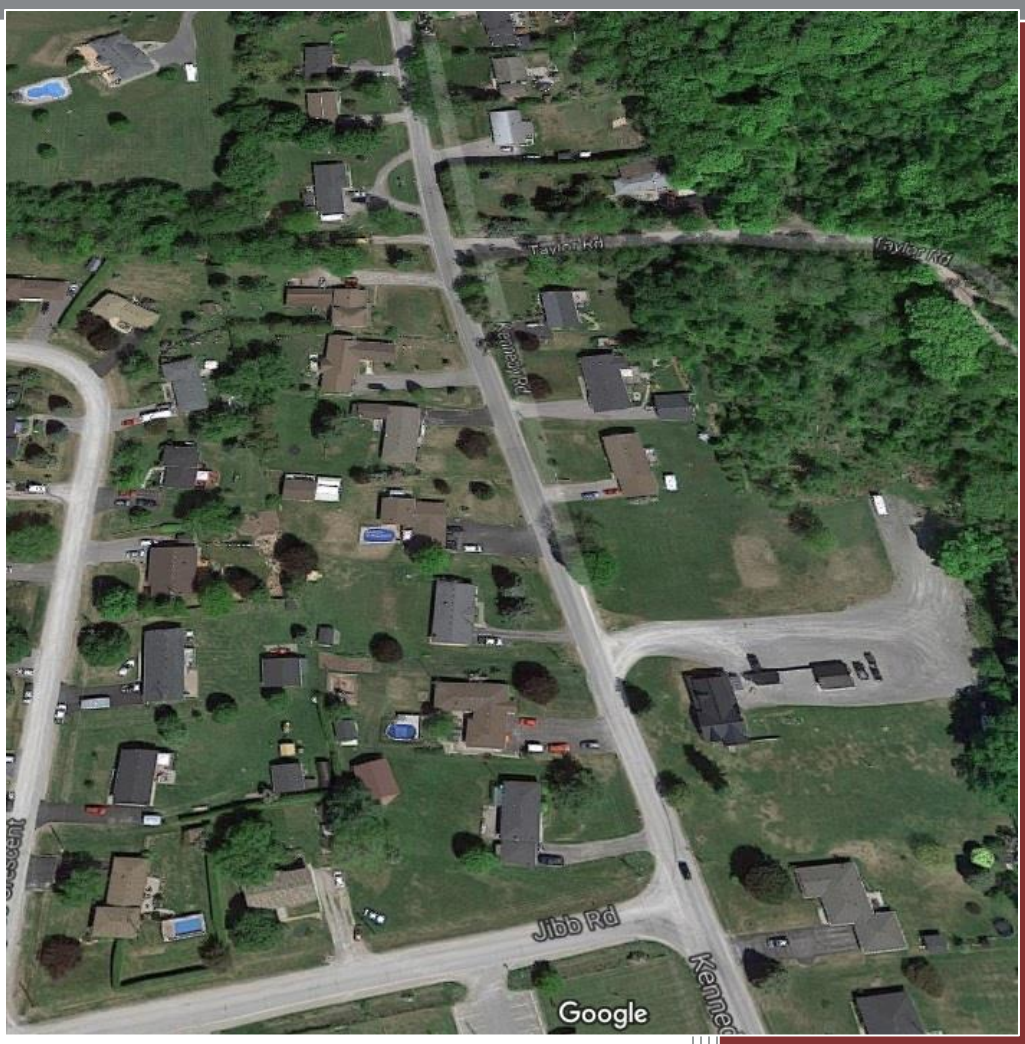
Project No. 12-1-5597

Kennedy Road

Geotechnical Report



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May 2017

Geotechnical Report for
Kennedy Road
Camborne, Ontario

Project No. 12-1-5597

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May 2017

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May 8, 2017

The Greer Galloway Group Inc.
973 Crawford Drive
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Re: Geotechnical Report for Kennedy Road
Project No. 12-1-5597

General Data
The project is located on Kennedy Road, from Burnham Street to Jamieson Road, in the town of Camborne, Ontario. The project length is approximately 2km.
New water main will be installed from the box culvert bridge at the south end, northerly to house 3647.
New storm sewer will also be installed along this section, and the roadway will be reconstructed as an urban section along this length. The new storm sewer will also be utilized to collect and redirect flowing water from various nearby artesian wells. The remaining sections of Kennedy Road will maintain a rural road section design.

Investigation
Fifteen exploratory test holes were placed on April 17, 2017. The test holes were generally placed through the edge of the existing pavement. The subsoil and moisture/groundwater conditions were logged for each test hole. The test hole logs and laboratory testing data have been appended to this report.

Existing Conditions
The soil physiography for the project location is defined as Drumlinized Till Plains.
The underlying bedrock consists of limestone of the Trenton Group.
There is currently old hot mix on the roadway.
The existing lane width is 3.1m.
The existing hot mix pavement has severe cracking and coarse aggregate loss, with moderate to severe wheel path rutting and/or distortion. The quality of the pavement is poor.
The typical existing pavement structure was as follows:

50-90mm	hot mix
100-150mm	crushed gravel base (some RAP layers or buried hot mix)
275mm	sand with gravel subbase

The typical depth of the pavement structure was 480mm.
The subgrade soil was generally silty sand or sandy silt.
The subgrade was typically wet due to groundwater seepage.
The typical encountered depth of water seepage was 1.2m below road surface.
The OHSA classification for subgrade soil was typically Type 3 for dry soil, and Type 4 soil when wet or saturated.

