APPENDIX D

Geotechnical Report

GEOTECHNICAL REPORT
PROPOSED RM OF MINIOTA WWSP EXPANSION
MINIOTA, MANITOBA

Prepared for:

RM of Miniota
11 Sarah Avenue
Box 70 Miniota, MB
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Project No: 131-16657-00
September, 2013

GENIVAR

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10 PRAIRIE WAY
WINNIPEG, MB R2J 3J8

TABLE OF CONTENTS

1.0 INTRODUCTION

The Rural Municipality of Miniota is located northwest of Winnipeg, Manitoba's capital city. It is on the Assiniboine River and encompasses the communities of Arrow River Beulah, Crandall, Isabela and Miniota. As part of future development for the community, a geotechnical investigation of the proposed wastewater lagoon expansion site located at NE 25-13-27 WPM was conducted.

This report deals with the site selection of the wastewater lagoon expansion based on the soil conditions with respect to the Environmental Act passed in 1988. Manitoba Conservation's Environmental guidelines require that the dykes and the bottom of any lagoon be provided with a layer consisting of at least one metre of soil having a permeability of $1x10^{-7}$ cm/s or less or equivalence, i.e. the used of plastic liner.

A site plan of the existing wastewater stabilization ponds, as well as the testhole locations is attached, see Appendix A; Site Plan.

2.0 BACKGROUND

At present, the community of Miniota has an existing wastewater storage pond comprised of one primary cell and one secondary cell located at NE 25-13-27 WPM.

3.0 TOPOGRAPHY

The proposed expansion site is located locally on an undulating topography. The topography drops suddenly at the edge of the valley approximately 400m to the west. The land slopes towards the Assiniboine River which is located approximately 1 km west of the lagoon. Surficial deposits are composed mainly of loamy textured glacial till (morainal) deposits over shale bedrock. Areas of deep sand and gravel glaciofluvial deposits are usually sandy at the surface, becoming coarser with depth. The proposed expansion site is developed on a layer of sand and gravel followed by lacustrine clay over glacial till and

followed by grey shale bedrock, that range from about 6.7 to 16.7m in thickness (see the attached nearest well log of NE 25-13-27 WPM).

4.0 FIELD METHODOLOGY AND TESTING

The subsoils encountered were visually classified to the full extent in the testhole and representative soil samples were recovered at regular depth intervals and some samples were submitted for moisture content, particle size analysis and Atterberg limit tests. Pocket penetrometer tests were conducted on the cohesive soil to determine the approximate unconfined compressive strength and relative density respectively. In addition, one Shelby undisturbed soil sample was obtained and tested for hydraulic conductivity test. Any groundwater seepage and sloughing encountered in the testholes were noted.

The field investigation was undertaken on May 30, 2013. A track-drill rig was used to drill sixteen testholes to a 4.6m depth below grade. The testholes locations are shown on the site plan in Appendix A. Detailed descriptions of the soil profiles in each testhole are shown on the attached logs, TH1 to TH16 in Appendix B. Laboratory test results for moisture contents, Atterberg limit, particle size analysis and hydraulic conductivity are attached in Appendix C.

5.0 SUBSURFACE CONDITIONS

5.1 SOIL PROFILE/GROUNDWATER

The general soil profile encountered in testholes, TH1 to TH16 revealed a consistent soil profile. The general soil profile revealed a topsoil/peat moss layer of 50 to 750mm in thickness underlain by an upper thin clay over a SAND/ SAND and GRAVEL layer followed by a high plasticity clay layer which extended to the bottom of the testholes at 4.6m below grade. Seepage from the SAND/SAND and GRAVEL layer was observed in some of the testholes five minutes after completion of drilling. However, surface seepage beneath the topsoil/peat moss should be expected as some water ponding on the low areas was noted during our investigation. A detailed description of the soil profile is presented in the attached logs, Appendix B.

At present, there is a groundwater report (synopsis) prepared by the Planning Branch of the Water Resources Division on this area. Based on this synopsis, groundwater bearing formations or aquifers are formed by surface sand and gravel, lenses of sand and gravel interbedded with glacial till and other surficial deposit (extensive sand and gravel confined to buried bedrock valleys and hard fractured shale bedrock). In the vicinity of our proposed site (closest well logs which are attached in Appendix B are from NE 25-13-27 WPM; our site is at NE 25-13-27 WPM, the main aquifer in this area is LENSES OF SAND AND GRAVEL. The potential well yield is 0.1 to 1.0 L/s. Water quality ranges from poor to fair potable water.

A review of the Groundwater Pollution Hazard Map and Flowing and High Water Level Well Map shows that the proposed site is located within the designated groundwater pollution hazard area.

Based on the drainage map of the area, groundwater flow is towards the west to the Assiniboine River Valley which flows in the south-east direction towards Brandon.

5.2 LABORATORY TESTING

In the laboratory, selected samples were submitted for moisture contents, Atterberg limit and hydrometer test for classification and hydraulic conductivity. The test results are shown in Appendix C.

As classified during our field investigation, the lower clay layer encountered at the site is medium to high plasticity brown clay between 1.2m and 2.7m depth with the exception of testholes, TH1, TH4 and TH5. At these testholes, the brown clay is encountered between 3.3m and 4.3m depth. The hydraulic conductivity of the in-situ massive brown clay at about 1.5m of TH2 was tested.

The brown clay material is a CL material based on Atterberg limit tests. *The estimated hydraulic conductivity of this material, if remoulded or reworked, should range between* 10^{-7} *to* 10^{-9} *cm/sec.*

The hydraulic conductivity of the in-situ clay obtained at 4m of TH2 was 1.0 $x10^{-7}$ cm/sec.

6.0 DESIGN CONSIDERATIONS

There were two anticipated expansion areas; east of the existing lagoon (east site) and south of the existing lagoon (south site). The surface drainage at the south site is very poor. In view of this and the presence of extensive surface water, it is expected that significant site access problems (construction traffic) and groundwater problems may occur during the construction for the proposed structure.

To minimize construction problems relative to the surface water, it is strongly recommended that prior to construction, a system of perimeter ditches leading to a lower spot (retention pond) be installed to drain surface water. These ditches should be provided with an adequate gradient to drain the water away from the site through a positive drainage outlet.

In addition, the sand/sand and gravel layer in some testholes is wet. Where this layer is shallow, the water at this layer could also be drained by perimeter ditching.

Assuming that the surface water and the water at the sand layer are drained, the proposed WWSP will be designed in accordance with the Province of Manitoba Design Objectives for Standard Sewage Lagoons (1985).

The proposed cell will contain a liquid depth of 1.5m and 1m freeboard to minimize the effects of wave action and to provide stability. The inside and outside side slopes of the dykes will be 4:1. The top of the dykes will be designed to be 3m wide to permit vehicles to be driven on the dyke crest. *Depths of more than 2.5m (vertical height from top of dyke to bottom of lagoon) should not be attempted without further analysis (slope or settlement).*

For lagoon construction, Manitoba Conservation's Environmental guidelines require that the proposed dykes and bottom of the proposed cells be provided with a layer consisting of

at least one metre of soil having a permeability of less than $1x10^{-7}$ cm/s. The proposed lagoon site consists mainly of an area where such clay is present.

