AECOM

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Memorandum

To	Asnee Pochanart	Page	1
CC	Ed Mayuga, Barry Biswanger		
Subject	GWWD / Aqueduct Crossing Foundation of Permanent Aqueduct Bridging Structure		
From	Omer Eissa		
Date	April 11, 2011	Project Number	60196984 (403.19)

1. Introduction

City of Winnipeg is planning the construction of a new bridging structure at the GWWD track / Aqueduct crossing. The site is located to the west of PR207/Aqueduct crossing in the vicinity of Deacon WTP. This memorandum discusses the subsurface conditions at the site and the feasible foundation alternatives. The discussions and the recommendations provided in this memorandum are based on existing information compiled from geotechnical investigations previously conducted by AECOM (then UMA I AECOM) in the period between August 2005 and January 2006 . No dedicated field investigation was undertaken for this project.

2. Subsurface Conditions (Based on Previous Investigations)

Five test holes (TH05-55 to 05-59) were drilled at locations in the vicinity of the proposed aqueduct crossing over the period between August 12th to 22nd, 2005 and January 18th, 2006. The approximate location of the test holes is shown on Figure 01. Table 01 provides additional information related to the test holes including the depth of the exploration. Three test holes (TH05-55 to 05-57) were drilled by Maple Leaf Drilling Ltd. using a truck mounted DR-150 rig equipped with 125 mm diameter solid stem augers. Two test holes (TH05-58 and 05-59) were drilled by Paddock Drilling Ltd. using an Acker SS drilling rig equipped with 125 mm solid stem augers. Three of the test holes (TH05-55, TH05-58 and TH05-59) were advanced to auger refusal in the till unit and two test holes (TH05-56 and TH05-57) were terminated at 3.0 m.

Table 01: Summary of the 2005/ 2006 Test Holes

Test Hole #	Diameter (mm)	Termination Depth (m)	Termination Elevation (m)	Termination Condition
TH05-55	125	21.8	215.8	Refusal
TH05-56	125	3.0	233.7	Pre-determined
TH05-57	125	3.0	234.1	Pre-determined
TH05-58	125	20.7	216.9	Refusal
TH10-59	125	19.5	218.1	Refusal

The general soil profile in descending order is:

- Fill
- Glaciolacustrine Clay
- Till

These soil units are described separately as follows:

2.1.1 Fill

A layer of fill was encountered in all test holes and extends from the ground surface to a depth ranging from 1.5 (TH05-56) to 2.7 m (TH05-58). Clay fill was encountered in TH05-55, TH05-58 and TH05-59. Granular fill (gravel road structure) was encountered in TH05-55 and TH05-56.

2.1.2 Clay

Glaciolacustrine clay was encountered beneath the fill and extends to the depth of exploration in the shallow test holes and to a depth range from 17.4 to 18.5 meters in the deep test holes.

Generally, the clay is silty, moist, soft to firm, and of high plasticity. The moisture contents ranged from 30 to 55 percent.

2.1.3 Till

Till was encountered in all three deep test holes (TH05-55, TH05-58 and TH05-59) that were advanced to power auger refusal . The till was encountered at depths ranging from 17.4 to 18.5 m below the ground surface. The till is generally a heterogenous mix of sand, gravel, cobbles and boulders in a silt matrix. The upper 0.8 to 1.5 m of the till was very soft. Power auger refusal was encountered in the till at depths ranging from 19.5 to 21.8 meters or corresponding elevations 218.1 to 215.8 meters.

3. Foundation Recommendations

3.1 Driven Prestressed Precast Concrete (PPC) Piles

Driven PPC piles can be used to support the proposed structure. PPC piles should be driven to practical refusal into the dense glacial till or on the underlying bedrock. Provided that a hammer with a rated energy of at least 40 kJ per blow is utilized, the piles may be assigned the conventional capacities shown in Table 02. These pile capacities are based on a series of studies and load tests and have been successfully used in the Winnipeg area for several decades.

Table 02: Driven PPC Piles – Allowable Pile Capacity

Pile Diameter (mm)	Maximum Allowable Capacity (kN)	Final Refusal (blows/25 mm)
300	450	6
350	625	8
400	800	12

Final set criteria for driven PPC piles shall be taken as three consecutive sets as defined in the table above. PPC piles driven to set into the till will develop the majority of their capacity from toe resistance, and therefore, no reduction in pile capacity is necessary for reasons related to group action. The design capacity of a pile group can be taken as the number of piles in the group multiplied by the allowable capacity per pile.

Based on past experience, the depth to auger refusal is roughly corresponding to the depth at which the pile could set (pile tip), however an allowance for natural soil variability should be considered in determining the required pile length. The local manufacturers can provide pile lengths up to 22 m without splices which is close to the depth of auger refusal encountered in the test holes drilled in the vicinity of this site (i.e., 21.8 m). It is the local practice in Winnipeg area that the Contractor, based on experience and available geotechnical information, will determine and supply the required pile lengths to achieve the specified pile capacity/set.

