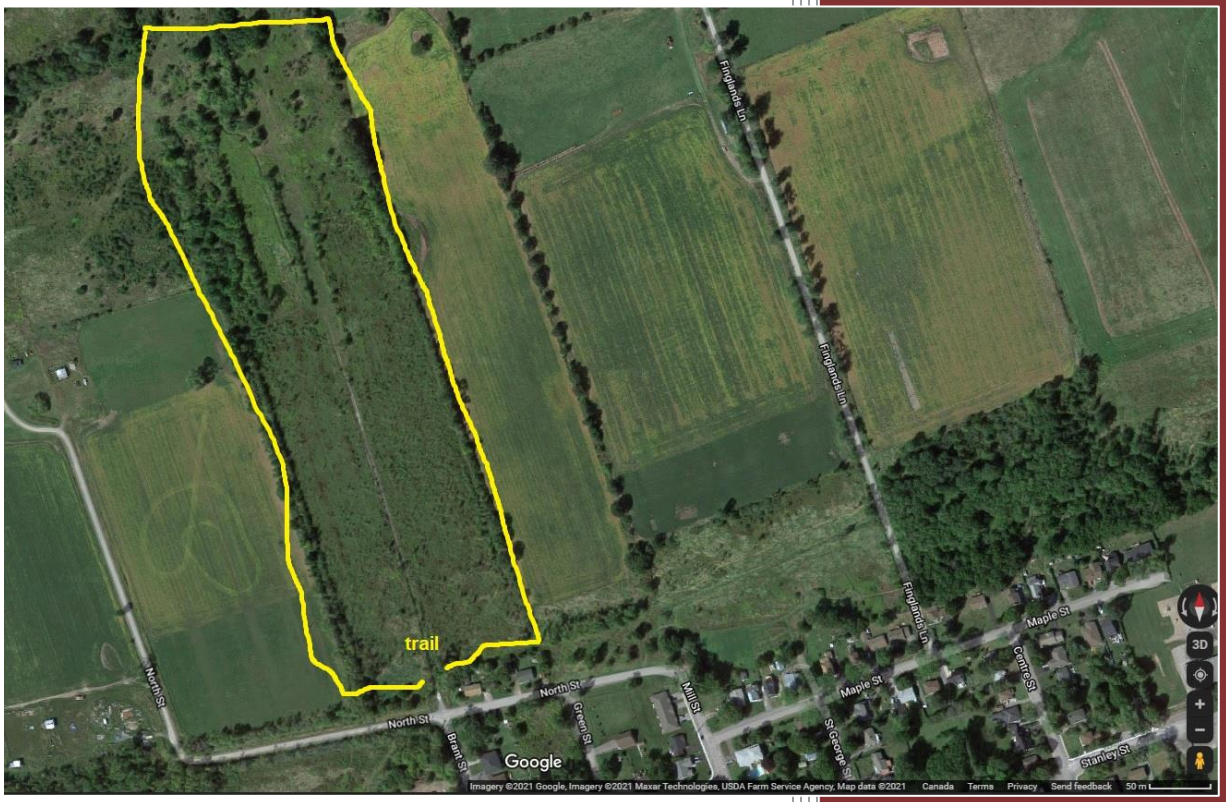
Project No. 21-3-5511

MBQ Housing

Geotechnical Report



Terraspec Engineering Inc.
Geotechnical Engineers
973 Crawford Drive
Peterborough, Ontario
K9J 3X1

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APPENDICES

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geotechnical engineers and materials testing

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December 10, 2021

Greer Galloway Inc.
1620 Wallbridge Loyalist Road
Belleville, Ontario
K8N 4Z5

Re: Geotechnical Report for North Street Trail
Project No. 21-3-5511

General Site Data
The project site is located on North Street in the Tyendinaga Mohawk Territory.
The project site is currently undeveloped. Construction of new residential buildings have been proposed for the site. A site plan indicating the extent of the property has been appended to this report.

Investigation
A soils investigation was conducted for the property in September 2021. Exploratory test holes were placed on site using an excavator. Soil laboratory testing consisted of moisture content determination and grain size analysis. The test hole logs and laboratory testing data have been appended to this report. The test hole locations have been indicated on the appended site plan.

Soil Conditions
The site is located within a physiographic region identified as clay plains and limestone plains. The bedrock in this area is identified as limestone of the Trenton Group. The project location typically contains relatively shallow depths of silty sand till and clay till, overlying the bedrock.

North Street
The property is located at the Brant Street intersection on North Street and proceeds north along the trail. The property extends up to 50m east and west of the trail.

Bedrock was inferred based on auger refusal. At the south end of the site, bedrock was typically at 4 to 4.7m, with an Artesian groundwater condition near to the bedrock surface.

The typical soil layers encountered were as follows:
To 250mm, organic topsoil,

To 3m, silty clay sand trace gravel, clay with silt, sandy silty clay trace gravel,
To 4.5m, silty sand some clay with gravel, and
limestone bedrock between 4 to 4.7m.

Groundwater was encountered at depths of 3.66m to 4.27m below ground surface at the south end of the site.

The underlying clayey subsoils were typically in a moist and very stiff condition.
The susceptibility to frost action for these subsoils was rated as low.

Bedrock was closer to ground surface at 100m north of North Street, and the bedrock rose closer to surface proceeding north on the property.

The typical soil layers encountered were as follows:
Clayey topsoil,
Silty clay sand trace gravel,
Bedrock ranged from 3.3 to 1.2m in the north end of the site.

Groundwater was encountered at 2.95m in borehole 1.
The underlying silty clay sand subsoils were typically in a moist and very stiff condition.
The susceptibility to frost action for these subsoils was rated as low.

Permeability
The percolation rates of the subsoils have been estimated as follows:

North Street Trail, soils are SC-SM T=40 min/cm

OHSA Soil Types
The subsoils present on site can be classified as Type 3 soils. The Type 3 soils will typically behave as Type 4 collapsing soils when water seepage is present in the soils, or where the groundwater elevation is contacted. The subsoils should be treated as Type 4 soils for any construction work that will take place under these conditions.

Recommendations

Foundations
Shallow footings may be placed at the south end of the site. It is suggested that the new buildings should not utilize basements so that excavations will not penetrate the groundwater interface. Similarly, shallow footings may be placed at all other locations (centre of and north end of site) where the artesian condition is not present.

Recommendations for placement of shallow foundations for the new building are as follows. Footings must be placed such that they will be a minimum 1.45m below the finished ground elevation, for frost protection. It is suggested that spread or strip footings may be placed onto

the undisturbed subsoils. The following natural soil bearing capacities will typically be available at the base of the new footings:

Silty clay sand subsoils, silty clay subsoils, typically starting at 1.5m below existing ground surface:
Factored ULS bearing capacity: 225 kPa
SLS allowable bearing capacity: 150 kPa

These capacities are based on standard settlement values of 25mm maximum total settlement, and 19mm maximum differential settlement.

Encountered soft areas can be removed by over-excavation where necessary, then back-filled with a 3inch minus crushed rock material. A 0.7MPa unshrinkable concrete fill (typically referred to as U-fill), may also be utilized as fill beneath new structures.

Bedrock Foundations
For the north end of the site (beyond 100m north of Brant Street), spread or strip footings may be placed onto the underlying sound bedrock surface. Specify in the contract that any weathered or loose bedrock surfaces must be removed to expose the underlying sound bedrock.

