

January 30, 2004

File No. 03-107-17

City of Winnipeg
Water and Waste Department
1500 Plessis Road
Winnipeg, Manitoba
R3C 5G6

ATTENTION: Mr. Kas Zurek, P.Eng.
Design and Construction Engineer

RE: Geotechnical Investigation
Montcalm Force Main Replacement

Dear Mr. Zurek:

Please find enclosed four copies of our geotechnical report for the proposed directional drilling force main installation at the Montcalm site. Two copies of this report are also being sent by KGS Group directly to Mr. Don Kingerski, P.Eng. in support of the Water and Waste Department application for a Waterways Permit.

The scope of work included:

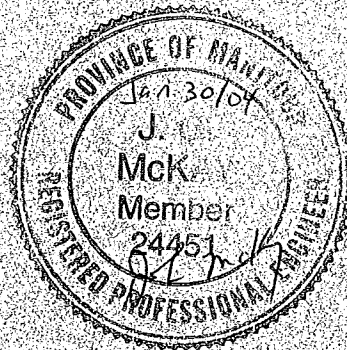
- Geotechnical site investigation
- Riverbank stability impact assessment
- Recommendations for vertical profile of the forcemain to minimize potential for bank movements impacting the pipe.
- Preparation of this geotechnical engineering report suitable for submission in support of a Waterways Permit Application

KGS Group thanks the City of Winnipeg for the opportunity to have provided services on this interesting project. Please contact Rob Kenyon, P.Eng. or the undersigned if you have questions.

Sincerely,



John G. McKay, P.Eng.
Senior Geotechnical Engineer



/af
Enclosure

LIST OF TABLES

1. Testhole Summary and Groundwater Readings

LIST OF FIGURES

1. Site Plan Showing Testhole Locations
2. Force Main Cross Section

LIST OF APPENDICES

- A. Testhole Logs

1.0 INTRODUCTION

This report presents the results of a geotechnical investigation along the alignment of a proposed subsurface directionally drilled sewer force main under the Red River in Winnipeg, Manitoba.

Authorization to proceed with this work was received verbally from Mr. John Elias, C.E.T., Winnipeg Water and Waste Department.

The site is within 107 m (350 ft) horizontal distance from the normal summer water edge of the Red River and in accordance with the City Waterway By-law, a Waterway Permit is required for new construction.

The scope of work was described in KGS Group's December 17, 2004 proposal and included:

Geotechnical Site Investigation - perform a subsurface drilling investigation on both sides of the River.

- **Qualitative Riverbank Stability Assessment** - assess the impact of the proposed works on the stability of existing riverbank by site reconnaissance, air photo review and the results of the geotechnical site investigation.
- **Report** - present results of work.

Previous available information reviewed includes:

- December 12, 2004, The City of Winnipeg, Water and Waste Department, Plot Index Map, Montcalm Forcemain, 1:1000 photograph.
- January 2004, Plan and Profile, Montcalm Forcemain, 2 – 600 Forcemains crossing Red River, The City of Winnipeg, Water and Waste Department.
- October 23, 1998, FF98096, Line 19, Numbers 249, 250; Scale 1:5000, airphotos.
- City of Winnipeg, 1998 Digital Ortho Based Mapping along City Waterways
- April 1994, KGS Group, Red River Bridge, Mile 124.6 Keewatin Subdivision, Bank and Bridge Monitoring Following East Bank Repairs of 1993 (Interim Report)

2.0 BACKGROUND

2.1 PROJECT DETAILS

The project is understood to comprise the abandonment of two existing 600 mm cast iron force mains and the underground directional drilling and installation of two 600 mm DR11 HDPE sewer force mains. Details of the proposed replacement are in the City of Winnipeg Tender Number 16-2004 and City Drawing 05356.

2.2 SITE DESCRIPTION AND LOCATION

The project is located within the areas of South Point Douglas and Tynes-Tees, just upstream of the CPR Keewatin Bridge, in the City of Winnipeg. The proposed directionally drilled pipeline will be approximately 1.35 km projected horizontal distance and connect to the pumping station on the east side and a manhole on the west. The east side of the river is parallel to Archibald Street. The west side of the river is adjacent to the fenced yard of Gateway Industries. The site location and plan are presented in Figure 1.

There was snow cover during the field work and the river initially had about 300 mm of ice.

Based on 1998 aerial photography derived contour mapping, the overall grades from summer river elevation (223.5 m) to top of bank are 3.4H:1V on the west (about 5 m high) and 10H:1V on the south (about 7.25 m high). Both sides have been regraded along the existing pipe alignment. On the west side just upstream of the alignment the natural grades are approximately 1.3H:1V (about 5 m high above summer river level). On the east side the steepest ground is at about 3.7H:1V over only about 2.5 m height above the summer river level.

KGS Group has designed and supervised the construction of remedial works including a shear key and rock columns along the east bank of the nearby CPR bridge at Mile 124.6 on the Keewatin Subdivision in the 1990's. The works were completed under Waterways Permit Number 135/92.

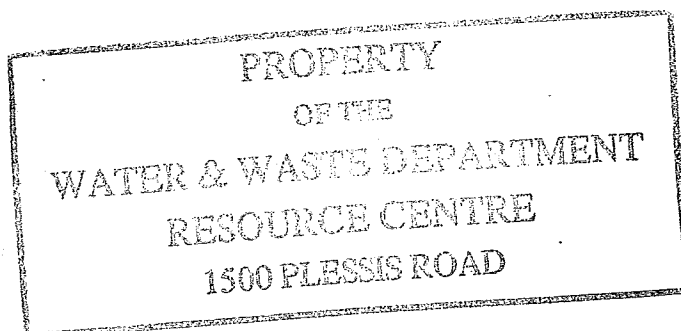
3.0 REGIONAL GEOLOGY

The regional surficial and bedrock geologic materials were as follows:

- **Fill** of variable depth.
- **Postglacial alluvial sediments** - Geologic Survey of Canada unpublished map, Surficial Geology of Southern Manitoba describes the postglacial alluvial sediments as 'gravelly, sand, sand silt, organic detritus; 1 to 3 m thick; sediments reworked by existing streams and deposited primarily as bars.'
- **Glaciolacustrine sediments** - Geologic Survey of Canada unpublished map, Surficial Geology of Southern Manitoba describes the glaciolacustrine sediments as 'clay, silt; 1 to 20 m thick; massive and laminated distal sediments derived from meltwater discharge and deposited from suspension in offshore, deep water of Lake Agassiz; commonly scoured and at least partially homogenized by icebergs.', approximately 11,600 to 8,700 years before present in age (Teller, 1980, Canadian Journal of Earth Sciences, Volume 13, 1976)
- **Glacial till** - Teller and Fenton (Canadian Journal of Earth Sciences, Volume 17, 1980) present several Late Wisconsinan basal tills and intertill sand and clay deposits in the Winnipeg area.