It is prudent that the following measures are taken to protect the existing aqueduct form the potential adverse effect of pile driving operations:

1. The piles should be driven at a minimum lateral offset of 4.0 meters from the centreline of the aqueduct.

2. The piles should be pre-bored to a depth of 1.5 meters below the invert elevation of the existing aqueduct.

3. Use low energy level or low hammer stroke during the early stage of pile driving.

Further design and construction recommendations for driven PPC piles are summarized below:

- The weight of the embedded portion of the pile may be neglected in the design.
- The above allowable values pertain to soil resistance only. The pile cross sections must be designed to withstand the design loads and the driving forces during installation.
- Pile spacing should not be less than 2.5 pile diameters, measured center to center.
- Pre-boring may be use at all driven pile locations, to protect the aqueduct, enhance pile plumbness and alignment, and to reduce the effects of pile heave during driving of adjacent piles. The diameter of the auger should not exceed the nominal diameter of the pre-cast concrete pile.
- All piles should be driven continuously to the depth of refusal, once driving is initiated.
- All piles driven within 5 pile diameters should be monitored for heave and where heave is observed, the piles should be re-driven. Piles that are re-driven should be driven to the refusal criteria outlined above (i.e. re-drive piles for one full set).
- Any piles that are damaged, excessively out of plumb or refuse prematurely due to encountering boulders in the till may need to be replaced, pending a review of their load carrying capacity and expected settlement by the structural and the geotechnical engineer.
- Where a steel follower is used to install the piles below ground surface, the set criteria may need to be adjusted to account for additional energy losses through the use of the follower. Adjustments to the set criteria should be determined by a qualified geotechnical engineer based on the site conditions, installation procedure and pile driving equipment.
- The driving of all piles should be documented by competent and knowledgeable geotechnical personnel.

- PDA testing is recommended to confirm efficiency of driving system, assess driving stresses and evaluate pile capacity.
- Vibration monitoring may be required to assess driving induced vibration levels and assess potential impact on the existing facilities.

3.2 Cast in Place Concrete Friction Piles

Cast-in-place friction piles can be used to support lightly loaded structures. However, due to the encountered subsurface conditions, these piles may be impractical and not cost-effective at this site. Limited skin friction resistance are expected from the native clay due to the low undrained shear strength. Table 03 provides values for the allowable unit skin friction resistance. No skin friction resistance shall be accounted for the length of the pile within the fill or from the top 2.5 m of the pile shaft for the potential volume change of soil and frost action. Selection of the pile length should recognize the depth to till and the requirements to control groundwater and to protect against the potential of hydraulic fracture due to artesian condition in the till. The pile tip should be terminated at least 2 m above the clay / till contact (i.e., pile tip not deeper than Elv. 222.5 m) .

Table 03: Cast-in-Place Piles – Allowable Unit Skin Friction Resistance

Zone (Elev. in m)	Allowable Unit Skin Friction (kPa)
Above 232.5	0
232.5 – 222.5	15

Further design and construction recommendations for cast-in-place concrete frictions piles are summarized below:

- The contribution from end-bearing should be ignored.
- The piles should be spaced a minimum of three pile diameters, measured center to center.
- The weight of the embedded portion of the pile may be neglected in the design.
- All piles should be provided with adequate steel reinforcement.
- Concrete should be placed as soon as practical following the drilling of each pile.
- Seepage and sloughing can be expected in pile holes, particularly during wetter times of the year. As such, steel sleeves should be made available on site and utilized as required during construction to maintain the pile holes in a clean dry state.

3.3 Foundation Concrete

All concrete in contact with soils should be made using sulphate resistant cement (TYPE HS) in accordance with CSA-23.1-M2004.

Please contact the undersigned if you have any questions or require further clarifications.

Sincerely,

Prepared By:

Omer Eissa, B.Eng., E.I.T.
Engineer-In-Training

Reviewed By:

Faris Khalil, P.Eng., PMP, M.Sc.
Manager, Geotechnical Engineering

Attachments:
- Test Hole Location Plan
- Test Hole Log

AECOM Canada Ltd.

GENERAL STATEMENT

NORMAL VARIABILITY OF SUBSURFACE CONDITIONS

The scope of the investigation presented herein is limited to an investigation of the subsurface conditions as to suitability for the proposed project. This report has been prepared to aid in the evaluation of the site and to assist the engineer in the design of the facilities. Our description of the project represents our understanding of the significant aspects of the project relevant to the design and construction of earth work, foundations and similar. In the event of any changes in the basic design or location of the structures as outlined in this report or plan, we should be given the opportunity to review the changes and to modify or reaffirm in writing the conclusions and recommendations of this report.

The analysis and recommendations presented in this report are based on the data obtained from the borings and test pit excavations made at the locations indicated on the site plans and from other information discussed herein. This report is based on the assumption that the subsurface conditions everywhere are not significantly different from those disclosed by the borings and excavations. However, variations in soil conditions may exist between the excavations and, also, general groundwater levels and conditions may fluctuate from time to time. The nature and extent of the variations may not become evident until construction. If subsurface conditions differ from those encountered in the exploratory borings and excavations, are observed or encountered during construction, or appear to be present beneath or beyond excavations, we should be advised at once so that we can observe and review these conditions and reconsider our recommendations where necessary.

