Geotechnical Engineering

Environmental Engineering

Hydrogeology

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Geotechnical Investigation

Proposed Residential Development - Phase 3-2
2710 Draper Avenue
Ottawa, Ontario

Prepared For

Greatwise Developments

February 21, 2019

Report: PG1630-4 Revision 1

Paterson Group Inc.
Consulting Engineers
154 Colonnade Road South
Ottawa (Nepean), Ontario
Canada K2E 7J5

Tel: (613) 226-7381
Fax: (613) 226-6344

www.patersongroup.ca

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Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by Greatwise Development to conduct a geotechnical investigation for Phase 3-2 of the proposed residential development (Qualicum Woods Crossing) located at the southeast corner of Morrison Drive and Draper Avenue, in the City of Ottawa (refer to Figure 5 - Key Plan in Appendix 2 of this report).

The objective of the current investigation was to:

- Determine the subsoil and groundwater conditions at this site by means of existing boreholes.

- Provide geotechnical recommendations pertaining to design of the proposed 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. It contains our findings and includes geotechnical recommendations pertaining to the design and construction of the subject development as they are understood at the time of writing this report.

Investigating the presence or potential presence of contamination on the subject property was not part of the scope of work of this present investigation. Therefore, the present report does not address environmental issues.

2.0 Proposed Development

It is our understanding that the subject phase of the proposed residential development consist of several three-storey townhouse blocks of slab on grade construction. A proposed neighbourhood park, parking areas, access lanes and landscaped areas are also anticipated for this development.

3.0 Method of Investigation

3.1 Field Investigation

The field program for the investigation was carried out between April 10 and 18, 2008. At that time, a total of seventeen (17) boreholes were advanced to a maximum depth of 16.4 m. The borehole locations were distributed in a manner to provide general coverage of the proposed residential development. The locations were determined in the field by Paterson personnel taking into consideration site features and underground services. The locations of the boreholes are shown in Drawing PG1630-3 - Test Hole Location Plan included in Appendix 2.

The boreholes were put down using truck and track-mounted auger drill rigs operated by two person crews. All fieldwork was conducted under the full-time supervision of our personnel under the direction of a senior engineer from our geotechnical department. The drilling procedure consisted of augering to the required depths at the selected locations and sampling the overburden.

Sampling and In Situ Testing

Soil samples from the boreholes were recovered from the auger flights or using a 50 mm diameter split-spoon sampler. All soil samples were initially classified on site. The auger and split spoon samples were placed in sealed plastic bags. All samples were transported to our laboratory. The depths at which the auger and split spoon samples were recovered from the test holes are shown as AU and SS, respectively, on the Soil Profile and Test Data sheets presented in Appendix 1.

The Standard Penetration Test (SPT) was conducted in conjunction with the recovery of the split spoon samples. The SPT results are recorded as “N” values on the Soil Profile and Test Data sheets. The “N” value is the number of blows required to drive the split spoon sampler 300 mm into the soil after a 150 mm initial penetration using a 63.5 kg hammer falling from a height of 760 mm.

Undrained shear strength testing, using a vane apparatus, was carried out in cohesive soils. The subsurface conditions observed in the boreholes were recorded in detail in the field. The soil profiles are logged on the Soil Profile and Test Data sheets presented in Appendix 1 of this report.

The overburden thickness was evaluated during the course of the investigation by dynamic cone penetration testing (DCPT) at BHs 2, 5, 9, 11 and 14 to 17. The DCPT consists of driving a steel drill rod, equipped with a 50 mm diameter cone at its tip, using a 63.5 kg hammer falling from a height of 760 mm. The number of blows required to drive the cone into the soil is recorded for each 300 mm increment.

Groundwater

Flexible standpipes were installed in all boreholes to permit monitoring of the groundwater levels subsequent to the completion of the sampling program.

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 we are otherwise directed.

3.2 Field Survey

The ground surface elevation at the borehole locations was referenced to a temporary benchmark (TBM), consisting of the top of spindle of the fire hydrant located on Morrison Drive approximately 80 m north of Baseline Road. A geodetic elevation of 75.25 was provided for the TBM, based on plans provided by Roderick Lahey Architect. The TBM, borehole locations and ground surface elevation at the borehole locations are presented in Drawing PG1630-3 - 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 analyzed to determine the concentrations of sulphate and chloride, as well as, the resistivity and the pH of the samples. The analytical test results are presented in Appendix 1 and discussed in Subsection 6.7 of this report.

4.0 Observations

4.1 Surface Conditions

Currently, the subject site is occupied by six (6) multi-storey buildings along with associated access lanes, parking and landscaped areas. Buildings E and F have been constructed as part of earlier phases of the proposed development. There are four (4) existing two (2) storey residential buildings in the north and central portions of the site, which will be removed as part of the current phases of the proposed development. The subject site is approximately at grade with surrounding roadways.

4.2 Subsurface Profile

The subsurface soil profile at the borehole locations consist of topsoil or pavement structure at ground surface followed by a silty clay layer. Clayey silt was encountered underlying the silty clay layer at several borehole locations. The silty clay and/or clayey silt are underlain by a deep silty sand deposit. Specific details of the soil profile at each test hole location can be seen on the Soil Profile & Test Data sheets in Appendix 1.

4.3 Groundwater

Groundwater levels (GWL) were measured in the borehole piezometers on April 25, 2008. The GWL readings are presented in Table 1. As groundwater levels are subject to seasonal fluctuations, it should be noted that the groundwater may be encountered at higher levels at the time of construction.

Table 1 - Summary of Groundwater Levels				
Borehole Number	Ground Surface Elevation (m)	Measured Groundwater Level (m)		Recording Date
		Depth	Groundwater Elevation (m)	
BH 1	74.98	3.60	71.38	April 25, 2008
BH 2	76.50	9.41	67.09	April 25, 2008
BH 3	74.15	6.21	67.94	April 25, 2008
BH 4	76.35	4.23	72.12	April 25, 2008
BH 5	76.20	5.94	70.26	April 25, 2008
BH 6	76.33	7.41	68.92	April 25, 2008
BH 7	76.37	7.10	69.27	April 25, 2008
BH 8	74.00	6.43	67.57	April 25, 2008
BH 9	73.93	6.21	67.72	April 25, 2008
BH 10	72.80	4.43	68.37	April 25, 2008
BH 11	73.87	4.48	69.39	April 25, 2008
BH 12	73.40	4.00	69.40	April 25, 2008
BH 13	72.88	5.60	67.28	April 25, 2008
BH 14	73.00	6.41	66.59	April 25, 2008
BH 15	73.26	5.12	68.14	April 25, 2008
BH 16	74.18	7.33	66.85	April 25, 2008
BH 17	74.24	6.39	67.85	April 25, 2008

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is adequate for the proposed residential development. The proposed buildings are expected to be founded on conventional footings placed over an undisturbed, stiff silty clay bearing surface.

