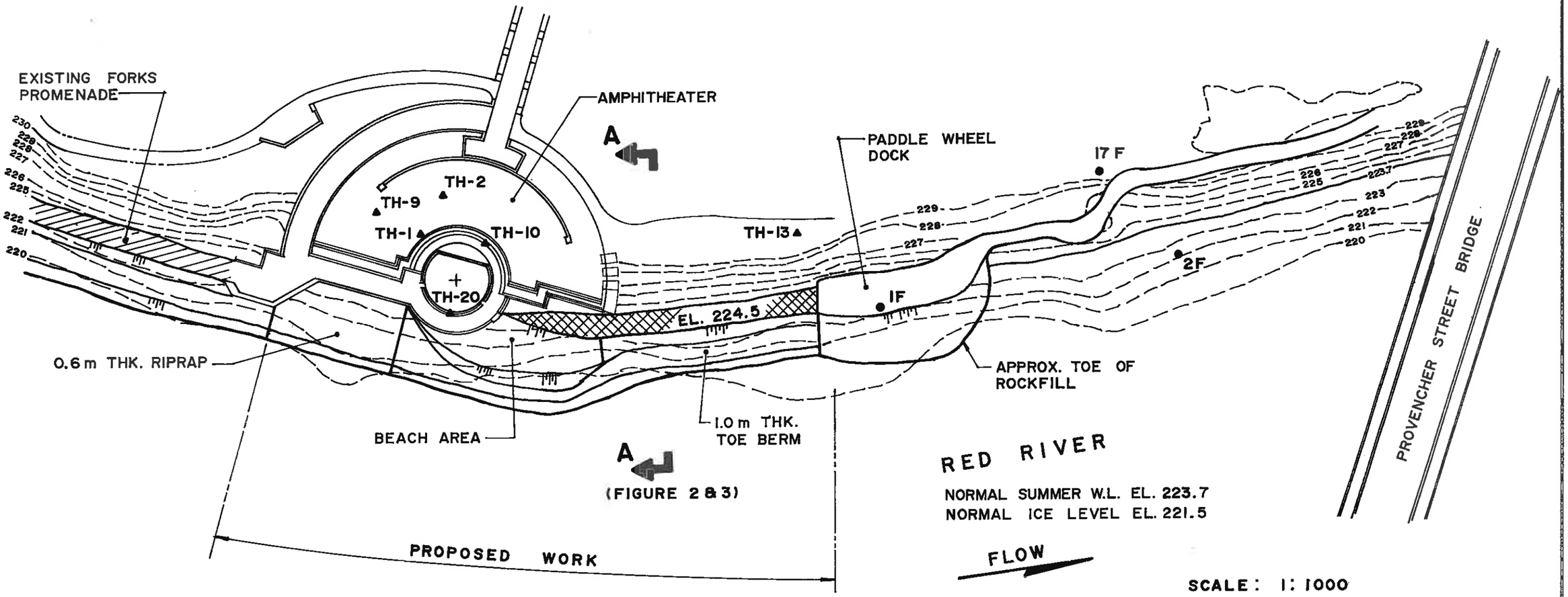
TABLE 1

SUMMARY OF STABILITY ANALYSIS
STRENGTH PARAMETERS

CASE	SLIP SURFACE	FILL	CLAYEY SILT		SAND		SILTY CLAY		GWL	RIVER LEVEL	FS	% CHANGE
		Ø′	Ø′	C′	Ø′	C′	Ø′	C′				
1. Back Analysis	1	28°	27°	5 kPa	32°	0	17.5°	5 kPa	GWL-A	WINTER	1.0	-
	1A	28°	27°	5	32°	0	17.5°	5	GWL-A	WINTER	1.03	-
	2	28°	27°	5	32°	0	17.5°	5	SAT	WINTER	1.72	-
2. Rockfill Walkway with 6 m wide x 1 m thick Toe Berm	1	28°	27°	5	32°	0	17.5°	5	GWL-A	WINTER	1.19	+19%
	1A	28°	27°	5	32°	0	17.5°	5	GWL-A	WINTER	1.21	+17%
	2	28°	27°	5	32°	0	17.5°	5	SAT	WINTER	1.43	-17%
3. Rockfill Beach Section with 3 m wide x 1 m thick toe berm	2	28°	27°	5	32°	0	17.5°	5	SAT	WINTER	1.64	-5%
	3	28°	27°	5	32°	0	17.5°	5	SAT	WINTER	1.50	-

NOTES:
1. SEE FIGURE 3 FOR SLIP SURFACE AND GWL LOCATIONS
2. WINTER RIVER LEVEL - 221.5 M
   SUMMER RIVER LEVEL - 223.7 M

FIGURES



LEGEND

- ▲ TH-2 — DRILL HOLE LOCATION, ITL 1987
- ● 1F — DRILL HOLE LOCATION, ITL 1988

NOTES:

