Geotechnical Engineering

Environmental Engineering

Hydrogeology

Geological Engineering

Materials Testing

Building Science

Archaeological Services

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Geotechnical Investigation
Proposed Residential Development
1298 Ogilvie Road
Ottawa, Ontario

Prepared For

Richcraft Group of Companies

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Report: PG2530-1 Revision 2

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Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by Richcraft Group of Companies to conduct a geotechnical investigation for the proposed residential development to be located at 1298 Ogilvie Road, in the City of Ottawa (refer to Figure 1 - Key Plan in Appendix 2).

The objective of the current investigation was:

☐ to determine the subsurface soil and groundwater conditions by means of test pits.

☐ to provide geotechnical recommendations pertaining to design of the proposed residential development including construction considerations which may affect the design.

The following report has been prepared specifically and solely for the aforementioned project which is described herein. This report contains our findings and includes geotechnical recommendations pertaining to the design and construction of the proposed residential development as understood at the time of writing this report.

A Phase I - Environmental Site Assessment (ESA) was conducted by Paterson for the subject site. The results and recommendations of the Phase I - ESA are presented under separate cover.

2.0 Proposed Development

It is understood that the proposed development is to consist of low-rise apartment style residential blocks with paved parking areas and access lanes. The subject site is further anticipated to be serviced by future municipal services.

3.0 Method of Investigation

3.1 Field Investigation

The field program for the investigation was conducted November 10, 2011. At that time, a total of six (6) test pits were excavated to a maximum depth of 4.3 m. The locations of the test pits are shown in Drawing PG2530-1 - Test Hole Location Plan included in Appendix 2.

The test pits were excavated using a rubber tire backhoe. All fieldwork was conducted under the full-time supervision of Paterson personnel under the direction of a senior engineer from our geotechnical department. The excavating procedures consisted of advancing each test pit to the required depths or practical refusal at the selected locations and sampling the subsurface soils.

Sampling and In Situ Testing

Soil samples were recovered from the sidewalls of the test pits. All soil samples were classified on site, placed in sealed plastic bags and transported to our laboratory for further inspection. The depths at which grab samples were recovered from the test pits are shown as G on the Soil Profile and Test Data sheets in Appendix 1.

The subsurface soil conditions observed in the test pits were recorded in detail in the field. Refer to the Soil Profile and Test Data sheets presented in Appendix 1 for specific details of the soil profile encountered at the test pit locations.

Groundwater

Groundwater infiltration levels were observed at the time of test pit excavation. Details of the groundwater infiltration are shown on the Soil Profile and Test Data sheets presented in Appendix 1.

Sample Storage

All samples will be stored in the laboratory for a period of one month after issuance of this report. They will then be discarded unless otherwise directed.

3.2 Field Survey

The test pit locations were selected in the field by Paterson personnel in a manner to provide general coverage of the proposed residential development with consideration of site features. The ground surface elevations at the test hole locations were referenced to a temporary benchmark (TBM), consisting of the top spindle of a fire hydrant located west of the subject site entrance, along Ogilvie Road. An assumed elevation of 100.00 m was assigned to the TBM. The test pit locations are presented in Drawing PG2530-1 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

All soil samples were recovered from the subject site and visually examined in our laboratory to review the results of the field logging.

3.4 Analytical Testing

One (1) soil sample was submitted for analytical testing to assess the corrosion potential for exposed ferrous metals and the potential of sulphate attacks against subsurface concrete structures. The sample was analysed to determine the concentration of sulphate and chloride, the resistivity and the pH of the sample. The analytical test results are presented in Appendix 1 and discussed in Subsection 6.7.

4.0 Observations

4.1 Surface Conditions

The subject site is currently vacant, with grass and treed areas throughout the entire property. Generally, the ground surface across the subject site is sloping to the south. The subject site is bordered by an existing church and residential development to the north and Aviation Parkway to the west. The subject site is approximately at grade with Aviation Parkway and 2 m below the grade of the existing residential development to the north of the subject site.

4.2 Subsurface Profile

The subsurface profile encountered at the test pit locations generally consists of topsoil underlain by a fill material, consisting of a loose to compact sand with gravel and cobbles mixed with some silt, clay, pieces of wood and wires, overlying a compact to dense glacial till. A possible fill material consisting of a loose to compact sand was encountered below the abovenoted fill layer at TP 1, TP 4 and TP 6. The glacial till consisted primarily of silty sand with gravel, cobbles and boulders. Practical refusal to excavation was encountered at TP 3 due to large boulders. Specific details of the soil profile at each test pit location are shown on the Soil Profile and Test Data sheets in Appendix 1.

Based on available geological mapping, the subject site is located in an area where the bedrock consists of shale from the Billings formation. The overburden drift thickness is anticipated to range from 3 to 5 m depth.

4.3 Groundwater

Groundwater was not observed upon completion of the test pits. It should be noted that groundwater levels are subject to seasonal fluctuations and could therefore vary at the time of construction.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is adequate for the proposed residential development. It is recommended that the footings for the proposed buildings be extended through the existing fill to the native glacial till. Alternatively, a ground improvement technique, such as a Rapid Impact Compaction (RIC) program, could be completed over the proposed building footprints. It is anticipated that the footings could be founded over an improved fill bearing surface upon successful completion of a ground improvement technique.