The following bearing capacities may be used for the sound bedrock:

Factored ULS bearing capacity: 706 kPa
SLS allowable bearing capacity: 600 kPa

Total and differential settlement is expected to be negligible where footings are placed onto the sound bedrock.

Bedrock Removal
It is anticipated that the top 1m of bedrock can be broken with heavy duty hoe ram equipment.

If deeper removals are required, it may be possible to conduct rock coring on a 450mm by 450mm grid throughout the bedrock surface, to weaken the bedrock sufficiently such that it can be broken by hoe ram equipment (with no blasting). This process would be repeated as necessary until the desired bedrock excavation depth is reached.

Subgrade Inspection
Once exposed during construction, it would be advisable to have all intended bearing surfaces examined by a geotechnical firm in order to ensure that the intended bearing surface area is consistent with the conditions encountered at the test hole locations, and that the bearing capacity will be sufficient for the proposed new buildings and structures.

Reinforcing Steel
Placement of longitudinal reinforcing steel within the footings is generally desirable for this site.

Dewatering – Low Volume
Shallow excavations within the subsoils are not expected to require extensive dewatering. A continuous pumping operation with sump equipment is anticipated to be sufficient for the placement of footings onto the undisturbed native subsoil.

Based on the site investigation data, construction dewatering for new perimeter footings are not expected to exceed 50,000 L/day. If it is anticipated that a dewatering operation beyond this daily limit is required, then dewatering under the Environmental Activity and Sector Registry (EASR) should be obtained, which applies for takings of groundwater and stormwater for construction dewatering purposes that total less than 400,000 L/day.

Dewatering – High Volume
There was an artesian condition at the south end of the property. The pressure from the water flowing near to the bedrock interface caused water to enter the boreholes and rise towards the ground surface.

Excavations that will penetrate the groundwater interface close to the bedrock are expected to require extensive dewatering, using a continuous pumping operation with sump equipment. Additional measures will likely be required such as:

Well point placement and pumping on all sides of the building footprint to alleviate the groundwater pressure.

Use of Benseal (sodium bentonite) along the trench excavations to control water seepage from the walls of the excavation.

As a minimum requirement a permit should be obtained for construction dewatering works under the Ministry of the Environment, Conservation and Parks (MECP) Environmental Activity and Sector Registry (EASR), which applies for taking of groundwater and stormwater for construction dewatering purposes that total less than 400,000 L/day. This approach would accommodate groundwater inflows from lenses or till layers which can be encountered in this area. An EASR will also provide the contractor with greater flexibility in managing groundwater seepage and stormwater flows since it replaces the need for an ECA for discharge under most circumstances.

Dewatering – General Requirements
Care should be taken to prevent ponding or inundation due to rain, and to control excess run-off that could cause erosion. The construction contract should stipulate that the integrity of all natural soil surfaces and soil bearing surfaces must be preserved at all times. Therefore, all excavations on site must be protected from high moisture levels due to rainfall or accumulating groundwater, using appropriate dewatering techniques.

Seismic Parameters
The following seismic design parameters may be utilized:

Foundation on natural subsoils:
Site Class C Soil Shear Wave Average Velocity (m/s) = 360 < Vs < 760

Foundation on bedrock:
Site Class B Soil Shear Wave Average Velocity (m/s) = 760 < Vs < 1500

The peak ground acceleration value for Tyendinaga, as given by the OBC, is 0.140.

Geotechnical Parameters
For calculating vertical and lateral earth pressures and other geotechnical parameters, the following unfactored coefficients may be utilized:

<u>Existing sandy silty clay subsoil</u>
internal friction angle = 31°
Ka = 0.32, Ko = 0.48, Kp = 3.12
Moist unit weight = 18.0 kN/m3
Coefficient of friction for the concrete/subsoil interface = 0.40

<u>Existing silty clay sand subsoil</u>
internal friction angle = 32°
Ka = 0.31, Ko = 0.47, Kp = 3.25
Moist unit weight = 19.5 kN/m3
Coefficient of friction for the concrete/subsoil interface = 0.40

Coefficient of friction for the concrete/bedrock interface.

Interface	Tan(delta)
concrete / bedrock	0.70

<u>typical imported sandy Granular B Type 1 backfill</u>
internal friction angle = 32°
Ka = 0.31, Ko = 0.47, Kp = 3.25
Moist unit weight = 22.3 kN/m3

<u>typical imported gravelly Granular B Type 1 backfill</u>
internal friction angle = 35°
Ka = 0.27, Ko = 0.43, Kp = 3.69
Moist unit weight = 23.0 kN/m3

Subdrains
Subdrain installations should consist of a perforated geotextile-wrapped pipe, placed at the footing depth along the outside perimeter of the footings. The subdrain pipe should have a

minimum diameter of 150mm and must be graded to a positive outlet away from the foundation. Backfill to the subdrain trenches should consist of OPSS 1004 Clear Stone. The type of back fill placed against the building over the subdrains should be a free-draining Granular B Type 1 material, placed full-depth to prevent the build-up of water pressure against the exterior walls of the building. Careful finished grading of the site should be applied to prevent the influx of storm water and surface runoff towards the foundation walls of the building.
Subdrains are required for below-grade building levels such as basements. It is anticipated that basement levels will not be utilized for this project.

Floor Slabs on Grade
The following minimum requirements are recommended for standard slab-on-grade floors:

Concrete Slab	127mm
OPSS 1010 Granular A or Clear Stone	150mm
OPSS 1010 Granular B Type 1 subbase	200mm
Over compact native subgrade soil	

The subgrade soil surface to remain should undergo proof-rolling to ensure that it is acceptable for placement of the base and subbase materials. Remove all deleterious soil such as topsoil and organics, from beneath the new floor area. It is recommended that a concrete compressive strength of 20 to 25MPa be utilized for interior floor slabs.

Concrete
The frost penetration treatment depth for this site is 1.5m. Use CSA concrete classes C1 or C2, and F1 or F2, as appropriate to the various structure elements in the building.
General Use (Type 10) concrete cement will be suitable for this project.

Pipe Installation
For new underground piping, utilize the following OPSD Standards for pipe installation:

For soil subgrade:

OPSD 802.010	Flexible Pipe	-	Type 3 Earth Excavation
OPSD 802.031	Rigid Pipe	-	Type 3 Earth Excavation, Class B

For bedrock subgrade:

OPSD 802.013	Flexible Pipe	-	Rock Excavation
OPSD 802.033	Rigid Pipe	-	Rock Excavation, Class B

Allow for bedrock excavation for this project. The bedrock rises closer to surface at approximately 100m north of North Street.

Utilize the granular bedding and cover depths as specified in the applicable OPSD standards listed above. For normal subgrade conditions, OPSS Granular A may be utilized for pipe embedment and pipe cover material for new piping.

For wet subgrade conditions, a crushed rock or gravel should be utilized for pipe embedment and pipe cover material for new piping. A suitable material would be OPSS 1010 Granular B Type 2 with 100% passing the 50mm sieve, or clear stone such as OPSS 1004 19mm Clear Stone.

