Geotechnical Investigation
Sage Creek Fire/Paramedic Station
Winnipeg, Manitoba

Prepared For:
Winnipeg Fire Paramedic Service
c/o Murphy & Murphy Architect Inc.
775 Waterloo St. London, Ontario

Prepared By:
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Winnipeg, Manitoba, R2X 3W2

August, 2010

Ref. No. 10-36

TABLE OF CONTENTS

ENCLOSURES

1.0 INTRODUCTION

TBT Engineering Limited (TBTE) has been retained by City of Winnipeg, Fire Paramedic Service through Murphy & Murphy Architect Inc., to conduct a geotechnical investigation for a proposed No.18 Fire/Paramedic Station located at 5000 Roblin Boulevard, Winnipeg, Manitoba. The purpose of this work was to establish the soil and groundwater conditions at the site and provide foundation and pavement recommendations for the proposed structure and parking lot. Authorization to proceed with the work was provided by Murphy & Murphy Architect Inc. in behalf of City of Winnipeg, Winnipeg Fire Paramedic Service.

The proposed structure will consist of a one storey structure with a heated floor. It is understood that the pavement will require design suitable for heavy turning vehicles and for the inside slab required to support fire trucks.

A sub-surface investigation for the proposed structure has been completed. This report documents the findings of the investigation and provides geotechnical recommendations for the proposed structure.

2.0 FIELD INVESTIGATION AND LABORATORY TESTING

The field investigation for the project was carried out on August 10 and 11, 2010. Boreholes 4, 5, 7 and 8 are located near the proposed structure. The remaining boreholes were distributed across the site. As insufficient bearing conditions were encountered at shallow depths, Boreholes 4, 5 and 8 were advanced to auger refusal which ranged from 15.4 to 16.3 m depth. The boreholes were advanced utilizing a drill rig equipped for geotechnical sampling (operated by Paddock Drilling Ltd.).

During the drilling operations soil samples were obtained from the auger flights and using the techniques of the standard penetration test (SPT). This involves driving a 51 mm diameter thick-walled sampler into the soil under the energy of a 63.5 kg weight falling through 760 mm. The number of blows required to drive the sampler 0.3 m is known as the standard penetration blow count (N) which provides an indication of the condition or consistency of the soil. Following completion of the test, representative soil samples are obtained from within the sampler. A relatively undisturbed thin walled tube sample was collected at a selected depth with the clay stratum. In addition, pocket penetrometer as well as field vane testing was carried out on selected samples to provide a measurement of the unconfined compressive strength of the cohesive soils.

The ground surface elevations at the borehole locations were surveyed and referenced to the top of the fire hydrant as shown on the borehole location plan (Enclosure 1). An elevation of 100.0 m was assigned to this benchmark.

Classification and index tests were subsequently performed in the laboratory on samples collected from the test holes to aid in the selection of engineering properties. Laboratory tests included natural moisture contents, Atterberg limits, and gradation analyses.

3.0 SUB-SURFACE CONDITIONS

Details of the subsurface conditions are provided on the borehole logs, and laboratory reports, Enclosures 17 and 18.

3.1 Sub-surface Stratigraphy

The general subsurface conditions at the site consist of topsoil overlying clay fill which is underlain by clay. The thick stratum of clay overlies deeper till deposits. A discontinuous silt zone was noted at several test locations.

Topsoil

A layer of topsoil was encountered at the surface of all boreholes and varied from 50 to 100 mm thick.

Fill

Clay fill with trace to some sand, and gravel and organics was identified underlying the topsoil at all borehole locations and extended to depths up to 1 m. This material is not suitable for re-use as structural backfill.

Clay

A thick clay deposit was encountered starting below the fill extending to depths of between 11 and 13 m. The upper metre of the clay is black and organic. The clay is generally stiff to firm, and usually softens with depth. The un-drained shear strength as measured from lab vanes varied from 60 to 25 kPa. An Atterberg limit test carried out on a selected sample indicates the clay is highly plastic with the natural moisture content between the liquid and plastic limits.

Till

The upper till soils (underlying the clay) consist of sandy clays in a heterogeneous mixture of clay, silt, sand and gravel with occasional cobbles. This deposit is wet and soft to firm and was encountered starting at depths of between 11.5 and 13.6 m.

The clay tills are underlain with a denser deposit of sand till. The sand till includes a mixture of sands silts gravels and cobbles. Auger refusal was met in this deposit at depths of between 15.7 and 16.4 m. Standard penetration test results in the till indicated SPT blow counts from 18 to more than 100 blows/0.3 m.

Silt

A discontinuous stratum of silt was encountered within the upper clay deposits at four of the 12 boreholes drilled. The silt seam was encountered between 0.9 m and 1.7 m below grade. The seam is generally up to 0.5 m thick. This material is considered highly frost susceptible and can heave when frozen.

Groundwater

Groundwater seepage and/or saturated conditions were observed in the silt seam during drilling. The groundwater level is expected to vary seasonally and with precipitation events. The design water table should be assumed to be within 1 m of the ground surface.

4.0 DISCUSSION AND RECOMMENDATIONS

TBT Engineering Limited (TBTE) has completed a geotechnical investigation for a proposed Sage Creek Fire/Paramedic Station to be located on Sage Creek Boulevard east of Lagimodiere Boulevard in Winnipeg, Manitoba (LOT 2 PLAN 49228 in LOTS 211, 212 and 213 Roman Catholic Mission Property). The proposed structure will consist of a single storey structure with in-floor heating. The floor structure should be suitable to support fire trucks and the pavement structure should be designed for heavy vehicle loadings. Moderate foundation loads are anticipated.

Given the presence of a high water table together with easily disturbed silts and shallow low strength highly plastic clays, shallow foundations are not considered to be suitable for heavy foundation loads. Given the relatively shallow depth to a dense till stratum, the use of driven

prestressed, precast piles is considered to be a practical foundation option. Cast in place piles may be considered for lighter structural loads.

All foundation design recommendations presented in this report are based on the assumption that an adequate level of construction monitoring during excavation and construction will be provided. An adequate level of construction monitoring is considered to be examination of all excavation surfaces prior to fill placement to ensure the integrity of the subgrade; and, that all fill and/or organic material has been removed. Full-time monitoring of pile installation, materials testing and compaction testing should be provided. All such monitoring should be carried out by TBT Engineering to confirm that recommendations based upon a discrete sample location and visual obervations are consistent throughout the site.

Unless noted otherwise, foundation design parameters are given for static, vertically and concentrically loaded foundations in compression. It should be noted that the settlement analysis has been based on estimated consolidation parameters of the clay material. Dynamic, lateral, eccentric and uplift design parameters can be provided upon request once design loads have been determined.

4.1 Prestressed, Precast Driven Concrete Piles

An appropriate foundation system which may be utilized for the proposed structure consists of a system of driven concrete piles bearing within the dense till stratum. These units, when driven to practical refusal in the dense till with a hammer capable of delivering a rated energy of 40 kJ per blow, may be assigned the following allowable loads.

Pile Size mm(in)	Allowable Loads kN, (tons)
300(12) hex	443 (50)
350(14) hex	620 (70)
400(16) hex	797 (90)

Pile spacing should not be less than 3 pile diameters, centre to centre. Pile heaving at groups should be monitored and redriving done where pile heaving is found to be significant. The pile driving may induce some vibration and subsoil displacements.