The above and other considerations are discussed in the following paragraphs.

5.2 Site Grading and Preparation

Stripping Depth

Topsoil, and any deleterious fill, such as those containing organic materials, should be stripped from under any proposed buildings and other settlement sensitive structures.

Ground Improvement - Rapid Impact Compaction (RIC)

RIC is a ground improvement technique which can improve the subsurface soil conditions at the subject site. Ground improvement programs are designed based on the level of density and the depth of improved soil required. RIC is generally effective to depths of up to 6 m. Dynamic compaction, which uses a heavier drop-weight, is effective to greater depths. However, dynamic compaction is more time-consuming and costly than RIC and is not required for the subject site.

A contractor specializing in these programs should be contacted for more information regarding costing and design details.

The entire footprint of the proposed buildings is expected to be subjected to ground improvement techniques. The ground improvement program should extend a minimum distance of 4 m around the exterior perimeter of the proposed buildings for the purpose of providing improved lateral support conditions.

Prior to considering RIC operations, vibration effects on the existing services, buildings and other structures should be addressed. A pre-construction survey of the existing structures located in proximity to the RIC operations should be completed prior to commencing site activities. The extent of the survey should be determined by the RIC contractor and should be sufficient to respond to any inquiries/claims related to the RIC operations.

As a general guideline, peak particle velocities (measured at the structures) should not exceed 50 mm/s during the RIC program to reduce the risks of damage to the existing structures. To reduce the potential for excessive vibrations, RIC should not be conducted within 6 m of any existing structures.

Fill Placement

Fill used for grading purposes beneath the proposed buildings, unless otherwise specified, should consist of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. The fill should be tested and approved prior to delivery to the site. The fill should be placed in lifts no greater than 300 mm in thickness and compacted using suitable compaction equipment for the specified lift thickness. Fill placed beneath the building areas should be compacted to at least 98% of the standard Proctor maximum dry density (SPMDD).

Non-specified existing fill along with site-excavated soil can be used as general landscaping fill where settlement of the ground surface is of minor concern. These materials should be spread in thin lifts and be compacted at minimum by the tracks of the spreading equipment to minimize voids. If these materials are to be used to build up the subgrade level for areas to be paved, then the areas should be compacted in thin lifts to a minimum density of 95% of the SPMDD. Non-specified existing fill and site-excavated soils are not suitable for use as backfill against foundation walls, unless used in conjunction with a composite drainage system.

5.3 Foundation Design

Footings placed on an undisturbed, dense glacial till bearing surface can be designed using a bearing resistance value at serviceability limit states (SLS) of **150 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **225 kPa**. A geotechnical resistance factor of 0.5 was applied to the reported bearing resistance value at ULS.

An undisturbed soil bearing surface consists of one from which all topsoil and deleterious materials, such as loose, frozen or disturbed soil, have been removed, in the dry, prior to the placement of concrete for footings.

Alternatively, the existing fill could be sub-excavated and replaced with a suitable engineered fill, such as OPSS Granular B Type I (pit run) or Type II, placed in 300 mm loose lifts and compacted to 98% of the SPMDD.

A bearing resistance value at SLS of **100 kPa** and a factored bearing resistance value at ULS of **150 kPa** can be used for footings placed over an improved sand fill or an approved engineered fill bearing surface, incorporating a geotechnical resistance factor of 0.5.

Footings designed using the bearing resistance values at SLS provided above will be subjected to potential post-construction total and differential settlements of 25 and 20 mm, respectively.

The bearing medium under footing-supported structures is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Above the groundwater level, adequate lateral support is provided to an undisturbed soil bearing surface or engineered fill when a plane extending down and out from the bottom edge of the footing at a minimum of 1.5H:1V passes only through in situ soil or engineered fill of the same or higher capacity as the bearing medium soil.

5.4 Design for Earthquakes

The site class for seismic site response can be taken as **Class C** for the shallow foundations at the subject site. A higher site class, such as Class A or B, may be applicable for this site. However, the higher site class must be confirmed by a site specific shear wave velocity test. The soils underlying the subject site are not susceptible to liquefaction. Reference should be made to the latest revision of the 2012 Ontario Building Code for a full discussion of the earthquake design requirements.

5.5 Basement Slab

With the removal of all topsoil and deleterious fill containing significant amounts of organic material, the existing fill material (upon completion of the ground improvement program) and approved by the geotechnical consultant will be considered to be an acceptable subgrade surface on which to commence backfilling for a basement slab.

Any soft areas should be removed and backfilled with appropriate backfill material. OPSS Granular A or Granular B Type II, with a maximum particle size of 50 mm, are recommended for backfilling below the floor slab. It is recommended that the upper 200 mm of sub-slab fill consist of 19 mm clear crushed stone below a basement slab. The upper 200 mm of sub-slab fill should consist of an OPSS Granular A material for slab-on-grade construction. All backfill materials within the footprint of the proposed buildings should be placed in maximum 300 mm thick loose layers and compacted to at least 98% of the SPMDD.

5.6 Pavement Design

For design purposes, the pavement structure presented in the following tables could be used for the design of car only parking areas and access lanes.

