coffey geotechnics
SPECIALISTS MANAGING THE EARTH

GEOTECHNICAL INVESTIGATION
UPTOWN CENTRE, SOUTHWEST CORNER
APPLEBY LINE & IRONSTONE DRIVE
BURLINGTON, ONTARIO

ICP Developers Inc.

Project: SPB737
February 10, 2009

Coffey Geotechnics Inc.
735 Griffith Court Units 2 & 3 Burlington Ontario L7L 5R9 Canada

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SPECIALISTS MANAGING THE EARTH

February 10, 2009

ICP Developers Inc.
100-48 Village Center Place
Mississauga, ON
L4Z 1V9

Attention: Mr. Liaquat J. Mian, President

Dear Sir:

RE: Geotechnical Investigation, Proposed Uptown Centre, Southwest Corner of Appleby Line and Ironstone Drive, Burlington, ON

Enclosed is a copy of our Geotechnical Investigation report for the proposed Uptown Centre at the southwest corner of Appleby Line and Ironstone Drive, Burlington, Ontario.

Please contact the undersigned with any questions or for further clarifications.

For and on behalf of Coffey Geotechnics Inc.

Eva Papp

Eva Papp, P.Eng.
Senior Project Engineer

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Project: SPB737

EXECUTIVE SUMMARY

A geotechnical investigation based on eight boreholes was carried out for the proposed commercial development to be constructed at the southwest corner of Appleby Line and Ironstone Drive in Burlington, Ontario.

It is understood that the proposed buildings will consist of single-storey structures with slab-on-grade construction, with paved parking lots.

The key findings of the geotechnical investigation are as follows.

Surficial vegetation, i.e. grass and weeds were observed throughout the site. Ponding water was observed in the area at boreholes BH2 and BH7. The site is generally covered with surficial vegetation, however, even though snow covered, stockpiles of fill and construction debris could be observed throughout the site. The stockpiles were observed in the areas of BH1 and BH2, and BH3. The stockpiled material could not be analysed due to frozen and snow covered conditions.

Topsoil ranging from 150 mm to 200 mm in thickness was encountered at the surface at most of the boreholes. At boreholes BH1, BH2, and BH7, fill consisting of topsoil or clayey silt mixed with topsoil was encountered and extended to depths varying between 0.9 m to 1.5 m.

It should be noted that the depth of topsoil or fill is subject to significant change in short distances and between boreholes and can be higher than that encountered in the boreholes elsewhere on the site. It is recommended that contractors bidding on the job confirm the topsoil and fill thicknesses through their own investigations or test pits.

Below the topsoil in BH3 to BH6 and at BH8, a reworked clayey silt layer was contacted that extended to depths of 0.8 to 0.9 m below grade. The clayey silt contained rootlets, organics and was in a loose state. Underlaying the reworked clayey silt, a clayey silt glacial till deposit was encountered in most of the boreholes. The till was typically brown and gravel was widely dispersed throughout the deposit. Inclusions of weathered shale were frequent in the lower levels of the deposit and this zone is commonly referred to as till/shale complex as noted in the boreholes. The till/shale complex was typically brown/red, moist and in a hard state.

The surface of the shale bedrock was contacted in BH3, BH5, and BH6 at depths varying between 1.5 m and 2.3 m below grade.

All boreholes were dry after completion of drilling. However, it is common to encounter water seepage at the fractured surface of the weathered bedrock.

The proposed structures can be supported by conventional spread and strip footings founded on the hard clayey silt till/weathered shale below any reworked clayey silt or fill. The footings can be designed for an allowable bearing pressure of 300 kPa(SLS)/450 kPa(ULS).

The floor slabs can be supported on grade provided that all fill, buried topsoil and surficially softened/disturbed native soils are removed and the native till remains undisturbed and relatively free of construction traffic. Fill required to raise the grade can consist of imported granular material, placed in

shallow lifts and compacted to 98 percent of Standard Proctor Maximum Dry Density (SPMDD). Alternatively, a structural floor slab can be used.

These and other geotechnical considerations are discussed in the body of this report.

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Appendix A

Bedrock Comments

1 INTRODUCTION

Coffey Geotechnics Inc. (Coffey) was retained by Mr. Liaquat J. Mian of ICP Developers Inc. to carry out a geotechnical investigation for the proposed commercial development located at the southwest corner of Appleby Line and Ironstone Drive in Burlington, Ontario.

It is understood that the proposed structure will consist of single-storey structures with slab on grade construction, i.e. without basement.

The purpose of this investigation was to determine the subsurface conditions at eight borehole locations. From the findings in these boreholes, engineering recommendations were to be made for the following:

1. Foundations
2. Floor slabs and permanent drainage
3. Excavations and backfill
4. Earthquake considerations
5. Environmental Consideration
6. Pavements

This report is provided on the basis of the terms of reference presented above and on the assumption that the design will be in accordance with the applicable codes and standards. If there are any changes in the design features relevant to the geotechnical analyses, or if any questions arise concerning the geotechnical aspects of the codes and standards, this office should be contacted to review the design. It may then be necessary to carry out additional borings and reporting before the recommendations of this office can be relied upon.

The site investigation and recommendations follow generally accepted practice for geotechnical consultants in Ontario. The format and contents are guided by client specific needs and economics and do not conform to generalized standards for services. Laboratory testing for most part follows ASTM or CSA Standards or modifications of these standards that have become standard practice.

This report has been prepared for ICP Developers Inc., its engineers and designers. Third party use of this report without Coffey Geotechnics Inc. consent is prohibited.

