THE CITY OF WINNIPEG
AMBULANCE STATION NO. 33
598 ST. MARY'S ROAD
WINNIPEG, MANITOBA

GEOTECHNICAL INVESTIGATION REPORT

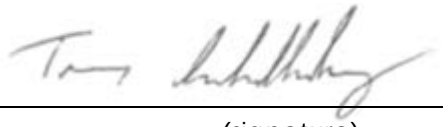
Prepared for:
Anh Duong
The City of Winnipeg
Planning, Property & Development
Municipal Accommodations Division
3rd Floor – 65 Garry St.
Winnipeg, Manitoba
R3C 4K4

Prepared by:
Stantec Consulting Ltd.
905 Waverley Street
Winnipeg, Manitoba
R3T 5P4

July 4, 2014

Sign-off Sheet

This document entitled Geotechnical Investigation Report for The City of Winnipeg Ambulance Station No. 33 – 598 St Mary's Road, Winnipeg, Manitoba was prepared by Stantec Consulting Ltd. for the account of The City of Winnipeg. The material in it reflects Stantec's best judgment in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. Stantec Consulting Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Prepared by 
(signature)

Trevor Schellenberg, EIT
Geotechnical Engineering

Reviewed by 
(signature)

Don Flatt, M.Eng., P.Eng.
Senior Geotechnical Engineer

Table of Contents

LIST OF TABLES

LIST OF APPENDICES

1.0 INTRODUCTION

Stantec Consulting Ltd. (Stantec) was retained to undertake a geotechnical investigation to evaluate the existing soil and groundwater conditions at the site of The City of Winnipeg Ambulance Station No. 33 located at the 598 St. Mary's Road in Winnipeg, Manitoba. Two testholes were drilled on the project site on June 10, 2014. The scope of work for this project was outlined in our proposal dated March 27, 2014. Anh Duong from The City of Winnipeg provided authorization to proceed with the geotechnical investigation on May 29, 2014.

The work that has been performed as part of this geotechnical study included the following:

- A geotechnical drilling and soil sampling program at the project site to identify the existing soil conditions.
- Laboratory testing on select samples to determine the engineering properties for the soils encountered during the geotechnical investigation. The laboratory testing program included moisture contents on all samples and torvane tests on grab samples and Shelby tube samples.
- Preparation of this geotechnical report outlining the existing site conditions, a site plan with testhole locations and testhole logs with information on soil and groundwater conditions. The following report also contains comments on potential construction issues, recommendations regarding cast-in-place concrete friction piles and the use of sulphate-resistant cement.

2.0 PROJECT SITE AND PROPOSED CONSTRUCTION

The project site is located at the 598 St. Mary's Road in Winnipeg, Manitoba and currently functions as The City of Winnipeg Ambulance Station No. 33. It is our understanding that the existing ground floor slab has deteriorated and consequently, the structural capacity of the floor slab has been reduced. Replacement of the floor slab is being considered to ensure it will safely support the loads from the vehicles parked in the ambulance station. It is our understanding that the ground floor slab will be replaced in sections to allow the ambulance station to continue to operate during reconstruction.

.

3.0 GEOTECHNICAL INVESTIGATION

3.1 TESTHOLE DRILLING AND SOIL SAMPLING

The subsurface drilling and sampling program was conducted on June 10, 2014. Drilling services were provided by Maple Leaf Drilling Ltd. under the supervision of our geotechnical field personnel. Two testholes were drilled on the project site using a truck-mounted drill rig equipped with 125 mm solid stem augers. Testholes TH1 and TH2 were drilled to a depth of 18.1 m and 16.5 m respectively. The testhole locations are shown on the Testhole Location Plan provided in Appendix B.

Soil samples were obtained directly from the auger flights at depth intervals ranging from 0.3 to 1.5 m. A total of six undisturbed Shelby tube samples were also collected from the testholes. The soil samples were visually classified in the field and returned to our soils laboratory for additional examination and testing. Upon completion of drilling, the testholes were examined for evidence of sloughing and groundwater seepage. The testholes were backfilled with auger cuttings.

