Crosier Kilgour & Partners Ltd.

New St. Vital Park Maintenance Building, Winnipeg, MB
Geotechnical Investigation Report

Prepared for:
Mr. Bart Flisak, M.Sc., MBA, P.Eng.
Crosier Kilgour & Partners Ltd.
275 Carlton Street
Winnipeg, MB
R3C 5R6

Project Number: 0020 039 00

Date: October 8, 2021

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October 8, 2021

Our File No. 0020 039 00

Mr. Bart Flisak, M.Sc., MBA, P.Eng.
Crosier Kilgour & Partners Ltd.
275 Carlton Street
Winnipeg, MB
R3C 5R6

RE: **New St. Vital Park Maintenance 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 should you have any questions.

Sincerely,

TREK Geotechnical Inc.
Per:

Brent Hay, P.Eng.
Geotechnical Engineer

Encl.

Revision History

Revision No.	Author	Issue Date	Description
0	BT	October 8, 2021	Final Report

Authorization Signatures

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TREK GEOTECHNICAL INC.
No. 4877 Date: Oct. 8/2021

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1.0 Introduction

This report summarizes the results of a geotechnical investigation completed by TREK Geotechnical Inc. (TREK) for the proposed maintenance building and staff house at the St. Vital Park in Winnipeg, MB. The terms of reference for the investigation are included in our proposal to Mr. Bart Flisak, M.Sc., MBA, P.Eng. of Crosier Kilgour & Partners Ltd. (Crosier), dated June 28, 2021. The scope of work includes a sub-surface investigation, soils laboratory testing and provision of recommendations for foundations, concrete slabs, excavation and backfill, site drainage and pavement.

2.0 Background and Site Conditions

The site is approximately 1,100 m^2 (11,840 ft^2) and currently vacant, delineated to the South by River Rd. and to the North by Perimeter Rd. It is understood that the building will be a single storey structure housing an office and staff use function, with an adjoining garage for minor vehicle maintenance and storage. TREK understands that the new building footprint will be approximately 330 m^2 (3,550 ft^2). Foundation loads have not yet been determined but are anticipated to be relatively light.

3.0 Field Program

3.1 Sub-surface Investigation

A sub-surface investigation was completed on September 10, 2021 under the supervision of TREK personnel to assess soil stratigraphy and groundwater conditions at the site. Test holes TH21-01 and 02 were drilled to respective depths of 10.7 m and 3.0 m below ground surface at the locations shown on Figure 01.

The test holes were drilled by XTERA Drilling using a DTC 30 Geax equipped with a 305 mm diameter auger mounted on ESP 60ZT track piling rig. The test holes were backfilled with auger cuttings to surface. Sub-surface soils encountered during drilling were visually classified based on the Unified Soil Classification System (USCS). Disturbed grab samples were taken at regular intervals. All samples retrieved during drilling were transported to TREK's testing laboratory in Winnipeg, Manitoba. Laboratory testing consisted of moisture content determination on all samples as well as Atterberg limits on a select sample.

The test hole location was recorded using handheld GPS. Test hole elevations were surveyed using a rod and level relative to a temporary benchmark (TBM) which was assigned an arbitrary elevation of 100.0 m. The temporary benchmark chosen for this project was the top of nut of the fire hydrant located Northeast of the site as shown on Figure 01. The UTM coordinates of the test hole are provided on the test hole logs. The test hole logs include a description of the soil units encountered and other pertinent information such as groundwater and sloughing conditions and a summary of the laboratory testing results. Laboratory testing results are included in Appendix A.

3.2 Soil Stratigraphy

A brief description of the soil stratigraphy and groundwater conditions encountered during drilling is provided in the following sections. All interpretations of soil stratigraphy for the purposes of design should refer to the detailed information provided on the attached test hole logs.

The soil stratigraphy encountered at the test hole locations consists of a 25 mm thick layer of asphalt over sand and gravel (fill), organic clay, and native silty clay. The sand and gravel (fill) is 0.2 m to 0.3 m thick, overlaying 0.3 m to 0.7 m thick of high plasticity organic clay. Silty clay was encountered at 1.1 m (TH21-01) and 0.7 m (TH21-02) below ground surface to the maximum depth explored. The silty clay is mottled grey and brown, it is moist, of high plasticity and stiff to very stiff becoming soft to firm with depth.

3.3 Power Auger Refusal

Power auger refusal was not encountered in the test holes.

3.4 Groundwater Conditions

Seepage and sloughing conditions were not observed during drilling. The groundwater observations made during drilling are short-term and should not be considered reflective of (static) groundwater levels at the site which would require monitoring over an extended period 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 observed sub-surface and anticipated loading conditions, Cast-in-place concrete (CIPC) friction piles are a suitable foundation alternative for the new building. Recommendations for this foundation alternative according to the National Building Code of Canada (NBCC, 2010) are provided in the following sections.

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 (2010) 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)

Bearing 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 static loading test results	0.6
Uplift resistance by semi-empirical analysis.	0.3
Uplift resistance using loading test results	0.4

4.2 Cast in Place Concrete Friction Piles

Cast-in-place concrete friction piles installed in silty clay will derive a majority of their resistance in shaft friction with a relatively small contribution from end bearing. Table 2 provides SLS and factored ULS axial (compressive and uplift) unit resistances for shaft adhesion and end bearing. Piles designed based on the SLS resistances are expected to exhibit less than 10 mm of settlement at the pile toe. Elastic shortening of the pile should be added to the tip displacement to calculate the pile head settlement.

