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March 14, 2017

File No. 174006

City of Winnipeg
Planning, Property & Development Department
Municipal Accommodations Division Project
Services Branch
4th floor, 185 King Street
Winnipeg, MB. R3B 1J1

Attn: John Atkinson

Dear Mr. Atkinson:

RE: La Barriere Park – Washroom Facility
Geotechnical Investigation

As requested, Dyregrov Robinson Inc. (DRI) has undertaken a geotechnical investigation for the proposed new washroom facility located in La Barriere Park at 4345 Waverley Street in Winnipeg, MB. It is understood that the new washroom building will be supported on cast-in-place concrete friction piles. The purpose of the investigation was to evaluate the subsurface conditions in order to provide foundation design recommendations that meet the requirements of the current Manitoba Building Code. The work was authorized by the City of Winnipeg via P.O. Number 459226.

Field Investigation

One test hole was drilled to a depth of 11.3 m near the location of the proposed washroom facility by Paddock Drilling Ltd. using a track mounted Acker Soil-X drill rig equipped with 125 mm diameter solid stem augers. The test hole was backfilled with auger cuttings and bentonite chips. The excess auger cuttings were bagged and removed from the area.

The subsurface conditions were visually logged during drilling by DRI. Disturbed (auger cuttings) and undisturbed (Shelby tube) samples were recovered from the test hole and taken to our Soils Testing Laboratory for additional visual classification and testing. The laboratory testing consisted of determining moisture contents on all samples and measuring bulk unit weights and undrained shear strengths on the Shelby tube samples. The test hole log is attached and includes a description of the test hole location, subsurface conditions encountered, results of the laboratory testing, and notes regarding the observations made during drilling.

Subsurface Conditions

The soil stratigraphy encountered in the test hole, from site grade, consists of organic clay and lacustrine silty clay. The test hole was not advanced into the glacial till.

A 600 mm thick layer of black clay was encountered at grade. It is silty with trace organics and is moist. The moisture content of the clay was about 40 percent.

A thick deposit of Lake Agassiz lacustrine silty clay was encountered below the black clay. The clay is brown to a depth of 1.2 m, mottled brown and grey to a depth of about 6.4 m and grey below this depth. It is moist with a stiff consistency to a depth of about 6.4 m and below 7 m the clay is wet and stiff. The clay has high plasticity and also contains trace silt inclusions. The moisture content of the clay ranges from 45 to 55 percent with an average around 50 percent.

The undrained shear strength of the clay was measured using Torvane, penetrometer and unconfined compressive strength tests. The clay has undrained shear strengths ranging from about 35 to 85 kPa. The average bulk unit weight of the clay is about 17 kN/m³.

No seepage or sloughing was observed during drilling of the test hole. The groundwater conditions should be expected to vary seasonally, from year to year and possibly as a result of construction activities.

Recommendations

The subsurface conditions at the proposed washroom facility site are suitable for cast-in-place concrete friction piles. Shallow foundations could be considered but some seasonal movements of the building would occur.

Cast-In-Place Concrete Friction Piles

Cast-in-place concrete friction piles under axial compressive loading can be designed in accordance to the current Manitoba Building Code (i.e. NBC 2010) using the service limit state (SLS) shaft adhesion value provided in Table 1 below. For the ultimate limit state (ULS) case, the piles can be designed with the factored shaft adhesion value and the factored end bearing pressure provided in Table 1. A resistance factor of 0.4 was used to calculate the factored ULS design values. Under the SLS loads, pile settlements are expected to be around 6 mm with differential settlements between piles around 3 to 6 mm.

Table 1: Design Parameters for CIP Concrete Friction Piles

Depth Below Existing Site Grade (m)	SLS Shaft Adhesion (kPa)	Factored ULS	
		Shaft Adhesion (kPa)	End Bearing (kPa)
0 to 2.5 (see Note 1)	0	0	n/a
2.5 to 11	16.6	20.0	180

Note 1: When determining effective pile lengths, the upper 2.5 m of the pile shaft below existing site grade should be ignored to account for potential soil shrinkage away from the pile.

The piles should not extend more than 11 m below the existing site grade which is the maximum depth of the test hole drilled for this project.

Piles should have a minimum diameter of 400 mm, a minimum length of 6 m and a minimum spacing of 3 pile diameters on centre. Where this spacing cannot be achieved DRI should be contacted for additional input. Small pile groups (maximum of 3 piles) can be considered for moderately high column loads.