3.2 LABORATORY TESTING

A laboratory testing program was performed on select soil samples from the drilling program to determine the relevant engineering properties of the subsurface materials. Diagnostic testing included moisture contents (ASTM D2216) on all soil samples and torvane tests on grab samples and Shelby tube samples. Laboratory testing results can be found on the testhole logs in Appendix C

4.0 INVESTIGATION RESULTS

4.1 SOIL PROFILE

Asphalt – Asphalt was encountered at the surface of both testholes. The thickness of asphalt was 140 mm in Testhole TH1 and 25 mm in Testhole TH2.

Concrete – Concrete was encountered below the asphalt in Testhole TH1. The thickness of the concrete was 165 mm.

Clay Fill – Clay fill was encountered below the concrete in Testhole TH1 and below the granular fill in Testhole TH2. The clay fill extended to depths of 1.1 m and 0.9 m in Testhole TH1 and Testhole TH2 respectively. The clay fill was black, firm, moist and of high plasticity, containing trace organic material, some fine to coarse sand, trace to some fine gravel. In Testhole TH1, the clay fill was silty. Water contents of the clay fill ranged from 28% to 37%.

Granular Fill – Granular fill was encountered below the asphalt in Testhole TH2 and extended to a depth of 0.15 m. The granular fill had a maximum aggregate size of 20 mm. The water content of the granular fill was 4%.

Clay – Clay was encountered beneath the clay fill. The clay layer was encountered at depths of 1.1 m and 0.9 m respectively in Testhole TH1 and Testhole TH2. The clay extended to a depth of 16.7 m in Testhole TH1 and to a depth of 16.1 m in Testhole TH2. Within the clay layer in Testhole TH2, clayey silt was encountered between 2.0 m and 2.7 m. The clay was brown to grey, firm to soft, moist, and of high plasticity, containing trace silt and silt till. Water contents of the clay ranged from 27% to 56%.

Clayey Silt – Clayey silt was encountered between 2.0 m and 2.7 m in Testhole TH2. The clayey silt was tan, firm and of medium plasticity. Water contents of the clayey silt ranged from 23% to 26%.

Silt Till – Silt till was encountered below the clay and extended to the depths explored in the testholes. The silt till was tan, compact to dense, moist and of low plasticity and contained some fine to coarse sand. Although not encountered in our site investigation, boulders and cobbles are often present within the silt till. The silt till was clayey and contained varying amounts of gravel. Water contents of the silt till ranged from 14% to 16%.

4.2 GROUNDWATER AND SLOUGHING CONDITIONS

Groundwater and soil sloughing conditions were recorded upon completion of drilling each testhole. Observed groundwater and soil sloughing conditions are presented in the following table.

Table 1 - Observed Groundwater Seepage and Sloughing Conditions

Testhole No.	Groundwater Seepage	Observed Depth of Groundwater Seepage	Depth to Groundwater Upon Completion of Drilling	Observed Depth of Soil Sloughing
TH1	Minor	16.8 m	18.0 m	16.8 m
TH2	Moderate	16.2 m	10.7 m	10.7 m

It should be noted that only short-term seepage and sloughing conditions were observed and groundwater levels will normally fluctuate during the year and will be dependent on precipitation and surface drainage.

5.0 Geotechnical Considerations

Based on our current understanding of the proposed renovations and the results of our geotechnical investigation, the primary geotechnical concern at the project site is potential soil sloughing and groundwater seepage during installation of cast-in-place concrete friction piles. This issue will be discussed in the following section.

6.0 Foundation Recommendations

Based on the soil and groundwater conditions encountered at the testhole locations, the new ground floor slab may be supported on cast-in-place concrete friction piles. Another foundation option that may be considered to support the structural concrete slab is a system of helical piles. The installation of driven precast concrete piles is not considered to be feasible within the existing structure and consequently, this foundation system is not recommended for the proposed project. A shallow foundation system is not recommended due to anticipated foundations movements related to volume change of the high plasticity clay. It is generally recommended that different foundation systems not be used to support the same structure unless they are used to support independent structural elements of the structure.

6.1 LIMIT STATES DESIGN

In accordance with the 2010 National Building Code of Canada (NBCC), the use of Limit States Design (LSD) is required for the design of buildings and their structural components including foundations. The limit states of LSD design are classified into two groups; the Ultimate Limit States (ULS) and the Serviceability Limit States (SLS).

