Surface Water Assessment Report

Toronto Zoo Anaerobic Digester

Riepma Consultants Inc.
May 2014

Surface Water Assessment Report

Contents

1.0 Introduction 2

1.1 Purpose 2

1.2 The Project 3

1.3 Project Location 3

1.4 Surface Water Location 3

2.0 Surface Water Conditions 4

2.1 Soils 4

2.2 Topography and drainage 4

3.0 Site Investigation 4

4.0 Facility Assessment 5

5.0 Stormwater Management 5

6.0 Mitigation Measures 5

Surface Water Assessment

ZooShare Toronto Zoo Anaerobic Digester Project

1.0 Introduction

1.1 Purpose

This report is prepared in partial fulfillment of the Renewable Energy Approval requirements as set out in Ontario Regulations 359/09 and 521/10. The project has received a FIT contract F-003038-BIG-211-203. A complete project description of the proposal is provided in the Project Description Report as well as the Design and Operations Report.

This report was prepared by Mr. Clare Riepma, BASc., P.Eng., MES, RPP. His CV is attached as Appendix 2.

Table 1 of the Regulation mandates the preparation of this report to: "Set out the following information:

i. Plans, specifications and descriptions of the surface water features at the project location and any surface water features that will receive a direct discharge of sewage as part of engaging in the project.
ii. An assessment of the suitability of the facility for the handling, storage and processing of biomass, source separated organics or farm material, taking into account:
    a. The design of the facility, including features that will be implemented to control the expected production of leachate, the flow of surface water and erosion and sedimentation resulting from the flow of surface water,
    b. The surface water features within 300 metres of the location where biomass, source separated organics or farm material will be handled, stored or processed, any surface water features that will receive a direct discharge of sewage from the facility and the surface water features of the project location
    c. The ability to identify any negative environmental effects of leachate production on the surface water by monitoring, and
    d. The feasibility of contingency plans that can be implemented to control the negative environmental effects on surface water resulting from the production of leachate in a quantity greater than expected or with a quality worse than expected."

1.2 The Project

The project is a Class 3 anaerobic digester as defined in the regulations. The facility will produce 500kW of electricity. No electricity will be generated from non-renewable resources. The organic material used in the facility will be zoo manure and grocery waste.

1.3 Project Location

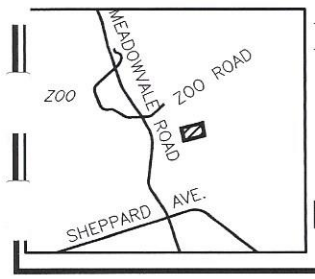
The project will be constructed on lands owned by the Toronto and Region Conservation Authority and leased to the City of Toronto. The location of the site is shown on the location plan. The site is the current location of the compost facility for the zoo's manure.

1.4 Surface Water Location

The nearest natural surface water location is the Little Rouge River, located 175 meters east of the Project Location. A small (0.1ha) man-made shallow pond occurs in the northeast corner of the Project. Surface water generally drains to this pond, and it is currently used for filtering compost runoff. A localized drainage course runs in a north to south direction, starting approximately 55m south of the Project Location, down a steep embankment within a deciduous forest. There is no direct connection to a watercourse, so the drainage is considered to be "Not Fish Habitat", as per the TRCA's Headwater Drainage Feature Guidelines. No other drainages, including those from TRCA's Digital Elevation Model were observed within the surrounding 120m.

There are no other water bodies in the records or physically existing.

ey Plan:



Toronto Zoo
Toronto, Ontario

Site

Toronto Zoo Biogas Plant

Location Plan

February 9 2011

1:5,000

Riepma
CONSULTANTS INC.
Urban and Rural Planning
Environmental Consulting

Clare Riepma P. Eng., M.E.S., R.P.P.
905-877-6751 ~ 416-346-8258
13041 Hwy #7 Georgetown, ON, L7G 4S4
riepma@riepma.ca

2.0 Surface Water Conditions

2.1 Soils

A geotechnical report prepared by Trow Associates Inc. for the general area is included as Appendix 1 of this report.

The original site condition consisted of topsoil underlain with a silty sand material. Clay fill has been placed over the original grade to construct the compost facility. Ground water was observed at depths between 0.3m and 2.1m below the surface.

2.2 Topography and drainage

The site slopes gently down from south to north and drains into the shallow man-made pond in the north east corner of the site. From the pond the surface drains along a very flat swale to the south east corner of the site where it discharges to the ground surface to the south.

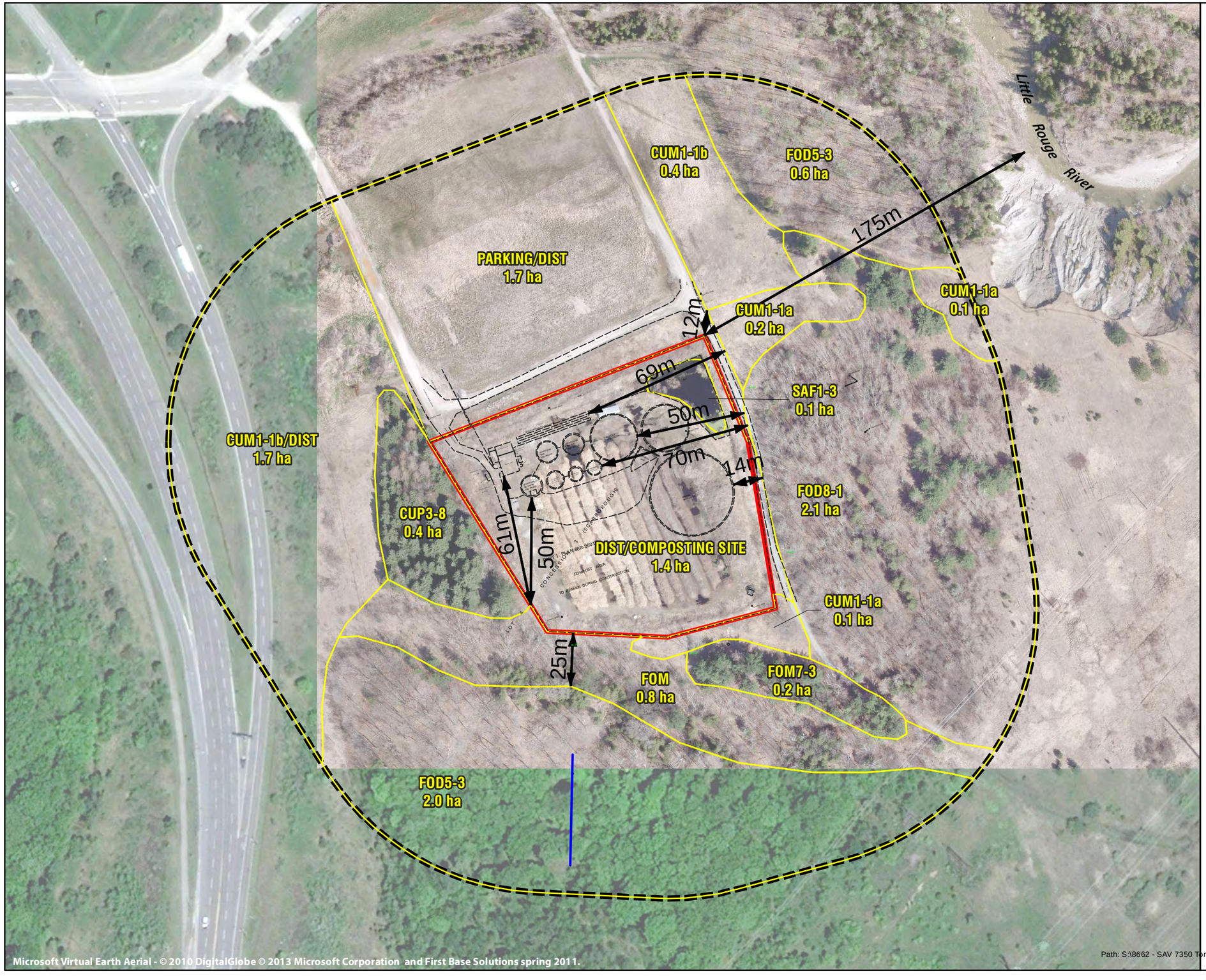
The grading of the proposed anaerobic digester facility will continue to follow the existing grades of the site. Drainage will continue to be to the man-made pond in the northeast corner outletting to the south east corner. As a result the flow from the facility will be unchanged except that it will no longer be contaminated as a result of contact with the manure.