Concrete should be placed as soon as possible after each pile hole is completed. Temporary steel sleeves should be on site and used where sloughing/caving of the pile borings occur and/or if groundwater seepage is encountered.

Piles that are subjected to freezing conditions must be protected from potential frost heave effects by using minimum pile lengths of 7.6 m and installing full length reinforcement. The use of flat lying rigid insulation, such as Styrofoam HI, can also be used to minimize frost penetration into the soil around the piles if the minimum pile length cannot be achieved. A greased, polyethylene wrapped sonotube can be placed around the upper 1.8 m of the pile shaft to act as a bond breaker and provide additional protection against frost heave.

Floor Slabs

Where there is minimal tolerance for floor slab movement it is recommended that structural floor slabs over a void space be considered as a preferred option due to the presence of high plastic (i.e. expansive) clay soils at the site. Structural floor slabs will minimize the potential for movement of the floor slab due to heave or swelling of the underlying clay soils. It is possible that the total amount of heave and swelling could be as much as 100 to 150 mm in the long term. A void separation between the structural floor slab and underlying soil should be at least 150 mm thick. A vapour barrier should be provided below the floor slab.

Where a slab on grade floor is to be considered it must recognized that the floor slab will undergo some movements overtime due to volumetric changes of the underlying clay soils. Vertical movements on the order of 25 to 50 mm should be expected and in the longer term could reasonably be on the order of 100 to 150 mm. The movements are differential and are not expected to be uniform across the floor slab. A major factor impacting the magnitude of floor slab movements, which should be expected, are the climatic effects during construction which might impact changes in the sub-soil moisture conditions. For these reasons, it is not possible to assess the amount of soil movement which will occur with any degree of accuracy.

If used, slab-on-grade floors could be isolated from fixed building components (e.g. grade beams) in an effort to allow for some floor slab movements to occur without affecting the structure. A vapour barrier should be provided below the floor slab. The floor slab should not be placed against frozen soil and should be supported on a minimum of 300 mm of compacted granular base material placed on a prepared subgrade consisting of compacted clay soil. The granular base should consist of 19 mm down crushed limestone material compacted to 98 percent of the Standard Proctor Maximum Dry Density (SPMDD).

Topsoil, fill, and other deleterious materials should be stripped from the subgrade area before subgrade preparation begins. During construction, the subgrade soils should not be permitted to dry excessively, which could be done by periodic watering. In addition, water should not be allowed to pond on the subgrade soils. The subgrade should be graded smooth, scarified to a depth of approximately 150 mm below grade and then uniformly re-compacted to 95 percent of the SPMDD.

Areas identified as being weak or soft during subgrade preparation should be stabilized by additional re-working and compaction or removal and replacement with suitable material. If encountered, silt can be over excavated and replaced with suitable material (i.e. compacted clay or granular sub-base) or bridged with additional granular base and non-woven geotextile to provide separation and some reinforcement. The amount of additional granular base should be determined at the time of construction to suit the conditions encountered. Non-woven geotextile should meet the requirements of the City of Winnipeg's Standard Construction Specifications, CW 3130 for the Supply and Installation of Geotextile Fabrics.

Other

A void separation of at least 150 mm should be provided under grade beams and pile caps.

The potential for sulphate attack is considered to be severe (Exposure Class S-2). All concrete in contact with soil should be made with sulphate resistance cement (Type HS) in accordance with the Building Code and relevant CSA standards.

Positive drainage should be provided away from the structure at gradients of at least 2 percent. Flow from downspouts and rain leaders should be directed on to splash pads that will direct runoff away from the perimeter of the building.

Closure

This report and its findings were prepared based on the subsurface conditions encountered in the random representative test hole drilled on February 23, 2017 for the sole purpose of this geotechnical investigation and our understanding of the proposed development at the time of this report. Subsurface conditions are inherently variable and should be expected to vary across the site.

This report was prepared for the sole and exclusive use of the City of Winnipeg for the proposed new washroom facility to be located in La Barriere Park at 4345 Waverley Street Winnipeg, MB. The information and recommendations contained in this report are for the benefit of the City of Winnipeg only and no other party or entity shall have any claim against Dyregrov Robinson Inc., or the author, nor may this report be used for any other projects, including but not limited to changes in this proposed development without the consent of Dyregrov Robinson Inc. The findings and recommendations in this report have been prepared in accordance with generally accepted geotechnical engineering principles and practises. No other warranty, expressed or implied, is provided.

