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File No. 153928

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, Project Officer

RE: Transcona Centennial Pool Redevelopment - Phase 1B Geotechnical Investigation

As requested, Dyregrov Robinson Inc. (DRI) has undertaken a geotechnical investigation for Phase 1B of the Transcona Centennial Pool redevelopment project. The site is located at 1101 Wabasha Street in Winnipeg, Manitoba. 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 on November 27, 2015 via P.O. Number 411964.

1) Proposed Pool Equipment Building

We understand that a single storey building will be constructed west of the outdoor pools to house pool related equipment. The new building will be about 330 m² in size. A 9 m deep manhole / sump pit will be provided inside the building.

2) Field Investigation

On December 3, 2015, one test hole was drilled in the foot print of the proposed building; at the approximate location described on the test hole log. The test hole was drilled to auger refusal by Paddock Drilling Ltd. using a track mounted RM 30 drill rig equipped with 125 mm diameter solid stem augers. The test hole was backfilled with auger cuttings and bentonite chips.

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 subsurface conditions encountered, results of the laboratory testing, and notes regarding the observations made during drilling.

3) Subsurface Conditions

The soil stratigraphy encountered in the test holes, from site grade, consists of black silty clay, silt, silty clay and glacial till.

Black Silty Clay

Black silty clay was encountered at grade and is about 1.5 m thick. The clay contains trace organics and is stiff and moist. The clay has a moisture content around 40 percent.

Silt

A 150 m thick layer of silt was encountered below the black clay. It contains traces of clay, is brown in color and is loose and wet. The moisture content is around 25 percent.

Silty Clay

The usual thick deposit Lake Agassiz lacustrine silty clay was encountered beneath the silt at a depth of 1.7 m below grade. The clay deposit is about 12.7 m thick, mottled brown and grey in color to a depth of about 8 m below which it is grey. It is moist, has a stiff consistency to a depth of about 10 m below which the clay is firm. The clay is of high plasticity and it contains trace silt inclusions. The moisture contents of the clay range from about 45 to 65 percent.

The undrained shear strength of the clay was measured using Torvane, penetrometer and unconfined compressive strength tests. The clay is stiff to a depth of about 10 m with undrained shear strengths ranging from about 35 to 70 kPa. Below 10 m, the consistency of the clay becomes firm with undrained shear strengths varying between about 25 and 45 kPa. The bulk unit weight of the clay is about 17 kN/m³.

Silt (Till)

Glacial silt till was encountered at a depth of 14.3 m. The till in the Winnipeg area is known to be a heterogeneous mixture of sand, gravel, cobble and boulder size materials in a clay and/or silt matrix. The till encountered in the test hole is a grey silt till containing trace amounts of sand and gravel. The moisture content of the till encountered is around 10 percent. Auger refusal occurred a depth of 14.9 m.

Test Hole Stability and Groundwater Conditions

A minor amount of seepage was observed from the silt layer. No sloughing conditions were observed in the test hole. The groundwater conditions should be expected to vary seasonally, from year to year and possibly as a result of construction activities.

4) Discussion and Recommendations

The subsurface conditions at this site are suitable for cast-in-place concrete friction piles.

Cast-In-Place Concrete Friction Piles

Cast-in-place concrete friction piles can be designed in accordance to the current Manitoba Building Code (i.e. NBC 2010) using the service limit state (SLS) shaft adhesion values provided in Table 1 below. For the ultimate limit state (ULS) case, the piles can be designed with the factored shaft adhesion values and the factored end bearing pressures 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	End Bearing
		(kPa)	(kPa)
0 to 3 (see Note 1)	0	0	0
3 to 10.5	16.5	20.0	180
10.5 to 13	11.5	14.0	125

Note 1: When determining effective pile lengths, the upper 3 m of the pile shaft below existing site grade or 1.5 m below crawl space level, whichever is deeper, should be ignored to account for the presence of fill materials, silt layers and the potential for soil shrinkage away from the pile.

The pile length should be limited to 13 m below existing site grade to avoid drilling into the glacial till layer. 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.

The manhole / sump pit excavation should have clear distance of at least 1.2 m to the nearest pile location. The manhole excavation should not be made until the manhole is ready to install and once installed the excavation should be promptly backfilled.

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.

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

Floor Slabs

We recommend that a structural floor slab over a void space be considered for the building, due to the presence of high plastic (i.e. expansive) clay soils at this site. 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. Structural floor slabs will minimize the potential for movement due to heave or swelling of the underlying clay soils. It is possible that the total amount of heave and swelling could be on the order of 100 mm in the long term. A major factor impacting the magnitude of floor slab movements, which will ultimately occur, are the climatic effects during construction which might impact changes in the sub-soil moisture conditions. For this reason, it is not possible to assess the amount of heave which will occur with any degree of accuracy.

If floor slabs on grade are considered, they must be expected to undergo movements as a result of volumetric changes of the underlying clay soils which are known to be expansive in nature. Floor slab movements are generally expected to be around 25 to 50 mm but it is possible that the long term floor movements could be on the order of 100 mm. If used, some maintenance / repair of a slab on grade floor may be required in the future.

If used, slab-on-grade floors could be isolated from fixed building components (e.g. walls / grade beams) to allow for some floor slab movements to occur without affecting the structure. A vapour barrier below the floor slab should be provided to minimize the potential for long term moisture changes within the underlying clay soils. The floor slab should not be placed against frozen soil. The floor slab should be supported on at least 200 mm of compacted granular base placed on a prepared sub-grade. The granular base should be a 19 mm down crushed limestone material that meets the material selection and construction requirements in the City of Winnipeg's Standard Construction Specifications. Fill, loose and deleterious materials should be stripped from the sub-grade surface prior to preparation. The sub-grade should be uniformly compacted to at least 95 of the standard Proctor maximum dry density before the granular sub-base material is placed.