Table 1 - Recommended Pavement Structure - Car Only Parking Areas

Thickness (mm)	Material Description
50	**Wear Course -** HL-3 or Superpave 12.5 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
300	**SUBBASE** - OPSS Granular B Type II
	SUBGRADE - Either fill, in situ soil, or OPSS Granular B Type I or II material placed over in situ soil or fill

Table 2 - Recommended Pavement Structure
Access Lanes and Heavy Truck Parking Areas

Thickness (mm)	Material Description
40	**Wear Course -** HL-3 or Superpave 12.5 Asphaltic Concrete
50	**Binder Course -** HL-8 or Superpave 19.0 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
450	**SUBBASE** - OPSS Granular B Type II
	SUBGRADE - Either fill, in situ soil, or OPSS Granular B Type I or II material placed over in situ soil or fill

Minimum Performance Graded (PG) 58-34 asphalt cement should be used for this project.

If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated and replaced with OPSS Granular B Type I or Type II material.

The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 98% of the SPMDD using suitable compaction equipment.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

A perimeter drainage system is recommended to be provided for the proposed structures. The system should consist of a 150 mm diameter perforated corrugated plastic pipe, surrounded on all sides by 150 mm of 10 mm clear crushed stone, placed at the footing level around the exterior perimeter of the structure. The pipe should have a positive outlet, such as a gravity connection to the storm sewer.

Backfill against the exterior sides of the foundation walls should consist of free-draining non frost susceptible granular materials. The greater part of the site excavated materials will be frost susceptible and are not recommended for re-use as backfill against the foundation walls unless used in conjunction with a composite drainage system (such as Delta Drain 6000 or equivalent). Imported granular materials, such as clean sand or OPSS Granular B Type I granular material, should be used for this purpose.

6.2 Protection of Footings Against Frost Action

Perimeter footings of heated structures are required to be insulated against the deleterious effects of frost action. A minimum of 1.5 m thick soil cover alone, or an equivalent combination of soil cover and insulation should be provided.

A minimum of 2.1 m thick soil cover (or equivalent) should be provided for other exterior unheated footings.

6.3 Excavation Side Slopes

The side slopes of excavations in the soil and fill overburden materials should be either cut back to acceptable slopes or should be retained by shoring systems from the start of the excavation until the structure is backfilled. Sufficient room is assumed to be available for the majority of the excavations to be undertaken by open-cut methods (i.e. unsupported excavations).

The excavation side slopes above the groundwater level extending to a maximum depth of 3 m should be cut back at 1H:1V or flatter. A flatter slope is required for excavation below groundwater level. The subsurface soil is considered to be mainly a Type 2 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects.

Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should be kept away from the excavation sides.

Slopes in excess of 3 m in height should be periodically inspected by the geotechnical consultant in order to detect if the slopes are exhibiting signs of distress.

A trench box is recommended to be used at all times to protect personnel working in excavations with steep or vertical sides. Services are expected to be installed by “cut and cover” methods and excavations should not remain exposed for extended periods of time.

6.4 Pipe Bedding and Backfill

The pipe bedding for sewer and water pipes should consist of at least 150 mm of OPSS Granular A material. The material should be placed in maximum 300 mm thick lifts and compacted to a minimum of 95% of the SPMDD. The bedding material should extend at least to the spring line of the pipe.

The cover material, which should consist of OPSS Granular A, should extend from the spring line of the pipe to at least 300 mm above the obvert of the pipe. The material should be placed in maximum 300 mm thick lifts and compacted to a minimum of 95% of the SPMDD.

Where hard surface areas are considered above the trench backfill, the trench backfill material within the frost zone (about 1.8 m below finished grade) should match the soils exposed at the trench walls to minimize differential frost heaving. The trench backfill should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 95% of the SPMDD.

6.5 Groundwater Control

The contractor should be prepared to direct water away from all bearing surfaces and subgrades, regardless of the source, to prevent disturbance to the founding medium.

The rate of flow of groundwater into the excavation through the overburden should be low. Pumping from open sumps are anticipated to be sufficient to control the groundwater influx through the sides of the excavations.

A temporary Ministry of the Environment and Climate Change (MOECC) permit to take water (PTTW) may be required for this project is more than 400,000 L/day of ground and/or surface water is to be pumped during the construction phase. A minimum of 4 to 5 months should be allowed for completion of the PTTW application package and issuance of the permit by the MOECC.

For typical ground or surface water volumes being pumped during the construction phase, typically between 50,000 and 400,000 L/day, it is required to register on the Environmental Activity and Sector Registry (EASR). A minimum of two to four weeks should be allotted for completion of the EASR registration and the Water Taking and Discharge Plan to be prepared by a Qualified Person stipulated under O.Reg. 63/16. If a project qualifies for a PTTW based upon anticipated conditions, an EASR will not be allowed as a temporary dewatering measure while awaiting the MOECC review of the PTTW application.

6.6 Winter Construction

Precautions must be taken if winter construction is considered for this project. The subsurface soil consist predominantly of frost susceptible materials. In the presence of water and freezing conditions, ice could form within the soil mass. Heaving and settlement upon thawing could occur.

In the event of construction during below zero temperatures, the founding stratum should be protected from freezing temperatures by the use of straw, propane heaters and tarpaulins or other suitable means. The base of the excavations should be insulated from sub-zero temperatures immediately upon exposure and until such time as heat is adequately supplied to the building and the footings are protected with sufficient soil cover to prevent freezing at founding level.

