APPENDIX C

Geotechnical Report

GEOTECHNICAL REPORT

PROPOSED RM OF MACDONALD - COMMUNITY OF LA SALLE

WWSP EXPANSION

LA SALLE, MANITOBA

Prepared for:

RM of Macdonald

Project No: 131-21138-00
January, 2014

WSP Canada Inc.
1600 Buffalo Place
WINNIPEG, MB R3T 6B8

TABLE OF CONTENTS

1.0 INTRODUCTION

The Rural Municipality of Macdonald is located in south central Manitoba and is situated adjacent to the southwestern boundary of Winnipeg, Manitoba's capital city. As part of future development for RM of Macdonald, a geotechnical investigation of the proposed wastewater lagoon expansion site located in section 27-8-2 EPM was conducted.

This report deals with the wastewater lagoon expansion based on the soil conditions with respect to the recent Environmental Act passed in 1988. Manitoba Conservation's Environmental guidelines now 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.

2.0 BACKGROUND

At present, the RM of Macdonald, community of La Salle, has an existing wastewater storage pond comprised of two primary cells and two secondary cells located in section 27-8-2 EPM.

3.0 TOPOGRAPHY

The proposed site is located on an area known as the Red River Plain sub-area. The Red River Plain sub-area is a clay basin, with local flood plains and river levees, which occupies the flat areas in the lower-lying part of the Lake Agassiz basin. The area consists of lacustrine clay and alluvial deposits which range from a few metres to 13 m or more in thickness. Limestone bedrock below thick clay and till layers (see the attached nearest well log of SW 26-8-2E) underlies much of the surficial deposits about 24 m below grade.

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, two shelby tube soil samples were obtained and one was tested for hydraulic conductivity test. Any groundwater seepage and sloughing encountered in the testholes were noted.

The field investigation was undertaken on November 19, 2013. A tracked-drill rig was used to drill a total of 14 testholes between 4.6 m and 7.6 m depths below grade. The testhole 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 TH14 in Appendix B. Laboratory test results for moisture contents and hydraulic conductivity are attached in Appendix C.

5.0 SUBSURFACE CONDITIONS

5.1 SOIL PROFILE/GROUNDWATER

The general soil profile reveals a topsoil layer of about 100 mm to 150 mm followed by a thick clay layer, which extended to the bottom of the testholes at 7.6 m below grade. Fractured high plasticity clay was observed down to 1 m. Beneath the fractured clay is a cohesive, high plasticity clay which extends down to 7.6 m depth.

No seepage and caving conditions were observed from the testholes. Detailed description of testholes, TH1 to TH14 are shown in Appendix B, Testhole Logs.

Groundwater

At present, there is a preliminary groundwater report prepared by the Planning Branch of the Water Resources Division on this area. Groundwater is readily available and fresh in

the area east of the Red and Rat Rivers. The main aquifer in the area is the carbonate bedrock (limestone and dolostone) that underlies the whole area but bears freshwater only in the areas east of the Red and Rat Rivers. The depth to the carbonate bedrock ranges from 12m to 40m. Minor shallow sand aquifers were found along the La Salle River meander belt and along one of its tributaries near Starbuck. The well yields of the main aquifer are adequate for moderate industrial and municipal requirements and groundwater quality ranges from fair to excellent.

A review of the Groundwater Pollution Hazard Map shows that the property is located outside a groundwater pollution hazard area.

Based on the drainage map of the area, groundwater flow at the site is immediately towards the north and eventually heading to the La Salle River.

5.2 LABORATORY TESTING

In the laboratory, selected samples as shown in Appendix C were submitted for moisture contents and one sample for hydraulic conductivity. The test results are shown in Appendix C.

As classified during our field investigation, the clay layer encountered at the site is heavily fractured beneath the topsoil layer down to at least 1 m below grade. For this reason, hydraulic conductivity of the in-situ clay at approximately 1 m below grade was tested.

The clay material in the upper 1.5 m of the soil profile is a CH material based on visual classification. The estimated hydraulic conductivity of this material should range between 10^{-8} to 10^{-9} cm/sec.

The hydraulic conductivity of the in-situ clay obtained at 1.5 m depth for TH4 was 5.6 $x10^{-9}$ cm/sec.