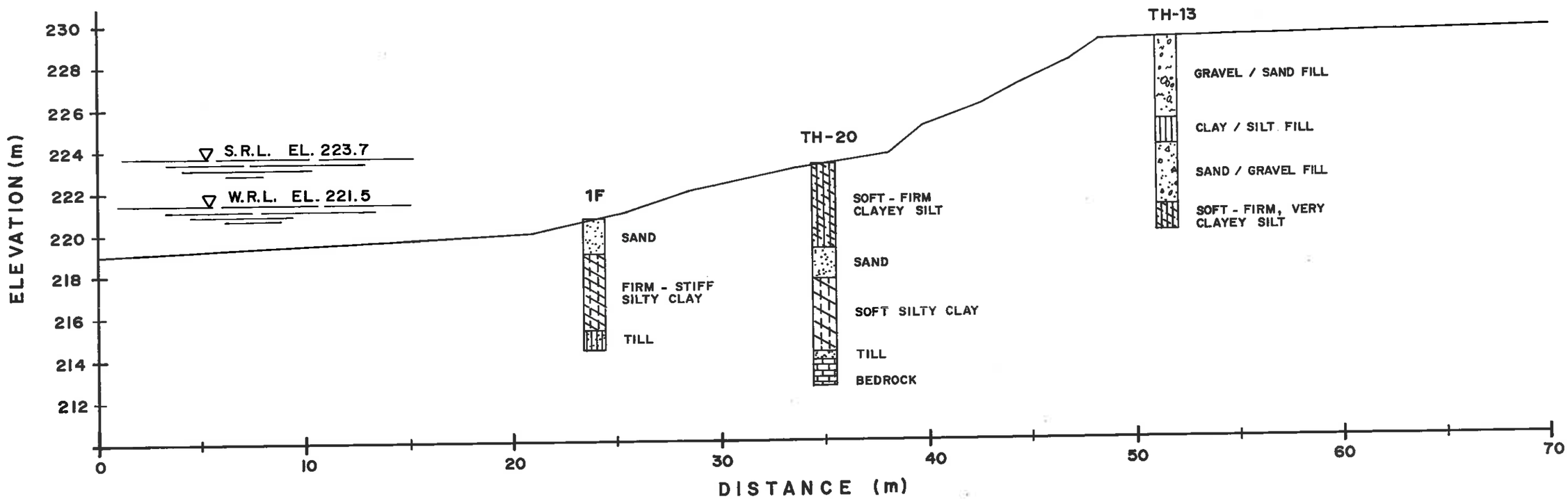
1. RIVERBANK CONTOURS ARE APPROXIMATE FROM HILDERMAN, WITTY, CROSBY, HANNA AND ASSOCIATES, DWG. Nº HPFKS 87/RI/E FOR THE FORKS NATIONAL HISTORIC PARK

SCALE: 1:1000

0 10 20 30 40 50 60 70 80 m

KGS GROUP	PARKS CANADA
FORKS PROMENADE EXTENSION	
LOCATION PLAN	
DSN. M.J. / DR. M.N.T.	DATE
DWG. NO. Figure 1	

91-147-01



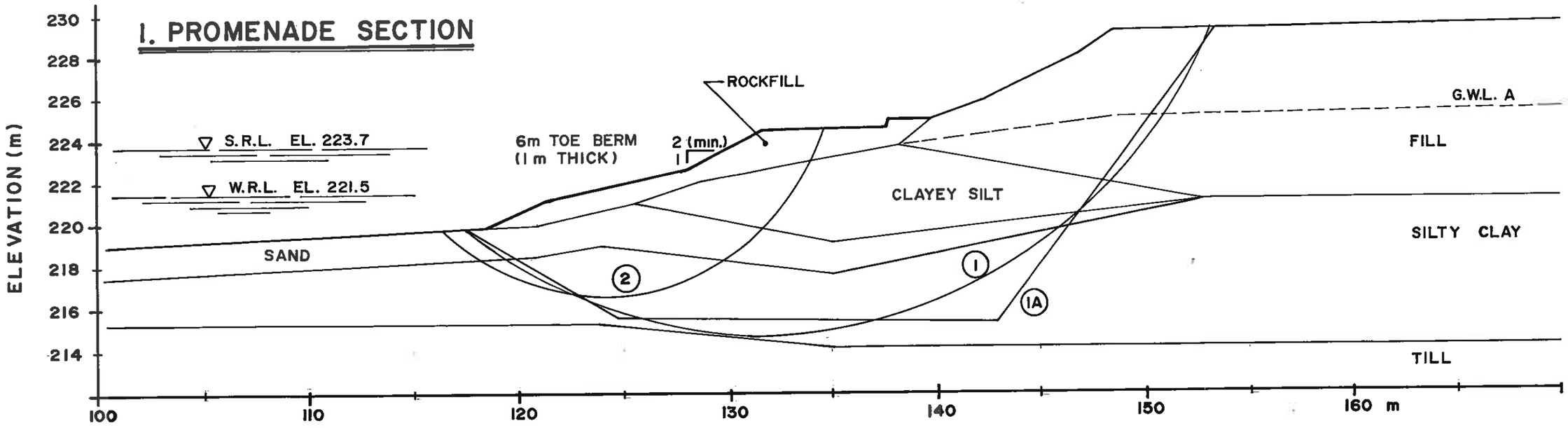
NOTES:

1. CROSS SECTION AND DRILL HOLE LOCATIONS SHOWN ON FIGURE 1.
2. DRILL HOLES TH-13 AND TH-20 FROM ITL, 1987. DRILL HOLE 1F FROM ITL, 1988.
3. DRILL HOLES PROJECTED TO PROFILE AT SECTION A-A

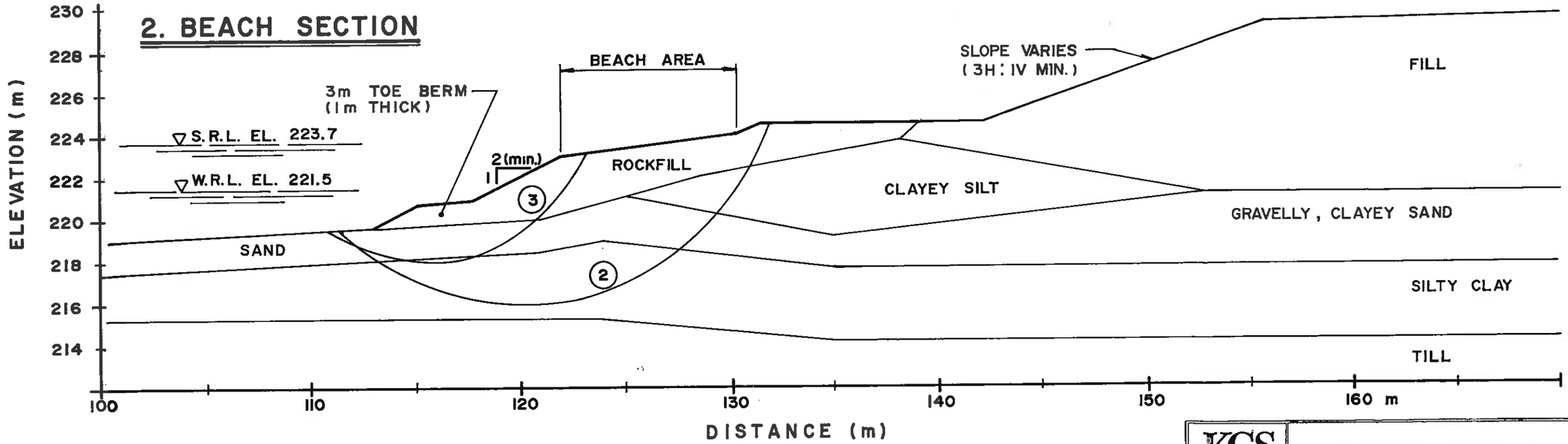
KGS GROUP	PARKS CANADA		
FORKS PROMENADE EXTENSION			
SOIL STRATIGRAPHY			
DSN. M.J.	DATE	DWG. NO. Figure 2	
DR. M.N.T			