2 PROCEDURE

Eight (8) boreholes (BH1 through BH8) were advanced to depths ranging between depths ranging from 1.7 m to 2.9 m by a drilling sub-contractor under the direction and supervision of Coffey Geotechnics Inc. personnel. The boreholes were terminated on refusal on assumed limestone layers in the till/weathered shale. Samples were retrieved at regular intervals with a 50 mm O.D. split-barrel sampler driven with a hammer weighing 624 N and dropping 760 mm. The samples were logged in the field and returned to the

Coffey Geotechnics Inc. laboratory for detailed examination by the project engineer and for laboratory testing.

Water level observations were made during drilling and in the open boreholes at the completion of the drilling operations.

The surveying of the borehole locations was undertaken by Coffey Geotechnics Inc. personnel. The ground surface elevations at the borehole locations were surveyed by S&P personnel and referenced to City of Burlington Benchmark No. 481 with a published elevation of 139.273 m.

As well as visual examination in the laboratory, all of the soil samples were tested for moisture content.

3 SUBSURFACE CONDITIONS

The borehole locations are shown on Drawing 1 and detailed subsurface conditions encountered in the boreholes are presented on the Borehole Logs, Drawings 2 to 9. These are summarized as follows.

Surficial vegetation, i.e. grass and weeds were observed throughout the site. Ponding water was observed in the area at boreholes BH2 and BH7. The site is generally covered with surficial vegetation, however, even though snow covered, stockpiles of fill and construction debris could be observed throughout the site. The stockpiles were observed in the areas of BH1 and BH2, and BH3. The stockpiled material could not be analysed due to frozen and snow covered conditions.

Topsoil ranging from 150 mm to 200 mm in thickness was encountered at the surface at most of the boreholes. At boreholes BH1, BH2, and BH7, fill consisting of topsoil or clayey silt mixed with topsoil was encountered and extended to depths varying between 0.9 m to 1.5 m.

It should be noted that the depth of topsoil or fill is subject to significant change in short distances and between boreholes and can be higher than that encountered in the boreholes elsewhere on the site. It is recommended that contractors bidding on the job confirm the topsoil and fill thicknesses through their own investigations or test pits.

Below the topsoil in BH3 to BH6 and at BH8, a reworked clayey silt layer was contacted that extended to depths of 0.8 to 0.9 m below grade. The clayey silt contained rootlets, organics and was in a loose state. Underlaying the reworked clayey silt, a clayey silt glacial till deposit was encountered in most of the boreholes. The till was typically brown and gravel was widely dispersed throughout the deposit. Inclusions of weathered shale were frequent in the lower levels of the deposit and this zone is commonly referred to as till/shale complex as noted in the boreholes. The till/shale complex was typically brown/red, moist and in a hard state.

The surface of the shale bedrock was contacted in BH3, BH5, and BH6 at depths varying between 1.5 m and 2.3 m below grade. The boreholes were terminated on refusal on possible limestone layers in the till/weathered shale. The bedrock was not proven by coring.

The bedrock underlying the site is known to belong to the Queenston Formation of the Upper Ordovician Period of the Paleozoic Era. The Queenston Formation is approximately 450 million years old and consists of red shale with some harder siltstone and sandstone and hard limestone and dolostone interbeds. The hard layers are usually less than about 200 mm thick but some layers are much thicker. These layers are

actually lenses and they can vary significantly in thickness over short distances. It is possible that limestone layers may be present in excess of 300 mm thick in this type of formation.

The shale is susceptible to disintegration and swelling upon exposure to air and water, with subsequent reversion to a clay soil, but the limy shale, limestone and sandstone bands would remain as rock slabs.

Methane gas is often encountered within the bedrock. A more detailed description of the bedrock is included as **Appendix A.**

All boreholes were dry after completion of drilling. However, it is common to encounter water seepage at the fractured surface of the weathered bedrock.

It should be noted that the groundwater level measurements are short term and are subject to fluctuation due to seasonal changes and in response to major weather events.

Combustible vapour readings were taken in the boreholes on completion of drilling with a portable Scott D-15 gas detector and no gas was detected.

4 FOUNDATIONS

The proposed structures can be supported by conventional spread and strip footings founded on the hard clayey silt till/weathered shale found below any fill or reworked/disturbed clayey silt for an allowable bearing pressure of **300 kPa (SLS) or 450 kPa (ULS).**

The bearing values and the corresponding founding elevations at the borehole locations are summarized on the following Table 1.

From top of finished level to bottom of footing

Table 1

Bearing Values for Spread and Strip Footings

Borehole	Material	Bearing Pressure (kPa)		Highest Founding Depth (m)	Founding Elevation (m)
		SLS	ULS		
BH1	Clayey Silt Till	300	450	Below 1.0	Below 135.1
BH2	Clayey Silt Till/Weathered Shale	300	450	Below 1.5	Below 134.6
BH3	Clayey Silt Till/Weathered Shale	300	450	Below 0.8	Below 135.6
BH4	Clayey Silt Till	300	450	Below 0.8	Below 135.0
BH5	Clayey Silt Till	300	450	Below 0.8	Below 135.3
BH6	Clayey Silt Till	300	450	Below 0.8	Below 135.9

Footings designed to the bearing values given on Table 1 are expected to settle less than 25 mm total and 19 mm differential.

All footings exposed to seasonal freezing conditions must have at least 1.2 metres of soil cover for frost protection.