Mollard and Janes, 1984 (Airphoto Interpretation and the Canadian Landscape) classify tills based on mode of release and deposition from ice. The top surface of the upper till typically called 'putty till' appears to be waterlain till, 'a crudely sorted and stratified variety of till that is deposited in water. It may have been released from icebergs, or from a floating glacier margin where it was buoyed up in a glacial lake or the sea.' Tills below the putty till include flow and meltout tills, and the most common and dense - lodgement till.

- **Bedrock** - Geologic Highway Map of Manitoba 1994, by Geological Survey of Canada, Manitoba Minerals Division indicates that the bedrock at the site is Ordovician (500 to 435 million years before present) in age, of the Red River Formation. The bedrock is described as mottled dolomitic limestone.



4.0 INVESTIGATION PROGRAM

4.1 FIELD AND LABORATORY WORK

From January 6 to 16, 2003, KGS Group supervised the drilling of six testholes at locations shown in Figure 1. The holes were drilled with both track and truck mounted drill rigs contracted from Paddock Drilling Ltd. The holes were advanced using 125 mm solid stem augers and a HQ Longyear wireline double tube core barrel with diamond drill bit to depths of between 9.4 and 28.8 m below existing ground surface. An ice bridge was constructed by Ken Palson Enterprises in order to drill testhole TH5 near the middle of the river channel. The hole location are as follows:

- Testhole TH1 was drilled on the east side top of bank near the pumphouse.
- Testhole TH2 on the east side nearest the river.
- Testhole TH3 was drilled on the west near the river.
- Testhole TH4 was drilled on the west near the existing discharge manhole.
- Testhole TH5 was drilled on the frozen river.
- Testhole TH6 was drilled on the east side near the directional drilling access shaft.

Solid stem auger samples and split-spoon samples were recovered for laboratory testing. Standard Penetration Tests (SPT's) were performed. Till and bedrock were cored with a 1.5 m HQ Longyear wireline double tube core barrel. Lockable protective steel casings and 25 mm PVC standpipes were installed in all holes except for testholes TH5 (on the river) and TH6. Installation details are presented on the testhole logs. Testhole logs are presented in Appendix A.

Ground surface elevations are referenced to geodetic. Horizontal coordinates are in NAD83 (North American Datum 1983) also known as UTM. Survey data were provided by the City of Winnipeg. A section along the new force main pipes through both east and west banks and showing the river bottom is presented in Figure 2.

Classification and index tests were performed at NTL Laboratories Ltd. on soil samples collected from the testholes. Laboratory tests included natural moisture content and Atterberg limits. These results are shown on the testhole logs.

5.0 GEOTECHNICAL SITE STRATIGRAPHY

5.1 STRATIGRAPHY

The stratigraphy logged at the six testholes drilled at the site is summarized as follows (please refer to the testhole logs for the full description and Table 1 for a summary):

▪ **Fill**

- **Gravel and Sand (Fill)**- road or surfacing material typically 75 mm and less than 200 mm thick in TH1, TH6 and TH4.
- **Clay (Fill)**- Unified Soil Classification System modifier CH, stiff, silty, trace sand to some sand, trace gravel, high plastic, damp, brown. Clay fill depths were 2.2 m in Testhole TH1 (not including 75 mm gravel road surface), and 3.0 m in Testhole TH6 (not including 75 mm gravel road surface).

The precise depth of fill can be difficult to determine in a borehole particularly when the fill is comprised of nearby native soil without organics or anthropogenic material.

- **Topsoil**- organic layer less than 200 mm thick encountered in TH2, TH4
- **Silt and Sand (Alluvium, Point Bar)** – compact, low to non plastic, moist to saturated, brown to grey (below zone of oxidation). Subhorizontally layered in TH3 and TH4. Isolated clay layer as in TH4 at 7.0 m (150 mm thick). The point bar alluvium was 13.7 m thick in TH3 and 10.7 m thick in TH4. Approximately 1.6 m of alluvium was logged in TH5 in the middle of the river. In testhole TH5, the material description of the soft riverbottom sediments above the till was based on the driller's feel as it was not sampled due to the river.
- **Clay (Glaciolacustrine or Lacustrine)**- CH, firm to soft with depth, silty, with isolated pieces of gravel, high plasticity, moist to saturated, brown to grey. Approximately 14.5 and 13.4 m thick in testholes TH1 and TH6 located on the east top of bank. Approximately 14.0 m thick in testhole TH2 located on the east near the river. Approximately 1.5 and 5.7 m thick in testholes TH3 and TH4 located on the west side nearest the river and at the top of bank.
- **Silt¹ or Clay (Till)**- stiff or compact, to hard and very dense, trace to some subrounded to angular gravel, low to nonplastic, saturated, light brown to grey. Encountered at elevations of 213.9 m and 213.0 m on the west bank in testholes TH3 and TH4. Encountered at elevations 213.6 and 212.4 at testholes TH1 (top) and TH2 (near river) on the east bank and at elevation 212.1 in testhole TH5 in the middle of the river.

¹ When more than 50% by mass is silt sized (passing the number 200 sieve) or smaller the soil is called CLAY when the plasticity index is greater than 7%, CLAY-SILT when the plasticity index is between 4 and 7%, and SILT when the plasticity index is less than 4% according to the Unified Classification System and the accompanying plasticity chart.

- **Limestone or Dolomite (Bedrock)**- strong to very strong (requires more than one blow to many blows of a geological hammer to fracture) intact pieces, sometimes fractured in the first approximately 1 m. Very light brownish grey, aphanitic (fine grain texture not visible to unaided eye), very close to moderately close spaced (20-600 mm) discontinuities or joints.

5.2 GROUNDWATER CONDITIONS

Groundwater depths and elevations are presented in Table 1. Standpipe response zones were in the lower till and upper bedrock. Groundwater elevations on both banks in this response zone on January 16th were approximately 222.4 to 222.5 m (approximately 6.6 to 8.0 m below grade) on both banks.

The corresponding river elevation was 221.41 m on January 12, 2004.

Groundwater elevations vary seasonally and in response to river levels and precipitation.

6.0 EXISTING RIVERBANK STABILITY ASSESSMENT

The east bank is on the outside bend of the Red River where erosion has progressed into the glaciolacustrine Lake Agassiz high plastic clay sediments. The east abutment of the nearby CPR bridge has undergone deep-seated movements (KGS Group slope indicator data). There may have been slope related movements at the Montcalm site in the past.

The west bank is on the inside bend and is a lateral accretion deposit or point bar comprised of sand and silt overlying high plastic glaciolacustrine clay. The point bar is relatively stronger than the lake deposits and appears steep edged and stable on the airphotos. The underlying glaciolacustrine clay is a possible plane of weakness. Although not anticipated, changes in river dynamics could undercut this bank and lead to instability.

Slope stability slip surfaces do not usually penetrate the strong till soils in Winnipeg. Therefore utilities beneath the top of till are at less risk to slope stability related ground movements.

