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City of Winnipeg

St. James Civic Centre New Additions and Building Geotechnical Investigation

Prepared for:

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Project Number:
0015 024 00

Date:
May 9, 2018

TREK GEOTECHNICAL
Quality Engineering | Valued Relationships

May 9, 2018 Our File No. 0015 024 00

Kathy Roberts
Project Officer
City of Winnipeg, Municipal Accommodations
4th Floor, 185 King Street
Winnipeg, Manitoba
R3B 1J1

RE: St. James Civic Centre New Additions and Building, Winnipeg, MB
Geotechnical Investigation Report

TREK Geotechnical Inc. is pleased to submit our Final Report for the Geotechnical Investigation for the above noted project.

Please contact the undersigned if you have any questions. Thank you for the opportunity to serve you on this assignment.

Sincerely,

TREK Geotechnical Inc.
Per:

Nelson John Ferreira, Ph.D., P.Eng.
Senior Goetechnical Engineer
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Encl.

Revision History

Revision No.	Author	Issue Date	Description
0	BT	May 9, 2018	Final Report

Authorization Signatures

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Certificate of Authorization
TREK GEOTECHNICAL INC.
No. 4877 Date: May 09, 2018

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1.0 Introduction

This report summarizes the results of the geotechnical investigation completed by TREK Geotechnical Inc. (TREK) for the proposed additions and standalone buildings at St. James Civic Centre located on 2055 Ness Avenue in Winnipeg, Manitoba. The scope of work includes a sub-surface investigation, laboratory testing and provision of design and construction recommendations for suitable foundation alternatives. Additional recommendations relative to site drainage, structural and grade-supported concrete slabs (interior and exterior), asphalt pavements, and foundation concrete are also included in this report. The terms of reference for the investigation are included in our proposal address to Kathy Roberts at the City of Winnipeg (COW) dated March 7, 2018.

2.0 Background

The St. James Civic center is a multi-purpose public leisure and recreation center which includes an indoor arena, swimming pool, auditorium, and weight room. TREK understands that three additions along the east and south sides of the existing building are currently being planned; Phase 1 at 958 sq. m, Phase 2 at 309 sq. m, and a future phase at about 1000 sq. m (Figure 01). A standalone building to be used as a library and potentially be located either along the west property line along with a new parking area or to the south of the existing building. The additions and standalone building are to be single storey, steel structures.

Based on drawings provided by the COW, the existing building is founded on a combination of straight shaft or belled cast-in-place end bearing piles of various diameters with the majority of the piles being belled. The belled piles were either mechanically cleaned and bearing on the hardpan (clay-silt till contact) or hand-cleaned and keyed into a denser silt till. The straight shaft cast-in-place piles were installed at the depth where auger refusal was observed.

3.0 Field Program

3.1 Sub-surface Investigation

The sub-surface investigation was performed on April 9 to 10, 2018 under the supervision of TREK personnel to determine the soil stratigraphy and groundwater conditions at the site. Nine test holes (TH18-01 to 09) were drilled using a Soilmec STM-20 truck-mounted piling rig equipped with 406 mm auger. Seven test holes were drilled in a landscaped (grassed) area located along east and south sides of the existing buildings (TH18-01, 04 and 05) and along the west property line (TH18-06 to 09). Two test holes were drilled through paved areas; TH18-02 located in the existing public parking lot south of existing building and TH18-03 located south east of staff parking lot.

Test holes TH18-01 to 06 were drilled to a depth of 15.5 m below existing grade or until power auger refusal was encountered. Test holes TH18-07 and 08 were drilled to a depth of 3.0 m below existing grade. Two test bells were performed in TH18-06 a few meters (8.7 m below natural grade) into the silt till and TH18-09 at the silty clay and silt till contact at a depth 6.7 m below natural grade. In paved areas, the test holes (TH18-02 and -03) were backfilled with auger cuttings and topped with granular materials and cold patch asphalt and the remaining test holes were backfilled with auger cuttings to existing grade.

Sub-surface soils observed during the drilling were visually classified based on the Unified Soil Classification System (USCS). Samples retrieved during drilling were transported to TREK's testing laboratory in Winnipeg, Manitoba for further testing and classification. Laboratory testing consisted of water content determination on all samples, as well as bulk unit weight measurements and unconfined compression testing on undisturbed samples.

Test hole locations were determined based on measuring offsets from the existing building. The test hole elevations were surveyed using a rod and level relative to the main floor at south entrance of existing building (denoted as TBM-01 on Figure 01) which was assigned an arbitrary elevation of 100.0 m. The test hole logs attached which describes the soil units encountered and other pertinent information such as test hole locations, elevations (local), groundwater conditions and a summary of the laboratory testing results.

3.2 Sub-surface Conditions

3.2.1 Soil Stratigraphy

A brief description of the soil units encountered during drilling is provided below. All interpretations of soil stratigraphy for the purposes of design should refer to the detailed information provided on the attached test hole logs.

In general, the soil stratigraphy encountered at the test hole locations in descending order from ground surface consists of organic clay, fill, silt, silty clay and silt till. The soil was generally frozen within the upper 2.1 m below grade at the time of drilling. A thin layer of organic clay (300 mm to 600 mm thick) was observed from existing ground surface in every test hole except in TH18-02 and 03. Fill was present in developed areas and is 0.6 m to 1.2 m thick and consisted of clay in landscaped area (TH18-01, 04 and 05) and sand and gravel followed by clay fill in paved areas (TH18-02 and 03). Fill was not encountered along the west side of the property (TH18-06 to 09) in the proposed library and new parking area.

Silt was observed in a few test holes, beneath either fill (TH18-01 and 04) or organic clay (TH18-07 and 08) and extended to depths ranging from 0.6 m to 2.1 m below existing grade. The silt contains trace clay, trace sand and trace gravel, it was brown, generally frozen, moist to wet and soft when thawed and of low plasticity. Silty clay was encountered in every test hole at depths ranging between 0.3 m to 2.1 m below existing grade. The silty clay contains trace sand and trace gravel, is brown and becoming grey below 2.1 m, moist, stiff becoming softer with depth and of high plasticity.

The underlying silt till was encountered from 6.7 m to 8.2 m below existing grade and extended to maximum depth explored at depths ranging from 13.1 m to 15.5 m. Power auger refusal was encountered in three test holes (TH18-01, 02 and 06) at depths ranging from 13.1 m to 15.5 m. The silt till contains trace clay, trace sand and trace gravel, it was light grey, generally moist to wet and compact, becoming moist and dense with depth. Trace cobbles was encountered in the silt till below 9.1 m in test holes TH18-02, 03 and 04.

Test hole information on the drawings for the existing building provided by COW noted about 7.0 to 7.7 m of clay above hardpan (inferred as silt till) in four test holes which is consistent with the contact elevation observed in TREK's test holes.

3.2.2 *Seepage and Sloughing*

Seepage was encountered in the silt till or silt in the majority of test holes. Seepage in the silt till typically occurred in the upper portion of the layer (TH18-01, 02, 04 and 05) between depths of 8.2 to 9.1 m. Seepage was also encountered in TH18-03 between 14.0 m and 14.1 m depth from a sand seam in the silt till. Sloughing was observed in the silt till in two test holes (TH18-01 between 9.8 m and 13.7 m, TH18-06 between 8.5 m and 8.7 m). Sloughing was also observed TH18-02 between 0.1 m to 0.9 m in sand and gravel (fill).

These observations are short-term and should not be considered reflective of (static) groundwater levels at the site which would require monitoring over an extended period of time to determine. It is important to recognize that groundwater conditions may vary seasonally, annually, or as a result of construction activities.

4.0 Foundation Recommendations

Based on the subsurface conditions, laboratory testing results and the existing structure foundation systems, Cast-in-place concrete bearing (belled or straight shaft) piles are considered the most suitable foundation alternative for this site. Limit state design and construction recommendations in accordance with the National Building Code of Canada (NBCC 2015) for these pile types are provided below.

4.1 Limit States Design

Limit States Design recommendations for deep foundations in accordance with the National Building Code of Canada (NBCC, 2010) are provided below. Limit states design requires consideration of distinct loading scenarios comparing the structural loads to the foundation bearing capacity using resistance and load factors that are based on reliability criteria. Two general design scenarios are evaluated corresponding to the serviceability and ultimate capacity requirements.

The **Ultimate Limit State (ULS)** is concerned with ensuring that the maximum structural loads do not exceed the nominal (ultimate) capacity of the foundation units. The ULS foundation bearing capacity is obtained by multiplying the nominal (ultimate) bearing capacity by a resistance factor (reduction factor), which is then compared to the factored (increased) structural loads. The ULS bearing capacity must be greater or equal to the maximum factored load to provide an adequate margin of safety. Table 1 summarizes the resistance factors that can be used for the design of deep foundations as per the NBCC (2015) depending upon the method of analysis and verification testing completed during construction.

The **Service Limit State (SLS)** is concerned with limiting deformation or settlement of the foundation under service loading conditions such that the integrity of the structure will not be impacted. The Service Limit State should generally be analysed by calculating the settlement resulting from applied service loads and comparing this to the settlement tolerance of the structure. However, the settlement tolerance of the structure is typically not yet defined at the preliminary design stage. As such, SLS bearing capacities are often provided that are developed on the basis of limiting settlement to 25 mm or less. A more detailed settlement analysis should be conducted to refine the estimated settlement and/or adjust the SLS capacity if a more stringent settlement tolerance is required or if large groups of piles are used.

Table 1. ULS Resistance Factors for Deep Foundations (NBCC, 2010)

Resistance to Axial load for Deep Foundations (Analysis Methods)	Resistance Factor
Semi-empirical analysis using laboratory and *in-situ* test data	0.4
Analysis using dynamic monitoring results	0.5
Analysis using static loading test results	0.6
Uplift resistance by semi-empirical analysis.	0.3

4.2 Cast-in-Place Concrete End Bearing Caisson

Cast-in-place concrete (CIPC) caissons installed in the compact or dense silt till will derive a majority of their resistance in end bearing with a relatively small contribution from shaft adhesion. Caissons may be designed either as a straight shaft or belled piles which has been successfully implemented for the existing building. Straight shaft caissons will be subjected to frost jacking (exterior piles) and tension loads will derive a majority of their axial-uplift resistance in shaft friction. Belled piles also need to be designed to structurally resist ad-freezing loads, however the majority of the resistance to uplift comes from soil bearing on the top of the bell. Table 2 provides the recommended ULS and SLS end bearing and shaft friction (adhesion) resistance values for loading conditions for caissons bearing on either compact silt till (belled piles) or very dense silt till (straight shaft piles). The SLS capacity of the caissons is settlement-dependent and is based on a maximum settlement of 25 mm. the elastic shortening of the pile should be added to the tip displacement to calculate the pile head settlement.

Table 2. Recommended End Bearing Resistances for CIPC Caissons

Foundation Systems	Factored ULS Axial Resistance (kPa)			SLS Axial Resistance (kPa)		
	Compression $\phi = 0.4$		Uplift $\phi = 0.3$	Compression		Uplift
	Shaft Adhesion	Unit End Bearing	Shaft Adhesion	Shaft Adhesion[1]	Unit End Bearing	Shaft Adhesion
CIPC End Bearing Straight Shaft Piles	15	680	11	0	450	12
CIPC End Bearing Belled Piles	15	220	N/A	0	180	N/A

Notes: [1] *Shaft adhesion is not applicable for the SLS axial-compression case*

Two test bells were performed as part of the investigation. One bell was excavated in TH18-06 at 8.7 m depth, a couple of meters within the silt till. Sloughing was observed with approximately 100 mm of sloughed material accumulating within the bell after about 30 minutes. The other test bell was excavated in TH18-09 at 6.7 m depth in the clay with the base of the bell bearing on the top of the compact silt till layer. The bell was left open for approximately 30 minutes and sloughing was not observed. Based on the observed conditions and historical success of belled piles on this site, TREK considers the site well suited belled piles. To reduce the risk of seepage and sloughing, TREK recommends that when possible piles be designed based on piles being machine cleaned and formed on top of the silt till layer. In the event the bell collapses or sloughs during drilling, a second bell should be attempted at a greater depth, if seepage and sloughing continues to occur replacement with straight shaft piles in may be necessary at some locations. Straight shaft caissons should be installed into very dense till which is anticipated to be several meters or more into the silt till layer.

It should be noted that the silt till encountered at the site may soften when exposed to water, which could lead to disturbance of the caisson base and a reduction in capacity. As such, it is critical that water not be permitted to enter the caisson/pond in the base during drilling. Full length sleeves (to the top of bell) may be required to maintain a dry shaft.

Caisson Design Recommendations:

1. The weight of the embedded portion of the pile may be neglected.
2. Shaft adhesion should be neglected within the upper 2.4 m below ground surface.
3. Caisson bases must be founded on compact (belled piles) and very dense silt till (straight shaft piles).
4. Caissons should have a minimum shaft diameter of 406 mm.
5. For belled end bearing caissons, a ratio from 2.7 to 3.0 between the pile bell diameter and shaft diameter should be used.
6. For straight shaft piles, a minimum pile length of 8.0 m below ground surface is recommended to protect against frost jacking. In this regard, uplift forces due to ad-freezing in the upper 2.4 m below ground should be based on an uplift adhesion of 65 kPa.
7. Caissons should have a minimum spacing of 2.5 diameters (shaft diameter for straight shaft piles and bell diameter for belled piles) measured centre to centre. If a closer spacing is required, TREK should be contacted to provide an efficiency (reduction) factor to account for potential group effects.
8. Caissons should be designed by a qualified structural engineer to resist all applied loads induced from the structure as well as tensile forces induced from seasonal movements of the bearing soils.
9. Grade beams and caisson caps should be constructed with a minimum 150 mm void between soils and the underside of the concrete to minimize the effects of soil heave due to swelling or frost action.

Caisson Installation Recommendations:

1. Temporary steel casings (*i.e.* sleeves) should be on site and used if sloughing of the caisson hole occurs, to control groundwater seepage if encountered, and/or if down-hole entry is required. Care should be taken in removing sleeves to prevent sloughing (necking) of the shaft walls and a reduction in the cross-sectional area of the pile.

2. The foundation contractor should expect to encounter some seepage and sloughing from the shallow silt layer and/or top of the silt till unit during installation of the caissons.
3. Caisson bases must be free of water, debris, or loose and/or disturbed soil.
4. Concrete should be placed in one continuous operation immediately after the completion of drilling the pile hole to avoid construction problems associated with sloughing or caving of the pile hole and groundwater seepage. Concrete should be poured under dry conditions. If groundwater is encountered, it should be controlled and removed.
5. Concrete placed by fee-fall methods should be directed through the middle of the caisson shaft and steel reinforcing cage to prevent striking of the caisson walls to protect against soil contamination of the concrete.
6. The drilling of all caisson shafts should be observed and documented by TREK Geotechnical to verify the soil conditions and proper installation of the caissons.

4.3 Lateral Capacity

Lateral capacity is not expected to be a concern for design; however, limit states design values can be provided if necessary once lateral loads are known.

4.4 Ad-freezing Effects

Concrete piles, pile caps, grade beams, and walls subjected to freezing conditions should be designed to resist ad-freeze and uplift forces related to frost action acting along the vertical face of the member within the depth of frost penetration (2.4 m). In this regard, concrete piles, pile caps, grade beams, and walls may be subject to an ad-freeze bond stress of 65 kPa within the depth of frost penetration.

Ad-freeze forces will be resisted by structural dead loads and uplift resistance provided by the length of the pile below the depth of frost penetration. The following design recommendations apply to piles subject to ad-freeze forces:

1. An ad-freeze bond stress of 65 kPa within the depth of frost penetration (2.4 m).
2. A load factor (α) of 1.2 may be used in the calculation of ad-freezing forces.
3. A resistance factor of 0.8 may be used in calculation of the geotechnical resistance for the factored ULS condition with an ultimate (nominal) resistance of 37 kPa. Structural dead loads should be added to the resistance.
4. The calculated geotechnical resistance plus the structural dead loads must be greater than the factored ad-freezing forces.
5. Straight shaft piles subject to ad-freezing forces should be a minimum of 8.0 m or as calculated by the method above, whichever is greater.

Measures such as flat lying rigid polystyrene insulation could be considered to reduce frost penetration depths and thereby ad-freezing and uplift forces.

4.5 Pile Caps and Grade Beams

A void space should be provided underneath all grade beams and pile caps to avoid uplift pressures from developing on the underside of the pile cap as a result of swelling or frost action. Void forms should be selected such that they can deform a minimum of 150 mm without transferring stresses to the structure. Excavations for grade beams should be backfilled with granular fill compacted to a minimum of 95% of the SPMDD. The excavation should be capped with clay sloped at a gradient of at least 2% to promote runoff away from the structure.