Since it is possible for conditions to vary from those assumed in the analysis and upon which our conclusions and recommendations are based, a contingency fund should be included in the construction budget to allow for the possibility of variations which may result in modification of the design and construction procedures.

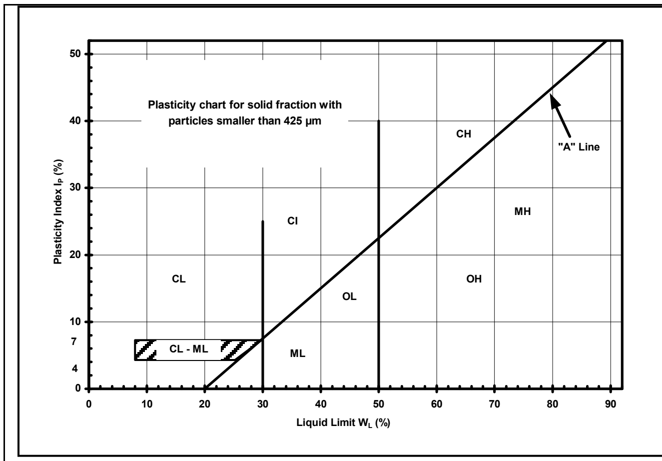
In order to observe compliance with the design concepts, specifications or recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated, we recommend that all construction operations dealing with earth work and the foundations be observed by an experienced soils engineer. We can be retained to provide these services for you during construction. In addition, we can be retained to review the plans and specifications that have been prepared to check for substantial conformance with the conclusions and recommendations contained in our report.

EXPLANATION OF FIELD & LABORATORY TEST DATA

Description				UMA Log Symbols	USCS Classification	Laboratory Classification Criteria			
						Fines (%)	Grading	Plasticity	Notes
COARSE GRAINED SOILS	GRAVELS (More than 50% of coarse fraction of gravel size)	CLEAN GRAVELS (Little or no fines)	Well graded gravels, sandy gravels, with little or no fines		GW	0-5	$C_U > 4$ $1 < C_C < 3$		Dual symbols if 5-12% fines. Dual symbols if above “A” line and $4<W_P<7$ $C_U = \frac{D_{60}}{D_{10}}$ $C_C = \frac{(D_{30})^2}{D_{10} x D_{60}}$
			Poorly graded gravels, sandy gravels, with little or no fines		GP	0-5	Not satisfying GW requirements		
		DIRTY GRAVELS (With some fines)	Silty gravels, silty sandy gravels		GM	> 12		Atterberg limits below “A” line or $W_P<4$	
			Clayey gravels, clayey sandy gravels		GC	> 12		Atterberg limits above “A” line or $W_P<7$	
	SANDS (More than 50% of coarse fraction of sand size)	CLEAN SANDS (Little or no fines)	Well graded sands, gravelly sands, with little or no fines		SW	0-5	$C_U > 6$ $1 < C_C < 3$		
			Poorly graded sands, gravelly sands, with little or no fines		SP	0-5	Not satisfying SW requirements		
		DIRTY SANDS (With some fines)	Silty sands, sand-silt mixtures		SM	> 12		Atterberg limits below “A” line or $W_P<4$	
			Clayey sands, sand-clay mixtures		SC	> 12		Atterberg limits above “A” line or $W_P<7$	
FINE GRAINED SOILS	SILTS (Below ‘A’ line negligible organic content)	$W_L<50$	Inorganic silts, silty or clayey fine sands, with slight plasticity		ML			Classification is Based upon Plasticity Chart	
		$W_L>50$	Inorganic silts of high plasticity		MH				
	CLAYS (Above ‘A’ line negligible organic content)	$W_L<30$	Inorganic clays, silty clays, sandy clays of low plasticity, lean clays		CL				
		$30<W_L<50$	Inorganic clays and silty clays of medium plasticity		CI				
		$W_L>50$	Inorganic clays of high plasticity, fat clays		CH				
	ORGANIC SILTS & CLAYS (Below ‘A’ line)	$W_L<50$	Organic silts and organic silty clays of low plasticity		OL				
		$W_L>50$	Organic clays of high plasticity		OH				
HIGHLY ORGAINIC SOILS			Peat and other highly organic soils		Pt	Von Post Classification Limit		Strong colour or odour, and often fibrous texture	

	Asphalt		Till		
	Concrete		Bedrock (Undifferentiated)		
	Fill		Bedrock (Limestone)		

When the above classification terms are used in this report or test hole logs, the designated fractions may be visually estimated and not measured.



FRACTION		SEIVE SIZE (mm)		DEFINING RANGES OF PERCENTAGE BY WEIGHT OF MINOR COMPONENTS	
		Passing	Retained	Percent	Identifier
Gravel	Coarse	76	19	35-50	and
	Fine	19	4.75		
Sand	Coarse	4.75	2.00	20-35	"y" or "ey" *
	Medium	2.00	0.425		
	Fine	0.425	0.075	10-20	some
Silt (non-plastic) or Clay (plastic)		< 0.075 mm		1-10	trace

* for example: gravelly, sandy clayey, silty

Definition of Oversize Material

COBBLES: 76mm to 300mm diameter
BOULDERS: >300mm diameter

LEGEND OF SYMBOLS

Laboratory and field tests are identified as follows:

q_u - undrained shear strength (kPa) derived from unconfined compression testing.