The selected area, fortunately, consists mainly of CL to CH clay, which should meet the specified hydraulic conductivity of $1x10^{-7}$ cm/s. Beneath the sand/sand and gravel layer, the brown clay at this depth achieved a hydraulic conductivity test result of $1.0x10^{-7}$ cm/s, thus meeting the guidelines.

Based on our field investigation, well logs from Manitoba Water Well reports and laboratory analysis, the proposed pond liner (base and interior) for this site should be constructed with a clay core within the proposed dykes; *note that the existing cells are lined with a 1m thick clay liner.*

The clay core would involve excavating a trench approximately 1.5m to 2m metres wide (minimum) around the inside perimeter of the bottom of the proposed pond and keying into the underlying impervious high plastic clay to an approximate depth between 1.2m and 2.7m below ground surface with the exception of TH1 and TH4, TH5. The trench will be backfilled with impervious clay in 150mm lifts compacted to at least eight passes with a sheepsfoot roller or vibratory equipment.

During construction of the proposed cells(assuming that dewatering of surface drainage and the sand layer has been conducted) the following steps should be followed.

1. The entire area for the proposed expansion pond should be stripped of vegetation, topsoil/peat moss and organic material; the depth of stripping is approximately 50mm to 300mm with the exception of TH1 (750mm thick). The stripped materials should be stockpiled and reused later for the outer slopes and top of the dykes.

2. Layout the proposed pond to the dimensions indicated in the design drawings.

3. For the proposed bottom and interior dykes, the liner and the key should be compacted to 95% standard Proctor density at ±2 to 3% of optimum moisture

content with a vibratory sheepsfoot roller. *Any unsuitable material such as sand or high percentage silt materials should be removed and replaced with the recommended liner and compacted to 95% standard Proctor density.* Ensure that the inside liner consists of at least one metre width of impervious clay compacted to at least a minimum of 95% standard Proctor maximum density in 150 to 200mm lifts. A shrinkage factor of about 25% should be used in calculating volumes of material to be used.

4. The unsuitable material can be used as backfill on the outside face of the dykes. The embankment material should be placed in 150mm lifts compacted to 95% standard Proctor maximum density.

Due to anticipated size of the cells, further erosion control against wind and rain action should be provided by riprap placement on the dykes immediately after construction. A well-developed and maintained grass cover above the riprap should add integrity to the dykes.

The entire completed pond system should be fenced to keep people, children in particular away from the pond. All gates should be locked to prevent access.

Appropriate warning signs should be provided on the fence around the pond, to designate the nature of the facility, and advise against trespassing.

We recommend that a minimum distance of 5 meters be maintained between the outside toe of the embankment and the fence.

7.0 ADDITIONAL CONSIDERATIONS

On the basis of the soil conditions encountered during drilling (i.e. mainly a brown clay or sand subgrade), the recommended road pavement construction at this site should be as follows:

Pavement Thicknesses

	Truck Route	% Compaction
Base Coarse	150 mm	100% Std Proctor
Subbase	225 mm	100% Std Proctor

The above pavement sections should be constructed on a prepared clay/sand subgrade, which should be free of any fibrous organics, softened and disturbed soils. The prepared subgrade should be proof rolled with a heavy sheepsfoot roller which translates to at least 95% Std Proctor and inspected by a qualified geotechnical engineer prior to the placement of the overlying granular fill.

The granular base course and subbase materials should include organic-free, non-frozen, aggregate conforming to the Manitoba Highway gradation limits.

Where soft spots are encountered at the subgrade level, construction traffic should be restricted. Soft spots should be excavated with a large backhoe fitted with a smooth bucket, to at least 300mm below the underside of the subbase and replaced with a 300mm thick layer of 100mm down crushed aggregate/limestone. In this regard, the total granular fill thickness would be 675mm for truck access.

Sieve analysis and compaction testing of the granular base and subbase materials should be conducted by qualified geotechnical personnel to ensure that the materials supplied and percent compactions are in accordance with design specifications.

8.0 STANDARD LIMITATIONS

The factual data, interpretations and recommendations contained in this report pertain to the specific project as described in this report and are not applicable to any other project, site location or party. The comments given in this report are intended only for the guidance of the design engineer. Contractors bidding on, or undertaking the work, should

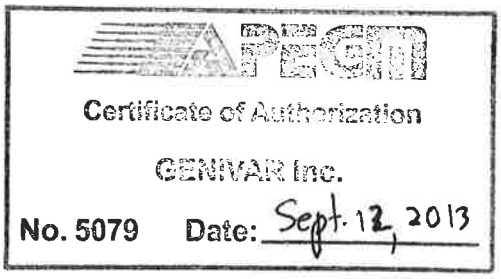
rely on their own investigations, as well as their own interpretations of the factual test data, as to how subsurface conditions may affect their work.

Soil descriptions in this report are based on commonly accepted methods of classification and identification employed in professional geotechnical practice. Classification and identification of soil involves judgement and GENIVAR does not guarantee descriptions as exact, but infers accuracy only to the extent that is common in current geotechnical practice.

Soil formations are variable to a greater or lesser extent. The testhole logs indicate the approximate subsurface conditions only at the locations of the testholes. Boundaries between zones on the logs are often not distinct, but rather transitional, and have been interpreted. Subsurface conditions between testholes are inferred and may vary significantly from conditions encountered at the testholes.

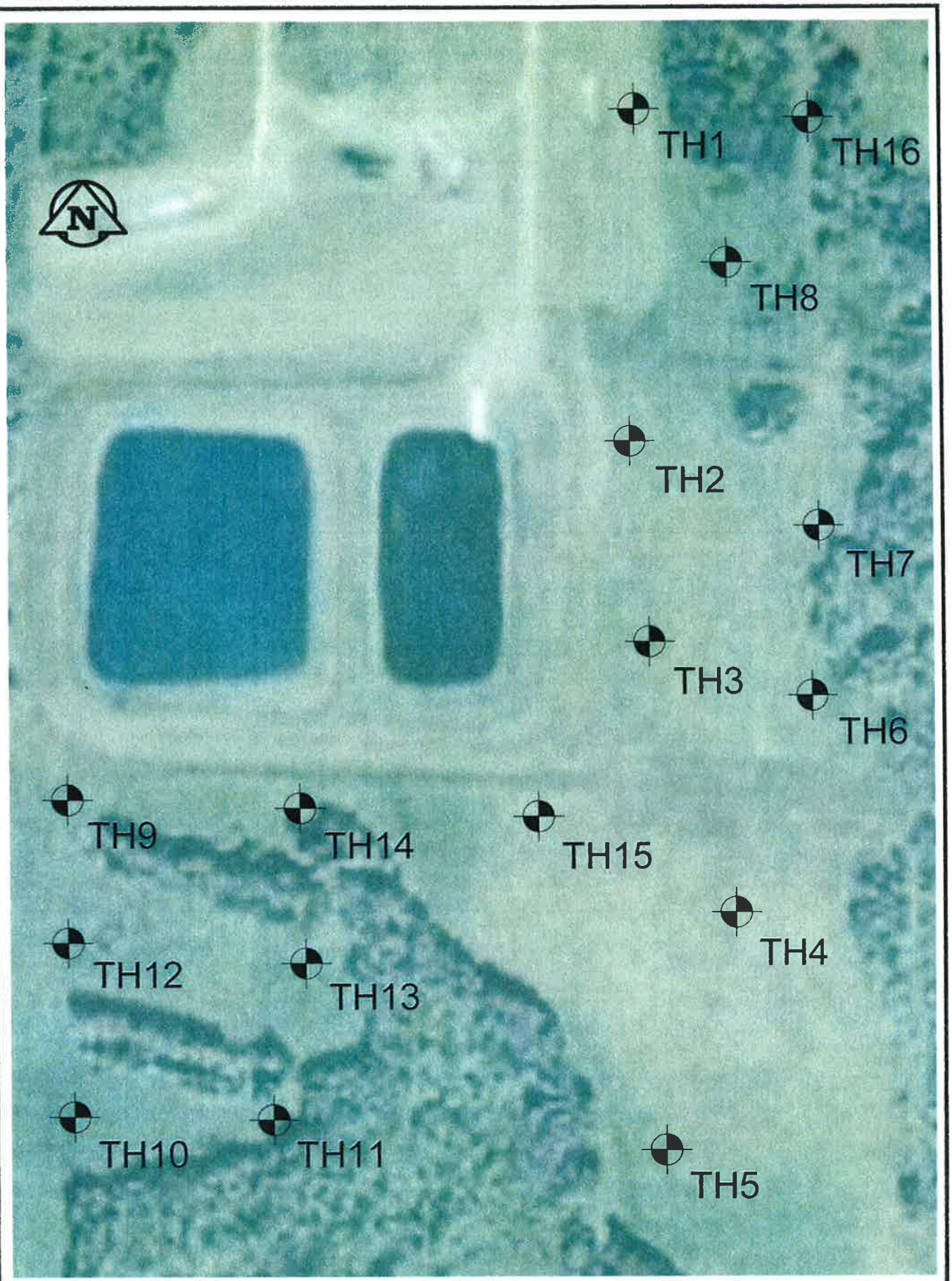
Where conditions encountered at the site differ significantly from those anticipated in the report, either due to natural variability of subsurface conditions or construction activities, it is a condition of the use, or reliance by the client, of this report that GENIVAR is notified of the changes and provided with an opportunity to review the recommendations of this report.