4.6 Foundation Concrete

All foundation concrete should be designed by a qualified structural engineer for the anticipated axial (compression and uplift), lateral, and bending loads from the structure. Based on local experience gathered through previous work in Winnipeg, the degree of exposure for concrete subjected to sulphate attack is classified as severe according to Table 3, CSA A23.1-14 (Concrete Materials and Methods of Concrete Construction). Accordingly, all concrete in contact with the native soil should be made with high sulphate-resistant cement (HS or HSb). Furthermore, the concrete should have a minimum specified 56-day compressive strength of 32 MPa and have a maximum water to cement ratio of 0.45 in accordance with Table 2, CSA A23.1-14 for concrete with severe sulphate exposure (S2). Concrete that may be exposed to freezing and thawing should be adequately air entrained to improve freeze-thaw durability in accordance with Table 4, CSA A23.1-14.

4.7 Foundation Inspection Requirements

In accordance with Section *4.2.2.3 Field Review* of the NBCC (2010), the designer or other suitably qualified person shall carry out a field review on:

1. a continuous basis during:
    i. the construction of all deep foundation units,
    ii. the installation and removal of retaining structures and related backfilling operations, and
    iii. during the placement of engineered fills.
2. on an as-required basis for the construction of shallow foundation units and in excavating, dewatering and other related works.

In consideration of the above and relative to this particular project, we recommend that TREK, as the geotechnical engineer of record, be retained to inspect the installation of any foundation elements. TREK is familiar with the geotechnical conditions and the basis for the foundation recommendations and can provide any design modifications deemed to be necessary should altered subsurface conditions be encountered.

5.0 Floor Slabs

5.1 Structural Slabs

A minimum void of 150 mm is recommended beneath the structural slab to accommodate volumetric changes in the underlying sub-grade soils. The void can consist of a compressible layer (*e.g.* low density polystyrene) to permit sub-grade soil movements of 150 mm without engaging the slab. A vapour barrier below the slab is also recommended to minimize long-term moisture changes within the sub-grade soils.

5.2 Grade-Supported Concrete Slabs

If some movement can be tolerated, grade supported concrete floor slabs can be used in areas where fill is not present or can be economically removed and replaced with suitable soils (e.g. granular fill). Vertical deformation of grade supported slabs should be expected due to moisture and volume changes of the underlying soils. Measures to reduce the risks of these movements are provided below. Slabs in unheated areas or near the perimeter of the structure will be subject to additional movements from freeze/thaw of the subgrade soils.

The following additional recommendations apply to grade-supported slabs:

1. To reduce the risk of long-term settlements, organics, silts, fill soils and any other deleterious material should be stripped such that the subgrade consists of undisturbed silty clay. It is anticipated that this will not be an economical approach in areas with deeper fills. Provided there is tolerance for increased settlement and maintenance requirements, the existing fill may be left in place. If this option is preferred, the exposed fill soils at subgrade elevation should be moisture conditioned and compacted to 95% of Standard Proctor Maximum Dry Density (SPMDD). Native clays should be left undisturbed.
2. Fill required to raise grades should consist of a well-graded granular base course (e.g. crushed rock or recycled concrete) compacted to 98% SPMDD in lifts not exceeding 150 mm.
3. Excavation should be completed with a backhoe equipped with a smooth bucket operating from the edge of the excavation. Care should be taken to minimize the subgrade disturbance at all times.
4. After excavation, the subgrade should be inspected by TREK.
5. The exposed subgrade surface should be protected from freezing, inundation, drying, or disturbance. If any of these conditions occur, the subgrade should be scarified, moisture conditioned as appropriate, and re-compacted to a minimum of 95% of the SPMDD.
6. In heated areas, the floor slab should be placed on a 150 mm thick layer of 50 mm down crushed granular sub-base underlying a 150 mm thick base consisting of 20 mm down crushed granular base course. In unheated areas (e.g. exterior slabs) the thickness of 50 mm down crushed granular sub-base should be increased to 250 mm. The crushed granular material should be placed in lifts no greater than 150 mm and compacted to 98% of the SPMDD.
7. Floor slabs should be designed to resist all structural loads and to minimize slab cracking associated with movements as a result of swelling, shrinkage, and thermal expansion and contraction of the subgrade soils.

8. To accommodate slab movements, it may be desirable to provide control joints to reduce random cracking and isolation joints to separate the slab from other structure elements. Allowances should be made to accommodate vertical movements of light weight structures (e.g. partitions) bearing on the slab.
9. The granular base course materials should consist of a well graded, durable crushed rock, in accordance with the City of Winnipeg Specification No. CW 3110.

6.0 Pavement Design

Recommended pavement sections for parking area and pavement areas subject to heavier vehicular loads are provided in Table 3. These recommendations area comparable to typical sections used for City of Winnipeg road works. Granular base and sub-base materials that are consistent with the City of Winnipeg Specification No. CW 3110 are recommended.

Table 3. Recommended Pavement Sections for Roads and Parking Areas (Asphalt)

Material	Layer Thickness		Compaction Requirements
	Car Parking Areas	Heavy Vehicular Loads	
Asphalt	100 mm	100 mm	Mix design and density requirements by others
20 mm down crushed limestone (Base)	75 mm	100 mm	100% of the SPMDD
50 down crushed limestone (Sub-Base)	250 mm	350 mm	98% of the SPMDD
Non-Woven Geotextile (Geotex 801 or equivalent)	Required	Required	Install as per manufacturer's recommendations

<u>Additional Pavement Recommendations:</u>

1. For best long-term performance, organics, silt, fill soils and any other deleterious material should be stripped such that the subgrade consists of undisturbed native silty clay. Based on test holes drilled in the proposed parking lot area this could result in removal of up to 0.6 m to 1.2 m of soils.

2. Excavation should be completed with an excavator equipped with a smooth-bladed bucket and operating from the edge of the excavation in order to minimize disturbance to the exposed sub-grade.
3. After excavation, the sub-grade should be inspected by TREK personnel to identify unsuitable deleterious material. The sub-grade should also be proof-rolled with a fully loaded tandem axle truck to detect soft areas. Soft and /or deleterious areas should be repaired as per directions provided by TREK. This will likely consist of excavating an additional 150 to 300 mm and placing a non-woven geotextile on the sub-grade and backfilling with a 50 mm down crushed limestone sub-base. The crushed limestone should be placed in lifts no greater than 150 mm and compacted to a minimum of 98% of the SPMDD.
4. The sub-grade should be protected from freezing, drying, inundation with water or disturbance. If any of these conditions occur the sub-grade should be scarified, moisture conditioned as

appropriate, and re-compacted to a minimum of 95% of the SPMDD.

5. A non-woven geotextile should be placed in accordance with the manufacturers recommendations on the prepared subgrade prior to placement of granular fill. Geotex 801 or equivalent would be appropriate for use.
6. The granular base course materials should consist of a well graded, durable crushed rock, in accordance with the City of Winnipeg Specification No. CW 3110.
7. The granular sub-base and base materials should be placed in lifts not exceeding 150 mm and compacted to as per the recommendations in Table 5.

7.0 Site Drainage

Drainage adjacent to structures and exterior slabs should promote runoff away from the structures. A minimum gradient of about 2% should be used for both landscaped and paved areas and maintained throughout the life of the structures. All paved areas should be provided with minimum slopes of 2% to improve long-term drainage. The water discharge from roof leaders and run-off from exposed slabs should be directed away from the structures.

8.0 Closure

The geotechnical information provided in this report is in accordance with current engineering principles and practices (Standard of Practice). The findings of this report were based on information provided (field investigation and laboratory testing). Soil conditions are natural deposits that can be highly variable across a site. If subsurface conditions are different than the conditions previously encountered on-site or those presented here, we should be notified to adjust our findings if necessary.

All information provided in this report is subject to our standard terms and conditions for engineering services, a copy of which is provided to each of our clients with the original scope of work, or a mutually executed standard engineering services agreement. If these conditions are not attached, and you are not already in possession of such terms and conditions, contact our office and you will be promptly provided with a copy.

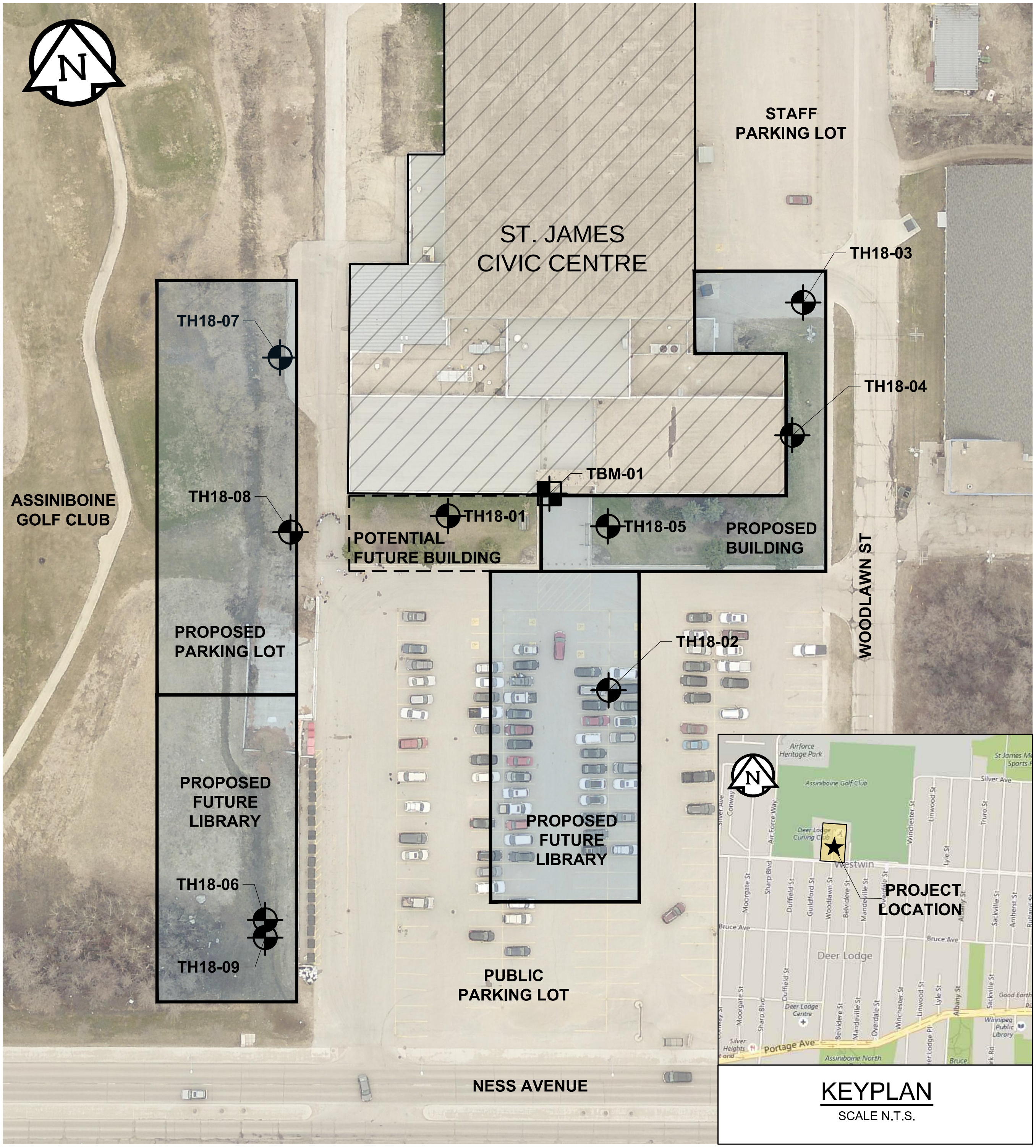
This report has been prepared by TREK Geotechnical Inc. (the Consultant) for the exclusive use of City of Winnipeg Municipal Accommodations (the Client) and their agents for the work product presented in the report. Any findings or recommendations provided in this report are not to be relied upon by any third parties, except as agreed to in writing by the Client and Consultant prior to use.

Figure

0015 024 00

City of Winnipeg

St. James Civic Centre New Additions and Building, Winnipeg, MB



LEGEND:

- TEST HOLE (TEST HOLE APRIL 9-10, 2018)
- TEMPORARY BENCHMARCH TBM-01
  LOCATED ON MAIN FLOOR AT ENTRANCE

NOTE:

1. AERIAL IMAGE FROM CITY OF WINNIPEG, FALL 2016

0 10 20 30 40 50 m

SCALE = 1 : 1 000 (216 mm x 279 mm)

Figure 01

Test Hole Location Plan

Z:\Projects\0015 City of Winnipeg\0015 024 00 St. James Civic Centre\3 Survey and Dwg\3.4 CAD\3.4.3 Working Folder\Fig.001 2018-04-11 0_A_SL 0015 024 00.dwg, 5/8/2018 9:57:17 AM

ANSI full bleed A (8.50 x 11.00 Inches)

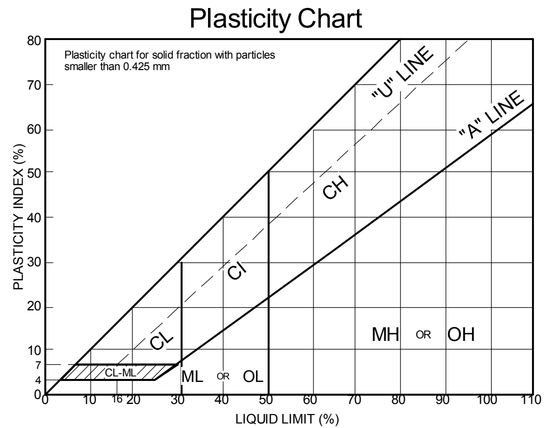
Test Hole Log

TREK GEOTECHNICAL

EXPLANATION OF FIELD AND LABORATORY TESTING

GENERAL NOTES

1. Classifications are based on the United Soil Classification System and include consistency, moisture, and color. Field descriptions have been modified to reflect results of laboratory tests where deemed appropriate.
2. Descriptions on these test hole logs apply only at the specific test hole locations and at the time the test holes were drilled. Variability of soil and groundwater conditions may exist between test hole locations.
3. When the following classification terms are used in this report or test hole logs, the primary and secondary soil fractions may be visually estimated.

Major Divisions			USCS Classification	Symbols	Typical Names	Laboratory Classification Criteria		
Coarse-Grained soils (More than half the material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than 4.75 mm)	Clean gravel (Little or no fines)	GW	●	Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain size curve, depending on percentage of fines (fraction smaller than No. 200 sieve) coarse-grained soils are classified as follows: Less than 5 percent...... GW, GP, SW, SP More than 12 percent...... GM, GC, SM, SC 6 to 12 percent...... Borderline case4s requiring dual symbols*	$C_U = \frac{D_{60}}{D_{10}}$ greater than 4; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP	○	Poorly-graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravel with fines (Appreciable amount of fines)	GM	◌	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are border-line cases requiring use of dual symbols
			GC	▨	Clayey gravels, gravel-sand-silt mixtures		Atterberg limits above "A" line or P.I. greater than 7	
	Sands (More than half of coarse fraction is smaller than 4.75 mm)	Clean sands (Little or no fines)	SW	∴	Well-graded sands, gravelly sands, little or no fines		$C_U = \frac{D_{60}}{D_{10}}$ greater than 6; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP	⁚	Poorly-graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM	▥	Silty sands, sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are border-line cases requiring use of dual symbols
			SC	▨	Clayey sands, sand-clay mixtures		Atterberg limits above "A" line or P.I. greater than 7	
Fine-Grained soils (More than half the material is smaller than No. 200 sieve size)	Silts and Clays (Liquid limit less than 50)		ML	▥	Inorganic silts and very fine sands, rock floor, silty or clayey fine sands or clayey silts with slight plasticity			
			CL	▨	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL	▤	Organic silts and organic silty clays of low plasticity			
	Silts and Clays (Liquid limit greater than 50)		MH	▥	Inorganic silts, micaceous or distomaceous fine sandy or silty soils, organic silts			
			CH	▨	Inorganic clays of high plasticity, fat clays			
			OH	≋	Organic clays of medium to high plasticity, organic silts			
	Highly Organic Soils		Pt	⁂	Peat and other highly organic soils	Von Post Classification Limit	Strong colour or odour, and often fibrous texture	

Material		Particle Size mm	ASTM Sieve sizes
Sand	Coarse	2.00 to 4.75	#10 to #4
	Medium	0.425 to 2.00	#40 to #10
	Fine	0.075 to 0.425	#200 to #40
Silt or Clay		< 0.075	< #200

Material		Particle Size mm	ASTM Sieve Sizes
Boulders		> 300	> 12 in.
Cobbles		75 to 300	3 in. to 12 in.
Gravel	Coarse	19 to 75	3/4 in. to 3 in.
	Fine	4.75 to 19	#4 to 3/4 in.