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

5.2 Site Grading and Preparation

Stripping Depth

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

Existing foundation walls and other construction debris should be entirely removed from within the proposed building perimeter. Under paved areas, existing construction remnants such as foundation walls should be excavated to a minimum of 1 m below final grade.

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. It 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 its 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, they should be compacted in thin lifts to a minimum density of 95% of their respective SPMDD. Non-specified existing fill and site-excavated soils are not suitable for use as backfill against foundation walls.

5.3 Foundation Design

Shallow Foundation

Strip footings, up to 3 m wide, and pad footings, up to 6 m wide, founded on an undisturbed, stiff silty clay 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**. Footings placed on an undisturbed, compact silty sand 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**.

The bearing resistance values at SLS will be subjected to potential post-construction total and differential settlements of 25 and 20 mm, respectively.

The bearing resistance values are provided on the assumption that the footings will be placed on bearing surfaces consisting of native undisturbed soil. The bearing surfaces should be free of fill, topsoil, surface water and deleterious materials, such as loose, frozen or disturbed soil prior to placing concrete.

Lateral Support

The bearing medium under footing-supported structures is required to be provided with adequate lateral support. Adequate lateral support is provided to a stiff silty clay or compact silty sand bearing medium when a plane extending down and out from the bottom edge of the footing, at a minimum of 1.5H:1V.

Permissible Grade Raise

A permissible grade raise restriction of 1 m is recommended for the proposed development, if the proposed buildings are founded by conventional shallow footings over a silty clay deposit.

5.4 Design for Earthquakes

The site class for seismic site response can be taken as **Class D** for the foundations considered at this site. The soils underlying the proposed shallow foundations 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 Slab on Grade Construction

With the removal of all topsoil and deleterious fill, such as those containing organic materials, and any existing foundations or construction debris, within the footprint of the proposed buildings, the native soil surface will be considered an acceptable subgrade on which to commence backfilling for floor slab construction.

Any soft areas should be removed and backfilled with appropriate backfill material prior to placing any fill. OPSS 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-floor fill consists of Granular A crushed stone. All backfill material within the footprint of the proposed buildings should be placed in maximum 300 mm thick loose layers and compacted to at least 98% of its SPMDD. .

5.6 Pavement Design

Car only parking and heavy traffic areas are anticipated at this site. The proposed pavement structures are shown in Tables 2 and 3.

Table 2 - Recommended Pavement Structure - Car Only Parking Areas

Thickness (mm)	Material Description
50	**Wear Course -** HL-3 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 3 - Recommended Pavement Structure - Access Lanes and Heavy Truck Parking Areas

Thickness (mm)	Material Description
40	**Wear Course -** HL-3 Asphaltic Concrete
50	**Binder Course -** HL-8 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 100% of the material's SPMDD using suitable compaction equipment.

Pavement Structure Drainage

Satisfactory performance of the pavement structure is largely dependent on keeping the contact zone between the subgrade material and the base stone in a dry condition. Failure to provide adequate drainage under conditions of heavy wheel loading can result in the fine subgrade soil being pumped into the voids in the stone subbase, thereby reducing its load carrying capacity.

In areas, where the subgrade soil consists predominantly of silty clay. Consideration should be given to installing subdrains at each catch basin. These drains should be at least 3 m long and should extend in four orthogonal directions or longitudinally when placed along a curb. The clear stone surrounding the drainage lines or the pipe itself, should be wrapped with a suitable filter cloth. The sub-drain inverts should be approximately 300 mm below subgrade level. The subgrade surface should be crowned to promote water flow to the drainage lines.

Road Cut Servicing

Where road cuts are proposed on Morrison Drive and Draper Avenue, the pavement granular base and subbase should be reinstated in maximum 300 mm thick lifts and compacted to a minimum of 100% of the material's SPMDD.

Where the proposed pavement structure meets the existing asphalt surface, the following recommendations should be followed:

❏ A 300 mm wide section of the existing asphalt roadway should be saw cut from the existing pavement edge to provide a sound surface to abut the proposed pavement structure.
❏ It is recommended to mill a 300 mm wide and 40 mm deep section of the existing asphalt at the saw cut edge.

- ❏ The proposed pavement structure subbase materials should be tapered no greater than 3H:1V to meet the existing subbase materials.
- ❏ Clean existing granular road subbase materials can be reused upon assessment by the geotechnical consultant at the time of excavation (construction) as to its suitability.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

A perimeter foundation 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 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.

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, as such, are not recommended for placement as backfill against the foundation walls unless used in conjunction with a composite drainage system, such as Delta Drain 6000 or Miradrain G100N. Imported granular materials, such as clean sand or OPSS Granular B Type I granular material, should be placed for this purpose.

6.2 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 in this regard.

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

6.3 Excavation Side Slopes

Temporary Side Slopes

The side slopes of excavations in the soil and fill overburden materials should either be cut back at acceptable slopes or should be retained by shoring systems from the start of the excavation until the structure is backfilled. It is assumed that sufficient room will be available for the greater part of the excavation 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. The flatter slope is required for excavation below groundwater level. The subsoil at this site is considered to be mainly a Type 2 or 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.

It is recommended that a trench box be used at all times to protect personnel working in trenches with steep or vertical sides. It is expected that services will be installed by “cut and cover” methods and excavations will not be left open 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. Where the bedding is located within the firm grey silty clay, the thickness of the bedding material may require to be increased to a minimum of 300 mm. The material should be placed in maximum 300 mm thick lifts and compacted to a minimum of 95% of its 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 its SPMDD.

Generally, it should be possible to re-use the moist, not wet, silty clay and silty sand above the cover material if the excavation and filling operations are carried out in dry weather conditions. The wet silty clay should be given a sufficient drying period to decrease its moisture content to an acceptable level to make compaction possible prior to being re-used.

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 material's SPMDD.

To reduce long-term lowering of the groundwater level at this site, clay seals should be provided in the service trenches. The seals should be at least 1.5 m long (in the trench direction) and should extend from trench wall to trench wall. 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 and at strategic locations at no more than 60 m intervals in the service trenches. Periodic inspection of the clay seal placement work should be completed by Paterson personnel during servicing installation work.

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. Infiltration levels are anticipated to be low through the excavation face. The groundwater infiltration will be controllable with open sumps and pumps.

A temporary Ministry of the Environment and Climate Change (MECP) 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 MECP.

