patersongroup

Consulting Engineers

154 Colonnade Road South
Ottawa, Ontario
K2E 7J5
Tel: (613) 226-7381
Fax: (613) 226-6344

Geotechnical Engineering
Environmental Engineering
Hydrogeology
Geological Engineering
Materials Testing
Building Science
Archaeological Services

www.patersongroup.ca

April 20, 2017
PG4093-LET.01

RND Construction
1155 Lola Street, Unit 5-B
Ottawa, ON
K1K 4C1

Attention: **Mr. Roy Nandram**

Subject: **Geotechnical Investigation**
Proposed Residential Development
1180 Kingston Avenue - Ottawa

Dear Sir,

Paterson Group (Paterson) was commissioned by RND Construction to conduct a geotechnical investigation for a proposed residential development to be located along 1180 Kingston Avenue, in the City of Ottawa, Ontario.

The proposed development is expected to consist of a series of residential dwellings with a basement level, access lanes and landscaped areas.

1.0 Field Investigation

The fieldwork for the current investigation was conducted on March 28, 2017, and consisted of excavating five (5) test pits to a maximum depth of 4 m below ground surface. The test pits were excavated using a rubber-tired backhoe. The test pits were reviewed in the field by Paterson personnel under the direction of a senior engineer from the geotechnical division. The field procedure consisted of reviewing the excavation, sampling and testing the overburden at selected locations.

The test pits were placed in a manner to provide general coverage of the property taking into consideration existing site features and underground services. The approximate locations of the test holes are shown on Drawing PG4093-1 - Test Hole Location Plan attached to the present report.

2.0 Field Observations

The subject site is currently a vacant parcel of land within a residential neighbourhood. The ground surface across the subject site is grass covered, relatively flat, and approximately at grade with Kingston Avenue. Landscaped areas, a chain link fence and mature trees are also located around the south, west and north perimeters of the subject property. An existing ditch is located along the east property boundary, along with a culvert and small bridge between the subject property and the adjacent property.

Generally, the subsurface profile encountered at the test pit locations consisted of topsoil overlying a stiff to firm brown silty clay layer followed by firm grey silty clay. A glacial till deposit, consisting of grey silty clay mixed with sand, gravel, cobbles and boulders, was encountered below the silty clay layers at TP 3, TP 4 and TP 5. Refer to the Soil Profile and Test Data sheets attached for specific details of the soil profile encountered at the test pit locations.

Based on available geological mapping, the bedrock consists of limestone of the Bobcaygeon formation. Bedrock is expected to range between 5 and 10 m depth.

Based on the field observations of the water infiltration within the side walls of the open test pits, experience in the local area, moisture levels and colour of the recovered soil samples, the long-term groundwater level is expected between 2.5 to 3.5 m depth below ground surface. Groundwater levels are subject to seasonal fluctuations and therefore, the groundwater levels could vary at the time of construction.

3.0 Geotechnical Assessment

From a geotechnical perspective, the subject site is suitable for the proposed residential buildings. The proposed residential buildings are expected to be founded over conventional shallow foundations and placed on an undisturbed, firm silty clay or glacial till bearing surface.

To avoid designing the foundation with two different bearing resistance values where buildings may be founded partially on silty clay and/or glacial till within the west portion of the subject site, footings could be placed over a lean concrete in-filled trench extending to an undisturbed, glacial till bearing surface. The near vertical, zero entry trench extending at least 150 mm beyond the proposed footing face should be excavated to an undisturbed, glacial till bearing surface and approved by the geotechnical consultant. The trench should be in-filled with a minimum 15 MPa lean concrete to underside of footing.

Due to the presence of a silty clay layer, the subject site will be subjected to permissible grade raise restrictions. The permissible grade raise recommendations will be discussed in the following sections.