Frost protection for underground piping should be utilized as per the following OPSD standards, with a frost treatment depth of k = 1.5m:

OPSD 803.030	Frost Penetration Line Below Bedding Grade
OPSD 803.031	Frost Penetration Line Above Bedding Grade

Reuse of Subsoils

The natural subsoils found on site cannot be used as fill beneath structures. Any fill required beneath new structures must consist of an engineered granular fill. The minimum requirement for an engineered fill is OPSS 1010 Granular B Type 1, however, there are other options available, such as 3inch minus rock fill.

The silty clay sand subsoils on site are acceptable as general subgrade fill for the roadway and parking lot areas. Any existing topsoil materials must be stripped from the site prior to placing new fill material.

Pavement Design

For the new roadways, remove all organic soil from the subgrade surface. Provide earth grading and cross fall as per OPSD 200.01 to prevent ponding of water on the soil subgrade, and to provide effective drainage of the new pavement structure.

Apply proof-rolling to the subgrade soil to ensure that it is acceptable for placement of the new granular subbase and base materials.

The following minimum pavement design as per OPSS 1150 specifications is recommended for placement of new pavement:

Pavement Structure

40mm	HL3 surface course
50mm	HL8 binder course
150mm	OPSS 1010 Granular A base
350mm	OPSS 1010 Granular B Type 1 subbase

Over compact natural subgrade soil or approved fill

If desired, light duty parking areas may have a reduced hot mix depth consisting of a single lift of 50mm HL3 surface course.

Asphalt Walkways

50mm	HL3 surface course
150mm	OPSS 1010 Granular A base
150mm	OPSS 1010 Granular B Type 1 subbase

Over compact natural subgrade soil or approved fill

It will also be acceptable to substitute SuperPave hot mix as per OPSS 1151, such as SP12.5 over SP19.0.

The asphalt cement should have a minimum rating of PGAC 58 -28.
Tack-coat the hot mix substrate, as per OPSS.PROV 308, prior to placing the surface course lift of hot mix. Stipulate in the contract that all hot mix paving operations shall be carried out in accordance with OPSS 310 specifications.

Compaction Requirements

All natural soil and all granular fill compaction requirements for the project should conform with OPSS 501, Subsection 501.08.02 - Method A, utilizing soil placement in maximum 300mm lifts and a compaction standard of 100% of Standard Proctor Maximum Dry Density.

Statement of Limitations

This report is intended for the guidance of the project design team. From a construction standpoint, contractors must make their own assessment of the soil and groundwater conditions and how these will affect their proposed construction techniques and schedules.

The recommendations in this report are based on information determined at the test hole locations. Soils and groundwater conditions between and beyond the test holes may differ from those encountered at the test hole locations and conditions may become apparent during construction that could not be detected or anticipated at the time of the soils investigation.
If this occurs, we recommend that Terraspec be retained for further consultation, testing, and analysis.

We also recommend that Terraspec be retained to ensure that all subgrade preparation requirements are met, and to confirm that the soil conditions do not deviate materially from those encountered in test holes. In the case that unforseen conditions arise, or our recommendations are not followed, the company's responsibility is limited to interpreting the information from the test hole data collected for this report.

This report is applicable only to this specific project, constructed substantially in accordance with details of alignment and elevations quoted in the text. Where rock excavation is proposed, a contingency cost item should be included in the contract to allow for any unforeseen subgrade conditions. Elevations quoted in the document are approximate. Original ground elevations for project design purposes should be obtained from an experienced topographical survey consultant.

~ ~ ~

TERRASPEC ENGINEERING INC.
GEOTECHNICAL ENGINEERS

Shane Galloway, B.A.
Manager

N.A. MacKinnon, P.Eng.
Senior Engineer

Notes

1. Soil types, strata, and groundwater conditions have been established only at test hole locations.
2. Soils are described according to the MTO Soils Classification System and OPSD 100.06.
3. Dimensions are in millimetres up to 1 metre, then in metres thereafter.

Abbreviations

asph	-	asphalt	&	-	and
blds	-	boulders	w	-	with
blk	-	black	so	-	some
br	-	brown	tr	-	trace
BR	-	bedrock			
cl	-	clay(ey)	S	-	soil sample
cob	-	cobbles	Su	-	vane shear strength (kPa)
conc	-	concrete	N	-	blow counts per 0.3m
cr	-	crushed			
f	-	fine			
gr	-	gravel(ly)			
gry	-	grey			
med	-	medium			
NFP	-	no further progress			
org	-	organics			
RF	-	rock fill			
sa	-	sand(y)			
si	-	silt(y)			
tps	-	topsoil			

September 3, 2021
North Street Trail

1 o/s 25m E

0	-	110	br cl tps	
110	-	1.70	br si cl sa -dry, very stiff	
1.70	-	3.30	gry si cl sa tr gr -moist, very stiff	S1 at 2.44m

-blds at 2.13 to 2.75m

3.3 NFP, flat ls bedrock, sound

-water seepage at 2.95m

-water not rising

-piezometer pipe installed

at 1.5m Kubota = yes

2 o/s 25m W

0	-	110	br cl tps	
110	-	1.68	br si cl sa tr gr -dry, very stiff	S2 at 1.5m

-so cob at 1.6m

1.68 NFP, flat ls bedrock, sound

- no water

at 1.5m Su=200 kPa

at 1.5m Kubota = yes

3 o/s 25m E

0	-	100	br cl tps	
100	-	1.68	br si cl sa tr gr -dry, very stiff	
1.68	-	2.29	gry si cl sa tr gr -moist, very stiff	S3 at 1.8m

-bld at 1.7m

-bld at 2.1m

2.29 NFP, flat ls bedrock, sound

- no water

4 o/s 16m E

0	-	120	br cl tps	
120	-	1.22	br si cl sa tr gr -dry, very stiff	S4 at 1.1m

1.22 NFP, flat ls bedrock, sound

- no water

North Street Trail
Laboratory Test Data

Soil Sample	**S1**	**S2**	**S3**	**S4**	
Sieve	**% Passing**				
13.2mm	100	100	100	100	grain size
9.50mm	96.0	98.9	98.6	100	
4.75mm	93.0	96.3	96.7	98.2	
2.36mm	85.0	91.7	92.1	94.7	
1.18mm	79.1	86.8	85.8	82.0	
600um	73.9	80.7	79.9	65.4	
300um	64.7	67.8	59.3	48.2	
150um	51.6	43.3	43.2	29.4	
75um	47.3	24.8	23.1	16.5	
ASTM	SC-SM	SC-SM	SC-SM	SC-SM	soil classification
frost rating	Low	Low	Low	Low	susceptibility to frost heave
W	10.0	14.9	10.3	16.4	field moisture content

North Street, South End of Property with Artesian Condition
February 2021

<u>S1</u> W limit, 15m E of trail, 35N of culvert
0 - 400 blk org tps
400 - 3.66 br sa si cl tr gr -moist, very stiff S1 at 3.5m
-cob at 3.35m
-cob at 3.55m
3.66 - 3.99 gry si cl sa tr gr -wet, stiff
3.99 NFP, flat limestone BR
-water at 3.66m

<u>S2</u> E limit, 9m W of trail, 37N of culvert
0 - 200 blk org tps
200 - 3.05 br si cl sa tr gr -moist, very stiff
-cob at 1.68m
at 2.13m N=24
3.05 - 3.96 gry/br si cl sa tr gr -moist, very stiff to hard
3.96 NFP, flat limestone BR
-water at 3.66m, rose to 2.44m