6.1 IMPACT OF PROPOSED CONSTRUCTION ON RIVERBANK STABILITY

As proposed, the abandonment of the existing 600 mm cast iron force mains and the construction and operation of the two 600 mm DR11 HDPE sewer force mains will not reduce the stability of the riverbank. As with any underground utility near a slope, the risk of leakage into the ground should be minimized. The abandoned 600 mm cast iron force mains should be grouted or otherwise sealed to prevent water leakage under hydrostatic head.

KGS Group recommends that the vertical alignment of the pipes should be below the top of till as much as possible on both sides of the river. Figure 2 presents a cross section showing two possible vertical alignments of the force mains suggested by the Water and Waste Department. One places the pipe in the till and the other in the bedrock. Both new alignments are much deeper and are beneath the top of till within about 20 m from the pump station starting from elevation 221 m (approximately 9 m below grade) on the east bank. On the west side, the pipes break above the till surface within 5 m of the top of bank but still at over 12 m depth. Either of the new alignments are significantly better than the existing with respect to slope stability,

reducing the risk of bank movements impacting the pipe. The final vertical alignment will be determined by the Contractor and approved by the City Contract Administrator.

6.2 WATERWAYS PERMIT RECOMMENDATION

The proposed construction will not endanger the stability of the riverbank, will not impede water flow and will not adversely alter the waterway. The proposed forcemain replacement will follow a vertical alignment that is at significantly lower risk to bank movements, particularly on the east side, than the existing vertical profile. Therefore, KGS Group recommends that a Waterways permit be granted.

7.0 LIMITATIONS

Geotechnical recommendations presented herein are based on findings in six testholes, previous available information and site observations. Geologic conditions are innately variable. Glacial deposits in particular are seldom spatially uniform. Information on subsurface stratigraphy is available only at discrete testhole locations and will vary elsewhere.

If conditions other than those reported are noted, KGS Group should be given the opportunity to review current recommendations. The recommendations presented herein may not be valid if an adequate level of monitoring is not provided during construction, or if relevant building code requirements are not met. This report does not include any recommendations related to contaminants in soil or groundwater. Environmental issues are not included in this scope of work.

This report has been prepared for the exclusive use of the City of Winnipeg for specific application to the proposed directionally drilled sewer pipe replacement. KGS Group makes no representations to any party with whom KGS Group has not entered into a contract. This report has been prepared in accordance with generally accepted soil and foundation engineering practices. No other warranty is made, either expressed or implied.

TABLES

ELEVATION (m) (ft)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE NUMBER	RECOVERY %	SPT (N) blows/0.30 m ▲	Cu TORVANE (kPa) ◆		
									PL	MC	LL
								20 40 60	20 40 60 80	20 40 60 80	
20	35		- Firm at 10.67 m.								
11	40					8					
12	45					9					
13	50		- Trace 1-2 mm ø silt nodules, trace fine grained angular gravel, between 14.94 and 15.24 m.			10					
14	55		- Soft at 16.5 m.			11					
15	60		- End of solid stem auger hole at 18.35 m on Jan 6/04. - Set casing to 18.59 m. - Begin HQ Coring from 18.35 m on Jan 8/04. - Limestone cobble at 18.35 m. - Tan, damp, very dense, low plasticity, trace gravel (to 25 mm ø), trace cobbles (-) at 18.48 m. - Poor recovery, good circulation. - Limestone cobble at 19.51 m.			12					
16	65		- Granitic cobble at 20.57 m. - Limestone cobble at 20.65 m.			13					
17	70		- Granitic cobble at 21.34 m. - Limestone cobble at 21.54 m.			1					
18						2					

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.30 m ▲	Cu TORVANE (kPa) ◆		
										PL	MC	LL
									20 40 60	20 40 60 80		
22.0			- Limestone boulder at 22.40 m.		22.0		3					
23.0	75		- Coarse grained, numerous granitic (10%) and limestone pebbles to 0.08 mm ø, minimal recovery, fine grained sand visible in drill fluid.		23.0							
23.3					23.3							
24.0			- Loss of circulation. Advance casing to 24.8 m.									
24.8												
26.1	80		LIMESTONE (BEDROCK) - Solid buff limestone core, very strong.				4					
25.0			- Distinct sedimentation planes with vug holes at 25.15 m.				5					
26.0	85						6					
27.0			- White, massive at 27.0 m.				7					
27.56	90		END OF HOLE AT 27.56 m		27.6							
28.0			Notes: 1. Installed Casagrande standpipe at 23.32 m depth. Pipe consists of 25 mm diameter PVC with response zone from 22.05 to 27.56 m depth. 2. Lockable protective steel casing installed at ground surface. 3. Groundwater depth at 7.92 m below ground surface on January 11, 2004.									

ENT CITY OF WINNIPEG
PROJECT MONTCALM FORCE MAIN REPLACEMENT
SITE MONTCALM FORCE MAIN
LOCATION RUE ARCHIBALD, EAST BANK NEAR RIVER
DRILLING METHOD 150 mm ø Solid Stem Auger, Nodwell and HQ Coring

JOB NO. 03-107-17
GROUND ELEV. 226.40 m
WATER ELEV. 222.30 m (8-Jan-04)
DATE DRILLED 6-7-Jan-04

ELEVATION m (ft)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.30 m ▲	Cu TORVANE (kPa) ◆			
									20	40	60	80
226.2	0		TOPSOIL - Organics, frozen to 0.3 m.									
226	0.3		CLAY (LACUSTRINE) (CH) Mottled grey-brown, moist, firm, high plasticity, silt striations, trace fine grained sand.									
225	1		- With some fine grained sand at 2.13 m.			1						
224	2					2						
223	3					3						
222	4		- Sandy (fine grained) with trace free water at 4.88 m.			4						
221	5					5						
220	6		- Grey, wet at 7.01 m.			6						
219	7					7						
218	8		- Light brown, 0.2 m silty lens with fine grained sand at 8.53 m.			8						
217	9					9						
216	10		- Brown, till inclusions at 9.75 m.			10						
215	11					11						
214	12					12						
213	13		- Occasional pebble to 19 mm ø at 13.11 m.			13						
212.4	14		CLAY-SILT (TILL) (CL-ML) Tan, damp, low plasticity, dense, trace gravel.			14						
212	15					15						
211	16		- End of solid stem auger at 15.24 m. - Set casing to 15.2 m. - Begin HQ coring at 15.7 m.		15.8	16						
210	17		- Cobbly, bouldery, very dense at 16.5 m.			17						