To reduce the effects of pile driving upon adjacent buildings and buried services, pre-boring to at least 1.5m below grade should be considered for all driven pile locations. The pre-bore hole should be equal to the nominal pile diameter.

To ensure that all piles can be driven adequately to a safe bearing stratum and to develop the recommended loads, full time pile inspection by qualified geotechnical personnel is recommended. Practical refusal can be defined as the final penetration resistance of 5, 8, and 12 blows per 25 mm for the 300, 350 and 400 mm sizes respectively. The final penetration resistances should be achieved at least 3 times for the final resistance.

The estimated pile refusal depth at this location is approximately 17 m based on data obtained at the boreholes.

If any piles are subjected to highly repetitive or vibratory loads, the above capacities should be reduced by 50%.

A minimum void space of 200 mm should be provided beneath all structural elements to accommodate potential heave of the high plastic clay.

4.2 Cast-In-Place Friction Piles

Cast in place piles may also be considered at this site where structural loads are lighter. Cast-in-place concrete friction piles are suitable for light to moderate foundation loads and may be designed based upon the following allowable skin friction values:

Depth Below Existing Grade (m)	Allowable Skin Friction (kPa)
1.5 to 4.5	13
4.5 to 10	12
10 to 13	8

The upper 1.5 m should be neglected due to potential for shrinkage around the pile and 2.5 m for frost action on exterior piles. The allowable skin friction value is applied to the circumference within the clay stratum over the depth intervals indicated in the above table. The contribution from end bearing should be ignored in pile calculation capacities.

Strong seepage and caving conditions should be expected where silt seams are encountered. Thus, a temporary sleeve should be on hand and used as required during pile installation. The length of the sleeve is entirely the responsibility of the foundation contractor.

Pile spacing should be at least three pile diameters, centre to centre. Pile excavations should be poured with concrete as soon as they are drilled to the design diameters and depths.

Piles located in unheated areas should be provided with full-length reinforcements, a minimum pile length of 7.62 m (25 ft) and the top 2.1 m (7 ft) of the pile should be wrapped with greased sono tube to reduce the potential for frost jacking. The structure perimeter and grade beams should be provided with insulation and void forms as described above.

Pile inspection by qualified geotechnical personnel should therefore be employed to ensure a satisfactory foundation installation.

If any piles are subjected to highly repetitive or vibratory loads, the above capacities should be reduced by 50%. The allowable uplift capacities of piles may be assumed to be approximately 40% of the allowable pile capacity

4.3 Floor Slab

Structural Slab with Crawlspace:

Where the floor will be constructed as a structural slab with crawlspace, the crawlspace should be heated and vented. The crawlspace floor should be protected with a 6 mil vapour barrier and topped with 100 mm of free draining sand bedding. To avoid ponding difficulty due to surface water infiltration, perimeter filter-protected weeping tiles should be installed at least 300 mm below the crawlspace floor, leading to a positive outlet. Any organic soil should be removed from all main floor and crawlspace areas of the proposed structure as it may produce hazardous methane gas.

Slab-on-grade:

Where potential long-term slab movements in the order of 25 to 40 mm are deemed acceptable to the owner, the main floor of the building may be supported on grade with suitable subgrade preparation. To minimize the rate and magnitude of total and differential floor movements, subgrade preparations for floor construction should include a complete removal of all existing fills and any softened/disturbed or organic clay or silt. Due to high swelling potential of the clay, any exposed clay subgrade should be proof rolled and compacted to 95% STD Proctor Density.

The floor construction should include the placement of at least 300 mm thick, well-graded subbase, topped with at least 150 mm of well-graded base course, all uniformly compacted in maximum 150 mm lifts to 100% standard Proctor density, respectively. The base course and subbase materials should conform to City of Winnipeg grading limit specifications.

Any soft or excessively wet soil detected at the subgrade level should be excavated at least 300 mm, covered with non-woven geotextile and replaced with a 150 mm down limestone material (bridging material). Saturated soil conditions, if encountered, should be dried off by quickly excavating sump pit or installing permanent subdrains connected to a catch basin prior to placing the slab-on-grade structure. For permanent drainage, filter-protected perimeter and under-floor weeping tiles should be provided at least 300 mm below the underside of the slab and connected to a positive outlet.

Based on the borehole data available, excavations may expose a thin layer of clay overlying silt soils. To minimise potential swelling conditions this clay would be removed. This will expose the silt soils which are subject to pumping and short term loss of strength under construction traffic. Where the silt is exposed, the use of geotextile and bridging material will be required. Where pumping conditions are encountered, sufficient time for the pumping condition to subside should be provided between fill placement lifts and prior to pouring concrete. The contractors operations will have to be carefully planned to avoid excessive softening of these soils. Alternatively, the silt may be excavated to expose the underlying clay.

The floor slab should be provided with joints to ensure separation between the floor and the structural elements. To limit the effects of slab movement and reduce random cracking, control joints should be provided at regular intervals in the slab and where heavier loading is anticipated at

any given floor area. The floor should be constructed to act independent of structural elements by use of isolation joints.

If construction takes place during the heating season, problems of freezing weather, frozen soils and difficulty in achieving satisfactory compaction may be encountered. For winter construction requirements beneath the slab on grade, it would be advisable to use well-graded 19 mm crushed limestone and 25 mm down crushed limestone for replacing the recommended base course and subbase, respectively.

A slab-on-grade built above the frost depth zone and along the perimeter grade beam should be protected from frost penetration by installation of an exterior synthetic insulation thickness (50 mm) of rigid STYROFOAM, skirted around the perimeter's building prior to backfilling and extending horizontally outward a distance of 1.2 m. Grade beams should be protected from uplift forces using a void form.

Prior to placement of the concrete floor slab, a polyethylene vapour barrier may be utilized below the concrete to limit moisture migration through the slab. Requirements for a vapour barrier should be coordinated with the flooring supplier.

4.4 Pavement Recommendation

On the basis of the soil conditions encountered during drilling (i.e. mainly a clay fill subgrade), the recommended asphaltic concrete pavement construction at this site for heavy duty traffic is as follows:

Pavement Thicknesses

	Truck Route	**% Compaction**
Asphaltic Concrete	100 mm	98% Marshall
Base Course	300 mm	98% Std Proctor
Subbase	300 mm	98% Std Proctor

The above pavement sections should be constructed on a prepared clay subgrade. The prepared clay subgrade should be proof rolled with a heavy sheeps foot roller to at least 95% Std Proctor and inspected by a qualified geotechnical engineer prior to the placement of the overlying granular fill.

Where soft areas are encountered, construction traffic should be restricted. Soft areas should be covered with non-woven geotextile and provided with a total of 750 mm of granular fill underneath the 100 mm asphalt; *the subbase material about 450 mm thick should comprised of 100 to 150 mm clean crushed limestone.*

Any saturated subgrade conditions should be dried off quickly by excavation of a sump pit and installation of permanent subdrains (600 mm below the subgrade level) connected to a positive outlet (catch basin) prior to placing the granular fill structure. At these locations, the placing of granular fill should follow the geotextile specifications for soft grounds.