For typical ground or surface water volumes, being pumped during the construction phase, 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, an EASR will not be allowed as a temporary dewatering measure while awaiting the MECP review of the PTTW application.

Based on our observations and design plans, an EASR permit is recommended for the subject site.

6.6 Winter Construction

The subsurface conditions at this site mostly 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. Precautions should be taken if winter construction is considered for this project.

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, tarpaulins or other suitable means. In this regard, 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 the founding level.

The trench excavations should be constructed in a manner that will avoid the introduction of frozen materials into the trenches. As well, pavement construction is difficult during winter. The subgrade consists of frost susceptible soils which will experience total and differential frost heaving as the work takes place. In addition, the introduction of frost, snow or ice into the pavement materials, which is difficult to avoid, could adversely affect the performance of the pavement structure. Additional information could be provided, if required.

6.7 Corrosion Potential and Sulphate

The results of analytical testing presented in Table 4 show that the sulphate contents are less than 0.1%. These results are indicative that Type 10 Portland cement (normal cement) would be appropriate for this site. The chloride content and the pH of the samples indicate that they are not significant factors in creating a corrosive environment for exposed ferrous metals at this site, whereas the resistivity is indicative of a moderate corrosive environment above the groundwater table and a slightly aggressive corrosive environment below the groundwater table.

Table 4 - Corrosion Potential			
Parameter	**Laboratory Result**	**Threshold**	**Commentary**
Chloride	92 µg/g	Chloride content less than 400 mg/g	Negligible concern
pH	6.78	pH value less than 5.0	Neutral Soil
Resistivity	26.6 ohm.m	Resistivity greater than 1,500 ohm.cm	Moderate Corrosion Potential
Sulphate	50 µg/g	Sulphate value greater than 1 mg/g	Negligible Concern

6.8 Landscaping Considerations

Tree Planting Restrictions

The proposed development is located in an area of low to medium sensitive silty clay deposits for tree planting. Based on our knowledge of the general site area, the plasticity index is expected to be lower than 40%. It should be further be noted that stiff to hard silty clay crust extending to 5 to 7 m below existing grade was present where silty clay was encountered. As such, the brown silty clay crust extends 2-3 m below design footing level should be considered low to medium sensitivity clay and should not be considered a sensitive marine clay.

Based on the above discussion, it is recommended that trees placed within 5 m of the foundation wall consist of street 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 moderate water demanding trees with roots extending to a maximum 2 m depth. It should be noted that shrubs and other small plantings are permitted within the 5 m setback area.

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.

Swimming Pools

The in-situ soils are considered to be acceptable for swimming pools. Above ground swimming pools must be placed a minimum of 5 m away from the residence and neighbouring foundations. Otherwise, pool construction is considered routine, and should be constructed in accordance with the manufacturer`s requirements.

Aboveground Hot Tubs

Additional grading around the hot tub should not exceed permissible grade raises. Otherwise, hot tub construction is considered routine, and can be constructed in accordance with the manufacturer’s specifications.

Installation of Decks or Additions

Additional grading around proposed deck or addition should not exceed permissible grade raises. Otherwise, standard construction practices are considered acceptable.

6.9 Slope Stability Analysis

The slope stability analysis of the proposed slope to be located east of the garage entrance side walls was completed using SLIDE, a computer program which permits a two-dimensional slope stability analysis using several methods including Bishop’s method, which is a widely used and accepted analysis method. The program calculates a factor of safety, which represents the ratio of the forces resisting failure to those favouring failure. Theoretically, a factor of safety of 1.0 represents a condition where the slope is stable. However, due to intrinsic limitations of the calculation methods and the variability of the subsoil and groundwater conditions, a factor of safety greater than one is usually required to ascertain that the risks of failure are acceptable.

Two (2) cross sections were analysed as the possible worst case scenarios along the proposed slope to be located east of the garage entrance of Building E. The location of the cross sections analyzed are presented on Drawing PG1630-3 - Test Hole Location Plan in Appendix 2.

Static Loading Analysis

The results of the static loading analysis for the proposed conditions at Sections A and B are shown in Figures 1 and 3 provided in Appendix 2. The minimum slope stability factor of safety was calculated to be 2.0 which is greater than the minimum recommended factor of safety of 1.5 for static conditions. Based on the results, the proposed conditions are considered stable under static loading.

Seismic Loading Analysis

An analysis considering seismic loading was also completed for each Section. A horizontal seismic acceleration, K_h, of 0.16G was considered for the analysed section. A factor of safety of 1.1 is considered to be satisfactory for stability analysis including seismic loading.

The results of the analysis including seismic loading is shown in Figures 2 and 4 in Appendix 2. The overall slope stability factor of safety for the subject sections when considering seismic loading was found to be greater than 1.1. Based on the results, the slope is considered stable under seismic loading.

7.0 Recommendations

It is a requirement for the foundation design data provided herein to be applicable that the following material testing and observation program be performed 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 provided in this report are in accordance with our present understanding of the project. We request permission to review our 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 those at the test locations, we request immediate notification to permit reassessment of our recommendations.

The recommendations provided herein should only be used by the design professionals associated with this project. They are not intended for contractors bidding on or undertaking the work. The latter should evaluate the factual information provided in this report and determine its suitability and completeness for their intended construction schedule and methods. Additional testing may be required for their purposes.

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 Greatwise Developments or their agents is not authorized without review by Paterson for the applicability of our recommendations to the alternative use of the report.

Paterson Group Inc.

LICENSED PROFESSIONAL ENGINEER
Feb. 21-2019
F. I. ABOU-SEIDO
100156744
PROVINCE OF ONTARIO

Nathan F. S. Christie, P.Eng.

Faisal I. Abou-Seido, P.Eng.

Report Distribution:

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APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

ANALYTICAL TESTING RESULTS

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Morrison Drive
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located centre of west property line, along Morrison Drive. Assumed geodetic elevation = 75.25m, as per plan provided by Roderick Lahey Architects Inc.