SPT & TORVANE PL
 CTS1200303FBED-119E010GSG03-107-17.GPJ

SAMPLE TYPE Auger Grab Split Spoon Select Core Barrel

CONTRACTOR Paddock Drilling Ltd. INSPECTOR G.E. HARRISON

APPROVED *g6m* DATE 22/01/04

ELEVATION m ()	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.30 m ▲	Cu TORVANE (kPa) ◆			
									PL	MC	LL	
209	17		- 360 mm ø boulder at 16.8 m, begin HQ Coring at 17.1 m. - Poor recovery, good circulation.		17.5							
208	18		- Recovered very dense granite cobble (150 mm ø), numerous granitic and limestone gravel sizes (<75 mm ø) at 17.98 m. Fines may have been washed out during coring. Sand visible in return cuttings.		17.8							
207	19					12						
206.4	20		LIMESTONE (BEDROCK) Core (0.13 m length) of buff limestone, very vuggy, very strong. - Buff to white, massive at 20.12 m.			13						
205	21					14						
204	22					14						
203.2	23		- 0.31 m of insitu vertical fracture planes at 22.56 m.		23.2	15						
203	23		END OF HOLE AT 23.16 m									
202	24		Notes: 1. Installed Casagrande standpipe at 17.83 m depth. Pipe consists of 25 mm diameter PVC with response zone from 15.85 to 23.16 m depth. 2. Lockable protective steel casing installed at ground surface. 3. Groundwater depth at 4.1 m below ground surface on January 8, 2004.									
201	25											
200	26											
199	27											
198	28											
197	29											
196	30											
195	31											
194	32											
193	33											
192	34											
191	35											
190	36											

SPT & TORVANE P:\PROJ\FACTS\2003\03\FBED-1\GEOLOGS\03-107-17.GPJ

SAMPLE TYPE Auger Grab Split Spoon Select Core Barrel

CONTRACTOR **Paddock Drilling Ltd.** INSPECTOR **G.E. HARRISON**

APPROVED *JGM* DATE 22/01/04

CLIENT **CITY OF WINNIPEG**
 PROJECT **MONTCALM FORCE MAIN REPLACEMENT**
 SITE **MONTCALM FORCE MAIN**
 LOCATION **WEST BANK NEAREST RIVER**
 DRILLING METHOD **150 mm ø Solid Stem Auger, Nodwell and HQ Coring**

JOB NO. **03-107-17**
 GROUND ELEV. **229.10 m**
 WATER ELEV. **222.73 m (13-Jan-04)**
 DATE DRILLED **6-Jan-04, 12-13-Jan-04**

ELEVATION m (ft)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.30 m ▲	Cu TORVANE (kPa) ◆			
									PL	MC	LL	
								20 40 60	20 40 60 80			
229			SAND (ALLUVIUM, POINT BAR) (SM) Brown, frozen to moist, compact, low to intermediate plasticity, silty.									
228	1					1						
227	2					2						
226	3		- Loose, non plastic, poorly graded, some clay at 3.05 m.									
225	4					3						
224	5		- Soft, low plasticity, gradual increase in clay content with depth, trace oxidation at 4.57 m.									
223	6					4						
222	7		- Water seepage at 6.71 m.									
221	8					5						
220	9		- Grey, wet, soft, low plasticity, with clay at 7.62 m.									
			SILT (ML) - Grey, wet, compact, low plasticity, clayey, trace sand, trace shells.			6						

SPT & TORVANE PIPE
 152000103FBED-11CEIOLG03-107-17-SPJ



SAMPLE TYPE Auger Grab Select Core Barrel

CONTRACTOR **Paddock Drilling Ltd.** INSPECTOR **J. CHING / G.E. HARRISON**


APPROVED *JGM* DATE **22/01/04**

ELEVATION m (m) (ft)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.30 m ▲	Cu TORVANE (kPa) ◆		
									PL	MC	LL
								20 40 60	20 40 60 80	20 40 60 80	20 40 60 80
219	35					7					
218	11					8					
217	12										
216	13		- With fine grained angular gravel, trace shells below 13.11 m.								
215.4	45		CLAY (LACUSTRINE) (CH) Grey, saturated, soft to firm, high plasticity, trace 5 mm ø silt nodules, trace angular gravel (-).			9					
215	14										
214	15		SILT (TILL) (ML) - Tan, dense, low plasticity, some fine to coarse grained angular gravel.			10					
213.9	50										
213	16										
212	17		- Damp, stiff to very stiff, low plasticity, pebbles to 50.8 mm ø (10% granitic) at 16.76 m. - End of solid stem auger hole at 16.8 m on Jan 6/04. Set casing to 17.37 m. - Begin HQ wireline coring from 16.76 m on Jan 12/04. - Poor recovery, good circulation. - Buff limestone cobble at 17.78 m.			11					
211	18		- Buff limestone cobble at 18.17 m.								
210	19										
209	20										
208	21		- Poor recovery, predominantly gravel sizes from 21.34 to 21.77 m. - Fine grained sand recirculating.								
	70										

SPT & TORVANE P/PI

SAMPLE TYPE  Auger Grab  Select Core Barrel

CONTRACTOR **Paddock Drilling Ltd.** INSPECTOR **J. CHING / G.E. HARRISON**

APPROVED  DATE **22/01/04**

ELEVATION m (ft)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.30 m ▲	Cu TORVANE (kPa) ◆		
										PL	MC	LL
									20 40 60	20 40 60 80		
207	22		- Grey granitic cobble at 21.77 m. - Minimal recovery, predominantly pebbles to 76.2 mm ø from 21.95 to 22.40 m. - Fine grained sand recirculating.		22.0							
206	23		- Light grey, very stiff, pebbles to 50.8 mm ø (20% granitic) at 22.94 m. - Minimal recovery, gravel recovered (20% granitic) from 23.34 to 24.49 m. - Fine grained sand recirculating.				4					
204.5	24.5		- Grey granitic cobble at 24.52 m.		24.6							
204	25		LIMESTONE (BEDROCK) - Buff, solid, vuggy at interface, medium strong.		24.9							
203	26		- White, massive at 25.96 m.				5					
202	27		END OF HOLE AT 26.59 m ON JAN 12/04		26.6		6					
201	28		Notes: 1. Installed Casagrande standpipe at 24.89 m depth. Pipe consists of 25 mm diameter PVC with response zone from 21.95 to 26.59 m depth. 2. Lockable protective steel casing installed at ground surface. 3. Groundwater depth at 6.37 m below ground surface upon completion on January 13, 2004. Groundwater depth at 6.67 m on January 14/04.									
197	32											
198	31											
199	30											
200	29											
201	28											
202	27											
203	26											
204	25											
204.5	24.5											
206	23											
207	22											