In the vicinity of the existing buried utilities, all footings must be lowered to undisturbed native soils, or alternatively the services must be structurally bridged.

Where it is necessary to place footings at different levels, the upper footing must be founded below an imaginary 10 horizontal to 7 vertical line drawn up from the base of the lower footing. The lower footing must be installed first to help minimize the risk of undermining the upper footing.

It should be noted that the recommended bearing capacities have been calculated by Coffey from the borehole information for the design stage only. The investigation and comments are necessarily on-going as new information of the underground conditions becomes available. For example, more specific information is available with respect to conditions between boreholes when foundation construction is underway. The interpretation between boreholes and the recommendations of this report must therefore be checked through field inspections provided by Coffey to validate the information for use during the construction stage.

5 FLOOR SLABS AND PERMANENT DRAINAGE

For maintenance free floor slabs, the floor can be supported on grade provided that all fill and surficially softened/disturbed native soils are removed and the native clayey silt till remains undisturbed and relatively free of construction traffic. Fill required to raise the grade can consist of imported granular material, placed in shallow lifts and compacted to 98 percent of Standard Proctor Maximum Dry Density (SPMDD). Alternatively, a structural floor slab can be used.

A moisture barrier consisting of at least 200 mm of 19 mm clear crushed stone should be installed under the floor slab.

If the floor slab is more than about 300 mm higher than the exterior grade then perimeter drainage is not considered to be necessary. If the floor is lower then the perimeter drainage system shown on Drawing 10 is recommended.

6 EARTH PRESSURES

The lateral earth pressures acting on basement walls, retaining walls, etc. may be calculated from the following expression:

$p = K(\gamma h + q)$

where p	=	Lateral earth pressure in kPa acting at depth h
K	=	Earth pressure coefficient equal to 0.4 for vertical walls and horizontal backfill used for permanent construction.
γ	=	Unit weight of backfill, a value of 21 kN/ cu.m. may be assumed
h	=	Depth to point of interest in metres
q	=	Equivalent value of surcharge on the ground surface in kPa

The above expression assumes that the perimeter drainage system prevents the build up of any hydrostatic pressure behind the wall and granular backfill will be used behind the wall.

7 EXCAVATIONS AND BACKFILL

Excavations can be carried out with hydraulic backhoes. No significant groundwater problems are anticipated. Any perched water entering the excavations can be easily controlled by pumping from perimeter sumps and trenches. The till/shale till complex will contain boulders/cobbles and the shale will contain harder limestone layers, as evidenced in some boreholes. Contractors must be prepared to deal with these obstructions should they occur.

Backhoes equipped with rock teeth may be required to excavate the shale. The shale bedrock (including the weathered rock) will contain hard limestone layers which may be as thick as 300 mm or greater.

Usually the thinner layers, up to about 100 mm, can be excavated with backhoes equipped with rock teeth. Thicker layers will probably have to be broken up with pneumatic rock hammers before they can be excavated with the backhoe.

All temporary excavations must be carried out in accordance with the most recent Occupational Health and Safety Act (OHSA). In accordance with OHSA, fill is classified as Type 3 soil, and the till/shale till complex and shale can be classified as Type 2 to 1 material.

The fill in the areas of BH1, BH2, and BH7 consists of topsoil and not suitable to be re-used as structural fill. The native soils can be used for construction fill provided that its moisture content is within ± 2 percent of its optimum moisture content at the time of the construction and can be compacted with sheepsfoot type compactors. Loose lifts of sand which are to be compacted should not exceed 200 mm.

It should be noted that the excavated soils are subject to moisture content increase during wet weather which would make these materials too wet for adequate compaction. Stockpiles should therefore be compacted at the surface or be covered with tarpaulins to help minimize moisture uptake.

Imported granular fill, which can be compacted with hand held equipment, should be used in confined areas.

Underfloor fill should be compacted to at least 98 percent SPMDD.

Where free draining backfill is required, imported granular fill such as OPSS Granular B should be used.

8 EARTHQUAKE CONSIDERATIONS

Under the new OBC2006 and NBC2005, the site can be categorized as Class C for seismic considerations.

9 UNDERGROUND SERVICES

Excavations for the installation of services may be carried out to depths deeper than the footing excavations. No significant problems with groundwater are anticipated in the clayey silt till and weathered shale. However, water bearing sand layers common to tills may yield much water. Contractors must be equipped to handle this situation should it occur. All excavations must be carried out in accordance with the Occupational Health and Safety Act.

Excavations into the sound Queenston Shale have been known to create slight lateral movement of the rock caused by the release of residual stress in the rock mantle, which can result in damage to buried services. Therefore, where sound shale is encountered at sewer invert or foundation elevations, it is recommended that the sides of the trenches be cut back at side slopes of 2 vertical to 1 horizontal or flatter. Sufficient space should be left between the pipe and the face of the rock (i.e. at least 0.3 m) and this should be backfilled with sand receiving moderate compaction only, i.e. 95 percent SPMDD.

Granular B should be used as backfill material for trenches located under slab on grade or paved areas. Compaction of the granular soils should be carried out with vibratory compactors and loose lifts not exceeding about 200 mm.

Trench backfill should be compacted to at least 95 percent SPMDD to within 0.6 m of the top of the subgrade and then to 98 percent SPMDD to the subgrade level.

Class B bedding should be suitable to support the pipes. The bedding material should conform to local municipality's bedding stone gradation requirements. Where the bedding falls below the anticipated water table, the bedding stone must be surrounded with a geotextile filter cloth.