REMARKS

BORINGS BY CME 55 Power Auger

DATE April 10, 2008

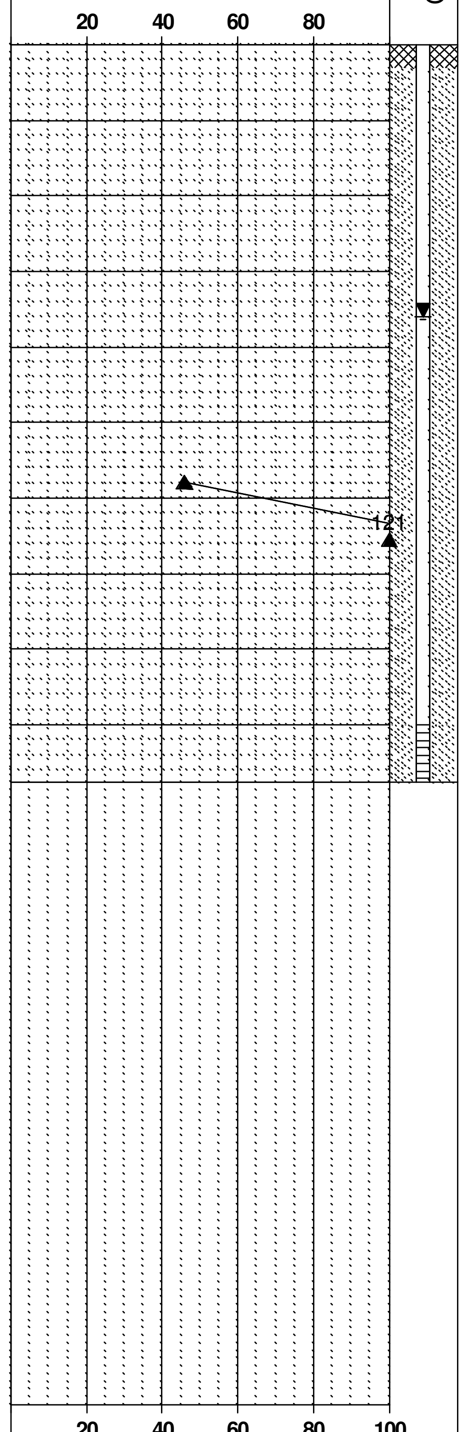
FILE NO. PG1630

HOLE NO. BH 1

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	74.98
Asphaltic concrete 0.05		AU	1				
FILL: Brown silty sand and gravel 0.46							
Very stiff, brown **SILTY CLAY**, some sand		SS	2	100	11	1	73.98
		SS	3	100	10	2	72.98
2.29							
Firm, brown **CLAYEY SILT**, some sand		SS	4	100	5	3	71.98
		SS	5	100	4		
		SS	6	100	5	4	70.98
		SS	7	100	2	5	69.98
6.10						6	68.98
Dense to compact, brown **SILTY SAND**		SS	8	75	34	7	67.98
		SS	9	83	25	8	66.98
- loose and grey by 8.5m depth						9	65.98
9.75		SS	10	100	8		
End of Borehole							
(GWL @ 3.60m-Apr. 25/08)							

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

○ Water Content %



Shear Strength (kPa)
▲ Undisturbed △ Remoulded

Piezometer Construction

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Morrison Drive
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located centre of west property line, along Morrison Drive. Assumed geodetic elevation = 75.25m, as per plan provided by Roderick Lahey Architects Inc.

REMARKS

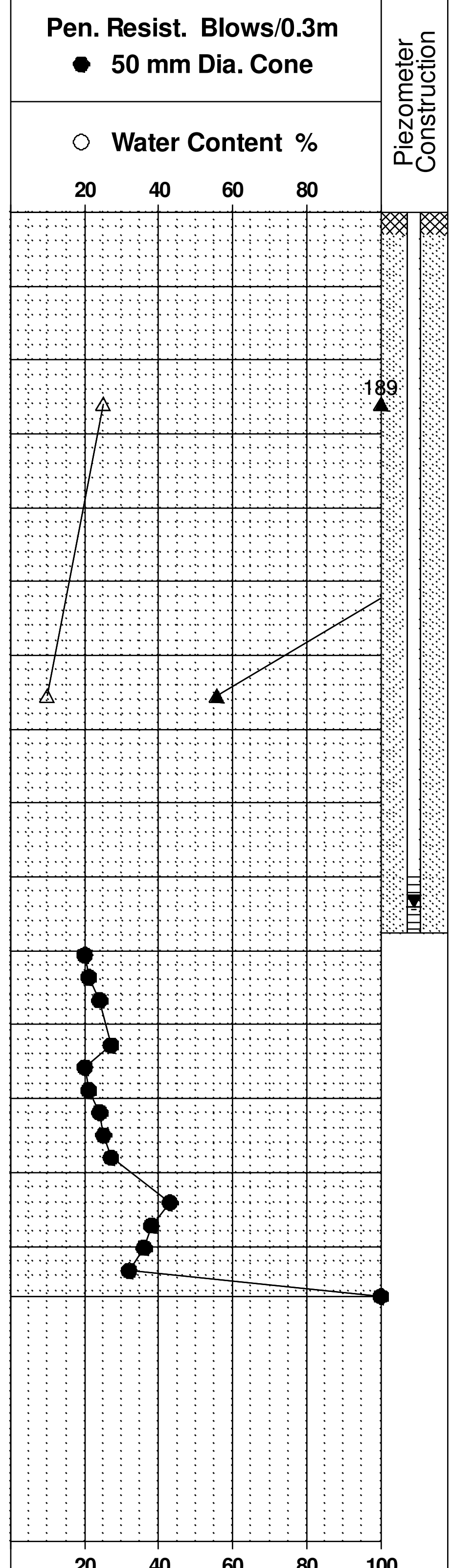
BORINGS BY CME 55 Power Auger

DATE April 10, 2008

FILE NO. PG1630

HOLE NO. BH 2

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	76.50
TOPSOIL 0.05		AU	1				
Very stiff to stiff, brown **SILTY CLAY**		SS	2	100	6	1	75.50
		SS	3	100	5	2	74.50
						3	73.50
		SS	4	100	4		
		SS	5	100	1	4	72.50
		SS	6	100	2	5	71.50
6.10		SS	7	100	2	6	70.50
Stiff, grey **CLAYEY SILT**						7	69.50
7.62		SS	8	83	1		
Compact, brown **SILTY SAND**		SS	9	67	13	8	68.50
		SS	10	67	13	9	67.50
9.75		SS	11	83	25		
Dynamic Cone Penetration Test commenced @ 9.75m depth						10	66.50
						11	65.50
Inferred **SILTY SAND**						12	64.50
						13	63.50
14.68						14	62.50
End of Borehole							
Practical refusal to DCPT @ 14.68m depth							
(GWL @ 9.41m-Apr. 25/08)							



Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Morrison Drive
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located centre of west property line, along Morrison Drive. Assumed geodetic elevation = 75.25m, as per plan provided by Roderick Lahey Architects Inc.