Table 2: Recommended Factored ULS and SLS Unit Resistances for CIPC Friction Piles

Approximate Pile Depth Below Existing Site Grade (m)	SLS Unit Resistance (kPa)	Factored ULS Unit Resistance (kPa)		
		Compression $\phi = 0.4$		Uplift $\phi = 0.3$
		Shaft Adhesion	End Bearing (Note 2)	Shaft Adhesion
0 to X (Note 1)	-	-	-	-
X to 10.5	15	16	80	12

1. *X=1.5 m for piles that will not be subjected to freezing conditions.*
   X=2.4 m for piles subject to freezing conditions.
2. *For piles with a diameter of less than 1.0 m. If larger pile diameters are required TREK should be contacted to provide revised end bearing values.*

CIPC Design Recommendations:

1. The weight of the embedded portion of the pile may be neglected.
2. Piles should be designed with a maximum depth of 10.5 m below existing site grade to avoid penetration into the underlying silt till and to protect against heaving at the base of the pile shaft. In the event the silt till is encountered at shallower depths, the pile design may have to be re-evaluated by the structural engineer.
3. For piles supporting heated structures (excluding perimeter piles), shaft adhesion in compression and uplift within the upper 1.5 m below final grade should be neglected. For piles subjected to freezing conditions or perimeter piles in heated structures, shaft adhesion in compression and uplift within the upper 2.4 m below final grade should be neglected.
4. Piles should have a minimum spacing of 3 pile diameters 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.
5. Piles require steel reinforcement designed by a qualified structural engineer for the anticipated axial (compression and tension), lateral and bending loads induced from the structure. Piles subject to frost jacking forces should be reinforced for their entire length.

CIPC Installation Recommendations:

1. Temporary steel casings (sleeves) should be available and used if sloughing of the pile hole occurs and/or to control groundwater seepage. 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. Concrete should be placed in one continuous operation immediately after the completion of drilling the pile hole to avoid potential construction problems such as sloughing or caving of the pile hole and groundwater seepage. Concrete placed by free-fall methods should be poured under dry conditions. If groundwater is encountered, it should be controlled or removed. If water cannot be controlled or removed, the concrete should be placed using tremie methods.
3. Concrete placed by free-fall methods should be directed through the middle of the pile shaft and steel reinforcing cage to prevent striking of the drilled shaft walls to protect against soil contamination of the concrete.

4.3 Lateral Pile 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 Pile Caps and Grade Beams

A minimum void of 150 mm should be provided underneath all grade beams and pile caps to accommodate volumetric changes in the underlying sub-grade soils (i.e., swelling, shrinkage, and thermal expansion and contraction in unheated areas). Void forms should be used under pile caps and grade beams and should be capable of deforming a minimum of 150 mm with tolerable stress transfer to the structure. Excavations for grade beams should be backfilled with non-frost susceptible granular fill compacted to a minimum of 98% of the SPMDD.

4.5 Adfreezing Effects

Concrete piles, pile caps, grade beams, and buried walls subjected to freezing conditions should be designed to resist ad-freeze and uplift forces related to frost 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. Adfreeze 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 adfreeze bond stress of 65 kPa within the depth of frost penetration.
2. A load factor (α) of 1.2 may be used in the calculation of ad-freezing forces.
3. A reduction factor of 0.8 may be used in calculation of the geotechnical resistance for the factored ULS condition with an ultimate (nominal) resistance of 40 kPa to a depth of 10.5 m below existing grade.
4. Resistance to adfreezing within the depth of frost penetration should be neglected.
5. The calculated geotechnical resistance plus the structural dead loads must be greater than the factored ad-freezing forces.
6. Piles subject to adfreezing forces should be a minimum of 8.0 m or as calculated by the method above, whichever is greater.
7. Measures such as flat lying rigid polystyrene insulation could be considered to reduce frost penetration depths and thereby ad-freezing and uplift forces.

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 test data 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 very severe sulphate exposure (S1). 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:

a) continuous basis during:
   i. the construction of all deep foundation units with all pertinent information recorded for each *foundation unit*,
   ii. during the installation and removal of retaining structures and related backfilling operations,
   iii. during the placement of engineered fills that are to be used to support the *foundation units*, and

b) as-required, unless otherwise directed by the *authority having jurisdiction*,
   i. in the construction of all *shallow foundation units*, and
   ii. in excavating, dewatering and other related works

In accordance with Engineers and Geoscientists of Manitoba, a Professional Engineer or delegated staff responsible to them must perform site reviews for the work presented in the documents they've sealed.

For conformance with the NBCC and EGM requirements, TREK should be retained on a full-time basis to observe and document the installation of all pile foundations, shoring or engineered fills supporting the structure, and on an as-required basis for other components such as sub-grade inspections and compaction testing. TREK is familiar with the geotechnical conditions present and the underlying design assumptions of our foundation recommendations. TREK is therefore solely qualified to evaluate any design modifications deemed to be necessary should altered subsurface conditions be encountered.

5.0 Floor Slabs

5.1 Grade Supported Floor Slabs

If some movement can be tolerated, grade supported concrete floor slabs can be used. Vertical deformation of grade supported slabs should be expected due to moisture and volume changes of the underlying soils. Although difficult to predict these movements could be in the order of 50 mm or more. Slabs in unheated areas or near the perimeter of the structure will be subject to additional movements from freeze/thaw of the sub-grade soils. If these movements cannot be tolerated, a structural floor slab will be required.