<u>S3</u> 14m E of 4, 39N of culvert
0 - 250 blk org tps
250 - 2.90 br si cl sa tr gr -moist, very stiff
at 1.83m N=18
at 2.13m N=24
2.90 - 4.39 br si sa so cl w gr -moist to wet, very stiff S2 at 3m
at 3.0m N=20
4.39 NFP, flat limestone BR
-water at 4.27m, rose to 1.7m

<u>S4</u> 14m E of 1, 38N of culvert
0 - 230 blk org tps
230 - 3.07 br cl w si -moist, very stiff to hard S3 at 2.1m
at 1.83m N=24 Su=200
3.07 - 4.72 gry si sa so cl w gr -moist to wet, compact S4 at 3.35m
-blds at 3.66 to 4m
4.72 NFP, flat limestone BR
-water at 4.27m, rose to 3.96m

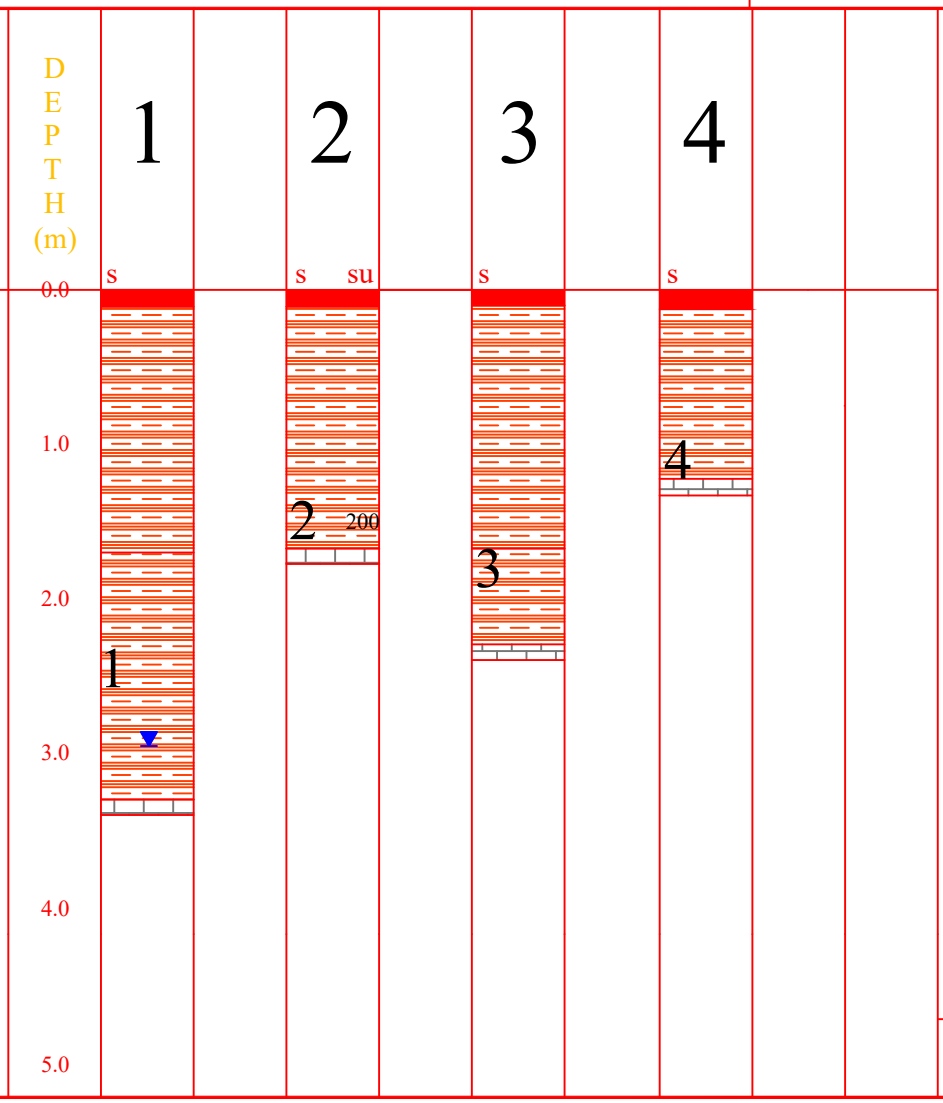
North Street Laboratory Test Data

Soil Sample	**S1**	**S2**	**S3**	**S4**	
Sieve	**% Passing**				
26.5mm	100	100	100	100	grain size
19.0mm	100	100	100	100	
13.2mm	100	92.4	100	94.5	
9.50mm	100	86.8	100	91.9	
4.75mm	98.2	81.4	100	87.0	
2.00mm	95.1	76.7	100	80.7	
850um	89.9	71.8	99.8	72.9	
425um	83.8	66.8	99.5	67.8	
250um	76.4	60.5	98.9	61.9	
106um	61.4	48.3	97.3	49.6	
75um	57.1	44.8	96.5	46.1	
ASTM	CL	SC-SM	CL	SC-SM	soil classification
frost rating	Low	Low	Low	Low	susceptibility to frost heave
W	15.0	21.5	22.5	16.4	field moisture content

TEST HOLE LOG DATA

PROJECT No.: 21-3-5511
CLIENT: MBQ
PROJECT: North Street Trail
DATE: September 3, 2021

SOIL DATA
METHOD: 130mm solid stem
s = soil sample
su = field shear strength (kPa)
▼ encountered water elevation



LEGEND

- clayey topsoil
- silty sand
- silty sand with gravel
- silty sand with gravel till
- fine sand with silt and gravel
- sandy silty clay with gravel
- sandy silty clay with gravel till
- silty clay sand trace gravel
- bedrock

Terraspec

BOREHOLE S1

PROJECT No.: 20-3-2698
CLIENT: MBQ
PROJECT: North Street
DATE: February 17, 2021

METHOD: 130mm Solid Stem Auger / Excavation
S = soil sample
N = blows per 0.3m
R = resistance to settlement (kPa)
▼ encountered water elevation

	DEPTH (m)		Description	S	N	
			S1 W limit			
	0.0		0 - 400 blk org tps			
	0.5		400 - 3.66 br si cl sa tr gr -moist, very stiff			
	1.0					
	1.5					
	2.0					
	2.5					
	3.0		-cob at 3.35m			
▼	3.5		-cob at 3.55m 3.66 - 3.99 gry si cl sa tr gr -wet, stiff	1		
	4.0		3.99 NFP, flat limestone BR			
	4.5					
	5.0					
	5.5					

LEGEND

- organic topsoil
- silty clay sand trace gravel
- clay with silt
- sandy silty clay trace gravel
- silty sand some clay with gravel
- bedrock inferred

Terraspec

BOREHOLE S2

PROJECT No.: 20-3-2698
CLIENT: MBQ
PROJECT: North Street
DATE: February 17, 2021

METHOD: 130mm Solid Stem Auger / Excavation
S = soil sample
N = blows per 0.3m
R = resistance to settlement (kPa)
▼ encountered water elevation

DEPTH (m)	Description	S	N
	S2 E limit		
0.0	0 - 200 blk org tps		
	200 - 3.05 br si cl sa tr gr -moist, very stiff		
0.5			
1.0			
1.5			
	-cob at 1.68m		
2.0			24
2.5			
3.0	3.05 - 3.96 gry/br si cl sa tr gr -moist, very stiff to hard		
3.5			
4.0	3.96 NFP, flat limestone BR		
4.5			
5.0			
5.5			