The granular base course and subbase materials should include organic-free, non-frozen, aggregate, conforming to City of Winnipeg gradation limits. Sieve analysis and compaction testing of the granular base and subgrade materials should be conducted by qualified geotechnical personnel to ensure that the materials supplied and percent compactions are in accordance with design specifications

For the hot mix asphaltic concrete, gradation analysis of the aggregates (i.e. stone, fines and additive), compaction testing and sampling of at least one representative hot mix asphalt mixture (during construction) for laboratory Marshall testing should be undertaken. This will provide data to confirm that the asphaltic concrete pavement complies with the project specification. Hot mix asphaltic concrete should not be placed at ambient temperatures lower than $+4^0$C. During placement, the temperature of the paving mix should be in the range of $+120^0$C to $+150^0$C and compaction should not take place at paving mix temperatures lower than $+85^0$C. The combined aggregate gradation limits and physical requirements of the asphaltic concrete should be in accordance with Manitoba Highway specifications.

For any concrete apron, sidewalk or curbs, the pavement structure should consist of 150 mm reinforced concrete followed by 300 mm of compacted (98% Standard Proctor Density) base course over the compacted subgrade. If a silt layer was encountered as subgrade, the silt should be removed, or at a minimum, the application of woven geotextile over the silt layer is recommended. Exterior, grade supported concrete slabs will be subjected to some seasonal vertical movements related to frost and moisture variations. Exterior concrete slabs should not be tied into rigid structures

such as grade beams, pile caps or interior slabs. To minimize the movements, consideration should be given to the use of rigid synthetic insulation, outward laterally (minimum 1.8 m length and about 100 mm thick) and beneath the structure.

4.5 Excavations

Excavations should be executed and sloped in accordance with the requirements of the Occupational Health and Safety act.

To limit the potential for frost jacking, any foundation excavations should have side slopes no steeper that 1H:1V and the excavation should be backfilled with a non-frost susceptible, free draining fill such as 50 mm sub base material.

Temporary excavations above the groundwater table should be constructed with side slopes no steeper than 2H:1V.

Excavations carried out to depths near or below the groundwater level are liable to slough to flat slopes especially where granular soils are encountered. Earth cuts to remove the existing fill may require excavations below the groundwater level. The excavation and construction must be planned to maintain the integrity of the sub-soil.

No surface surcharges should be placed in close proximity to the edge of excavation unless the stability of the excavation slope has been assessed.

4.6 Additional Considerations

Concrete used for foundations should be manufactured with sulphate-resistant (Type 50) cement, have a minimum compressive strength of 32 MPa and air content between 4% and 7%. Any concrete subject to cycles of freezing and thawing should be air entrained in accordance with the latest edition of CSA A23.1, *Concrete Materials and Methods of Concrete Construction*. Proper construction joints between the existing and the addition building should be installed to accommodate any relative differential movements.

To ensure adequate site drainage, the following recommendations are made:

- ♦ A 10% slope should be considered for the first 2 m from the foundation wall.
- ♦ Ensure downspout extensions direct water away from walls.
- ♦ Provide splash blocks away from walls to prevent erosion and ponding.
- ♦ On a sloping site, grade from the centre out to the corners of the building. Provide a swale.
- ♦ For winter construction, the foundation and other loaded areas should be protected against freezing.
- ♦ Concrete should not be poured on frozen ground.

5.0 LIMITATIONS OF REPORT

Conclusions and recommendations presented in this report are based on the information determined at the borehole locations. Subsurface and groundwater conditions between and beyond these locations may differ from those encountered. Conditions may become apparent during construction that were not detected and could not be anticipated at the time of the site investigation.

The design recommendations provided in this report are based on the project described in the text and then only if constructed substantially in accordance with the details stated in this report. The comments given in this report on potential construction problems and possible methods of construction are intended only for the guidance of the designer.

Benchmarks and elevations referred to in this report are used primarily to establish relative elevation differences between the test hole locations and should not be used for other purposes such as grading, excavating, planning, development, etc.

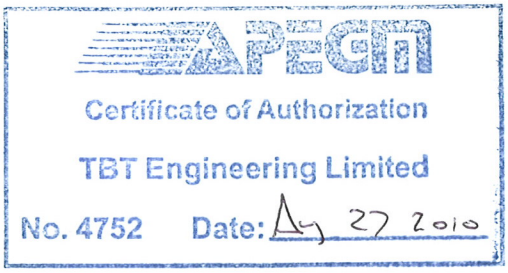
Groundwater levels indicated are based on the information described within the report. The presence of all conditions that could affect the type and scope of dewatering procedures which may be considered cannot readily be determined from boreholes. These include local and seasonal fluctuations of the groundwater level, changes in soil conditions between test locations, thin and/or discontinuous layers of highly permeable soils, etc.

The information contained within this report in no way reflects any environmental aspect of the site or soil.

6.0 CLOSURE

We trust the above addresses your project requirements at this time. Should you have any questions or comments, please do not hesitate the contact us at your convenience.

Yours truly,
For TBT ENGINEERING



Wayne Hurley, P.Eng.
Principal

ENCLOSURES

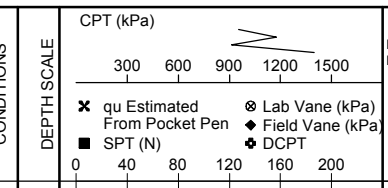
DWG. TITLE: BOREHOLE LOCATION PLAN	TBT ENGINEERING CONSULTING GROUP	DRAWN BY: D.S./T.B.	PROJECT NO. 10-636
PROJECT: #27 FIRE AND PARAMEDIC STATION SAGE CREEK BOULEVARD WINNIPEG, MANITOBA	CLIENT: WINNIPEG FIRE PARAMEDIC SERVICE	APPROVED BY: W.H.	DATE: AUG 2010
		SCALE: AS SHOWN	ENCLOSURE 1

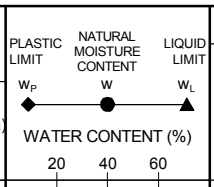
LOG OF BOREHOLE 1

TBT REF. No.: **10-636**
CLIENT: **Winnipeg Fire Paramedic Service**
PROJECT: **#27 Fire and Paramedic Station**
LOCATION: **Sage Creek Boulevard**
Winnipeg,Manitoba

SURFACE ELEV.: **99.0 metres**
EQUIPMENT: **SS Auger**
DIAMETER: **125 mm**
DATE: **2010 August 10**
DRILL COMPANY: **Paddock Drilling Ltd.**

DEPTH	ELEV.	DESCRIPTION	STRAT PLOT	% RECOVERY	TYPE	"N" VALUES	GROUND WATER CONDITIONS
		TOPSOIL - 80 mm					
		CLAY FILL - Silty, brown, stiff, moist					
		CLAY - organic, black/mottled with grey, stiff, moist			AS		
1	98	- - - - -					
		- grey, stiff, moist, homogeneous, high plastic			AS		
2	97				AS		
3	96				AS		
		- trace sulfate inclusions					
4	95				AS		
		End of Borehole @ 4.6 m.					
5	94						
6	93						
7	92						
8	91						
9	90						





REMARKS

Dry on completion.

GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

TBT Engineering Limited
110 Paramount Road
Winnipeg, Manitoba R2X 2W3
PH: 204-633-6008
FX: 204-633-6620
Email: tbte@tbte.ca
Web: www.tbte.ca

SAMPLE TYPE LEGEND

AS	Auger Sample	RC	Rock Core
SS	Split Spoon Sample	PS	Ponar Sample
TW	70mm Thin Wall Tube	SD	Side Sample
CC	Concrete Core		

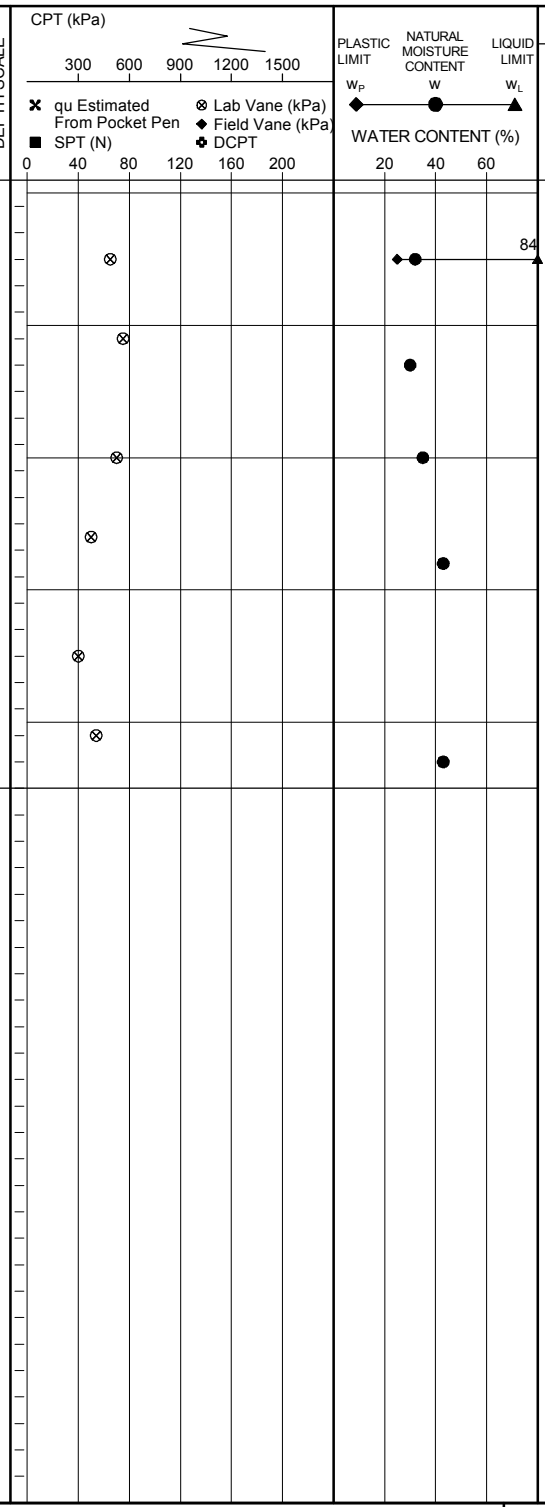
ENCLOSURE 2

LOG OF BOREHOLE 2

TBT REF. No.: **10-636**
CLIENT: **Winnipeg Fire Paramedic Service**
PROJECT: **#27 Fire and Paramedic Station**
LOCATION: **Sage Creek Boulevard**
Winnipeg,Manitoba

SURFACE ELEV.: **99.1 metres**
EQUIPMENT: **SS Auger**
DIAMETER: **125 mm**
DATE: **2010 August 10**
DRILL COMPANY: **Paddock Drilling Ltd.**

DEPTH	ELEV.	DESCRIPTION	STRAT PLOT	% RECOVERY	TYPE	"N" VALUES	GROUND WATER CONDITIONS
	99	TOPSOIL - 50 mm					
		CLAY FILL - Silty, brown, stiff, moist			AS		
		- - - - -					
1	98	- grey CLAY - organic, Silty, black, stiff, moist			AS		
		- - - - -					
		- grey, stiff, moist, homogeneous, high plastic					
2	97	- - - - -			AS		
		- brown - trace sulfate inclusions					
3	96				AS		
		- - - - -					
		- firm					
4	95				AS		
		End of Borehole @ 4.6 m.					
5	94						
6	93						
7	92						
8	91						
9	90						



REMARKS

Dry on completion.

GRAIN SIZE DISTRIBUTION (%)

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SAMPLE TYPE LEGEND

AS	Auger Sample	RC	Rock Core
SS	Split Spoon Sample	PS	Ponar Sample
TW	70mm Thin Wall Tube	SD	Side Sample
CC	Concrete Core		

ENCLOSURE 3

LOG OF BOREHOLE 3

TBT REF. No.: **10-636**
CLIENT: **Winnipeg Fire Paramedic Service**
PROJECT: **#27 Fire and Paramedic Station**
LOCATION: **Sage Creek Boulevard**
Winnipeg,Manitoba

SURFACE ELEV.: **99.1 metres**
EQUIPMENT: **SS Auger**
DIAMETER: **125 mm**
DATE: **2010 August 10**
DRILL COMPANY: **Paddock Drilling Ltd.**

DEPTH	ELEV.	DESCRIPTION	STRAT PLOT	% RECOVERY	TYPE	"N" VALUES	GROUND WATER CONDITIONS
0	99	TOPSOIL - 100 mm CLAY FILL - grey, stiff, moist			AS		
1	98	CLAY - organic, black, stiff, moist			AS		
2	97	SILT - light brown, wet CLAY - grey, stiff, moist, homogeneous, high plastic			AS		
3	96				AS		
4	95				AS		
		End of Borehole @ 4.6 m.					
5	94						
6	93						
7	92						
8	91						
9	90						

CPT (kPa): 300, 600, 900, 1200, 1500
× qu Estimated From Pocket Pen
■ SPT (N)
⊗ Lab Vane (kPa)
◆ Field Vane (kPa)
✪ DCPT
0, 40, 80, 120, 160, 200

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%): 20, 40, 60

REMARKS
Dry on completion.

GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

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FX: 204-633-6620
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SAMPLE TYPE LEGEND

AS	Auger Sample	RC	Rock Core
SS	Split Spoon Sample	PS	Ponar Sample
TW	70mm Thin Wall Tube	SD	Side Sample
CC	Concrete Core		

ENCLOSURE 4

PAGE 1 OF 1

W TBT BOREHOLE 3 10-636.GPJ TBT.GDT 10/8/27

LOG OF BOREHOLE 4

TBT REF. No.: **10-636**
CLIENT: **Winnipeg Fire Paramedic Service**
PROJECT: **#27 Fire and Paramedic Station**
LOCATION: **Sage Creek Boulevard**
Winnipeg,Manitoba

SURFACE ELEV.: **99.1 metres**
EQUIPMENT: **SS Auger**
DIAMETER: **125 mm**
DATE: **2010 August 11**
DRILL COMPANY: **Paddock Drilling Ltd.**

DEPTH	ELEV.	DESCRIPTION	STRAT PLOT	% RECOVERY	TYPE	"N" VALUES	GROUND WATER CONDITIONS
	99	TOPSOIL - 100 mm					
		CLAY FILL - grey, stiff, moist			AS		
1	98	CLAY - organic, black, stiff, moist - - - - - - grey			AS		
2	97	- - - - - - grey, stiff, moist, homogeneous, high plastic			AS		
3	96				AS		
4	95				AS		
5	94						
6	93				AS		
7	92						
		- - - - - - firm			AS		
8	91						▼
9	90				AS		

CPT (kPa): 300, 600, 900, 1200, 1500
qu Estimated From Pocket Pen; SPT (N); Lab Vane (kPa); Field Vane (kPa); DCPT
DEPTH SCALE: 0, 40, 80, 120, 160, 200

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%): 20, 40, 60

REMARKS
Water level @ 8.5 m 16 hrs after completion.

GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

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SAMPLE TYPE LEGEND

AS	Auger Sample	RC	Rock Core
SS	Split Spoon Sample	PS	Ponar Sample
TW	70mm Thin Wall Tube	SD	Side Sample
CC	Concrete Core		

ENCLOSURE 5

W TBT BOREHOLE 3 10-636.GPJ TBT.GDT 10/8/27

LOG OF BOREHOLE 4

TBT REF. No.: **10-636**
CLIENT: **Winnipeg Fire Paramedic Service**
PROJECT: **#27 Fire and Paramedic Station**
LOCATION: **Sage Creek Boulevard**
Winnipeg,Manitoba

SURFACE ELEV.: **99.1 metres**
EQUIPMENT: **SS Auger**
DIAMETER: **125 mm**
DATE: **2010 August 11**
DRILL COMPANY: **Paddock Drilling Ltd.**

DEPTH	ELEV.	DESCRIPTION	% RECOVERY	TYPE	"N" VALUES	GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	89	CLAY - grey				
				AS		
11	88					
12	87			AS		
13	86					
14	85	TILL - CLAY - Silty, Sandy, trace gravel, grey, soft, wet, medium plastic		AS		
15	84			AS		
16	83	TILL - SAND - Clayey, Silty, some gravel, light brown, medium dense to dense, wet		AS		13 38 23 26
				SS	>100	
		End of Borehole @ 16.4 m. Auger Refusal.				
17	82					
18	81					
19	80					

CPT (kPa): 300 600 900 1200 1500
qu Estimated From Pocket Pen ⊗ Lab Vane (kPa) ◆ Field Vane (kPa) ■ SPT (N) ✪ DCPT
0 40 80 120 160 200

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

GROUND WATER CONDITIONS

DEPTH SCALE 11 12 13 14 15 16 17 18 19

REMARKS

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SAMPLE TYPE LEGEND

AS	Auger Sample	RC	Rock Core
SS	Split Spoon Sample	PS	Ponar Sample
TW	70mm Thin Wall Tube	SD	Side Sample
CC	Concrete Core		

ENCLOSURE 6

LOG OF BOREHOLE 5

TBT REF. No.: **10-636**
CLIENT: **Winnipeg Fire Paramedic Service**
PROJECT: **#27 Fire and Paramedic Station**
LOCATION: **Sage Creek Boulevard**
Winnipeg,Manitoba

SURFACE ELEV.: **99.1 metres**
EQUIPMENT: **SS Auger**
DIAMETER: **125 mm**
DATE: **2010 August 10**
DRILL COMPANY: **Paddock Drilling Ltd.**

DEPTH	ELEV.	DESCRIPTION	STRAT PLOT	% RECOVERY	TYPE	"N" VALUES	GROUND WATER CONDITIONS
0	99	TOPSOIL - 100 mm CLAY FILL - grey, stiff, moist					
		CLAY - organic, black, stiff, moist			AS		
1	98	SILT - brown, wet					
		CLAY - grey, stiff, moist, homogeneous, high plastic			AS		
2	97				AS		▼
					AS		
3	96						
4	95				AS		
5	94	- trace sulfate inclusions					
6	93				AS		
7	92				AS		
8	91	- trace sulfate inclusions					
9	90				AS		

CPT (kPa): 300, 600, 900, 1200, 1500
× qu Estimated From Pocket Pen ■ SPT (N) ⊗ Lab Vane (kPa) ◆ Field Vane (kPa) ✪ DCPT
DEPTH SCALE: 0, 40, 80, 120, 160, 200

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%): 20, 40, 60

REMARKS
GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

Water level @ 1.8 m on completion.

Sloughing and seepage @ silt layer.

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SAMPLE TYPE LEGEND

AS	Auger Sample	RC	Rock Core
SS	Split Spoon Sample	PS	Ponar Sample
TW	70mm Thin Wall Tube	SD	Side Sample
CC	Concrete Core		

ENCLOSURE 7

LOG OF BOREHOLE 5

TBT REF. No.: **10-636**
CLIENT: **Winnipeg Fire Paramedic Service**
PROJECT: **#27 Fire and Paramedic Station**
LOCATION: **Sage Creek Boulevard**
Winnipeg,Manitoba

SURFACE ELEV.: **99.1 metres**
EQUIPMENT: **SS Auger**
DIAMETER: **125 mm**
DATE: **2010 August 10**
DRILL COMPANY: **Paddock Drilling Ltd.**

DEPTH	ELEV.	DESCRIPTION	% RECOVERY	TYPE	"N" VALUES
11	88			AS	
12	87	TILL - CLAY - Silty, Sandy, trace gravel, grey, soft, wet, medium plastic		AS	
13	86			AS	
14	85			AS	
15	84	TILL - SAND - Silty, Clayey, trace gravel, light brown, medium to dense, wet		SS	31
16	83	End of Borehole @ 15.8 m. Auger Refusal.			
17	82				
18	81				
19	80				

SOIL PROFILE | SAMPLES | GROUND WATER CONDITIONS | DEPTH SCALE | REMARKS

CPT (kPa): 300 600 900 1200 1500
× qu Estimated From Pocket Pen ■ SPT (N) ⊗ Lab Vane (kPa) ◆ Field Vane (kPa) ✪ DCPT
0 40 80 120 160 200

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%): 20 40 60

82

REMARKS: GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

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SAMPLE TYPE LEGEND

AS	Auger Sample	RC	Rock Core
SS	Split Spoon Sample	PS	Ponar Sample
TW	70mm Thin Wall Tube	SD	Side Sample
CC	Concrete Core		

ENCLOSURE 8

W TBT BOREHOLE 3 10-636.GPJ TBT.GDT 10/8/27

LOG OF BOREHOLE 6

TBT REF. No.: **10-636**
CLIENT: **Winnipeg Fire Paramedic Service**
PROJECT: **#27 Fire and Paramedic Station**
LOCATION: **Sage Creek Boulevard**
Winnipeg,Manitoba

SURFACE ELEV.: **99.2 metres**
EQUIPMENT: **SS Auger**
DIAMETER: **125 mm**
DATE: **2010 August 10**
DRILL COMPANY: **Paddock Drilling Ltd.**

DEPTH	ELEV.	DESCRIPTION	STRAT PLOT	% RECOVERY	SAMPLES TYPE	"N" VALUES	GROUND WATER CONDITIONS	DEPTH SCALE	REMARKS
0	99	TOPSOIL - 50 mm							Water level @ 1.8 m on completion.
		CLAY FILL - Silty, grey, stiff, moist, high plastic			AS				
1	98	CLAY - black - - - - - - grey			AS			1	
		SILT - light brown, loose, wet					▼		
2	97	CLAY - grey, stiff, moist, high plastic, homogeneous			AS			2	Sloughing and seepage @ silt layer.
3	96				AS			3	
4	95				AS			4	
5	94	End of Borehole @ 4.6 m.						5	
6	93							6	
7	92							7	
8	91							8	
9	90							9	