Please contact the undersigned if we can be of further assistance.

DYREGROV ROBINSON INC.

Gil Robinson

Gil Robinson, M.Sc., P.Eng.
President, Senior Geotechnical Engineer
gilrobinson@drgeotechnical.com

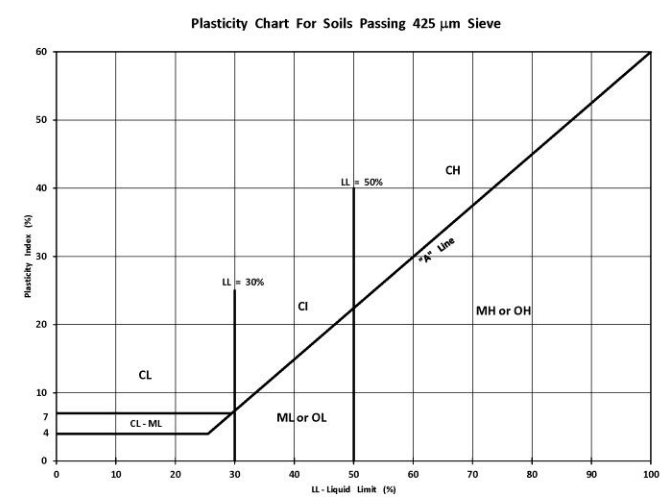
PROVINCE OF MANITOBA
G.G.B.
ROBINSON
14 March 2017
REGISTERED PROFESSIONAL ENGINEER

APEGM
Certificate of Authorization
Dyregrov Robinson Inc.
No. 86 Date: 14 March 2017

EXPLANATION OF TERMS & SYMBOLS

Description				TH 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 ORGANIC SOILS			Peat and other highly organic soils		Pt	Von Post Classification Limit		Strong colour or odour, and often fibrous texture	

	Asphalt		Glacial Till		Bedrock (Igneous)	
	Concrete		Clay Shale		Bedrock (Limestone)	DYREGROV ROBINSON INC. CONSULTING GEOTECHNICAL ENGINEERS
	Fill				Bedrock (Undifferentiated)	



FRACTION		PARTICLE SIZE (mm) Min.	Max.
Boulders		>300	
Cobbles		75	300
Gravel	Coarse	19	75
	Fine	4.75	19
Sand	Coarse	2.0	4.75
	Medium	0.425	2.0
	Fine	0.075	0.425
Silt (non-plastic) or Clay (plastic)		< 0.075 mm	

RELATIVE PROPORTIONS (by weight)	
Percent	Descriptor
>35%	main fraction
35 - 50	"and"
20 – 35	Adjective e.g. silty, clayey
10 – 20	"some"
1 - 10	"trace"

Soil Classification Example

Clay 50% (main fraction), Silt 25%, Sand 17%, Gravel 8%

Clay – silty, some sand, trace gravel

TERMS and SYMBOLS

Laboratory and field tests are identified as follows:

Unconfined Comp.: undrained shear strength (kPa or psf) derived from unconfined compression testing.

Torvane: undrained shear strength (kPa or psf) measured using a Torvane

Pocket Pen.: undrained shear strength (kPa or psf) measured using a pocket penetrometer.

Unit Weight bulk unit weight of soil or rock (kN/m^3 or pcf).

SPT – N Standard Penetration Test: The number of blows (N) required to drive a 51 mm O.D. split barrel sampler 300 mm into the soil using a 63.5 kg hammer with a free fall drop height of 760 mm.

DCPT Dynamic Cone Penetration Test. The number of blows (N) required to drive a 50 mm diameter cone 300 mm into the soil using a 63.5 kg hammer with a free fall drop height of 760 mm.