3.0 Site Investigation

A site inspection was conducted on October 21, 2013 by Savanta. The weather was cloudy, 14 degrees Celsius, and light winds. The work was commenced at 11:30 am and was completed by 2:30pm. Additional information can be found in the Water Bodies report.

The site investigation and the photographic record confirm that there are no water bodies in the Project Location or within 120m of the site. This is further confirmed by a review of aerial imagery for the area. As previously mentioned in Section 1.4, a small man-made shallow pond occurs in the northeast corner of the Project Location, and is currently used for filtering compost runoff. The construction of the proposed anaerobic digester will occur outside of the pond area, and the pond will continue to be used for filtering localized surface runoff after the digester is constructed. Mitigation measures detailed in Section 9 will adequately protect the pond from impacts from construction.

As well, a localized drainage feature (unnamed) runs in a north to south direction, starting approximately 55m south of the Project Location, down the steep embankment within a deciduous forest. The drainage is within a gulley area and appears to only occur within the steep slope, and likely is ephemeral. As the slope subsides further south, any flow likely occurs as overland sheet flow before it (potentially) reaches the Rouge River, located approximately



ELC LEGEND

FOREST
FOM Mixed Forest Ecosite
FOM7-3* Fresh-Moist White Pine-Hardwood Mixed Forest
FOD5-3 Dry-Fresh Sugar Maple-Oak Deciduous Forest
FOD8-1 Fresh-Moist Poplar Deciduous Forest

SHALLOW WATER
SAF1-3 Duckweed Floating-leaved Shallow Aquatic

CULTURAL
CUP3-8 White Spruce Coniferous Plantation
CUM1-1a Dry-Fresh Old Field Meadow
CUM1-1b Dry-Fresh Old Field Meadow (Barnyard Grass)

DIST Disturbed

**not listed in Southern Ontario ELC*

Project Location
120m setback
Ecological Land Classification

Unnamed Drainage (Savanta 2013)

Toronto Zoo Anaerobic Digester

Figure 4
Natural Heritage Features

0 50 M
1:1,750
N

SAVANTA

Path: S:\8662 - SAV 7350 Toronto Zoo Anaerobic Digester\gis\mxd\report figures\Figure 4 Natural Heritage Features.mxd
Date Saved: 2013-10-25 5:46:37 PM

400m south of the Project Location. Without a direct connection to a watercourse, the drainage is considered to be “Not Fish Habitat” as per the TRCA’s Headwater Drainage Feature Guidelines. The feature had a bankful width ranging from 1 to 1.5m, a bankful height of approximately 0.4m, and a wetted perimeter of approximately six inches. The drainage was buried in woody debris further upslope. A slow trickle of water was observed in some areas, likely due to the fact that it had rained the previous day. No other drainages, including those from TRCA’s Digital Elevation Model, were observed within the surrounding 120m.

4.0 Facility Assessment

The proposed anaerobic digester facility does not contain a washroom and therefore there will be no sewage produced on the site. The site will only be staffed several hours per day when it is operational and will not require a permanent washroom. Should the need for a washroom occur in the future, a portable toilet will be placed on the site and any waste produced will be disposed of by a licensed contractor.

Appropriate siltation control measures will be in place before construction commences and until the site is stabilized. All disturbed areas will be seeded and planted to prevent erosion and sedimentation.

5.0 Stormwater Management

The storm water management report prepared by MGM outlines the proposed storm water management of the site.

6.0 Mitigation Measures

The following mitigation measures will be implemented to minimize any potential impact of the project on the surface water regime:

1. Silt fencing to be installed and maintained at the outlet of the construction site before the commencement of construction and to be maintained in place until construction is complete and the site is stabilized.
2. All disturbed areas are to be topsoiled and seeded or planted when construction is complete.
3. Storage of construction materials and fuel will not be located in the vicinity of the pond or the drainage course.

Appendix 1 ….. Trow Geotechnical Report

Appendix 2…… CV Clare Riepma

Trow

Geotechnical Investigation
Proposed Bio-Gas Facility
Toronto Zoo
Scarborough, Ontario

Prepared for:

Ms. Leona Mitchell, Project Manager
Toronto Zoo
361A Old Finch Avenue
Scarborough, Ontario
M1B 5K7

Trow Associates Inc.

70 Gibson Drive, Unit 12
Markham, Ontario L3R 4C2
Telephone: (905) 470-0073
Facsimile: (905) 470-9848

BRGE00366068A
May 27, 2009

TABLE OF CONTENTS

1. Introduction 1

2. Site Description 2

3. Procedure 3

4. Laboratory Testing 4

5. Subsurface Conditions 5

5.1 Soil 5

5.2 Groundwater 6

6. Engineering Discussion and Recommendations 7

6.1 General 7

6.2 Buildings Construction 7

6.2.1 Foundations 7

6.2.2 Excavation and Groundwater Control 9

6.2.3 Backfill Considerations 9

6.2.4 Floor Slab Construction and Permanent Drainage 10

6.2.5 Earthquake Considerations 10

6.3 Installation of Underground Services 12

6.4 Parking Areas and Access Roadways 12

7. General Comments 15

Drawings

Borehole Location Plan 1

Borehole Logs 2-4

1. Introduction

This report presents the findings of a geotechnical investigation conducted for the proposed Bio-Gas Facility to be located on the south side of Beare Road and east of Meadowvale Road in Scarborough, Ontario. The work was authorized by Ms. Leona Mitchell of the Toronto Zoo.