SPT & TORVANE P/PRC - CTST200303FEBD-11GEOLGGS03-107-17.GPJ

SAMPLE TYPE Auger Grab Select Core Barrel

CONTRACTOR **Paddock Drilling Ltd.** INSPECTOR **J. CHING / G.E. HARRISON**

APPROVED 96m DATE 22/01/04

ELEVATION m	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.30 m ▲	Cu TORVANE (kPa) ◆									
									20	40	60	20	40	60	80			
219																		
218.4	11		CLAY (LACUSTRINE) (CH) Grey, saturated, soft, high plasticity. One piece of subrounded white gravel (13 mm ø) at 10.97 m.			10	72	▲ 4										
217	12		- 25 mm ø piece of white gravel at 12.50 m. - Hole appears to be squeezing.			11	133	▲ 4										
216	13																	
215	14					12	156	▲ 4										
214	15																	
213	16					13	133	▲ 3										
212.3	17		SILT (TILL) (ML)- Light brown, saturated, very dense, trace angular gravel, trace sand. - Harder to drill.			14	63	▲ 3										
212			- HQ core set in HWT casing, viscosifier drilling fluid at 17.22 m. - Run 1 Recovered (17.22 to 17.45 m): Granitic boulder, light brown, damp, hard, low plasticity, trace clay, trace angular gravel, trace cobbles, no joints/massive. Tight and not saturated.			R1	92											
211	18					NR												
210	19		- Run 2 Recovered (18.75 to 19.20 m): No pressure increase, no blockage during drilling, likely missing 1.07 m. Atterberg Limits test result at 19.1 m: - Liquid Limit 14% - Plastic Limit 11%			R2	30											
209	20					NR												
208	21		- Run 3 (20.27 to 21.34 m): Disturbed core, till, washed out gravel, one cobble. Core just fell out of barrel, sound top of barrel, not latched, sitting of core from Run 2. Pull drill rods and core barrel, 75 mm piece of granite was jammed preventing core barrel from latching.			R3	29											
						NR												
			- Run 4 Recovered (21.34 to 22.25 m): Recovered 0.10 m granite, 0.05 m till. Circulation has been very good.			R4	17											

SPT & TORVANE PAIP
YTS0203103FBED-1GEOLOGS03-107-17.GPJ

SAMPLE TYPE Auger Grab Split Spoon Core Barrel

CONTRACTOR
Paddock Drilling Ltd.

INSPECTOR
J. McKAY

APPROVED DATE **22/01/04**

ELEVATION m (ft)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.30 m ▲	Cu TORVANE (kPa) ◆			
									PL	MC	LL	
22												
207			- Run 5 Recovered (22.25 to 25.76 m): Includes 0.20 m light brown clay till, 0.75 m grey clay till, 0.08 m cobbles, 0.10 m light brown silt till.		22.9	R5	17					
23	75		- Driller says he is in silt till and mostly washing away. Circulation is still good. Hole staying open. Poor recovery. Description estimated from minimal returns and drilling characteristics.									
206												
24												
205	80											
25												
204												
26	85		- Run 6 Recovered (25.76 to 26.82 m): 0.30 m recovery, several cobbles, 0.08 m of hard silt till. Circulation is still good.		26.2	R6	29					
203					26.5							
202.3			- Run 7 Recovered (26.90 to 27.10 m): Washed gravel from silt till (bedrock keeps in barrel).									
202	90		LIMESTONE (BEDROCK) - Very light brownish grey, very strong.									
			- Run 8 Recovered (27.23 to 28.80 m): Joints 75-300 mm spacing, rough, irregular, horizontal. RQD = 95%									
			- Slightly weathered on joint surfaces to 27.53 m.									
201												
200.6					28.8							
29	95		END OF HOLE AT 28.8 m									
200			Notes: 1. Installed Casagrande standpipe at 26.52 m depth. Response zone from 22.9 to 28.8 m depth. 2. Lockable protective steel casing installed at ground surface. 3. Groundwater at 7.78 m depth upon completion.									
199	100											
198												
197	105											
196	110											

SPT & TORVANE P-11 CTS12003103F-BED-1GEOLOG03-107-17-GPJ

SAMPLE TYPE Auger Grab Split Spoon Core Barrel

CONTRACTOR **Paddock Drilling Ltd.** INSPECTOR **J. McKAY**

APPROVED *JGM* DATE 22/01/04

CLIENT CITY OF WINNIPEG
 PROJECT MONTCALM FORCE MAIN REPLACEMENT
 SITE MONTCALM FORCE MAIN
 LOCATION CENTRE OF RIVER
 DRILLING METHOD Ranger Coring

JOB NO. 03-107-17
 GROUND ELEV. 213.70 m
 WATER ELEV.
 DATE DRILLED 04 Jan 15

ELEVATION m (ft)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.30 m ▲	Cu TORVANE (kPa) ◆		
							PL	MC	LL
						20 40 60	20 40 60 80	20 40 60 80	%
213	1		SOFT SOIL						
			- Trace gravel below 0.81 m. - No Recovery. - 0.46 m of ice. Ice elevation 221.4 m. - Bottom of river is 7.72 m from top of ice. The above descriptions are based on driller's input.						
212.1 212	5		SILT (TILL) - Brown, moist, low plasticity, with fine to coarse grained angular gravel, some fine to coarse grained sand. - Trace to some cobbles at 1.78 m. - Full core runs shown on right. Recovery not recorded.	1					140 Fbr 76 mm
211	2			2					
			- Some to with cobbles at 3.25 m.						
210	3			3					
209	4			4					
208	5			5					
207	6			6					
206 205.9	7			7					
204.3	8		LIMESTONE BEDROCK	8					
204	9			9					
			END OF HOLE AT 9.40 m						

TS2003103FBED-1GEOLOSS103-107-17.GPJ
SPT & TORVANE PIP

SAMPLE TYPE Core Barrel Split Spoon

CONTRACTOR Paddock Drilling Ltd. INSPECTOR J. CHING

APPROVED *JGM* DATE 22/01/04

CLIENT **CITY OF WINNIPEG**
 PROJECT **MONTCALM FORCE MAIN REPLACEMENT**
 SITE **MONTCALM FORCE MAIN**
 LOCATION **EAST TOP OF BANK AT SHAFT**
 DRILLING METHOD **150 mm ø Solid Stem Auger, Acker MP5-T**

JOB NO. **03-107-17**
 GROUND ELEV. **230.40 m**
 WATER ELEV.
 DATE DRILLED **04 Jan 16**

ELEVATION m (ft)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.30 m ▲	Cu TORVANE (kPa) ◆		
							PL	MC	LL
						20 40 60	20 40 60 80	20 40 60 80	20 40 60 80
230.3			GRAVEL FILL						
230			CLAY (FILL) (CH) - Brown, moist, stiff, high plasticity, trace organics, trace coarse grained gravel, trace silt.						
229.5	1		CLAY (LACUSTRINE) (CH) - Brown, moist, stiff, trace to some fine to coarse grained sand, trace fine grained gravel (-), trace oxidation.	1	100				
229	5								
228	2		- Firm at 2.25 m.	2	100				
227	10								
226	15		- Grey, wet at 4.57 m.	3	100				
225	20								
224	25		- Trace 1-2 mm ø silt nodules at 7.62 m. - Water seepage at 7.62 m.	4	100				
223	25								
222	30		- Increased silt nodules (3-5 mm ø) at 9.14 m.	5	100				
221	30			6	100				

SPT & TORVANE P/IPS
 'S1200303FBED-1\GEOLOGS103-107-17.GPJ

SAMPLE TYPE Auger Grab Split Spoon

CONTRACTOR **Paddock Drilling Ltd.** INSPECTOR **J. CHING**

APPROVED *JCM* DATE **22/01/04**

ELEVATION m (ft)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.30 m ▲	Cu TORVANE (kPa) ◆			
							PL %	MC %	LL %	
220	35			7	100		45	55	75	
219	40				8	100		50	65	80
218	45				9	100		55	70	85
217	50				10	100		60	75	90
216	55				11	100		65	80	95
215	55				12	100		70	85	100
214	55				13	100		75	90	105
213.0	55				14	100		80	95	110
213	55				15	100		85	100	115
212	60				16	100		90	105	120
211.7	60				17	100		95	110	125
211	65				18	100		100	115	130
210	70				19	100		105	120	135
209	70				20	100		110	125	140

- Soft at 13.72 m.

