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Soils Materials Environment

## Municipality of North Perth

# North Perth Wastewater Treatment Plant
# Headworks Upgrades
# 6115 Line 84 and 1200 Highway 23
# Municipality of North Perth, Ontario

## Geotechnical Investigation Report

Date: July 13, 2016
Ref. N°: 163-P-0010059-0-01-100-GE-R-0001-00

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## Geotechnical Engineering Report | 163-P-0010059-0-01-100


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# TABLE OF CONTENTS



**Tables**

# TABLE OF CONTENTS

**Appendices**

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Municipality of North Perth
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Attention: Mr. Mark Hackett

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# INTRODUCTION

Englobe Corp. (Englobe) was retained by the Municipality of North Perth to carry out a geotechnical investigation at the existing Wastewater Treatment Plant (WWTP) located on 6115 Line 84 and at the existing pumping station at 1200 Highway 83 in the Municipality of North Perth, Ontario at the locations shown on Drawing 1 in Appendix 1. This work was authorized by Mr. Matt Ash, C.E.T. of GM BluePlan Engineering Limited in an email dated March 11, 2016, following submission of a detailed proposal. It is understood the original design was modified and the proposed new structures will be located south of the existing structures. Additional drilling was requested in this area on May 13, 2016.

The project involves the installation of additional process structures, a small building and generator slab as well as a new 450 mm diameter forcemain installation at the WWTP. The additional process structures may include grit and grease channels, grit classifier, grit bin, screenings bin, mechanical screen, washer-compactor and by-pass channel. Preliminary concepts were provided to Englobe by GM BluePlan Engineering Limited. No design drawings were available at this time.

The project will also include a new 500 mm diameter PVC forcemain sewer at the pumping station located on Highway 23. It is understood the forcemain will be directionally drilled beneath the highway and elevations will generally match the existing forcemain invert. The new forcemain will connect to the existing 450 mm diameter outfall.

The purpose of the geotechnical investigation was to determine the subsurface soil and groundwater conditions in order to provide geotechnical recommendations for the WWTP upgrades and new forcemain including site preparation, foundation design, re-use of excavated material, concrete slab-on-grade, excavations, trench backfill, dewatering, pipe bedding, and trenchless technology.

# 1 PREVIOUS WORK AND CONCURRENT WORK

In 1991, Trow Consulting Engineers Ltd. carried out a geotechnical investigation at the WWTP for new clarifiers, pumping station chambers, filters, control building and berms. The fieldwork for this investigation comprised the drilling of eight boreholes, including two Boreholes (BH5 and BH8) in the vicinity of the current investigation at the approximate locations shown on Drawing 2 in Appendix 1. The results of the investigation were reported in the following document;

- Trow Consulting Engineers Ltd., Geotechnical Investigation Proposed Sanitary Sewage Works, Listowel, Ontario, Project Q595A, June 3, 1991.

In 1992, Trow Consulting Engineers Ltd. carried out a geotechnical investigation at the WWTP. The fieldwork for this investigation involved seventeen boreholes, including Boreholes BH15 in the vicinity of the current investigation. The results of this investigation were reported in the following document;

- Trow Consulting Engineers Ltd., Supplemental Geotechnical Investigation Proposed Sanitary Sewage Works, Listowel, Ontario, Project Q595B, January 10, 1992.

The relevant geotechnical information from the above referenced reports has been incorporated into this report. The relevant borehole logs are provided in Appendix 2.

# 2 INVESTIGATION PROCEDURES

## 2.1 FIELD PROGRAM

The fieldwork for the original investigation was carried out on April 4 and 5, 2016, and involved the drilling of six boreholes (Boreholes BH-01-16 to BH-05-16 and BH-08-16) at the WWTP to depths between 5.0 and 5.8 m at the locations shown on the Site 1 Plan, Drawing 2 in Appendix 1. Three additional boreholes (BH-101-16 to BH-103-16) were drilled at the WWTP on June 1, 2016, to a depth of 9.8 m.