Site Grading and Preparation

Topsoil, asphalt, and fill, containing deleterious or organic materials, should be stripped from under any building, paved areas, pipe bedding and other settlement sensitive structures. Care should be provided to not disturb adequate bearing soils at subgrade level during site preparation activities.

Engineered fill placed for grading beneath the proposed building footprint, 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 maximum lift thickness of 300 mm and compacted with suitable compaction equipment. Fill placed beneath the building should be compacted to a minimum of 98% of the standard Proctor maximum dry density (SPMDD).

Non-specified existing fill along with site-excavated soil could be placed as general landscaping fill where surface settlement is of minor concern. The existing materials should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids. If the existing materials are to be placed to increase the subgrade level for areas to be paved, the non-specified existing fill should be compacted in 300 mm lifts and compacted to a minimum density of 95% of the respective SPMDD.

Foundation Design

Strip footings up to 3 m wide and pad footings, up to 5 m wide, placed on an undisturbed, stiff brown silty clay bearing surface can be designed using a bearing resistance value at Serviceability Limit States (SLS) of **80 kPa** and a factored bearing resistance value at Ultimate Limit States (ULS) of **125 kPa**.

Footings placed on an undisturbed, glacial till bearing surface, or a concrete in-filled trench extended to glacial till bearing surface, can be designed using a bearing resistance value at SLS of **150 kPa** and a factored bearing resistance value at ULS of **225 kPa**. A geotechnical factor of 0.5 was used to calculate the 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 prior to the placement of concrete for footings.

The bearing resistance value at SLS given for footings will be subjected to potential post construction total and differential settlements of 25 and 20 mm, respectively.

Lateral Support

The bearing medium under footing-supported structures is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Adequate lateral support is provided to a soil bearing medium when a plane extending horizontally and vertically from the footing perimeter at a minimum of 1.5H:1V, passing through in situ soil or engineered fill of equal or higher capacity as the soil.

Permissible Grade Raise

A permissible grade raise restriction has been determined for the subject site based on the subsoil information and our knowledge of the local area in which the site is located. Based on available information, a permissible grade raise restriction of **1.0 m** above existing ground surface is recommended for the subject site. A post development groundwater lowering of 0.5 m was considered in the permissible grade raise restriction calculation.

Design for Earthquakes

The site class for seismic site response can be taken as **Class C** for foundations constructed at the subject site. Refer to the latest revision of the 2012 Ontario Building Code for a full discussion of the earthquake design requirements.

Pavement Structure

For design purposes, the pavement structure presented in the following tables could be designed for car only parking areas.

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	

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 sub-excavated and replaced with OPSS Granular B 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 with suitable vibratory equipment.

4.0 Design and Construction Precautions

Foundation Drainage

A perimeter foundation drainage system is recommended to be provided for the proposed structure. The system should consist of a 150 mm diameter perforated corrugated plastic pipe, surrounded on all sides by 150 mm of 19 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.

Underfloor Drainage

Based on the groundwater level observations, a sub-floor drainage for the proposed buildings with basements may be required. A geotextile wrapped 150 mm diameter perforated, corrugated plastic pipes be placed at 4 to 6 m spacing below the basement slab. A sleeve through the footing should be provided to connect the sub-floor drainage pipes to the perimeter foundation drainage system. It is further recommended that the perimeter drainage system have a positive outlet to the storm sewer. It is recommended that the geotechnical consultant inspect the water infiltration at the time of construction to better assess the groundwater level.

Foundation Backfill

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 placement as backfill against the foundation walls, unless placed in conjunction with a drainage geocomposite, such as Miradrain G100N or Delta Drain 6000. The drainage geocomposite should be connected to the perimeter foundation drainage system. Otherwise, imported granular materials, such as clean sand or OPSS Granular B Type I granular material, should be placed for foundation backfill.

Protection of Footings Against Frost Action

Perimeter footings of heated structures are required to be insulated against the deleterious effect of frost action. A minimum of 1.5 m thick soil cover (or equivalent) should be provided.