Additional Recommendations:

1. Organics, fill materials, debris, and any other deleterious material should be stripped such that the sub-grade consists of stiff, silty clay. The organic clay encountered in both test holes is not suitable for a sub-grade and should be removed in its entirety.
2. Excavation should be completed with an excavator equipped with a smooth bucket operating from the edge of the excavation. Care should be taken to minimize disturbance to the sub-grade at all times.
3. After stripping, the sub-grade should be proof rolled and inspected by TREK prior to placement of granular base materials. The sub grade should be proof rolled with a fully loaded tandem axle truck to detect silt or soft areas. Silt or soft areas should be repaired as per directions provided by TREK. This will likely consist of excavating an additional 150 to 300 mm and replacing with 50 mm down crushed granular fill in lifts not exceeding 150 mm and compacted to 98% of the SPMDD.
4. The sub-grade should be protected from freezing, drying, inundation 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. 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 thick and compacted to 98% of the SPMDD.
6. The granular base course materials should consist of a well graded, durable crushed rock in accordance with City of Winnipeg Specification No. CW 3110 (or equivalent as approved by TREK).
7. A vapour barrier should be placed above the granular base and beneath the floor slab.
8. Floor slabs should be designed by a qualified structural engineer 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 sub-grade soils.
9. 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 structural elements. Allowances should be made to accommodate vertical movements of light weight structures (e.g., partitions) bearing on the slab.

5.2 Structural Slabs

In areas where movement of floor slabs is not tolerable, a structural floor slab should be used. A minimum void space of 150 mm beneath structural floor slabs is recommended to accommodate volumetric changes in the underlying sub-grade soils (i.e., freeze-thaw volume changes and thermal expansion and contraction in unheated areas). The void should consist of a compressible layer (e.g., void form) to permit sub-grade soil movements without causing intolerable stress on the floor slab or, alternatively, a crawl space may be used. A vapour barrier should be placed between the floor slab and the void form (if present).

6.0 Pavements

The recommended pavement structure is provided in Table 3 for parking areas. Crushed 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

Material	Layer Thickness	Compaction/Installation Requirements
	Car Parking Areas	
Asphalt	100 mm	by others
20 mm down crushed granular (Base)	75 mm	100% of the SPMDD
50 down crushed granular (Sub-base)	250 mm	98% of the SPMDD
Non-Woven Geotextile (TE-8 or equivalent)	Required	Install as per manufacturer's recommendations

<u>Additional Recommendations:</u>

1. Organics, fill materials, silt, debris, and any other deleterious material should be stripped such that the sub-grade consists of stiff, silty clay. The organic clay encountered in both test holes is not suitable for a sub-grade and should be removed in its entirety.
2. After stripping, the sub-grade should be proof-rolled and inspected by TREK prior to placement of granular base materials. The sub-grade should be proof rolled with a fully loaded tandem axle truck to detect silt or soft areas. Silt or soft areas should be repaired as per directions provided by TREK. This will likely consist of excavating an additional 150 to 300 mm and replacing with 50 mm down crushed granular fill in lifts not exceeding 150 mm and compacted to 98% of the SPMDD.
3. The sub-grade should be protected from freezing, drying, inundation 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.
4. A non-woven geotextile such as Titan Environmental TE-8 should be placed in accordance with the manufacturer's recommendations on the prepared sub-grade prior to placement of granular fill.
5. The granular base materials should consist of a well graded, durable crushed rock, in accordance with the City of Winnipeg Specification No. CW 3110.
6. The granular base materials should be placed in lifts not exceeding 150 mm and compacted to as per the recommendations above in Table 3.

7.0 Excavations and Dewatering

Excavations must be carried out in compliance with the appropriate regulations under the Manitoba Workplace Safety and Health Act. Although not anticipated, any open-cut excavation greater than 3 m deep (although not anticipated) must be designed and sealed by a professional engineer and should be reviewed by the geotechnical engineer of record (TREK). Design and construction of stable excavations is the responsibility of the Contractor for the duration of construction. Excavations should be monitored regularly and flattened as necessary to maintain stability recognizing that excavation stability is time and weather dependent. Excavated slopes should be covered with polyethylene sheets to prevent wetting and drying.

Stockpiles of excavated material and heavy equipment should be kept away from the edge of any excavation by a distance equal to or greater than the depth of excavation, or a minimum of 1 m, whichever is greater. If heavy equipment is required to work near the edge of an open excavation, workers should not be permitted to work within the excavation at that time.

Sloughing, or caving conditions may be encountered in excavations and may require additional measures such as further slope flattening, shoring, or the incorporation of gravel buttresses. If space is limited or the stability of adjacent structures may be endangered by an excavation, a shoring system may be required to prevent damage to, or movement of, any part of adjacent structures, and the creation of a hazard to workers and the public. Seepage can be expected from silt layers. Dewatering measures should be completed as necessary to maintain a dry excavation and permit proper completion of the work. If seepage is encountered, it should be directed to a sump pit and pumped out of the excavation. Surface water should be diverted away from the excavation and the excavation should be backfilled as soon as possible following construction. If excessive seepage and sloughing occurs TREK should be contacted to provide additional recommendations.

TREK recommends that the inspection of any open excavations be carried out once a day for the length of time the excavation remains open. Daily inspections may be performed by qualified on-site personnel.

8.0 Lateral Earth Pressures and Backfill

Based on the information provided to date, buried structures or temporary shoring are not anticipated for this project. If recommendations are necessary for lateral earth pressures and associated design issues, TREK can provide a separate letter as required.

9.0 Site Drainage

Drainage adjacent to structures and exterior slabs should promote runoff away from the structures and slabs. A minimum gradient of 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 a minimum gradient 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.