CLAY (TILL) - Grey, moist, soft, trace to some fine to coarse grained gravel, trace fine grained sand.

SILT (TILL) - Brown, moist, compact, non plastic, some fine to coarse grained angular gravel, trace fine grained sand.

END OF HOLE AT 18.69 m

185
For 0.25 m

SPT & TORVANE P/PA "S12003103FBED-11GEOLOGS103-107-17-GP-J

SAMPLE TYPE Auger Grab Split Spoon

CONTRACTOR Paddock Drilling Ltd. INSPECTOR J. CHING

APPROVED *Jgm* DATE 22/01/04

APPENDIX A
TEST HOLE LOGS

CLIENT CITY OF WINNIPEG
 PROJECT MONTCALM FORCE MAIN REPLACEMENT
 LOCATION MONTCALM FORCE MAIN

JOB NO. 03-107-17
 DATE DRILLED 6-13-Jan-04

GRAPHICS	DESCRIPTION	SAMPLE TYPE	NUMBER	Cu from Unconfined Comp. Test (kPa) \diamond
				Cu TORVANE (kPa) \blacklozenge
				PL MC LL ----- % - kPa 20 40 60 80
SOIL DESCRIPTION				
	TOPSOIL			
	SAND AND GRAVEL FILL			
	GRAVEL FILL			
	CLAY FILL			
	SAND			
	SILT			
	CLAY			
	CLAY (LACUSTRINE)			
	CLAY TILL			
	SILT TILL			
	LIMESTONE BEDROCK			

SAMPLE TYPE AUGER GRAB SHELBY SPLIT SPOON SPLIT BARREL

CONTRACTOR _____ INSPECTOR _____ APPROVED _____ DATE 22/01/04

PRINCIPAL AND MINOR SOIL COMPONENTS

And	35 - 50%
With	20 - 35%
Some	10 - 20%
Trace	0 - 10%
Occasional	Trace of very local concentration

FIELD MOISTURE CONTENT

Dry	No moisture visible or to touch when fresh exposure is examined
Damp	Slightly wet to touch
Moist	Fresh exposure wet to touch
Wet	A film of water is readily visible around particles of granular soils, cohesive soils can readily be smeared or remolded; water can be squeezed out
Saturated	Water can easily be squeezed out
Free Water	Water completely separated from the soil particles

DEPOSITIONAL STRUCTURE

Massive	Structureless soil
Stratified (Layered)	Different soils or visible variations in soil constituents arranged in layers, generally but not necessarily parallel to one another, and not necessarily in horizontal position, at least 6 mm thick
Varved	Glaciolacustrine deposits with annual pairs of fine and coarser laminae (thin laminae of alternately deposited inorganic silt and clay)
Laminated	Closely spaced, regularly alternating layers of differing soils and/or colours, or shades of similar gradation, relatively consistent in thickness and consisting of sand, silt, or clay
Lens	Inclusions of a different soil within surrounding soils, which thins out horizontally and may not be continuous over any significant distance
Pocket	A different soil type of very limited thickness or lateral extent (a small lens)
Inclusions	Small pockets
Anggetying	A different soil type in the form of small lumps Paper thin separation of one type by another

POST DEPOSITIONAL STRUCTURE

Fissured	A soil breaks along definite, pre-existing planes or fracture with little resistance to fracturing
Slickensided	Polished or glossy, sometimes striated surfaces resulting from movement of a material block relative to the adjacent blocks
Blocky/Friable/Platy	Cohesive soil that can be broken down into angular larger fragments (blocky), small fragments (friable), or thin plate-like fragments (platy) which resist further breakdown
Cemented	Soil particles or fragments held together by cemented materials, often chemical precipitants, or deposits within overall soil mass

GRAIN SIZE DISTRIBUTION IN COARSE GRAINED SOIL

Boulders	>200 mm ϕ
Cobbles	75 - 200 mm ϕ
Coarse Grained Gravel	19 - 75 mm ϕ
Fine Grained Gravel	4.75 - 19 mm ϕ
Coarse Grained Sand	2 - 4.75 mm ϕ
Medium Grained Sand	0.425 - 2 mm ϕ
Fine Grained Sand	0.075 - 0.425 mm ϕ

DENSITY OF GRANULAR SOIL

Description	Standard Penetration Test	Relative Density
Very Loose	0 - 4 Blows Per 0.3 m	<15%
Loose	4 - 10 Blows Per 0.3 m	15 - 35%
Compact	10 - 30 Blows Per 0.3 m	35 - 65%
Dense	30 - 50 Blows Per 0.3 m	65 - 85%
Very Dense	>50 Blows Per 0.3 m	>85%

CONSISTENCY OF COHESIVE SOILS

Description	Torvane	Standard Penetration Test
Very Soft	<12 kPa	<2
Soft	12 - 25 kPa	2 - 4
Firm	25 - 50 kPa	4 - 8
Stiff	50 - 100 kPa	8 - 15
Very Stiff	100 - 200 kPa	15 - 30
Hard	>200 kPa	>30

CLIENT CITY OF WINNIPEG
 PROJECT MONTCALM FORCE MAIN REPLACEMENT
 SITE MONTCALM FORCE MAIN
 LOCATION RUE ARCHIBALD, EAST TOP OF BANK
 DRILLING METHOD 150 mm ø Solid Stem Auger, Nodwell and HQ Coring