Prepared by: S.S. Urbano Jr., P. Eng.
Reviewed by: Ross Webster, P.Eng.



APPENDIX A

Site Plan



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TITLE:

GEOTECHNICAL INVESTIGATION
– TESTHOLES –
MAY 30, 2013

SCALE: NTS

DATE: 2013/05/31

PROJECT NO: 131-16657-00

REVISION: 0

DRAWING NO: GT Site Plan

XREF

STAMP

APPENDIX B

Testhole and Well Logs

GENIVAR

Project No: 131-16657-00 **TH1**

Project: RM of Miniota WWSP Expansion

Client: RM of Miniota **Enclosure:**

Location: Miniota, MB. (NE 25-13-27 WPM) **Engineer:** SSU

SUBSURFACE PROFILE				SAMPLE		
Depth (ft / m)	Symbol	Description	Depth/Elev.,m	PP(kPa) 50 150 250 350	SPT, N	Water Content % Wp 10 30 — 0 — 50 70 Wl 90
0 / 0		Ground Surface	100			
1		***TOPSOIL*** 750mm thick; 200mm of ROOTLETS over 550mm of CLAYEY LOAM, black	99.3			
3 / 1		***CLAY*** firm, SILTY, tan-brown	99			
6 / 2		***SAND AND GRAVEL*** medium dense, fine to medium grained, fine to coarse gravel; WET at 1.5m	96.9	250		
11 / 3		***CLAY*** stiff, brown, fissured, high plasticity; grey at 3.3m. TESTHOLE CAVED IN AND WATER WAS MEASURED AT 1.8M AFTER COMPLETION OF DRILLING.	95.5	350		
15 / 5		End of Testhole				
20 / 6						
23 / 7						
25						

Drill Method: S/S Auger

Drill Date: 05/30/13

Hole Size: 125 mm

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10 Prairie Way
Winnipeg, MB.
R2J 3J8

Elevation:

Checked by: SSU

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Project No: 131-16657-00 **TH2**

Project: RM of Miniota WWSP Expansion

Client: RM of Miniota **Enclosure:**

Location: Miniota, MB. (NE 25-13-27 WPM) **Engineer:** SSU

SUBSURFACE PROFILE | **SAMPLE**

Depth (ft / m)	Symbol	Description	Depth/Elev., m	PP(kPa)	SPT, N	Water Content %
0 / 0		Ground Surface	100			
		TOPSOIL 150mm thick; 50mm of ROOTLETS over 150mm of CLAYEY LOAM, black				
		SAND AND GRAVEL medium dense, fine to medium grained, fine to coarse gravel, WET	99.2			
1 / 2 / 3 / 4 / 5 / 6 / 7 / 8 / 9 / 10 / 11 / 12 / 13 / 14 / 15		***CLAY*** stiff, brown, fissured, high plasticity; grey at 3.3m. TESTHOLE CAVED IN AND WATER WAS MEASURED AT 3.3M AFTER COMPLETION OF DRILLING.		250 kPa; 350 kPa		
		End of Testhole	95.5			

PP(kPa) scale: 50 150 250 350

Water Content % scale: 10 Wp 30 50 70 WI 90

Drill Method: S/S Auger

Drill Date: 05/30/13

Hole Size: 125 mm

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Project No: 131-16657-00

TH3

Project: RM of Miniota WWSP Expansion

Client: RM of Miniota

Enclosure:

Location: Miniota, MB. (NE 25-13-27 WPM)

Engineer: SSU

SUBSURFACE PROFILE				SAMPLE		
Depth (ft / m)	Symbol	Description	Depth/Elev., m	PP(kPa)	SPT, N	Water Content %
		Ground Surface	100			
0 / 0		**TOPSOIL** 300mm thick; 100mm of ROOTLETS over 200mm of CLAYEY LOAM, black				
1 / 0		**SAND** loose, clayey, tan-brown; trace of fine gravel at 1.5m, moist to wet				
5 / 1			98.4			
6 / 2		**CLAY** stiff, brown, fissured, high plasticity; grey at 2.4m. TESTHOLE WAS OPEN ALL THE WAY. 300MM OF WATER WAS OBSERVED AT THE BASE OF HOLE AFTER COMPLETION OF DRILLING.		175		
10 / 3				275		
13 / 4			95.5	400		
15 / 5		End of Testhole				
20 / 6						
23 / 7						

PP(kPa): 50, 150, 250, 350

Water Content %: 10, Wp, 30, 50, 70, Wl, 90

Drill Method: S/S Auger

Drill Date: 05/30/13

Hole Size: 125 mm

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Elevation:

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GENIVAR

Project No: 131-16657-00

TH4

Project: RM of Miniota WWSP Expansion

Client: RM of Miniota

Enclosure:

Location: Miniota, MB. (NE 25-13-27 WPM)

Engineer: SSU

SUBSURFACE PROFILE				SAMPLE		
Depth (ft / m)	Symbol	Description	Depth/Elev.,m	PP(kPa) 50 150 250 350	SPT, N	Water Content % Wp 10 30 50 70 90 Wl
0 / 0		Ground Surface	100			
0–1 / 0		**TOPSOIL** 50mm thick; 50mm of ROOTLETS				
1–10 / 1–3		**SAND AND GRAVEL** loose to medium dense, medium grained, tan-brown; trace of fine to coarse gravel , moist to wet; WET at 1.8m, gravelly	96.7	150		
11–15 / 4		**CLAY** stiff, brown, fissured, high plasticity; grey at 3.7m. TESTHOLE WAS OPEN TO 3.7M. WATER WAS MEASURED AT 1.5M AFTER COMPLETION OF DRILLING.	95.5	125		
15 / 5		End of Testhole				
16–25 / 5–7						