The project involves the proposed design and construction of a Bio-Gas facility which comprised several low-rise buildings. It is understood the proposed buildings will be one (1) storey slab-on-grade structures with no basement, and will be provided with paved access and parking areas.

The purpose of the geotechnical investigation was to determine the subsurface soil and groundwater conditions at the site by putting down a limited number of sampled boreholes and, based on an assessment of the factual borehole data, to provide geotechnical engineering guidelines for the design and construction of the proposed facility. More specifically, recommendations and/or comments regarding site grading, foundation type, allowable bearing pressures, groundwater conditions, excavation and backfill, slab-on-grade construction, permanent drainage requirements, earthquake considerations and pavement structures were to be provided.

The information contained in this report in no way reflects on the environmental aspects of the soils and groundwater.

2. Site Description

The site is situated on the south side of Beare Road and east of Meadowvale Road in Scarborough, Ontario. The north half of the site comprised open land and is presently vacant. The south half of the site is currently used for the storage of animal manure. The site is relatively flat and sloping slightly downward towards the centre.

3. Procedure

The fieldwork was carried out on May 20, 2009. A total of three (3) sampled boreholes were put down at the site. The boreholes were drilled to a depth of 6.55 m below existing grade. The approximate borehole locations are shown on the attached Borehole Location Plan (Drawing No. 1).

The boreholes were advanced using continuous flight solid stem augering equipment owned and operated by a specialist drilling contractor. In each borehole, samples were recovered using conventional split spoon equipment and standard penetration test methods.

Water levels were observed in the open boreholes during the course of the fieldwork.

The fieldwork was supervised by a Trow geotechnical engineer who monitored the drilling operations and logged the borings. All split spoon samples were transported to our laboratory for detailed examination.

The location and ground surface elevation of the boreholes were established in the field by Trow Associates Inc. The elevations were referenced to a temporary benchmark (TBM) described as follows:

TBM: Top of existing Manhole cover located on the south side of Beare Road as indicated on the enclosed Drawing No. 1.

Elevation: 100.00 m (assumed).

4. Laboratory Testing

The laboratory testing program comprised the following:

- Moisture content determination on all recovered soil samples, with results presented on the Log of Borehole sheets.

- Potential for corrosion attack on subsurface concrete (including pH, Sulphate, Sulphides, Chlorides and Redox Potential) was carried out for two (2) soil samples. The results of the tests will be reported once they become available.

- Two (2) composite soil samples were tested in accordance with the Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act (general and inorganic parameters) and TRCA Lakefill disposal guidelines. The results of the tests will be reported once they become available.

5. Subsurface Conditions

5.1 Soil

The detailed soil profile encountered in each borehole and the results of laboratory moisture content determinations are indicated on the attached borehole logs (Drawing Nos. 2 to 4). It should be noted the soil boundaries indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect approximate transition zones for the purpose of geotechnical design and should not be interpreted as exact planes of geological change. The "Notes on Sample Descriptions" preceding the borehole logs form an integral part of and should be read in conjunction with this report.

The stratigraphy of the north portion of the site, as revealed in Borehole 1, comprised surficial topsoil over native deposits of silty sand and clayey silt till. At the south portion of the site (Boreholes 2 and 3) the subsoil comprised surficial fill overlying topsoil underlain by native deposits of sand and gravel, silt and silty clay.

A brief description of the soil stratigraphy, in order of depth, follows.

Topsoil

Topsoil was encountered surficially in Borehole 1 and below the fill in Boreholes 2 and 3. The topsoil comprised dark brown sandy silt with organic inclusions. The thickness of the topsoil varied from about 220 to 300 mm.

Topsoil measurements were carried out at the borehole locations only and were found to be variable. Consequently, topsoil quantities should not be established from the information provided at the borehole locations only.

Fill

Fill was encountered surficially in Boreholes 2 and 3, and comprised brown sandy silt to clayey silt with scattered organic stained materials. The fill extended to depths of approximately 0.7 to 1.9 m below existing grade. The fill material generally existed in a compact state. Moisture contents of the fill ranged from 8 to 10 %, indicating a moist condition.

Silty Sand

At Borehole 1, a silty sand deposit was encountered below the surficial topsoil extending to a depth of about 2.3 m below existing grade. The relative density of the silty sand deposit was found to be compact to dense. Moisture contents ranged from 16 to 18 %, indicating a wet to saturated condition.

Clayey Silt Till

Below the silty sand unit in Borehole 1, a deposit of clayey silt till was encountered. The clayey silt till comprised brown to grey clayey silt, trace sand and gravel with numerous wet silt and sand seams. The consistency of the clayey silt till was typically stiff. Moisture contents of the clayey silt till ranged from 13 to 14 %. The clayey silt till deposit extended to beyond the maximum investigated depth of 6.55 m below existing grade.

Sand and Gravel

At Boreholes 2 and 3, a sand and gravel deposit was encountered at depths of about 1.0 to 2.1 m below existing grade, and extended to depths of about 4.6 m below existing grade. Based on the obtained 'SPT' values, the relative density of the sand and gravel deposit was inferred to be compact to very dense, being typically compact. It should be noted that some of the recovered sand samples below the water table were disturbed and the resulting 'N' values may be lower than actual. Moisture contents of recovered samples ranged from 5 to 18 %, indicating a moist to wet condition.

Silt

Below the sand and gravel deposit at Boreholes 2 and 3, a silt unit was encountered extending to a depth of about 6.1 m below existing grade. The silt deposit was grey in colour and was dense to very dense. Moisture contents of the silt ranged from 12 to 18 %, indicating a wet to saturated condition.

Silty Clay

A deposit of silty clay was encountered below the silt in Boreholes 2 and 3, extending to beyond the maximum investigated depth of 6.55 m below existing grade. The consistency of the silty clay was generally firm to stiff. Moisture contents of the silty clay ranged from 19 to 23 %.

5.2 Groundwater

Groundwater conditions were observed in the open boreholes during the course of the fieldwork. Groundwater measurements are included on the attached borehole logs.

Free groundwater was observed in the boreholes upon completion of drilling. The groundwater level was measured at depths of about 0.97 to 2.49 m below existing grade. Based on the observed groundwater levels and moisture contents of the recovered soil samples, it is our opinion that the groundwater table lies at shallow depths of about 0.3 to 2.1 m below existing grade (i.e. immediately below the original topsoil layer).

Seasonal fluctuation of the groundwater level at the site should be anticipated.

6. Engineering Discussion and Recommendations

6.1 General

The project involves the proposed design and construction of a Bio-Gas facility which comprised several low-rise buildings. It is understood the proposed buildings will be one (1) storey slab-on-grade structures with no basement, and will be provided with paved access and parking areas.