Exterior unheated footings, such as isolated exterior piers, are more prone to deleterious movement associated with frost action than the exterior walls of the structure proper and require additional protection, such as soil cover of 2.1 m or a combination of soil cover and foundation insulation.

Excavation Side Slopes

The excavation side slopes above the groundwater level extending to a maximum depth of 3 m should be excavated at 1H:1V or shallower. The shallower slope is required for excavation below groundwater level. The subsurface soil is considered to be mainly 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 maintain safe working distance 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.

Pipe Bedding

Bedding and backfill materials should be in accordance with City of Ottawa standards and specifications.

The pipe bedding for sewer and water pipes should consist of at least 150 mm of OPSS Granular A material. Where the bedding is located within soft to firm grey silty clay, the thickness of the bedding material should be increased to a minimum of 300 mm, which is a recommended deviation from specifications provided in City of Ottawa standard drawing S6. 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 a minimum to the spring line of the pipe.

The cover material, which should consist of OPSS Granular A crushed stone, should extend from the spring line of the pipe to a minimum of 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.

Generally, the dry, brown silty clay could be placed above the cover material if the excavation and backfilling operations are completed in dry and above freezing weather conditions. The wet silty clay materials could be difficult to place and compact, due to the high water content.

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 consist of 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.

To reduce long-term lowering of the groundwater level, clay seals should be provided in the service trenches. The seals should be a minimum of 1.5 m long (in the trench direction) and should extend from trench wall to trench wall. Generally, the seals should extend from the frost line and fully penetrate the bedding, subbedding and cover material. The barriers should consist of relatively dry and compactable brown silty clay placed in maximum 225 mm thick loose layers and compacted to a minimum of 95% of the SPMDD. The clay seals should be placed at the site boundaries, roadway intersections and at a maximum distance of every 50 m in the service trenches.

Groundwater Control

It is anticipated that groundwater infiltration into the excavations should be low and controllable using open sumps. Pumping from open sumps should be sufficient to control the groundwater influx through the sides of the shallow excavation. 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.

A temporary Ministry of the Environment and Climate Change (MOECC) permit to take water (PTTW) may be required for this project if more than 400,000 L/day of ground and/or surface water is to be pumped during the construction phase. A minimum 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 to 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 as stipulated under O.Reg. 63/16. If a project qualifies for a PTTW based upon anticipated conditions, and EASR will not be allowed as a temporary dewatering measure while awaiting the MOECC review of the PTTW application.

Winter Construction

If winter construction is considered for this project, precautions should be provided for frost protection. The subsurface soil conditions mainly consist of frost susceptible materials. In 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 installation of straw, propane heaters and tarpaulins or other suitable means. The excavation base 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.

The trench excavations should be completed in a manner to avoid the introduction of frozen materials, snow or ice into the trenches. Where excavations are constructed in proximity of existing structures precaution to adversely affecting the existing structure due to the freezing conditions should be provided.

Corrosion Potential and Sulphate

The analytical test results indicate the sulphate content is less than 0.1%. The result is indicative that Type 10 Portland cement is applicable for the subject site. The chloride content and the pH of the sample are indicative of non significant factors in creating a corrosive environment for exposed ferrous metals, whereas the resistivity is indicative of a high corrosive environment.

Tree Planting Restrictions

The proposed residential buildings are located in a moderate sensitivity area with respect to tree plantings over a silty clay deposit. It is recommended that trees placed within 6 m of the foundation wall should consist of low water demand trees with shallow roots systems that extend less than 1.5 m below ground surface. Trees placed greater than 5 m from the foundation wall may consist of typical street trees, which are typically moderate water demand species with roots extending to a maximum depth of 2 m below ground surface.