Drill Method: S/S Auger

Drill Date: 05/30/13

Hole Size: 125 mm

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Elevation:

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GENIVAR

Project No: 131-16657-00

TH5

Project: RM of Miniota WWSP Expansion

Client: RM of Miniota

Enclosure:

Location: Miniota, MB. (NE 25-13-27 WPM)

Engineer: SSU

SUBSURFACE PROFILE				SAMPLE		
Depth (ft / m)	Symbol	Description	Depth/Elev.,m	PP(kPa) 50 150 250 350	SPT, N	Water Content % Wp 10 30 50 70 90 Wl
0 / 0		Ground Surface	100			
		TOPSOIL 50mm thick; 50mm of ROOTLETS				
1 / 2 / 3 / 4 / 5 / 6 / 7 / 8 / 9 / 10 / 11 / 12 / 13 / 1 / 2 / 3 / 4		***SAND AND GRAVEL*** loose to medium dense, medium grained, tan-brown; trace of fine to coarse gravel , moist to wet; WET at 1.5m, gravelly	96			
14 / 15 / 16 / 17 / 18 / 19 / 20 / 21 / 22 / 23 / 24 / 25 / 5 / 6 / 7		***CLAY*** stiff, brown, fissured, high plasticity; grey at 4.3m. TESTHOLE WAS OPEN TO 0.8M. WATER WAS MEASURED AT 0.8M AFTER COMPLETION OF DRILLING. End of Testhole	95.5	150		

Drill Method: S/S Auger

Drill Date: 05/30/13

Hole Size: 125 mm

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GENIVAR

Project No: 131-16657-00

TH6

Project: RM of Miniota WWSP Expansion

Client: RM of Miniota

Enclosure:

Location: Miniota, MB. (NE 25-13-27 WPM)

Engineer: SSU

SUBSURFACE PROFILE				SAMPLE		
Depth (ft / m)	Symbol	Description	Depth/Elev., m	PP(kPa)	SPT, N	Water Content %
				50 150 250 350		Wp 10 30 — 0 — 50 70 Wl 90
0 / 0		Ground Surface	100			
0–1		***TOPSOIL*** 100mm thick; 50mm of ROOTLETS over SANDY LOAM				
1–7 / 1–2		***SAND AND GRAVEL*** loose to medium dense, medium grained, tan-brown; trace of fine to coarse gravel , moist to wet; WET at 1.5m, gravelly	97.7			
8–15 / 3–4		***CLAY*** stiff, brown, fissured, high plasticity; grey at 2.7m. TESTHOLE WAS OPEN TO 1.6M. WATER WAS MEASURED AT 1.5M AFTER COMPLETION OF DRILLING.	95.5	350		
15 / 5		End of Testhole				
16–25 / 5–7						

Drill Method: S/S Auger

Drill Date: 05/30/13

Hole Size: 125 mm

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Project No: 131-16657-00

TH7

Project: RM of Miniota WWSP Expansion

Client: RM of Miniota

Enclosure:

Location: Miniota, MB. (NE 25-13-27 WPM)

Engineer: SSU

SUBSURFACE PROFILE				SAMPLE		
Depth (ft / m)	Symbol	Description	Depth/Elev., m	PP(kPa)	SPT, N	Water Content %
				50 150 250 350		Wp 10 30 | 50 | 70 WI 90
0 / 0		Ground Surface	100			
		TOPSOIL 100mm thick; 50mm of ROOTLETS over SANDY LOAM				
1 / 0		***SAND AND GRAVEL*** loose to medium dense, medium grained, tan-brown; trace of fine to coarse gravel , DRY				
3 / 1						
5 / 1			98.3	250		
6 / 2		***CLAY*** stiff, brown, fissured, high plasticity; grey at 3m. TESTHOLE WAS DRY AFTER COMPLETION OF DRILLING.				
8 / 2						
10 / 3				250		
12 / 4						
13 / 4			95.5	400		
15 / 5		End of Testhole				
16 / 5						
18 / 6						
20 / 6						
21 / 7						
23 / 7						
24 / 7						
25						

Drill Method: S/S Auger

Drill Date: 05/30/13

Hole Size: 125 mm

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Project No: 131-16657-00

TH8

Project: RM of Miniota WWSP Expansion

Client: RM of Miniota

Enclosure:

Location: Miniota, MB. (NE 25-13-27 WPM)

Engineer: SSU

SUBSURFACE PROFILE				SAMPLE		
Depth (ft / m)	Symbol	Description	Depth/Elev.,m	PP(kPa)	SPT, N	Water Content %
		Ground Surface	100			
0 / 0		***TOPSOIL*** 100mm thick; 50mm of ROOTLETS over SANDY LOAM				
1 / 1		***SAND*** loose, fine grained, tan-brown; WET at 0.3m; trace of fine gravel at 1.2m	98.3			
6 / 2		***CLAY*** stiff, brown, fissured, high plasticity; grey at 2.6m. TESTHOLE WAS OPEN TO 1.2M. WATER WAS MEASURED AT 0.9M AFTER COMPLETION OF DRILLING.	95.5	350		
15 / 4		End of Testhole				