T_v - undrained shear strength (kPa) measured using a torvane

pp - undrained shear strength (kPa) measured using a pocket penetrometer.

L_v - undrained shear strength (kPa) measured using a lab vane.

F_v - undrained shear strength (kPa) measured using a field vane.

γ - bulk unit weight (kN/m^3).

SPT - Standard Penetration Test. Recorded as number of blows (N) from a 63.5 kg hammer dropped 0.76 m (free fall) which is required to drive a 51 mm O.D. Raymond type sampler 0.30 m into the soil.

DPPT - Drive Point Pentrometer Test. Recorded as number of blows from a 63.5 kg hammer dropped 0.76 m (free fall) which is required to drive a 50 mm drive point 0.30 m into the soil.

w - moisture content (W_L, W_P)

The undrained shear strength (Su) of a cohesive soil can be related to its consistency as follows:

Su (kPa)	**CONSISTENCY**
<12	very soft
12 – 25	soft
25 – 50	medium or firm
50 – 100	stiff
100 – 200	very stiff
200	hard

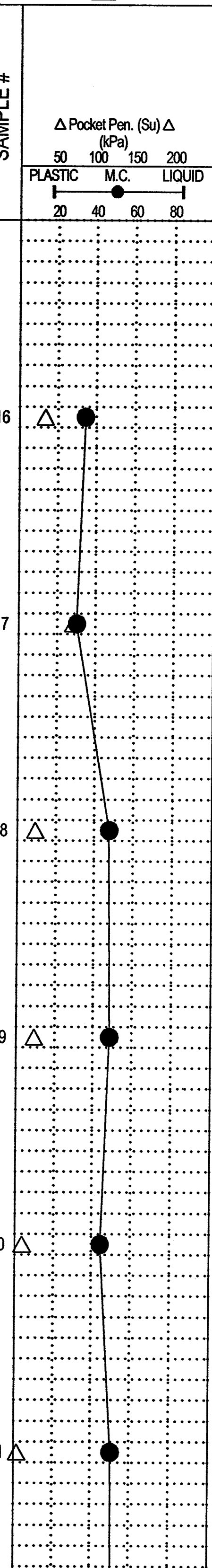
The resistance (N) of a non-cohesive soil can be related to compactness condition as follows

N – BLOWS/0.30 m	**COMPACTNESS**
0 - 4	very loose
4 - 10	loose
10 - 30	compact
30 - 50	dense
50	very dense

PROJECT: Winnipeg Water Treatment Plant	CLIENT: City of Winnipeg (Earth Tech Can Ltd)	TESTHOLE NO: **05-55**
LOCATION: Bridge Abutments - N 5523935.216 E - 648112.076		PROJECT NO.: 3398-055-00-01
CONTRACTOR: Maple Leaf Drilling	METHOD: DR 150 - 125 mm Solid Stem Auger	ELEVATION (m): 237.591

SAMPLE TYPE: GRAB, SHELBY TUBE, SPLIT SPOON, BULK, NO RECOVERY, CORE

DEPTH (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	COMMENTS	ELEVATION (m)
0	CLAY (FILL) - silty - brown - moist, firm to stiff - medium plasticity				237
1.5	CLAY (TOPSOIL) - silty, black, moist, stiff, medium plasticity, trace organics	GRAB	516		236
1.7	CLAY - silty, trace silt inclusions(<30mm diam.), trace oxidation - mottled light brown and grey - moist, stiff, high plasticity				
3.0		GRAB	517		235
3.8	- grey, brownish, no silt inclusions, trace sulphur inclusions (<3mm diam.) below 3.8 m				234
4.5		GRAB	518		233
6.0		GRAB	519		232
6.7	- grey, firm below 6.7 m				231
7.5		GRAB	520		230
9.0		GRAB	521		229
9.1	- no sulphur inclusions below 9.1 m				228
10					



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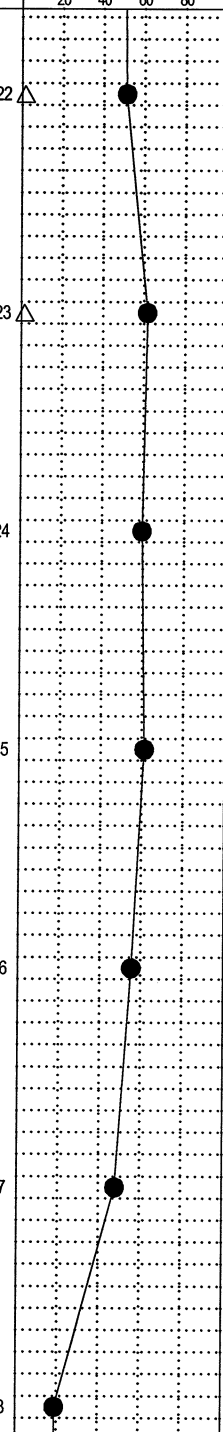
LOGGED BY: Kate Franklin	COMPLETION DEPTH: 21.79 m
REVIEWED BY: Nelson Ferreira	COMPLETION DATE: 8/22/05
PROJECT ENGINEER: Ken Skaftfeld	