It is well documented in the literature, and is our experience, that fast-growing trees located near buildings founded on cohesive soils that shrink on drying can result in long-term differential settlements of the structures. Tree varieties that have the most pronounced effect on foundations are seen to consist of poplars, willows and some maples (i.e. Manitoba Maples) and, as such, they should not be considered in the landscaping design.

5.0 Recommendations

A materials testing and observation services program is a requirement for the provided foundation design data to be applicable. The following aspects of the program should be performed by the geotechnical consultant:

- ❑ A review of the final grading plan(s) from a geotechnical perspective.
- ❑ 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 the construction have been conducted in general accordance with Paterson's recommendations could be issued upon the completion of a satisfactory inspection program by the geotechnical consultant.

6.0 Statement of Limitations

The recommendations provided in the report are in accordance with Paterson's present understanding of the project. Paterson request permission to review the recommendations when the drawings and specifications are completed.

A soils investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from the test locations, Paterson requests immediate notification to permit reassessment of the 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 the report. The use of the report for purposes other than those described above or by person(s) other than RND Construction or their agents is not authorized without review by Paterson.

Best Regards,

Paterson Group Inc.

Faisal I. Abou-Seido, P.Eng.

David J. Gilbert, P.Eng.

Attachments

- ❑ Soil Profile and Test Data sheets
- ❑ Symbols and Terms
- ❑ Drawing PG4093-1 - Test Hole Location Plan

Report Distribution

- ❑ RND Construction (3 copies)
- ❑ Paterson Group (1 copy)

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - 1180 Kingston Ave.
Ottawa, Ontario

DATUM TBM - Top of grate of manhole located near the centreline of the road, across from subject site. Geodetic elevation = 79.22m was provided to the TBM by Annis, O'Sullivan, Vollebekk Ltd.

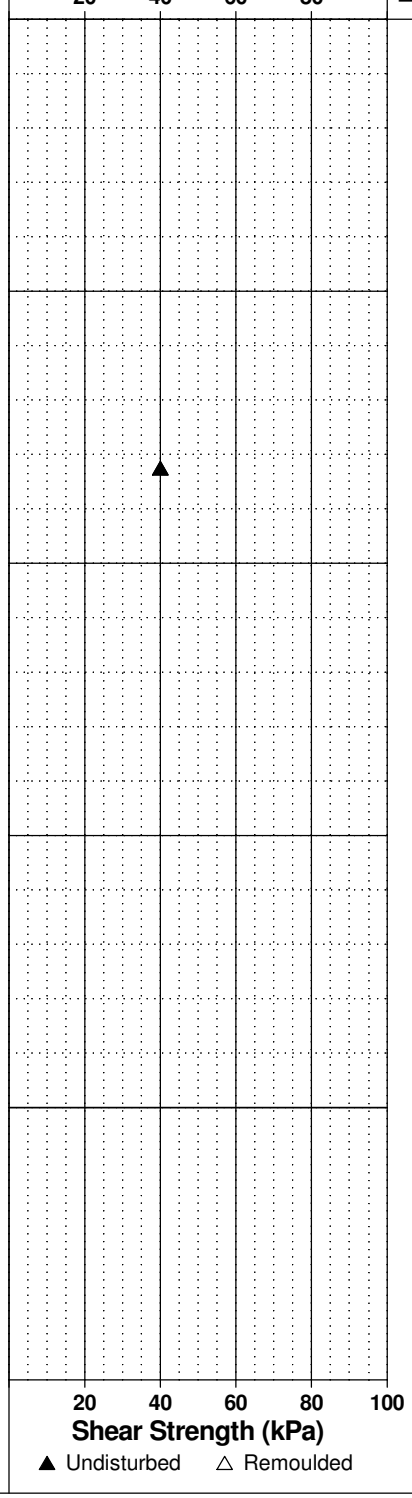
REMARKS

FILE NO. PG4093

HOLE NO. TP 1

BORINGS BY Backhoe **DATE** March 28, 2017

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	79.30		
TOPSOIL 0.25		G	1						
		G	2			1	78.30		
Stiff to firm, brown **SILTY CLAY,** trace sand		G	3						
		G	4			2	77.30		
2.50									
		G	5			3	76.30		
Firm, grey **SILTY CLAY**									
4.00						4	75.30		
End of Test Pit									
(No apparent water infiltration noted)									



patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - 1180 Kingston Ave.
Ottawa, Ontario