* Borderline classifications used for soils possessing characteristics of two groups are designated by combinations of groups symbols.
For example; GW-GC, well-graded gravel-sand mixture with clay binder.

Other Symbol Types

■	Asphalt	▧	Bedrock (undifferentiated)	○	Cobbles
⁘	Concrete	⊞	Limestone Bedrock	●	Boulders and Cobbles
▩	Fill	☰	Cemented Shale	▥	Silt Till
		▱	Non-Cemented Shale	▨	Clay Till

TREK GEOTECHNICAL

EXPLANATION OF FIELD AND LABORATORY TESTING

LEGEND OF ABBREVIATIONS AND SYMBOLS

LL - Liquid Limit (%)
PL - Plastic Limit (%)
PI - Plasticity Index (%)
MC - Moisture Content (%)
SPT - Standard Penetration Test
RQD - Rock Quality Designation
Qu - Unconfined Compression
Su - Undrained Shear Strength
VW - Vibrating Wire Piezometer
SI - Slope Inclinometer

▽ Water Level at Time of Drilling

▼ Water Level at End of Drilling

⧨ Water Level After Drilling as Indicated on Test Hole Logs

FRACTION OF SECONDARY SOIL CONSTITUENTS ARE BASED ON THE FOLLOWING TERMINOLOGY

TERM	EXAMPLES	PERCENTAGE
and	and CLAY	35 to 50 percent
"y" or "ey"	clayey, silty	20 to 35 percent
some	some silt	10 to 20 percent
trace	trace gravel	1 to 10 percent

TERMS DESCRIBING CONSISTENCY OR COMPACTION CONDITION

The Standard Penetration Test blow count (N) of a non-cohesive soil can be related to compactness condition as follows:

Descriptive Terms	SPT (N) (Blows/300 mm)
Very loose	< 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	> 50

The Standard Penetration Test blow count (N) of a cohesive soil can be related to its consistency as follows:

Descriptive Terms	SPT (N) (Blows/300 mm)
Very soft	< 2
Soft	2 to 4
Firm	4 to 8
Stiff	8 to 15
Very stiff	15 to 30
Hard	> 30

The undrained shear strength (Su) of a cohesive soil can be related to its consistency as follows:

Descriptive Terms	Undrained Shear Strength (kPa)
Very soft	< 12
Soft	12 to 25
Firm	25 to 50
Stiff	50 to 100
Very stiff	100 to 200
Hard	> 200

TREK GEOTECHNICAL

Sub-Surface Log

Test Hole TH18-01

1 of 2

Client: City of Winnipeg

Project Number: 0015 024 00

Project Name: St. James Civic Centre New Additions and Building, Winnipeg, MB

Location: Refer to Figure 01 for Test Hole locations

Contractor: Subterranean Ltd.

Ground Elevation: 99.73 m

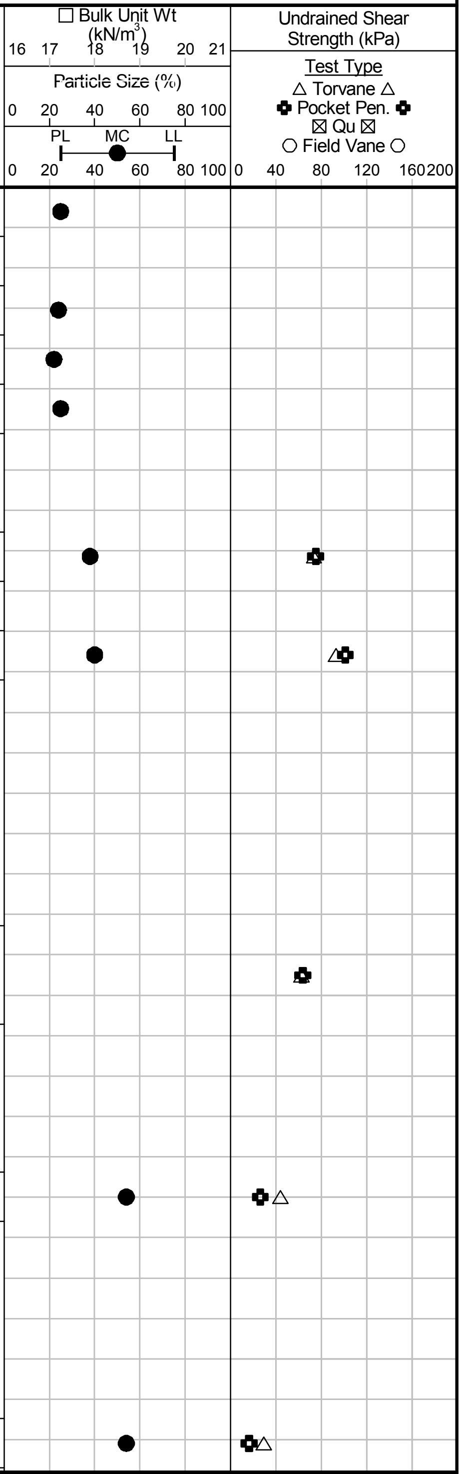
Method: 406 mm Auger, Soilmec STM-20

Date Drilled: April 9, 2018

Sample Type: ◢ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧓ Split Barrel (SB) ▯ Core (C)

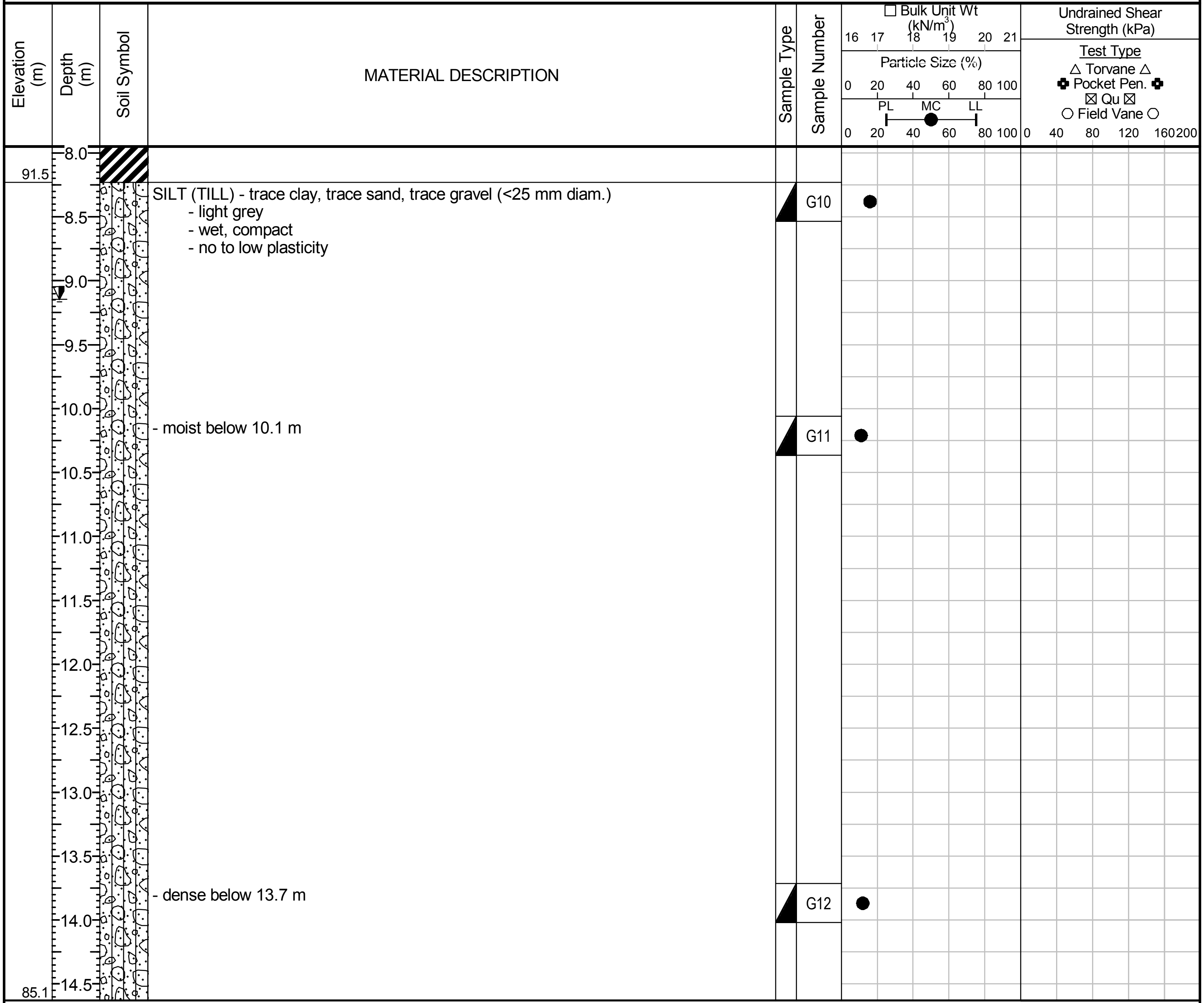
Particle Size Legend: ▥ Fines ▨ Clay ▥ Silt ⁘ Sand ● Gravel ◌ Cobbles ■ Boulders

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number
99.4	0.3	ORGANIC CLAY - silty, trace to some sand, trace gravel (<10 mm diam.), trace rootlets, black, frozen, moist and stiff when thawed, low to intermediate plasticity	◢	G01
98.8	0.9	CLAY (FILL) - silty, trace sand, trace gravel (<10 mm diam.), trace organcis - dark brown - frozen, moist and firm when thawed - intermediate plasticity	◢	G02
98.5	1.2	SILT - trace clay, trace sand, trace gravel (<5 mm diam.) - brown, frozen, moist and soft when thawed, low plasticity	◢	G03
		CLAY - silty, trace sand, trace gravel (<5 mm diam.), trace oxidation, trace silt inclusions (<15 mm diam.) - brown - frozen to 2.1 m, moist and stiff when thawed - high plasticity	◢	G04
		- grey below 2.1 m	◢	G05
		- stiff to very stiff below 2.7 m	◢	G06
			▮	T07
		- firm below 6.1 m	◢	G08
		- trace till inclusions, soft to firm below 7.6 m	◢	G09



Logged By: Beta Taryana **Reviewed By:** Nelson Ferreira **Project Engineer:** Nelson Ferreira

Sub-Surface Log



SILT (TILL) - trace clay, trace sand, trace gravel (<25 mm diam.)
- light grey
- wet, compact
- no to low plasticity

- moist below 10.1 m

- dense below 13.7 m

POWER AUGER REFUSAL AT 14.6 m IN SILT (TILL)

Notes:

1. Seepage observed between 8.2 m depth and 10.1 m depth in SILT (TILL) layer.
2. Sloughing observed between 9.8 m depth and 13.7 m depth in SILT (TILL) layer.
3. Unable to recover soil sample between 10.7 m and 13.7 m due to slough material.
4. Test Hole open to 9.4 m depth and groundwater level at 9.1 m depth fifteen minutes after drilling.
5. Test Hole backfilled with auger cuttings.
6. Elevation relative to the main floor located at south entrance of existing building, which was assigned a temporary benchmark elevation of 100.00 m.

Logged By: Beta Taryana **Reviewed By:** Nelson Ferreira **Project Engineer:** Nelson Ferreira

Sub-Surface Log

Test Hole TH18-02

Client: City of Winnipeg

Project Number: 0015 024 00

Project Name: St. James Civic Centre New Additions and Building, Winnipeg, MB

Location: Refer to Figure 01 for Test Hole locations

Contractor: Subterranean Ltd.

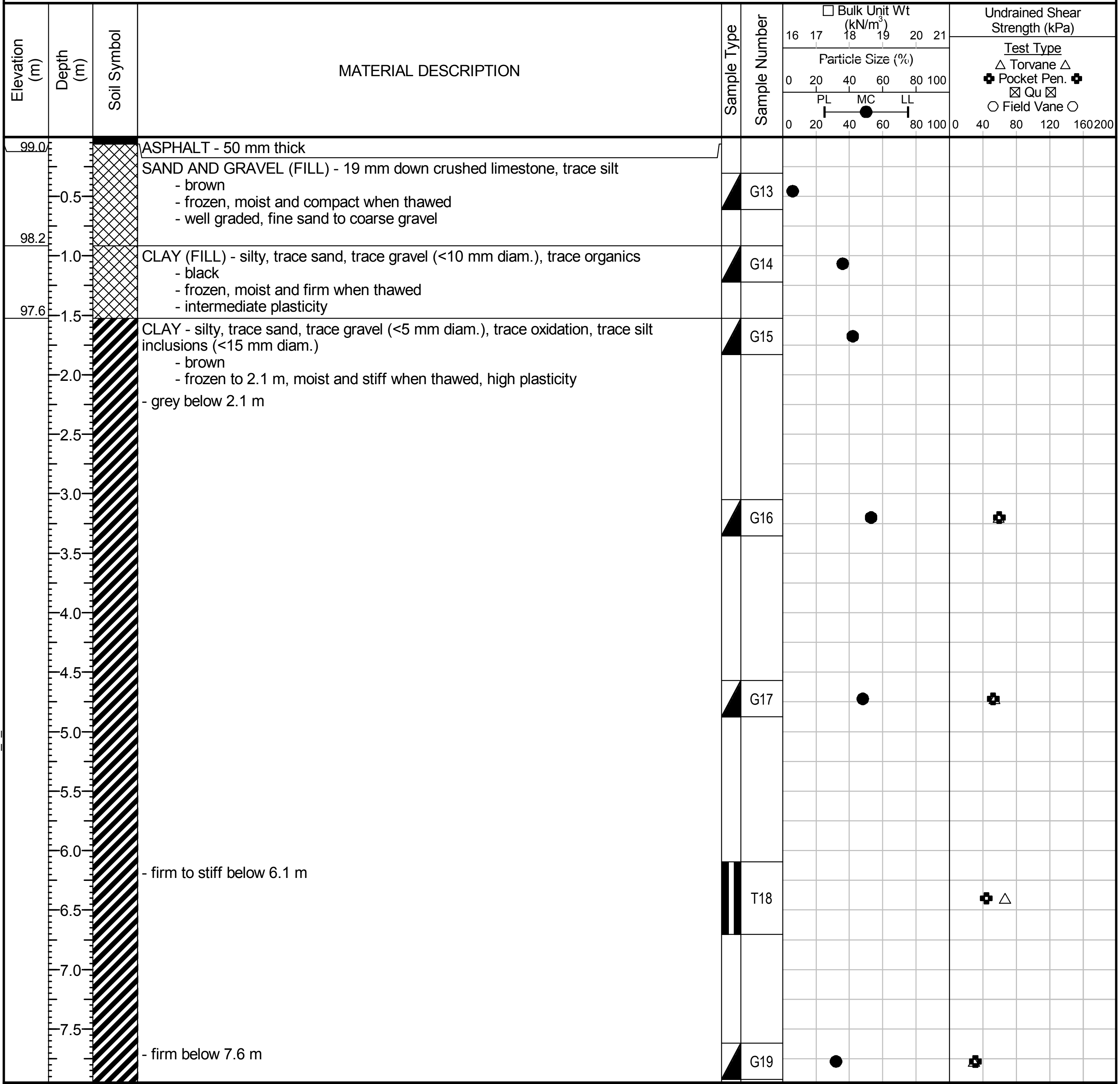
Ground Elevation: 99.10 m

Method: 406 mm Auger, Soilmec STM-20

Date Drilled: April 9, 2018

Sample Type: ◪ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ☒ Split Barrel (SB) ▯ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ⛆ Sand ● Gravel ◌ Cobbles ● Boulders



ASPHALT - 50 mm thick

SAND AND GRAVEL (FILL) - 19 mm down crushed limestone, trace silt
- brown
- frozen, moist and compact when thawed
- well graded, fine sand to coarse gravel

CLAY (FILL) - silty, trace sand, trace gravel (<10 mm diam.), trace organics
- black
- frozen, moist and firm when thawed
- intermediate plasticity

CLAY - silty, trace sand, trace gravel (<5 mm diam.), trace oxidation, trace silt inclusions (<15 mm diam.)
- brown
- frozen to 2.1 m, moist and stiff when thawed, high plasticity