91-147-01

1. PROMENADE SECTION



2. BEACH SECTION



NOTES:

1. SEE TABLE 1 FOR FACTORS OF SAFETY
2. GRAVELLY / CLAYEY SAND LAYER BASED ON ITL DRILLING AT AMPHITHEATER LOCATION (DRILL HOLES TH 1, 2, 9 & 10 - 1987)

STRENGTH PARAMETERS

	ø'	c' (kPa)
FILL	28°	0
CLAYEY SILT	27°	5
SAND	32°	0
SILTY CLAY	17.5°	5
ROCKFILL	35°	0

KGS GROUP

PARKS CANADA

FORKS PROMENADE EXTENSION

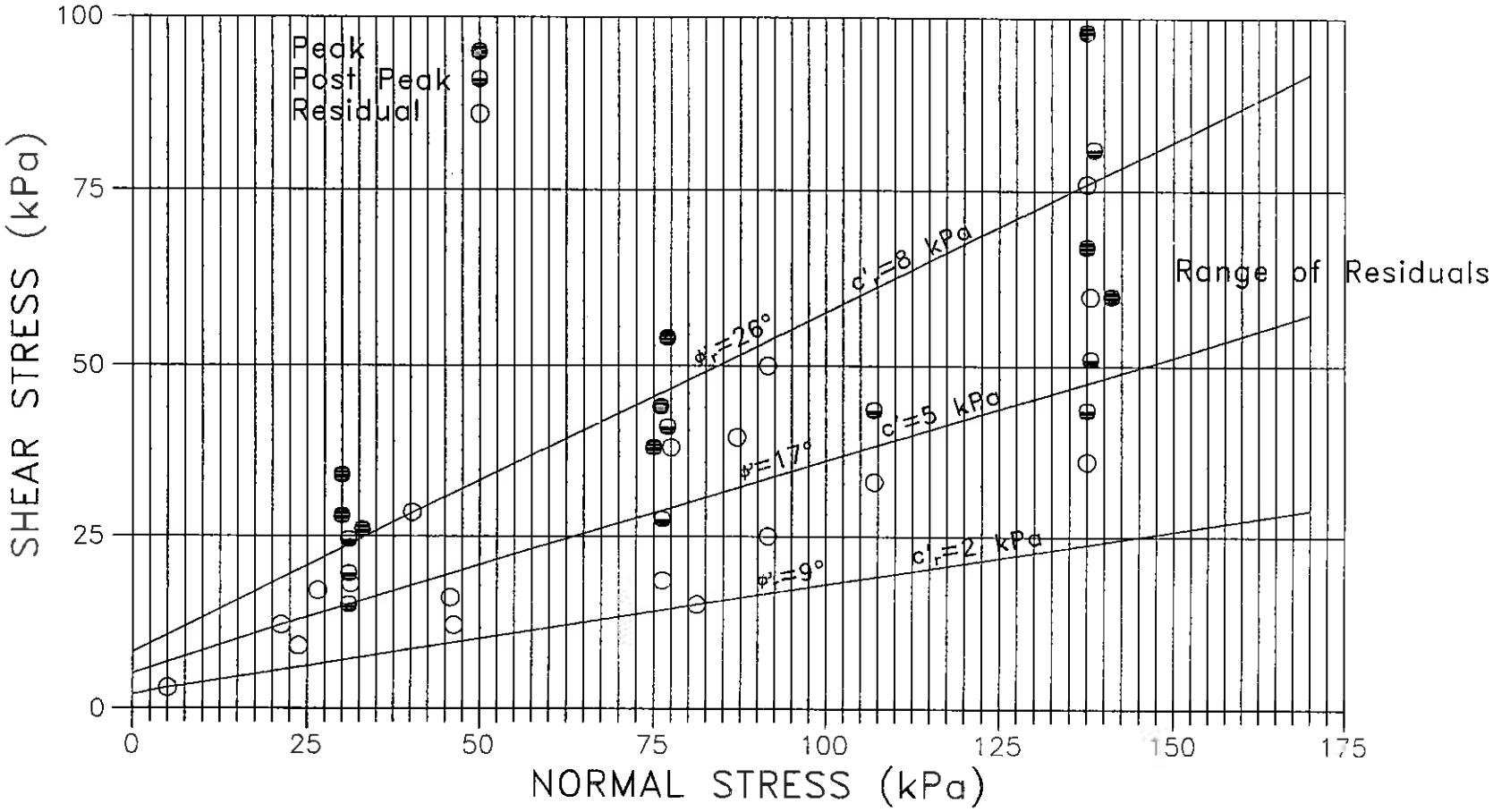
STABILITY ANALYSIS

DSN. M.J. | DR. M.N.T. | DATE | DWG. NO. Figure 3

91-147-01

APPENDIX A

DRILL HOLE LOGS
AND LAB TEST RESULTS



Note:
The direct shear data is based on samples from ITL Ltd. (drill holes TH-6, F1,5,3 and 16, 1987 and 1988) from the Forks National Historic Park Area.