JOB NO. 03-107-17
 GROUND ELEV. 230.40 m
 WATER ELEV. 222.48 m (9-Jan-04)
 DATE DRILLED 6-Jan-04, 8-9-Jan-04

ELEVATION m (ft)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.30 m ▲	Cu TORVANE (kPa) ◆		
									PL	MC	LL
								20 40 60	20 40 60 80	20 40 60 80	20 40 60 80
230.3			GRAVEL (FILL)- Crushed limestone.								
230			CLAY (FILL)- Brown, frozen to moist, stiff, high plasticity, trace fine grained sand. - Frozen to 0.6 m.								
229	1					1					
228.1	2		CLAY (LAGUSTRINE) (CH) Brown, moist, stiff, high plasticity, silty.			2					
228											
227	3		- Silt layer from 3.35 to 3.66 m. - Increased silt content, trace 2-3 mm ø silt nodules, trace oxidation below 3.35 m.			4					
226	4					3					
225	5										
224	6					5					
223	7		- Increased moisture content, soft, high plasticity between 7.32 to 7.62 m.			6					
222	8										
221	9		- Increased moisture content, decreased silt nodules between 8.84 to 9.14 m. - Grey, saturated at 9.14 m.			7					

SPT & TORVANE F-VP/ TSL200303FBED-1(GEOL)GSI03-107-17, 99-J

SAMPLE TYPE Auger Grab Split Spoon Select Core Barrel

CONTRACTOR Paddock Drilling Ltd. INSPECTOR J. CHING / G.E. HARRISON

APPROVED *JGM* DATE 22/01/04

**TABLE 1
TESTHOLE SUMMARY AND GROUNDWATER READINGS
MONTCALM FORCE MAIN CROSSING**

meters

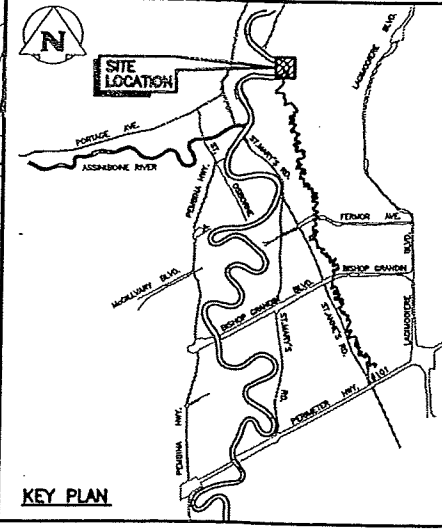
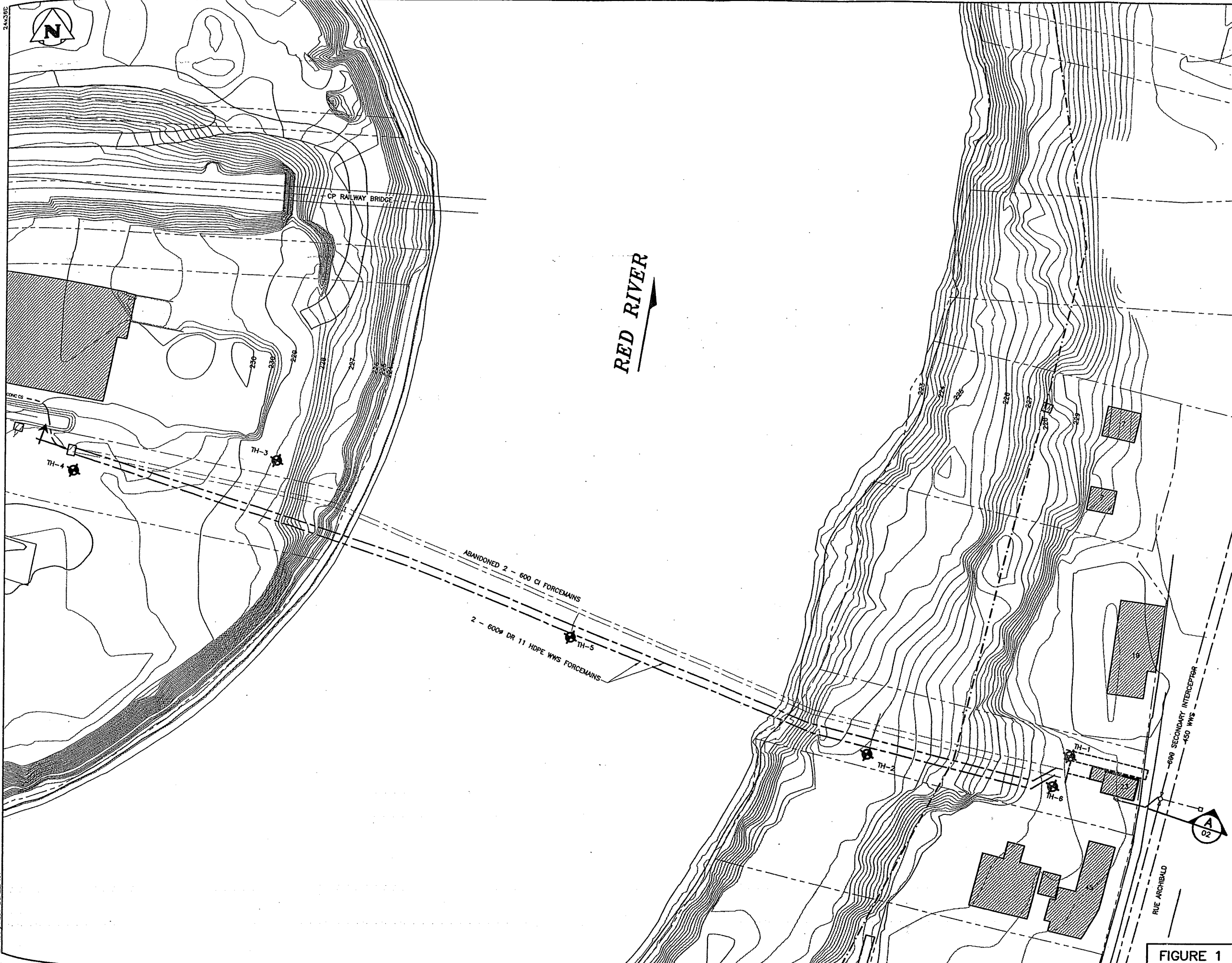
Bore Hole	Elev. Geodetic Ground	UTM North	UTM East	Depth End of Fill	Thickness Alluvium	Thickness Lacustrine Clay	Depth Top of Till	Elev. Top of Till	Thickness Till	Depth Top of Bedrock	Elev. Top of Bedrock	Depth End of Hole	Piezometer Response Zone		Depth GWL	Elev. GWL	Date GWL	Comments	
													Top	Bottom					
1	230.4	5529380.2	635928.9	2.3		14.5	16.8	213.6	7.7	24.5	205.9	27.6	208.4	202.8	7.92	222.5	9-Jan-04	east side top of bank	
															8.00	222.4	16-Jan-04		
6	230.4	5529372.0	635924.6	3.1		13.4	16.5	213.9				18.7							east top of bank @ shaft
2	226.4	5529380.6	635873.1			14.0	14.0	212.4	6.0	20.0	206.4	23.2	210.6	203.3	3.91	222.5	16-Jan-04	east side nearest river	
3	229.1	5529461.0	635708.7		13.7	1.5	15.2	213.9	9.4	24.6	204.5	26.6	207.1	202.5	6.37	222.7	13-Jan-04	west side nearest river	
															6.63	222.5			
4	229.4	5529458.4	635652.3	0.3	10.7	5.7	16.5	213.0	10.6	27.1	202.3	28.8	206.6	200.6	7.78	221.6	14-Jan-04	west side top of bank	
															7.00	222.4	16-Jan-04		
5	213.7	5529412.5	635790.6		1.6		1.6	212.1	6.2	7.8	205.9	9.4							depths from bottom of river