PROJECT: Winnipeg Water Treatment Plant	CLIENT: City of Winnipeg (Earth Tech Can Ltd)	TESTHOLE NO: **05-55**
LOCATION: Bridge Abutments - N 5523935.216 E - 648112.076		PROJECT NO.: 3398-055-00-01
CONTRACTOR: Maple Leaf Drilling	METHOD: DR 150 - 125 mm Solid Stem Auger	ELEVATION (m): 237.591

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	△ Pocket Pen. (Su) △ (kPa) 50 100 150 200 / PLASTIC M.C. LIQUID 20 40 60 80	COMMENTS	ELEVATION (m)
10							
			GRAB	522	△		227
11							
							226
12							
			GRAB	523	△		
							225
13							
			GRAB	524			224
14							
							223
15							
			GRAB	525			
							222
16							
			GRAB	526			221
17							
							220
18							
			GRAB	527			
		SILT (TILL) - trace clay, trace sand, trace gravel - light brown - moist, loose to compact with depth - low to no plasticity					219
19							
		- dense below 19.5 m					218
			GRAB	528			
20							



UMA | AECOM

LOGGED BY: Kate Franklin	COMPLETION DEPTH: 21.79 m
REVIEWED BY: Nelson Ferreira	COMPLETION DATE: 8/22/05
PROJECT ENGINEER: Ken Skaftfeld	

PROJECT: Winnipeg Water Treatment Plant	CLIENT: City of Winnipeg (Earth Tech Can Ltd)	TESTHOLE NO: **05-55**
LOCATION: Bridge Abutments - N 5523935.216 E - 648112.076		PROJECT NO.: 3398-055-00-01
CONTRACTOR: Maple Leaf Drilling	METHOD: DR 150 - 125 mm Solid Stem Auger	ELEVATION (m): 237.591

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

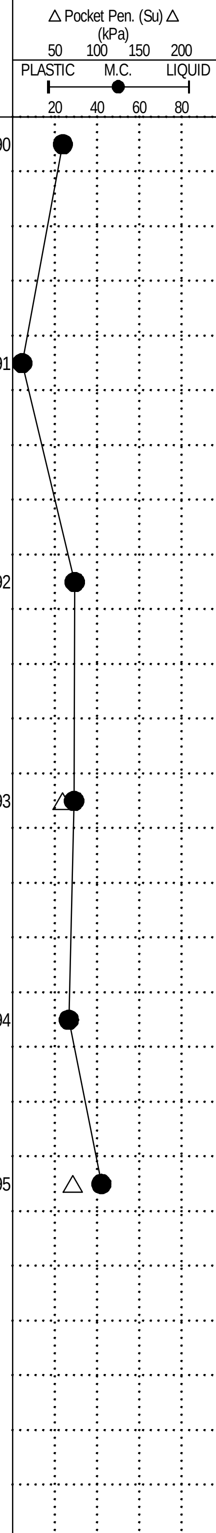
DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	△ Pocket Pen. (Su) △ (kPa) 50 100 150 200; PLASTIC M.C. LIQUID 20 40 60 80	COMMENTS	ELEVATION (m)
20							
							217
21			GRAB	529			
							216
22		END OF TEST HOLE AT 21.8 m IN SILT TILL. Notes: 1. Power auger refusal at 21.8 m. 2. Water level at 12.8 m at completion of drilling. 3. Sloughing to approximately 19.0 m at completion of drilling. 4. Backfilled with bentonite pellets.					
							215
23							
							214
24							
							213
25							
							212
26							
							211
27							
							210
28							
							209
29							
							208
30							

UMA | AECOM	LOGGED BY: Kate Franklin	COMPLETION DEPTH: 21.79 m
	REVIEWED BY: Nelson Ferreira	COMPLETION DATE: 8/22/05
	PROJECT ENGINEER: Ken Skaftfeld	Page 3 of 3

PROJECT: Winnipeg Water Treatment Plant	CLIENT: City of Winnipeg (Earth Tech Can Ltd)	TESTHOLE NO: 05-56
LOCATION: Access Roads - N 5523913.568 E 648170.816		PROJECT NO.: 3398-055-00-01
CONTRACTOR: Maple Leaf Drilling	METHOD: DR 150 - 125 mm Solid Stem Auger	ELEVATION (m): 236.673

SAMPLE TYPE: GRAB, SHELBY TUBE, SPLIT SPOON, BULK, NO RECOVERY, CORE

DEPTH (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	COMMENTS	ELEVATION (m)
0	GRAVEL (FILL) 20 mm down limestone - light brown - dry - sub angular to angular	GRAB	G-490		
	SAND (FILL) - trace gravel, trace silt - brown - very dense, moist - rounded	GRAB	G-491		236
1	CLAY (FILL)- silty, trace sand, trace gravel - dark brown and black - stiff, moist - low to intermediate plasticity	GRAB	G-492		
2	CLAY - silty - brown - stiff, moist - medium plasticity - trace silt inclusions	GRAB	G-493		235
		GRAB	G-494		234
3		GRAB	G-495		
	END OF TEST HOLE AT 3.0 m IN CLAY 1. No seepage or sloughing				233
4					