Trench excavations and pavement construction are also difficult activities to complete during freezing conditions without introducing frost in the subgrade or in the excavation walls and bottoms. Precautions should be taken if such activities are to be conducted during freezing conditions. Additional information could be provided, if required.

6.7 Corrosion Potential and Sulphate

The results of analytical testing show that the sulphate content is less than 0.1%. This result is indicative that Type 10 Portland cement (normal cement) would be appropriate for this site. The chloride content and the pH of the sample indicate that they are not significant factors in creating a corrosive environment for exposed ferrous metals, whereas the resistivity is indicative of an aggressive to very aggressive corrosive environment.

6.8 Landscaping Considerations

The proposed development is located in an area where the subsoil consists primarily of non-cohesive soils. As a result, shrinkage of the soils due to drying and resulting differential settlements of nearby structures is not anticipated. Tree planting restrictions are therefore not required at this site, from a geotechnical perspective.

7.0 Recommendations

For the foundation design data provided herein to be applicable, the following material testing and observation program is required to be conducted by the geotechnical consultant.

☐ Observation of all bearing surfaces prior to the placement of concrete.

☐ Sampling and testing of the concrete and fill materials used.

☐ Periodic observation of the condition of unsupported excavation side slopes in excess of 3 m in height, if applicable.

☐ Observation of all subgrades prior to backfilling.

☐ Field density tests to determine the level of compaction achieved.

☐ Sampling and testing of the bituminous concrete including mix design reviews.

A report confirming that these works have been conducted in general accordance with our recommendations could be issued upon the completion of a satisfactory inspection program by the geotechnical consultant.

8.0 Statement of Limitations

The recommendations considered in this report are in accordance with our present understanding of the project. Our recommendations should be reviewed when the project drawings and specifications are complete.

A geotechnical investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from those at the test pit locations, we request immediate notification in order to reassess our recommendations.

The recommendations provided should only be used by the design professionals associated with this project. The recommendations are not intended for contractors bidding on or constructing the project. The latter should evaluate the factual information provided in the report. The contractor should also determine the suitability and completeness for the intended construction schedule and methods. Additional testing may be required for the contractors' purpose.

The present report applies only to the project described in this document. Use of this report for purposes other than those described herein or by person(s) other than Richcraft Group of Companies or their agent(s) is not authorized without review by this firm for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

Nathan Christ

LICENSED PROFESSIONAL ENGINEER
Feb. 5, 2018
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Report Distribution:

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APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

ANALYTICAL TEST RESULTS

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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development-1298 Ogilive Road
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located along Ogilvie Road, just west of site entrace. Assumed elevation = 100.00m.

REMARKS

BORINGS BY Backhoe

DATE 10 November 2011

FILE NO. PG2530

HOLE NO. TP 1

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	99.43
TOPSOIL with sand 0.30		AU	1				
FILL: Loose to compact, brown silty sand with gravel, cobbles, boulders, trace clay 1.96		G	2			1	98.43
Dense, brown **SAND,** some silt (possible fill) 3.35		G G	3 4			2 3	97.43 96.43
GLACIAL TILL: Very dense, grey silty sand with gravel, cobbles and boulders, trace clay 4.27		G	5			4	95.43
End of Test Pit (TP dry upon completion)							

Pen. Resist. Blows/0.3m
● **50 mm Dia. Cone**
○ **Water Content %**
20 40 60 80

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

Piezometer Construction

patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development-1298 Ogilive Road
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located along Ogilvie Road, just west of site entrace. Assumed elevation = 100.00m.

REMARKS

BORINGS BY Backhoe

DATE 10 November 2011

FILE NO. PG2530

HOLE NO. TP 2

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	97.23
TOPSOIL with sand — 0.28							
FILL: Loose to compact, brown sand with some silt		G	1				
		G	2			1	96.23
		G	3				
						2	95.23
		G	4				
3.05						3	94.23
GLACIAL TILL: Very dense, grey-brown silty sand with gravel, cobbles and boulders, trace clay		G	5				
		G	6				
3.81							
End of Test Pit (TP dry upon completion)							

Pen. Resist. Blows/0.3m
● **50 mm Dia. Cone**

○ **Water Content %**

20 40 60 80

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

Piezometer Construction

patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development-1298 Ogilive Road
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located along Ogilvie Road, just west of site entrace. Assumed elevation = 100.00m.

REMARKS

BORINGS BY Backhoe

DATE 10 November 2011

FILE NO. PG2530

HOLE NO. TP 3

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
TOPSOIL with sand 0.30	■					0	95.08
FILL: Loose to compact, brown sand with silt, gravel, cobbles and boulders 1.09	▨	G	1			1	94.08
GLACIAL TILL: Very dense, grey silty sand with gravel, cobbles and boulders 2.29	^^^	G	2			2	93.08
End of Test Pit Practical refusal to excavation on large boulders @ 2.29m depth (TP dry upon completion)							

Pen. Resist. Blows/0.3m

● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development-1298 Ogilive Road
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located along Ogilvie Road, just west of site entrace. Assumed elevation = 100.00m.