- grey below 2.1 m

- firm to stiff below 6.1 m

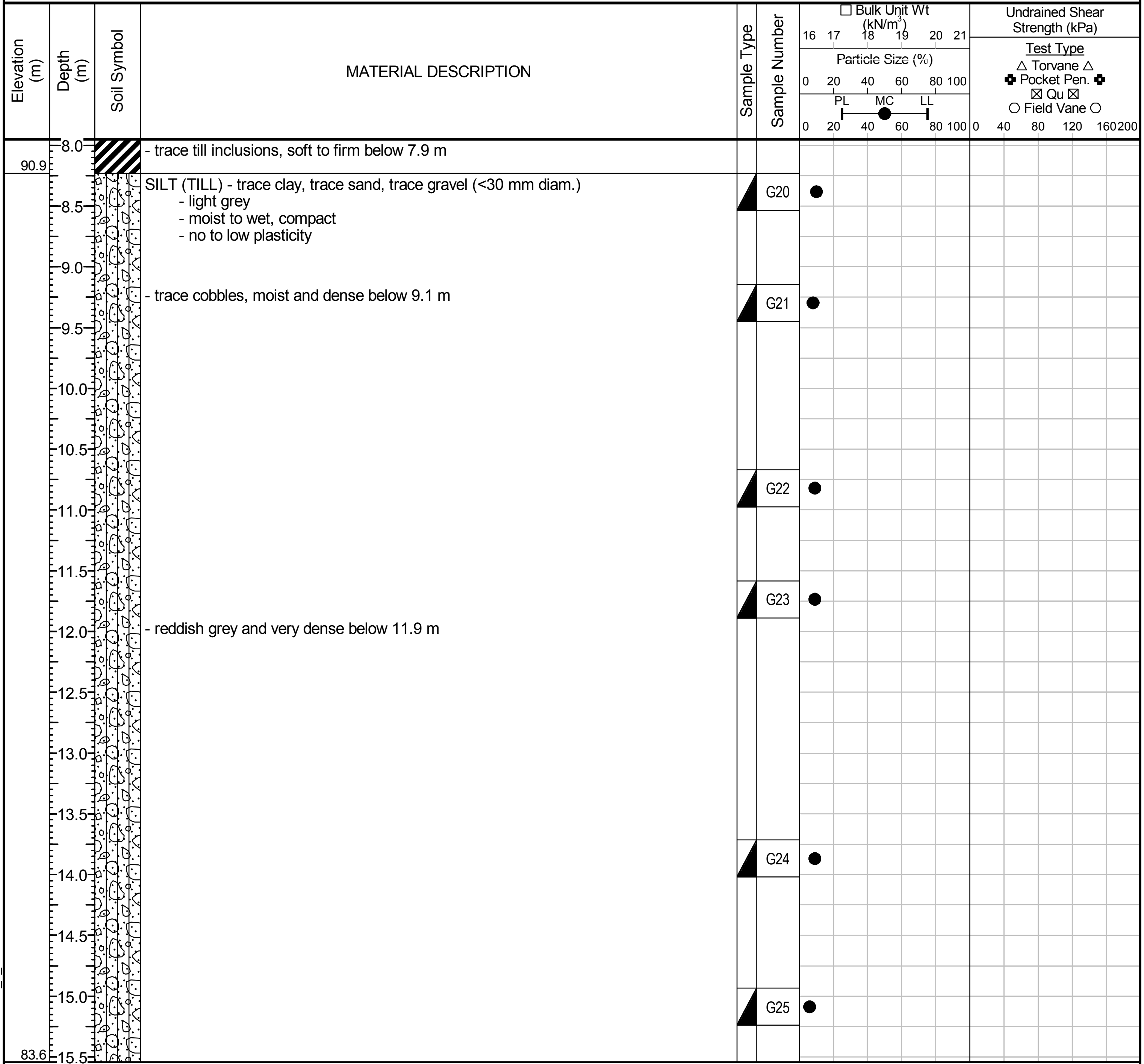
- firm below 7.6 m

Logged By: Beta Taryana **Reviewed By:** Nelson Ferreira **Project Engineer:** Nelson Ferreira

Sub-Surface Log

Test Hole TH18-02

2 of 2



- trace till inclusions, soft to firm below 7.9 m

SILT (TILL) - trace clay, trace sand, trace gravel (<30 mm diam.)
- light grey
- moist to wet, compact
- no to low plasticity

- trace cobbles, moist and dense below 9.1 m

- reddish grey and very dense below 11.9 m

POWER AUGER REFUSAL AT 15.5 m IN SILT (TILL)

Notes:

1. Seepage observed between 8.2 m depth and 9.1 m depth in SILT (TILL) layer.
2. Sloughing observed between 0.1 m depth and 0.9 m depth in SAND AND GRAVEL (FILL) layer.
3. Test Hole open to 15.5 m depth and dry fifteen minutes after drilling.
4. Test Hole backfilled with auger cuttings and topped with granular material and cold patch asphalt.
5. Elevation relative to the main floor located at south entrance of existing building, which was assigned a temporary benchmark elevation of 100.00 m.

Logged By: Beta Taryana **Reviewed By:** Nelson Ferreira **Project Engineer:** Nelson Ferreira

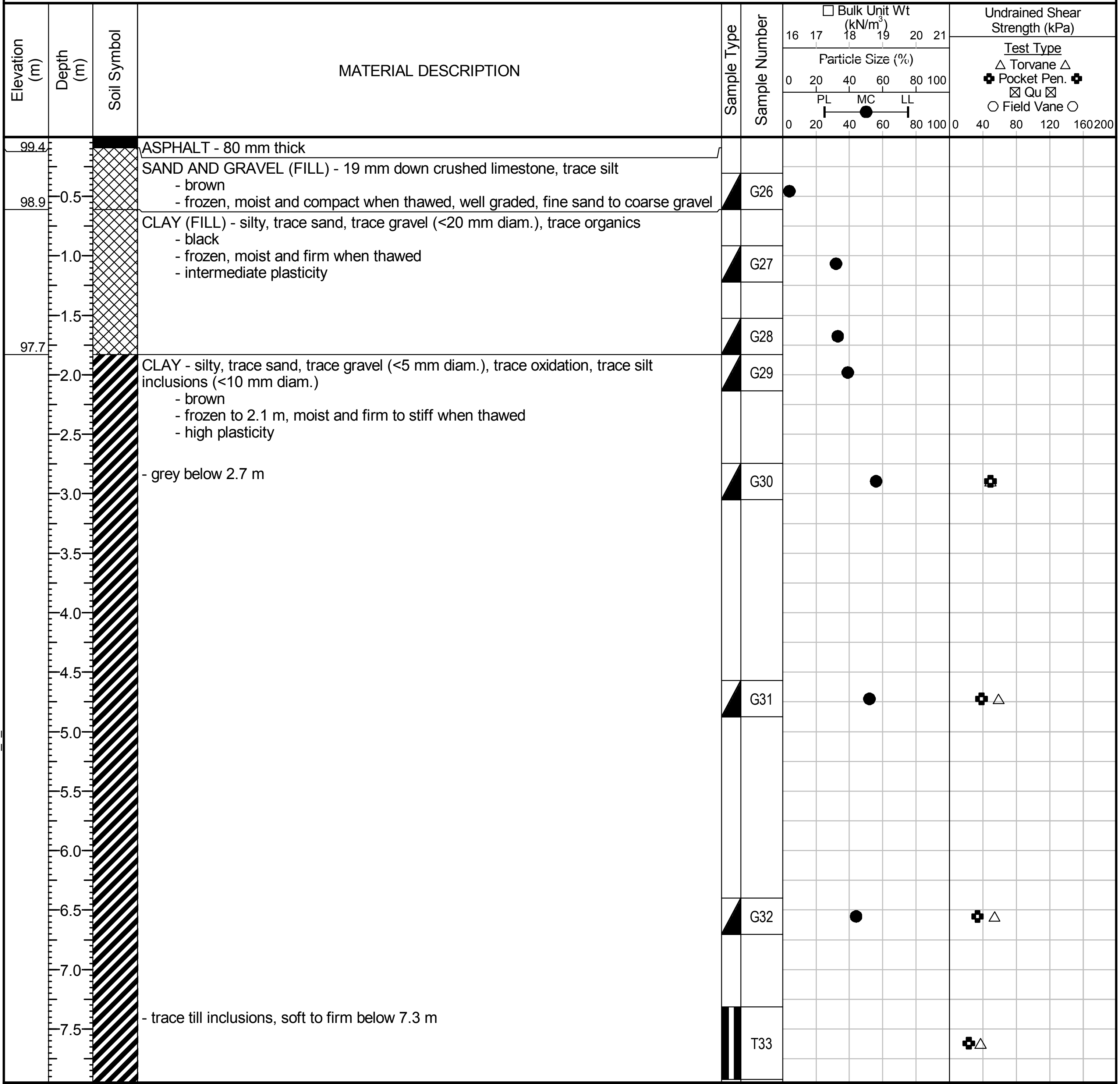
Test Hole TH18-03

Sub-Surface Log

Client:	City of Winnipeg	**Project Number:**	0015 024 00
Project Name:	St. James Civic Centre New Additions and Building, Winnipeg, MB	**Location:**	Refer to Figure 01 for Test Hole locations
Contractor:	Subterranean Ltd.	**Ground Elevation:**	99.52 m
Method:	406 mm Auger, Soilmec STM-20	**Date Drilled:**	April 9, 2018

Sample Type: Grab (G) Shelby Tube (T) Split Spoon (SS) Split Barrel (SB) Core (C)

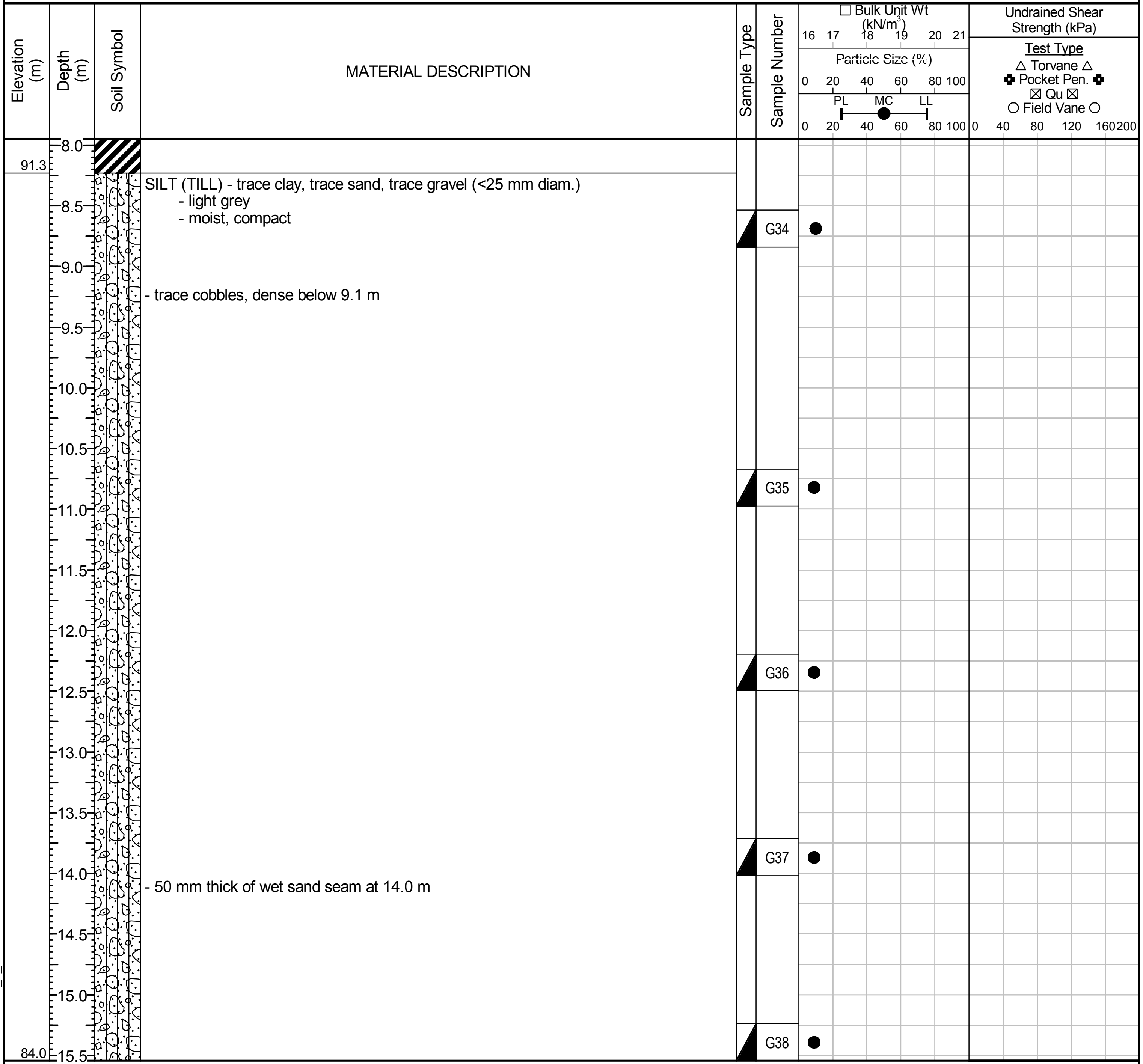
Particle Size Legend: Fines Clay Silt Sand Gravel Cobbles Boulders



Elevation (m)	MATERIAL DESCRIPTION	Sample Number
99.4	ASPHALT - 80 mm thick	
98.9	SAND AND GRAVEL (FILL) - 19 mm down crushed limestone, trace silt - brown - frozen, moist and compact when thawed, well graded, fine sand to coarse gravel	G26
97.7	CLAY (FILL) - silty, trace sand, trace gravel (<20 mm diam.), trace organics - black - frozen, moist and firm when thawed - intermediate plasticity	G27 G28
	CLAY - silty, trace sand, trace gravel (<5 mm diam.), trace oxidation, trace silt inclusions (<10 mm diam.) - brown - frozen to 2.1 m, moist and firm to stiff when thawed - high plasticity - grey below 2.7 m - trace till inclusions, soft to firm below 7.3 m	G29 G30 G31 G32 T33

Logged By: Beta Taryana **Reviewed By:** Nelson Ferreira **Project Engineer:** Nelson Ferreira

Sub-Surface Log



SILT (TILL) - trace clay, trace sand, trace gravel (<25 mm diam.)
- light grey
- moist, compact

- trace cobbles, dense below 9.1 m

- 50 mm thick of wet sand seam at 14.0 m

END OF TEST HOLE AT 15.5 m IN SILT (TILL)
Notes:
1. Seepage observed between 14.0 m depth and 14.1 m depth in sand seam.
2. No sloughing observed.
3. Test Hole open to 15.5 m depth and dry fifteen minutes after drilling.
4. Test Hole backfilled with auger cuttings and topped with granular material and cold patch asphalt.
5. TH18-03 moved 0.7 m north and 0.7 m east from its original location due to auger refusal on suspected concrete pad at 0.6 m below existing grade.
6. Elevation relative to the main floor located at south entrance of existing building, which was assigned a temporary benchmark elevation of 100.00 m.