The following subsections provide geotechnical engineering guidelines for the design and construction of the proposed shopping plaza.

6.2 Buildings Construction

6.2.1 Foundations

Based on the results of the investigation, the site is generally considered suitable for construction of the proposed buildings with no basement. However, due to the high groundwater table at the site, it is recommended that the footings be founded as high as possible at the site to minimize major groundwater problems during construction. It is anticipated that some groundwater control measures or alternative methods of footing construction (such as trench and pour) will be required.

The proposed structures may be supported on conventional spread and strip footings founded on the native silty sand or sand and gravel below all topsoil, fill and disturbed soil. Footings founded on the compact to dense silty sand, sand and gravel below depths of about 1.0 to 2.2 m below existing grade may be designed for a factored bearing capacity of 200 kPa at Serviceability Limit State (SLS). The factored bearing capacity at Ultimate Limit State (ULS) is 300 kPa, subject to inspection during construction.

Alternatively, the proposed buildings may also be supported on footings founded at nominal depth on engineered fill developed over the native undisturbed soil and designed for a factored bearing capacity of 150 kPa at SLS. The factored bearing capacity at ULS is 225 kPa. It is recommended the engineered fill be constructed to design floor subgrade level prior to installation of footings. This will ensure the engineered fill placed will be suitable for foundations and slab-on-grade construction.

The engineered fill should be constructed by removing all existing topsoil, fill, buried topsoil and soft/loose disturbed native soils within the building envelope. The engineered fill should extend at least 3.0 m beyond the outside edge of the proposed exterior footings. The required extent of engineered fill should be determined based on a known fixed location for the structure and adherement of the conditions outlined above. In general, after the fill has been placed, the location of the structure cannot be changed. Accordingly, accurate survey control is essential to the success of engineered fill construction. In this regard, the boundaries of the engineered fill

should be laid out by a surveyor in consultation with engineering staff from Trow Associates Inc.

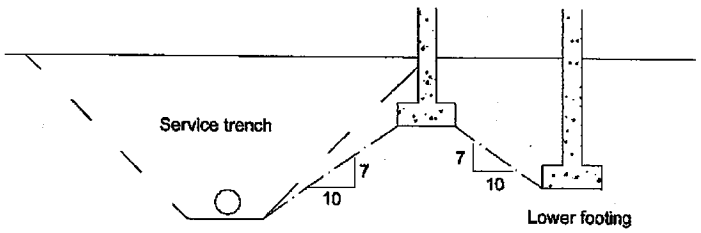
Prior to the placement of engineered fill, the exposed subgrade surface should be proofrolled by a heavy roller (no vibration) and examined by geotechnical personnel. Any loose/soft areas detected should be removed and replaced with approved material compacted to 100 % standard Proctor maximum dry density. The area can then be brought up to design subgrade level with approved on-site or imported material placed in lifts not exceeding 300 mm and compacted to 100 % standard Proctor maximum dry density. The native soils and fill not contaminated with topsoil may be used for engineered fill purposes.

The engineered fill construction should be monitored on a full-time basis by geotechnical personnel from Trow Associates Inc. to examine and approve backfill materials, to evaluate placement operations, and to verify the specified degree of compaction is being achieved uniformly throughout the fill.

It is recommended nominal reinforcing steel be installed in the footings and foundation walls to minimize cracking as a result of differential settlement due to the variable thickness of engineered fill or if footings are partially on native soil and partially on engineered fill. The reinforcing steel should be designed by a structural engineer.

6.2.1.1 Foundations General

Footings which are to be placed at different elevations should be located such that the higher footings are set below a line drawn up at 10 horizontal to 7 vertical from the near edge of the lower footing, as indicated on the following sketch:



FOOTINGS NEAR SERVICE TRENCHES OR AT DIFFERENT ELEVATIONS

All footings exposed to seasonal freezing conditions should be protected from frost action by at least 1.2 m of soil cover or equivalent insulation, depending on the final design requirements.

The total and differential settlements of well designed and constructed footings on native soil placed in accordance with the above recommendations are expected to be less than 25 mm and 20 mm, respectively.

It should be noted the recommended bearing capacities have been calculated by Trow from the borehole information for the design stage only. The investigation and comments are necessarily ongoing as new information on underground conditions becomes available. For example, it should be appreciated that modifications to the bearing level may be required if unforeseen subsoil conditions are revealed after the excavation is exposed to full view or if final design decisions differ from those assumed in this report. For this reason this office should be retained to review final foundation drawings and to provide field inspections during the construction stage.

6.2.2 Excavation and Groundwater Control

Due to the high groundwater table at the site, it is anticipated that the underlying soils will be wet to saturated, and the subgrade will be prone to disturbance and side collapse. As such, and depending on the depth of the excavation, normal footing excavation is not considered to be feasible and dewatering using frequent sump pumps or wells will be required prior to excavation for the foundations. Alternatively, a trench and pour method for shallow footing construction may be utilized, provided that concrete is readily available for placement immediately upon excavation and subgrade approval by Trow Associates Inc.

Excavation must be carried out in accordance with the current Occupational Health and Safety Act and local regulations. For preliminary guidance, side slopes of 1 vertical to 1 horizontal may be used for the temporary shallow excavations subject to geotechnical inspection. Where loose soil is encountered, it may be necessary to locally flatten the side slopes.

Seepage of water into the shallow excavation should be anticipated during construction. It should be possible to control and remove seepage from perched water in the upper sand layers using conventional construction dewatering techniques, i.e. pumping from frequent sumps or wells in conjunction with oversize excavation.

6.2.3 Backfill Considerations

Backfill used to satisfy underfloor slab requirements, in footing and service trenches, etc., should be compactible fill, i.e. inorganic soil with its moisture content close to its optimum value determined in the standard Proctor maximum dry density test. The excavated materials will primarily consist of topsoil, fill, silty sand, sand and gravel and clayey silt till. The topsoil is considered not suitable for re-use as backfill material. Fill material contaminated with organics will not be suitable for reuse as backfill. These materials should be used in non-structural landscaping areas. The native silty sand, sand and gravel and clayey silt till materials are considered suitable for re-use as backfill. However, these materials are wet and moisture adjustment will be required for proper compaction (i.e. air drying).

Organic/topsoil or excessively wet or otherwise deleterious material should not be used for backfilling purposes. Any shortfall of suitable on-site excavated material can be made up with imported granular material, OPSS Granular 'B' or equivalent. The backfill should be placed in lifts not more than 300 mm thick in the loose state with each lift being compacted to 98 % standard Proctor maximum dry density before subsequent lifts are placed. Smaller lifts may be

required depending on the size of compaction equipment used by the contractor and the moisture content of the fill at the time of compaction. Heavy compactors which generate large stresses should be kept a safe distance from walls to avoid structural damage. The degree of compaction achieved in the field should be checked by in-place density tests.