6.0 DESIGN CONSIDERATIONS

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 1.5 m 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 3 m to 5 m wide to permit large vehicles to be driven on the dyke crest. *Depths of more than 2.5 m (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, unfortunately, consists mainly of upper CH clay with fracture structure, which may not meet the specified hydraulic conductivity of 1x10-7 cm/s. Beneath the fractured clay is high plasticity clay down to 7.6m below grade and which achieved a hydraulic conductivity test result of less than $1.0x10^{-7}$ cm/s, thus meeting the guidelines. The intention is to cut at least 0.3m to 0.6m from grade. If this is the case, the fractured clay should be recompacted with at least 10 passes of heavy vibratory roller to meet the guideline for clay liner. Otherwise, the entire area should be excavated to 1m below grade where less fractured clay is encountered.

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 a constructed 1 m thick clay liner.

Ensure that the outside slopes of existing dykes should be covered with at least 1m of CH material compacted to at least 95% STD proctor density during the construction of the expansion.

During construction of the proposed expansion cells, the following steps should be followed.

1. The entire area for the proposed pond should be stripped of vegetation, topsoil and organic material; the depth of stripping is approximately 100 mm to 150 mm. 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 should be compacted to 95% standard Proctor density at 2 to 3% of optimum moisture content with a 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 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 mm to 200 mm 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 150 mm lifts compacted with at least eight passes with a sheepsfoot roller having a foot pressure of no less than 700 kPa.

Further erosion control against wind and rain action using riprap placed on the interior slope of the dykes should be provided, if needed, 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 and 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 subgrade), the recommended road pavement construction at this site should be as follows:

Pavement Thicknesses

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

The above pavement sections should be constructed on a prepared stiff clay subgrade, which should be free of any fibrous organics, softened and disturbed soils. The average depth of site stripping is about 100 mm to 150 mm below ground surface. The prepared subgrade should be proof rolled with a heavy sheepsfoot roller (min. 20 passes) 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, see Appendix D.

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 300 mm below the underside of the subbase and replaced with a 300 mm thick layer of 100 mm down crushed aggregate/limestone. In this regard, the total granular fill thickness would be 675 mm 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 WSP Canada Inc. does not guarantee descriptions as exact, but infers accuracy only to the extent that is common in current geotechnical practice.