The fieldwork also involved drilling two boreholes (BH-06-16 and BH-07-16) at the pumping station on Highway 23 to a depth of 6.6 m at the locations shown on the Site 2 Plan, Drawing 3 in Appendix 1.

Private and public utility companies were contacted prior to the start of drilling activities in order to demarcate underground utilities near the boring locations.

The boreholes were advanced using a track-mounted drillrig equipped with continuous flight solid or hollow stem augers supplied and operated by specialist drilling company.

Representative samples of the subsoils were recovered from the boreholes at regular 0.76 and 1.50 m depth intervals using conventional spilt spoon sampling equipment in accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586). The SPT N-values recorded are plotted on the borehole logs in Appendix 2.

Samples of the cohesive soils were tested using a hand-held pocket penetrometer to determine approximate shear strengths. The pocket penetrometer test results are plotted on the borehole logs in Appendix 2.

Groundwater observations were carried out in the open boreholes during and upon completion of drilling and the observations are summarized in the appended borehole logs.

Standpipes were installed in Boreholes BH-101-16 and BH-102-16 to allow measurement of the stabilized groundwater levels. The standpipe installations comprised 19 mm diameter pipes with slotted and filtered screens, as well as a bentonite seals near the ground surface. Details of the installations and groundwater observations and measurements are provided on the borehole logs in Appendix 2.

Upon completion of drilling, the remaining boreholes were backfilled with bentonite in accordance with Ontario Regulation 903 (as amended) under the province's Water Resources Act.

The fieldwork was monitored throughout by a member of our engineering staff who arranged utility locates; directed the drilling and sampling procedures; conducted SPT and pocket penetrometer tests; documented the soil stratigraphies; monitored groundwater conditions; observed the standpipe installation; and, transported the recovered soil samples to the laboratory for further visual classification and engineering analysis.

The borehole locations and ground surface elevations were surveyed by GM BluePlan Engineering Limited and the data was supplied to Englobe in emails dated March 30, 2016 and June 6, 2016. It is understood that the elevations are related to a geodetic datum.

## 2.2 LABORATORY TESTING

All soil samples secured during the investigation were returned to our laboratory for visual examination, as well as moisture content tests, the results of which are plotted on the individual borehole logs. Laboratory tests carried out on selected samples of the major subsurface soils from this investigation comprised the following:

- four particle size distribution analyses with results presented on Figures 1 and 2 in Appendix 3 and summarized in Subsection 3.4;
- three soluble chloride and sulphate determinations with results summarized on Table 2 in Subsection 4.4.; and,
- three soil corrositivity tests with results summarized on Table 3 in Subsection 4.10.

The soil samples will be stored for a period of three months from the date of sampling. After this time, they will be discarded unless prior arrangements have been made for longer storage.

# 3 SUMMARIZED CONDITIONS

## 3.1 SITE DESCRIPTION – NORTH PERTH WWTP (SITE 1)

The site of the North Perth WWTP is located on the south side of Line 84 west of Highway 23 in the Municipality of North Perth. The site originally contained an aeration cell and sewage lagoons. It is understood new clarifiers, pumping station, disinfection chamber, grit tank, basin, effluent filter, control building, and transform stations were installed in 1992.

The existing grades at the WWTP site are relatively level and range from Elevation 379.0 m to Elevation 379.8 m at the borehole locations near the existing structures. The site generally slopes down from south to north approximately 3 m. There are existing lagoons on the south and east sides of the site.

The proposed WWTP upgrades may include numerous process structures and a small building on the east side of the existing structures as well as a new generator slab on the north side of the site. A new 450 mm forcemain is also to be installed from Highway 23 to the site.

## 3.2 SITE DESCRIPTION – HIGHWAY 23 PUMPING STATION (SITE 2)

The existing pumping station is located south of the Middle Maitland River on the east side of Highway 23 between Line 84 and Barnett Street.