REMARKS

BORINGS BY CME 55 Power Auger

DATE April 10, 2008

FILE NO. PG1630

HOLE NO. BH 3

SOIL DESCRIPTION	Depth of change (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	74.15
TOPSOIL	0.08						
FILL: Crushed stone	0.25	AU	1				
FILL: Sand and gravel	0.51	SS	2	58	12	1	73.15
Very stiff to stiff, brown **SILTY CLAY**, trace sand		SS	3	100	11	2	72.15
		SS	4	100	7	3	71.15
		SS	5	100	5	4	70.15
		SS	6	100	6	5	69.15
		SS	7	100	8		
	5.94	SS	8	100	5	6	68.15
Loose, brown **SILTY SAND**		SS	9	78	66		
- grey and very dense by 6.0m depth		SS	10	100	50+	7	67.15
		SS	11	67	34	8	66.15
			12	100	50+	9	65.15
	9.75	SS	13	58	59		
End of Borehole							
(GWL @ 6.21m-Apr. 25/08)							

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

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Morrison Drive
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located centre of west property line, along Morrison Drive. Assumed geodetic elevation = 75.25m, as per plan provided by Roderick Lahey Architects Inc.

REMARKS

BORINGS BY CME 55 Power Auger

DATE April 10, 2008

FILE NO. PG1630

HOLE NO. BH 4

SOIL DESCRIPTION	DEPTH TO BASE (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
TOPSOIL	0.05				
Grey-brown **SILTY CLAY**, trace sand	6.10	SS	1	100	7
		SS	2	100	11
		SS	3	100	3
		SS	4	100	2
		SS	5	100	2
		SS	6	100	1
		SS	7	100	1
Grey-brown **CLAYEY SILT**, some sand	7.62	SS	8	83	1
		SS	9	100	2
Very loose to compact, brown **SILTY SAND**	9.75	SS	10	8	11
		SS	11	50	24
		SS	12	50	20
End of Borehole					
(GWL @ 4.23m-Apr. 25/08)					

DEPTH (m)	ELEV. (m)
0	76.35
1	75.35
2	74.35
3	73.35
4	72.35
5	71.35
6	70.35
7	69.35
8	68.35
9	67.35

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

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Morrison Drive
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located centre of west property line, along Morrison Drive. Assumed geodetic elevation = 75.25m, as per plan provided by Roderick Lahey Architects Inc.

REMARKS

FILE NO. PG1630

HOLE NO. BH 5

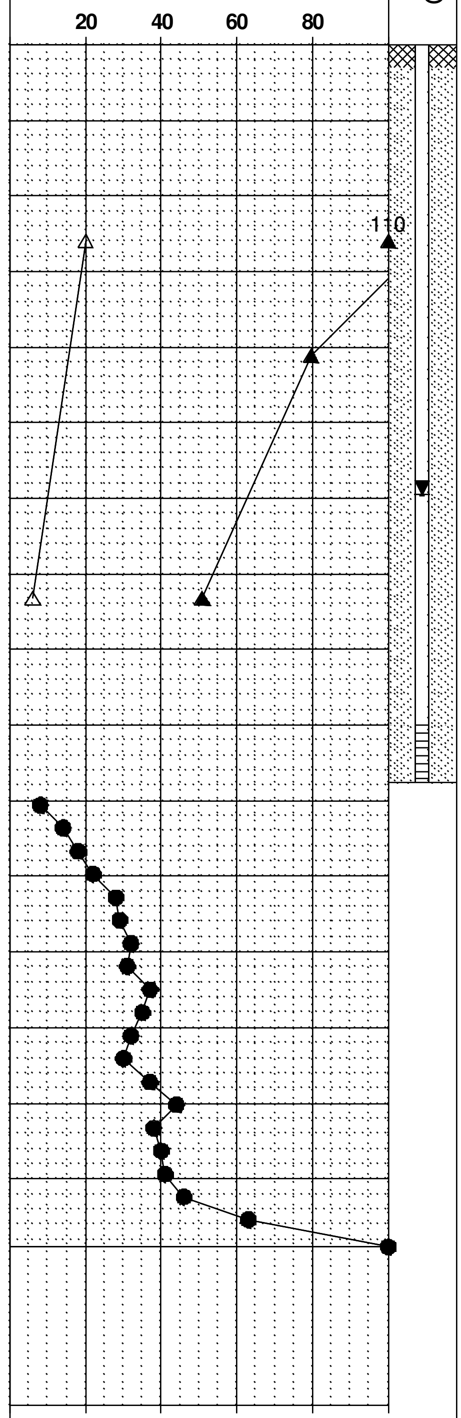
BORINGS BY CME 55 Power Auger **DATE** April 11, 2008

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	76.20
TOPSOIL 0.05							
Very stiff to stiff, brown **SILTY CLAY**, some sand		SS	1	100	9	1	75.20
		SS	2	100	6	2	74.20
		SS	3	100	3	3	73.20
						4	72.20
		SS	4	100	1	5	71.20
		SS	5	100	1	6	70.20
6.86		SS	6	100	1		
Stiff, grey **CLAYEY SILT**		SS	7	100	1	7	69.20
		SS	8	100	2	8	68.20
		SS	9	100	2	9	67.20
9.75		SS	10	100	4		
Dynamic Cone Penetration Test commenced @ 9.75m depth						10	66.20
Inferred **SILTY SAND**						11	65.20
						12	64.20
						13	63.20
						14	62.20
(GWL @ 5.94m-Apr. 25/08)						15	61.20
15.90							
End of Borehole Practical refusal to DCPT @ 15.90m depth							

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

○ Water Content %

Piezometer Construction



Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Morrison Drive
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located centre of west property line, along Morrison Drive. Assumed geodetic elevation = 75.25m, as per plan provided by Roderick Lahey Architects Inc.