The Ultimate Limit State case is primarily concerned with the collapse mechanisms for the structure and hence, safety. For foundation design, ultimate limit state consists of:

- Exceeding the load-carrying capacity of the foundation;
- Sliding;
- Uplift;
- Large deformation of foundation, leading to an ultimate limit state being induced in the superstructure or building;
- Overturning, and
- Loss of overall stability.

The factored resistance at the ULS is the ultimate geotechnical resistance multiplied by the appropriate resistance factor.

The Serviceability Limit State (SLS) case considers mechanisms that restrict or constrain the intended use or occupancy of the structure. They are typically associated with movements that interrupt or hinder the purpose of the structure. For foundation design, serviceability limit state consists of:

- Excessive movements, and
- Unacceptable vibrations

The SLS case is addressed by determining the maximum available resistance to keep the foundation under service loads within tolerable limits as provided by the structural engineer. Unfactored permanent and transitory loads are used for calculating total deformation in non-cohesive soils. Unfactored permanent loads and appropriate portions of transitory loads are used for the initial and time-dependent final deformations of cohesive soils. Therefore, the foundation loads and serviceability tolerances have to be known to properly determine the SLS

resistance values. In cases where tolerable movements are not provided by the structural engineer, the tolerable limit of total settlement for foundations subject to compression is typically assumed to be 25 mm.

6.2 FOUNDATION DESIGN

6.2.1 Cast-in-Place Concrete Friction Piles

Cast-in-place concrete friction piles are suitable for light to moderate foundation loads and may be designed based on the shaft resistance values shown in the following table.

Table 2 - Geotechnical Shaft Resistance for Cast-In-Place Concrete Friction Piles

Depth Interval below Existing Grade	Factored Geotechnical Shaft Resistance at ULS
0 to 2 m	0 kPa
2 to 15.5 m	17 kPa

For friction piles, less than 15 mm of settlement is required to mobilize shaft resistance, and therefore the SLS case does not govern pile design.

The shaft resistance value is applied to the pile circumference within the clay stratum over the depth intervals indicated in the above table. Due to the presence of high plasticity clay and the potential for soil drying and shrinkage near the ground surface, frictional support should be ignored to a depth of 1 m below the top of the pile. The contribution from end bearing should be ignored in pile capacity calculations.

To avoid pile group effects, the minimum pile spacing should be three pile diameters measured center to center. If pile spacing is less than three pile diameters, additional analyses will be required to evaluate the settlement and capacity of the pile group. Settlement calculation for a pile group is based on the foundation load and the consolidation properties of the soil below the base of the piles. The capacity of a pile group is reduced as the pile spacing is decreased.

Groundwater conditions can vary seasonally, and seepage and soil sloughing may occur during pile installation. Temporary steel sleeves should be available during pile installation to control soil sloughing and groundwater seepage. Groundwater, if encountered in the pile holes, should be removed prior to concrete placement. Pile holes should be poured with concrete as soon as they are drilled to minimize any potential problems related to soil sloughing and groundwater seepage.

The depth to silt till ranged from 16.1 m to 16.7 m at the testhole locations. It is recommended that the pile length not exceed 15.5 m from existing grade to reduce the risk of encountering silt till and to avoid groundwater seepage from the silt till. A minimum void space of 150 mm should

be provided beneath all structural elements to accommodate potential heave of the high plasticity clay. Pile inspection by qualified geotechnical personnel should be provided during foundation construction to confirm that the piles are constructed in accordance with the project specifications.

6.2.2 Helical Piles

A foundation system consisting of helical piles (screw piles) may be considered to support the proposed structural floor slab. As helical piles are a proprietary foundation system, design recommendations should be provided by an experienced helical pile contractor.

6.3 FOUNDATION CONCRETE

The clay soils in the Winnipeg area contain sulphates that will cause deterioration of concrete. The class of exposure for concrete in contact with clay soil in the Winnipeg area is considered to be severe (S-2 in CSA A23.1-09 Table 3). The requirements for concrete exposed to severe sulphate attack are provided in the following table.

Table 3 - Foundation Concrete Requirements

Parameter	Design Requirement
class of exposure	S-2
compressive strength	32 MPa at 56 days
air content	4 to 7%
water-to-cementing materials ratio	0.45 max.
cement	Type HS or HSb

Concrete in contact with the native soils should meet the above requirements.