The overburden soils are not free draining and therefore should not be used where this characteristic is required or in confined areas where smaller compaction equipment is required. Imported granular material conforming to OPSS Granular 'B' specifications would also be suitable for these purposes.

6.2.4 Floor Slab Construction and Permanent Drainage

Slab-on-grade construction is feasible at the site and may be carried out in accordance with the following recommendations.

Prior to slab-on-grade construction, all existing organic/topsoil, fill and unsuitable material should be removed from the underfloor area. Following rough grading, the exposed subgrade should be proofrolled with a heavy roller under the supervision of Trow Associates Inc. Any soft spots detected should be subexcavated and the area brought up to design grade using clean compactible fill placed in 300 mm thick lifts and compacted to at least 98 % of its standard Proctor maximum dry density.

A 200 mm layer of 19 mm clear limestone should be placed between the prepared subgrade and the floor slab to serve as a moisture barrier. Also, within any unheated areas and the concrete sidewalk in front of the entrances, 50 mm of Styrofoam insulation should be provided below the floor slab to protect against frost heave.

The floor slab should be above the exterior finished grade. In view of the relatively high groundwater level at the site, underfloor drains should be installed below the floor slab. The drains should consist of 100 mm diameter perforated pipe surrounded by 150 mm of 19 mm clear stone all wrapped in Terrafix 270R or equivalent. The drainage system should lead to frost free sumps or outlets from which the water can be removed. Around the perimeter of the building, the ground surface should be sloped on a positive grade away from the structure to promote surface water run-off and to reduce groundwater infiltration adjacent to the foundations.

6.2.5 Earthquake Considerations

The recommendations for the geotechnical aspects to determine the earthquake loading are presented below.

6.2.5.1 Subsoil Conditions

The subsoil and groundwater information at this site have been examined in relation to Section 4.1.8.4 of the OBC 2006. The subsoil generally consisted of, in succession, native silty sand,

sand and gravel, silt, clayey silt till and silty clay deposits. The shallow foundations, such as footing or raft, will be founded in the compact silty sand or sand and gravel. The reported N-values for the soil below the founding level ranged from 6 to 100+.

There have been no shear wave velocity measurements carried out at this site and therefore, undrained shear strength and N-values will have to be used to determine the site classification.

6.2.5.2 Corrected N-Values N_{60}

The Average Standard Penetration Resistance shown in Table 4.1.8.4.A. Site Classification for Seismic Site Response in OBC 2006 refers to N_{60} which is defined as "Average Standard Penetration Resistance for the top 30m, corrected to a rod energy efficiency of 60% of the theoretical maximum". It should be noted that the drillers in the GTA area do not have their rod energy efficiencies measured and therefore, computed N_{60} values are not available for this site.

For the CME automatic hammer used by the driller for the boreholes at this site, the energy transfer compiled by Utah State and reported by GRL in Cleveland, Ohio, indicated that the range would be 67-83% and 59-91% for one and two standard deviations respectively. In our opinion, the reported N-value would therefore be approximately equivalent to the normalized N_{60} values as noted in the OBC 2006 for the purpose of establishing the site classification.

For the purpose of determining the averaged N-values, only the overburden values were used. Where the split spoon met refusal in the overburden soil, the N-value has been taken as 100.

6.2.5.3 Depth of Boreholes

Table 4.1.8.4.A. Site Classification for Seismic Site Response in OBC 2006 indicated that to determine the site classification, the average properties in the top 30 m are to be used. The boreholes advanced at the site were to a depth of about 6.55 m depth as per the terms of references. No bedrock was encountered within the depths investigated. Therefore, the site classification recommendation would be based on the available information as well as our interpretation of conditions below the boreholes.

6.2.5.4 Site Classification

Based on the above assumptions and interpretations and the known soil conditions, the Site Class for this site is "D" as per Table 4.1.8.4.A, Site Classification for Seismic Site Response, OBC 2006.

6.3 Installation of Underground Services

Installation of sewer and watermain may be required at the site. The depth of the sewer invert levels are not known but is anticipated to be less than 2 m below existing grade. All sewers and watermains should be protected from frost action by at least 1.2 m of soil cover.

Based on the results of the investigation, it is anticipated that the groundwater table will be relatively high at the site. As such, normal sewer excavation is not considered to be feasible and dewatering using frequent sump pumps or wells in conjunction with oversized excavations will be required prior to sewer or watermain excavation. The groundwater control system should be designed and installed by a dewatering specialist.

Following site dewatering, excavations in open cuts should be relatively straightforward using a hydraulic backhoe. Side slopes of temporary excavation must conform to the current Occupational Health and Safety Act and local regulations.

No bearing capacity problems are anticipated for pipes founded in the native soils provided adequate groundwater control measures are implemented. A minimum 150 mm bedding thickness of OPSS Granular 'A' crusher-run limestone or bedding in accordance with the town standard is recommended under the pipes. The bedding material should be compacted to at least 98% SPMDD. In wet subgrade areas, the pipe bedding should comprise 19 mm clear stone completely wrapped in geotextile filter fabric to prevent the migration of fines into the void spaces of the bedding material.

Granular material meeting the city standard should be extended upward as trench backfill for at least 300 mm above the obvert of the pipe or as per local practice. The remaining trench to final subgrade level should be backfilled in 300 mm thick lifts with approved excavated material compacted to 98% SPMDD.

Frequent inspection by Trow Associates Inc. geotechnical personnel should be carried out to examine and approve backfill materials, to carefully inspect placement, and to verify the specified degree of compaction has been obtained.

6.4 Parking Areas and Access Roadways

The recommended pavement structures provided in Table 1 are based upon an estimate of the subgrade soil properties determined from visual examination and textural classification of the soil samples. Consequently, the recommended pavement structures should be considered for preliminary design purposes only. A functional design life of eight to ten years has been used to establish the pavement recommendations. This represents the number of years to the first rehabilitation, assuming regular maintenance is carried out.

Table 1: Recommended Pavement Structure Thicknesses

Pavement Layer	Compaction Requirements	Light-Duty Pavement (Car Parking)	Heavy-Duty Pavement (Access Routes, Truck Parking)
Asphaltic Concrete (OPSS 310)	92 to 96.5 % Maximum Relative Density	40 mm HL3 50 mm HL8	40 mm HL3 65 mm HL8
OPSS Granular A Base (OPSS 1010)	100% SPMDD*	150 mm	150 mm
OPSS Granular B Subbase (OPSS 1010)	100% SPMDD*	200 mm	400 mm

* Denotes standard Proctor maximum dry density, ASTM-D698

The granular bases may comprise sand and gravel or Crusher-Run Limestone material. The subgrade should be compacted to 98 % SPMDD for at least the upper 300 mm.

The foregoing design assumes construction is carried out during dry periods and the subgrade is stable under the load of construction equipment. If construction is carried out during wet weather and heaving or rolling of the subgrade is experienced, additional thickness of sub-base course material may be required.