LEGEND

- organic topsoil
- silty clay sand trace gravel
- clay with silt
- sandy silty clay trace gravel
- silty sand some clay with gravel
- bedrock inferred

Terraspec

BOREHOLE S3

PROJECT No.: 20-3-2698
CLIENT: MBQ
PROJECT: North Street
DATE: February 17, 2021

METHOD: 130mm Solid Stem Auger / Excavation
S = soil sample
N = blows per 0.3m
R = resistance to settlement (kPa)
▼ encountered water elevation

DEPTH (m)	S3	Description	S	N
0.0	0 - 250	blk org tps		
0.5	250 - 2.90	br si cl sa tr gr -moist, very stiff		
1.0				
1.5				
2.0				18
2.5				24
3.0	2.90 - 4.39	br si sa so cl w gr -moist to wet, very stiff	2	20
3.5				
4.0				
4.5	4.39	NFP, flat limestone BR		
5.0				
5.5				

LEGEND

- organic topsoil
- silty clay sand trace gravel
- clay with silt
- sandy silty clay trace gravel
- silty sand some clay with gravel
- bedrock inferred

Terraspec

BOREHOLE S4

PROJECT No.: 20-3-2698
CLIENT: MBQ
PROJECT: North Street
DATE: February 17, 2021

METHOD: 130mm Solid Stem Auger / Excavation
S = soil sample
N = blows per 0.3m
R = resistance to settlement (kPa)
▼ encountered water elevation

DEPTH (m)	Description	S	N
	S4		
0.0	0 - 230 blk org tps		
0.5	230 - 3.07 br cl w si -moist, very stiff to hard		
1.0			
1.5			
2.0		3	24
2.5			
3.0	3.07 - 4.72 gry si sa so cl w gr -moist to wet, compact	4	
3.5	-blds at 3.66 to 4m		
4.0			
4.5			
5.0	4.72 NFP, flat limestone BR		
5.5			

LEGEND

- organic topsoil
- silty clay sand trace gravel
- clay with silt
- sandy silty clay trace gravel
- silty sand some clay with gravel
- bedrock inferred

Terraspec

North Street Trail

North Street Trail

North Street Trail

North Street

Project No. 20-3-2698

MBQ Triplexes

Geotechnical Report

Terraspec Engineering Inc.
Geotechnical Engineers
973 Crawford Drive
Peterborough, Ontario
K9J 3X1

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terraspec engineering inc.
geotechnical engineers and materials testing

973 Crawford Drive
Peterborough, Ontario **Phone: (705) 743-7880**
K9J 3X1 **Fax: (705) 743-9592**

March 10, 2021

The Greer Galloway Group Inc.
1620 Wallbridge Loyalist Road
Belleville, Ontario
K8N 4Z5

Re: Geotechnical Report for North Street Triplex Project
Project No. 20-3-2698

General Site Data
The project site is located on North Street in the Tyendinaga Mohawk Territory. Construction of a new residential building has been proposed for the site. A site plan indicating the extent of the property has been appended to this report.

Investigation
A soils investigation was conducted for the property on February 17, 2021. Four exploratory test holes were placed on site using a track-mounted drill rig. Soil laboratory testing consisted of moisture content determination and grain size analysis. The test hole logs and laboratory testing data have been appended to this report. The test hole locations have been indicated on the appended site plan.

Soil Conditions
The site is located within a physiographic region identified as clay plains and limestone plains. The bedrock in this area is identified as limestone of the Trenton Group. The project location typically contains relatively deep depths of clayey subsoils, overlying the bedrock.
The typical soil layers encountered on site were as follows:

topsoil
clay with silt
sandy silty clay trace gravel
silty clay sand trace gravel
limestone bedrock

The original project site is currently undeveloped.

The underlying clayey subsoils were typically in a moist and very stiff condition.
The susceptibility to frost action for the subsoils with a clay content was rated as low.

Bedrock was inferred based on auger refusal.
Bedrock was generally 4 to 4.5m below surface at the North Street site.
The bedrock consisted of flat limestone.

Groundwater was typically encountered at depths of 3.66 to 5m at the North Street site.
There was an artesian condition in Boreholes 1 to 4, where groundwater from the soil layer near to the bedrock surface rose from its original location, upwards towards the existing ground surface.

Permeability
The percolation rates of the subsoils have been estimated as follows:

North Street
Soils are SC-SM to CL T=50 min/cm

OHSA Soil Types
The subsoils present on site can be classified as Type 3 soils. The Type 3 soils will typically behave as Type 4 collapsing soils when water seepage is present in the soils, or where the groundwater elevation is contacted. The subsoils should be treated as Type 4 soils for any construction work that will take place under these conditions.

Recommendations

Foundations
Recommendations for placement of shallow foundations for the new building are as follows. Footings must be placed such that they will be a minimum 1.5m below the finished ground elevation, for frost protection. It is suggested that spread or strip footings may be placed onto the undisturbed subsoils, beginning at a typical depth of 1.2m below existing ground surface. The following natural soil bearing capacities will typically be available at the base of the new footings:

Clay with silt, sandy silty clay trace gravel, silty clay sand trace gravel subsoils:
Factored ULS bearing capacity: 216 kPa
SLS allowable bearing capacity: 144 kPa

These capacities are based on standard settlement values of 25mm maximum total settlement, and 19mm maximum differential settlement.

Encountered soft areas can be removed by over-excavation where necessary, then back-filled with a 3inch minus crushed rock material. A 0.7MPa unshrinkable concrete fill (typically referred to as U-fill), may also be utilized as fill beneath new structures.

Bedrock Foundations
Spread or strip footings may also be placed onto the underlying sound bedrock surface. Specify in the contract that any weathered or loose bedrock surfaces must be removed to expose the underlying sound bedrock. Note that weathered bedrock exists on the ground surface at the Upper Slash Road property.

The following bearing capacities may be used for the sound bedrock:

Factored ULS bearing capacity:	882 kPa
SLS allowable bearing capacity:	750 kPa

Total and differential settlement is expected to be negligible where footings are placed onto the sound bedrock.

Subgrade Inspection
Once exposed during construction, it would be advisable to have all intended bearing surfaces examined by a geotechnical firm in order to ensure that the intended bearing surface area is consistent with the conditions encountered at the test hole locations, and that the bearing capacity will be sufficient for the proposed new buildings and structures.

Reinforcing Steel
Placement of longitudinal reinforcing steel within the footings is generally desirable for this site.

Dewatering – North Street
There was an artesian condition at Boreholes 1 to 4. The pressure from the water flowing near to the bedrock interface caused water to enter the boreholes and rise towards the ground surface.

Excavations within the subsoils can be expected to require extensive dewatering. A continuous pumping operation with sump equipment is anticipated to be required for placement of the new sewer main, and additional measures are anticipated to be required at Boreholes 1 to 4, such as:

- Well point placement and pumping on either side of the road to alleviate the groundwater pressure.
- Use of Benseal (sodium bentonite) along the trench excavations to control water seepage from the walls of the excavation.

As a minimum requirement a permit should be obtained for construction dewatering works under the Ministry of the Environment, Conservation and Parks (MECP) Environmental Activity and Sector Registry (EASR), which applies for taking of groundwater and stormwater for construction dewatering purposes that total less than 400,000 L/day. This approach would accommodate groundwater inflows from lenses or till layers which can be encountered in this area. An EASR will also provide the contractor with greater flexibility in managing groundwater seepage and stormwater flows since it replaces the need for an ECA for discharge under most circumstances.