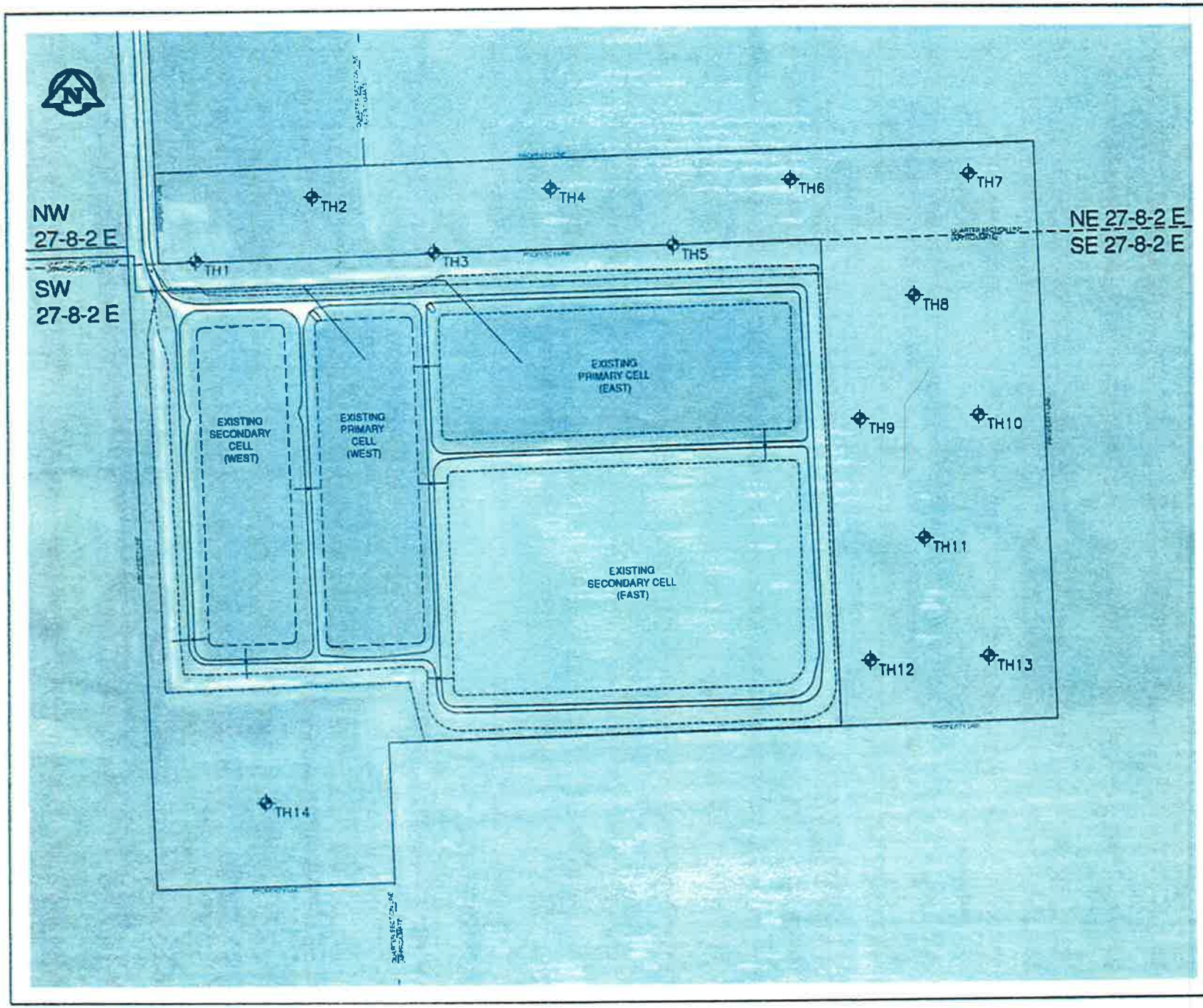
Soil formations are variable to a greater or lesser extent. The testhole logs indicate the approximate subsurface conditions only at the locations of the testhole. Boundaries between zones on the logs are often not distinct, but rather transitional, and have been interpreted. Subsurface conditions between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

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 WSP Canada Inc. 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



GENIVAR

PRELIMINARY
NOT FOR CONSTRUCTION

R.M. OF MACDONALD

R.M. OF MACDONALD
LA SALLE LAGOON EXPANSION

CIVIL

EXISTING SITE PLAN WITH TESTHOLES

C01

GEOTECHNICAL REPORT

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APPENDIX B

TESTHOLE LOGS and WELL LOGS

GENIVAR

Project No: 131-21138-00 **TH1**

Project: La Salle WWSP Expansion

Client: RM of Macdonald **Enclosure:**

Location: SE 27-8-2 EPM **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 150mm, clayey loam with rootlets, black		250		
1 / 1						
2				100		
3 / 2		**CLAY** stiff, brown, fractured to 1m; cohesive below 1m, high plasticity. TESTHOLE IS DRY AND OPEN DOWN TO 4.6M.				
4 / 3				100		
5						
6 / 4						
7						
8 / 5			95.5	100		
9		End of Testhole				
10 / 6						
11						
12 / 7						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						

Drill Method: S/S Auger

Drill Date: 11/19/13

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: 131-21138-00

TH2

Project: La Salle WWSP Expansion

Client: RM of Macdonald

Enclosure:

Location: SE 27-8-2 EPM

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			
		TOPSOIL 150mm, clayey loam with rootlets, black		250		
1 / 1						
2 / 2		**CLAY** stiff, brown, fractured to 0.6m; cohesive below 0.6m, high plasticity. TESTHOLE IS DRY AND OPEN DOWN TO 4.6M.		200		
3 / 3				150		
4 / 4			95.5	100		
5 / 5		End of Testhole				
6 / 6						
7 / 7						

Drill Method: S/S Auger

Drill Date: 11/19/13

Hole Size: 125 mm

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Elevation:

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GENIVAR

Project No: 131-21138-00 **TH3**

Project: La Salle WWSP Expansion

Client: RM of Macdonald **Enclosure:**

Location: SE 27-8-2 EPM **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 125mm, clayey loam with rootlets, black		250		
1 / 1						
2				200		
3		**CLAY** stiff, grey-black, fractured to 0.8m; brown, cohesive below 0.8m, high plasticity. TESTHOLE IS DRY AND OPEN DOWN TO 4.6M.				
4 / 2						
5						
6						
7						
8						
9				100		
10 / 3						
11						
12						
13						
14 / 4						
15			95.5	100		
16		End of Testhole				
17 / 5						
18						
19						
20 / 6						
21						
22						
23 / 7						
24						
25						

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

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

Drill Method: S/S Auger

Drill Date: 11/19/13

Hole Size: 125 mm

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Elevation:

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GENIVAR

Project No: 131-21138-00

TH4

Project: La Salle WWSP Expansion

Client: RM of Macdonald

Enclosure:

Location: SE 27-8-2 EPM

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			
		TOPSOIL 100mm, clayey loam with rootlets, black		250		
3 / 1				250		
6 / 2						
10 / 3				100		
		CLAY stiff, grey-black, fractured to 0.8m; brown at 0.8m; cohesive below 1.2m, high plasticity; grey at 6.1m. TESTHOLE IS DRY AND OPEN DOWN TO 7.6M.				
13 / 4				100		
16 / 5						
19 / 6				75		
23 / 7						
25			92.5	50		

Drill Method: S/S Auger

Drill Date: 11/19/13

Hole Size: 125 mm

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GENIVAR

Project No: 131-21138-00 **TH5**

Project: La Salle WWSP Expansion

Client: RM of Macdonald **Enclosure:**

Location: SE 27-8-2 EPM **Engineer:** SSU

SUBSURFACE PROFILE

Depth (ft / m)	Symbol	Description	Depth/Elev., m
0 / 0		Ground Surface	100
		TOPSOIL 100mm, clayey loam with rootlets, black	
1 / 2 / 3 / 4 / 5 / 6 / 7 / 8 / 9 / 10 / 3 / 11 / 12 / 13 / 4 / 14 / 15		***CLAY*** stiff, brown, fractured to 0.9m; cohesive below 0.9m, high plasticity; trace of silt inclusions at 0.3 to 1.2m. TESTHOLE IS DRY AND OPEN DOWN TO 4.6M.	
		End of Testhole	95.5
16 / 5 / 17 / 18 / 19 / 6 / 20 / 21 / 22 / 23 / 7 / 24 / 25			

SAMPLE

PP(kPa)	SPT, N	Water Content %
250		
200		
100		
100		

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

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

Drill Method: S/S Auger

Drill Date: 11/19/13

Hole Size: 125 mm

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GENIVAR

Project No: 131-21138-00

TH6

Project: La Salle WWSP Expansion

Client: RM of Macdonald

Enclosure:

Location: SE 27-8-2 EPM

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, clayey loam with rootlets, black		250		
1 / 1				200		
2 / 2		**CLAY** stiff, brown, fractured to 0.9m; cohesive below 0.9m, high plasticity. TESTHOLE IS DRY AND OPEN DOWN TO 4.6M.		150		
3 / 3						
4 / 4			95.5	100		
5 / 5		End of Testhole				
6 / 6						
7 / 7						

PP(kPa) scale: 50 150 250 350

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

Drill Method: S/S Auger

Drill Date: 11/19/13

Hole Size: 125 mm

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GENIVAR

Project No: 131-21138-00

TH7

Project: La Salle WWSP Expansion

Client: RM of Macdonald

Enclosure:

Location: SE 27-8-2 EPM

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			
		TOPSOIL 75mm, clayey loam with rootlets, black		250		
1 / 1						
				200		
2 / 2		**CLAY** stiff, grey-black, fractured to 0.6m; SILTY at 0.6 to 0.9m; cohesive below 0.9m, high plasticity. TESTHOLE IS DRY AND OPEN DOWN TO 4.6M.				
3 / 3				100		
4 / 4			95.5	100		
5 / 5		End of Testhole				
6 / 6						
7 / 7						

Drill Method: S/S Auger

Drill Date: 11/19/13

Hole Size: 125 mm

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GENIVAR

Project No: 131-21138-00

TH8

Project: La Salle WWSP Expansion

Client: RM of Macdonald

Enclosure:

Location: SE 27-8-2 EPM

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			
		TOPSOIL 150mm, clayey loam with rootlets, black		250		
1 / 1						
				200		
2 / 2		***CLAY*** stiff, brown, fractured to 0.8m; cohesive below 0.8m, high plasticity. TESTHOLE IS DRY AND OPEN DOWN TO 4.6M.				
3 / 3				125		
4 / 4			95.5	100		
5 / 5		End of Testhole				
6 / 6						
7 / 7						

Drill Method: S/S Auger

Drill Date: 11/19/13

Hole Size: 125 mm

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GENIVAR

Project No: 131-21138-00 **TH9**

Project: La Salle WWSP Expansion

Client: RM of Macdonald **Enclosure:**

Location: SE 27-8-2 EPM **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, clayey loam with rootlets, black	99.8	250		
1 / 1						
2				200		
3 / 1		**CLAY** silty, dry to 1m, stiff, tan-brown; cohesive below 1m, brown, high plasticity. TESTHOLE IS DRY AND OPEN DOWN TO 4.6M.				
4						
5						
6 / 2						
7						
8						
9				100		
10 / 3						
11						
12						
13 / 4						
14						
15			95.5	100		
16		End of Testhole				
17 / 5						
18						
19						
20 / 6						
21						
22						
23 / 7						
24						
25						

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

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

Drill Method: S/S Auger

Drill Date: 11/19/13

Hole Size: 125 mm

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GENIVAR

Project No: 131-21138-00 **TH10**

Project: La Salle WWSP Expansion

Client: RM of Macdonald **Enclosure:**

Location: SE 27-8-2 EPM **Engineer:** SSU

SUBSURFACE PROFILE

Depth (ft / m)	Symbol	Description	Depth/Elev.,m	PP(kPa)	SPT, N	Water Content %
0 / 0		Ground Surface	100			
		TOPSOIL 150mm, clayey loam with rootlets, black		250		
				250		
				125		
		CLAY stiff, grey-black, fractured to 0.9m; brown at 0.9m, cohesive below 0.9m, high plasticity; grey-brown at 4.6m. TESTHOLE IS DRY AND OPEN DOWN TO 7.6M.		100		
				100		
			92.5	100		

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

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

Drill Method: S/S Auger

Drill Date: 11/19/13

Hole Size: 125 mm

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Project No: 131-21138-00

TH11

Project: La Salle WWSP Expansion

Client: RM of Macdonald

Enclosure:

Location: SE 27-8-2 EPM

Engineer: SSU

SUBSURFACE PROFILE

Depth (ft / m)	Symbol	Description	Depth/Elev.,m
0 / 0		Ground Surface	100
		TOPSOIL 125mm, clayey loam with rootlets, black	
		CLAY stiff, grey-black, fractured to 1m; brown at 0.6m; cohesive below 1m, high plasticity; grey-brown at 4.6m. TESTHOLE IS DRY AND OPEN DOWN TO 7.6M.	
25			92.5

SAMPLE

Depth (ft / m)	PP(kPa) (50 150 250 350)	SPT, N	Water Content % (Wp | 0 | Wl; 10 30 50 70 90)
0 / 0			
1	250		
2			
3 / 1			
4			
5	250		
6			
7 / 2			
8			
9			
10 / 3	125		
11			
12			
13 / 4			
14			
15	100		
16			
17 / 5			
18			
19			
20 / 6	100		
21			
22			
23 / 7			
24			
25	100		

Drill Method: S/S Auger

Drill Date: 11/19/13

Hole Size: 125 mm

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GENIVAR

Project No: 131-21138-00

TH12

Project: La Salle WWSP Expansion

Client: RM of Macdonald

Enclosure:

Location: SE 27-8-2 EPM

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, clayey loam with rootlets, black		250		
1 / 1						
				200		
2 / 2		**CLAY** stiff, grey-black, fractured to 1m; brown at 1m; cohesive below 1m, high plasticity. TESTHOLE IS DRY AND OPEN DOWN TO 4.6M.				
3 / 3				125		
4 / 4			95.5	100		
5 / 5		End of Testhole				
6 / 6						
7 / 7						