10.0 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 sub-surface 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 Crosier Kilgour & Partners Ltd. (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

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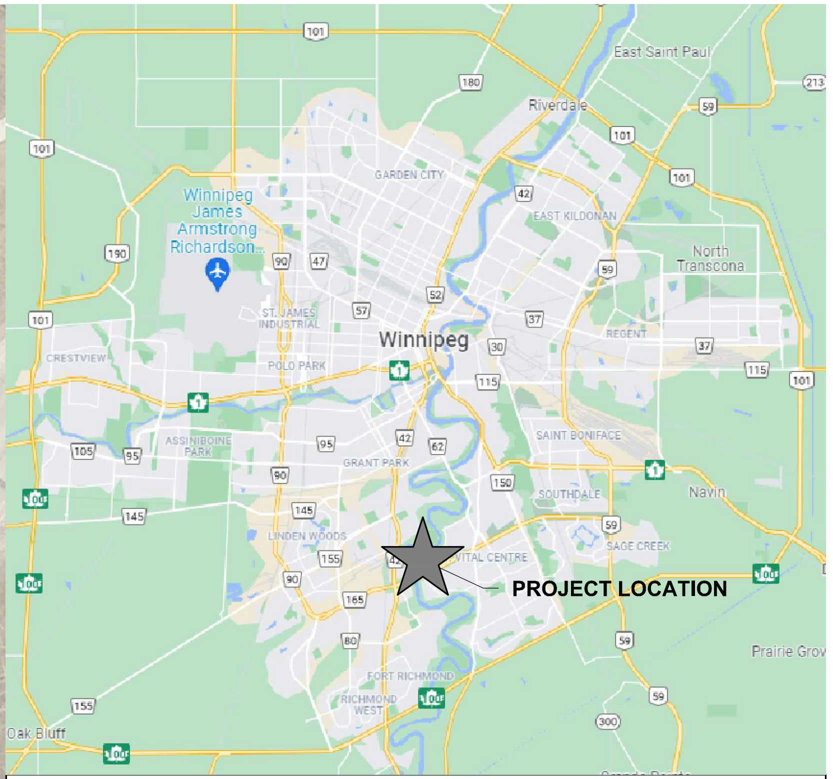
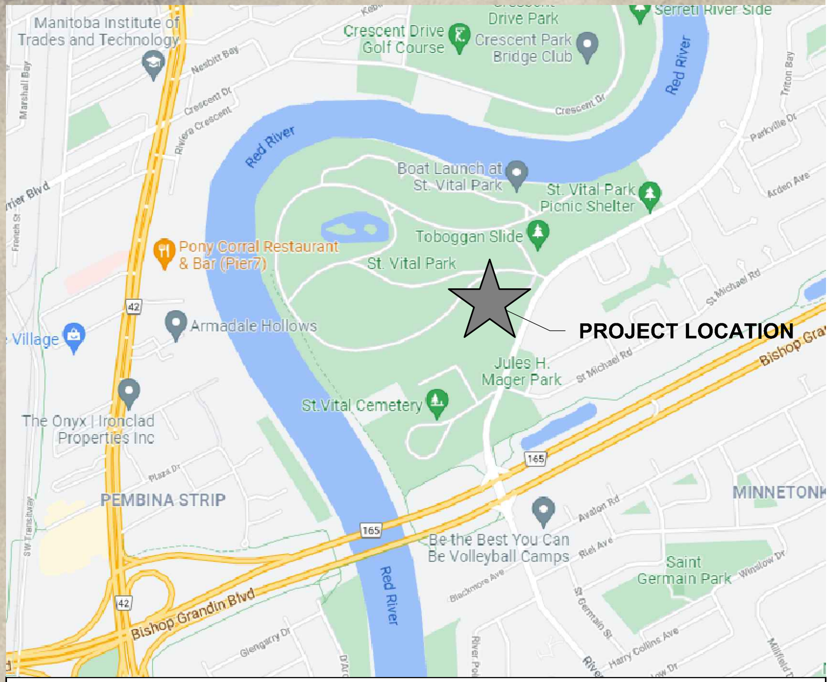
0020 039 00
Crosier Kilgour & Partners Ltd.
New St. Vital Park Maintenance Building

Z:\Projects\0020 Crosier Kilgour\0020 039 00 St. Vital Park Maintenance Building\3 Survey and Dwg\3.4 CAD\3.4.3 Working Folder\0020-039-00 New St Vital Park Maintenance Bldg Figure 01 CT.dwg, 2021-09-13 3:11:05 PM



KEY PLAN
SCALE: N.T.S.



LOCATION PLAN
SCALE: N.T.S.

0 5 10 15 20 25 m
SCALE = 1 : 600 (279 mm x 432 mm)

LEGEND:

⊕ TEST HOLE (TREK, 2021)

▣ TEMPORARY BENCHMARK

NOTES:

1. AERIAL IMAGERY FROM CITY OF WINNIPEG, (FALL 2006).
2. TEMPORARY BENCHMARK TBM1 IS THE TOP OF NUT OF FIRE HYDRANT, ASSIGNED ELEVATION OF 100.0 m.