KGS GROUP	PARKS CANADA
FORKS PROMENADE EXTENSION SUMMARY DIRECT SHEAR TESTING	
	FIGURE A-1

ITL INDEPENDENT TEST-LAB LIMITED

Geotechnical Engineering and Materials Testing

SOIL LOG SHEET

HOLE NO. 1

CLIENT PARKS CANADA

PROJECT THE FORKS

SITE OR SECTION —

LOCATION REFER TO SITE PLAN

CONTRACTOR PADDOCK DRILLING LTD. RIG MOBILE B-61

JOB NO. 17-46-184

SHEET 1 OF 2

DATE DRILLED JUNE 4/87

LOGGED BY CKK

ENGINEER KVL

HOLE SIZE 125 mm/200 mm ϕ

DEPTH (FT)	DEPTH (m)	ELEV. & WATER	UNIFIED SYSTEM	SOIL PROFILE	SOIL DESCRIPTION	unconfined compressive strength (K.s.F.) / (KPa) / water content (%) P.L. W L.L.	TYPE	SAMPLE NO.	BLOWS/FT (0.3m) OR RECOVERY	OTHER TESTS (SEE CODE)
					SURFACE —					
2	1				SAND & GRAVEL FILL - BROWN - DRY TO 0.6m, SLIGHTLY MOIST BELOW 0.6m - WITH STONES UP TO 25mm					
4										
6	2				- WITH OCC. CLAY CHUNKS BELOW 1.5m					
8										
10	3				- PIECES OF WHITE, HARD LIME @ 2.4m					
12										
	4									
14					CONCRETE RUBBLE - WITH CLAY					
					CLAY FILL - PIECES OF BRICKS, CONCRETE & STONES					
16	5				GRAVELLY SAND FILL - WITH NUMEROUS STONES					
18										
20	6				CLAYEY SILT - GREY - SOFT - MOIST TO WET - OCC. ORGANIC STREAKS - OCC. TREE ROOTS - WITH FINE SILTY SAND BELOW 6.1m					
22										
24	7				CLAYEY SILT FILL - GREY - SOFT - MOIST - VERY CLAYEY - WITH PIECES OF CHARCOAL & FIBROUS MATERIAL		T	R1		
26	8				CLAYEY SILT - GREY - SOFT - MOIST TO WET - WITH ORGANIC & FINE SILTY SAND INCL. - WITH FINE GRAVEL BELOW 7.6m		T	R2		
28										

ITL INDEPENDENT TEST-LAB LIMITED

Geotechnical Engineering and Materials Testing

SOIL LOG SHEET

HOLE NO. 2

CLIENT PARKS CANADA

PROJECT THE FORKS

SITE OR SECTION —

LOCATION REFER TO SITE PLAN

CONTRACTOR PADDOCK DRILLING LTD. RIG MOBILE B-61

JOB NO. 17-46-184

SHEET 1 OF 2

DATE DRILLED JUNE 9/87

LOGGED BY CKK

ENGINEER KVL

HOLE SIZE 125mm/200mm ϕ

DEPTH (FT)	DEPTH (m)	ELEV. & WATER	UNIFIED SYSTEM	SOIL PROFILE	SOIL DESCRIPTION
SURFACE –					
2					GRAVELLY SAND FILL - BROWN - DRY - WITH PEBBLES - OCC. WOOD FIBRES
4	1				
6					
8	2				CINDERS / CHARCOAL - BLACK - MOIST BELOW 2.7m - SANDY, GRAVELLY
10	3				
12					
14	4				CLAYEY SILT FILL - GREY - SOFT - MOIST TO WET
					SILT FILL - TAN - MOIST - SOFT TO FIRM - WITH ORGANIC STREAKS
16	5				SILTY CLAY / CLAYEY SILT FILL - BROWN, WITH STREAKS OF TAN & BLACK - WITH ORGANICS
18					
20	6				SILTY CLAY - GREY - SOFT TO FIRM - VERY SILTY
22	7				CLAYEY SILT - GREY / STREAKS OF BLACK - WET - VERY SOFT - WITH FINE SAND & NUMEROUS ORGANIC INCL.
24					SILTY SAND - GREY - WET - FINE - WITH BLACK ORGANICS
					CLAYEY SILT - GREY / BLACK - WET - VERY SOFT - WITH SAND
26	8				CLAYEY SAND - GREY - WATER BEARING - FINE - POORLY GRADED - OCC. PIECES OF WOOD
28					

unconfined compressive strength – o – (K.s.F.) 2 4 6 8 10

100 200 300 400 500 (KPa)

water content (%) P.L. W L.L. 0 10 20 30 40 50 60

TYPE	SAMPLE NO.	BLOWS/FT (0.3m) OR RECOVERY	OTHER TESTS (SEE CODE)
X	S1	5	
X	S2	5	
	T3		
	R4		
	T5		
	R6		
	R7		
X	S8	7	
	R9		