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

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

Drill Method: S/S Auger

Drill Date: 11/19/13

Hole Size: 125 mm

GENIVAR
10 Prairie Way
Winnipeg, MB.
R2J 3J8

Elevation:

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GENIVAR

Project No: 131-21138-00 **TH13**

Project: La Salle WWSP Expansion

Client: RM of Macdonald **Enclosure:**

Location: SE 27-8-2 EPM **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					
		150mm, clayey loam with rootlets, black		250			
1							
2							
3 / 1							
4				200			
5							
6		***CLAY***					
7 / 2		stiff, grey-black to 0.8m; fractured to 1m; brown below 0.8m; cohesive below 1m, high plasticity. TESTHOLE IS DRY AND OPEN DOWN TO 4.6M.					
8							
9							
10 / 3				125			
11							
12							
13 / 4							
14							
15			95.5	100			
16		End of Testhole					
17 / 5							
18							
19							
20 / 6							
21							
22							
23 / 7							
24							
25							

Drill Method: S/S Auger

Drill Date: 11/19/13

Hole Size: 125 mm

GENIVAR
10 Prairie Way
Winnipeg, MB.
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Elevation:

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Sheet: 1 of 1

GENIVAR

Project No: 131-21138-00

TH14

Project: La Salle WWSP Expansion

Client: RM of Macdonald

Enclosure:

Location: SE 27-8-2 EPM

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 Wl 90
0 / 0		Ground Surface	100			
		TOPSOIL				
		125mm, clayey loam with rootlets, black		250		
1 / 1						
2				200		
3						
4 / 2		***CLAY*** stiff, grey-black to 1m; fractured to 1m; brown below 1m; cohesive below 1m, high plasticity. TESTHOLE IS DRY AND OPEN DOWN TO 4.6M.				
5				125		
6 / 3						
7						
8						
9						
10 / 4						
11						
12						
13						
14						
15			95.5	100		
16 / 5		End of Testhole				
17						
18						
19						
20 / 6						
21						
22						
23 / 7						
24						
25						

Drill Method: S/S Auger

Drill Date: 11/19/13

Hole Size: 125 mm

GENIVAR
10 Prairie Way
Winnipeg, MB.
R2J 3J8

Elevation:

Checked by: SSU

Sheet: 1 of 1

LOCATION: SW26-8-2E

Owner: R GINEDERICH
Driller: Friesen Drillers Ltd.
Well Name:
Well Use: PRODUCTION
Water Use: Domestic
Date Completed: 1986 May 20

WELL LOG

From (ft.)	To (ft.)	Log
0	14.0	CLAY; YELLOW
14.0	42.0	CLAY; GREY
42.0	54.0	SAND AND GRAVEL
54.0	78.9	TILL
78.9	119.9	LIMESTONE

WELL CONSTRUCTION

From (ft.)	To (ft.)	Casing Type	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0	79.9	casing	4.20			INSERT	BLACK IRON
79.9	119.9	open hole	4.00				

Top of Casing: ft. below ground

PUMPING TEST

Date: 1986 May 20
Pumping Rate: 10.0 Imp. gallons/minute
Water level before pumping: 19.0 ft. below ground
Pumping level at end of test: ?? ft. below ground
Test duration: hours, 30 minutes
Water temperature: ?? degrees F

LOCATION: NE28-8-2E

Owner: DUNCAN ASSOCIATES
Driller: ASSINIBOINE DRILLING CO. LTD.
Well Name:
Well Use: PRODUCTION
Water Use: Domestic
Date Completed: 1983 Jan 26

WELL LOG

From (ft.)	To (ft.)	Log
0	23.0	YELLOW SANDY SILTY CLAY
23.0	28.0	BLUE MEDIUM COARSE SAND
28.0	31.0	FIRM GRAVEL AND CLAY WITH SMALL BOULDERS

WELL CONSTRUCTION

APPENDIX C

LABORATORY TEST RESULTS

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

January 14, 2013

File No. 13-035-02

WSP Canada Inc.
1600 Buffalo Place,
Winnipeg, MB
R3T 6B8

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

RE: Hydraulic Conductivity, Clay Liner, Town of La Salle, Manitoba

ENG-TECH Consulting Limited (ENG-TECH) completed the hydraulic conductivity testing service for the above facility in the Town of Salle, MB. ENG-TECH received a Shelby tube sample identified as TH4 @ 5ft from the above location. The hydraulic conductivity test data 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 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 4.7×10^{-9} cm/sec was obtained for the 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