CPT (kPa): 300, 600, 900, 1200, 1500
qu Estimated From Pocket Pen ⊗ Lab Vane (kPa) ◆ Field Vane (kPa) ■ SPT (N) ✪ DCPT
0, 40, 80, 120, 160, 200

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
20, 40, 60

87

REMARKS: GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

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SAMPLE TYPE LEGEND

AS	Auger Sample	RC	Rock Core
SS	Split Spoon Sample	PS	Ponar Sample
TW	70mm Thin Wall Tube	SD	Side Sample
CC	Concrete Core		

ENCLOSURE 9

PAGE 1 OF 1

W TBT BOREHOLE 3 10-636.GPJ TBT.GDT 10/8/27

LOG OF BOREHOLE 7

TBT REF. No.: **10-636**
CLIENT: **Winnipeg Fire Paramedic Service**
PROJECT: **#27 Fire and Paramedic Station**
LOCATION: **Sage Creek Boulevard**
Winnipeg,Manitoba

SURFACE ELEV.: **99.3 metres**
EQUIPMENT: **SS Auger**
DIAMETER: **125 mm**
DATE: **2010 August 11**
DRILL COMPANY: **Paddock Drilling Ltd.**

DEPTH	ELEV.	DESCRIPTION	STRAT PLOT	% RECOVERY	TYPE	"N" VALUES	GROUND WATER CONDITIONS
0	99	TOPSOIL - 100 mm CLAY FILL - grey, soft, moist, high plastic			AS		
1	98	CLAY - organic, black, stiff, moist, high plastic - - - - - - grey, stiff, moist, high plastic, homogeneous			AS		
2	97				AS		
3	96				AS		
4	95	- - - - - - firm			AS		
5	94						
6	93				AS		
7	92						
8	91				AS		
9	90				AS		

CPT (kPa): 300 600 900 1200 1500
× qu Estimated From Pocket Pen ■ SPT (N) ⊗ Lab Vane (kPa) ◆ Field Vane (kPa) ✪ DCPT
DEPTH SCALE: 0 40 80 120 160 200

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%): 20 40 60

REMARKS
GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

Water level @ 12.0 m on completion.

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SAMPLE TYPE LEGEND

AS	Auger Sample	RC	Rock Core
SS	Split Spoon Sample	PS	Ponar Sample
TW	70mm Thin Wall Tube	SD	Side Sample
CC	Concrete Core		

ENCLOSURE 10

W TBT BOREHOLE 3 10-636.GPJ TBT.GDT 10/8/27

LOG OF BOREHOLE 7

TBT REF. No.: **10-636**
CLIENT: **Winnipeg Fire Paramedic Service**
PROJECT: **#27 Fire and Paramedic Station**
LOCATION: **Sage Creek Boulevard**
Winnipeg,Manitoba

SURFACE ELEV.: **99.3 metres**
EQUIPMENT: **SS Auger**
DIAMETER: **125 mm**
DATE: **2010 August 11**
DRILL COMPANY: **Paddock Drilling Ltd.**

DEPTH	ELEV.	DESCRIPTION	STRAT PLOT	% RECOVERY	TYPE	"N" VALUES	GROUND WATER CONDITIONS	REMARKS: GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
11	89	CLAY - firm			AS			
12	88				AS		▼	
13	87							
14	86	TILL - CLAY - Silty, Sandy, trace gravel, grey, soft, wet, medium plastic			AS			8 26 29 37
15	85	TILL - SAND - Clayey, Silty, some gravel, light brown, medium to dense, wet			AS			
16	84				SS	18		
17	83	End of Borehole @ 15.7 m. Auger Refusal.						
18	82							
19	81							
	80							

CPT (kPa): 300 600 900 1200 1500
qu Estimated From Pocket Pen ⊗ Lab Vane (kPa) ◆ Field Vane (kPa) ■ SPT (N) ✪ DCPT
0 40 80 120 160 200

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
20 40 60

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SAMPLE TYPE LEGEND

AS	Auger Sample	RC	Rock Core
SS	Split Spoon Sample	PS	Ponar Sample
TW	70mm Thin Wall Tube	SD	Side Sample
CC	Concrete Core		

ENCLOSURE 11

LOG OF BOREHOLE 8

TBT REF. No.: **10-636**
CLIENT: **Winnipeg Fire Paramedic Service**
PROJECT: **#27 Fire and Paramedic Station**
LOCATION: **Sage Creek Boulevard**
Winnipeg,Manitoba

SURFACE ELEV.: **99.4 metres**
EQUIPMENT: **SS Auger**
DIAMETER: **125 mm**
DATE: **2010 August 10**
DRILL COMPANY: **Paddock Drilling Ltd.**

DEPTH	ELEV.	DESCRIPTION	STRAT PLOT	% RECOVERY	TYPE	"N" VALUES	GROUND WATER CONDITIONS
0	99	TOPSOIL - 80 mm CLAY FILL - grey, medium to high plastic			AS		
1		CLAY - organic, black, stiff, moist, high plastic - trace silt inclusions - - - - -			AS		
2	98	- grey, stiff, moist, high plastic			AS		
3	97	- - - - - - firm			AS		
4	96				AS		
5	95				AS		
6	94	End of Borehole @ 4.6 m.					
7	93						
8	92						
9	91						
	90						

CPT (kPa): 300, 600, 900, 1200, 1500
× qu Estimated From Pocket Pen ■ SPT (N) ⊗ Lab Vane (kPa) ◆ Field Vane (kPa) ✪ DCPT
0, 40, 80, 120, 160, 200

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%): 20, 40, 60

REMARKS: Dry on completion.
GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

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SAMPLE TYPE LEGEND

AS	Auger Sample	RC	Rock Core
SS	Split Spoon Sample	PS	Ponar Sample
TW	70mm Thin Wall Tube	SD	Side Sample
CC	Concrete Core		

ENCLOSURE 12

PAGE 1 OF 1

W TBT BOREHOLE 3 10-636.GPJ TBT.GDT 10/8/27

LOG OF BOREHOLE 9

TBT REF. No.: **10-636**
CLIENT: **Winnipeg Fire Paramedic Service**
PROJECT: **#27 Fire and Paramedic Station**
LOCATION: **Sage Creek Boulevard**
Winnipeg,Manitoba

SURFACE ELEV.: **99.4 metres**
EQUIPMENT: **SS Auger**
DIAMETER: **125 mm**
DATE: **2010 August 10**
DRILL COMPANY: **Paddock Drilling Ltd.**

DEPTH	ELEV.	DESCRIPTION	STRAT PLOT	% RECOVERY	TYPE	"N" VALUES	GROUND WATER CONDITIONS
	99	TOPSOIL - 100 mm CLAY FILL - brown			AS		
1		CLAY - organic, black, moist, stiff					
	98	- - - - - - brown, stiff, high plastic			AS		
2							
	97	SILT - brown, loose, wet			AS		
		CLAY - grey, moist, soft to firm, high plastic					
3					AS		
	96						
					AS		
4		- trace sulfate inclusions					
	95				AS		
		End of Borehole @ 4.6 m.					
5							
	94						
6							
	93						
7							
	92						
8							
	91						
9							
	90						

DEPTH SCALE: 1 2 3 4 5 6 7 8 9

CPT (kPa): 300 600 900 1200 1500
× qu Estimated From Pocket Pen ■ SPT (N) ⊗ Lab Vane (kPa) ◆ Field Vane (kPa) ✪ DCPT
0 40 80 120 160 200

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
20 40 60

REMARKS
GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

Dry on completion.