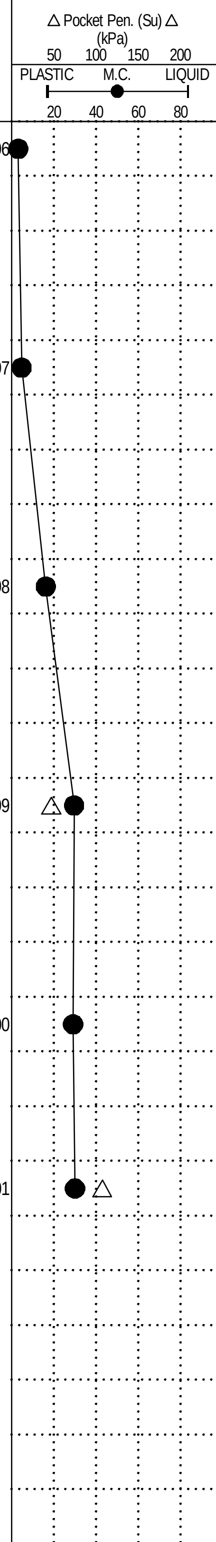


UMA AECOM	LOGGED BY: Kate Franklin	COMPLETION DEPTH: 3.05 m
	REVIEWED BY:	COMPLETION DATE: 8/12/05
	PROJECT ENGINEER: Ken Skaftfeld	Page 1 of 1

PROJECT: Winnipeg Water Treatment Plant	CLIENT: City of Winnipeg (Earth Tech Can Ltd)	TESTHOLE NO: 05-57
LOCATION: Access Roads - N 5523912.595 E 648362.023		PROJECT NO.: 3398-055-00-01
CONTRACTOR: Maple Leaf Drilling	METHOD: DR 150 - 125 mm Solid Stem Auger	ELEVATION (m): 237.086

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	COMMENTS	ELEVATION (m)
0	GRAVEL (FILL) 20 mm down limestone - light brown, dry, sub angular to angular	GRAB	G-496		237
	SAND (FILL) - trace gravel - dark brown - very dense, moist - rounded	GRAB	G-497		
1	- brown, moist to wet below 0.9 m	GRAB	G-498		236
	CLAY (FILL)- silty, trace sand, trace gravel - dark brown and black - stiff, moist - low to intermediate plasticity	GRAB	G-499		
2	CLAY - silty - brown - very stiff, moist - medium plasticity - trace silt inclusions	GRAB	G-500		235
3		GRAB	G-501		234
	END OF TEST HOLE AT 3.0 m IN CLAY 1. No seepage or sloughing				
4					



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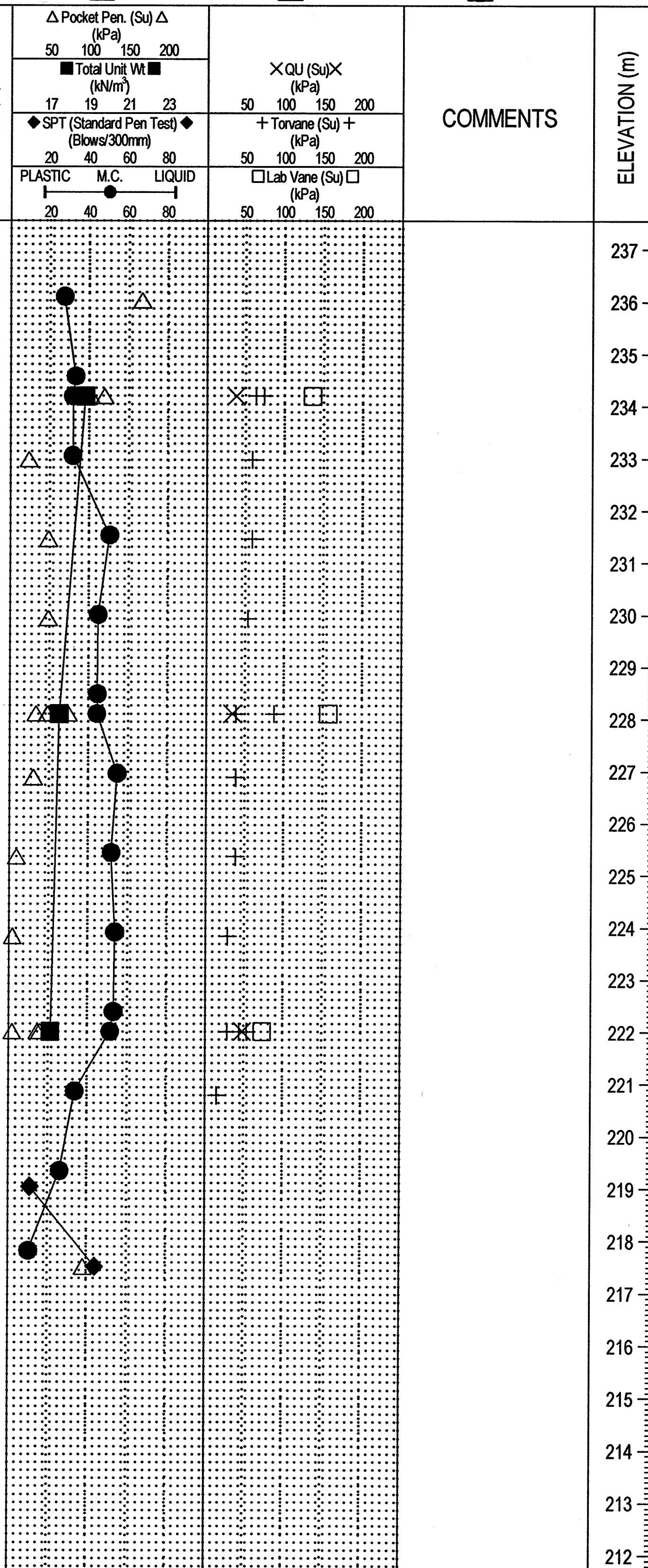
LOGGED BY: Kate Franklin	COMPLETION DEPTH: 3.05 m
REVIEWED BY:	COMPLETION DATE: 8/12/05
PROJECT ENGINEER: Ken Skaftfeld	