6.4 DESIGN REVIEW, CONSTRUCTION MONITORING AND TESTING

Stantec should be retained to review the foundation plans and specifications for conformance with the intent of our recommendations. During construction, we recommend that a representative from our firm be involved with the following tasks:

- Inspection of foundation installation
- Testing of concrete

The purpose of the foundation inspection services would be to provide Stantec the opportunity to observe the soil conditions encountered during construction, evaluate the applicability of the recommendations presented in this report to the soil conditions encountered, and recommend appropriate changes in design or construction procedures if conditions differ from those described herein. The purpose of the concrete testing is to ensure these materials comply with the specification requirements.

7.0 Closure

This report has been prepared for the sole benefit of the City of Winnipeg and its agents, and may not be used by any third party without the express written consent of Stantec Consulting Ltd. Any use, which a third party makes of this report, is the responsibility of such third party. Use of this report is subject to the Statement of General Conditions provided in Appendix A. It is the responsibility of the City of Winnipeg who is identified as "the Client" within the Statement of General Conditions, and its agents to review the conditions and to notify Stantec Consulting Ltd. should any of these not be satisfied. The Statement of General Conditions addresses the following:

- Use of the report
- Basis of the report
- Standard of care
- Interpretation of site conditions
- Varying or unexpected site conditions
- Planning, design or construction

We trust the above information meets with your present requirements. Should you have any questions or require further information, please contact us. This report has been prepared by Trevor Schellenberg, EIT and reviewed by Don Flatt, M.Eng., P.Eng.

Thank you for the opportunity to be of service to you.

STANTEC CONSULTING LTD

Trevor Schellenberg, EIT
Geotechnical Engineering
Tel: (204) 928-4007

Don Flatt, M.Eng., P.Eng.
Senior Geotechnical Engineer
Tel: (204) 928-4001

APEGM
Certificate of Authorization
Stantec Consulting Ltd.
No. 1301

PROVINCE OF MANITOBA
D.G.
FLATT
Member
5062
REGISTERED PROFESSIONAL ENGINEER

APPENDIX A

Statement of General Conditions

USE OF THIS REPORT: This report has been prepared for the sole benefit of the Client or its agent and may not be used by any third party without the express written consent of Stantec and the Client. Any use which a third party makes of this report is the responsibility of such third party.

BASIS OF THE REPORT: The information, opinions, and/or recommendations made in this report are in accordance with Stantec's present understanding of the site specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time of the investigation or study. If the proposed site specific project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Stantec is requested by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

STANDARD OF CARE: Preparation of this report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state or province of execution for the specific professional service provided to the Client. No other warranty is made.

INTERPRETATION OF SITE CONDITIONS: Soil, rock, or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Stantec at the time of the work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behavior. Extrapolation of in situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

VARYING OR UNEXPECTED CONDITIONS: Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Stantec must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Stantec will not be responsible to any party for damages incurred as a result of failing to notify Stantec that differing site or sub-surface conditions are present upon becoming aware of such conditions.

PLANNING, DESIGN, OR CONSTRUCTION: Development or design plans and specifications should be reviewed by Stantec, sufficiently ahead of initiating the next project stage (property acquisition, tender, construction, etc), to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site work relating to the recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Stantec cannot be responsible for site work carried out without being present.

APPENDIX B

Testhole Location Plan

Stantec	Project No. 123311256	Drawn by:SB	Figure: 1	**Testhole Location Plan** **598 St. Mary's Road** **Winnipeg, Manitoba**
	Date:July 4, 2014	Reviewed by:DF	Scale: NTS	