The long-term performance of the pavement structure is highly dependent upon the subgrade support conditions. Stringent construction control procedures should be maintained to ensure uniform subgrade moisture and density conditions are achieved. In addition, the need for adequate drainage cannot be over-emphasized. The finished pavement surface and underlying subgrade should be free of depressions and should be sloped to provide effective surface drainage toward catchbasins. Surface water should not be allowed to pond adjacent to the outside edges of pavement areas.

Additional comments on the construction of parking areas, driveways are as follows:

1. All existing topsoil and unsuitable material within the proposed parking areas and driveways should be removed. The exposed subgrade should be proofrolled in the presence of a representative of this office. Soft or spongy subgrade areas should be subexcavated and replaced with suitable approved backfill compacted to 98% SPMDD. Fill required to raise the grades to design elevations should be organic-free and at a moisture content which will permit compaction to 98% SPMDD. The final subgrade surface should be properly shaped and crowned.

2. The location and extent of sub-drainage required within the paved areas should be reviewed by this office in conjunction with the proposed site grading. Perimeter subdrains should be provided around parking areas and along driveways. In addition, subdrains extending from and between catchbasins should also be installed.

3. To minimize problems of differential movement between the pavement and catchbasins/manholes due to frost action, backfill around these structures should consist of free-draining granular material. The granular material should be compacted to 98% SPMDD with a small tamper to avoid damaging the structures.

4. The most severe loading conditions on light-duty pavement areas and the subgrade may occur during construction. Consequently, special provisions such as restricted lanes, half-loads during paving, etc. may be required, especially if construction is carried out during unfavorable weather.

5. It is recommended Trow be retained to review the final pavement structure design and drainage plans prior to construction to ensure they are consistent with the recommendations of this report.

7. General Comments

Trow Associates Inc. should be retained for a general review of the final design and specifications to verify this report has been properly interpreted and implemented. If not accorded the privilege of making this review, Trow Associates Inc. will assume no responsibility for interpretation of the recommendations in the report.

The comments given in this report are intended only for the guidance of design engineers. The number of boreholes required to determine the localized underground conditions between boreholes affecting construction costs, techniques, sequencing, equipment, scheduling, etc. could be greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should, in this light, decide on their own investigations as well as their own interpretations of the factual borehole results so that they may draw their own conclusions as to how the subsurface conditions may affect them.

More specific information with respect to the conditions between samples or the lateral and vertical extent of materials may become apparent during excavation operations. The interpretation of the borehole information must, therefore, be validated during excavation operations. Consequently, during the future development of the property, conditions not observed during this investigation may become apparent; should this occur, Trow Associates Inc. should be contacted to assess the situation and additional testing and reporting may be required. Trow has qualified personnel to provide assistance in regard to future geotechnical issues related to this property.

We trust this report is satisfactory for your purposes. Should you have any questions or comments, please do not hesitate to contact this office.

Yours truly,

Trow Associates Inc.

LICENSED PROFESSIONAL ENGINEER S-L. YIP PROVINCE OF ONTARIO

So-Lim Yip, P. Eng.
Project Engineer

REGISTERED PROFESSIONAL ENGINEER P T-L. CHAN PROVINCE OF ONTARIO

Peter Chan, P. Eng.
Manager, Markham Office

Distribution: Client (3)
Trow Markham (1)
Trow Brampton (1)

Drawings

Borehole Location Plan
Borehole Logs

Log of Borehole 1

Project No. BRGE00366068A

Project: Geotechnical Investigation

Location: Proposed Bio-Gas Facility, Toronto Zoo, ON

Drawing No. 2

Sheet No. 1 of 1

Date Drilled: May 20, 2009

Drill Type: Solid Stem Auger 150 mm

Datum: TBM = 100.00 m (assumed)

Auger Sample ☒
SPT (N) Value ○ ▨
Dynamic Cone Test ——
Shelby Tube ■
Field Vane Test S

Combustible Vapour Reading □
Natural Moisture ×
Plastic and Liquid Limit |—○
Undrained Triaxial at % Strain at Failure ⊕
Penetrometer ▲

GWL	SYMBOL	Soil Description	ELEV. m
		TOPSOIL - 220mm topsoil with organics, grass covered; dark brown, saturated	98.52
		SILTY SAND- fine grained, organic stains in upper zone; brown changing to grey at ~1.1m, saturated, compact to dense	98.3
		CLAYEY SILT TILL- trace to some sand, trace gravel, occasional wet silty sand seams; grey, about plastic limit, stiff	96.2
		END OF BOREHOLE	92.0

DEPTH

N Value: 20 40 60 80
Shear Strength: 0.1 MPa 0.2
Combustible Vapour Reading (ppm): 250 500 750
Natural Moisture Content % Atterberg Limits (% Dry Weight): 10 20 30
SAMPLES
Natural Unit Weight kN/m³