Logged By: Beta Taryana **Reviewed By:** Nelson Ferreira **Project Engineer:** Nelson Ferreira

TREK GEOTECHNICAL

Sub-Surface Log

Test Hole TH18-04

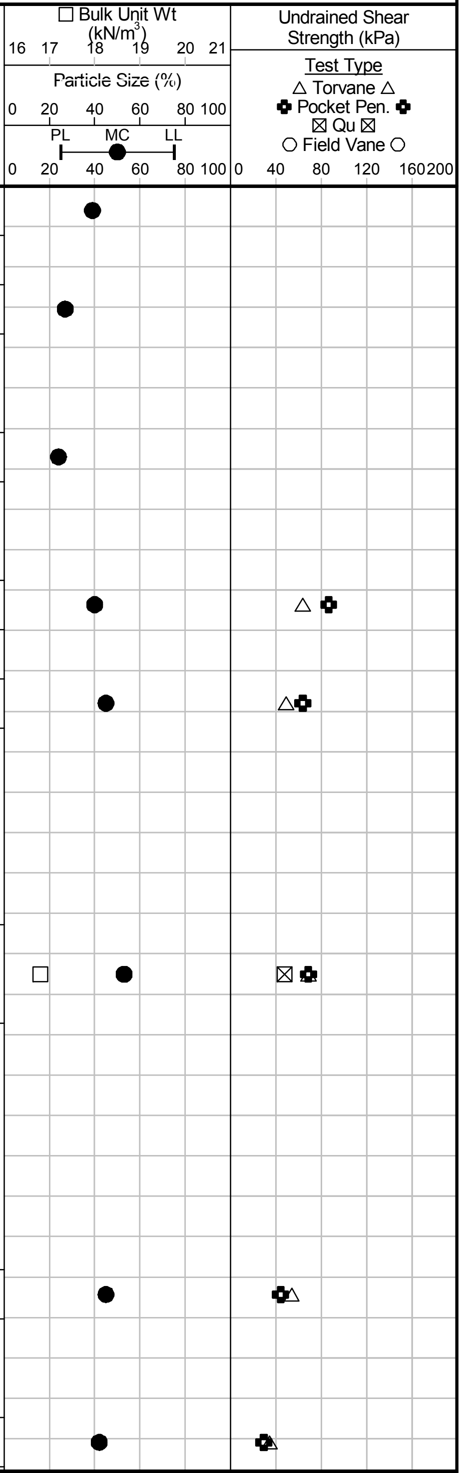
1 of 2

Client: City of Winnipeg
Project Number: 0015 024 00
Project Name: St. James Civic Centre New Additions and Building, Winnipeg, MB
Location: Refer to Figure 01 for Test Hole locations
Contractor: Subterranean Ltd.
Ground Elevation: 99.77 m
Method: 406 mm Auger, Soilmec STM-20
Date Drilled: April 9, 2018

Sample Type: ◢ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧓ Split Barrel (SB) ▯ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ⁘ Sand Gravel Cobbles Boulders

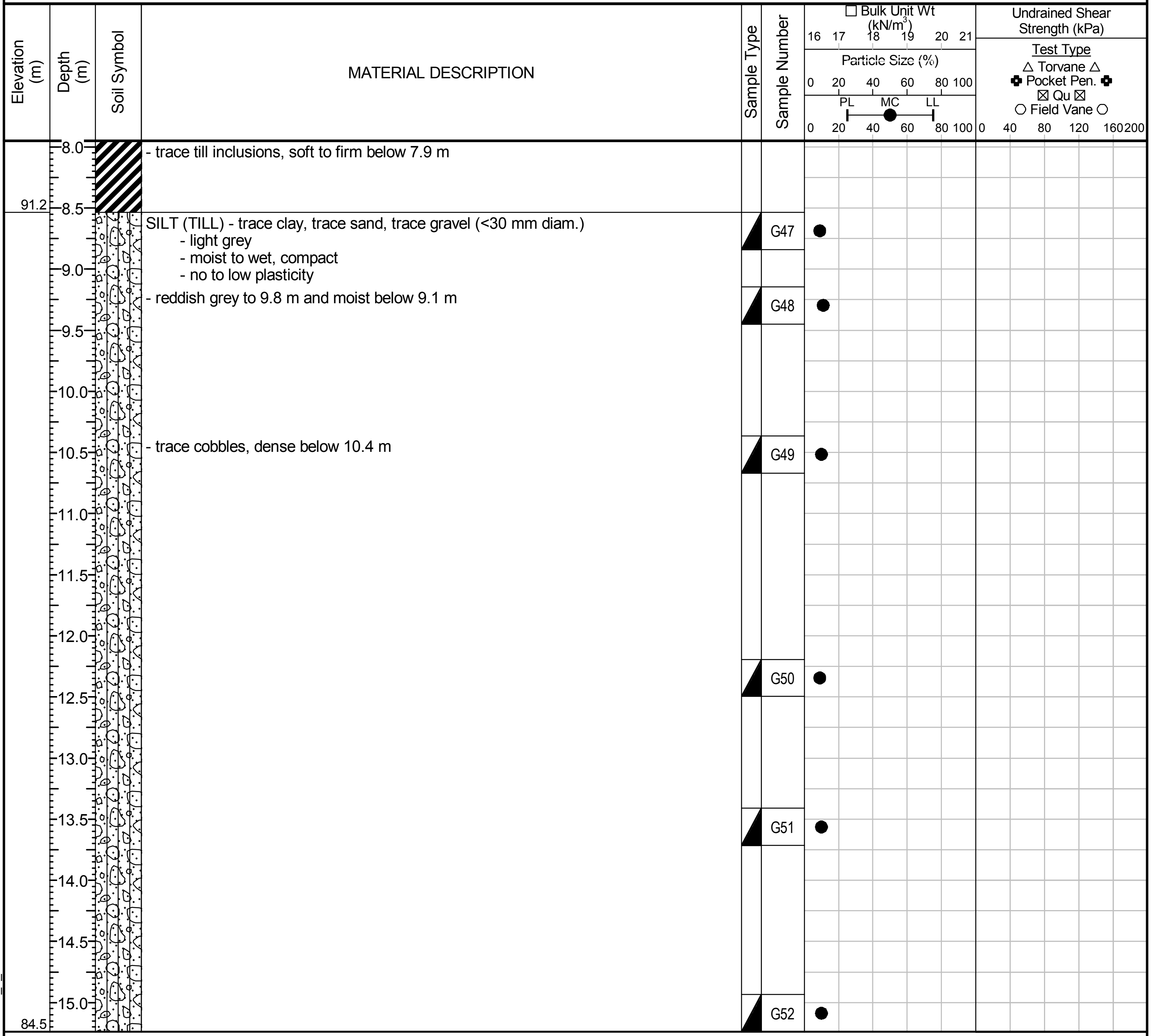
Elevation (m)	Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number
99.2	0.0 – 0.5	ORGANIC CLAY - silty, trace sand, trace gravel (<10 mm diam.), trace rootlets - black - frozen, moist and stiff when thawed - low to intermediate plasticity	G	G39
98.2	0.5 – 1.5	CLAY (FILL) - silty, some sand, trace gravel (<15 mm diam.) - brown - frozen, moist and firm when thawed - intermediate plasticity	G	G40
97.6	1.5 – 2.0	SILT - trace clay, trace sand, trace gravel (<5 mm diam.) - brown - moist to wet, soft - low plasticity	G	G41
	2.0 –	CLAY - silty, trace sand, trace gravel (<5 mm diam.), trace silt inclusions (<25 mm diam.) - grey - moist, firm to stiff - high plasticity - firm below 7.6 m	G G T G G	G42 G43 T44 G45 G46



Logged By: Beta Taryana **Reviewed By:** Nelson Ferreira **Project Engineer:** Nelson Ferreira

Sub-Surface Log

Test Hole TH18-04



- trace till inclusions, soft to firm below 7.9 m

SILT (TILL) - trace clay, trace sand, trace gravel (<30 mm diam.)
- light grey
- moist to wet, compact
- no to low plasticity

- reddish grey to 9.8 m and moist below 9.1 m

- trace cobbles, dense below 10.4 m

END OF TEST HOLE AT 15.2 m IN SILT (TILL)

Notes:

1. Seepage observed between 1.5 m depth and 2.1 m depth in SILT layer and between 8.5 m depth and 9.1 m depth in SILT (TILL) layer.
2. No sloughing observed..
3. Test Hole open to 15.2 m depth and dry fifteen minutes after drilling.
4. Test Hole backfilled with auger cuttings.
5. Elevation relative to the main floor located at south entrance of existing building, which was assigned a temporary benchmark elevation of 100.00 m.

Logged By: Beta Taryana **Reviewed By:** Nelson Ferreira **Project Engineer:** Nelson Ferreira

Sub-Surface Log

Test Hole TH18-05

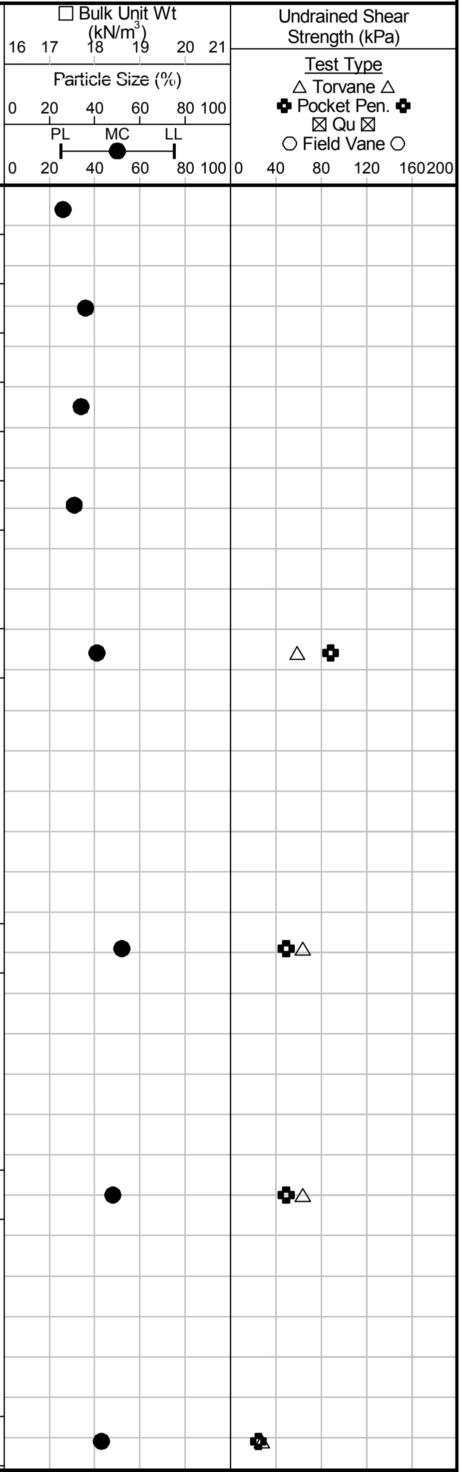
1 of 2

Client:	City of Winnipeg	**Project Number:**	0015 024 00
Project Name:	St. James Civic Centre New Additions and Building, Winnipeg, MB	**Location:**	Refer to Figure 01 for Test Hole locations
Contractor:	Subterranean Ltd.	**Ground Elevation:**	99.83 m
Method:	406 mm Auger, Soilmec STM-20	**Date Drilled:**	April 9, 2018

Sample Type: ◪ Grab (G) ◨ Shelby Tube (T) ☒ Split Spoon (SS) ⧓ Split Barrel (SB) ◫ Core (C)

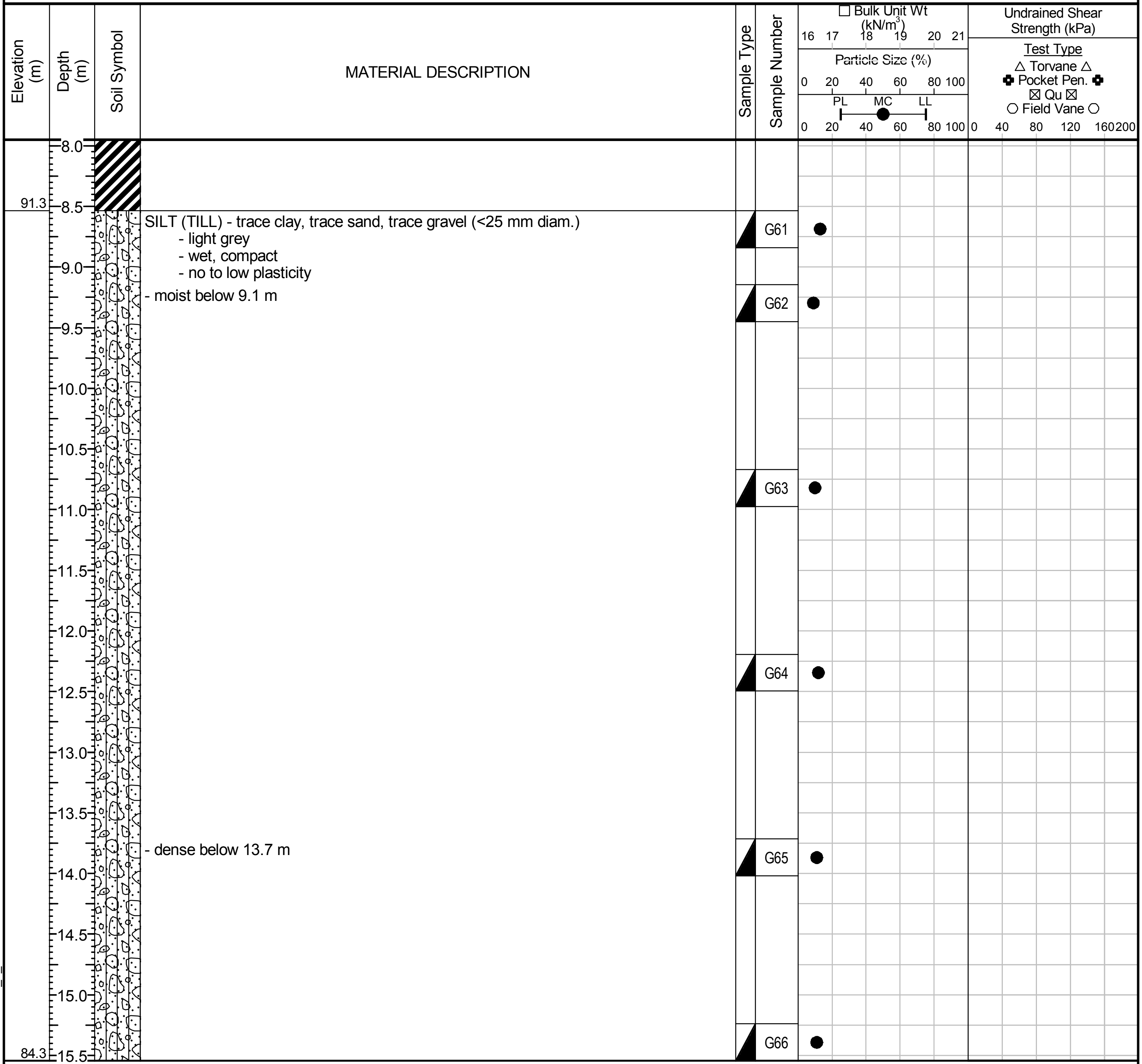
Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ▒ Sand ● Gravel ▢ Cobbles ■ Boulders

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number
99.5		ORGANIC CLAY - silty, trace sand, trace gravel (<15 mm diam.), trace rootlets - black, frozen, moist and stiff when thawed, low to intermediate plasticity	G	G53
98.3	1.5	CLAY (FILL) - silty, trace sand, trace gravel (<10 mm diam.), trace organics - mottled brown and black - frozen, moist and firm when thawed - intermediate plasticity	G G	G54 G55
		CLAY - silty, trace sand, trace gravel (<5 mm diam.), trace oxidation, trace silt inclusions (<15 mm diam.) - brown - frozen to 2.1 m, moist and stiff when thawed, high plasticity - grey below 2.1 m - firm to stiff below 4.6 m - trace till inclusions below 6.7 m - soft to firm below 7.6 m	G G G G G	G56 G57 G58 G59 G60



Logged By: Beta Taryana **Reviewed By:** Nelson Ferreira **Project Engineer:** Nelson Ferreira

Sub-Surface Log



SILT (TILL) - trace clay, trace sand, trace gravel (<25 mm diam.)
- light grey
- wet, compact
- no to low plasticity

- moist below 9.1 m

- dense below 13.7 m

END OF TEST HOLE AT 15.5 m IN SILT (TILL)

Notes:
1. Seepage observed between 8.5 m depth and 9.1 m depth in SILT (TILL) layer.
2. No sloughing observed.
3. Test Hole open to 15.5 m depth and dry fifteen minutes after drilling.
4. Test Hole backfilled with auger cuttings.
5. Elevation relative to the main floor located at south entrance of existing building, which was assigned a temporary benchmark elevation of 100.00 m.

Logged By: Beta Taryana **Reviewed By:** Nelson Ferreira **Project Engineer:** Nelson Ferreira

Sub-Surface Log

Test Hole TH18-06

1 of 2

Client: City of Winnipeg

Project Number: 0015 024 00

Project Name: St. James Civic Centre New Additions and Building, Winnipeg, MB

Location: Refer to Figure 01 for Test Hole locations

Contractor: Subterranean Ltd.