DATUM TBM - Top of grate of manhole located near the centreline of the road, across from subject site. Geodetic elevation = 79.22m was provided to the TBM by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

FILE NO. PG4093

HOLE NO. TP 2

BORINGS BY Backhoe **DATE** March 28, 2017

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	79.18		
TOPSOIL, some clay		G	1						
0.30									
		G	2						
						1	78.18		
Stiff, brown **SILTY CLAY,** trace sand		G	3						
						2	77.18		
		G	4						
2.50									
		G	5						
						3	76.18		▽
Firm, grey **SILTY CLAY**									
4.00									
						4	75.18		
End of Test Pit									
(Groundwater infiltration at 3.3m depth)									

Pen. Resist. Blows/0.3m: 20 40 60 80

Water Content %: 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - 1180 Kingston Ave.
Ottawa, Ontario

DATUM TBM - Top of grate of manhole located near the centreline of the road, across from subject site. Geodetic elevation = 79.22m was provided to the TBM by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

FILE NO. PG4093

HOLE NO. TP 3

BORINGS BY Backhoe **DATE** March 28, 2017

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	79.16		
TOPSOIL, some clay		G	1						
0.30									
		G	2						
						1	78.16		
Stiff to firm, brown **SILTY CLAY,** trace sand		G	3						
						2	77.16		
		G	4						
2.80									
Firm, grey **SILTY CLAY,** trace sand		G	5			3	76.16		
3.50									
GLACIAL TILL: Grey silty clay with sand, gravel, cobbles and boulders		G	6						
4.00						4	75.16		
End of Test Pit									
(Groundwater infiltration at 2.6m depth)									

20 40 60 80

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - 1180 Kingston Ave.
Ottawa, Ontario

DATUM TBM - Top of grate of manhole located near the centreline of the road, across from subject site. Geodetic elevation = 79.22m was provided to the TBM by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

FILE NO. PG4093

HOLE NO. TP 4

BORINGS BY Backhoe **DATE** March 28, 2017

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	79.12		
TOPSOIL, some clay		G	1						
0.50									
		G	2						
		G	3			1	78.12		
Stiff to firm, brown **SILTY CLAY,** some sand									
		G	4			2	77.12		▽
2.70									
		G	5						
Firm, grey **SILTY CLAY,** trace sand						3	76.12		
3.20									
GLACIAL TILL: Grey silty clay with sand, gravel, cobbles and boulders		G	6						
4.00						4	75.12		
End of Test Pit									
(Groundwater infiltration at 2.5m depth)									

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

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - 1180 Kingston Ave.
Ottawa, Ontario

DATUM TBM - Top of grate of manhole located near the centreline of the road, across from subject site. Geodetic elevation = 79.22m was provided to the TBM by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

FILE NO. PG4093

HOLE NO. TP 5

BORINGS BY Backhoe **DATE** March 28, 2017

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	79.01		
TOPSOIL, some clay		G	1						
0.30									
		G	2						
						1	78.01		
Stiff, brown **SILTY CLAY,** some sand		G	3						
						2	77.01		▽
		G	4						
2.80									
Firm, grey **SILTY CLAY** with sand		G	5						
3.20						3	76.01		
		G	6						
GLACIAL TILL: Grey silty clay with sand, gravel, cobbles and boulders									
4.00						4	75.01		
End of Test Pit									
(Groundwater infiltration at 2.8m depth)									

Pen. Resist. Blows/0.3m: 20 40 60 80

Water Content %: 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ 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 strength of cohesionless soils is the relative density, 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.