10 PAVEMENTS

The recommended pavement structures provided in Table 2 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. If required, a more refined pavement structure design can be performed based on specific traffic data and design life requirements and will involve specific laboratory tests to determine frost susceptibility and strength characteristics of the subgrade soils, as well as specific data input from the client.

Table 2: Recommended Pavement Structure Thickness

Pavement Layer	Compaction Requirements	Light Duty Parking (Cars)	Heavy Duty Parking/Driveway (Delivery Trucks)
Asphaltic Concrete	97% Marshall Density	40 mm OPSS HL 3 40 mm OPSS HL 8	40 mm OPSS HL 3 80 mm OPSS HL 8
OPSS Granular A Base (Crushed Limestone)	100% SPMDD*	150 mm	150 mm
OPSS Granular B Sub-base	100% SPMDD	200 mm	300 mm

* Denotes Standard Proctor Maximum Dry Density, ASTM-D698
The subgrade must be compacted to 98% SPMDD for at least the upper 300 mm unless accepted by Coffey Geotechnics

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 (preferably at a minimum grade of two percent) to provide effective surface drainage toward catch basins. Surface water should not be allowed to pond adjacent to the outside edges of pavement areas. Subdrains should be installed to intercept excess subsurface moisture and prevent subgrade softening. This is particularly important in heavy-duty pavement areas.

Additional comments on the construction of parking areas and access roadways are as follows:

- As part of the subgrade preparation, proposed parking areas and access roadways should be stripped of topsoil, topsoil containing fill and other obvious objectionable material. Fill required to raise the grades to design elevations should conform to backfill requirements outlined in previous sections of this report. The subgrade should be properly shaped, crowned then proof-rolled in the full time presence of a representative of this office. Soft or spongy subgrade areas should be sub-excavated and properly replaced with suitable approved backfill compacted to 98% SPMDD.

- The locations and extent of sub-drainage required within the paved areas should be reviewed by this office in conjunction with the proposed lot grading. Assuming that satisfactory crossfalls in the order of two percent have been provided, subdrains extending from and between catch basins may be satisfactory. In the event that shallower crossfalls are considered, a more extensive system of sub-drainage may be necessary and should be reviewed by Coffey.

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

- It is recommended that Coffey be retained to review the final pavement structure designs and drainage plans prior to construction to ensure that they are consistent with the recommendations of this report.

11 ENVIRONMENTAL CONSIDERATIONS

The information in this report in no way reflects on the environmental aspects of the site and this has not been addressed in this report, since this aspect is beyond the scope and terms of reference. Should specific information be required, additional testing will be required.

12 GENERAL COMMENTS

Coffey should be retained for a general review of the final design and specifications to verify that this report has been properly interpreted and implemented. If not accorded the privilege of making this review, Coffey 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., would be much 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.

13 LIMITATIONS OF REPORT

This report is intended solely for the Client named. The material in it reflects our best judgment in light of the information available to Coffey Geotechnics Inc. at the time of preparation. Unless otherwise agreed in writing by Coffey Geotechnics Inc., it shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. No portion of this report may be used as a separate entity, it is written to be read in its entirety.

The conclusions and recommendations given in this report are based on information determined at the test hole locations. The information contained herein in no way reflects on the environment aspects of the project, unless otherwise stated. Subsurface 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, which could not be detected or anticipated at the time of the site investigation. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the test hole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of test holes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Coffey Geotechnics Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

We accept no responsibility for any decisions made or actions taken as a result of this report unless we are specifically advised of and participate in such action, in which case our responsibility will be as agreed to at that time. Any user of this report specifically denies any right to claims against the Consultant, Sub-Consultants, their officers, agents and employees in excess of the fee paid for professional services.

We trust that the information contained in this report is satisfactory. Should you have any questions, please do not hesitate to contact this office.