The buried hot mix layers appear to be causing some drainage issues which are contributing to distortion of the pavement surface. It will be preferable to excavate the site to allow placement of a new granular subbase and base, placed full-width including the existing road shoulders.

Recommendations

Pavement Structure Design
The target GBE value for the new pavement is 542.
The new pavement structure proposed is as follows:

90mm	Hot Mix
150mm	Granular A
350mm	Granular B1 Modified

The GBE value of the above structure is 563.

Dewatering
The Contractor will be required to devise a suitable dewatering plan to install new water main and storm sewer. It can be expected that many locations will have a continuous influx of water, which will also cause Type 4 collapsing soils.

Pipe Installation
Excavate roadway as necessary to install the new water main and the new storm drain system. For 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

Place a note in the contract that soils encountered below the water seepage elevation will typically behave as Type 4 collapsing soils, and will require a Type 4 Earth Excavation.

Utilize the granular bedding and cover depths as specified in the applicable OPSD standards

listed above. For normal (dry) subgrade conditions, OPSS Granular A may be utilized for pipe embedment and pipe cover material for new piping.

Make a note in the contract that most of the project within the urban section will encounter wet subgrade conditions, therefore, a gravel material such as Clear Stone must be supplied for pipe embedment and pipe cover material.

Frost protection for underground piping beneath roadways should be utilized as per the following OPSD standards, with a frost penetration 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 excavated subgrade soils will typically be wet, with an elevated silt content. As such, these materials will likely be of little use as backfill within the roadway. Allow for a contingency item in the contract to place imported fill soils as needed. The fill soil should meet the minimum requirements of OPSS 1010 SSM, or, a 3 inch minus rock fill material may also be utilized.

Pavement Reconstruction
Break up and remove the existing hot mix from the roadway. It will be feasible to stockpile this material and re-use it as RAP on a future road project. Place a note in the contract that all buried pavement must be excavated and removed from the roadway as well.

Construct earth grading of the road subgrade as per OPSD 200.01.
Improve the ditching on both sides of the road where new storm sewer will not be present. Improvement of the ditching is generally required on the south side of the road from 3662 to Jamieson Road.

Reconstruct both shoulders, conduct widenings, and place the driving lanes, by placing new granular materials full-width, as follows:

150mm Granular A base
350mm Granular B1 Modified subbase

Granular B1 Modified is similar to OPSS 1010 Granular B Type 1, but with the following gradation specification:

Granular B1 Modified

Sieve	% Passing
150mm	100
53.0mm	100
26.5mm	50-100
4.75mm	25-50
1.18mm	10-35
300um	5-20
75um	3-8

Due to the potential for a wet subgrade surface, it will be satisfactory to allow substitution of Granular B Type 2, for Granular B Type 1 Modified, if necessary in the contract. However, the Granular B Type 2 material must be limited to a maximum particle size of 75mm. Put a special provision in the contract to allow for this specific substitution.

Pave the roadway with 40mm HL3 over 50mm HL8. Use this same thickness for any paved shoulders. The paved area behind the new concrete curb should be placed 50mm thick, using HL3.

Materials for hot mix pavement should be as per OPSS 1150 specifications.
The asphalt cement should have a minimum rating of PGAC 58 -34.
Stipulate in the contract that all hot mix paving operations shall be carried out in strict accordance with OPSS 310 specifications.

Compaction Requirements
All native soil and granular 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 careful 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 substantially 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 recalled to the site 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 and rock 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 project, constructed substantially in accordance with details of alignment and elevations quoted in the text.

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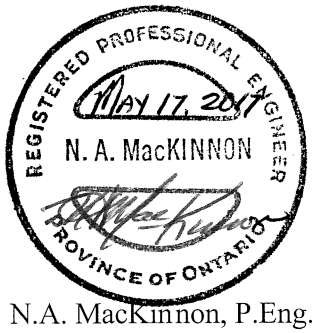
TERRASPEC ENGINEERING INC.
GEOTECHNICAL ENGINEERS



Shane Galloway, B.A.
Manager

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

Test Hole Data
Kennedy Road
April 17, 2017

Notes

1. Soil types, strata, and groundwater conditions have been established only at test hole locations.
2. Soils are described according to the ASTM 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			
conc	-	concrete			
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			

Test Holes from Burnham Street to Jamieson Road, numbered 1 through 17.