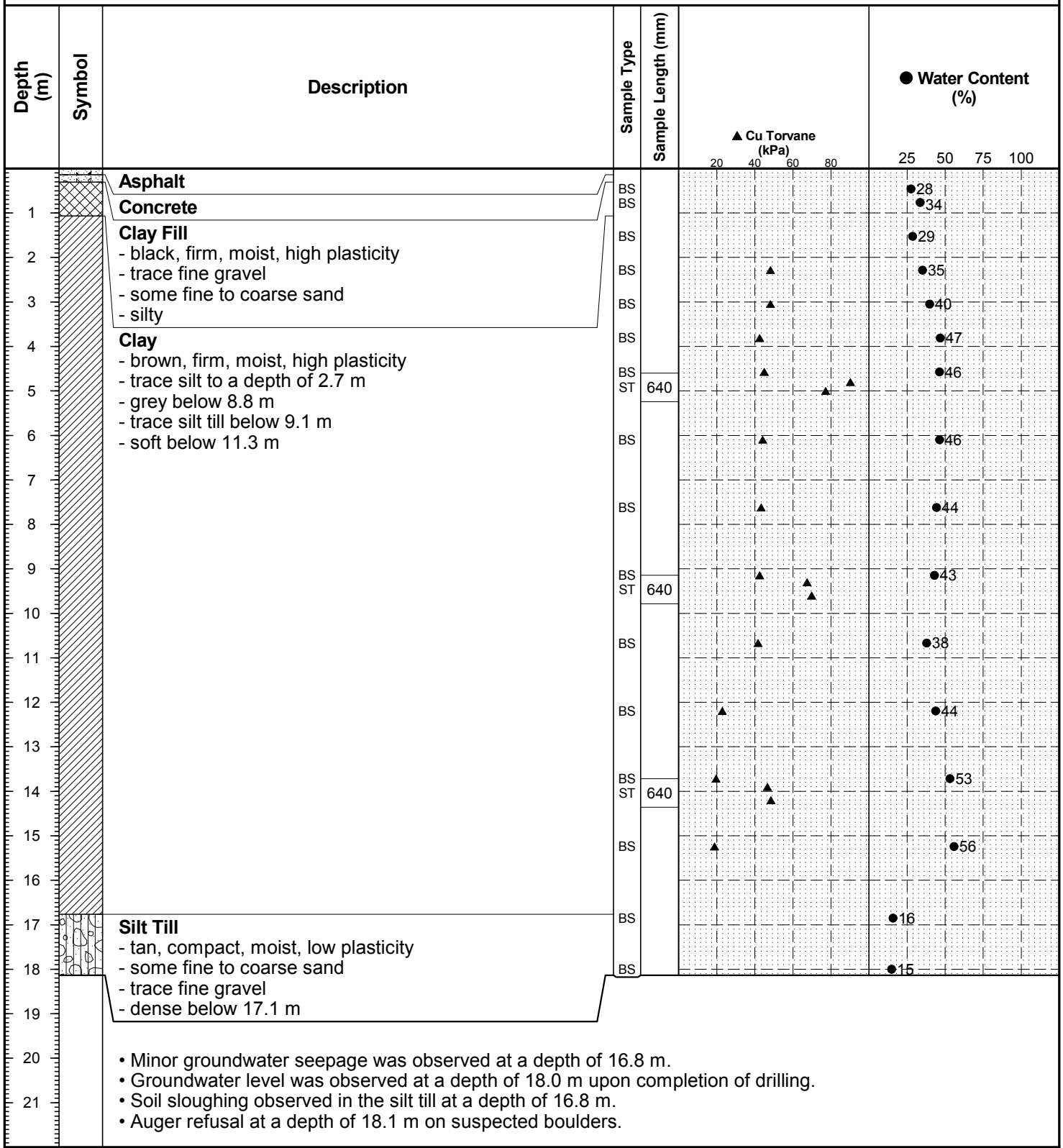
APPENDIX C

Testhole Logs

TESTHOLE TH1

Project Name: 598 St. Mary's Road
Project Location: Winnipeg, Manitoba
Client: City of Winnipeg
Drilling Contractor: Maple Leaf Drilling Ltd.
Drilling Method: 125 mm Solid Stem Auger

Date Drilled: June 10, 2014
Depth of Testhole: 18.1 m
Logged by: Larry Presado
Reviewed by: Aron Piamsalee