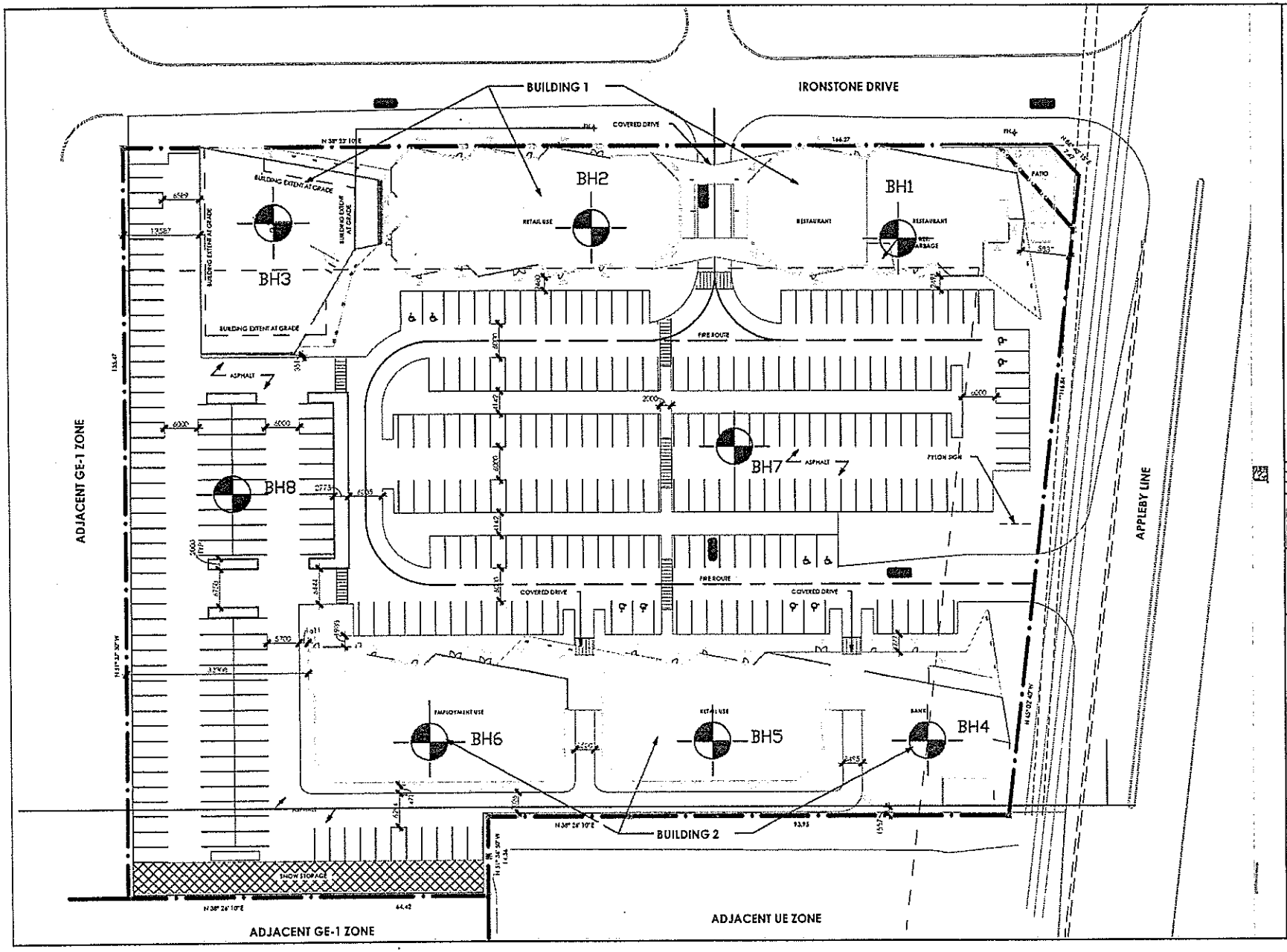
For and on behalf of Coffey Geotechnics Inc.

Eva Papp, P.Eng.
Senior Project Engineer



Osbert (Ozzie) Benjamin, P.Eng.
Manager, Burlington Branch Office





NOTES

1. The boundaries and soil types have been established only at borehole locations. Between boreholes they are assumed and may be subject to considerable error.
2. Soil samples will be retained in storage for 3 months and then destroyed unless the client advises an extended time period is required.
3. Topsoil quantities should not be established from the information provided at the borehole locations.
4. Borehole elevations should not be used to design building(s) or floor slab(s) or parking lot(s) grades.
5. This drawing forms part of the report (project number as referenced) and should only be used in conjunction with this report.

Notes:

1. Site Plan adapted from Drawing supplied by ICP Developers Inc.
2. Site features are not necessarily to scale.

NO.	DESCRIPTION	DATE
REVISION		

coffey geotechnics
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PREPARED FOR

UPTOWN CENTER

GEOTECHNICAL INVESTIGATION
PROPOSED UPTOWN CENTER
APPLEBY LINE AND IRONSTONE DRIVE
BURLINGTON, ONTARIO

TITLE

BOREHOLE LOCATION PLAN

SCALE	DATE
N.T.S.	JANUARY 2008
DRAWN BY	PROJECT NO.
VH	SPE07427
APPROVED BY	DRAWING NO.
CB	1

Notes On Sample Descriptions - Drawing 1A

1. All sample descriptions included in this report follow the Canadian Foundations Engineering Manual soil classification system. This system follows the standard proposed by the International Society for Soil Mechanics and Foundation Engineering. Laboratory grain size analyses provided by Shaheen & Peaker Limited also follow the same system. Different classification systems may be used by others; one such system is the Unified Soil Classification. Please note that, with the exception of those samples where a grain size analysis has been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.

ISSMFE SOIL CLASSIFICATION

CLAY	SILT			SAND			GRAVEL			COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE		

0.002 0.006 0.02 0.06 0.2 0.6 2.0 6.0 20 60 200

EQUIVALENT GRAIN DIAMETER IN MILLIMETRES

CLAY (PLASTIC) TO	FINE	MEDIUM	CRS.	FINE	COARSE
SILT (NONPLASTIC)	SAND			GRAVEL	

UNIFIED SOIL CLASSIFICATION

2. Fill: Where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc., none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional geotechnical site investigation.

3. Till: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand,

gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

Log of Borehole BH1

Project No. SPB737 | Drawing No. 2

Project: Geotechnical Investigation | Sheet No. 1 of 1

Location: Appleby Line and Ironstone Drive, Burlington, ON

Date Drilled: January 23, 2009

Drill Type: Probing

Datum: Geodetic

Auger Sample ☒
SPT (N) Value ○ ▨
Dynamic Cone Test ——
Shelby Tube ■
Field Vane Test ✚
Sensitivity S
Piezometric Water Level ▼

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

GWL	SYMBOL	Soil Description	ELEV. m	DEPTH
		FILL: topsoil to clayey silt mixed with topsoil	136.10	0
		CLAYEY SILT TILL: brown, moist, hard	135.20	1
		CLAYEY SILT TILL/WEATHERED SHALE COMPLEX: red, moist, hard	134.60	
		Refusal at 2 m depth on Assumed Bedrock: **No Detectable Gas:**	134.10	2