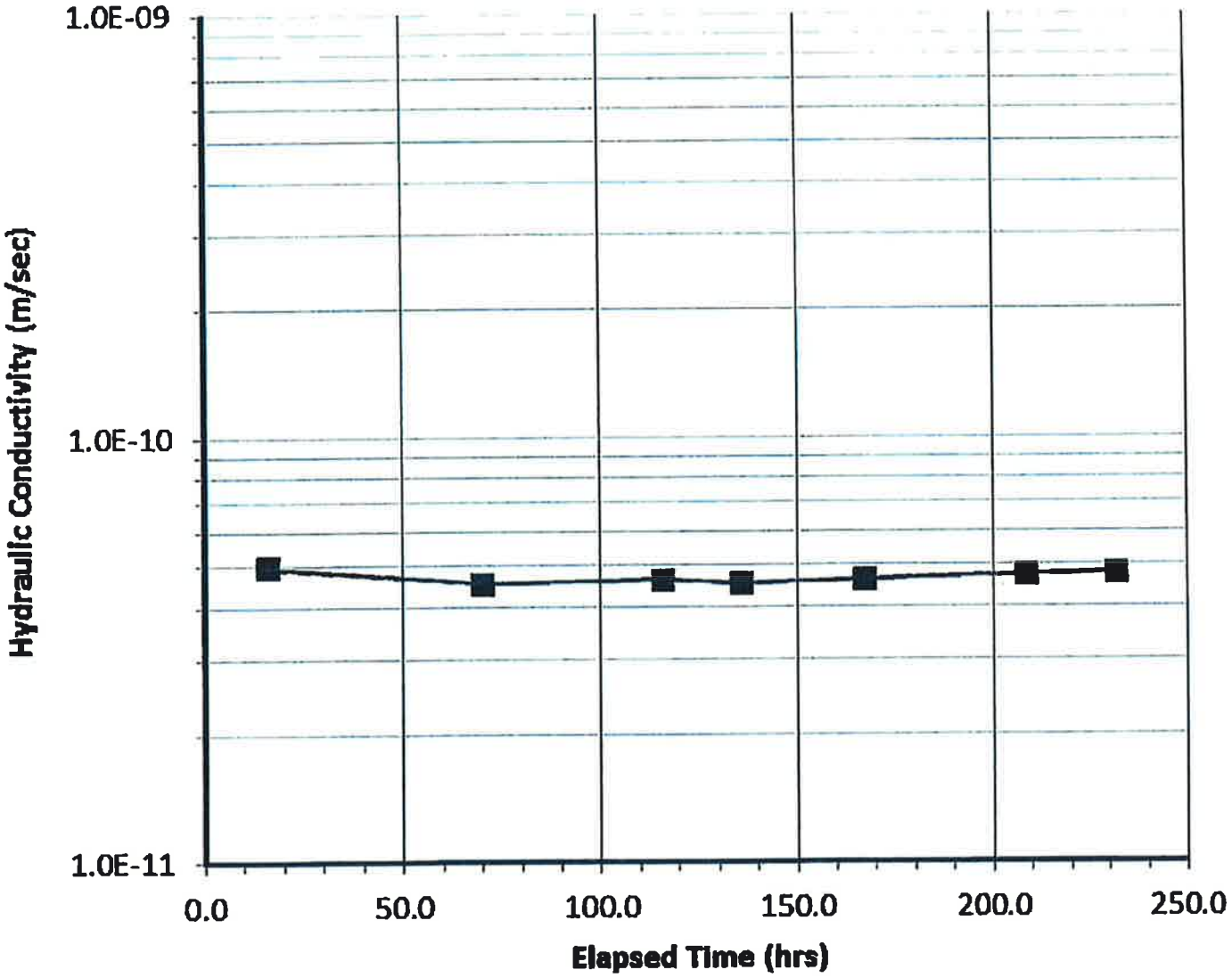
Clark Hryhoruk, M.Sc., P.Eng.
President, Geotechnical Engineer