PP(kPa): 50 150 250 350

Water Content %: 10 Wp |----0----| Wl 30 50 70 90

Drill Method: S/S Auger

Drill Date: 05/30/13

Hole Size: 125 mm

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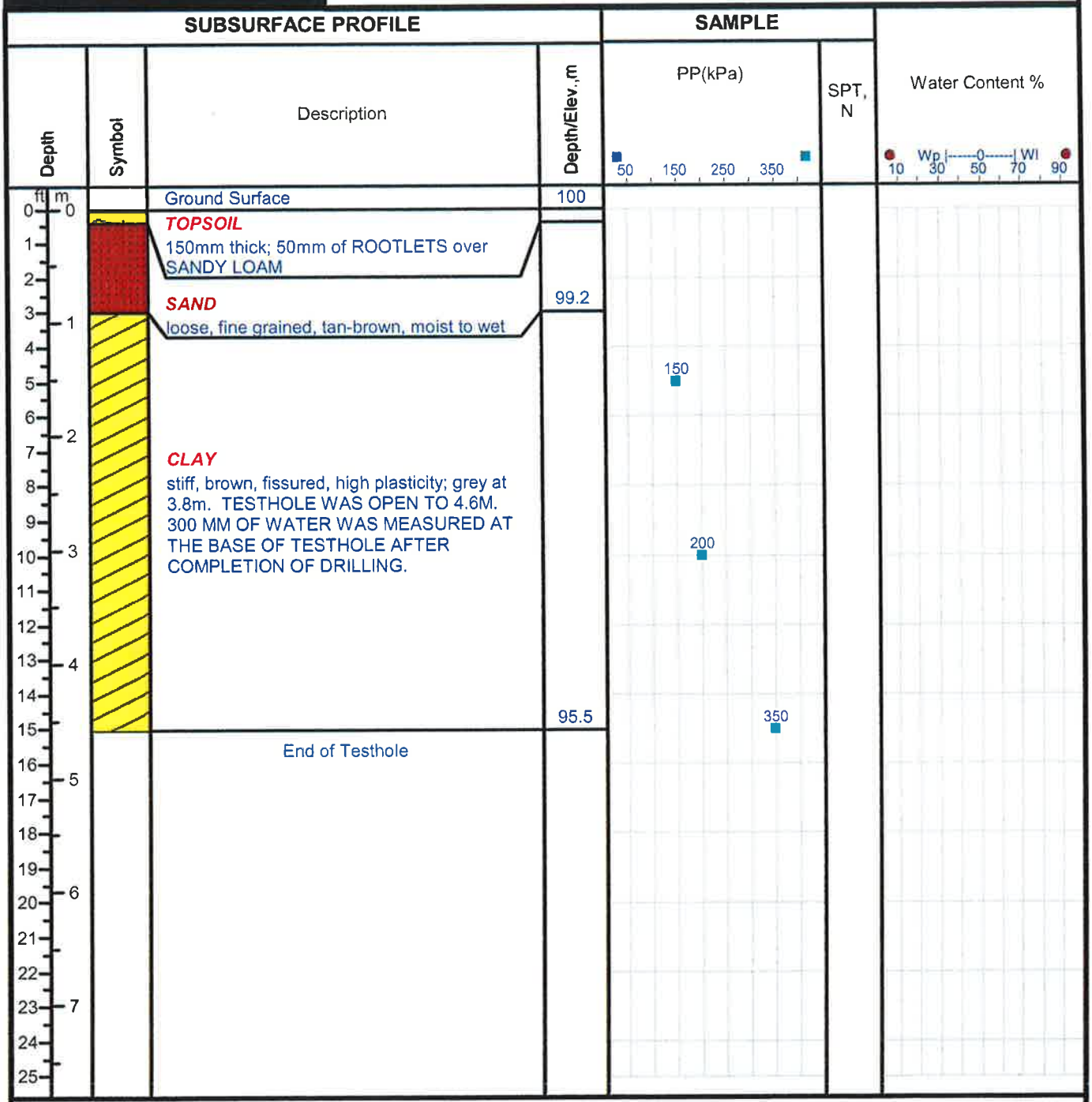
Project No: 131-16657-00 **TH9**

Project: RM of Miniota WWSP Expansion

Client: RM of Miniota **Enclosure:**

Location: Miniota, MB. (NE 25-13-27 WPM) **Engineer:** SSU



Drill Method: S/S Auger

Drill Date: 05/30/13

Hole Size: 125 mm

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Project No: 131-16657-00

TH10

Project: RM of Miniota WWSP Expansion

Client: RM of Miniota

Enclosure:

Location: Miniota, MB. (NE 25-13-27 WPM)

Engineer: SSU

SUBSURFACE PROFILE				SAMPLE		
Depth (ft / m)	Symbol	Description	Depth/Elev.,m	PP(kPa)	SPT, N	Water Content %
		Ground Surface	100			
0		**TOPSOIL** 150mm thick; 50mm of ROOTLETS over CLAYEY LOAM				
2		**SAND** loose, fine grained, tan-brown, silty, WET	99.3			
5				250		
7		**CLAY** stiff, brown, fissured, high plasticity; grey at 3.8m. TESTHOLE WAS OPEN DOWN TO 4.3M. 600MM OF WATER COMING FROM SURFACE WAS MEASURED AT THE BOTTOM OF TESTHOLE AFTER COMPLETION OF DRILLING.				
10				250		
13			95.5			
15		End of Testhole		250		

PP(kPa): 50 150 250 350

Water Content %: Wp |----0----| Wl; 10 30 50 70 90

Drill Method: S/S Auger

Drill Date: 05/30/13

Hole Size: 125 mm

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Winnipeg, MB.
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Elevation:

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GENIVAR

Project No: 131-16657-00 **TH11**

Project: RM of Miniota WWSP Expansion

Client: RM of Miniota **Enclosure:**

Location: Miniota, MB. (NE 25-13-27 WPM) **Engineer:** SSU

SUBSURFACE PROFILE				SAMPLE		
Depth (ft / m)	Symbol	Description	Depth/Elev.,m	PP(kPa)	SPT, N	Water Content %
		Ground Surface	100			
0 / 0		**TOPSOIL** 100mm thick; 50mm of ROOTLETS over CLAYEY LOAM	99.6			
3 / 1		**CLAY** soft, grey-black, silty				
5 / 1		**SAND** loose, fine grained, tan-brown, silty, WET	98.3	150		
6 / 2		**CLAY** stiff, brown, fissured, high plasticity; grey at 2.4m. TESTHOLE WAS OPEN DOWN TO 1.5M. WATER WAS MEASURED AT 0.3M BELOW GRADE AFTER COMPLETION OF DRILLING.		150		
15 / 4			95.5	100		
		End of Testhole				

PP(kPa) scale: 50 150 250 350

Water Content % scale: Wp 10 30 — 0 — 50 70 Wl 90

Drill Method: S/S Auger

Drill Date: 05/30/13

Hole Size: 125 mm

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10 Prairie Way
Winnipeg, MB.
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Elevation:

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Project No: 131-16657-00

TH12

Project: RM of Miniota WWSP Expansion

Client: RM of Miniota

Enclosure:

Location: Miniota, MB. (NE 25-13-27 WPM)

Engineer: SSU

SUBSURFACE PROFILE				SAMPLE		
Depth (ft / m)	Symbol	Description	Depth/Elev.,m	PP(kPa)	SPT, N	Water Content %
		Ground Surface	100			
0		***TOPSOIL*** 125mm thick; 50mm of ROOTLETS over CLAYEY LOAM				
			99.3			
1		***CLAY*** soft, grey-black, silty, moist to wet	98.9			
2		***SAND*** loose, fine grained, tan-brown, silty, WET		150		
3		***CLAY*** stiff, brown, fissured, high plasticity; trace of fine gravel inclusions below 2.6m; grey at 4.1m. TESTHOLE WAS OPEN DOWN TO 1.5M. WATER AT 1.5M AFTER COMPLETION OF DRILLING.		150		
4				350		
			95.5			
5		End of Testhole				
6						
7						

PP(kPa) scale: 50, 150, 250, 350

Water Content % scale: Wp, 0, Wl; 10, 30, 50, 70, 90

Drill Method: S/S Auger

Drill Date: 05/30/13

Hole Size: 125 mm

GENIVAR
10 Prairie Way
Winnipeg, MB.
R2J 3J8

Elevation:

Checked by: SSU

Sheet: 1 of 1

GENIVAR

Project No: 131-16657-00

TH13

Project: RM of Miniota WWSP Expansion

Client: RM of Miniota

Enclosure:

Location: Miniota, MB. (NE 25-13-27 WPM)

Engineer: SSU

SUBSURFACE PROFILE | **SAMPLE**

Depth (ft / m)	Symbol	Description	Depth/Elev., m	PP(kPa)	SPT, N	Water Content %
0 / 0		Ground Surface	100			
0–1 / 0		***TOPSOIL*** 100mm thick; 50mm of ROOTLETS over CLAYEY LOAM	99.5			
1–3 / 0–1		***CLAY*** soft, grey-black, silty, moist to wet	99.2			
3–5 / 1		***SAND*** loose, fine grained, tan-brown, silty, WET		150		
5–15 / 2–4		***CLAY*** stiff, brown, fissured, high plasticity; grey at 2.1m. TESTHOLE WAS OPEN DOWN TO 1.5M. WATER AT 1.5M AFTER COMPLETION OF DRILLING.		175 350		
15 / 5		End of Testhole	95.5			