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
50/125mm

SAMPLES

Natural Unit Weight kN/m³

S & P **Shaheen & Peaker Consulting Engineers**

Time	Water Level (m)	Depth to Cave (m)
on completion	dry	open

Borehole BH1

Log of Borehole BH2

Project No. SPB737

Drawing No. 3

Project: Geotechnical Investigation

Sheet No. 1 of 1

Location: Appleby Line and Ironstone Drive, Burlington, ON

Date Drilled: January 23, 2009

Drill Type: Probing

Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test
Sensitivity S
Piezometric Water Level

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

GWL	SYMBOL	Soil Description	ELEV. m	DEPTH m
		FILL: topsoil, over clayey silt mixed with topsoil, dark brown/black	136.10	0
			134.60	1
		CLAYEY SILT TILL/WEATHERED SHALE COMPLEX: red, moist, hard		
			133.80	2
		Refusal on Assumed Bedrock at 2.3 m depth: No Detectable Gas:		

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

50/125mm

S & P Shaheen & Peaker Consulting Engineers

Time	Water Level (m)	Depth to Cave (m)
on completion	dry	open

Borehole BH2

Log of Borehole BH3

Project No. SPB737

Drawing No. 4

Project: Geotechnical Investigation

Sheet No. 1 of 1

Location: Appleby Line and Ironstone Drive, Burlington, ON

Date Drilled: January 23, 2009

Drill Type: Probing

Datum: Geodetic

Auger Sample ☒
SPT (N) Value ○ ▨
Dynamic Cone Test
Shelby Tube ■
Field Vane Test ✚
Sensitivity S
Piezometric Water Level ▼

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

GWL	SYMBOL	Soil Description	ELEV. m	DEPTH m
		TOPSOIL: 150mm over	136.40	0
		CLAYEY SILT: reworked with organics and topsoil pockets, brown, moist, loose	136.25	
		CLAYEY SILT TILL/WEATHERED SHALE COMPLEX: red, moist, hard	135.80	1
		WEATHERED SHALE: red, moist	134.90	
		Refusal at 1.7 m depth: **No Detectable Gas:**	134.70	

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

50/50mm

S & P **Shaheen & Peaker Consulting Engineers**

Borehole BH3

Time	Water Level (m)	Depth to Cave (m)
on completion	dry	open

Log of Borehole BH4

Project No. SPB737

Drawing No. 5

Project: Geotechnical Investigation

Sheet No. 1 of 1

Location: Appleby Line and Ironstone Drive, Burlington, ON

Date Drilled: January 23, 2009

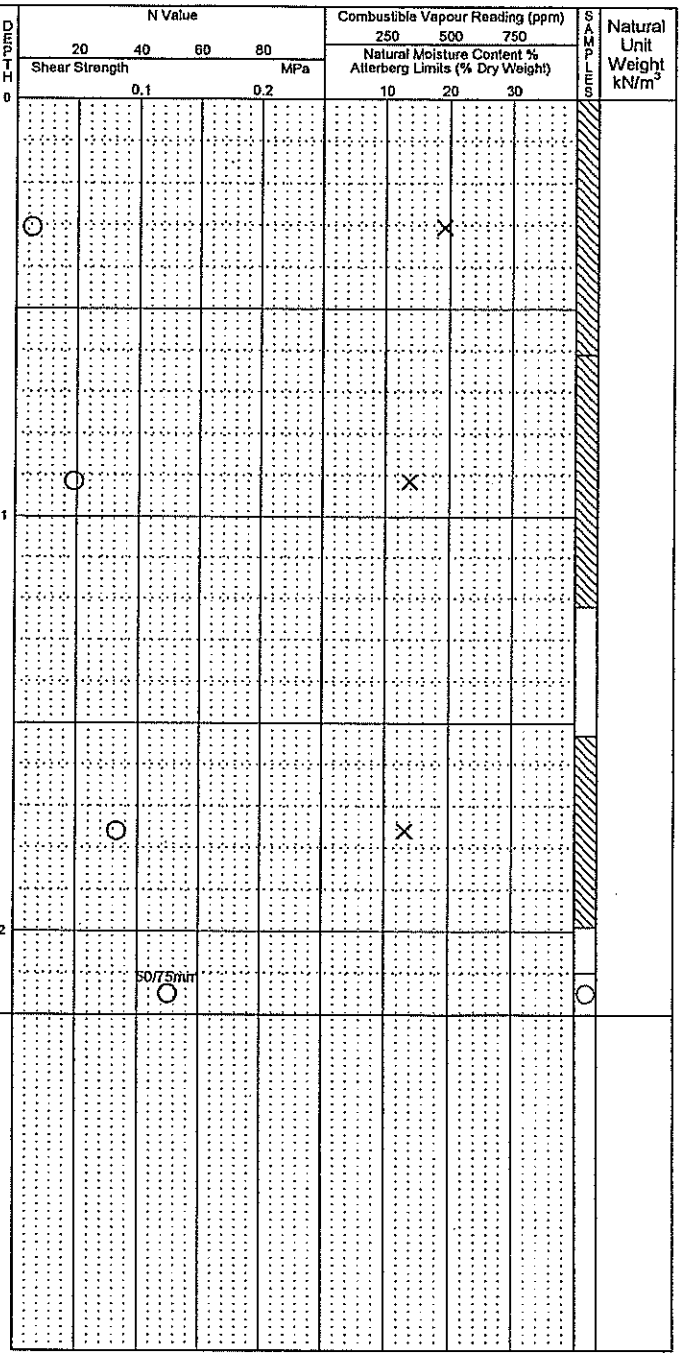
Drill Type: Probing

Datum: Geodetic

Auger Sample ⊠
SPT (N) Value ○ ◪
Dynamic Cone Test ——
Shelby Tube ■
Field Vane Test ✚
Sensitivity S
Piezometric Water Level ▼