REMARKS

BORINGS BY CME 55 Power Auger

DATE April 11, 2008

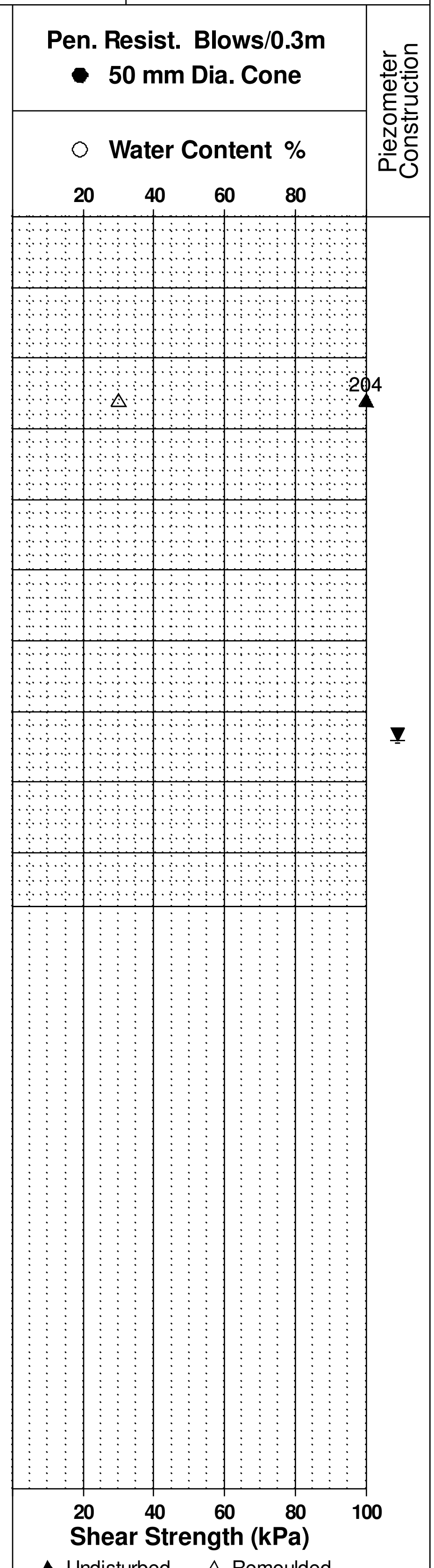
FILE NO. PG1630

HOLE NO. BH 6

SOIL DESCRIPTION	Depth to base (m)	TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	76.33
TOPSOIL	0.10	AU	1				
Hard to stiff, brown **SILTY CLAY**, some sand	6.10	SS	2	17		1	75.33
		SS	3	12	5	2	74.33
		SS	4	100	5	3	73.33
		SS	5	100	2	4	72.33
		SS	6	100	3	5	71.33
		SS	7	75	2	6	70.33
Compact, brown **SILTY SAND**	9.75	SS	8	67	24	7	69.33
		SS	9	67	23	8	68.33
		SS	10	75	23	9	67.33
		SS	11		24		

End of Borehole

(GWL @ 7.41m-Apr. 25/08)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Morrison Drive
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located centre of west property line, along Morrison Drive. Assumed geodetic elevation = 75.25m, as per plan provided by Roderick Lahey Architects Inc.

REMARKS

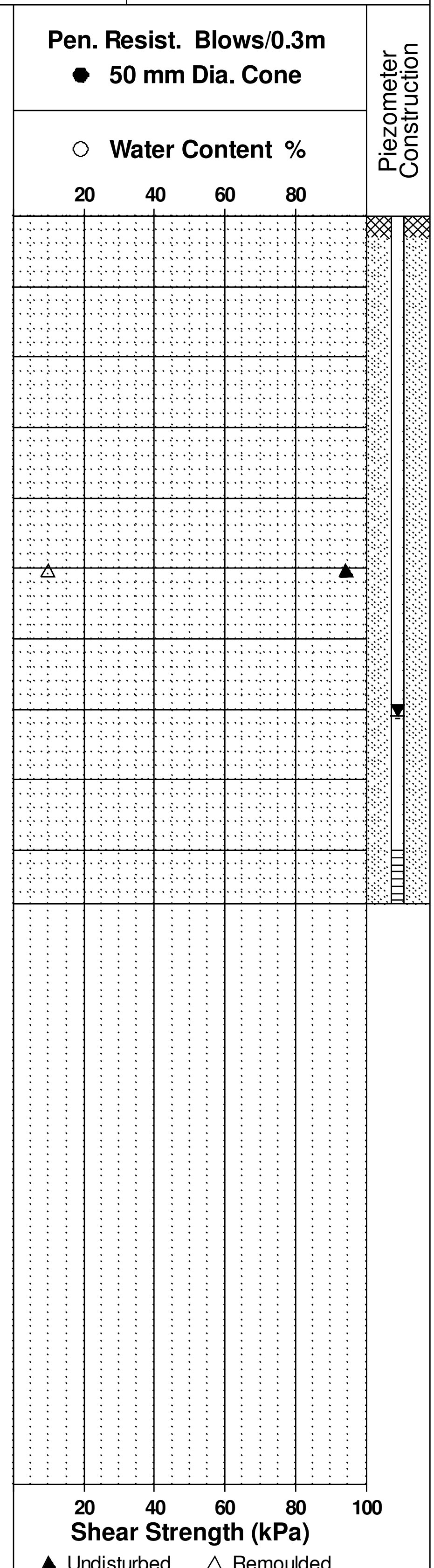
BORINGS BY CME 55 Power Auger

DATE April 11, 2008

FILE NO. PG1630

HOLE NO. BH 7

SOIL DESCRIPTION	Strata depth (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	76.37
TOPSOIL	0.13						
Very stiff to stiff, brown **SILTY CLAY**, some sand		SS	1	100	6	1	75.37
		SS	2	100	5	2	74.37
		SS	3	100	6	3	73.37
		SS	4	100	4	4	72.37
	5.33	SS	5	83	2	5	71.37
Stiff, brown **CLAYEY SILT**, some sand		SS	6	83	3	6	70.37
	6.70	SS	7	83	3		
Compact, brown **SILTY SAND**		SS	8	75	19	7	69.37
		SS	9	67	22	8	68.37
	9.75	SS	10	50	27	9	67.37
End of Borehole							
(GWL @ 7.10m-Apr. 25/08)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Morrison Drive
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located centre of west property line, along Morrison Drive. Assumed geodetic elevation = 75.25m, as per plan provided by Roderick Lahey Architects Inc.