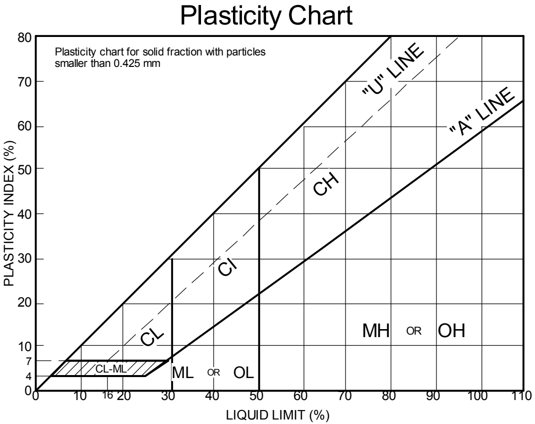
Figure 01
Test Hole Location Plan

Test Hole Logs

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 Classi-fication	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

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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

Sub-Surface Log

Test Hole TH21-01

1 of 2

Client: Crosier Kilgour

Project Name: St. Vital Park Maintenance Building

Contractor: XTERA Drilling

Method: DTC 30 Geax with 305 mm diam. auger mounted on ESP 60ZT track piling rig

Project Number: 0020 039 00

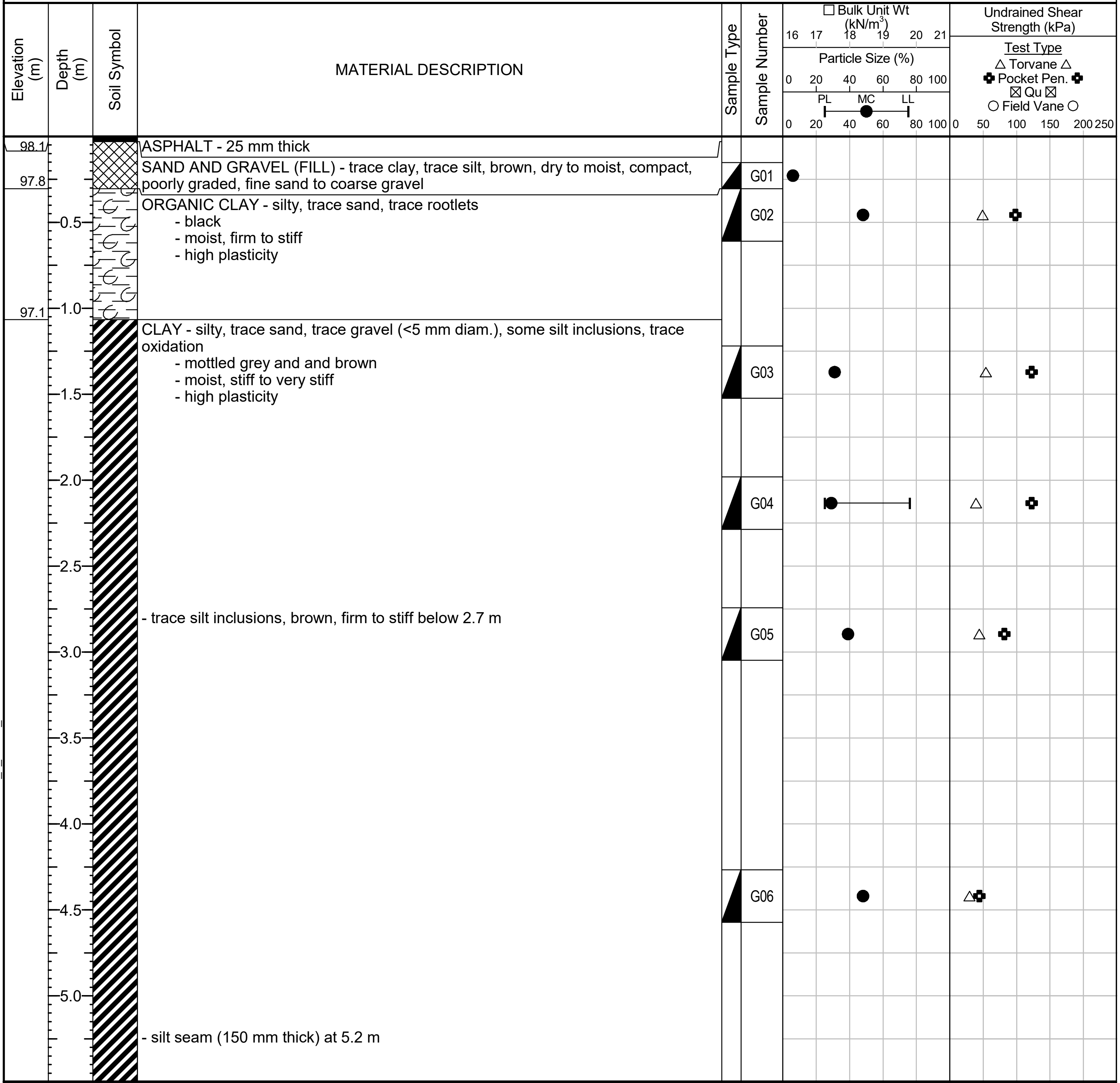
Location: UTM N-5521143, E-633908

Ground Elevation: 98.12 m (local datum)

Date Drilled: September 10, 2021

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

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



ASPHALT - 25 mm thick

SAND AND GRAVEL (FILL) - trace clay, trace silt, brown, dry to moist, compact, poorly graded, fine sand to coarse gravel

ORGANIC CLAY - silty, trace sand, trace rootlets
- black
- moist, firm to stiff
- high plasticity