REMARKS

BORINGS BY Backhoe

DATE 10 November 2011

FILE NO. PG2530

HOLE NO. TP 4

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20 40 60 80)	Piezometer Construction
GROUND SURFACE						0	96.06		
TOPSOIL with sand — 0.25									
FILL: Loose to compact, brown sand with silt, gravel, cobbles and boulders						1	95.06		
		G	1						
1.52									
Loose, brown **SAND,** some silt (possible fill)		G	2						
						2	94.06		
		G	3			3	93.06		
3.35									
GLACIAL TILL: Very dense, grey silty sand with gravel, cobbles and boulders, trace clay		G	4						
3.81									
End of Test Pit (TP dry upon completion)									

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development-1298 Ogilive Road
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located along Ogilvie Road, just west of site entrace. Assumed elevation = 100.00m.

REMARKS

BORINGS BY Backhoe

DATE 10 November 2011

FILE NO. PG2530

HOLE NO. TP 5

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	94.76		
TOPSOIL with sand	■								
0.25									
FILL: Loose to compact, brown sand with silt, trace gravel and cobbles	▨					1	93.76		
						2	92.76		
2.64									
GLACIAL TILL: Very dense, grey silty sand with gravel, cobbles and boulders	^								
3.05						3	91.76		
End of Test Pit Test pit terminated because sand sidewall collapsed. (TP dry upon completion)									

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development-1298 Ogilive Road
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located along Ogilvie Road, just west of site entrace. Assumed elevation = 100.00m.

REMARKS

BORINGS BY Backhoe

DATE 10 November 2011

FILE NO. PG2530

HOLE NO. TP 6

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20 40 60 80)	Piezometer Construction
GROUND SURFACE						0	95.18		
TOPSOIL with sand — 0.25									
Loose, brown **SAND,** some silt, trace gravel (possible fill)		G	1						
						1	94.18		
						2	93.18		
						3	92.18		
— 3.35									
GLACIAL TILL: Very dense, grey silty sand with gravel, cobbles and boulders		G	2						
						4	91.18		
— 4.27									
End of Test Pit (TP dry upon completion)									

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

SYMBOLS AND TERMS

SOIL DESCRIPTION

Behavioural properties, such as structure and strength, take precedence over particle gradation in describing soils. Terminology describing soil structure are as follows:

Desiccated	-	having visible signs of weathering by oxidation of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure.
Varved	-	composed of regular alternating layers of silt and clay.
Stratified	-	composed of alternating layers of different soil types, e.g. silt and sand or silt and clay.
Well-Graded	-	Having wide range in grain sizes and substantial amounts of all intermediate particle sizes (see Grain Size Distribution).
Uniformly-Graded	-	Predominantly of one grain size (see Grain Size Distribution).

The standard terminology to describe the relative strength of cohesionless soils is the compactness condition, usually inferred from the results of the Standard Penetration Test (SPT) ‘N’ value. The SPT N value is the number of blows of a 63.5 kg hammer, falling 760 mm, required to drive a 51 mm O.D. split spoon sampler 300 mm into the soil after an initial penetration of 150 mm. An SPT N value of “P” denotes that the split-spoon sampler was pushed 300 mm into the soil without the use of a falling hammer.

Compactness Condition	‘N’ Value	Relative Density %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>50	>85

The standard terminology to describe the strength of cohesive soils is the consistency, which is based on the undisturbed undrained shear strength as measured by the in situ or laboratory shear vane tests, unconfined compression tests, or occasionally by the Standard Penetration Test (SPT). Note that the typical correlations of undrained shear strength to SPT N value (tabulated below) tend to underestimate the consistency for sensitive silty clays, so Paterson reviews the applicable split spoon samples in the laboratory to provide a more representative consistency value based on tactile examination.

Consistency	Undrained Shear Strength (kPa)	‘N’ Value
Very Soft	<12	<2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

SYMBOLS AND TERMS (continued)

SOIL DESCRIPTION (continued)

Cohesive soils can also be classified according to their “sensitivity”. The sensitivity, S_t, is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil. The classes of sensitivity may be defined as follows:

Low Sensitivity: $S_t < 2$
Medium Sensitivity: $2 < S_t < 4$
Sensitive: $4 < S_t < 8$
Extra Sensitive: $8 < S_t < 16$
Quick Clay: $S_t > 16$

ROCK DESCRIPTION

The structural description of the bedrock mass is based on the Rock Quality Designation (RQD).

The RQD classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be a result of closely-spaced discontinuities (resulting from shearing, jointing, faulting, or weathering) in the rock mass and are not counted. RQD is ideally determined from NQ or larger size core. However, it can be used on smaller core sizes, such as BQ, if the bulk of the fractures caused by drilling stresses (called “mechanical breaks”) are easily distinguishable from the normal in situ fractures.