INDEPENDENT TEST-LAB LIMITED

Geotechnical Engineering and Materials Testing

SOIL LOG SHEET

HOLE NO. 2

CLIENT PARKS CANADA

PROJECT THE FORKS

JOB NO. 17-46-184

SHEET 2 OF 2

DEPTH (FT)	DEPTH (m)	ELEV. & WATER	UNIFIED SYSTEM	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO.	BLOWS/FT(0.3m) OR RECOVERY	OTHER TESTS (SEE CODE)
30	9				CLAYEY SAND AS ABOVE			
32	10				GRAVELLY SAND - GREY - WATER BEARING - WITH PEBBLES & STONES - SLIGHTLY CLAYEY - WITH OCC. SHELL INCL.	S10 R11	20	
34								
36	11				-HOLE DISCONTINUED @ 10.7m			

unconfined compressive strength — o — (K.s.F.) 2 4 6 8 10

100 200 300 400 500 (KPa)

water content (%) P.L. W L.L. 0 10 20 30 40 50 60

INDEPENDENT TEST-LAB LIMITED

Geotechnical Engineering and Materials Testing

SOIL LOG SHEET

HOLE NO. 9

CLIENT PARKS CANADA

PROJECT THE FORKS

SITE OR SECTION —

LOCATION REFER TO SITE PLAN

CONTRACTOR PADDOCK DRILLING LTD. RIG MOBILE B-61

JOB NO. 17-46-184

SHEET 1 OF 2

DATE DRILLED JUNE 9/87

LOGGED BY CKK

ENGINEER KVL

HOLE SIZE 125mm / 200mm ϕ

DEPTH (FT)	DEPTH (m)	ELEV. & WATER	UNIFIED SYSTEM	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO.	TYPE	BLOWS/FT (0.3m) OR RECOVERY	OTHER TESTS (SEE CODE)
					SURFACE —				
2					GRAVELLY SAND FILL - BROWN - DRY - WITH SILTY CLAY CHUNKS BELOW 0.9m				
4	1								
					LIME WITH SAND FILL - WHITE				
6					GRAVELLY SAND FILL - WITH LIME TO APPROX. 2.5m	S1		3	
8	2								
10	3				SAND/GRAVEL/RUBBLE FILL - MOIST @ 3.7m	S2		6	
12									
14	4				SILT CLAY FILL - BROWN - SOFT TO FIRM - LOW PLASTIC - WITH FINE GRAVEL, PEBBLES & STONES				
16	5								
18					CLAYEY SILT - GREY/STREAKS OF BLACK - VERY SOFT TO SOFT - WITH FINE SAND SEAMS - WITH ORGANIC STREAKS	R3			
20	6								
22					SILTY CLAY/CLAYEY SILT FILL - GREY, BROWN MIXED - NUMEROUS PEBBLES & STONES - OCC. FIBROUS MATERIAL - WITH TRACE OF LIME, WITH PUNGENT SMELL	R4			
24	7								
26	8								
28					CLAYEY SILT - GREY/BLACK - VARVED WITH FINE SAND SEAMS - WET - WITH GRAVEL & STONES	R5			

unconfined compressive strength — o — (K.S.F.): 2, 4, 6, 8, 10

100, 200, 300, 400, 500 (KPa)

water content (%): P.L., W, L.L.; 10, 20, 30, 40, 50, 60

INDEPENDENT TEST-LAB LIMITED

Geotechnical Engineering and Materials Testing

SOIL LOG SHEET

HOLE NO. 9

CLIENT PARKS CANADA

PROJECT THE FORKS

JOB NO. 17-46-184

SHEET 2 OF 2

DEPTH (FT)	DEPTH (m)	ELEV. & WATER	UNIFIED SYSTEM	SOIL PROFILE	SOIL DESCRIPTION	unconfined compressive strength (K.S.F.) / (KPa) / water content (%) P.L. W L.L.	TYPE	SAMPLE NO.	BLOWS/FT(0.3m) OR RECOVERY	OTHER TESTS (SEE CODE)
30	9				CLAYEY SILT AS ABOVE					
32	10				GRAVELLY SAND - BLACKISH-GREY - MEDIUM - WITH PEBBLES & STONES - WATER BEARING - WITH SHELL INCL.			R6		
34										
36	11									
38								R7		
40	12									
42	13				- HOLE DISCONTINUED @ 12.2m					

INDEPENDENT TEST-LAB LIMITED

Geotechnical Engineering and Materials Testing

SOIL LOG SHEET

HOLE NO. 10

CLIENT PARKS CANADA

PROJECT THE FORKS

SITE OR SECTION —

LOCATION REFER TO SITE PLAN

CONTRACTOR PADDOCK DRILLING LTD. RIG MOBILE B-61

JOB NO. 17-46-184

SHEET 1 OF 2

DATE DRILLED JUNE 9/87

LOGGED BY CKK

ENGINEER KVL

HOLE SIZE 125mm/200mm ϕ

DEPTH (FT)	DEPTH (m)	ELEV. & WATER	UNIFIED SYSTEM	SOIL PROFILE	SOIL DESCRIPTION
SURFACE –					
2					GRAVELLY SAND FILL - BROWN - DRY
4	1				CONCRETE RUBBLE
6					CLAYEY GRAVELLY SAND FILL - BLACKISH-BROWN
8	2				- WITH STONES - WITH ORGANICS
10	3				- PIECES OF BRICK
12					
14	4				- MOIST BELOW 3.7m
16					
18	5				CLAYEY SILT/SILTY CLAY FILL - GREY/BROWN MIXED - SOFT TO FIRM - LOW PLASTIC - WITH ORGANIC STREAKS
20	6	▽			
22	7				SILTY CLAY FILL - GREY/BROWN - FIRM - MEDIUM PLASTIC - VARVED - WITH ORGANIC STREAKS
24					CLAYEY SILT - BLACK - MOIST TO WET - VERY SOFT - SLIGHTLY SANDY - NUMEROUS ORGANIC INCL.
26	8				CLAYEY SAND - BLACKISH-GREY - FINE - POORLY GRADED - ORGANIC INCL. - GRAVELLY & PEBBLEY @ 7.9-8.2m
28					

unconfined compressive strength (K.S.F.): 2, 4, 6, 8, 10

100 200 300 400 500 (KPa)

water content (%): P.L. W L.L.