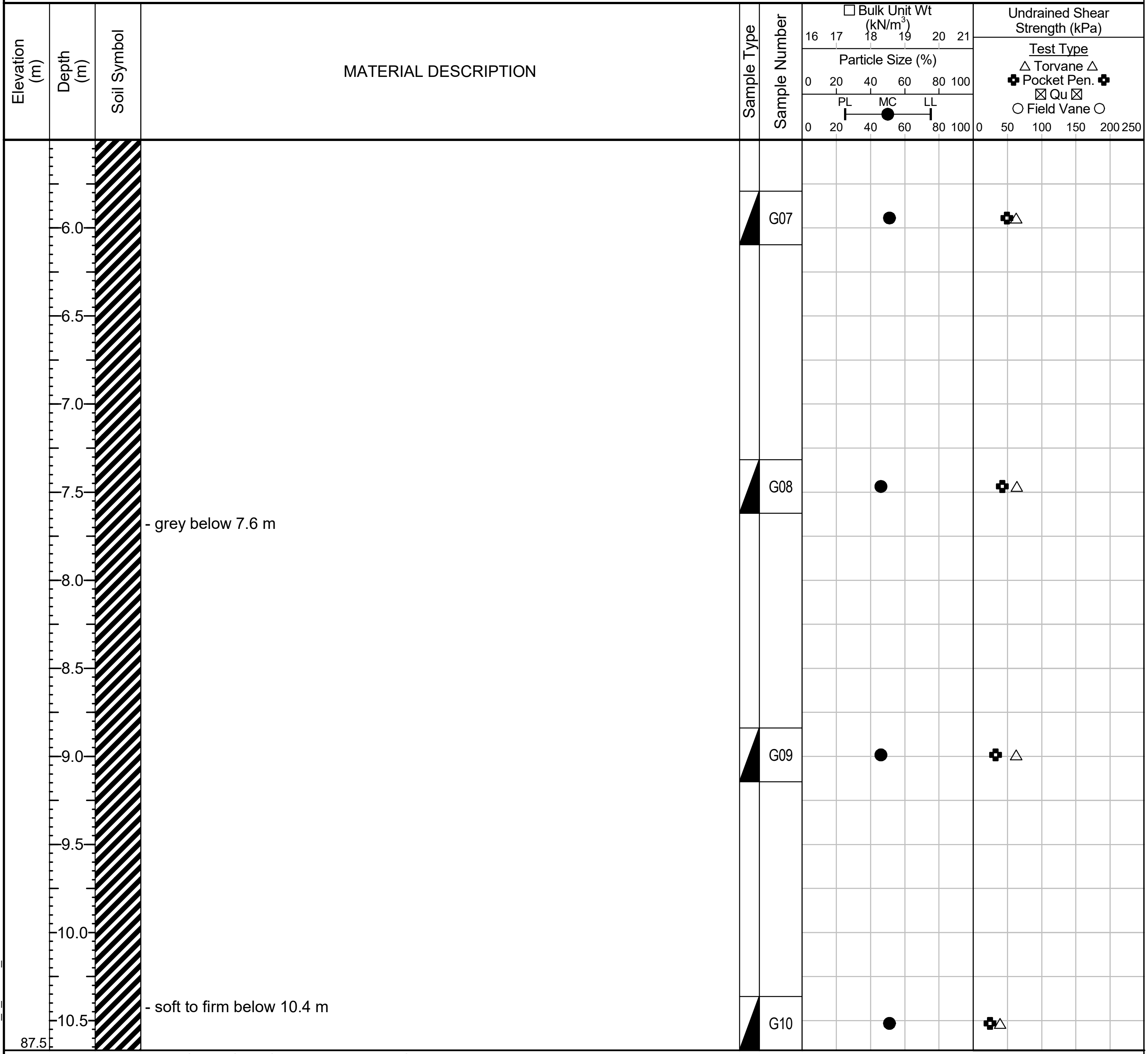
CLAY - silty, trace sand, trace gravel (<5 mm diam.), some silt inclusions, trace oxidation
- mottled grey and and brown
- moist, stiff to very stiff
- high plasticity

- trace silt inclusions, brown, firm to stiff below 2.7 m

- silt seam (150 mm thick) at 5.2 m

Logged By: Beta Taryana **Reviewed By:** Kent Bannister **Project Engineer:** Brent Hay

Sub-Surface Log



- grey below 7.6 m

- soft to firm below 10.4 m

END OF TEST HOLE AT 10.7 m IN CLAY

Notes:

1. No seepage or sloughing observed.
2. Test Hole open to 10.7 m depth and dry immediately after drilling.
3. Test Hole backfilled with auger cuttings to surface.
4. Test Hole elevation measured relative to temporary benchmark TBM1 (top of nut of fire hydrant and is assigned local elevation of 100.0 m).

Logged By: Beta Taryana **Reviewed By:** Kent Bannister **Project Engineer:** Brent Hay

TREK GEOTECHNICAL

Sub-Surface Log

Test Hole TH21-02

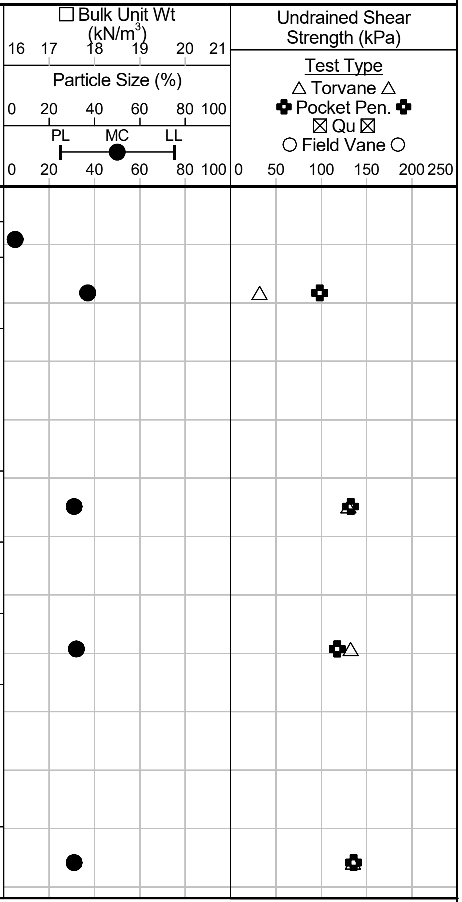
1 of 1

Client:	Crosier Kilgour	**Project Number:**	0020 039 00
Project Name:	St. Vital Park Maintenance Building	**Location:**	UTM N-5521219, E-634031
Contractor:	XTERA Drilling	**Ground Elevation:**	98.16 m (local datum)
Method:	DTC 30 Geax with 305 mm diam. auger mounted on ESP 60ZT track piling rig	**Date Drilled:**	September 10, 2021