PP(kPa) scale: 50 150 250 350

Water Content % scale: 10 Wp 30 50 70 WI 90

Drill Method: S/S Auger

Drill Date: 05/30/13

Hole Size: 125 mm

GENIVAR
10 Prairie Way
Winnipeg, MB.
R2J 3J8

Elevation:

Checked by: SSU

Sheet: 1 of 1

GENIVAR

Project No: 131-16657-00

TH14

Project: RM of Miniota WWSP Expansion

Client: RM of Miniota

Enclosure:

Location: Miniota, MB. (NE 25-13-27 WPM)

Engineer: SSU

SUBSURFACE PROFILE				SAMPLE		
Depth (ft / m)	Symbol	Description	Depth/Elev.,m	PP(kPa)	SPT, N	Water Content %
		Ground Surface	100			
0		***TOPSOIL*** 125mm thick; 50mm of ROOTLETS over CLAYEY LOAM				
1		***SAND*** loose, fine grained, tan-brown, silty; gravelly below 0.8m; WET at 0.9m		150		
2			97.8			
3		***CLAY*** stiff, brown, fissured, high plasticity; grey at 2.4m. TESTHOLE WAS OPEN DOWN TO 1.2M. WATER AT 1.2M AFTER COMPLETION OF DRILLING.		350		
4			95.5	350		
5		End of Testhole				
6						
7						

PP(kPa) scale: 50, 150, 250, 350

Water Content % scale: Wp, 0, Wl; 10, 30, 50, 70, 90

Drill Method: S/S Auger

Drill Date: 05/30/13

Hole Size: 125 mm

GENIVAR
10 Prairie Way
Winnipeg, MB.
R2J 3J8

Elevation:

Checked by: SSU

Sheet: 1 of 1

GENIVAR

Project No: 131-16657-00

TH15

Project: RM of Miniota WWSP Expansion

Client: RM of Miniota

Enclosure:

Location: Miniota, MB. (NE 25-13-27 WPM)

Engineer: SSU

SUBSURFACE PROFILE | **SAMPLE**

Depth (ft / m)	Symbol	Description	Depth/Elev.,m	PP(kPa)	SPT, N	Water Content %
0 / 0		Ground Surface	100			
		TOPSOIL 100mm thick; 50mm of ROOTLETS over CLAYEY LOAM				
1 / 1		***SAND and GRAVEL*** medium dense, fine to medium grained, tan-brown; WET at 1.8m				
2 / 2			97.7	200		
3 / 3		***CLAY*** stiff, brown, fissured, high plasticity; grey at 3.3m. TESTHOLE WAS OPEN DOWN TO 1.8M. WATER AT 0.9M AFTER COMPLETION OF DRILLING.		350		
4 / 4			95.5	350		
5 / 5		End of Testhole				
6 / 6						
7 / 7						

PP(kPa) scale: 50 150 250 350

Water Content % scale: Wp 10 30 — 0 — 50 70 Wl 90

Drill Method: S/S Auger

Drill Date: 05/30/13

Hole Size: 125 mm

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10 Prairie Way
Winnipeg, MB.
R2J 3J8

Elevation:

Checked by: SSU

Sheet: 1 of 1

GENIVAR

Project No: 131-16657-00

TH16

Project: RM of Miniota WWSP Expansion

Client: RM of Miniota

Enclosure:

Location: Miniota, MB. (NE 25-13-27 WPM)

Engineer: SSU

SUBSURFACE PROFILE

Depth (ft / m)	Symbol	Description	Depth/Elev.,m
0 / 0		Ground Surface	100
		TOPSOIL 300mm thick; 50mm of ROOTLETS over CLAYEY LOAM	
3 / 1		***CLAY*** soft, grey-black, fissured, moist to wet; sandy below 0.6m	99.2
6 / 2		***SAND and GRAVEL*** loose, fine to medium grained, fine to coarse gravel, tan-brown, WET	97.8
10 / 3		***CLAY*** stiff, brown, fissured, high plasticity; grey at 2.4m. TESTHOLE WAS OPEN DOWN TO 1.2M. WATER AT 1.2M AFTER COMPLETION OF DRILLING.	95.5
15 / 5		End of Testhole	

SAMPLE

PP(kPa): 50, 150, 250, 350

Depth	PP(kPa)	SPT, N
7	200	
10	200	
15	350	

Water Content %: 10, Wp, 30, 50, 70, Wl, 90

Drill Method: S/S Auger

Drill Date: 05/30/13

Hole Size: 125 mm

GENIVAR
10 Prairie Way
Winnipeg, MB.
R2J 3J8

Elevation:

Checked by: SSU

Sheet: 1 of 1

SURACE WITH BENTONITE.

LOCATION: 25-13-27W

Owner: DOUG MCAULEY
Driller: Paddock Drilling Ltd.
Well Name: TH #5
Well Use: TEST WELL
Water Use: Municipal
Date Completed: 1993 Jan 13

WELL LOG

From (ft.)	To (ft.)	Log
0	11.0	FIRM BROWN TILL
11.0	15.0	MILLWOOD SHALE

No construction data for this well.

Top of Casing: 0.0

No pump test data for this well.

REMARKS

EXISTING LANDFILL. RM OF MINIOTA. 6" DIAMETER HOLE DRILLED TO 15' BACKFILLED WITH CUTTINGS AND 2' OF ENVIROPLUG, SEALED AT SURFACE.

LOCATION: NE25-13-27W

Owner: WRB
Driller: PRUDEN DRILLING CO. LTD.
Well Name: MINIOTA TH #1
Well Use: TEST WELL
Water Use:
Date Completed: 1962 Feb 12

WELL LOG

From (ft.)	To (ft.)	Log
0	1.0	DARK GREY SILTY SAND
1.0	17.5	LIGHT BROWN SAND AND GRAVEL
17.5	22.0	BOULDERS
22.0	55.0	GREY SHALE

No construction data for this well.

Top of Casing: ft. below ground

PUMPING TEST

Date:
Pumping Rate: ?? Imp. gallons/minute

APPENDIX C

Laboratory Test Results

H. MANALO CONSULTING LTD.
100 Mallard Way
Winnipeg, Manitoba R2R 1Y1
Phone - 204 997 1355

MOISTURE CONTENT OF SOIL
ASTM D2216

CLIENT:	Silvestre Urbano	TEST NO:	1	PROJECT NO:	13-35
PROJECT:	Miniota WWSP	DATE SAMPLEI	unknown	SAMPLED BY:	SU
PROJECT CONTACT:		DATE TESTED:	June 3/13	TESTED BY:	ES