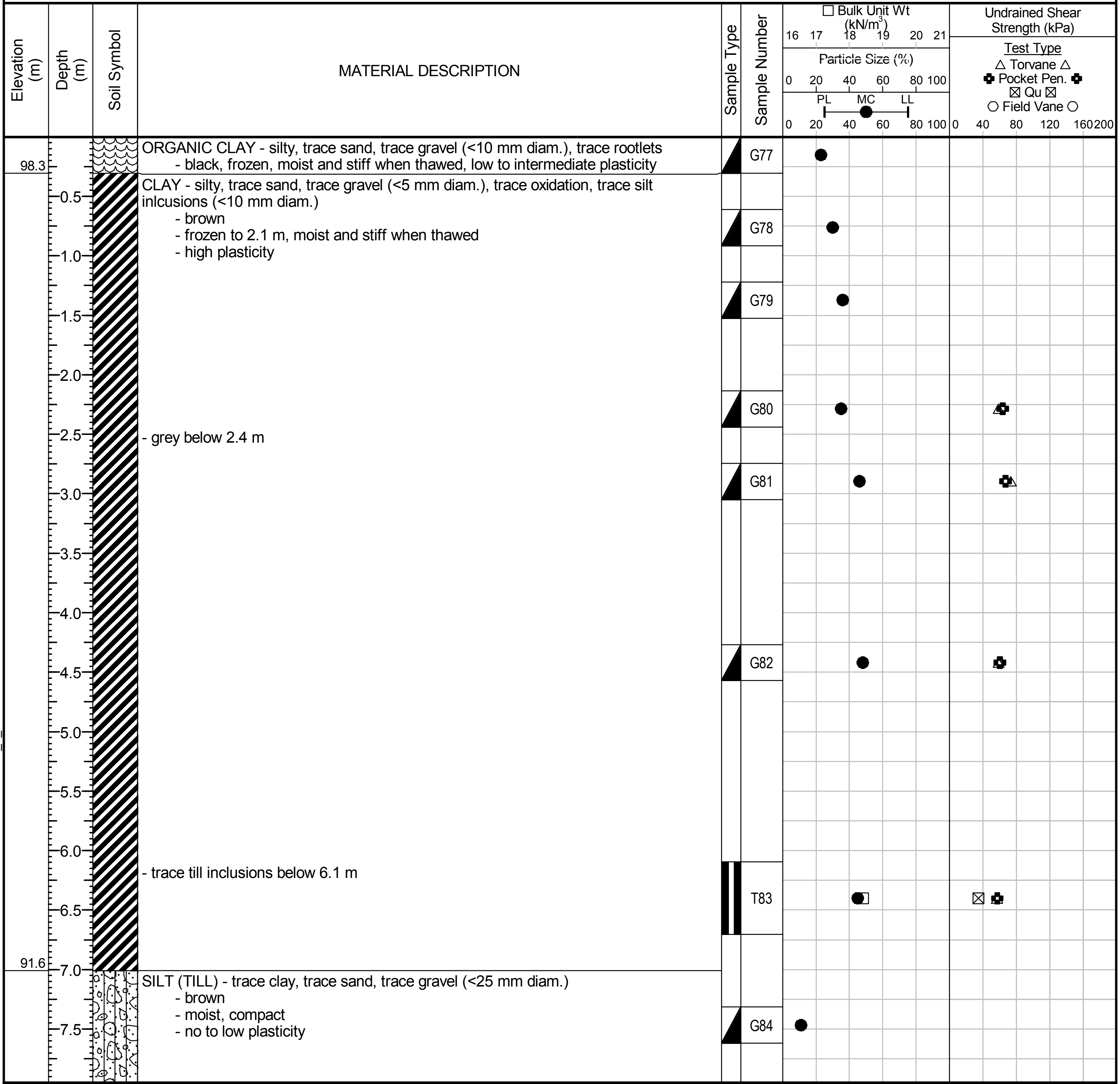
Ground Elevation: 98.65 m

Method: 406 mm Auger, Soilmec STM-20

Date Drilled: April 10, 2018

Sample Type: ◢ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧓ Split Barrel (SB) ▯ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ⁙ Sand ● Gravel ◌ Cobbles ⬛ Boulders



ORGANIC CLAY - silty, trace sand, trace gravel (<10 mm diam.), trace rootlets
- black, frozen, moist and stiff when thawed, low to intermediate plasticity

CLAY - silty, trace sand, trace gravel (<5 mm diam.), trace oxidation, trace silt inlcusions (<10 mm diam.)
- brown
- frozen to 2.1 m, moist and stiff when thawed
- high plasticity

- grey below 2.4 m

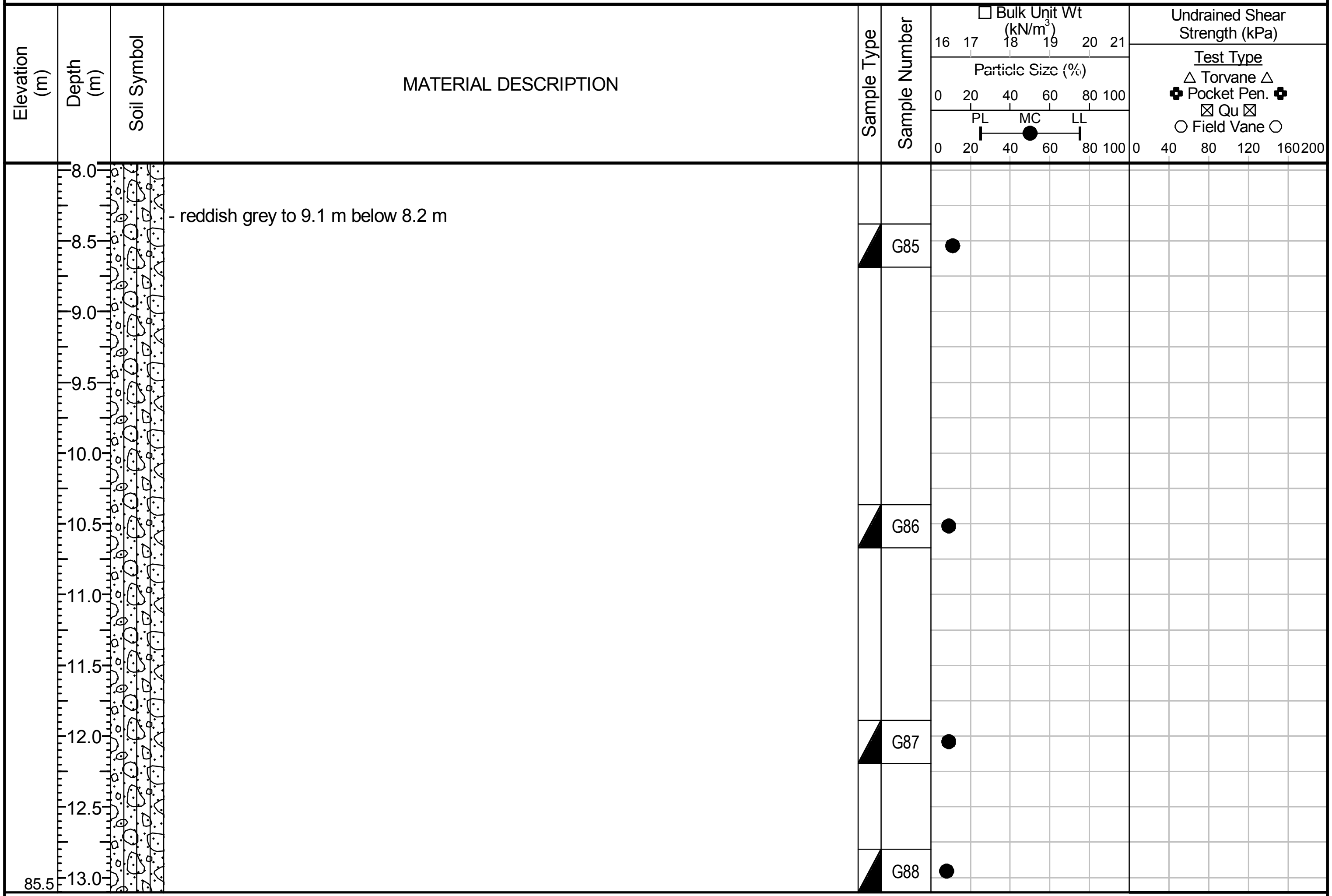
- trace till inclusions below 6.1 m

SILT (TILL) - trace clay, trace sand, trace gravel (<25 mm diam.)
- brown
- moist, compact
- no to low plasticity

Logged By: Beta Taryana **Reviewed By:** Nelson Ferreira **Project Engineer:** Nelson Ferreira

Test Hole TH18-06

Sub-Surface Log



- reddish grey to 9.1 m below 8.2 m

POWER AUGER REFUSAL AT 13.1 m IN SILT (TILL)
Notes:
1. No seepage observed.
2. Sloughing observed between 8.5 m depth and 8.7 m depth in SILT (TILL) layer 30 minutes after belling.
3. Test bell performed at 8.7 m below existing ground in SILT (TILL) layer.
4. Test bell remained open with about 100 mm of slough at the base 30 minutes after belling.
5. Drilling continued to power auger refusal 30 minutes after test bell performed.
6. Test Hole open to 13.1 m depth and dry fifteen minutes after drilling.
7. Test Hole backfilled with auger cuttings.
8. Elevation relative to the main floor located at south entrance of existing building, which was assigned a temporary benchmark elevation of 100.00 m.

Logged By: Beta Taryana **Reviewed By:** Nelson Ferreira **Project Engineer:** Nelson Ferreira

Sub-Surface Log

Test Hole TH18-07

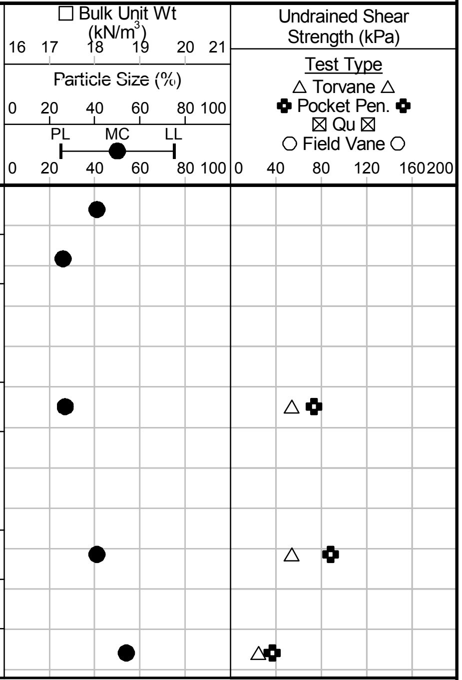
1 of 1

Client: City of Winnipeg
Project Number: 0015 024 00
Project Name: St. James Civic Centre New Additions and Building, Winnipeg, MB
Location: Refer to Figure 01 for Test Hole locations
Contractor: Subterranean Ltd.
Ground Elevation: 99.21 m
Method: 406 mm Auger, Soilmec STM-20
Date Drilled: April 10, 2018

Sample Type: ◪ Grab (G) ◨ Shelby Tube (T) ☒ Split Spoon (SS) ☒ Split Barrel (SB) ◨ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ▒ Sand Gravel Cobbles Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number
98.9			ORGANIC CLAY - silty, trace sand, trace gravel (<10 mm diam.), trace rootlets - black, frozen, moist and stiff when thawed, low to intermediate plasticity	◪	G67
98.6	0.5		SILT - trace clay, trace sand, trace gravel (<5 mm diam.) - brown, frozen, moist and soft when thawed, low plasticity	◪	G68
96.2	1.0 1.5 2.0 2.5 3.0		CLAY - silty, trace sand, trace gravel (<5 mm diam.), trace oxidation, trace silt inclusions (<15 mm diam.) - brown - frozen to 2.1 m, moist and stiff when thawed - high plasticity - grey below 2.4 m - soft to firm below 2.7 m	◪ ◪ ◪	G69 G70 G71



END OF TEST HOLE AT 3.0 m IN CLAY

Notes:

1. No seepage or sloughing observed.
2. Test Hole open to 3.0 m depth and dry fifteen minutes after drilling.
3. Test Hole backfilled with auger cuttings.
4. Elevation relative to the main floor located at south entrance of existing building, which was assigned a temporary benchmark elevation of 100.00 m.

Logged By: Beta Taryana
Reviewed By: Nelson Ferreira
Project Engineer: Nelson Ferreira

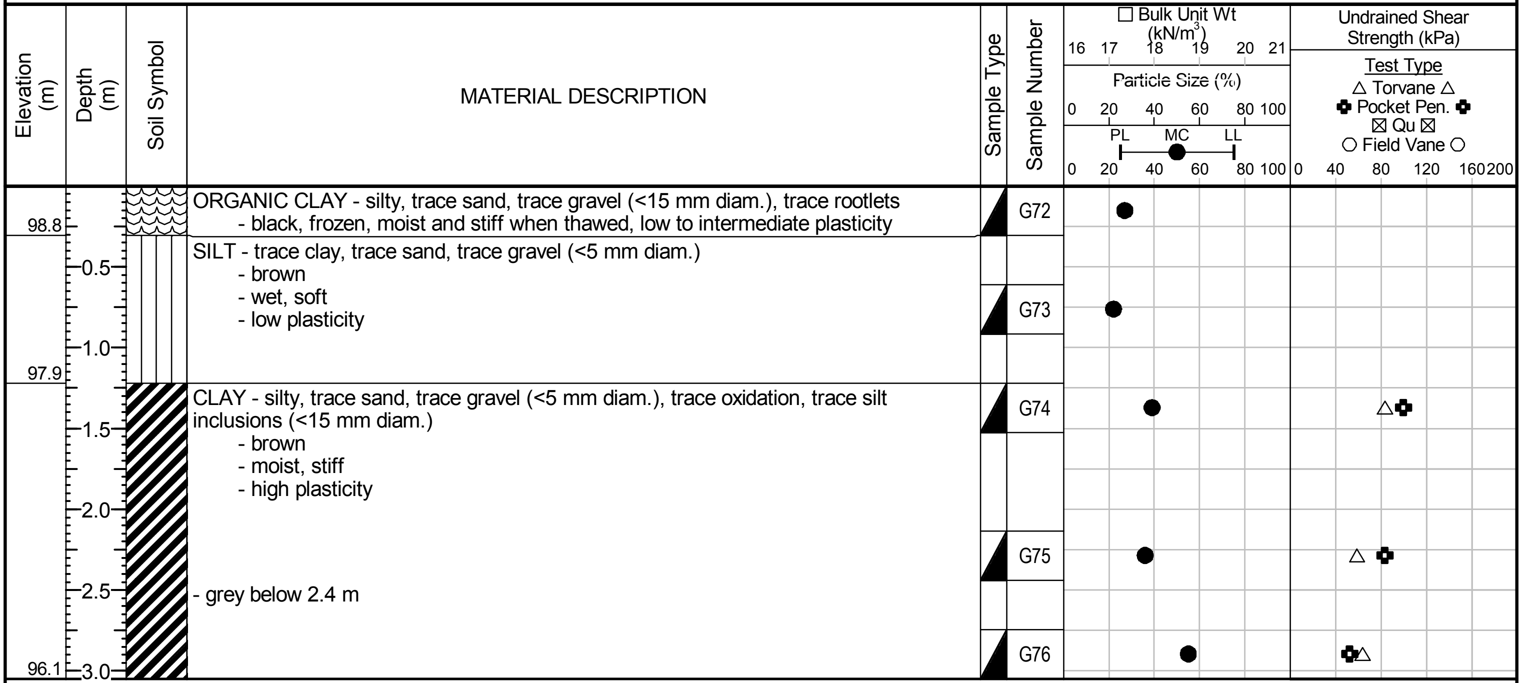
Sub-Surface Log

Test Hole TH18-08

Client: City of Winnipeg
Project Number: 0015 024 00
Project Name: St. James Civic Centre New Additions and Building, Winnipeg, MB
Location: Refer to Figure 01 for Test Hole locations
Contractor: Subterranean Ltd.
Ground Elevation: 99.12 m
Method: 406 mm Auger, Soilmec STM-20
Date Drilled: April 10, 2018

Sample Type: ◢ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧓ Split Barrel (SB) ▯ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ⁘ Sand Gravel Cobbles Boulders



ORGANIC CLAY - silty, trace sand, trace gravel (<15 mm diam.), trace rootlets
- black, frozen, moist and stiff when thawed, low to intermediate plasticity

SILT - trace clay, trace sand, trace gravel (<5 mm diam.)
- brown
- wet, soft
- low plasticity

CLAY - silty, trace sand, trace gravel (<5 mm diam.), trace oxidation, trace silt inclusions (<15 mm diam.)
- brown
- moist, stiff
- high plasticity

- grey below 2.4 m

END OF TEST HOLE AT 3.0 m IN CLAY

Notes:
1. Seepage observed between 0.3 m depth and 1.2 m depth in SILT layer.
2. No sloughing observed.
3. Test Hole open to 3.0 m depth and dry fifteen minutes after drilling.
4. Test Hole backfilled with auger cuttings.
5. Elevation relative to the main floor located at south entrance of existing building, which was assigned a temporary benchmark elevation of 100.00 m.

Logged By: Beta Taryana
Reviewed By: Nelson Ferreira
Project Engineer: Nelson Ferreira

TREK GEOTECHNICAL

Sub-Surface Log

Test Hole TH18-09

1 of 1

Client: City of Winnipeg

Project Number: 0015 024 00

Project Name: St. James Civic Centre New Additions and Building, Winnipeg, MB

Location: Refer to Figure 01 for Test Hole locations

Contractor: Subterranean Ltd.