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

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

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number
98.1		ASPHALT - 25 mm thick		
97.9		SAND AND GRAVEL (FILL) - trace clay, trace silt, brown, dry to moist, compact, poorly graded, fine sand to coarse gravel	◢	G11
97.6	0.5	ORGANIC CLAY - silty, trace sand, trace rootlets - black, moist, firm to stiff, high plasticity	◢	G12
	1.0	CLAY - silty, trace sand, trace gravel (<5 mm diam.), some silt inclusions, trace oxidation - mottled grey and and brown - moist, stiff to very stiff - high plasticity		
	1.5		◢	G13
	2.0		◢	G14
	2.5			
95.1	3.0		◢	G15



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 immediately after drilling.
3. Test Hole backfilled with auger cuttings to surface.
4. Test Hole elevation measured relative to temporary benchmark TBM1 (top of nut of fire hydrant and is assigned local elevation of 100.0 m).

Logged By: Beta Taryana **Reviewed By:** Kent Bannister **Project Engineer:** Brent Hay

Appendix A

Laboratory Testing Results

TREK GEOTECHNICAL Quality Engineering | Valued Relationships

MEMORANDUM

Date	September 16, 2021
To	Beta Taryana, TREK Geotechnical
From	Angela Fidler-Kliewer, TREK Geotechnical
Project No.	0020-039-00
Project	St Vital Park Maintenance Building
Subject	Laboratory Testing Results – Lab Req. R21-426
Distribution	Beta Taryana

Attached are the laboratory testing results for the above noted project. The testing included moisture content determinations and Atterberg limits.

Regards,

Angela Fidler-Kliewer, C.Tech.

Attach.

Review Control:

Prepared By: JN	*Reviewed By:* AFK	*Checked By:* NJF

Lab Requisition

TREK GEOTECHNICAL
1712 St. James Street
Winnipeg, Manitoba R3H 0L3
T 204.975.9433 F 204.975.9435

PROJECT: St. Vital Park Maintenance Building
PROJECT NO: 0020 039 00
CLIENT: Crosier Kilgour
FIELD TECHNICIAN: Beta Taryana

TEST HOLE NUMBER	SAMPLE NUMBER	Sample Start Depth (ft)	Sample End Depth (ft)		MOISTURE	VISUAL CLASS.	ATTERBERG LIMITS	HYDROMETER	GRADATION	STD. PROCTOR	UNCONFINED AND AUXILLARY TESTS				Soil Description/ Comments
TH21-01	G01	0.5	1.0		X										SAND AND GRAVEL (FILL)
TH21-01	G02	1.0	2.0		X										CLAY (ORGANICS)
TH21-01	G03	4.0	5.0		X										CLAY
TH21-01	G04	6.5	7.5		X		X								CLAY
TH21-01	G05	9.0	10.0		X										CLAY
TH21-01	G06	14.0	15.0		X										CLAY
TH21-01	G07	19.0	20.0		X										CLAY
TH21-01	G08	24.0	25.0		X										CLAY
TH21-01	G09	29.0	30.0		X										CLAY
TH21-01	G10	34.0	35.0		X										CLAY
TH21-02	G11	0.5	1.0		X										SAND AND GRAVEL (FILL)
TH21-02	G12	1.0	2.0		X										CLAY (ORGANICS)
TH21-02	G13	4.0	5.0		X										CLAY
TH21-02	G14	6.0	7.0		X										CLAY
TH21-02	G15	9.0	10.0		X										CLAY

REQUESTED BY: Beta Taryana
REPORT TO: Beta Taryana
REQUISTION DATE: 14-Sep-21
DATE REQUIRED: 21-Sep-21
COMMENTS:

REQUISITION NO.
R21-426

SHEET 1 OF 1

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Moisture Content Report
ASTM D2216-10

Project No. 0020-039-00
Client Crosier Kilgour
Project St. Vital Park Maintenance Building

Sample Date 13-Sep-21
Test Date 14-Sep-21
Technician JN

Test Hole	TH21-01	TH21-01	TH21-01	TH21-01	TH21-01	TH21-01
Depth (m)	0.2 - 0.3	0.3 - 0.6	1.2 - 1.5	2.0 - 2.3	2.7 - 3.0	4.3 - 4.6
Sample #	G01	G02	G03	G04	G05	G06
Tare ID	P33	P06	F34	F63	W91	F14
Mass of tare	8.6	8.6	8.6	8.6	8.6	8.2
Mass wet + tare	244.2	222.2	252.5	249.0	243.9	236.2
Mass dry + tare	231.6	153.2	194.2	195.0	178.0	162.0
Mass water	12.6	69.0	58.3	54.0	65.9	74.2
Mass dry soil	223.0	144.6	185.6	186.4	169.4	153.8
Moisture %	5.7%	47.7%	31.4%	29.0%	38.9%	48.2%