Test Hole No.	**TH 15**	**TH5**	**TH10**	**TH 10**	
Depth	**5'**	**5'**	**1'**	**5'**	
Wt Wet Sample + Tare	1447.3	984.4	1303.2	746	
Wt Dry Sample + Tare	1408.1	940.3	1110.7	654.7	
Wt Water	39.2	44.1	192.5	91.3	
Wt Tare	430.6	432.7	432.5	325.1	
Wt Dry Sample	977.5	507.6	678.2	329.6	
Moisture Content (%)	**4.01**	**8.69**	**28.38**	**27.70**	
Test Hole No.	**TH5**	**TH2**	**TH10 (1)**	**TH10 (2)**	
Depth	**10'**	**2.5'**	**15'**	**15'**	
Wt Wet Sample + Tare	467.1	1242.9	997.9	705.6	
Wt Dry Sample + Tare	451.8	1165.4	886.8	621.2	
Wt Water	15.3	77.5	111.1	84.4	
Wt Tare	311.1	342.6	428.7	317.9	
Wt Dry Sample	140.7	822.8	458.1	303.3	
Moisture Content (%)	**10.87**	**9.42**	**24.25**	**27.83**	
Test Hole No.	**TH5**	**TH2**	**TH2**	**TH2**	**TH 15**
Depth	**15'**	**15'**	**5'**	**10'**	n/a
Wt Wet Sample + Tare	922.5	745.8	876.3	668.4	1401.6
Wt Dry Sample + Tare	801.9	667.7	791	603.7	1286.5
Wt Water	120.6	78.1	85.3	64.7	115.1
Wt Tare	336.4	315.9	311.5	316.8	827.1
Wt Dry Sample	465.5	351.8	479.5	286.9	459.4
Moisture Content (%)	**25.91**	**22.20**	**17.79**	**22.55**	**25.05**

HERMIE MANALO CONSULTING

H. MANALO CONSULTING LTD.
100 MALLARD WAY, WINNIPEG, MB R2R 1Y1
PHONE: 204 632-7519 CELL: 204 997-1355
hmanalo@mts.net

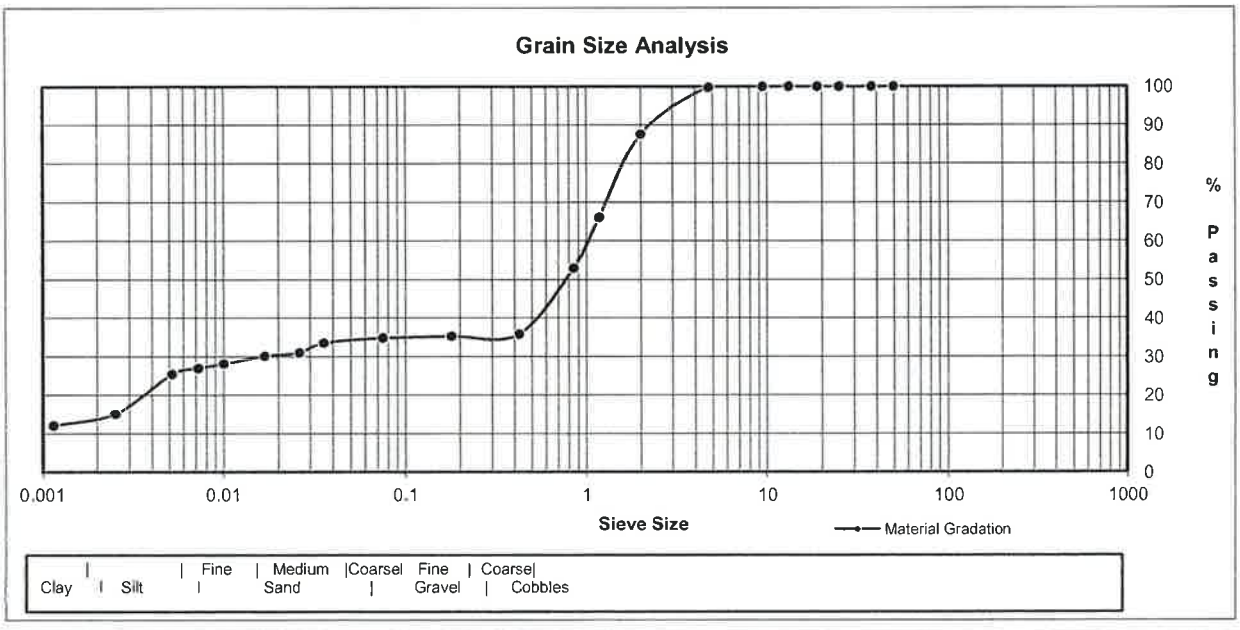
PARTICLE SIZE ANALYSIS OF SOIL REPORT

CLIENT: GENIVAR
10 Prairie Way, The Waters Business Park
SW Corner of Mazenod and Dugald Road
Winnipeg, MB R2J 3J8
ATTN: Silvestre Urbano
PROJECT: Miniota WWSP

HMCL Project No. 13-35
Test No. 2

Sieve Analysis		Hydrometer Analysis	
Sieve	% Passing	Diameter	% Finer
50.0 mm			
37.5 mm			
25.0 mm		0.035559	33.6
19.0 mm		0.026212	31.1
13.2 mm		0.016824	30.2
9.5 mm	100.0	0.010037	28.2
4.75 mm	99.8	0.007225	27.0
2.00 mm	87.7	0.005181	25.5
1.180 mm	66.3	0.002524	15.2
0.850 mm	53.0	0.001146	12.1
0.425 mm	35.9		
0.180 mm	35.4		
0.075 mm	34.9		

SAMPLE ID TH10 - 1 FT.



Remarks: Test Method LS 701, 702/ASTM D422, D4318

ENG-TECH
CONSULTING LIMITED

#6 - 854 Marion Street, Winnipeg, Manitoba, R2J 0K4
Phone: (204) 233-1694 Fax: (204) 235-1579
E-mail: eng_tech@mts.net
www.eng-tech.ca

July 8, 2013

File No. 13-035-02

Genivar Consultants Limited
10 Prairie Way,
Winnipeg, MB
R2J 3J8

ATTENTION: Mr. Silvestre S. Urbano, P. Eng.

RE: WWSP, Minniota, Manitoba

ENG-TECH Consulting Limited (ENG-TECH) completed the hydraulic conductivity test on one Shelby tube sample received and identified as TH2 @ 5ft from the above location. Preliminary hydraulic conductivity results indicated a value greater than $1x10^{-7}$ cm/s for the sample being tested. As such, the sample was stopped, examined and a different sample tested from the same tube. Visual observations of the samples tested indicate the clay is medium to highly plastic and the first sample tested appeared blocky in nature, which can lead to preferential flow paths and the faster rate observed. The hydraulic conductivity test data for the retest is outlined in Table 1, while the graphical representation of the hydraulic conductivity versus elapsed time is shown in Figure 1.

ENG-TECH prepared the sample for hydraulic conductivity testing in accordance with ASTM D5084-03, *Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials using a Flexible Wall Permeameter*. The final hydraulic conductivity value (k_{20}) of 1.0×10^{-7} cm/sec was obtained for the retest sample.

ENG-TECH trusts the above is all the information you require. If you have any questions, please contact the undersigned.