0 10 20 30 40 50 60

TYPE	SAMPLE NO.	BLOWS/FT(0.3m) OR RECOVERY	OTHER TESTS (SEE CODE)
X	S1	12	
↕	R2		
↕	R3		

INDEPENDENT TEST-LAB LIMITED

Geotechnical Engineering and Materials Testing

SOIL LOG SHEET

HOLE NO. 10

CLIENT PARKS CANADA

PROJECT THE FORKS

JOB NO. 17-46-184

SHEET 2 OF 2

DEPTH (FT)	DEPTH (m)	ELEV. & WATER	UNIFIED SYSTEM	SOIL PROFILE	SOIL DESCRIPTION	unconfined compressive strength (K.S.F.) / water content (%)	TYPE	SAMPLE NO.	BLOWS/FT (0.3m) OR RECOVERY	OTHER TESTS (SEE CODE)
30	9				CLAYEY SAND AS ABOVE			R4		
32										
34	10				GRAVELLY SAND - BLACKISH-GREY - MEDIUM - WITH STONES - WATER BEARING - SHELL INCL. - SLIGHTLY CLAYEY			R5		
36	11				SILTY CLAY - GREY - SOFT TO FIRM - HIGHLY PLASTIC - WITH NUMEROUS TAN SILT & PEBBLE INCL.			R6		
38								R7		
40	12									
42	13				- HOLE DISCONTINUED @ 12.2m - WATER @ 6.2m UPON COMPLETION OF TEST HOLE - HOLE CAVED-IN TO 6.7m					

INDEPENDENT TEST-LAB LIMITED

Geotechnical Engineering and Materials Testing

SOIL LOG SHEET

HOLE NO. 13

CLIENT PARKS CANADA

PROJECT THE FORKS

SITE OR SECTION —

LOCATION REFER TO SITE PLAN

CONTRACTOR PADDOCK DRILLING LTD. RIG MOBILE B-61

JOB NO. 17-46-184

SHEET 1 OF 2

DATE DRILLED JUNE 10/87

LOGGED BY CKK

ENGINEER KVL

HOLE SIZE 125mm ϕ

DEPTH (FT)	DEPTH (m)	ELEV. & WATER	UNIFIED SYSTEM	SOIL PROFILE	SOIL DESCRIPTION	unconfined compressive strength (K.s.f.) / (KPa) / water content (%) P.L. W L.L.	TYPE	SAMPLE NO.	BLOWS/FT (0.3m) OR RECOVERY	OTHER TESTS (SEE CODE)
					SURFACE —					
2					GRAVELLY SAND FILL - BROWN - WITH STONES - WITH ORGANICS					
4	1									
6	2									
8										
10	3									
12					- WITH WHITE LIME BELOW 3.5mm					
14	4				CLAYEY SILT / SILTY CLAY FILL - BROWN/GREY MIXED - WITH BLACK ORGANICS - PIECES OF WOOD					
16										
18	5	▽			- WITH NUMEROUS PEBBLES, GRAVEL AND STONES UP TO 12mm BELOW 4.6m - MOIST BELOW 4.0m					
20	6				WOOD - BURNT - DECOMPOSED					
22					SANDY GRAVEL FILL - BROWN - WITH OCC. ORGANIC CLAYEY SILT LAYERS					
24	7									
26	8									
28					CLAYEY SILT - GREYISH-BLACK - SOFT TO MED. FIRM - ORGANIC STREAKS - VERY CLAYEY					

INDEPENDENT TEST-LAB LIMITED

Geotechnical Engineering and Materials Testing

SOIL LOG SHEET

HOLE NO. 13

CLIENT PARKS CANADA

PROJECT THE FORKS

JOB NO. 17-46-184

SHEET 2 OF 2

DEPTH (FT)	DEPTH (m)	ELEV. & WATER	UNIFIED SYSTEM	SOIL PROFILE	SOIL DESCRIPTION	unconfined compressive strength (K.s.F.) / (KPa) — water content (%) P.L. W L.L.	TYPE	SAMPLE NO.	BLOWS/FT(0.3m) OR RECOVERY	OTHER TESTS (SEE CODE)
30	9				CLAYEY SILT AS ABOVE					
32	10				-HOLE DISCONTINUED @ 9.1m -WATER @ 5.3m, CAVED-IN @ 5.8m UPON COMPLETION OF TEST HOLE					

INDEPENDENT TEST-LAB LIMITED

Geotechnical Engineering and Materials Testing

SOIL LOG SHEET

HOLE NO. 14

CLIENT PARKS CANADA

PROJECT THE FORKS

SITE OR SECTION —

LOCATION REFER TO SITE PLAN

CONTRACTOR PADDOCK DRILLING LTD. RIG MOBILE B-61

JOB NO. 17-46-184

SHEET 1 OF 2

DATE DRILLED JUNE 10/87

LOGGED BY CKK

ENGINEER KVL

HOLE SIZE 125mm ϕ

DEPTH (FT)	DEPTH (m)	ELEV. & WATER	UNIFIED SYSTEM	SOIL PROFILE	SOIL DESCRIPTION
SURFACE –					
2					GRAVELLY ORGANIC FILL
4	1				WOOD FILL – FRESH WOOD SMELL
6	2				SAND FILL – BROWN – DRY – GRAVELLY
8					CLAY/GRAVEL/CINDERS FILL
10	3				– MIXED FILL – WITH BOLTS, WIRE ETC.
12					
14	4				– MOIST BELOW 4.0m
16	5	▽			
18					
20	6				
22	7				SANDY GRAVEL FILL – BLACK – WET – WITH PIECES OF WOOD
24					
26	8				
28					CLAYEY SILT – BLACK – WET – VERY SOFT – WITH ORGANICS – WITH occ. SAND INCL.

unconfined compressive strength – o – (K.s.F.)
2 4 6 8 10
100 200 300 400 500 (KPa)
water content (%) P.L. W L.L.