CDH/erm

Attachments: Table 1 – Soil Sample Analysis
Figure 1 – Hydraulic Conductivity Versus Elapsed Time (TH4 @ 5ft)

TABLE 1
HYDRAULIC CONDUCTIVITY TEST DATA
LA SALLE

SAMPLE IDENTIFICATION	TH4 @ 5ft
INITIAL VALUES	
ENG-TECH Reference No.	13-35-2-14
Length of Sample in Tube (cm)	33.0
Length (cm)	6.43
Diameter (cm)	7.15
Area (cm^2)	40.1
Volume (cm^3)	257.6
Water Content (%)	40.1
Bulk Dry Density (kg/m^3)	1281
Specific Gravity (G_s) (assumed)	2.70
Void Ratio	1.108
Degree of Saturation (%)	97.8
FINAL VALUES	
Length (cm)	6.73
Diameter (cm)	7.27
Area (cm^2)	41.5
Volume (cm^3)	279.6
Water Content (%)	46.9
Bulk Dry Density (kg/m^3)	1185
Specific Gravity (G_s) (assumed)	2.70
Void Ratio	1.278
Degree of Saturation (%)	99.1
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	16.7
Permeant Fluid	Distilled Water
HYDRAULIC CONDUCTIVITY at TEST TEMPERATURE OF 21 °C (cm/sec)	4.8×10^{-9}
HYDRAULIC CONDUCTIVITY at TEMPERATURE OF 20 °C (K_{20}) (cm/sec)	4.7×10^{-9}



ENG-TECH Consulting Limited
6 - 884 Marion Street
Winnipeg, MB R2J 0K4
Phone: (204) 233-1894
Fax: (204) 235-1579

ENG. STAMP:

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

CLIENT: WPS CANADA INC.			PROJECT: HYDRAULIC CONDUCTIVITY, CLAY LINER, LA SALLE, MANITOBA
DATE: JANUARY 2014			FILE No.: 13-035-02
DRAWN BY: ERM	FIGURE No.: 1	REV.:	SCALE: N/A

HYDRAULIC CONDUCTIVITY VERSUS ELAPSED TIME (TH4 @ 5ft)

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

MOISTURE CONTENT OF SOIL
ASTM D2216

CLIENT:	Genivar	TEST NO:		PROJECT NO:	13-111
PROJECT:	La Salle WWSP	DATE SAMPLEI	n/a	SAMPLED BY:	SU
PROJECT CONTACT:	SU	DATE TESTED:	21-Nov-13	TESTED BY:	GM

Test Hole No.	**TH4**	**TH4**	**TH4**	**TH4**	**TH4**
Depth	**2.5'**	**5'**	**10'**	**15'**	**20'**
Wt Wet Sample + Tare	158.3	159.6	158.7	171.9	180.3
Wt Dry Sample + Tare	123.5	121.3	108.7	118.4	127.2
Wt Water	34.8	38.3	50	53.5	53.1
Wt Tare	9.2	7.1	7.4	7.2	7.2
Wt Dry Sample	114.3	114.2	101.3	111.2	120.0
Moisture Content (%)	**30.45**	**33.54**	**49.36**	**48.11**	**44.25**
Test Hole No.	**TH4**	**TH10**	**TH10**	**TH10**	**TH10**
Depth	**25'**	**2.5'**	**5'**	**10'**	**15'**
Wt Wet Sample + Tare	166.8	167.2	171.9	174.1	193.5
Wt Dry Sample + Tare	113.8	133.1	130.8	120.5	134.4
Wt Water	53	34.1	41.1	53.6	59.1
Wt Tare	7.6	7.3	7.1	6.9	7.0
Wt Dry Sample	106.2	125.8	123.7	113.6	127.4
Moisture Content (%)	**49.91**	**27.11**	**33.23**	**47.18**	**46.39**
Test Hole No.	**TH14**	**TH10**			
Depth	**20'**	**25'**			
Wt Wet Sample + Tare	201	192.2			
Wt Dry Sample + Tare	138	129.6			
Wt Water	63	62.6			
Wt Tare	6.9	6.9			
Wt Dry Sample	131.1	122.7			
Moisture Content (%)	**48.05**	**51.02**			

APPENDIX D

GRANULAR SPECIFICATIONS

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%		