REMARKS

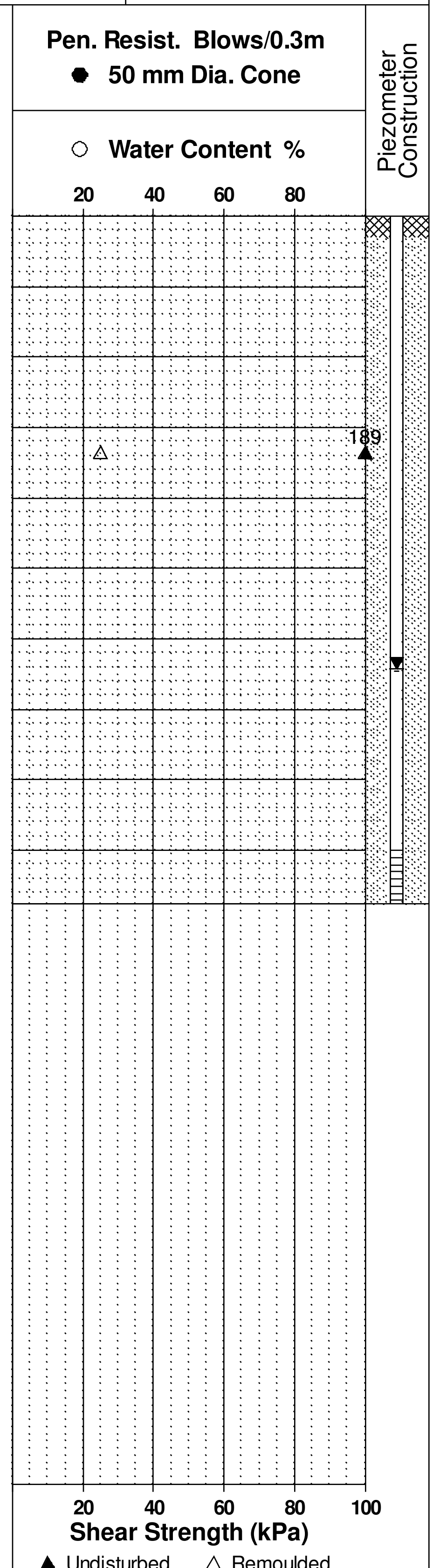
BORINGS BY CME 55 Power Auger

DATE April 11, 2008

FILE NO. PG1630

HOLE NO. BH 8

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	74.00
TOPSOIL	0.10	AU	1				
Very stiff to stiff, brown **SILTY CLAY**, some sand		SS	2	83	3	1	73.00
		SS	3	58	1	2	72.00
		SS	4	100	1	3	71.00
	3.66	SS	5	100	4		
Compact to dense, brown **SILTY SAND**		SS	6	50	16	4	70.00
		SS	7	67	21	5	69.00
		SS	8	50	45	6	68.00
		SS	9	58	41	7	67.00
		SS	10	67	25	8	66.00
	9.75	SS	11	58	30	9	65.00
End of Borehole							
(GWL @ 6.43m-Apr. 25/08)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Morrison Drive
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located centre of west property line, along Morrison Drive. Assumed geodetic elevation = 75.25m, as per plan provided by Roderick Lahey Architects Inc.

REMARKS

BORINGS BY CME 55 Power Auger

DATE April 14, 2008

FILE NO. PG1630

HOLE NO. BH 9

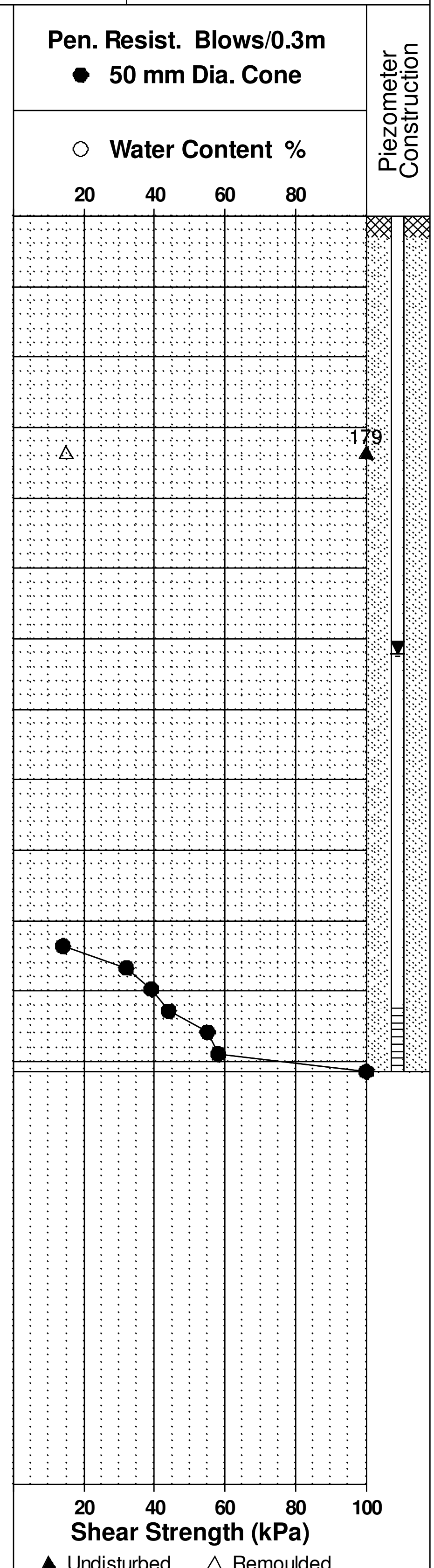
SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
TOPSOIL	0.10	AU	1		
Very stiff to stiff, brown **SILTY CLAY**		SS	2	100	4
		SS	3	100	3
		SS	4	100	4
		SS	5	100	2
		SS	6	100	1
	5.26	SS	7	100	3
Compact, grey-brown **SILTY SAND**		SS	8	67	10
		SS	9	75	24
		SS	10	100	29
	9.75	SS	11	100	30
Dynamic Cone Penetration Test commenced @ 9.75m depth Inferred **SILTY SAND**	12.14				

End of Borehole

Practical refusal to DCPT @ 12.14m depth

(GWL @ 6.21m-Apr. 25/08)

DEPTH (m)	ELEV. (m)
0	73.93
1	72.93
2	71.93
3	70.93
4	69.93
5	68.93
6	67.93
7	66.93
8	65.93
9	64.93
10	63.93
11	62.93
12	61.93



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Morrison Drive
Ottawa, Ontario

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REMARKS

BORINGS BY CME 55 Power Auger

DATE April 14, 2008

FILE NO. PG1630

HOLE NO. BH10

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	72.80
TOPSOIL 0.13		AU	1				
Very stiff to stiff, brown **SILTY CLAY**		SS	2	67	5	1	71.80
		SS	3	100	5	2	70.80
		SS	4	100	4	3	69.80
3.81		SS	5	75	6		
Compact to dense, brown **SILTY SAND**		SS	6	67	8	4	68.80
		SS	7	50	30	5	67.80
		SS	8	50	15	6	66.80
		SS	9	50	24	7	65.80
		SS	10	67	22	8	64.80
9.75		SS	11	25	31	9	63.80
End of Borehole							
(GWL @ 4.43m-Apr. 25/08)							

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

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Morrison Drive
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located centre of west property line, along Morrison Drive. Assumed geodetic elevation = 75.25m, as per plan provided by Roderick Lahey Architects Inc.