PROJECT: Winnipeg Water Treatment Plant	CLIENT: City of Winnipeg (Earth Tech Can Ltd)	TESTHOLE NO: **05-58**
LOCATION: East Side of PR 207 South of Aqueduct Crossing - N 5523977.7 E 648427.5		PROJECT NO.: 3398-055-00-01
CONTRACTOR: Paddock Drilling Ltd.	METHOD: Acker SS, 125 mm SSA	ELEVATION (m): 237.55

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	SOIL DESCRIPTION	SAMPLE #	SPT (N)
0	SAND (FILL) - trace gravel, frozen, poorly graded, fine grained		
	CLAY (FILL) - trace silt, trace gravel - dark brown - dry, very stiff - high plasticity	G661	
~2.7	CLAY - brown - dry to moist, very stiff - high plasticity - trace silt inclusions (<3 mm dia.) - trace oxidized silt inclusions below 3.1 m - stiff below 3.1 m - silt layer (<3 mm thick) at 3.7 m - firm below 4.3 m - dark grey, moist, trace silt inclusions (<3 mm dia.) below 4.9 m	G662, T663, G664, G665, G666, G667, T668	
	- trace gravel, some silt inclusions (<3 mm dia.) below 10.7 m	G669	
	- soft below 12.2 m	G670, G671	
	- very soft and silty with some gravel below 15.2 m	G672, T673, G674	
~17.4	CLAY (TILL) - silty, some gravel to gravelly, trace sand - light grey - moist, very soft, low to medium plastic	G675, S676	11
~18.6	SILT (TILL) - gravelly, some clay, trace sand - light brown - damp to moist, stiff - low plasticity - damp, dense with cobbles below 19.8 m	G677, S678	44
20.7	END OF TEST HOLE AT 20.7 m IN SILT TILL. Notes: 1. Power auger refusal at 20.7 m. 2. No seepage or sloughing observed during drilling. 3. Test hole backfilled to surface with bentonite chips and auger cuttings upon completion.		



LOGGED BY: Andrea Hachkowski	COMPLETION DEPTH: 20.73 m
REVIEWED BY: Nelson Ferreira	COMPLETION DATE: 1/18/06
PROJECT ENGINEER: Ken Skaftfeld	Page 1 of 1

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PROJECT: Winnipeg Water Treatment Plant	CLIENT: City of Winnipeg (Earth Tech Can Ltd)	TESTHOLE NO: 05-59
LOCATION: East Side of P.R. 207 North of Aqueduct Crossing - N 5523952.7 E 648427.2		PROJECT NO.: 3398-055-00-01
CONTRACTOR: Paddock Drilling Ltd.	METHOD: Acker SS, 125 mm SSA	ELEVATION (m): 237.6

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	+ Torvane (Su) + (kPa) 50 100 150 200; △ Pocket Pen. (Su) △ (kPa) 50 100 150 200; ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 20 40 60 80; PLASTIC M.C. LIQUID 20 40 60 80	COMMENTS	ELEVATION (m)
0		CLAY (FILL) - trace silt inclusions, trace gravel, trace organics - dark brown - dry, very stiff - high plasticity						237
			GRAB	G679				236
2		TOPSOIL (Clay) - 25 mm thick						
		CLAY - brown - moist, firm to stiff - high plasticity - some oxidized silt inclusions - some silt lenses (<3 mm dia.) below 3.1 m						235
3			GRAB	G680				
			SHELBY TUBE	T681				234
			GRAB	G682				233
5		- dark grey, moist, trace silt inclusions (<3 mm dia.) below 4.9 m						
6			GRAB	G683				231
8			GRAB	G684				230
9			GRAB	G685				
			SHELBY TUBE	T686				228
11			GRAB	G687				227
12		- very moist, very soft below 12.2 m	GRAB	G688				225
14		- trace gravel below 13.7 m	GRAB	G689				224
15			GRAB	G690				
			SHELBY TUBE	T691				222
17			GRAB	G692				221
17.5		SILT (TILL) - gravelly, some clay, trace sand - light grey - damp to moist, stiff - low plasticity						220
19			SPLIT SPOON	S693	15			219
19.5		END OF TEST HOLE AT 19.5 m IN SILT TILL. Notes: 1. Power auger refusal at 19.5 m. 2. No seepage or sloughing observed during drilling. 3. Test hole backfilled with auger cuttings and bentonite chips upon completion.						218