Dewatering – General Requirements
Care should be taken to prevent ponding or inundation due to rain, and to control excess run-off that could cause erosion. The construction contract should stipulate that the integrity of all natural soil surfaces and soil bearing surfaces must be preserved at all times. Therefore, all excavations on site must be protected from high moisture levels due to rainfall or accumulating groundwater, using appropriate dewatering techniques.

Seismic Parameters
The following seismic design parameters may be utilized:

Foundation on natural subsoils:
Site Class C Soil Shear Wave Average Velocity (m/s) = 360 < Vs < 760

Foundation on bedrock:
Site Class B Soil Shear Wave Average Velocity (m/s) = 760 < Vs < 1500

The peak ground acceleration value for Tyendinaga, as given by the OBC, is 0.140.

Geotechnical Parameters
For calculating vertical and lateral earth pressures and other geotechnical parameters, the following unfactored coefficients may be utilized:

<u>Existing silty clay sand trace gravel</u>
internal friction angle = 31°
Ka = 0.32, Ko = 0.48, Kp = 3.12
Moist unit weight = 19.6 kN/m3
Coefficient of friction for the concrete/subsoil interface = 0.40

Coefficient of friction for the concrete/bedrock interface.

Interface	Tan(delta)
concrete / bedrock	0.70

<u>typical imported sandy Granular B Type 1 backfill</u>
internal friction angle = 32°
Ka = 0.31, Ko = 0.47, Kp = 3.25
Moist unit weight = 22.3 kN/m3

<u>typical imported gravelly Granular B Type 1 backfill</u>
internal friction angle = 35°
Ka = 0.27, Ko = 0.43, Kp = 3.69
Moist unit weight = 23.0 kN/m3

Subdrains
Subdrain installations should consist of a perforated geotextile-wrapped pipe, placed at the footing depth along the outside perimeter of the footings. The subdrain pipe should have a minimum diameter of 150mm and must be graded to a positive outlet away from the foundation. Backfill to the subdrain trenches should consist of OPSS 1004 Clear Stone. The type of back fill placed against the building over the subdrains should be a free-draining Granular B Type 1 material, placed full-depth to prevent the build-up of water pressure against the exterior walls of the building. Careful finished grading of the site should be applied to prevent the influx of storm water and surface runoff towards the foundation walls of the building.
Subdrains are required for below-grade building levels such as basements. It is anticipated that basement levels will not be required for this project.

Floor Slabs on Grade
The following minimum requirements are recommended for standard slab-on-grade floors:

Concrete Slab	127mm
OPSS 1010 Granular A base	150mm
OPSS 1010 Granular B Type 1 subbase	200mm
Over compact native subgrade soil	

The subgrade soil surface to remain should undergo proof-rolling to ensure that it is acceptable for placement of the base and subbase materials. Remove all deleterious soil such as topsoil and organics, from beneath the new floor area. It is recommended that a concrete compressive strength of 20 to 25MPa be utilized for interior floor slabs.

Concrete
The frost penetration treatment depth for this site is 1.5m. Use CSA concrete classes C1 or C2, and F1 or F2, as appropriate to the various structure elements in the building.
Standard Type 10 concrete cement will be suitable for this project.

Pipe Installation
For new underground piping, utilize the following OPSD Standards for pipe installation:

For soil subgrade:

OPSD 802.010	Flexible Pipe	-	Type 3 Earth Excavation
OPSD 802.031	Rigid Pipe	-	Type 3 Earth Excavation, Class B

For bedrock subgrade:

OPSD 802.013	Flexible Pipe	-	Rock Excavation
OPSD 802.033	Rigid Pipe	-	Rock Excavation, Class B

Allow for bedrock excavation in the Contract where site excavation beyond 2.75m below existing ground is required.

Utilize the granular bedding and cover depths as specified in the applicable OPSD standards listed above. For normal subgrade conditions, OPSS Granular A may be utilized for pipe embedment and pipe cover material for new piping.

For wet subgrade conditions, a crushed rock or gravel should be utilized for pipe embedment and pipe cover material for new piping. A suitable material would be OPSS 1010 Granular B Type 2 with 100% passing the 50mm sieve, or clear stone such as OPSS 1004 19mm Clear Stone.

Frost protection for underground piping should be utilized as per the following OPSD standards, with a frost treatment depth of k = 1.5m:

OPSD 803.030	Frost Penetration Line Below Bedding Grade
OPSD 803.031	Frost Penetration Line Above Bedding Grade

Reuse of Subsoils

The natural subsoils found on site cannot be used as fill beneath structures. Any fill required beneath new structures must consist of an engineered granular fill. The minimum requirement for an engineered fill is OPSS 1010 Granular B Type 1, however, there are other options available, such as 3inch minus rock fill.

The clay sand subsoils on site are acceptable as general subgrade fill for the roadway and parking lot areas. Any existing topsoil materials must be stripped from the site prior to placing new fill material.

Pavement Design

For the new roadways, remove all organic soil from the subgrade surface. Provide earth grading and cross fall as per OPSD 200.01 to prevent ponding of water on the soil subgrade, and to provide effective drainage of the new pavement structure.

Apply proof-rolling to the subgrade soil to ensure that it is acceptable for placement of the new granular subbase and base materials.

The following minimum pavement design as per OPSS 1150 specifications is recommended for placement of new pavement:

Pavement Structure

40mm	HL3 surface course
50mm	HL8 binder course
150mm	OPSS 1010 Granular A base
350mm	OPSS 1010 Granular B Type 1 subbase

Over compact native subgrade soil or approved fill

If desired, light duty parking areas may have a reduced hot mix depth consisting of a single lift of 50mm HL3 surface course.

It will also be acceptable to substitute SuperPave hot mix as per OPSS 1151, such as SP12.5 over SP19.0.

The asphalt cement should have a minimum rating of PGAC 58 -28.
Tack-coat the hot mix substrate, as per OPSS.PROV 308, prior to placing the surface course lift of hot mix. Stipulate in the contract that all hot mix paving operations shall be carried out in accordance with OPSS 310 specifications.

Compaction Requirements
All natural soil and all granular fill compaction requirements for the project should conform with OPSS 501, Subsection 501.08.02 - Method A, utilizing soil placement in maximum 300mm lifts and a compaction standard of 100% of Standard Proctor Maximum Dry Density.

Statement of Limitations
This report is intended for the guidance of the project design team. From a construction standpoint, contractors must make their own assessment of the soil and groundwater conditions and how these will affect their proposed construction techniques and schedules.

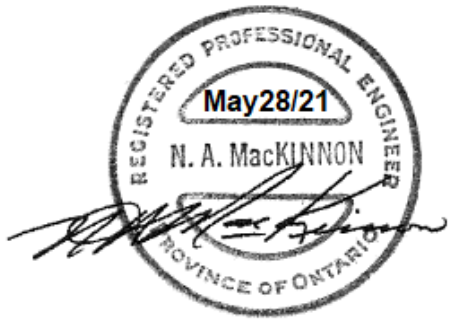
The recommendations in this report are based on information determined at the test hole locations. Soils and groundwater conditions between and beyond the test holes may differ from those encountered at the test hole locations and conditions may become apparent during construction that could not be detected or anticipated at the time of the soils investigation.
If this occurs, we recommend that Terraspec be retained for further consultation, testing, and analysis.