Below Grade Walls

Basement walls, should be designed to resist lateral earth pressures that are derived on the basis of the following conventional relationship which produces a triangular pressure distribution:

$$P = K \gamma D$$

where P = lateral earth pressure at depth D (kPa)
K = earth pressure coefficient (0.5)
 γ = soil/backfill unit weight 17.3 (kN/m³)
D = depth from surface to point of pressure calculation (m)

The base of the wall should be provided with a filter-protected positive drainage system to prevent the buildup of hydrostatic pressure against the wall. The basement walls should be backfilled with a clean pit run sand and gravel with a maximum particle size of 75 mm. The upper 0.6 m (minimum) of the backfill around the basement walls should be a compacted clay to act as a barrier to prevent infiltration of water

into the granular backfill. The clay should be compacted to 90 to 92 percent of the standard Proctor maximum dry density.

Excavations

All excavation work should be completed by the Contractor in accordance with the current Manitoba Workplace Health and Safety Regulations to suit the planned and expected construction activities and schedule.

Other

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

Positive drainage should be provided away from all structures at gradients of at least 2 percent.

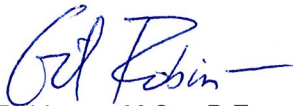
5) Closure

This report and its findings were prepared based on the subsurface conditions encountered in the random representative sample of test holes drilled on 3 December 2015 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.

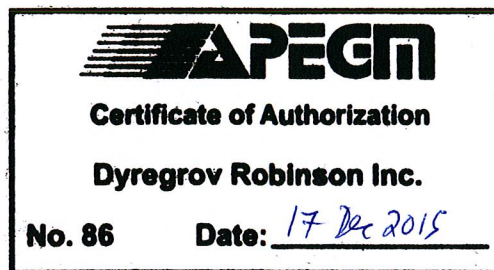
This report was prepared for the sole and exclusive use of the City of Winnipeg for Phase 1B of the Transcona Centennial Pool redevelopment project located at 1101 Wabasha Avenue in Winnipeg, MB. The information and recommendations contained in this report are for the benefit of the City of Winnipeg only and no other party or entity shall have any claim against 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 the author. 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.

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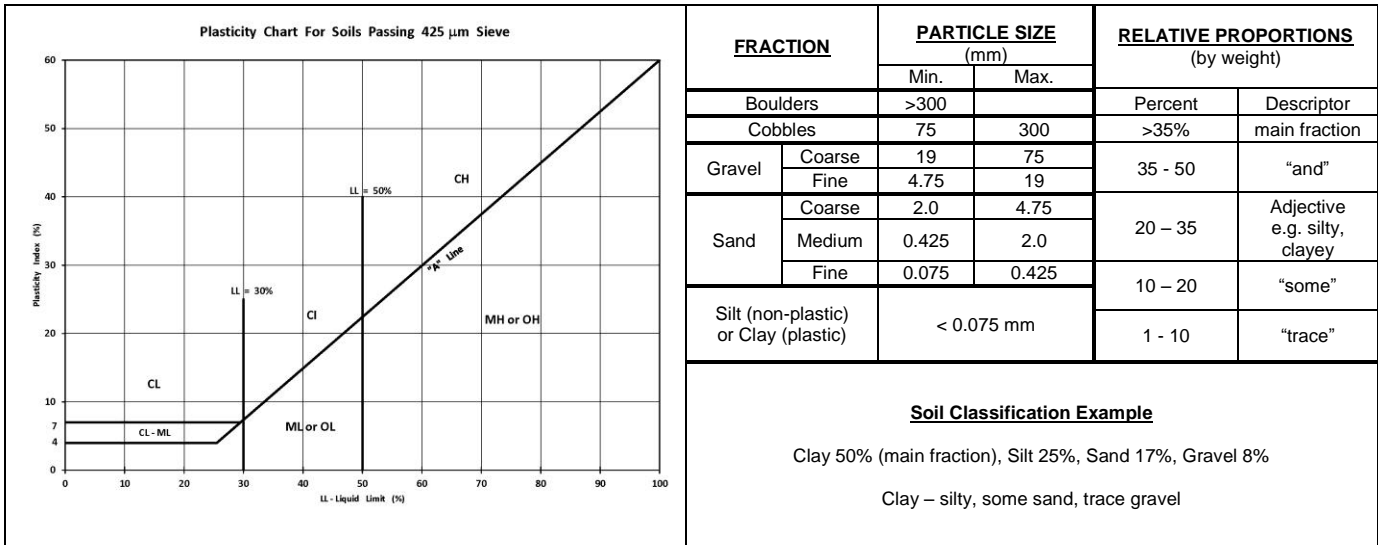


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EXPLANATION OF TERMS & SYMBOLS

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 $4 < W_p < 7$ $C_u = \frac{D_{60}}{D_{10}}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$	
			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)	DYREGROV ROBINSON INC. CONSULTING GEOTECHNICAL ENGINEERS			
	Concrete		Clay Shale		Bedrock (Limestone)				
	Fill				Bedrock (Undifferentiated)				



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/m³ 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: Transcona Pool - Phase 1B		CLIENT: City of Winnipeg			TESTHOLE NO: 1	
LOCATION: 24 m west and 11 m south from south west corner of existing swimming pool					PROJECT NO.: 153928	
CONTRACTOR: Paddock Drilling Ltd.		METHOD: RM - 30 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