The proposed forcemain will be located north of the existing pumping station. The ground surface in this area generally slopes down to the Middle Maitland River.

Photographs of the sites are provided in Appendix 4.

## 3.3 PLEISTOCENE GEOLOGY

The site is located within the physiographic region of Southern Ontario known as the Stratford Till Plain (Chapman and Putnam, 1984). The region is mostly level, modified by occasional moderate hills and ridges. The soil materials are fairly uniform and comprise silt and clay tills. Sand and gravel is present in terraces along some of the river valleys.

The region is underlain by Middle Devonian bedrock of the Paleozoic system. The predominant rock types are limestone and dolomite of the Detroit River Group. The bedrock surface dips gently to the southwest. The soil cover over these rocks is generally about 60 m thick.

## 3.4 SUBSURFACE SOIL CONDITIONS

We refer to the borehole logs in Appendix 2 for detailed soil descriptions and stratigraphies, results of SPT and pocket penetrometer testing, moisture content profiles, and groundwater observation and measurements.

In general, the subsurface stratigraphy contacted at the sites comprises fill overlying native glacial till. Descriptions of the various soil deposits encountered are provided in the following subsections.

### 3.4.1 Fill

Fill was encountered surficially in all of the boreholes. The fill extends past the termination depth of Boreholes BH-01-16 to BH-04-16 and is 3.8 to 6.1 m thick in the remaining boreholes. The fill ranges in composition from brown sand and gravel with some silt to silt with some clay, sand and gravel. Organics (topsoil) were noted in the fill at the majority of the borehole locations at the WWTP. SPT N-values taken in the fill range from 7 to above 50 blows per 300 mm penetration of the split spoon sampler indicating a loose to dense compactness condition (relative density).

It is noted the average SPT N-value in the WWTP fill is 16 blows per 300 mm penetration of the split spoon sampler and the average SPT N-value in the boreholes at the pumping station in the fill is 14 blows per 300 mm penetrations of the split spoon sampler. In-situ moisture contents in the fill range from 4 to 21% indicating moist to wet conditions.

### 3.4.2 Sand

Sand was encountered beneath the fill in Boreholes BH-101-16 and BH-102-16, and is 0.3 to 1.1 m thick. The sand comprises silty sand with trace gravel and clay. The results of the particle size distribution analysis conducted in the sand are plotted on Figure 2 in Appendix 3 and indicate the sample contains 6% gravel, 63% sand, 27% silt, and 4% clay. The sand was saturated at the time of the fieldwork.

### 3.4.3 Glacial Till

Glacial till was encountered beneath the fill in Boreholes BH-05-16 to BH-08-16 and BH-101-16 to BH-103-16, and extends to the termination depth of the boreholes.

The till ranges in composition from sandy clayey silt with some gravel to clayey silt with some gravel and trace sand. The results of three particle size distribution analyses complete on samples of till are plotted on Figures 1 and 2 in Appendix 3, and summarized on the following table:

Table 1: Glacial Till Particle Size Distribution Analyses.

| BOREHOLE NUMBER | SAMPLE DEPTH (m) | GRAVEL (%) | SAND (%) | SILT (%) | CLAY (%) |
|---|---|---|---|---|---|
| BH-06-16 | 6.10 – 6.55 | 4 | 22 | 40 | 34 |
| BH-07-16 | 4.57 – 5.03 | 6 | 25 | 40 | 29 |
| BH-101-16 | 6.86 – 7.47 | 2 | 4 | 60 | 34 |

SPT N-values in the till range from 7 to above 50 blows per 300 mm penetration indicating a loose to very dense relative density. In-situ moisture contents in the till range from 11 to 28% indicating moist to saturated or drier than the plastic limit to about the plastic limit conditions.