Relative Density	'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 vane tests, penetrometer tests, unconfined compression tests, or occasionally by Standard Penetration Tests.

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 is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil.

Terminology used for describing soil strata based upon texture, or the proportion of individual particle sizes present is provided on the Textural Soil Classification Chart at the end of this information package.

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 NXL size core. However, it can be used on smaller core sizes, such as BX, 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
PS	-	Piston sample
AU	-	Auger sample or bulk sample
WS	-	Wash sample
RC	-	Rock core sample (Core bit size AXT, BXL, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

SYMBOLS AND TERMS (continued)

GRAIN SIZE DISTRIBUTION

MC%	-	Natural moisture 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 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 x 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

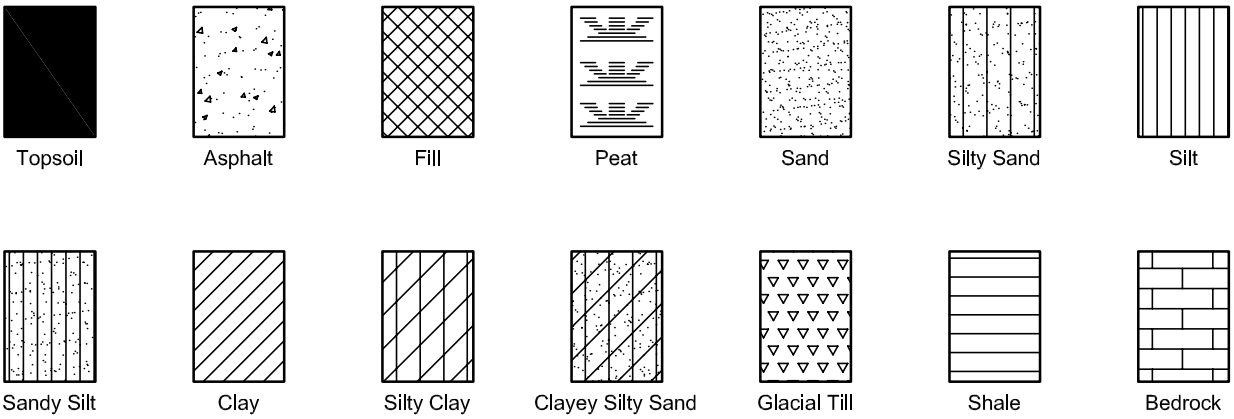
p'_o	-	Present effective overburden pressure at sample depth
p'_c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'_c)
Cc	-	Compression index (in effect at pressures above p'_c)
OC Ratio		Overconsolidaton ratio = p'_c / p'_o
Void 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.

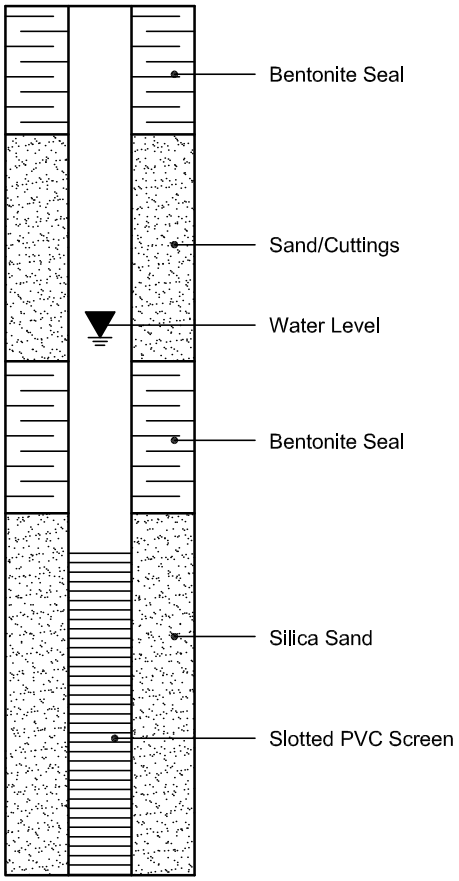
SYMBOLS AND TERMS (continued)