12
36
42
10 75 kPa
50 kPa
50 kPa
50 kPa

LAGWGL02 GE00366068A.GPJ NEW.GDT 5/27/09

Trow

Time	Water Level (m)	Depth to Cave (m)
On completion	0.97	1.34

Log of Borehole 2

Project No. BRGE00366068A

Project: Geotechnical Investigation

Location: Proposed Bio-Gas Facility, Toronto Zoo, ON

Drawing No. 3

Sheet No. 1 of 1

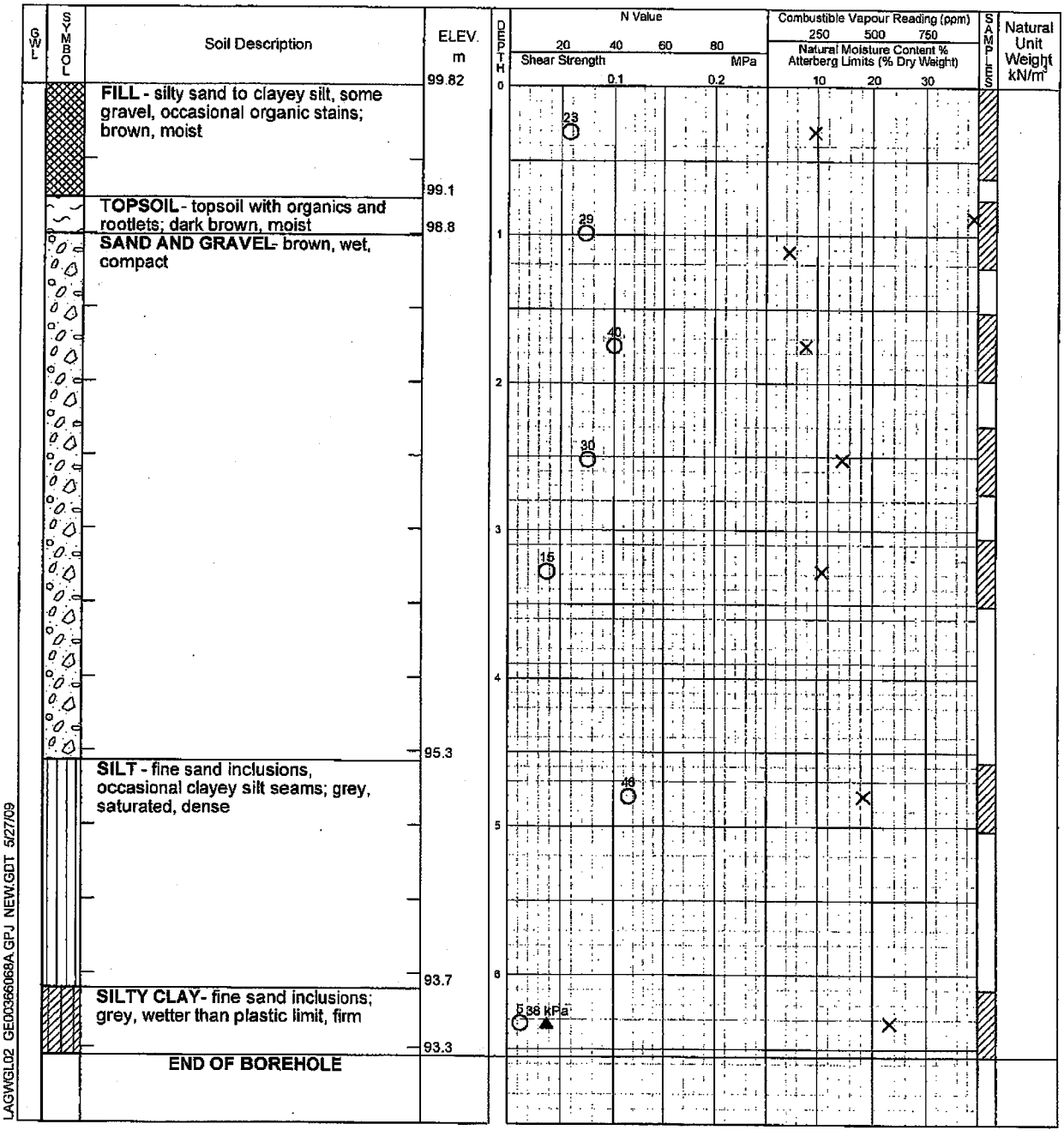
Date Drilled: May 20, 2009

Drill Type: Solid Stem Auger 150 mm

Datum: TBM = 100.00 m (assumed)

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer



LAGWGL02 GE00366068A.GPJ NEW.GDT 5/27/09

Trow

Time	Water Level (m)	Depth to Cave (m)
On completion	1.10	1.25

Log of Borehole 3

Project No. BRGE00366068A

Project: Geotechnical Investigation

Location: Proposed Bio-Gas Facility, Toronto Zoo, ON

Drawing No. 4

Sheet No. 1 of 1

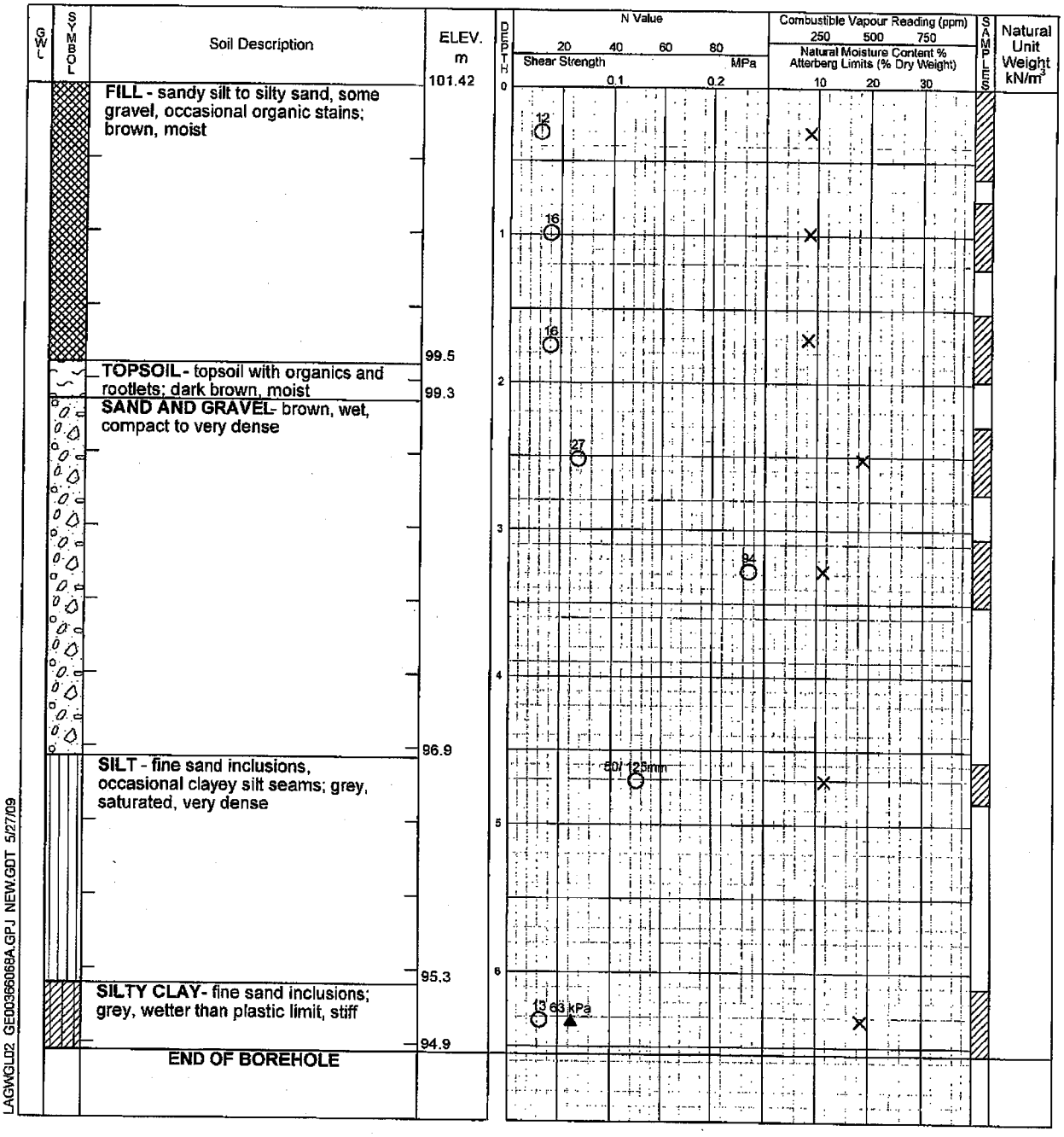
Date Drilled: May 20, 2009

Drill Type: Solid Stem Auger 150 mm

Datum: TBM = 100.00 m (assumed)