We also recommend that Terraspec be retained to ensure that all subgrade preparation requirements are met, and to confirm that the soil conditions do not deviate materially from those encountered in test holes. In the case that unforseen conditions arise, or our recommendations are not followed, the company's responsibility is limited to interpreting the information from the test hole data collected for this report.

This report is applicable only to this specific project, constructed substantially in accordance with details of alignment and elevations quoted in the text. Where rock excavation is proposed, a contingency cost item should be included in the contract to allow for any unforeseen subgrade conditions. Elevations quoted in the document are approximate. Original ground elevations for project design purposes should be obtained from an experienced topographical survey consultant.

~ ~ ~

TERRASPEC ENGINEERING INC.
GEOTECHNICAL ENGINEERS



Shane Galloway, B.A.
Manager

N.A. MacKinnon, P.Eng.
Senior Engineer

Test Hole Data
February 17, 2021

Notes

1. Soil types, strata, and groundwater conditions have been established only at test hole locations.
2. Soils are described according to the MTO Soils Classification System and OPSD 100.06.
3. Dimensions are in millimetres up to 1 metre, then in metres thereafter.

Abbreviations

asph	-	asphalt	&	-	and
blds	-	boulders	w	-	with
blk	-	black	so	-	some
br	-	brown	tr	-	trace
BR	-	bedrock			
cl	-	clay(ey)	S	-	soil sample
cob	-	cobbles	Su	-	vane shear strength (kPa)
conc	-	concrete	N	-	blow counts per 0.3m
cr	-	crushed			
f	-	fine			
gr	-	gravel(ly)			
gry	-	grey			
med	-	medium			
NFP	-	no further progress			
org	-	organics			
RF	-	rock fill			
sa	-	sand(y)			
si	-	silt(y)			
tps	-	topsoil			

1 W limit, 15m E of trail, 35N of culvert

0 - 400 blk org tps
400 - 3.66 br sa si cl tr gr -moist, very stiff S1 at 3.5m
-cob at 3.35m
-cob at 3.55m
3.66 - 3.99 gry si cl sa tr gr -wet, stiff
3.99 NFP, flat limestone BR
-water at 3.66m

2 E limit, 9m W of trail, 37N of culvert

0 - 200 blk org tps
200 - 3.05 br si cl sa tr gr -moist, very stiff
-cob at 1.68m
at 2.13m N=24
3.05 - 3.96 gry/br si cl sa tr gr -moist, very stiff to hard
3.96 NFP, flat limestone BR
-water at 3.66m, rose to 2.44m

3 14m E of 4, 39N of culvert

0	-	250	blk org tps	
250	-	2.90	br si cl sa tr gr -moist, very stiff	
at 1.83m		N=18		
at 2.13m		N=24		
2.90	-	4.39	br si sa so cl w gr -moist to wet, very stiff	S2 at 3m
at 3.0m		N=20		
4.39			NFP, flat limestone BR	

-water at 4.27m, rose to 1.7m

4 14m E of 1, 38N of culvert

0	-	230	blk org tps	
230	-	3.07	br cl w si -moist, very stiff to hard	S3 at 2.1m
at 1.83m		N=24	Su=200	
3.07	-	4.72	gry si sa so cl w gr -moist to wet, compact	S4 at 3.35m

-blds at 3.66 to 4m

4.72			NFP, flat limestone BR	

-water at 4.27m, rose to 3.96m

North Street Laboratory Test Data

Soil Sample	**S1**	**S2**	**S3**	**S4**	
Sieve	**% Passing**				
26.5mm	100	100	100	100	grain size
19.0mm	100	100	100	100	
13.2mm	100	92.4	100	94.5	
9.50mm	100	86.8	100	91.9	
4.75mm	98.2	81.4	100	87.0	
2.00mm	95.1	76.7	100	80.7	
850um	89.9	71.8	99.8	72.9	
425um	83.8	66.8	99.5	67.8	
250um	76.4	60.5	98.9	61.9	
106um	61.4	48.3	97.3	49.6	
75um	57.1	44.8	96.5	46.1	
ASTM	CL	SC-SM	CL	SC-SM	soil classification
frost rating	Low	Low	Low	Low	susceptibility to frost heave
W	15.0	21.5	22.5	16.4	field moisture content

BOREHOLE 1

PROJECT No.: 20-3-2698
CLIENT: MBQ
PROJECT: North Street
DATE: February 17, 2021

METHOD: 130mm Solid Stem Auger / Excavation
S = soil sample
N = blows per 0.3m
R = resistance to settlement (kPa)
▼ encountered water elevation

DEPTH (m)	Description	S	N
	1 W limit		
0.0	0 - 400 blk org tps		
0.5	400 - 3.66 br si cl sa tr gr -moist, very stiff		
1.0			
1.5			
2.0			
2.5			
3.0			
	-cob at 3.35m		
3.5	-cob at 3.55m	1	
	3.66 - 3.99 gry si cl sa tr gr -wet, stiff		
4.0	3.99 NFP, flat limestone BR		
4.5			
5.0			
5.5			

LEGEND

- organic topsoil
- silty clay sand trace gravel
- clay with silt
- sandy silty clay trace gravel
- silty sand some clay with gravel
- bedrock inferred

Terraspec

BOREHOLE 2

PROJECT No.: 20-3-2698
CLIENT: MBQ
PROJECT: North Street
DATE: February 17, 2021

METHOD: 130mm Solid Stem Auger / Excavation
S = soil sample
N = blows per 0.3m
R = resistance to settlement (kPa)
▼ encountered water elevation

DEPTH (m)	Description	S	N
	2 E limit		
0.0	0 - 200 blk org tps		
	200 - 3.05 br si cl sa tr gr -moist, very stiff		
0.5			
1.0			
1.5			
	-cob at 1.68m		
2.0			24
2.5			
3.0	3.05 - 3.96 gry/br si cl sa tr gr -moist, very stiff to hard		
3.5 ▼			
4.0	3.96 NFP, flat limestone BR		
4.5			
5.0			
5.5			

LEGEND

- organic topsoil
- silty clay sand trace gravel
- clay with silt
- sandy silty clay trace gravel
- silty sand some clay with gravel
- bedrock inferred

Terraspec

BOREHOLE 3

PROJECT No.: 20-3-2698
CLIENT: MBQ
PROJECT: North Street
DATE: February 17, 2021

METHOD: 130mm Solid Stem Auger / Excavation
S = soil sample
N = blows per 0.3m
R = resistance to settlement (kPa)
▼ encountered water elevation

DEPTH (m)	Description	S	N
	3		
0.0	0 - 250 blk org tps		
0.5	250 - 2.90 br si cl sa tr gr -moist, very stiff		
1.0			
1.5			
2.0			18 24
2.5			
3.0	2.90 - 4.39 br si sa so cl w gr -moist to wet, very stiff	2	20
3.5			
4.0			
▼ 4.5	4.39 NFP, flat limestone BR		
5.0			
5.5			

LEGEND

- organic topsoil
- silty clay sand trace gravel
- clay with silt
- sandy silty clay trace gravel
- silty sand some clay with gravel
- bedrock inferred