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SAMPLE TYPE LEGEND

AS	Auger Sample	RC	Rock Core
SS	Split Spoon Sample	PS	Ponar Sample
TW	70mm Thin Wall Tube	SD	Side Sample
CC	Concrete Core		

ENCLOSURE 13

LOG OF BOREHOLE 10

TBT REF. No.: **10-636**
CLIENT: **Winnipeg Fire Paramedic Service**
PROJECT: **#27 Fire and Paramedic Station**
LOCATION: **Sage Creek Boulevard**
Winnipeg,Manitoba

SURFACE ELEV.: **99.4 metres**
EQUIPMENT: **SS Auger**
DIAMETER: **125 mm**
DATE: **2010 August 10**
DRILL COMPANY: **Paddock Drilling Ltd.**

DEPTH	ELEV.	DESCRIPTION	STRAT PLOT	% RECOVERY	TYPE	"N" VALUES	GROUND WATER CONDITIONS	DEPTH SCALE
0	99	TOPSOIL - 50 mm, clay, silty, brown, moist, stiff			AS			0
		CLAY FILL - Silty, grey, stiff, moist						
1		CLAY - Silty, organic, black, stiff, moist			AS			1
	98	SILT - light brown, wet						
		CLAY - grey, stiff, moist, high plastic						
2					AS			2
	97	- - - - -						
		- firm to stiff						
3		- trace sulfate inclusions			AS			3
	96							
					AS			
4								4
	95				AS			
		End of Borehole @ 4.6 m.						
5								5
	94							
6								6
	93							
7								7
	92							
8								8
	91							
9								9
	90							

CPT (kPa): 300, 600, 900, 1200, 1500
× qu Estimated From Pocket Pen ■ SPT (N) ⊗ Lab Vane (kPa) ◆ Field Vane (kPa) ✪ DCPT
0, 40, 80, 120, 160, 200

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%): 20, 40, 60

REMARKS: Dry on completion.

GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

W TBT BOREHOLE 3 10-636.GPJ TBT.GDT 10/8/27

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SAMPLE TYPE LEGEND

AS	Auger Sample	RC	Rock Core
SS	Split Spoon Sample	PS	Ponar Sample
TW	70mm Thin Wall Tube	SD	Side Sample
CC	Concrete Core		

ENCLOSURE 14

LOG OF BOREHOLE 11

TBT REF. No.: **10-636**
CLIENT: **Winnipeg Fire Paramedic Service**
PROJECT: **#27 Fire and Paramedic Station**
LOCATION: **Sage Creek Boulevard**
Winnipeg,Manitoba

SURFACE ELEV.: **99.2 metres**
EQUIPMENT: **SS Auger**
DIAMETER: **125 mm**
DATE: **2010 August 10**
DRILL COMPANY: **Paddock Drilling Ltd.**

DEPTH	ELEV.	DESCRIPTION	STRAT PLOT	% RECOVERY	TYPE	"N" VALUES	GROUND WATER CONDITIONS
	99	TOPSOIL - 50 mm					
		CLAY FILL - grey, stiff, moist, medium to high plastic			AS		
1	98	CLAY - organic, black, stiff, moist - - - - - - grey, stiff, moist, high plastic			AS		
2	97	- trace silt inclusions			AS		
		- - - - - - firm to stiff			AS		
3	96						
					AS		
4	95	- trace silt inclusions			AS		
5	94	End of Borehole @ 4.6 m.					
6	93						
7	92						
8	91						
9	90						

CPT (kPa): 300 600 900 1200 1500
qu Estimated From Pocket Pen ⊗ Lab Vane (kPa)
SPT (N) ◆ Field Vane (kPa)
DCPT
0 40 80 120 160 200

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
20 40 60

REMARKS
GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

Dry on completion.

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SAMPLE TYPE LEGEND

AS	Auger Sample	RC	Rock Core
SS	Split Spoon Sample	PS	Ponar Sample
TW	70mm Thin Wall Tube	SD	Side Sample
CC	Concrete Core		

ENCLOSURE 15

W TBT BOREHOLE 3 10-636.GPJ TBT.GDT 10/8/27

LOG OF BOREHOLE 12

TBT REF. No.: **10-636**
CLIENT: **Winnipeg Fire Paramedic Service**
PROJECT: **#27 Fire and Paramedic Station**
LOCATION: **Sage Creek Boulevard**
Winnipeg,Manitoba

SURFACE ELEV.: **99.2 metres**
EQUIPMENT: **SS Auger**
DIAMETER: **125 mm**
DATE: **2010 August 10**
DRILL COMPANY: **Paddock Drilling Ltd.**

DEPTH	ELEV.	DESCRIPTION	STRAT PLOT	% RECOVERY	TYPE	"N" VALUES	GROUND WATER CONDITIONS
0	99	TOPSOIL - 100 mm					
		CLAY FILL - brown					
		CLAY - black			AS		
1	98	- - - - -					
		- grey			AS		
					TW		
2	97				AS		
3	96	- - - - -					
		- firm to stiff			AS		
4	95				AS		
		End of Borehole @ 4.6 m.					
5	94						
6	93						
7	92						
8	91						
9	90						

CPT (kPa): 300, 600, 900, 1200, 1500
qu Estimated From Pocket Pen ⊗ Lab Vane (kPa) ◆ Field Vane (kPa) ■ SPT (N) ✪ DCPT
0, 40, 80, 120, 160, 200

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
20, 40, 60

REMARKS: Dry on completion.

GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

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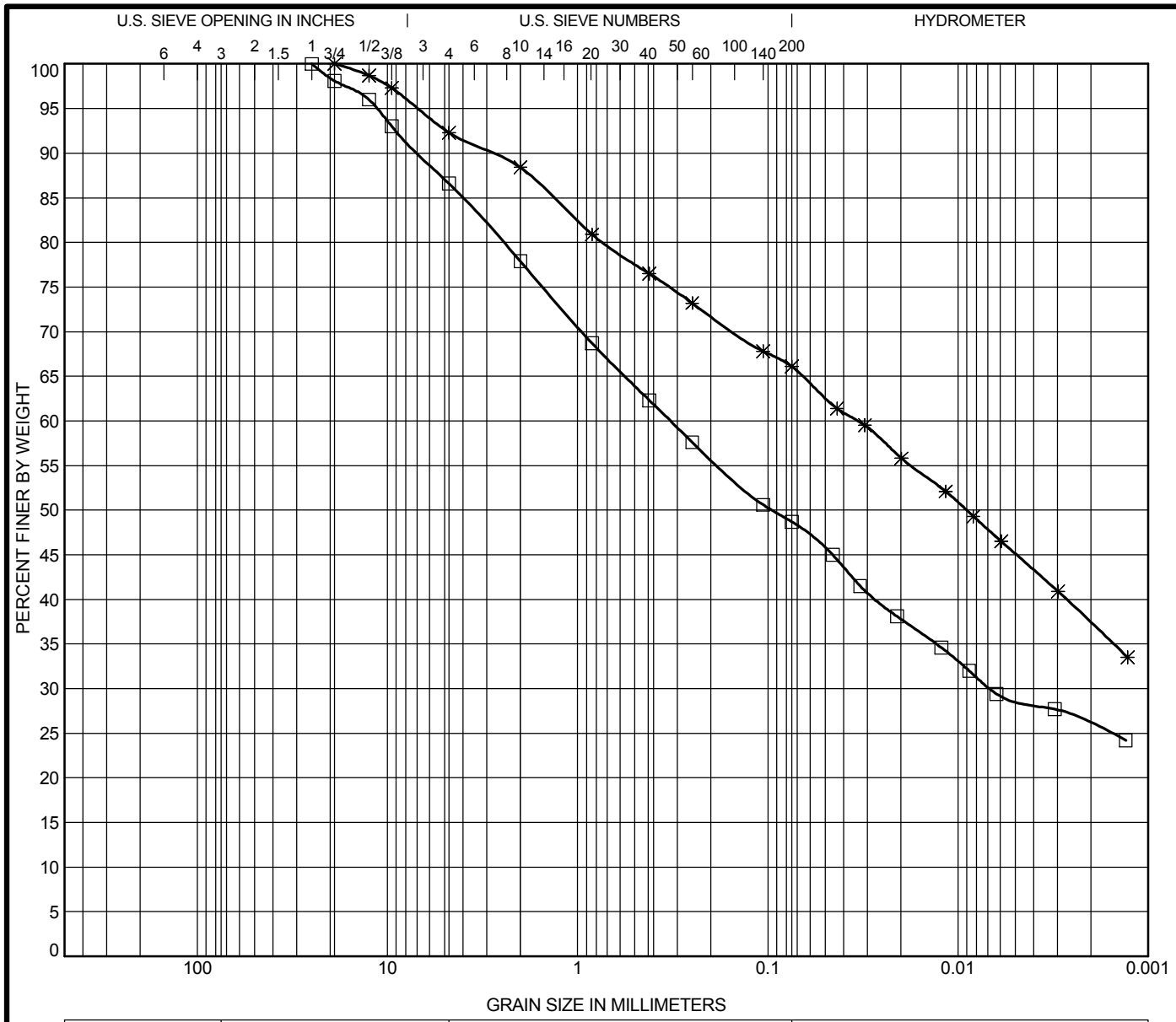
SAMPLE TYPE LEGEND

AS	Auger Sample	RC	Rock Core
SS	Split Spoon Sample	PS	Ponar Sample
TW	70mm Thin Wall Tube	SD	Side Sample
CC	Concrete Core		

ENCLOSURE 16



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Remarks:

	Test Hole	Sample	Depth (m)	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
□	**4**		**16.10**	**25**	**0.326**	**0.007**		**13.4**	**37.9**	**22.8**	**25.9**
✳	**7**		**13.50**	**19**	**0.034**			**7.7**	**26.2**	**28.7**	**37.4**

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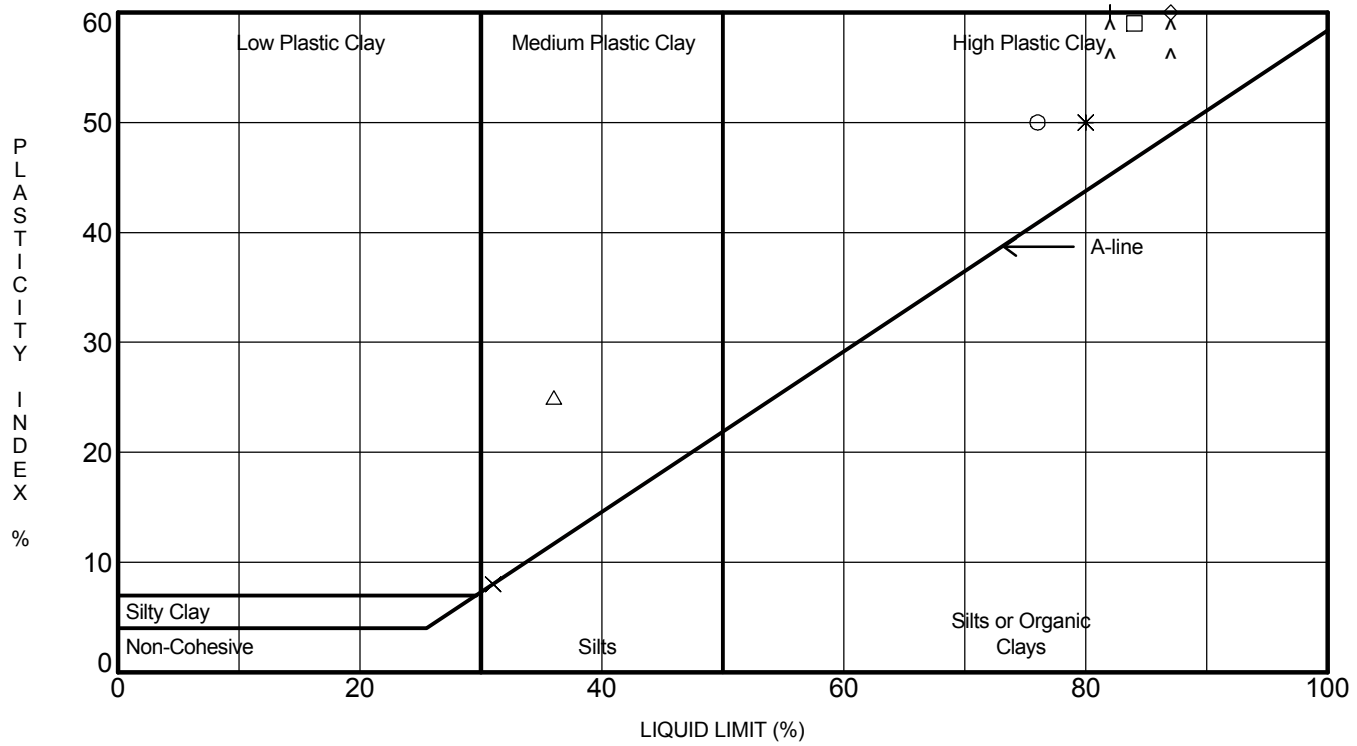
GRAIN SIZE DISTRIBUTION

Project: #27 Fire and Paramedic Station

Location: Sage Creek Boulevard

Number: 10-636

ENCLOSURE 17



	Testhole No.	Sample No.	Depth (m)	LL%	PL%	PI%	M/C%
□	**2**		**0.60**	**84**	**25**	**59**	**32**
✳	**4**		**7.40**	**80**	**30**	**50**	**44**
×	**4**		**16.10**	**31**	**23**	**8**	**25**
+	**5**		**10.50**	**82**	**20**	**62**	**54**
◇	**6**		**4.40**	**87**	**24**	**63**	**55**
△	**7**		**13.50**	**36**	**11**	**25**	
○	**11**		**1.40**	**76**	**26**	**50**	**32**

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ATTERBERG LIMIT RESULTS

Project: #27 Fire and Paramedic Station

Location: Sage Creek Boulevard

Number: 10-636

ENCLOSURE 18