TYPE	SAMPLE NO.	BLOWS/FT (0.3m) OR RECOVERY	OTHER TESTS (SEE CODE)

INDEPENDENT TEST-LAB LIMITED

Geotechnical Engineering and Materials Testing

SOIL LOG SHEET

HOLE NO. 14

CLIENT PARKS CANADA

PROJECT THE FORKS

JOB NO. 17-46-184

SHEET 2 OF 2

DEPTH (FT)	DEPTH (m)	ELEV. & WATER	UNIFIED SYSTEM	SOIL PROFILE	SOIL DESCRIPTION	unconfined compressive strength (K.s.F.) / (KPa) — water content (%) P.L. W L.L.	TYPE	SAMPLE NO.	BLOWS/FT(0.3m) OR RECOVERY	OTHER TESTS (SEE CODE)
30	9				CLAYEY SILT AS ABOVE					
32	10				- HOLE DISCONTINUED @ 9.1m - WATER @ 4.9m, CAVED-IN @ 5.9m UPON COMPLETION OF TEST HOLE					

INDEPENDENT TEST-LAB LIMITED

Geotechnical Engineering and Materials Testing

SOIL LOG SHEET

HOLE NO. 20

CLIENT PARKS CANADA

PROJECT THE FORKS

SITE OR SECTION AMPHITHEATRE

LOCATION REFER TO SITE PLAN

CONTRACTOR PADDOCK DRILLING LTD. RIG B61 Hollow Stem

JOB NO. 17-46-184

SHEET 1 OF 2

DATE DRILLED NOV. 16/87

LOGGED BY GVN

ENGINEER KVL

HOLE SIZE 200 mm Ø

DEPTH (FT)	DEPTH (m)	ELEV. & WATER	UNIFIED SYSTEM	SOIL PROFILE	SOIL DESCRIPTION	unconfined compressive strength (K.s.f.) / water content (%)	TYPE	SAMPLE NO.	BLOWS/FT (Q 3m) OR RECOVERY	OTHER TESTS
					SURFACE – ELEV. 223.23 m	0 20 40 60 80				
2					CLAYEY SILT – black – organic – varved with black sand – soft to firm					
4	1									
6	2									
8							X	S1	11	
10	3									
12							X	S2		
	4				∇ El 219.7					
14					SAND – black – shell inclusions – gravel particles to 10 mm ø		X	S3		
16	5									
18					~ 218					
					SILTY CLAY – brown – soft – tan silt pockets		X	S4	3	
20	6									
22	7									
24										
26	8						X	S5	3	
28										

INDEPENDENT TEST-LAB LIMITED

Geotechnical Engineering and Materials Testing

SOIL LOG SHEET

HOLE NO. 20

CLIENT PARKS CANADA

PROJECT THE FORKS

JOB NO. 17-46-184

SHEET 2 OF 2

DEPTH (FT)	DEPTH (m)	ELEV. & WATER	UNIFIED SYSTEM	SOIL PROFILE	SOIL DESCRIPTION	TYPE	SAMPLE NO.	BLOWS/FT(0.3m) OR RECOVERY	OTHER TESTS
30	9				SILTY CLAY - Brown - Soft - Tan silt pockets				
					CLAY-TILL - Stoney ~21¼				
32	10				LIMESTONE-BEDROCK	X	S6	79	
34									
36	11				END OF TEST HOLE 10.8m				
38									
40	12								
42									
44	13								
46	14								
48									
50	15								
52									
54	16								
56	17								

unconfined compressive strength — o — t
2 4 6 8 10 (K, S, F)
100 200 300 400 500 (KPa)
water content (%) P.L. W L.L.

INDEPENDENT TEST-LAB LIMITED

Geotechnical Engineering and Materials Testing

SOIL LOG SHEET

HOLE NO. 1F

CLIENT THE FORKS RENEWAL CORPORATION

JOB NO. 35-1029

PROJECT THE FORKS

SITE OR SECTION

LOCATION REFER TO SITE PLAN

SHEET 1 OF 1

DATE DRILLED FEB 12/88

LOGGED BY GVN

ENGINEER KVL

CONTRACTOR PADDOCK DRILLING LTD. RIG MOBILE B-61

HOLE SIZE 200mm ϕ

DEPTH (FT)	DEPTH (m)	ELEV. & WATER	UNIFIED SYSTEM	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO.	TYPE	BLOWS/FT (0.3m) OR RECOVERY	OTHER TESTS (SEE CODE)
					SURFACE – ± el 227				
2					ICE				
					WATER				
4	1		(SP)		SAND - GREY - FINE	R1			
6						R2			
8	2				- BLACKISH - GREY, WITH ANGULAR LIMESTONE GRAVEL UP TO 19mm BELOW 2.0m	S3		18	
10	3		(CL/CH)		SILTY CLAY - GREY/BROWN - STIFF - MEDIUM PLASTIC - OCC. BANDS OF SILT	S4		7	
						T5			
12	4				- BROWN, NUGGETY, SLIGHTLY SOFTER BELOW 3.7m	T6			
14					- SLIP @ 4.0m, ≈ 40°, ALONG SILTY PLANE	T7			
						T8			
16	5		CH		SILTY CLAY - BROWNISH - GREY - FIRM TO STIFF - MED. PLASTIC - WITH LARGE SILT POCKETS - SLIP @ 4.6m, ≈ 30° - SLIP @ 4.7m, ≈ 10°	T9			
18					- MULTIPLE SLIPS @ 4.9 - 5.0m - SLIP @ 5.4m, ≈ 0° - SLIP @ 5.5m, ≈ 30°	T10			
20	6				- POSSIBLE SLIPS BTW. 5.6 - 6.0m - POSSIBLE SLIP @ CLAY-TILL INTERFACE (6.1m)	T11			
22					TILL - TAN - SOFT - SILTY, SANDY, GRAVELLY, STONY	S12		56	
	7				- DENSE BELOW 6.9m	S13		92 FOR 0.23m	
24									
					- REFUSAL OF SPT @ 7.2m				
26	8								

unconfined compressive strength (K.s.f.) 2 4 6 8 10

100 200 300 400 500 (KPa)

water content (%) P.L. W L.L.