Terraspec

BOREHOLE 4

PROJECT No.: 20-3-2698
CLIENT: MBQ
PROJECT: North Street
DATE: February 17, 2021

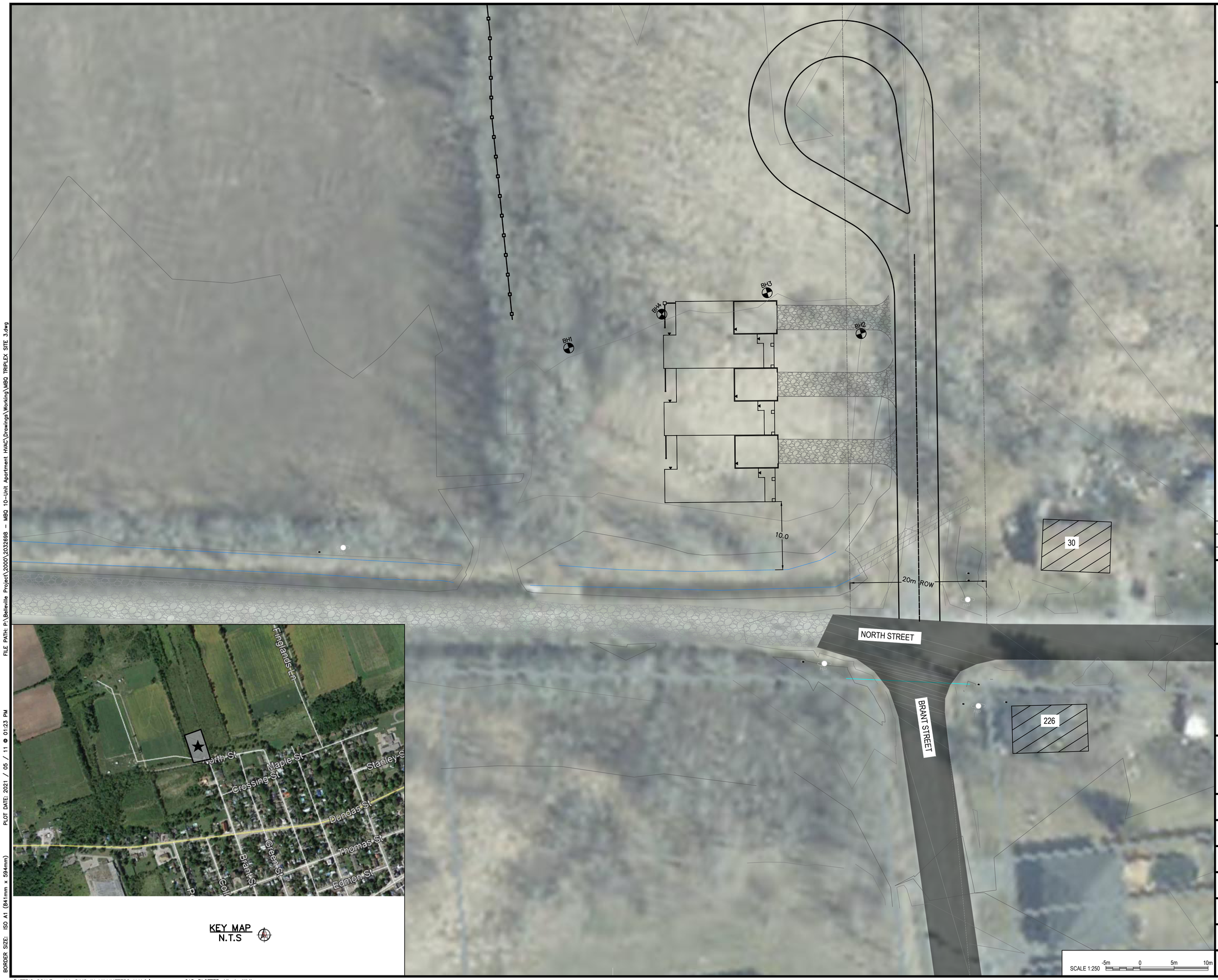
METHOD: 130mm Solid Stem Auger / Excavation
S = soil sample
N = blows per 0.3m
R = resistance to settlement (kPa)
▼ encountered water elevation

DEPTH (m)	Description	S	N
	4		
0.0	0 - 230 blk org tps		
0.5	230 - 3.07 br cl w si -moist, very stiff to hard		
1.0			
1.5			
2.0		3	24
2.5			
3.0	3.07 - 4.72 gry si sa so cl w gr -moist to wet, compact	4	
3.5	-blds at 3.66 to 4m		
4.0			
4.5			
5.0	4.72 NFP, flat limestone BR		
5.5			

LEGEND

- organic topsoil
- silty clay sand trace gravel
- clay with silt
- sandy silty clay trace gravel
- silty sand some clay with gravel
- bedrock inferred

Terraspec



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NOTES:

1. ALL WORK SHALL BE IN ACCORDANCE WITH RELEVANT CODES AND GUIDELINES.
2. ALL DRAWINGS AND ADDENDA ARE TO BE READ AS, AND IN CONJUNCTION WITH THE SPECIFICATIONS.
3. ALL EQUIPMENT SHALL BE INSTALLED AS SPECIFIED OR APPROVED EQUIVALENT.
4. CONTRACTOR MUST CHECK AND VERIFY ALL DIMENSIONS BEFORE PROCEEDING WITH WORK AND BE RESPONSIBLE FOR SAME.
5. CONTRACTOR MUST REPORT ANY DISCREPANCIES TO ENGINEER FOR RESOLUTION BEFORE COMMENCING THE WORK.
6. ANY CHANGES MUST BE APPROVED BY THE ENGINEER.

A/B — A DETAIL NO. / B DRAWING NO. – WHERE DETAILED

EXISTING	DESCRIPTION	PROPOSED
	ASPHALT	
	EDGE OF ROAD	
	DRIVEWAY	
	PROPERTY LINE	
	CULVERT	
	BOTTOM OF DITCH	
	FENCE	
HP	HYDRO POLE	
	HYDRO POLE ANCHOR	
	BOREHOLE	

REVISION	DESCRIPTION	DATE
02	ISSUED FOR EXAMPLE	YY/MM/DD
01	–	YY/MM/DD

NORTH

STAMP

PROJECT
MBQ 3-PLEX
LOT 37D CONCESSION II
TYENDINAGA MOHAWK TERRITORY
TOWNSHIP OF TYENDINAGA
COUNTY OF HASTINGS
SITE 3
MOHAWKS OF THE BAY OF QUINTE

DRAWING TITLE
SITE PLAN
NORTH STREET

DESIGNED BY

DRAWN BY
N. WHITMAN

REVIEWED BY
A. VOLDOCK

APPROVED BY
A. VOLDOCK

PROJECT DATE
2021-01-15 (YYYY/MM/DD)

PROJECT #
20-3-2698

DRAWING #
SP 3

DRAWING SCALE (ISO A1)
HOR: 1:250
VER: N/A

BORDER SIZE: ISO A1 (841mm x 594mm) PLOT DATE: 2021 / 05 / 11 @ 01:23 PM FILE PATH: P:\Belleville Project\2000\2032698 - MBQ 10-Unit Apartment HVAC\Drawings\Working\MBQ TRIPLEX SITE 3.dwg

(METRIC SCALE – ALL DIMS IN MILLIMETERS U.N.O.) CAD PLOTTER: Nicole Whitman