Depth scale: 0 – 26 m; Elevation scale: 237 – 212 m.

UMA | AECOM	LOGGED BY: Andrea Hachkowski	COMPLETION DEPTH: 19.51 m
	REVIEWED BY: Nelson Ferreira	COMPLETION DATE: 1/18/06
	PROJECT ENGINEER: Ken Skaftfeld	Page 1 of 1

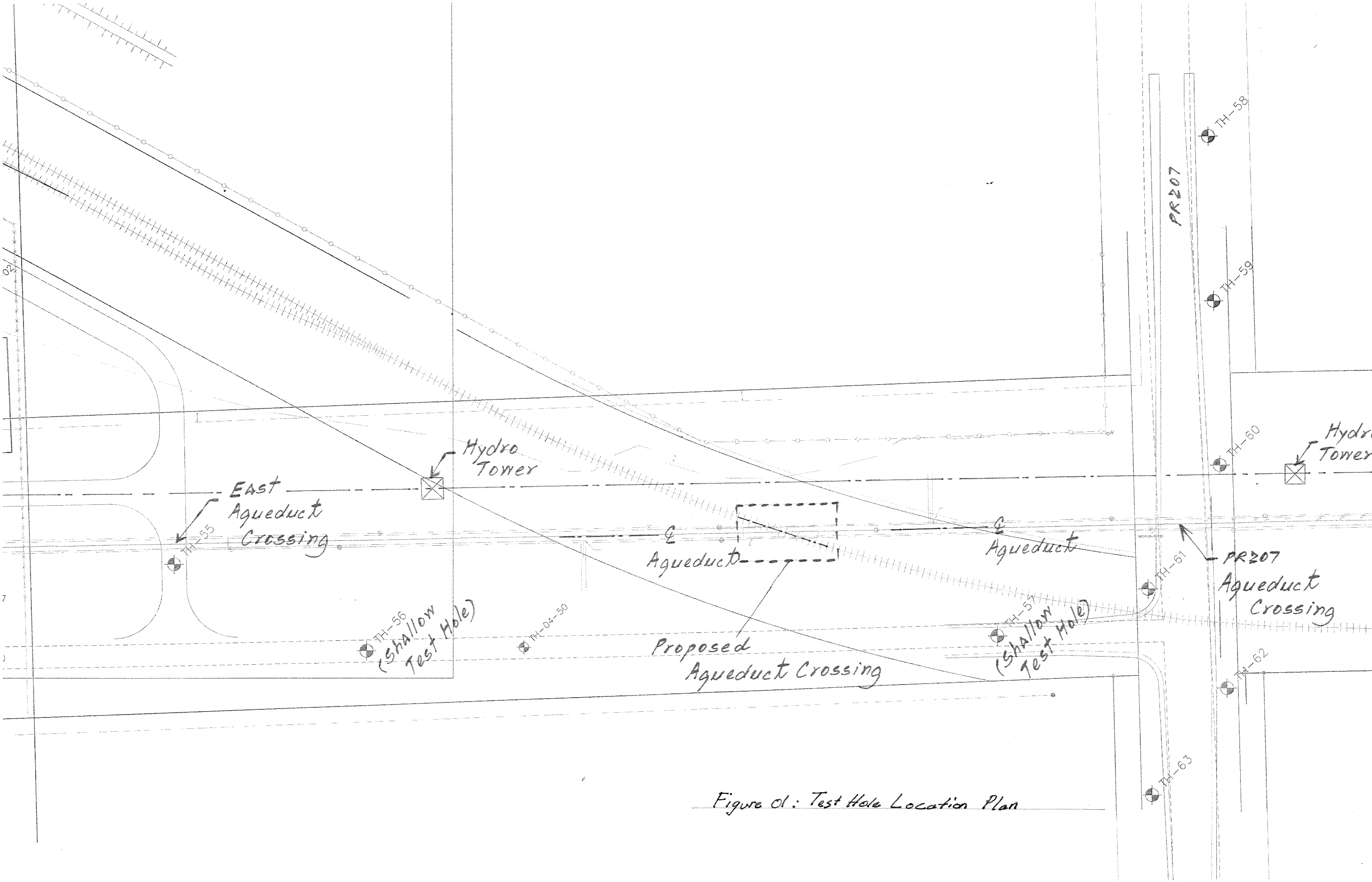

Figure 01: Test Hole Location Plan