M/C insitu soil moisture content in percent

PL Plastic limit, moisture content in percent

LL Liquid limit, moisture content in percent

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

Su (kPa)	Su (psf)	CONSISTENCY
<12	250	very soft
12 – 25	250 – 525	soft
25 – 50	525 – 1050	firm
50 – 100	1050 – 2100	stiff
100 – 200	2100 – 4200	very stiff
200	4200	hard

The SPT - N of non-cohesive soil is related to compactness condition as follows:

N – Blows / 300 mm	COMPACTNESS
0 - 4	very loose
4 - 10	loose
10 - 30	compact
30 - 50	dense
50 +	very dense

References:

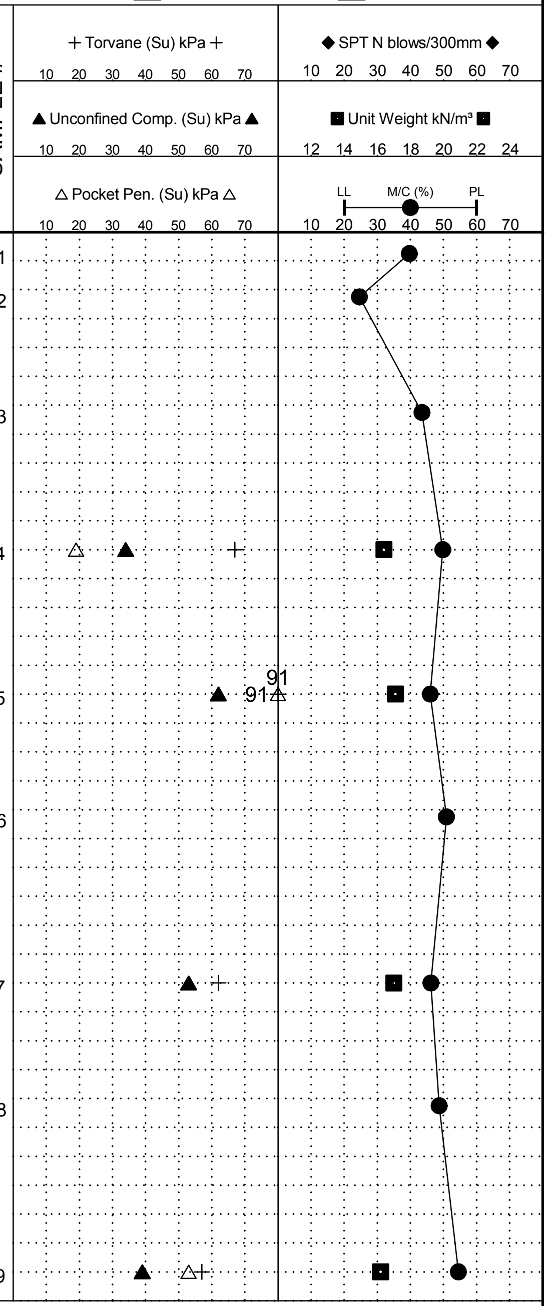
ASTM D2487 – Classification of Soils For Engineering Purposes (Unified Soil Classification System)

Canadian Foundation Engineering Manual, 4th Edition, Canadian Geotechnical Society, 2006

PROJECT: La Barriere Park - Washroom Project	CLIENT: City of Winnipeg	TEST HOLE NO: **1**
LOCATION: Approx 7m west of parking lot. UTM 631,608m E & 5,509,084m N		PROJECT NO.: 174006
CONTRACTOR: Paddock Drilling Ltd.	METHOD: Acker Soil-X Drill Rig: 125 mm SS augers	ELEVATION (m):

SAMPLE TYPE	GRAB	SHELBY TUBE	SPLIT SPOON	BULK	NO RECOVERY	CORE
BACKFILL TYPE	BENTONITE	GRAVEL	SLOUGH	GROUT	CUTTINGS	SAND

ELEVATION (m)	DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #
	0–0.6		CLAY - silty, trace organics - black	GRAB	G1
	0.6–11.3		CLAY - silty - brown - stiff, moist - high plasticity, trace silt inclusions - mottled brown and grey below 1.2 m - grey and wet below 6.4 m	GRAB, SHELBY TUBE	G2, G3, T4, T5, G6, T7, G8, T9



END OF TEST HOLE IN CLAY AT 11.3 m

Notes:

1. No sloughing or seepage observed.
2. Test hole backfilled with auger cuttings and bentonite chips.

DYREGROV ROBINSON INC. Consulting Geotechnical Engineers	LOGGED BY: CR	COMPLETION DEPTH: 11.28 m
	REVIEWED BY: GR	COMPLETION DATE: 23/2/17
	PROJECT ENGINEER: Gil Robinson	Page 1 of 1