0 20 40 60 80 100

INDEPENDENT TEST-LAB LIMITED

Geotechnical Engineering and Materials Testing

SOIL LOG SHEET

HOLE NO. 2F

CLIENT THE FORKS RENEWAL CORPORATION

JOB NO. 35-1029

PROJECT THE FORKS

SITE OR SECTION

LOCATION REFER TO SITE PLAN

SHEET 1 OF 1

DATE DRILLED FEB 12/88

LOGGED BY GVN

ENGINEER KVL

CONTRACTOR PADDOCK DRILLING LTD. RIG MOBILE B-61

HOLE SIZE 200 mm ϕ

DEPTH (FT)	DEPTH (m)	ELEV. & WATER	UNIFIED SYSTEM	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO.	TYPE	BLOWS/FT (0.3m) OR RECOVERY	OTHER TESTS (SEE CODE)
					SURFACE –				
2					ICE – 322				
					WATER				
4	1		(CL)		SILTY CLAY – DARK GREY – WET – ORGANIC POCKETS – SOFT – TRACE OF SILT POCKETS	T1			
6	2		(SM)		SANDY SILT – GREYISH – BLACK – SOFT – WITH SAND SEAMS – TRACE OF GRAVEL – PIECES OF GLASS, SEA SHELLS	T2			
8			(SP)		SAND – GREY – FINE – VARVED WITH SILTY SAND & CLAYEY SAND	R3			
10	3				– MEDIUM TO COARSE SAND WITH FINE GRAVEL BELOW 2.6m	S4		20	
12					SILTY CLAY – GREYISH – BROWN – FIRM – OCC. SMALL STONES – HIGHLY PLASTIC – WITH SILT POCKETS – SLIPS @ 3.9 – 4.0m, ≤ 30° – MULTIPLE SLIPS @ 4.7 – 4.8m, ≤ 0° – TRACE OF SOFT TILL PUTTY BELOW 4.6m	S5		2	
14	4					T6			
16	5		(CH)			T7			
18						T8			
20	6				– SLIP @ 5.2m, ≤ 15° – SLIP @ 5.4m, ≤ 10° – SLIP @ 5.8m, ≤ 0° – SLIP @ 5.9m, ≤ 10° – SLIP @ 6.0m, ≤ 0°	T9			
22					TILL – TAN – SILTY – STONY – SOFT TO 6.1m, DENSE BELOW	T10			
24	7				– REFUSAL ON SPT @ 6.6m	S11		165	

unconfined compressive strength – o – 2 4 6 8 10 (K.S.F.)

100 200 300 400 500 (KPa)

water content (%) P.L. W L.L.

0 20 40 60 80 100

INDEPENDENT TEST-LAB LIMITED

Geotechnical Engineering and Materials Testing

SOIL LOG SHEET

HOLE NO. 17F

CLIENT THE FORKS RENEWAL CORPORATION

JOB NO. 35-1029

PROJECT THE FORKS

SITE OR SECTION

LOCATION REFER TO SITE PLAN

SHEET 1 OF 2

DATE DRILLED FEB. 16, 17/88

LOGGED BY CKK/GVN

ENGINEER KVL

CONTRACTOR PILE FOUNDATION LTD./ PADDOCK DRILLING LTD. RIG WILLIAMS AUGER/ MOBILE B-61

HOLE SIZE 400 mm/200 mm ϕ

DEPTH (FT)	DEPTH (m)	ELEV. & WATER	UNIFIED SYSTEM	SOIL PROFILE	SOIL DESCRIPTION	unconfined compressive strength (K.s.f.) / water content (%)	TYPE	SAMPLE NO.	BLOWS/FT (0.3m) OR RECOVERY	OTHER TESTS (SEE CODE)
					SURFACE –					
2					FILL – GRAVEL, STONES, CONCRETE RUBBLE					
4	1				– CINDERS, BRICKS @ 0.6m					
6					– BRICKS, RUBBLE @ 1.2m					
	2				– WITH SAND BELOW 1.5m					
8					– CLAY, SILT, ORGANICS, SAND, GRAVEL & RUBBLE FILL @ 2.1m					
10	3				– CINDERS, GRAVEL & ORGANICS FILL @ 3.0m					
12										
14	4				– WITH SILT & CLAY CHUNKS @ 4.0m					
16	5				– WITH LARGE CONCRETE CHUNKS @ 4.6m					
18										
20	6				– SILT CHUNKS WITH SAND & GRAVEL FILL					
22										
24	7		(ML)		CLAYEY SILT – GREY / STREAKS OF BLACK – SOFT – WET – CLAYEY – WITH GREY SAND SEAMS			R1		
26	8		(SC)		CLAYEY SAND – GREY – FINE – WATER BEARING			R2 T3		
28										

INDEPENDENT TEST-LAB LIMITED

Geotechnical Engineering and Materials Testing

SOIL LOG SHEET

HOLE NO. 17F

CLIENT THE FORKS RENEWAL CORPORATION

JOB NO. 35-1029

PROJECT THE FORKS

SHEET 2 OF 2

DEPTH (FT)	DEPTH (m)	ELEV. & WATER	UNIFIED SYSTEM	SOIL PROFILE	SOIL DESCRIPTION	TYPE	SAMPLE NO.	BLOWS/FT (0.3m) OR RECOVERY	OTHER TESTS (SEE CODE)
30	9		(SC)		CLAYEY SAND AS ABOVE		T4		
32	10								
34			(CL)		SILTY CLAY - GREY - FIRM - VERY SILTY - WITH TAN SILT POCKETS				
36	11						SS	3	
38									
40	12						T6		
42	13								
44									
46	14						T7		
48					TILL - TAN - STONY		SS	>70 FOR 0.15m	
50	15				- REFUSAL OF SPT ON BOULDER @ 14.9m - HOLE CAVED-IN TO 7.0m UPON WITHDRAWAL OF AUGERS				

unconfined compressive strength 2 4 6 8 10 (K.S.F.)

100 200 300 400 500 (KPa)

water content (%) P.L. W L.L.

0 20 40 60 80 100