Test Hole	TH21-01	TH21-01	TH21-01	TH21-01	TH21-02	TH21-02
Depth (m)	5.8 - 6.1	7.3 - 7.6	8.8 - 9.1	10.4 - 10.7	0.2 - 0.3	0.3 - 0.6
Sample #	G07	G08	G09	G10	G11	G12
Tare ID	N19	E33	Z68	H67	E69	E113
Mass of tare	8.7	8.8	8.5	8.7	8.6	8.6
Mass wet + tare	261.1	320.4	222.8	255.9	239.6	229.8
Mass dry + tare	175.4	221.6	155.8	172.0	229.0	170.6
Mass water	85.7	98.8	67.0	83.9	10.6	59.2
Mass dry soil	166.7	212.8	147.3	163.3	220.4	162.0
Moisture %	51.4%	46.4%	45.5%	51.4%	4.8%	36.5%

Test Hole	TH21-02	TH21-02	TH21-02			
Depth (m)	1.2 - 1.5	1.8 - 2.1	2.7 - 3.0			
Sample #	G13	G14	G15			
Tare ID	F48	E121	N75			
Mass of tare	8.6	8.4	8.7			
Mass wet + tare	280.2	224.2	229.4			
Mass dry + tare	215.6	171.8	176.6			
Mass water	64.6	52.4	52.8			
Mass dry soil	207.0	163.4	167.9			
Moisture %	31.2%	32.1%	31.4%			

www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Atterberg Limits
ASTM D4318-17e1

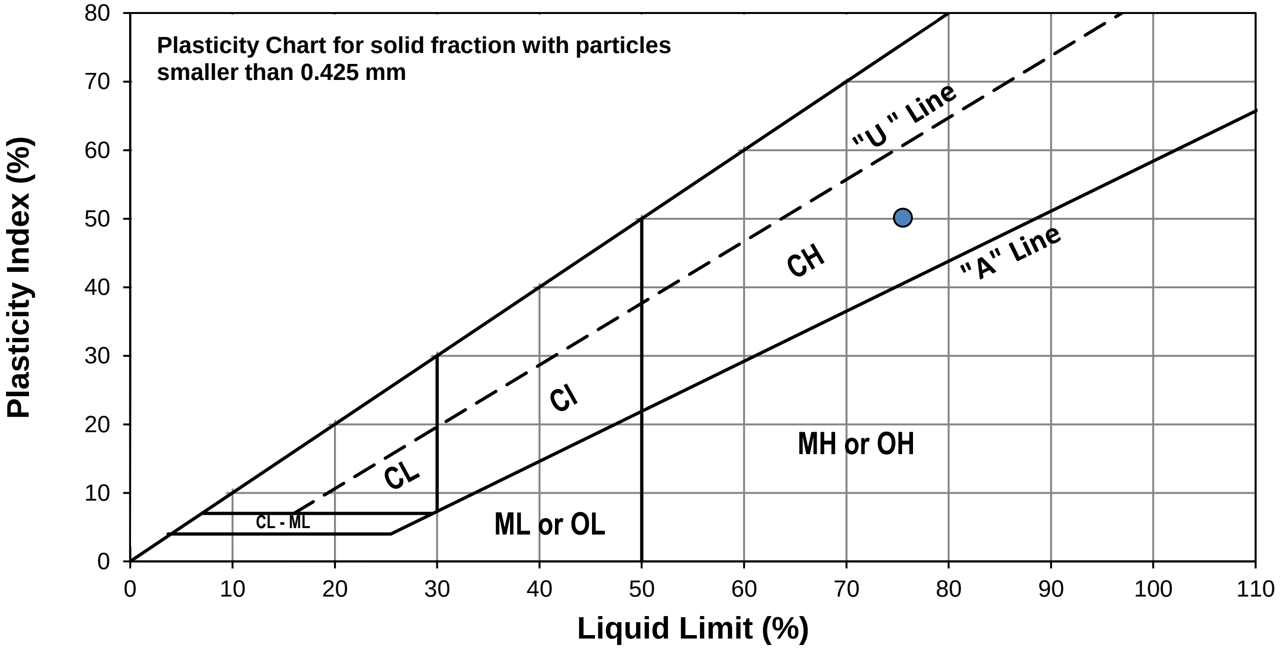
CERTIFIED BY CCIL Canadian Council of Independent Laboratories For specific tests as listed on www.ccil.com

Project No.	0020-039-00
Client	Crosier Kilgour
Project	St. Vital Park Maintenance Building
Source	TH21-01
Sample #	G04
Soil Desc.	Clay
Sample Date	13-Sep-21
Test Date	15-Sep-21
Technician	HL

Liquid Limit	76
Plastic Limit	25
Plasticity Index	50

Liquid Limit

Trial #	**1**	**2**	**3**		
Number of Blows (N)	32	22	18		
Mass Tare (g)	14.086	14.096	14.068		
Mass Wet Soil + Tare (g)	22.703	24.107	23.891		
Mass Dry Soil + Tare (g)	19.012	19.789	19.638		
Mass Water (g)	3.691	4.318	4.253		
Mass Dry Soil (g)	4.926	5.693	5.570		
Moisture Content (%)	74.929	75.848	76.355		



Plastic Limit

Trial #	**1**	**2**	**3**	**4**	**5**
Mass Tare (g)	13.713	14.000			
Mass Wet Soil + Tare (g)	21.226	22.508			
Mass Dry Soil + Tare (g)	19.697	20.793			
Mass Water (g)	1.529	1.715			
Mass Dry Soil (g)	5.984	6.793			
Moisture Content (%)	25.551	25.247			