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

GWL	SYMBOL	Soil Description	ELEV. m
		TOPSOIL: 200mm over	135.80
		CLAYEY SILT: reworked, with rootlets, brown, moist	135.60
		CLAYEY SILT TILL: brown, moist, hard	135.00
		CLAYEY SILT TILL/WEATHERED SHALE COMPLEX: red, moist	134.30
		Refusal at 2.2 m depth: No Detectable Gas:	133.60



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Time	Water Level (m)	Depth to Cave (m)
on completion	dry	open

Borehole BH4

Log of Borehole BH5

Project No. SPB737

Project: Geotechnical Investigation

Location: Appleby Line and Ironstone Drive, Burlington, ON

Drawing No. 6

Sheet No. 1 of 1

Date Drilled: January 23, 2009

Drill Type: Probing

Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test
Sensitivity S
Piezometric Water Level

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

GWL	SYMBOL	Soil Description	ELEV. m
		TOPSOIL: 150mm over	136.10
		CLAYEY SILT: reworked, with rootlets, brown, moist	135.95
		CLAYEY SILT TILL: brown, moist, hard	135.30
		WEATHERED SHALE: red, moist	133.80
		Refusal at 2.9 m depth: No Detectable Gas:	133.20

DEPTH

N Value: 20 40 60 80

Shear Strength: 0.1 0.2 MPa

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % Atterberg Limits (% Dry Weight): 10 20 30

SAMPLES

Natural Unit Weight kN/m³

50/0mm

S & P Shaheen & Peaker Consulting Engineers

Time	Water Level (m)	Depth to Cave (m)
on completion	dry	open

Borehole BH5

Log of Borehole BH6

Project No. SPB737

Drawing No. 7

Project: Geotechnical Investigation

Sheet No. 1 of 1

Location: Appleby Line and Ironstone Drive, Burlington, ON

Date Drilled: January 23, 2009

Drill Type: Probing

Datum: Geodetic

Auger Sample ☒
SPT (N) Value ○ ▨
Dynamic Cone Test ——
Shelby Tube ■
Field Vane Test ✚
Sensitivity S
Piezometric Water Level ▼

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

GWL	SYMBOL	Soil Description	ELEV. m	DEPTH m
		TOPSOIL: 150mm over	136.70	0
		CLAYEY SILT: reworked, with organics, brown, moist	136.55	
		CLAYEY SILT TILL: brown, moist, hard	135.90	1
		CLAYEY SILT TILL/WEATHERED SHALE COMPLEX: brown/red, moist, hard	135.20	
		WEATHERED SHALE: red, moist	134.40	2
		Refusal at 2.6 m depth: No Detectable Gas:	134.10	

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

50/100mm

S & P Shaheen & Peaker Consulting Engineers

Time	Water Level (m)	Depth to Cave (m)
on completion	dry	open

Borehole BH6

Log of Borehole BH7

Project No. SPB737

Drawing No. 8

Project: Geotechnical Investigation

Sheet No. 1 of 1

Location: Appleby Line and Ironstone Drive, Burlington, ON

Date Drilled: January 23, 2009

Drill Type: Probing

Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test
Sensitivity S
Piezometric Water Level

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

GWL	SYMBOL	Soil Description	ELEV. m	DEPTH	N Value 20 40 60 80 / Shear Strength 0.1 0.2 MPa	Combustible Vapour Reading (ppm) 250 500 750 / Natural Moisture Content % Atterberg Limits (% Dry Weight) 10 20 30	SAMPLES	Natural Unit Weight kN/m³
		FILL: clayey silt, gravel, organics, over topsoil	136.00	0				
		CLAYEY SILT TILL/WEATHERED SHALE COMPLEX: red, moist, hard	134.80	1				
		End of Borehole: No Detectable Gas:	134.00	2				

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Time	Water Level (m)	Depth to Cave (m)
on completion	dry	open

Borehole BH7

Log of Borehole BH8

Project No. SPB737

Drawing No. 9

Project: Geotechnical Investigation

Sheet No. 1 of 1

Location: Appleby Line and Ironstone Drive, Burlington, ON

Date Drilled: January 23, 2009

Drill Type: Probing

Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test
Sensitivity S
Piezometric Water Level

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

GWL	SYMBOL	Soil Description	ELEV. m
		TOPSOIL: 200mm over	136.60
		CLAYEY SILT: reworked, with rootlets, brown, moist	136.40
		CLAYEY SILT TILL: brown, moist, hard	135.80
		CLAYEY SILT TILL/WEATHERED SHALE COMPLEX: red, moist	135.10
		Refusal at 1.8 m depth: **No Detectable Gas:**	134.80

DEPTH

N Value: 20 40 60 80

Shear Strength: 0.1 0.2 MPa

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % Atterberg Limits (% Dry Weight): 10 20 30