Sincerely,
ENG-TECH Consulting Limited

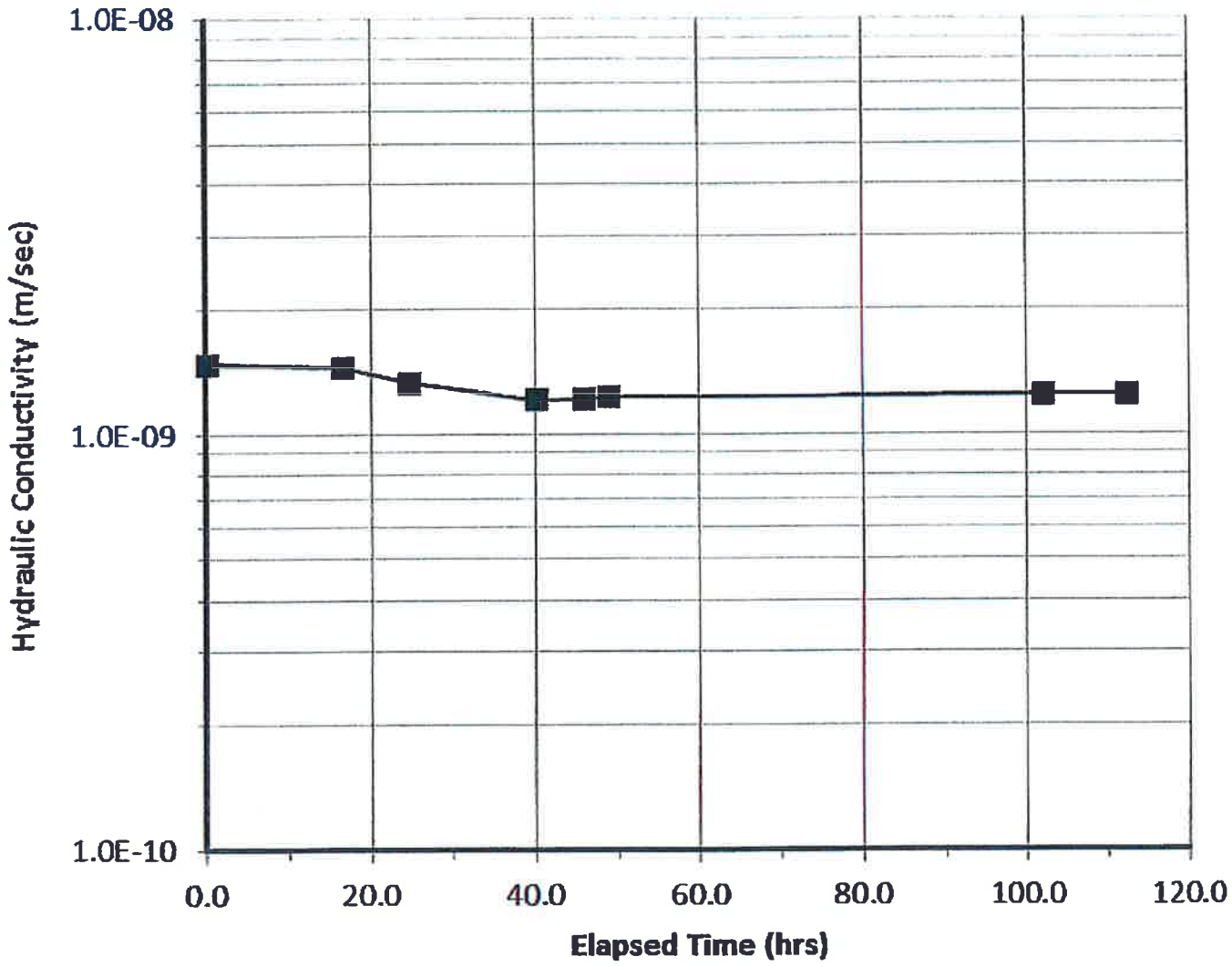
Clark Hryhoruk, M.Sc., P.Eng.
President, Geotechnical Engineer

CDH/erm

Attachments: Table 1 – Soil Sample Analysis
Figure 1 – Hydraulic Conductivity Versus Elapsed Time (TH2 @ 5ft Retest)

TABLE 2
HYDRAULIC CONDUCTIVITY TEST DATA
MINNIOTA, MANITOBA

SAMPLE IDENTIFICATION	TH2 @ 5ft Retest
INITIAL VALUES	
ENG-TECH Reference No.	13-035-2-3
Length of Sample in Tube (cm)	47.0
Length (cm)	5.86
Diameter (cm)	7.09
Area (cm^2)	39.5
Volume (cm^3)	231.3
Water Content (%)	24.2
Bulk Dry Density (kg/m^3)	1626
Specific Gravity (G_s) (assumed)	2.70
Void Ratio	0.611
Degree of Saturation (%)	98.8
FINAL VALUES	
Length (cm)	5.91
Diameter (cm)	7.19
Area (cm^2)	40.6
Volume (cm^3)	240.0
Water Content (%)	26.5
Bulk Dry Density (kg/m^3)	1578
Specific Gravity (G_s) (assumed)	2.70
Void Ratio	0.711
Degree of Saturation (%)	~100
CONSOLIDATION PHASE	
Confining Pressure (kPa)	103.4
Pore Water Pressure (kPa)	82.7
Effective Stress (kPa)	20.7
PERMEATION PHASE	
Confining Pressure (kPa)	103.4
Pore Water Pressure (kPa)	82.7
Effective Stress (kPa)	20.7
Hydraulic Gradient	14.3
Permeant Fluid	Distilled Water
HYDRAULIC CONDUCTIVITY at TEST TEMPERATURE OF 27 °C (cm/sec)	1.2×10^{-7}
HYDRAULIC CONDUCTIVITY at TEMPERATURE OF 20 °C (K_{20}) (cm/sec)	1.0×10^{-7}



ENG-TECH Consulting Limited
#6 - 654 Marion Street
Winnipeg, MB R2J 0K4
Phone: (204) 233-1694
Fax: (204) 235-1579

ENG. STAMP:

APEGM
Certificate of Authorization
ENG-TECH Consulting Limited
No. 2475 Expiry: April 30, 2014

CLIENT: GENIVAR CONSULTING LIMITED

PROJECT: WWSP, TOWN OF MINNIOTA, MANITOBA

DATE: JULY 2013

FILE No.: 13-035-01

DRAWN BY: ERM

FIGURE No.: 1

REV.:

SCALE: N/A

HYDRAULIC CONDUCTIVITY VERSUS ELAPSED TIME (TH2 @ 5ft RETEST)

APPENDIX D

Granular Specification

900. 3.2 - Aggregate Requirements (Cont'd)

The Los Angeles Abrasion Loss on granular base course aggregate will be based on the total sample submitted.

Shale Content is the percent by weight of the particles retained on a 4.75 sieve that are shale particles.

Clay balls are the percent by weight of particles retained on a 12.5 mm sieve that are clay particles.

The aggregate shall be well graded and shall not vary from maximum to minimum of the specification ranges for consecutive tests.

The requirements for each Class will be as follows:

GRANULAR BASE COURSE					
Passing Standard Sieves	CLASS "A"		CLASS "B"	CLASS "C"	
	Gravel	Limestone	Gravel or Limestone	Gravel	Limestone
37.5 mm sieve				100%	
25 mm sieve				85 - 100%	100%
19 mm sieve	100%	100%	100%		
16 mm sieve	80 - 100%				
4.75 mm sieve	40 - 70%	35 - 70%	30 - 75%	25 - 80%	25 - 80%
2 mm sieve	25 - 55%		25 - 65%		
425 um sieve	15 - 30%	15 - 30%	15 - 35%	15 - 40%	
75 um sieve	8 - 15%	8 - 17%	8 - 18%	8 - 18%	8 - 20%
Minimum Crush Count	35%	100%	25%	15%	100%
Maximum					
a) Los Angeles Abrasion Loss	35%	35%	35%	40%	40%
b) Shale Content	12%		12%	20%	
c) Clay Balls	10%		10%		