STRATA PLOT

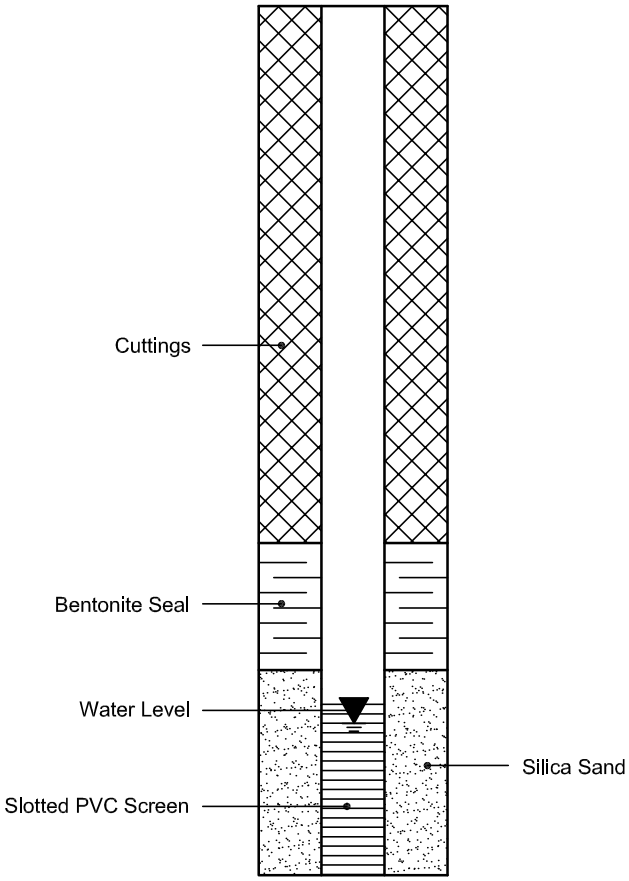


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



Certificate of Analysis

Client: Paterson Group Consulting Engineers

Client PO: 21800

Report Date: 11-Apr-2017

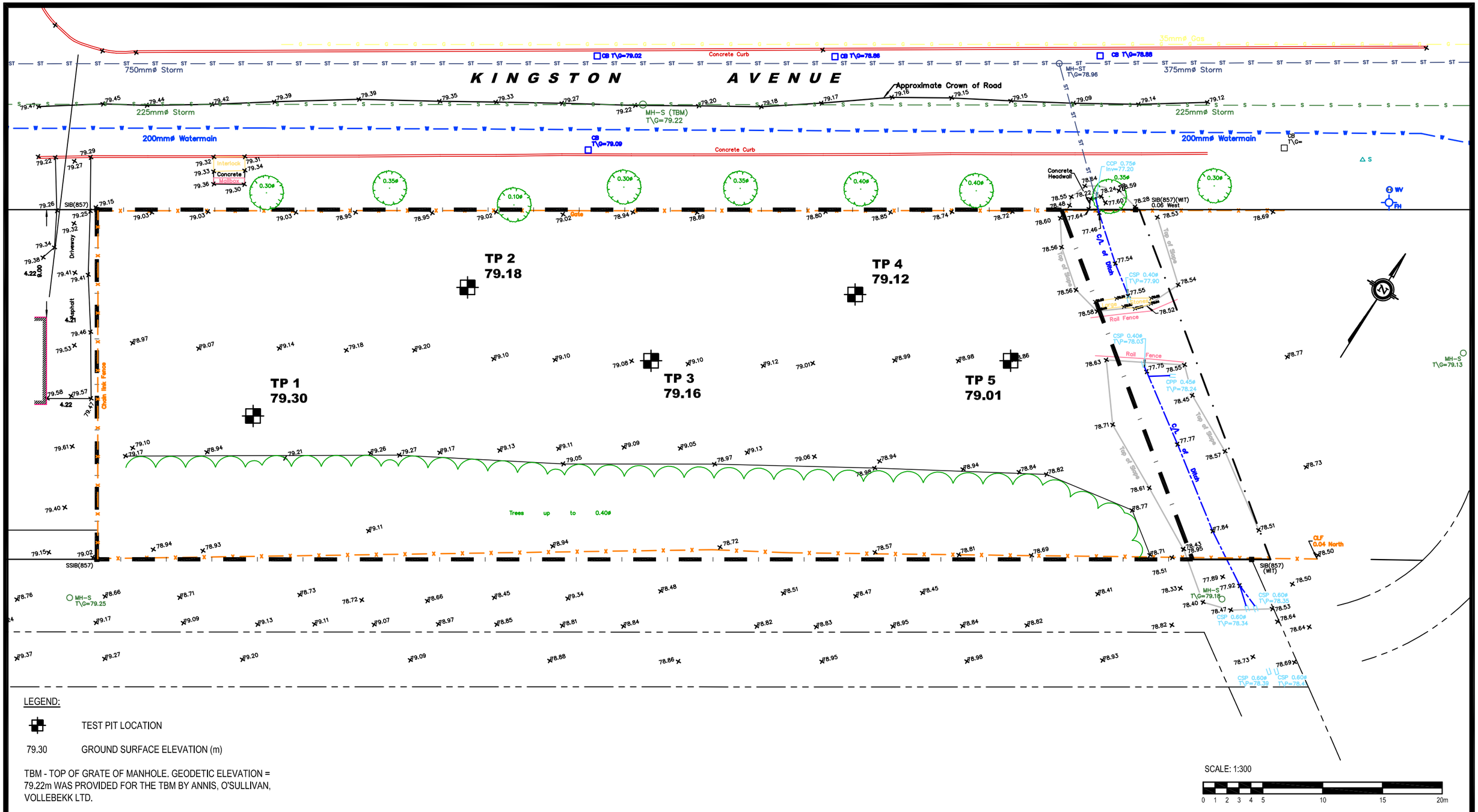
Order Date: 5-Apr-2017

Project Description: PG4093

	Client ID:	TP4-G4	-	-	-
	Sample Date:	28-Mar-17	-	-	-
	Sample ID:	1714321-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	66.2	-	-	-
General Inorganics					
pH	0.05 pH Units	7.69	-	-	-
Resistivity	0.10 Ohm.m	19.1	-	-	-
Anions					
Chloride	5 ug/g dry	186	-	-	-
Sulphate	5 ug/g dry	115	-	-	-

FIGURE 1

KEY PLAN



LEGEND:

TEST PIT LOCATION

79.30 GROUND SURFACE ELEVATION (m)

TBM - TOP OF GRATE OF MANHOLE. GEODETIC ELEVATION = 79.22m WAS PROVIDED FOR THE TBM BY ANNIS, O'SULLIVAN, VOLLEBEKK LTD.

SCALE: 1:300

0 1 2 3 4 5 10 15 20m

patersongroup
consulting engineers

154 Colonnade Road South
Ottawa, Ontario K2E 7J5
Tel: (613) 226-7381 Fax: (613) 226-6344

NO.	REVISIONS	DATE	INITIAL
0			

RND CONSTRUCTION

GEOTECHNICAL INVESTIGATION
PROP. RESIDENTIAL DEVELOPMENT -1180 KINGSTON AVENUE
OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:300	Date: 04/2017
Drawn by: MPG	Report No.: PG4093-1
Checked by: CB	Dwg. No.: PG4093-1
Approved by: DJG	Revision No.: 0

p:\autocad drawings\geotechnical\pg40xx\pg4093-1 thlp.dwg