50/25mm

SAMPLES

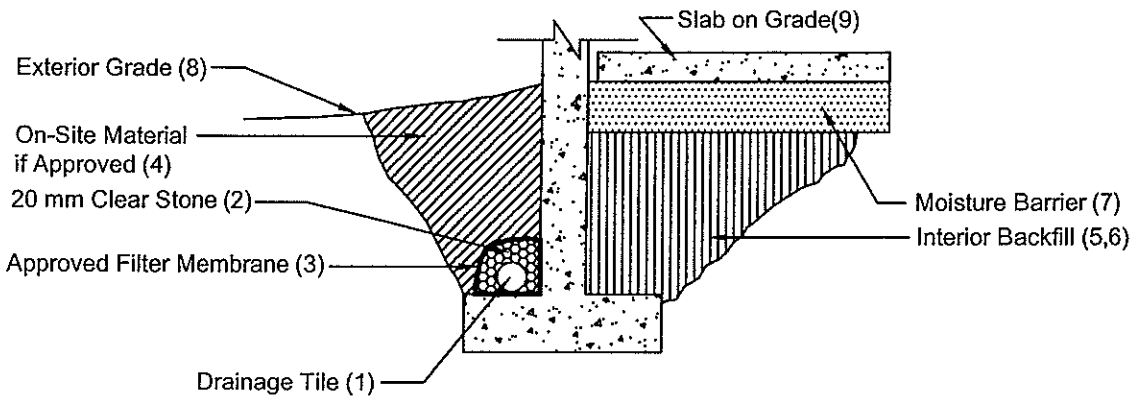
Natural Unit Weight kN/m³

S & P

Shaheen & Peaker Consulting Engineers

Time	Water Level (m)	Depth to Cave (m)
on completion	dry	open

Borehole BH8



EXTERIOR FOOTING

Notes

1. Drainage tile to consist of 100 mm (4") diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet.
2. 20 mm (3/4") clear stone - 150 mm (6") top and side of drain. If drain is not on footing, place100 mm (4 inches) of stone below drain .
3. Wrap the clear stone with an approved filter membrane (Terrafix 270R or equivalent).
4. The on-site material, if approved, can be used as backfill.
5. The interior fill may be any clean non-organic soil which can be compacted to the specified density in this confined space.
6. Do not use heavy compaction equipment within 450 mm (18") of the wall. Do not fill or compact within 1.8 m (6') of the wall unless fill is placed on both sides simultaneously.
7. Moisture barrier to be at least 200 mm (8") of compacted clear 20 mm (3/4") stone or equivalent free draining material. A vapour barrier may be required for specialty floors.
8. Exterior grade to slope away from building.
9. Slab on grade should not be structurally connected to the wall or footing.
10. Review the geotechnical report for specific details.

DRAINAGE AND BACKFILL RECOMMENDATIONS
Slab on Grade Construction Without Underfloor Drainage

(not to scale)

GENERAL COMMENTS – BEDROCK GREATER TORONTO AREA

The bedrock that makes spread footings or caissons a popular choice for high-rise foundation support is a shale or shale limestone composition. The highest member, the Queenston Formation, is generally found west of Toronto, while the Georgian Bay Formation underlies most of Metro Toronto, with the Collingwood Formation east of Toronto. The Queenston is, relatively speaking, the weaker of the three formations that are likely to support caissons or footings.

The Georgian Bay as well as the Queenston and Collingwood Formation are of Upper Ordovician Age. It is defined as the rock unit that overlies the bluish grey shales of the Collingwood Formation and is in turn overlain by the red shale of the Queenston Formation. The Georgian Bay Formation consists of bluish and grey shale with interbeds of sandstone, limestone and dolostone. Towards the west where the Georgian Bay formation underlies the Queenston Formation, the limestone content increases significantly and limestone and/or sandstone may comprise as much as 70 to 90 percent of the bedrock. The hard layers are usually less than about 100 to 150 mm thick but some layers are much thicker. The thicker layers have been observed to be as much as 750 to 900 mm at some sites. The layers are actually lenses and they can vary significantly in thickness over short distances.

The upper portion of the bedrock is commonly weathered for a depth of 600 to 1000 mm and within this weathered zone hard limestone layers or lenses are common. These hard limestone layers can result in contractual problems for augers, and can provide misleading bedrock elevations. Where the weathering is more extensive a shale till layer may be found above the bedrock. In the sound bedrock, the limestone, sandstone, dolostone is hard to very hard.

Stress relief features such as folds and faults are common in the bedrock. In these features, the rock is heavily fractured and sheared, and contains layers of shale rubble and clay. Weathering is much deeper than the surrounding rock in these features and often there is a lateral migration of the stress relief features resulting in sound unweathered bedrock overlying fractured and weather bedrock. The stress relief features are usually in the order of 4 to 6 m wide, but the depth can vary from 4 to 5 m to in excess of 10 m. These features occur randomly.

The bedrock contains significant high locked in horizontal stresses. These stresses can impose significant loads on tunnel walls but the slower rate of construction for basements allows for a relaxation of these stresses and they are not normally a problem for basement construction.

Methane gas exists in the bedrock, normally below the top 1000 mm and more concentrated with depth. Appropriate care and monitoring is essential in all confined bedrock excavations, particularly caissons and tunnels.

Groundwater seepage below the top 1000 mm is generally small, however, at several locations in Toronto and Mississauga large quantities have been encountered.

Bedding joints in the bedrock are very close-to-close, smooth planar in the shale and rough planar in the limestone. Significant vertical jointing is common.

Design features related to the bedrock are discussed in other sections of this report, and these general comments must be considered with these comments.