1 at 50km/h sign, 4.5m E of Road CL

0	-	40	asph	
40	-	140	cr gr & sa -moist, dense	good quality
140	-	350	br gr sa -moist, compact	good
350	-	1.8	br f sa -moist, compact	

-water not encountered

2 address 3517, 3.1m W

0	-	50	asph	
50	-	160	cr gr & sa -moist, dense	good
160	-	1.2	br gr sa w cob -moist, compact	good
1.2			NFP, bld	

-water not encountered

3 3535, 3.1m E

0	-	50	asph	
50	-	280	cr gr & sa -moist, compact	poor
280	-	330	asph/RAP	buried pavement
330	-	1.69	br f sa w gr so cob -dry, dense	good
1.69			NFP, cob	

-water not encountered

4 3570, 3.1m E

0	-	50	asph		
50	-	90	br f sa -moist, compact		
90	-	150	asph/RAP	buried pavement	
150	-	2.13	br f sa w si & gr -moist, compact	Type 3 soil	S1

-water not encountered

5 3596, 3.0m W

0	-	60	asph	
60	-	90	RAP	
90	-	150	cr gr & sa -moist, compact	poor
150	-	1.22	br si sa & gr/cob -moist, compact	Type 4 soil
1.22	-	1.98	br si cl sa -moist, compact	Type 4 soil

-water seepage at 1.22m

6 3606, 3.0m E

0	-	90	asph	
90	-	110	RAP	
110	-	180	cr gr & sa -moist, compact	poor
180	-	305	br si sa -moist, loose	poor
305	-	410	br si sa w gr/cob -moist, compact	good
410	-	2.13	br f sa w si & gr/cob -moist, compact	Type 4 soil

-water seepage at 1.22m

7 3613, 3.0m E

0	-	80	asph	
80	-	220	asph/RAP	buried pavement
220	-	330	cr gr & si sa -moist, compact	poor
330	-	480	br f sa w gr/cob -moist, compact	good
480	-	1.98	br si sa tr gr/cob -wet, compact	Type 4 soil

-water at 1.22m

8 3621, 2.0m W

0	-	90	asph		
90	-	130	RAP	buried pavement	
130	-	200	cr gr & si sa -moist, dense	poor	
200	-	480	br gr sa -moist, compact	good	S2
480	-	1.98	br si sa tr gr -wet, loose	Type 4 soil	

-water at 1.22m, rose to 1.07m

10 3636, 2.0m E

0	-	50	asph		
50	-	80	RAP		
80	-	200	cr gr & si sa -moist, compact	poor	
200	-	430	br si sa w gr -moist, compact	poor	
430	-	1.22	br si sa -wet, loose to compact	Type 4 soil	S3
1.22	-	1.98	br si sa so gr/cob -wet, compact	Type 4 soil	

-water at 1.22m, rose to 0.91m

11 3641, 3.0m E

0	-	50	asph		
50	-	80	RAP	buried pavement	
80	-	300	cr gr & si sa -moist, compact	poor	
300	-	1.83	br sa si tr org -wet, loose	Type 3 soil	

-water not encountered

12 3647, 2.0m E

0	-	100	asph		
100	-	250	cr gr & si sa -moist, compact	poor	
250	-	480	br si sa w gr -moist, compact	poor	
480	-	2.13	br sa si tr org -wet, loose	Type 4 soil	

-water at 1.52m, rose to 1.22m

13 3662, 3.0m W

0	-	50	asph		
50	-	200	cr gr & sa -moist, compact	good	
200	-	250	asph	buried pavement	
250	-	330	cr gr & sa -moist, dense	good	
330	-	510	br f sa w gr -moist, compact	good	
510	-	1.83	br si sa -moist to wet, compact	Type 3 soil	

-trace water seepage at 1.52m

14 3676 on curve, 3.0m W

0	-	50	asph	
50	-	200	cr gr & sa -moist, compact	good
200	-	460	br gr sa -moist, compact	good
460	-	900	br f sa tr gr -moist, compact	Type 3 soil
900	-	1.83	br si sa -moist to wet, compact	Type 3 soil

-trace water seepage at 1.07m

16 3687, 3.0m E

0	-	75	asph	
75	-	230	cr gr & sa/RAP -moist, compact	good
230	-	460	br f sa w gr -moist, compact	good
460	-	1.07	br si sa tr gr/cob -moist, compact	Type 3 soil
1.07			NFP, bld	

-water not encountered

17 at Jamieson Road, 3.0m E

0	-	60	asph	
60	-	190	cr gr & sa -moist, compact	good
190	-	460	br gr sa -moist, compact	good
460	-	1.83	br gr si sa -moist, compact	Type 3 soil

-water not encountered

Laboratory Test Data

Soil Sample	**1**	**2**	**3**	
Sieve	**% Passing**			
19.0mm	100	100	100	grain size
13.2mm	100	93.5	100	
9.50mm	95.3	82.7	100	
4.75mm	88.7	61.9	100	
2.36mm	88.0	51.5	99.8	
1.18mm	86.2	39.7	98.9	
600um	82.8	28.9	95.3	
300um	70.5	16.4	87.6	
150um	34.5	8.8	74.4	
75um	11.9	5.4	49.8	
W	7.2	5.1	19.4	moisture content
ASTM	SP-SM	SP	SM	soil classification
frost rating	Low	Low	Mod	susceptibility to frost heave