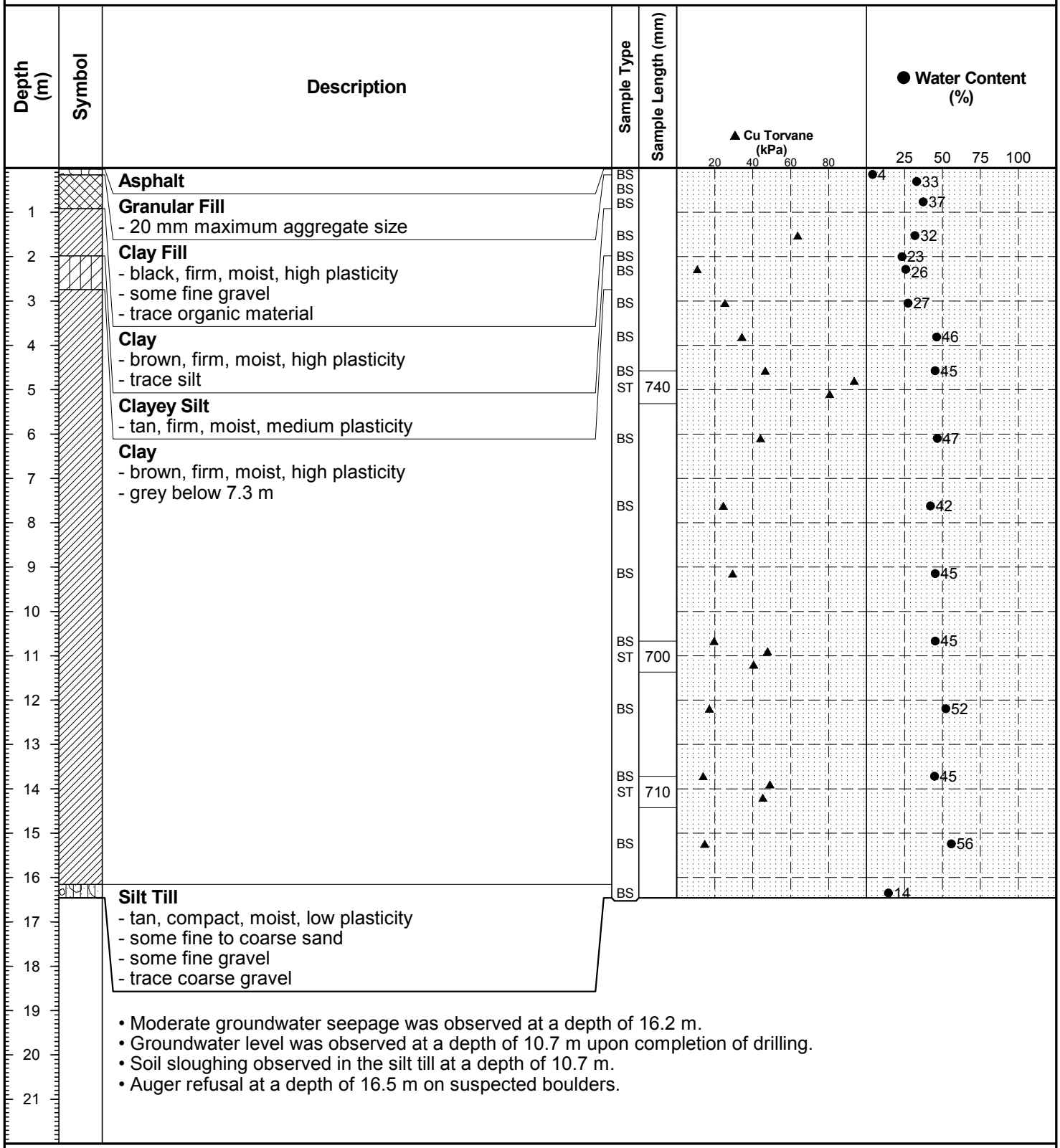


- Minor groundwater seepage was observed at a depth of 16.8 m.
- Groundwater level was observed at a depth of 18.0 m upon completion of drilling.
- Soil sloughing observed in the silt till at a depth of 16.8 m.
- Auger refusal at a depth of 18.1 m on suspected boulders.

TESTHOLE TH2

Project Name: 598 St. Mary's Road
Project Location: Winnipeg, Manitoba
Client: City of Winnipeg
Drilling Contractor: Maple Leaf Drilling Ltd.
Drilling Method: 125 mm Solid Stem Auger

Date Drilled: June 10, 2014
Depth of Testhole: 16.5 m
Logged by: Larry Presado
Reviewed by: Aron Piamsalee



- Moderate groundwater seepage was observed at a depth of 16.2 m.
- Groundwater level was observed at a depth of 10.7 m upon completion of drilling.
- Soil sloughing observed in the silt till at a depth of 10.7 m.
- Auger refusal at a depth of 16.5 m on suspected boulders.