River elevation 221.41 m on January 12, 2004
River elevation 223.79 m on June 2, 2003
@ James Avenue

This table is a simplified summary.
Please refer to the testhole logs for complete details.
Geodetic elevation and UTM coordinates from City of Winnipeg survey.
GWL- groundwater level
Units of meters

PROPERTY
OF THE
WATER & WASTE DEPARTMENT
RESOURCE CENTRE
1500 PLESSIS ROAD

FIGURES



- LEGEND**
- PROPERTY LINE
 - 230 — GEODETIC CONTOUR (m)
 - ⊛ TESTHOLE
 - ▨ EXISTING BUILDING

NOTES

TOPOGRAPHIC MAP BASED ON 1999 DIGITAL-ORTHO BASE MAPPING FROM 1998 AIR PHOTOS SUPPLIED BY THE CITY OF WINNIPEG.

0 10 20 30 40 50m

SCALE: 1:500 METRIC 24"x36"
1:1000 METRIC 11"x17"

NO.	D / M / Y	DESCRIPTION	BY
1	29/01/04	ISSUED FOR WATERWAYS PERMIT	JMc
0	19/01/04	ISSUED FOR INFORMATION	JMc

REVISIONS / ISSUE

A	B	A
SECTION LETTER OR DETAIL NUMBER IS DRAWN	OR	SECTION LETTER OR DETAIL NUMBER IS DRAWN
DRAWING WHERE SECTION OR DETAIL WAS INDICATED	OR	DRAWING WHERE SECTION OR DETAIL WAS INDICATED
SECTION OR DETAIL SHOWN ON SAME DRAWING		SECTION OR DETAIL SHOWN ON SAME DRAWING

KGS GROUP CONSULTING ENGINEERS & PROJECT MANAGERS
 WINNIPEG (204) 896-1208
 THUNDER BAY (807) 345-2233

CLIENT: **CITY OF WINNIPEG**
 WATERWORKS WASTE AND DISPOSAL DEPARTMENT

PROJECT: **MONTCALM FORCEMAIN GEOTECHNICAL EVALUATION**

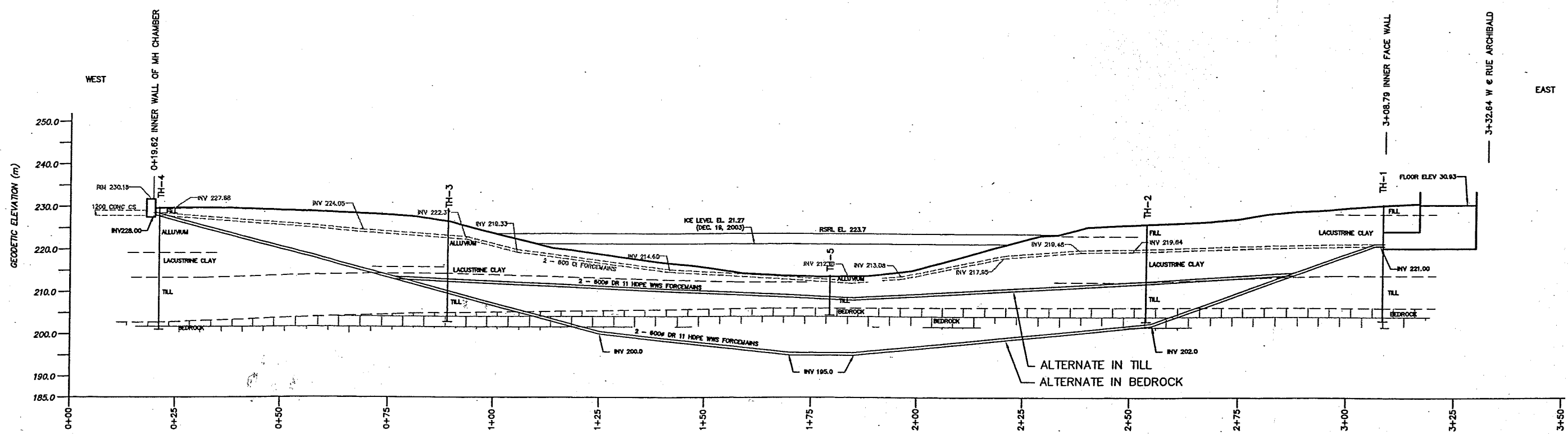
DWG. DESCRIPTION: **FORCEMAIN SITE PLAN SHOWING TESTHOLE LOCATIONS**

DWG. STAMP	DESIGNED BY: JMc	DRAWN BY: TE
	CHECKED: RKe	CHECKED:
	SCALE: AS NOTED	DATE: JANUARY 2004
	KGS DWG. NO.: 03-0107-17 01	
CLIENT DWG. NO.:	REV: 1	

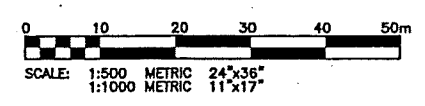
FIGURE 1

KGS FILE NO.: P:\Projects\2003\03-0107-17\Gen\Drawings\Revision\1\03-0107-17-01 Rev1.dwg
 25.000 (2500) SCALE: 1:1

24-36B



SECTION (LOOKING DOWNSTREAM)



1	29/01/04	ISSUED FOR WATERWAYS PERMIT	JMc
0	19/01/04	ISSUED FOR INFORMATION	JMc
NO.	D / M / Y	DESCRIPTION	BY
REVISIONS / ISSUE			
A. SECTION LETTER OR DETAIL NUMBER B. DRAWING WHERE SECTION OR DETAIL IS DRAWN OR DRAWING WHERE SECTION OR DETAIL WAS INDICATED — SECTION OR DETAIL SHOWN ON SAME DRAWING			
(A) (B)			(A) (—)
KGS GROUP CONSULTING ENGINEERS & PROJECT MANAGERS WINNIPEG (204) 896-1209 THUNDER BAY (807) 345-2233			
CLIENT: CITY OF WINNIPEG WATERWORKS WASTE AND DISPOSAL DEPARTMENT			
PROJECT: MONTCALM FORCEMAIN GEOTECHNICAL EVALUATION			
ORG. DESCRIPTION: FORCEMAIN CROSS SECTION			
DESIGNED BY: JMc CHECKED BY: TE	DRAWN BY: TE CHECKED BY:		
APPROVED:			
SCALE: AS NOTED		DATE: JANUARY 2004	
KGS ORG. NO. 03-0107-17 02			
CLIENT ORG. NO.			REV: 1

FIGURE 2 1