RQD %	**ROCK QUALITY**
90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

SAMPLE TYPES

SS - Split spoon sample (obtained in conjunction with the performing of the Standard Penetration Test (SPT))
TW - Thin wall tube or Shelby tube, generally recovered using a piston sampler
G - "Grab" sample from test pit or surface materials
AU - Auger sample or bulk sample
WS - Wash sample
RC - Rock core sample (Core bit size BQ, NQ, HQ, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

SYMBOLS AND TERMS (continued)

PLASTICITY LIMITS AND GRAIN SIZE DISTRIBUTION

WC% - Natural water content or water content of sample, %
LL - Liquid Limit, % (water content above which soil behaves as a liquid)
PL - Plastic Limit, % (water content above which soil behaves plastically)
PI - Plasticity Index, % (difference between LL and PL)

Dxx - Grain size at which xx% of the soil, by weight, is of finer grain sizes
These grain size descriptions are not used below 0.075 mm grain size
D10 - Grain size at which 10% of the soil is finer (effective grain size)
D60 - Grain size at which 60% of the soil is finer

Cc - Concavity coefficient = $(D30)^2 / (D10 \times D60)$
Cu - Uniformity coefficient = D60 / D10

Cc and Cu are used to assess the grading of sands and gravels:
Well-graded gravels have: $1 < Cc < 3$ and $Cu > 4$
Well-graded sands have: $1 < Cc < 3$ and $Cu > 6$
Sands and gravels not meeting the above requirements are poorly-graded or uniformly-graded.
Cc and Cu are not applicable for the description of soils with more than 10% silt and clay
(more than 10% finer than 0.075 mm or the #200 sieve)

CONSOLIDATION TEST

p'_o - Present effective overburden pressure at sample depth
p'_c - Preconsolidation pressure of (maximum past pressure on) sample
Ccr - Recompression index (in effect at pressures below p'_c)
Cc - Compression index (in effect at pressures above p'_c)

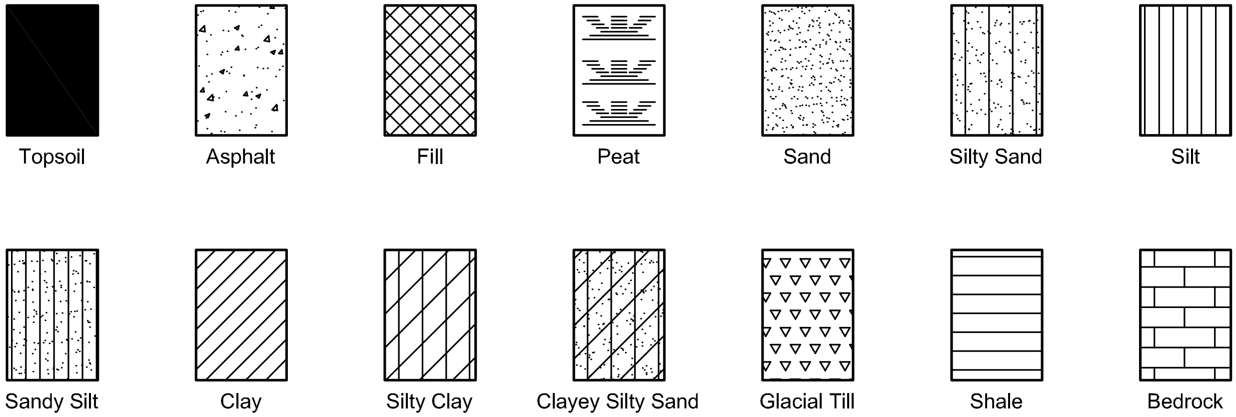
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

PERMEABILITY TEST

k - Coefficient of permeability or hydraulic conductivity is a measure of the ability of water to flow through the sample. The value of k is measured at a specified unit weight for (remoulded) cohesionless soil samples, because its value will vary with the unit weight or density of the sample during the test.

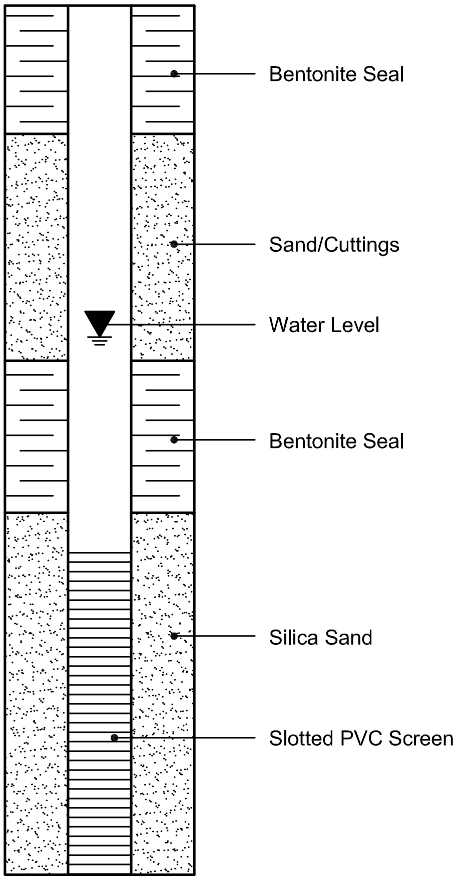
SYMBOLS AND TERMS (continued)