Ground Elevation: 98.66 m

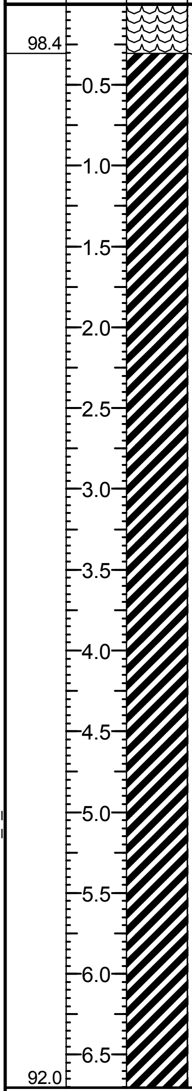
Method: 406 mm Auger, Soilmec STM-20

Date Drilled: April 10, 2018

Sample Type: ◩ Grab (G) ◨ Shelby Tube (T) ☒ Split Spoon (SS) ⧓ Split Barrel (SB) ◫ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ⁘ Sand Gravel Cobbles Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	☐ Bulk Unit Wt (kN/m^3) 16 17 18 19 20 21 Particle Size (%) 0 20 40 60 80 100 PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type △ Torvane △ ✥ Pocket Pen. ✥ ☒ Qu ☒ ○ Field Vane ○ 0 40 80 120 160 200
98.4			ORGANIC CLAY - silty, trace sand, trace gravel (<10 mm diam.), trace rootlets - black, frozen, moist and stiff when thawed, low to intermediate plasticity				
	0.5–6.5		CLAY - silty, trace sand, trace gravel (<5 mm diam.), trace oxidation, trace silt inlcusions (<10 mm diam.) - brown - frozen to 2.1 m, moist and stiff when thawed - high plasticity - grey below 1.8 m				
92.0							



END OF TEST HOLE AT 6.7 m IN CLAY (CLAY and SILT (TILL) CONTACT)

Notes:

1. No seepage or sloughing observed.
2. Test bell performed at 6.7 m below existing grade in CLAY layer.
3. Test Hole open to 6.7 m depth and dry 30 minutes after belling.
4. Test Hole backfilled with auger cuttings.
5. Elevation relative to the main floor located at south entrance of existing building, which was assigned a temporary benchmark elevation of 100.00 m.

Logged By: Beta Taryana **Reviewed By:** Nelson Ferreira **Project Engineer:** Nelson Ferreira

Appendix A

Laboratory Testing Results

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Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Moisture Content Report
ASTM D2216-10

Project No. 0015-024-00
Client City of Winnipeg
Project St. James Civic Centre

Sample Date 09-Apr-18
Test Date 12-Apr-18
Technician LI

Test Pit	TH18-01	TH18-01	TH18-01	TH18-01	TH18-01	TH18-01
Depth (m)	0.0 - 0.3	0.6 - 0.9	0.9 - 1.2	1.2 - 1.5	2.1 - 2.4	2.7 - 3.0
Sample #	G01	G02	G03	G04	G05	G06
Tare ID	F40	W07	Z120	K4	E25	Z50
Mass of tare	8.6	8.6	8.6	8.6	8.8	8.6
Mass wet + tare	282.8	274.6	336.4	277.2	304.6	249.0
Mass dry + tare	228.2	223.8	277.2	224.2	224.0	180.2
Mass water	54.6	50.8	59.2	53.0	80.6	68.8
Mass dry soil	219.6	215.2	268.6	215.6	215.2	171.6
Moisture %	24.9%	23.6%	22.0%	24.6%	37.5%	40.1%

Test Pit	TH18-01	TH18-01	TH18-01	TH18-01	TH18-01	TH18-02
Depth (m)	6.1 - 6.4	7.6 - 7.9	8.2 - 8.5	10.1 - 10.4	13.7 - 14.0	0.3 - 0.6
Sample #	G08	G09	G10	G11	G12	G13
Tare ID	N06	C28	W48	K26	W81	D44
Mass of tare	8.4	8.4	8.4	8.4	8.6	8.4
Mass wet + tare	251.2	264	296.8	315.2	335.2	423.2
Mass dry + tare	165.8	174.0	256.2	284.2	301.2	401.6
Mass water	85.4	90.0	40.6	31.0	34.0	21.6
Mass dry soil	157.4	165.6	247.8	275.8	292.6	393.2
Moisture %	54.3%	54.3%	16.4%	11.2%	11.6%	5.5%

Test Pit	TH18-02	TH18-02	TH18-02	TH18-02	TH18-02	TH18-02
Depth (m)	0.9 - 1.2	1.5 - 1.8	3.0 - 3.4	4.6 - 4.9	7.6 - 7.9	8.2 - 8.5
Sample #	G14	G15	G16	G17	G19	G20
Tare ID	K3	P20	F76	E66	F29	E68
Mass of tare	8.6	8.6	8.6	9.0	8.2	8.6
Mass wet + tare	240.0	274.0	245.6	281.4	305.4	417.4
Mass dry + tare	179.4	196.2	163.4	193.6	232.6	380.2
Mass water	60.6	77.8	82.2	87.8	72.8	37.2
Mass dry soil	170.8	187.6	154.8	184.6	224.4	371.6
Moisture %	35.5%	41.5%	53.1%	47.6%	32.4%	10.0%

Moisture Content Report
ASTM D2216-10

Project No. 0015-024-00
Client City of Winnipeg
Project St. James Civic Centre

Sample Date 09-Apr-18
Test Date 12-Apr-18
Technician LI

Test Pit	TH18-02	TH18-02	TH18-02	TH18-02	TH18-02	TH18-03
Depth (m)	9.1 - 9.4	10.7 - 11.0	11.6 - 11.9	13.7 - 14.0	14.9 - 15.2	0.3 - 0.6
Sample #	G21	G22	G23	G24	G25	G26
Tare ID	E108	E92	H52	AC07	F41	Z82
Mass of tare	8.6	8.4	8.6	6.8	8.4	8.2
Mass wet + tare	379.2	385.6	372.8	419.8	393.4	315.4
Mass dry + tare	351.6	355.8	341.8	387.4	370.2	303.4
Mass water	27.6	29.8	31.0	32.4	23.2	12.0
Mass dry soil	343.0	347.4	333.2	380.6	361.8	295.2
Moisture %	8.0%	8.6%	9.3%	8.5%	6.4%	4.1%

Test Pit	TH18-03	TH18-03	TH18-03	TH18-03	TH18-03	TH18-03
Depth (m)	0.9 - 1.2	1.5 - 1.8	1.8 - 2.1	2.7 - 3.0	4.6 - 4.9	6.4 - 6.7
Sample #	G27	G28	G29	G30	G31	G32
Tare ID	F114	F50	F110	H56	K13	F81
Mass of tare	8.2	8.8	8.4	8.6	8.8	8.6
Mass wet + tare	273.2	280.4	270.0	219.4	258.6	314.2
Mass dry + tare	209.0	212.6	196.6	143.4	173.0	220.6
Mass water	64.2	67.8	73.4	76.0	85.6	93.6
Mass dry soil	200.8	203.8	188.2	134.8	164.2	212.0
Moisture %	32.0%	33.3%	39.0%	56.4%	52.1%	44.2%

Test Pit	TH18-03	TH18-03	TH18-03	TH18-03	TH18-03	TH18-04
Depth (m)	8.5 - 8.8	10.7 - 11.0	12.2 - 12.5	13.7 - 14.0	15.2 - 15.5	0.0 - 0.3
Sample #	G34	G35	G36	G37	G38	G39
Tare ID	W110	W63	P13	F52	AA08	AB54
Mass of tare	8.4	8.6	8.4	8.4	6.8	6.6
Mass wet + tare	379.0	370.0	396.2	406.6	392.0	248.4
Mass dry + tare	344.6	340.6	364.0	373.0	360.0	180.4
Mass water	34.4	29.4	32.2	33.6	32.0	68.0
Mass dry soil	336.2	332.0	355.6	364.6	353.2	173.8
Moisture %	10.2%	8.9%	9.1%	9.2%	9.1%	39.1%

Moisture Content Report
ASTM D2216-10

Project No.	0015-024-00
Client	City of Winnipeg
Project	St. James Civic Centre

Sample Date	09-Apr-18
Test Date	12-Apr-18
Technician	LI

Test Pit	TH18-04	TH18-04	TH18-04	TH18-04	TH18-04	TH18-04
Depth (m)	0.6 - 0.9	1.5 - 1.8	2.4 - 2.7	3.0 - 3.4	6.7 - 7.0	7.6 - 7.9
Sample #	G40	G41	G42	G43	G45	G46
Tare ID	A102	N69	N40	K19	AB19	AB80
Mass of tare	8.4	8.9	8.6	8.4	6.6	6.8
Mass wet + tare	335.1	255.8	253.2	291.6	280.6	281.6
Mass dry + tare	266.0	207.6	183.2	204.2	195.6	200.8
Mass water	69.1	48.2	70.0	87.4	85.0	80.8
Mass dry soil	257.6	198.7	174.6	195.8	189.0	194.0
Moisture %	26.8%	24.3%	40.1%	44.6%	45.0%	41.6%

Test Pit	TH18-04	TH18-04	TH18-04	TH18-04	TH18-04	TH18-04
Depth (m)	8.5 - 8.8	9.1 - 9.4	10.4 - 10.7	12.2 - 12.5	13.4 - 13.7	14.9 - 15.2
Sample #	G47	G48	G49	G50	G51	G52
Tare ID	AB40	F20	AA09	E13	F10	C2
Mass of tare	6.6	8.4	6.8	8.8	8.8	8.4
Mass wet + tare	363.0	416.6	365.4	418.8	389.8	447.8
Mass dry + tare	333.6	377.8	334.2	383.6	355.6	408.6
Mass water	29.4	38.8	31.2	35.2	34.2	39.2
Mass dry soil	327.0	369.4	327.4	374.8	346.8	400.2
Moisture %	9.0%	10.5%	9.5%	9.4%	9.9%	9.8%

Test Pit	TH18-05	TH18-05	TH18-05	TH18-05	TH18-05	TH18-05
Depth (m)	0.0 - 0.3	0.6 - 0.9	1.2 - 1.5	1.8 - 2.1	2.7 - 3.0	4.6 - 4.9
Sample #	G53	G54	G55	G56	G57	G58
Tare ID	N24	K35	F19	E128	F105	P28
Mass of tare	8.6	8.6	8.6	8.4	8.4	8.6
Mass wet + tare	278.4	289.4	246.6	284.2	301.0	308.2
Mass dry + tare	222.8	214.4	186.0	219.0	215.6	205.8
Mass water	55.6	75.0	60.6	65.2	85.4	102.4
Mass dry soil	214.2	205.8	177.4	210.6	207.2	197.2
Moisture %	26.0%	36.4%	34.2%	31.0%	41.2%	51.9%

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Moisture Content Report
ASTM D2216-10

Project No. 0015-024-00
Client City of Winnipeg
Project St. James Civic Centre

Sample Date 09-Apr-18
Test Date 12-Apr-18
Technician LI

Test Pit	TH18-05	TH18-05	TH18-05	TH18-05	TH18-05	TH18-05
Depth (m)	6.1 - 6.4	7.6 - 7.9	8.5 - 8.8	9.1 - 9.4	10.7 - 11.0	12.2 - 12.5
Sample #	G59	G60	G61	G62	G63	G64
Tare ID	P33	A104	F117	F126	C21	F42
Mass of tare	8.4	8.6	8.4	8.4	8.4	8.4
Mass wet + tare	285.8	296.6	359.2	348.8	336.8	305.4
Mass dry + tare	195.4	209.8	319.8	320.2	306.6	274.4
Mass water	90.4	86.8	39.4	28.6	30.2	31.0
Mass dry soil	187.0	201.2	311.4	311.8	298.2	266.0
Moisture %	48.3%	43.1%	12.7%	9.2%	10.1%	11.7%

Test Pit	TH18-05	TH18-05	TH18-07	TH18-07	TH18-07	TH18-07
Depth (m)	13.7 - 14.0	15.2 - 15.5	0.0 - 0.3	0.3 - 0.6	1.2 - 1.5	2.1 - 2.4
Sample #	G65	G66	G67	G68	G69	G70
Tare ID	K16	W74	AB28	H3	C20	D25
Mass of tare	8.6	8.4	6.6	8.4	8.4	8.6
Mass wet + tare	395.4	424.0	255.8	227.6	269.6	309.2
Mass dry + tare	357.8	383.4	184.0	183.0	214.4	222.2
Mass water	37.6	40.6	71.8	44.6	55.2	87.0
Mass dry soil	349.2	375.0	177.4	174.6	206.0	213.6
Moisture %	10.8%	10.8%	40.5%	25.5%	26.8%	40.7%

Test Pit	TH18-07	TH18-08	TH18-08	TH18-08	TH18-08	TH18-08
Depth (m)	2.7 - 3.0	0.0 - 0.3	0.6 - 0.9	1.2 - 1.5	2.1 - 2.4	2.7 - 3.0
Sample #	G71	G72	G73	G74	G75	G76
Tare ID	AB95	Z127	K10	H72	Z63	H33
Mass of tare	6.6	8.4	8.6	8.4	8.6	8.6
Mass wet + tare	336.6	307.2	305.0	278.8	309.6	265.4
Mass dry + tare	221.4	244.6	251.6	202.6	229.4	174.4
Mass water	115.2	62.6	53.4	76.2	80.2	91.0
Mass dry soil	214.8	236.2	243.0	194.2	220.8	165.8
Moisture %	53.6%	26.5%	22.0%	39.2%	36.3%	54.9%

Moisture Content Report
ASTM D2216-10

Project No. 0015-024-00
Client City of Winnipeg
Project St. James Civic Centre

Sample Date 09-Apr-18
Test Date 12-Apr-18
Technician LI

Test Pit	TH18-06	TH18-06	TH18-06	TH18-06	TH18-06	TH18-06
Depth (m)	0.0 - 0.3	0.6 - 0.9	1.2 - 1.5	2.1 - 2.4	2.7 - 3.0	4.3 - 4.6
Sample #	G77	G78	G79	G80	G81	G82
Tare ID	H25	H79	Z77	D28	E18	N65
Mass of tare	8.4	8.4	8.4	8.6	8.4	8.8
Mass wet + tare	290.4	257.2	278.0	241.2	241.4	286.2
Mass dry + tare	238.2	199.6	207.0	180.4	167.8	196.2
Mass water	52.2	57.6	71.0	60.8	73.6	90.0
Mass dry soil	229.8	191.2	198.6	171.8	159.4	187.4
Moisture %	22.7%	30.1%	35.8%	35.4%	46.2%	48.0%

Test Pit	TH18-06	TH18-06	TH18-06	TH18-06	TH18-06	
Depth (m)	7.3 - 7.6	8.4 - 8.7	10.4 - 10.7	11.9 - 12.2	12.8 - 13.1	
Sample #	G84	G85	G86	G87	G88	
Tare ID	N02	N105	Z52	E27	A109	
Mass of tare	8.4	8.4	8.4	8.6	8.4	
Mass wet + tare	378.2	395.4	419.0	331.4	365.4	
Mass dry + tare	340.6	357.4	387.0	305.0	338.6	
Mass water	37.6	38.0	32.0	26.4	26.8	
Mass dry soil	332.2	349.0	378.6	296.4	330.2	
Moisture %	11.3%	10.9%	8.5%	8.9%	8.1%	

Test Pit						
Depth (m)						
Sample #						
Tare ID						
Mass of tare						
Mass wet + tare						
Mass dry + tare						
Mass water						
Mass dry soil						
Moisture %						

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Shelby Tube Visual

Project No.	0015-024-00
Client	City of Winnipeg
Project	St. James Civic Centre
Test Hole	TH18-04
Sample #	T44
Depth (m)	4.6 - 5.2
Sample Date	09-Apr-18
Test Date	13-Apr-18
Technician	LI

Tube Extraction

Recovery (mm) 555

Bottom - 5.2 m	5.00 m	4.86 m	4.70 m	**Top - 4.6 m**
Keep	Moisture Content Visual	PP Tv	Qu Bulk	Toss
160 mm	140 mm		160 mm	95 mm

Visual Classification

Material	Clay
Composition	silty
trace silt inclusions (<15 mm ∅)	
trace precipitates (sulphates)	
trace rootlets	
Color	brown
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.70
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	68.7

Pocket Penetrometer

Reading	**1**	1.30
	2	1.30
	3	1.60
	Average	1.40
Undrained Shear Strength (kPa)		68.6

Moisture Content

Tare ID	N22
Mass tare (g)	8.6
Mass wet + tare (g)	295.6
Mass dry + tare (g)	196.5
Moisture %	52.7%

Unit Weight

Bulk Weight (g)		1052.0
Length (mm)	**1**	146.40
	2	146.79
	3	147.00
	4	146.43
Average Length (m)		0.147
Diam. (mm)	**1**	72.62
	2	73.24
	3	73.12
	4	72.76
Average Diameter (m)		0.073
Volume (m^3)		6.13E-04
Bulk Unit Weight (kN/m^3)		16.8
Bulk Unit Weight (pcf)		107.2
Dry Unit Weight (kN/m^3)		11.0
Dry Unit Weight (pcf)		70.2

Unconfined Compressive Strength
ASTM D2166

Project No. 0015-024-00
Client City of Winnipeg
Project St. James Civic Centre

Test Hole TH18-04
Sample # T44
Depth (m) 4.6 - 5.2
Sample Date 9-Apr-18
Test Date 13-Apr-18
Technician LI

Unconfined Strength

	kPa	ksf
Max q_u	95.1	2.0
Max S_u	47.6	1.0

Specimen Data

Description Clay - silty, trace silt inclusions (<15 mm Ø), trace precipitates (sulphates), trace rootlets, brown, moist, stiff, high plasticity