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test

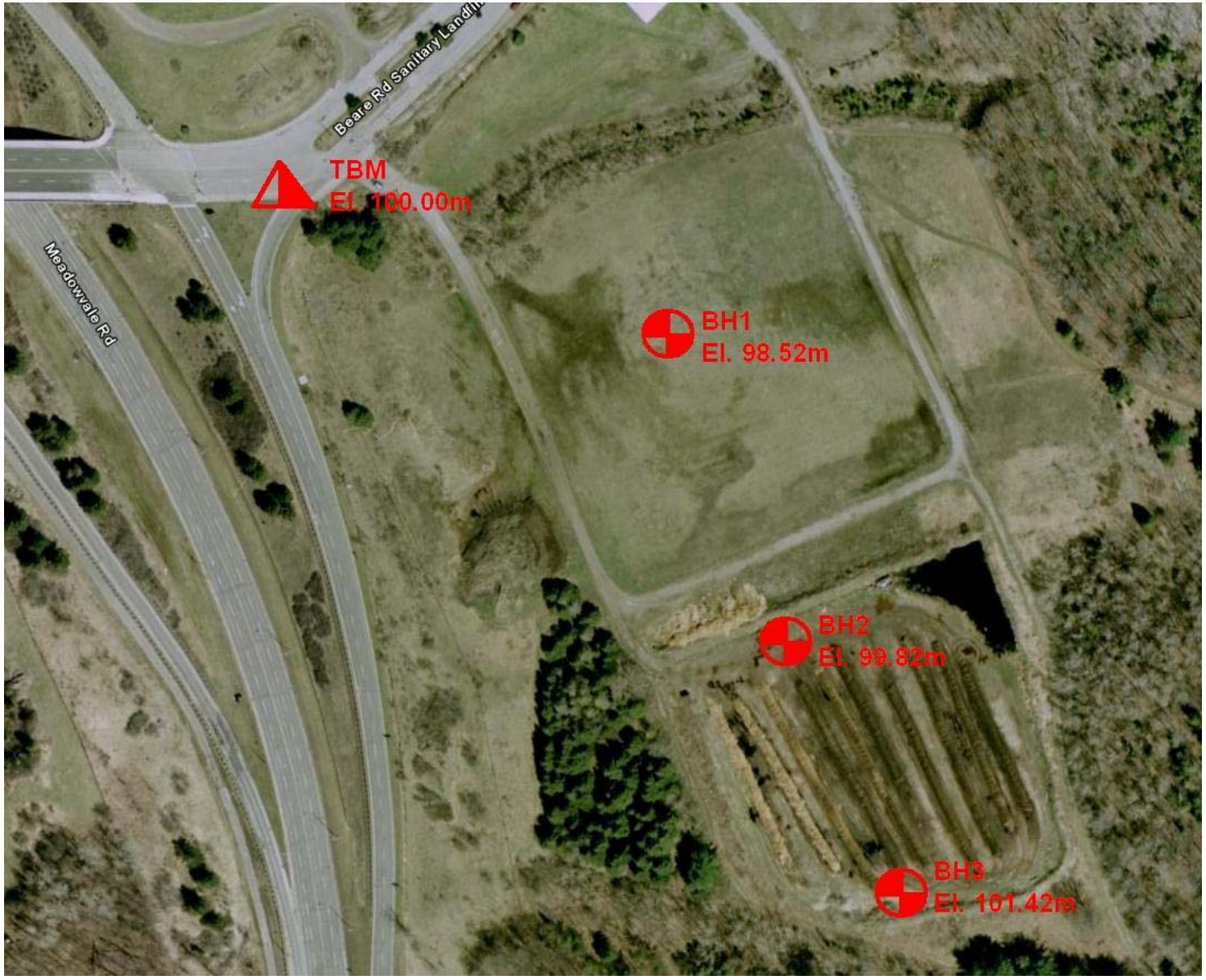
Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer



LAGWGLD2 GE00366068A.GPJ NEW.GDT 5/27/09

Trow

Time	Water Level (m)	Depth to Cave (m)
On completion	2.49	2.59



Borehole Location Plan

TBM: Top of Catch Basin in the existing roadway of Beare Road at Meadowvale Road northbound

Trow Associates Inc.
70 Gibson Drive, Unit 12
Markham Ontario
L3R 4C2
Telephone: (905) 470-0073
Fax: (905) 470-9848

SCALE: ~ NTS

DATE: May 2009

Geotechnical Investigation
Proposed Bio-Gas Facility
Toronto Zoo
361A Old Finch Avenue
Scarborough, ON

DWN.: VT | **CHKD.: VT**

PROJECT NO.: BRGE00366068A

DRAWING NO.: 1

Clare Riepma, B.A.Sc.,M.E.S.,P.Eng.,R.P.P.

Education and Professional Memberships

- Bachelor of Applied Science (Civil Engineering) University of Toronto, 1972
- Master in Environmental Studies, York University, 1982
- Professional Engineers of Ontario
- Member Canadian Institute of Planners
- Registered Professional Planner

Summary of Biogas Experience

Mr. Riepma is the past president of PlanET Biogas Solutions Inc. and is a recognized authority in the area anaerobic digester feasibility assessment, design, approval and construction. He is regularly asked to speak at conferences on the subject of Anaerobic Digestion. He received training in Germany and has led the implementation of the following installations in Canada:

- Bayview Flowers, Jordan Station, Ontario, 250kW, $1.8m
- Vandermeer Greenhouses, Niagara-on-the-Lake, 335kW, $2.4m
- Ledgecroft farms, Seeley's Bay, 500kW, $2.5m
- Delft Blue Veal, Cambridge, Ontario, 500kW, $2.5m
- Catalyst Energy, Abbottsford, B.C., 1.5MW equivalent, $3.5m
- University of Guelph, Ridgetown College, 250kW, $2.3m

In addition he has completed feasibility and design assignments for many agricultural, industrial and municipal clients and undertook the environmental assessment for the Gardiner Farms Anerobic Digester. He has completed reports for the City of Toronto with respect to biogas utilization in both their Dufferin and Disco Road plants. Currently he is leading the design and approvals of a digester to be constructed at the Toronto Zoo.

Employment History

1990 – Pres. Riepma Consultants Inc.
President
Focused on the planning, design and implementation of renewable energy projects, principally biogas and solar installations. Urban and rural planning, expert testimony, environmental consulting.

2007 - 2009 PlanET Biogas Solutions Inc.
President
Responsible for operating Canada's leading biogas company designing and building anaerobic digesters producing energy from organic inputs. Awarded the

Environmental Company of the Year by the Niagara Chamber of Commerce in 2009.

1976 – 1990 **F. J. Reinders and Associates Limited**
Vice-President
Responsible for the municipal services of the firm including municipal planning, transportation, environmental assessment, land development, special research and analysis studies and resource management.