STRATA PLOT

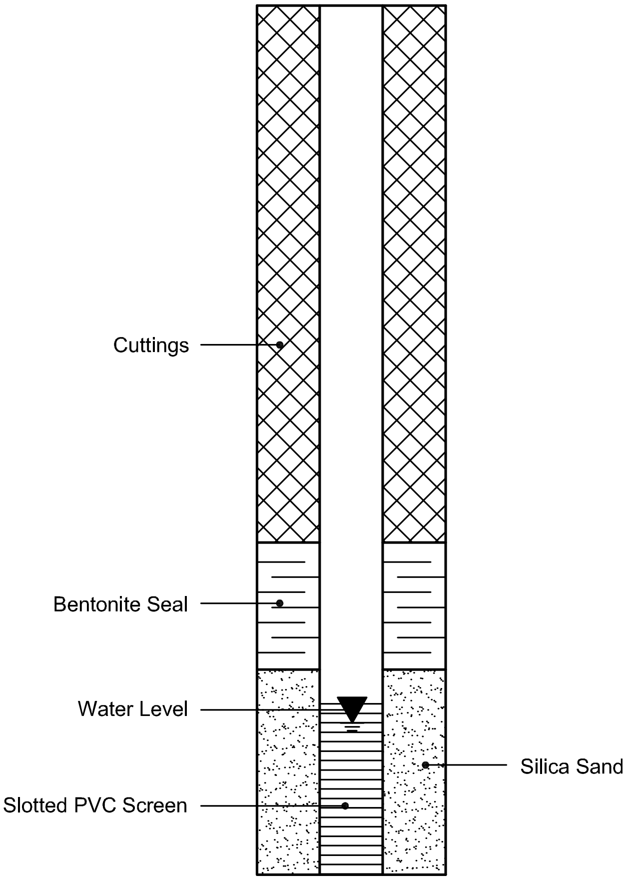


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



Certificate of Analysis
Client: **Paterson Group Consulting Engineers**
Client PO: 11994
Project Description: PG2530

Report Date: 16-Nov-2011
Order Date:11-Nov-2011

	Client ID:	TP2-G3	-	-	-
	Sample Date:	10-Nov-11	-	-	-
	Sample ID:	1146205-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	94.4	-	-	-
General Inorganics					
pH	0.1 pH Units	7.5	-	-	-
Resistivity	0.10 Ohm.m	26.2	-	-	-
Anions					
Chloride	5 ug/g dry	<5	-	-	-
Sulphate	5 ug/g dry	691	-	-	-