Length	146.7	(mm)	**Moisture %**	53%	
Diameter	72.9	(mm)	**Bulk Unit Wt.**	16.8	(kN/m^3)
L/D Ratio	2.0		**Dry Unit Wt.**	11.0	(kN/m^3)
Initial Area	0.00418	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.70	68.7	1.43
Vane Size		
m		

Pocket Penetrometer

	Reading	**Undrained Shear Strength**	
	tsf	**kPa**	**ksf**
	1.30	63.8	1.33
	1.30	63.8	1.33
	1.60	78.5	1.64
Average	**1.40**	**68.7**	**1.43**

Failure Geometry

Sketch:

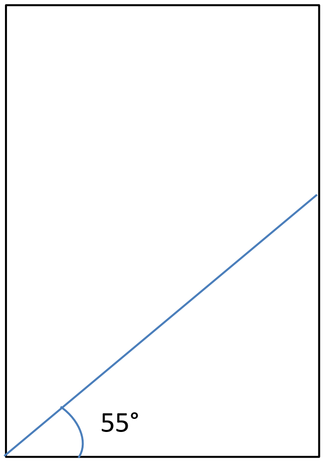


Photo:

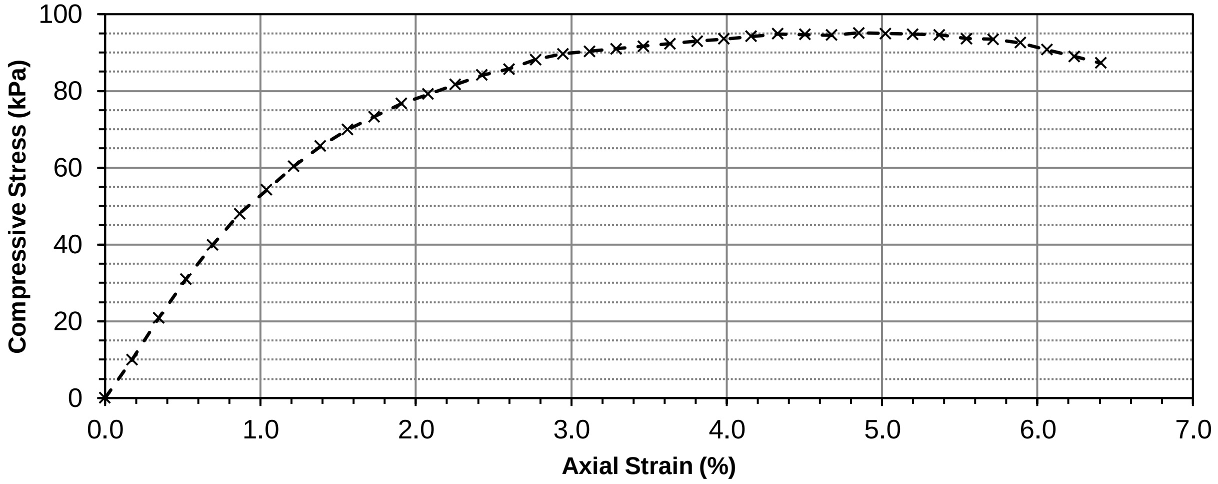
Project 0015-024-00
Location 2055 NESS AVE
Hole No. TH18-04 Sample No. T44
Depth 15-17
Technician BT Date April 9/18

Unconfined Compressive Strength

ASTM D2166

Project No. 0015-024-00
Client City of Winnipeg
Project St. James Civic Centre

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004178	0.0	0.00	0.00
10	11	0.2540	0.17	0.004185	41.7	9.97	4.98
20	23	0.5080	0.35	0.004192	87.6	20.91	10.45
30	34	0.7620	0.52	0.004200	129.8	30.90	15.45
40	44	1.0160	0.69	0.004207	168.0	39.94	19.97
50	53	1.2700	0.87	0.004214	202.3	48.01	24.00
60	60	1.5240	1.04	0.004222	228.8	54.19	27.09
70	67	1.7780	1.21	0.004229	255.2	60.34	30.17
80	73	2.0320	1.39	0.004237	277.8	65.58	32.79
90	78	2.2860	1.56	0.004244	296.6	69.89	34.95
100	82	2.5400	1.73	0.004252	311.6	73.29	36.64
110	86	2.7940	1.91	0.004259	326.5	76.67	38.33
120	89	3.0480	2.08	0.004267	337.8	79.16	39.58
130	92	3.3020	2.25	0.004274	349.0	81.65	40.82
140	95	3.5560	2.42	0.004282	360.2	84.12	42.06
150	97	3.8100	2.60	0.004289	367.7	85.72	42.86
160	100	4.0640	2.77	0.004297	378.9	88.18	44.09
170	102	4.3180	2.94	0.004305	386.0	89.66	44.83
180	103	4.5720	3.12	0.004312	389.5	90.32	45.16
190	104	4.8260	3.29	0.004320	393.0	90.98	45.49
200	105	5.0800	3.46	0.004328	396.6	91.63	45.81
210	106	5.3340	3.64	0.004336	400.1	92.28	46.14
220	107	5.5880	3.81	0.004343	403.6	92.93	46.46
230	108	5.8420	3.98	0.004351	407.2	93.57	46.79

Project No. 0015-024-00
Client City of Winnipeg
Project St. James Civic Centre

Unconfined Compression Test Data (cont'd)

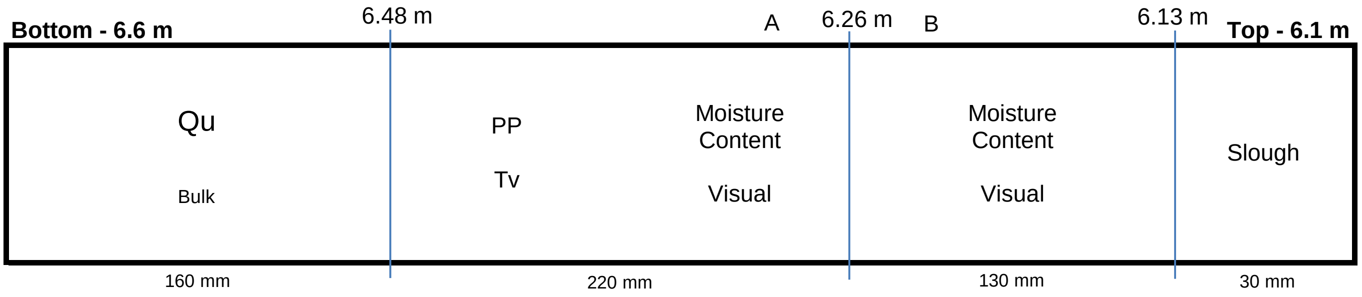
Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	109	6.0960	4.16	0.004359	410.7	94.21	47.11
250	110	6.3500	4.33	0.004367	414.2	94.85	47.43
260	110	6.6040	4.50	0.004375	414.2	94.68	47.34
270	110	6.8580	4.68	0.004383	414.2	94.51	47.25
280	111	7.1120	4.85	0.004391	417.8	95.14	47.57
290	111	7.3660	5.02	0.004399	417.8	94.97	47.48
300	111	7.6200	5.20	0.004407	417.8	94.79	47.40
310	111	7.8740	5.37	0.004415	417.8	94.62	47.31
320	110	8.1280	5.54	0.004423	414.2	93.65	46.82
330	110	8.3820	5.72	0.004431	414.2	93.48	46.74
340	109	8.6360	5.89	0.004439	410.7	92.51	46.26
350	107	8.8900	6.06	0.004448	403.6	90.75	45.38
360	105	9.1440	6.24	0.004456	396.6	89.00	44.50
370	103	9.3980	6.41	0.004464	389.5	87.25	43.63

Shelby Tube Visual

Project No.	0015-024-00
Client	City of Winnipeg
Project	St. James Civic Centre
Test Hole	TH18-06
Sample #	T83
Depth (m)	6.1 - 6.6
Sample Date	10-Apr-18
Test Date	13-Apr-18
Technician	LI

Tube Extraction

Recovery (mm) 540



Visual Classification

	A	B
Material	Clay	Silt Till
Composition	silty	sandy
	trace silt inclusions (<10 mm Ø)	trace clay
	trace sand	some gravel (<45 mm Ø)
	trace gravel (<10 mm Ø)	
Color	brown	light brown
Moisture	moist	moist
Consistency	stiff	
Plasticity	high plasticity	low to intermediate
		plasticity
Structure		
Gradation		

Torvane

	A	B	
Reading	0.58		
Vane Size (s,m,l)	m		
Undrained Shear Strength	56.9		(kPa)

Pocket Penetrometer

		A	B	
Reading	**1**	1.20		
	2	1.10		
	3	1.20		
	Average	1.17		
Undrained Shear Strength		57.2		(kPa)

Moisture Content

	A	B
Tare ID	F14	W14
Mass tare (g)	8.5	8.6
Mass wet + tare (g)	221.1	294.1
Mass dry + tare (g)	155.5	238.6
Moisture %	44.6%	24.1%

Unit Weight

Bulk Weight (g)		1145.60	
Length (mm)	**1**	145.36	
	2	145.44	
	3	146.01	
	4	145.93	
Average Length (m)		0.146	
Diam. (mm)	**1**	73.27	
	2	72.36	
	3	72.67	
	4	73.79	
Average Diameter (m)		0.073	
Volume (m^3)		6.10E-04	
Bulk Unit Weight (kN/m^3)		18.4	
Bulk Unit Weight (pcf)		117.2	
Dry Unit Weight (kN/m^3)		12.7	
Dry Unit Weight (pcf)		81.1	

Unconfined Compressive Strength

ASTM D2166

Project No.	0015-024-00
Client	City of Winnipeg
Project	St. James Civic Centre
Test Hole	TH18-06
Sample #	T83
Depth (m)	6.1 - 6.6
Sample Date	10-Apr-18
Test Date	13-Apr-18
Technician	LI

Unconfined Strength

	kPa	ksf
Max q_u	69.4	1.4
Max S_u	34.7	0.7

Specimen Data

Description A: Clay - silty, trace silt inclusions (<10 mm Ø), trace sand, trace gravel (<10 mm Ø), brown, moist, stiff, high plasticity

Length	145.7	(mm)	**Moisture %**	45%	
Diameter	73.0	(mm)	**Bulk Unit Wt.**	18.4	(kN/m^3)
L/D Ratio	2.0		**Dry Unit Wt.**	12.7	(kN/m^3)
Initial Area	0.00419	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.58	56.9	1.19
Vane Size		
m		

Pocket Penetrometer

	Reading	**Undrained Shear Strength**	
	tsf	**kPa**	**ksf**
	1.20	58.9	1.23
	1.10	54.0	1.13
	1.20	58.9	1.23
Average	**1.17**	**57.2**	**1.20**

Failure Geometry

Sketch:

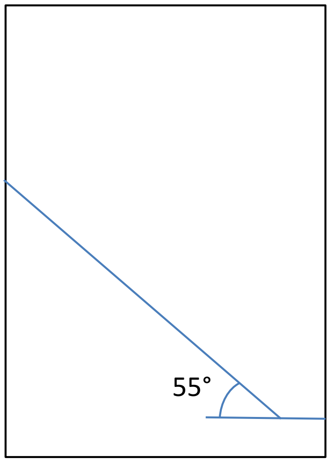


Photo:

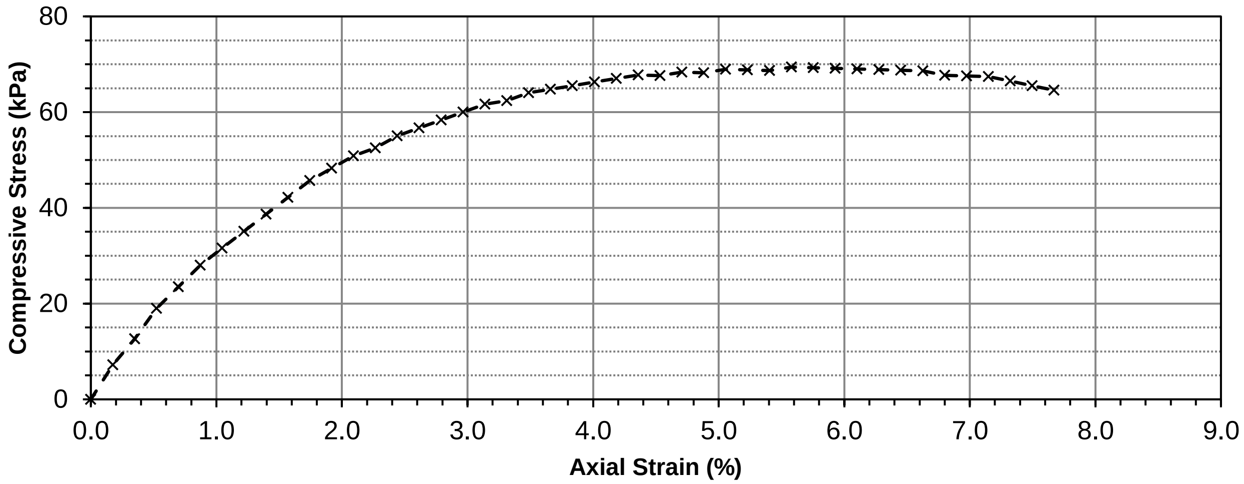
Project 0015-024-00
Location 2055 NESS AVE
Hole No. TH18-06 Sample No. T83
Depth 20 - 22
Technician BT Date April 10/18

Unconfined Compressive Strength

ASTM D2166

Project No. 0015-024-00
Client City of Winnipeg
Project St. James Civic Centre

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004188	0.0	0.00	0.00
10	8	0.2540	0.17	0.004195	30.2	7.20	3.60
20	14	0.5080	0.35	0.004203	53.2	12.66	6.33
30	21	0.7620	0.52	0.004210	80.0	19.00	9.50
40	26	1.0160	0.70	0.004217	99.1	23.50	11.75
50	31	1.2700	0.87	0.004225	118.3	27.99	14.00
60	35	1.5240	1.05	0.004232	133.6	31.56	15.78
70	39	1.7780	1.22	0.004240	148.9	35.12	17.56
80	43	2.0320	1.39	0.004247	164.2	38.66	19.33
90	47	2.2860	1.57	0.004255	179.5	42.19	21.10
100	51	2.5400	1.74	0.004262	194.8	45.70	22.85
110	54	2.7940	1.92	0.004270	206.1	48.27	24.13
120	57	3.0480	2.09	0.004277	217.4	50.83	25.42
130	59	3.3020	2.27	0.004285	225.0	52.50	26.25
140	62	3.5560	2.44	0.004293	236.3	55.05	27.52
150	64	3.8100	2.62	0.004300	243.9	56.71	28.35
160	66	4.0640	2.79	0.004308	251.4	58.36	29.18
170	68	4.3180	2.96	0.004316	259.0	60.00	30.00
180	70	4.5720	3.14	0.004324	266.5	61.64	30.82
190	71	4.8260	3.31	0.004331	270.3	62.40	31.20
200	73	5.0800	3.49	0.004339	277.8	64.03	32.02
210	74	5.3340	3.66	0.004347	281.6	64.78	32.39
220	75	5.5880	3.84	0.004355	285.4	65.53	32.77
230	76	5.8420	4.01	0.004363	289.1	66.27	33.14

Unconfined Compressive Strength

ASTM D2166

Project No. 0015-024-00
Client City of Winnipeg
Project St. James Civic Centre

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	77	6.0960	4.18	0.004371	292.9	67.01	33.50
250	78	6.3500	4.36	0.004379	296.6	67.74	33.87
260	78	6.6040	4.53	0.004387	296.6	67.62	33.81
270	79	6.8580	4.71	0.004395	300.4	68.34	34.17
280	79	7.1120	4.88	0.004403	300.4	68.22	34.11
290	80	7.3660	5.06	0.004411	304.1	68.94	34.47
300	80	7.6200	5.23	0.004419	304.1	68.81	34.41
310	80	7.8740	5.40	0.004427	304.1	68.69	34.34
320	81	8.1280	5.58	0.004435	307.8	69.40	34.70
330	81	8.3820	5.75	0.004444	307.8	69.28	34.64
340	81	8.6360	5.93	0.004452	307.8	69.15	34.57
350	81	8.8900	6.10	0.004460	307.8	69.02	34.51
360	81	9.1440	6.28	0.004468	307.8	68.89	34.45
370	81	9.3980	6.45	0.004477	307.8	68.76	34.38
380	81	9.6520	6.63	0.004485	307.8	68.64	34.32
390	80	9.9060	6.80	0.004494	304.1	67.68	33.84
400	80	10.1600	6.97	0.004502	304.1	67.55	33.77
410	80	10.4140	7.15	0.004510	304.1	67.42	33.71
420	79	10.6680	7.32	0.004519	300.4	66.47	33.23
430	78	10.9220	7.50	0.004527	296.6	65.52	32.76
440	77	11.1760	7.67	0.004536	292.9	64.57	32.28