### 3.5 GROUNDWATER

Groundwater observations and measurements carried out in the open boreholes are provided on the borehole logs in Appendix 2. Free groundwater was noted in Borehole BH-07-16 within the fill at a depth of 2.3 m below existing grade (Elevation 373.9 m); in Borehole BH-101-16 at a depth of 5.2 m (Elevation 373.8 m); in Borehole BH-102-16 at a depth of 5.4 m (Elevation 374.1 m); and, in Borehole BH-103-16 at a depth of 5.8 m (Elevation 373.5 m). No free groundwater was noted in the remaining boreholes. Perched groundwater would be expected within the fill deposit. Seasonal fluctuations and local variations in groundwater levels would be expected.

## 4 DISCUSSION AND RECOMMENDATIONS

### 4.1 GENERAL

It is understood that the project involves installing new process structures, a small building and a generator slab, as well as a new 450 mm diameter forcemain installation at the WWTP. Boreholes BH-01-16 to BH-05-16, BH-08-16, and BH-101-16 to BH-103-16 were drilled within this area.

The project also involves the directional drilling installation of a 500 mm diameter PVC forcemain sewer under Highway 23 at the pumping station (refer to Boreholes BH-06-17 and BH-07-16).

The soil conditions contacted at the site comprise fill overlying glacial till. Free groundwater was noted in Boreholes BH-07-16 and BH-101-16 to BH-103-16 at depths ranging from 2.3 to 5.8 m (Elevation 373.5 m to Elevation 374.1 m).

Based on the results of this geotechnical investigation, the soils at the sites are suitable for the proposed upgrades; however, the design and construction will be affected by the pre-existing fill. The following subsections of this report contain geotechnical recommendations pertaining to foundation design, concrete slabs, excavations and backfilling, and trenchless technology.

## 4.2 FOUNDATIONS

The subsurface conditions at the WWTP comprises approximately 4.9 to 6.1 m of fill based on the current investigation borehole logs and Trow Consulting Engineers Ltd. boreholes in the vicinity. The fill material is not suitable to support conventional spread footings. It is noted compaction testing reports during fill placement were not available to Englobe. The proposed location is in close proximity to the existing infrastructure raising concerns about spatial limitations between the new structures and existing infrastructure for deep open cut excavation. It is our recommendation that deep foundation options be explored for critical process structures and buildings due to the extensive fill at the site. The following paragraphs provide two deep foundations options.

### 4.2.1 Helical Piers

Helical piers may be used at the WWTP to support the structures and negate the removal of the existing fill. A helical pier foundation system comprises medium diameter steel helices on the end of small diameter solid steel shafts. The steel helices are screwed into the ground to the level of compact bearing soil and attached to grade beams to support the structure. A pull-down grout system should be used in order to encase the shaft and to provide additional support, lifting resistance and longevity to the foundation system.

The estimated shaft length to achieve adequate load capacity is approximately 7 m below existing grade; however, this must be determined by torque measurements at the time of installation. The pile stability, pile head and pile cap details should be determined and checked by an experienced Structural Engineer and reviewed by the Geotechnical Consultant.

The grade beams between the helical piers should be provided with 1.2 m of earth cover to prevent frost damage.

The helical pier installation operations should be monitored on a full-time basis by qualified geotechnical personnel to check foundation elevation, and allowable pier loading through torque testing.

### 4.2.2 Continuous Flight Auger Piles

Due to the cohesionless sandy fill soils, typical caissons are not ideal for this site. It is for this reason that we recommended cast-in-place continuous flight auger (CFA) piles. It is understood GM BluePlan Engineering Limited is exploring this option for foundation design at this time. This system consists of drilling a pile to the foundation depth with continuous-flight hollow-stem augers. As the augers are removed from the hole, concrete is pumped through the bottom of the augers, filling the void left behind as the augers are simultaneously withdrawn. This ensures that the hole is supported. This technique minimizes the amount of excavations, shoring and dewatering that would be required for this project.