APPENDIX 2

FIGURE 1 - KEY PLAN

DRAWING PG2530-1 - TEST HOLE LOCATION PLAN

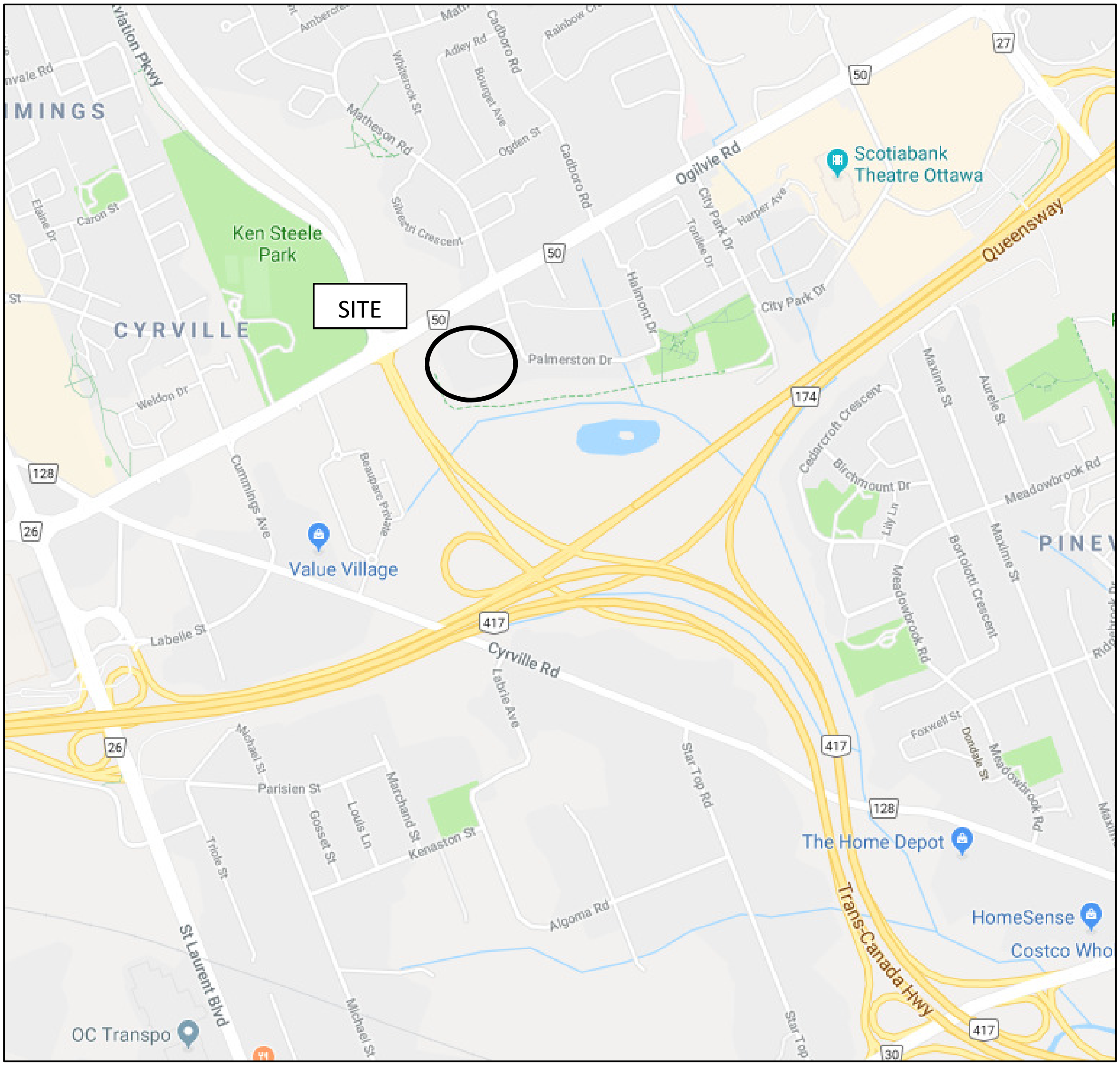
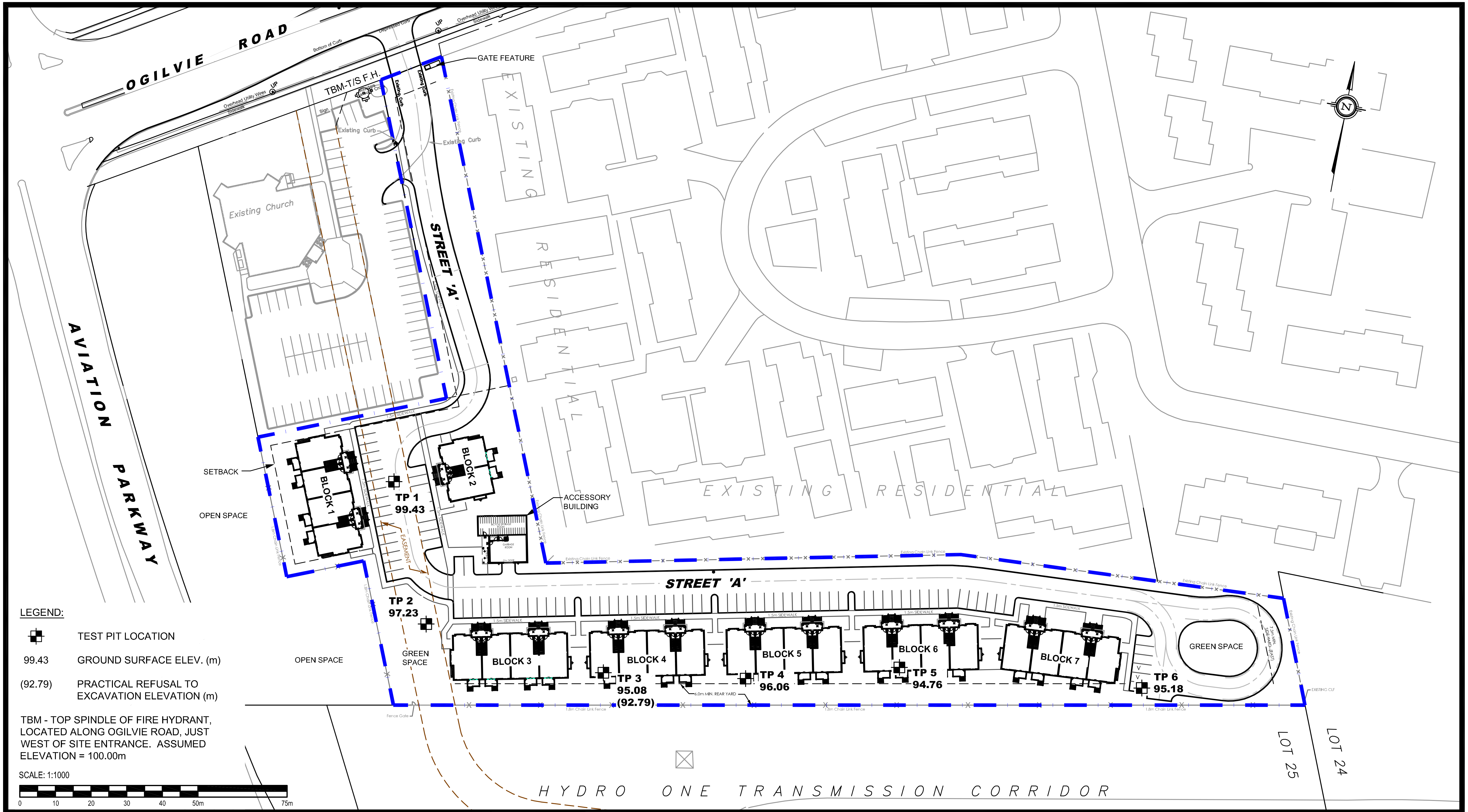


FIGURE 1

KEY PLAN



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NO.	REVISIONS	DATE	INITIAL
1	BASE PLAN UPDATED	30/01/2018	DJG

RICHCRAFT GROUP OF COMPANIES

GEOTECHNICAL INVESTIGATION
PROP. RESIDENTIAL DEVELOPMENT - 1298 OGILVIE RD.

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:1000
Date: 01/2018
Drawn by: RCG
Report No.: PG2530-2
Checked by: NC
Dwg. No.: PG2530-1
Approved by: DJG
Revision No.: 1

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