REMARKS

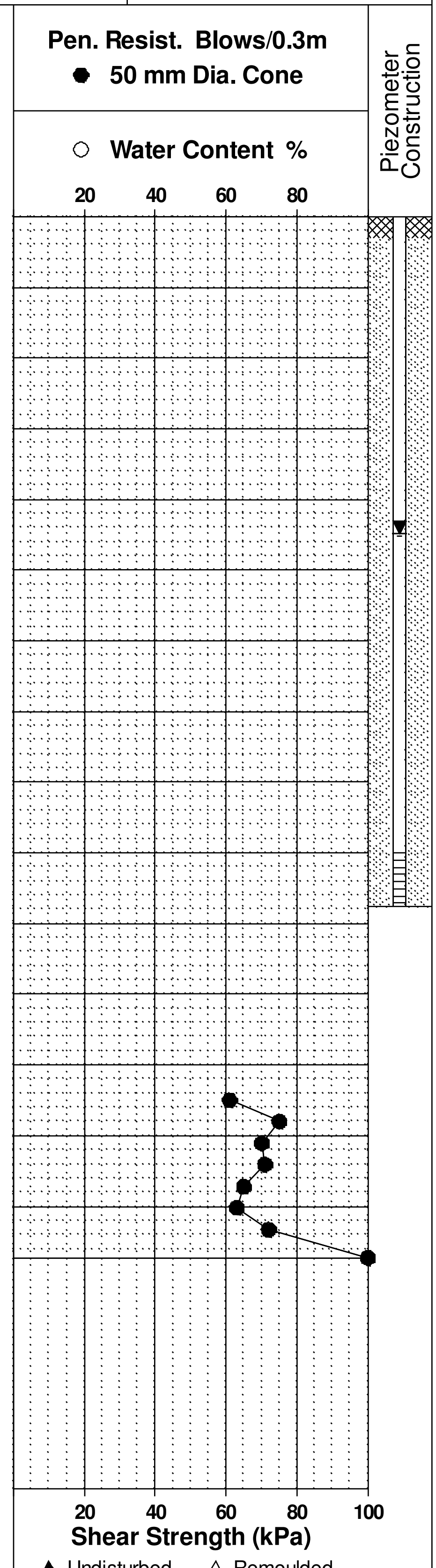
BORINGS BY CME 55 Power Auger

DATE April 15, 2008

FILE NO. PG1630

HOLE NO. BH11

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	73.87
25mm Asphaltic concrete over silty sand with gravel **FILL** (0.15)		AU	1				
Very stiff to stiff, brown **SILTY CLAY**, trace sand		SS	2	67	12	1	72.87
		SS	3	100	5	2	71.87
		SS	4	100	2	3	70.87
(3.66)		SS	5	100	3		
Brown **CLAYEY SILT**, some sand (4.57)		SS	6	100	8	4	69.87
Compact, brown **SILTY SAND**		SS	7	67	11	5	68.87
		SS	8	75	22		
		SS	9	50	25	6	67.87
						7	66.87
		SS	10	67	28	8	65.87
						9	64.87
		SS	11	50	26		
						10	63.87
						11	62.87
(12.19)						12	61.87
Dynamic Cone Penetration Test commenced @ 12.19m depth Inferred **SILTY SAND**						13	60.87
(14.73)						14	59.87
End of Borehole Practical refusal to DCPT @ 14.73m depth (GWL @ 4.48m-Apr. 25/08)							



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Morrison Drive
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located centre of west property line, along Morrison Drive. Assumed geodetic elevation = 75.25m, as per plan provided by Roderick Lahey Architects Inc.

REMARKS

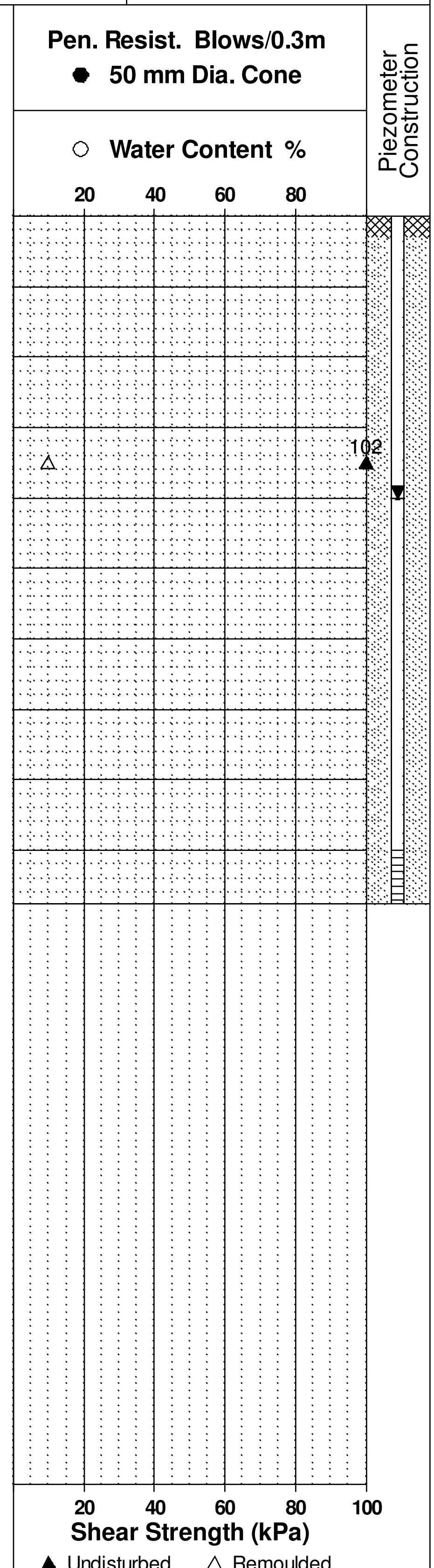
FILE NO. PG1630

HOLE NO. BH12

BORINGS BY CME 55 Power Auger

DATE April 15, 2008

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	73.40
TOPSOIL 0.13		AU	1				
Very stiff, brown **SILTY CLAY**, some sand		SS	2	83	4	1	72.40
		SS	3	92	5	2	71.40
		SS	4	100	4	3	70.40
3.66							
Very stiff, brown **CLAYEY SILT**		SS	5	100	4	4	69.40
4.57							
Compact to dense, brown **SILTY SAND** to **SAND**		SS	6	42	23	5	68.40
		SS	7	42	29	6	67.40
		SS	8	50	26	7	66.40
		SS	9	33	26	8	65.40
		SS	10	25	30	9	64.40
9.75							
End of Borehole							
(GWL @ 4.00m-Apr. 25/08)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Morrison Drive
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REMARKS

BORINGS BY CME 55 Power Auger

DATE April 16, 2008

FILE NO. PG1630

HOLE NO. BH13

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	72.88
TOPSOIL 0.13		AU	1				
Very stiff to stiff, brown **SILTY CLAY**, some sand		SS	2	83	7	1	71.88
		SS	3	100	7	2	70.88
		SS	4	100	6		
3.81		SS	5	100	6	3	69.88
Compact, brown **SILTY SAND** to **SAND**		SS	6	50	18	4	68.88
		SS	7	33	16	5	67.88
		SS	8	25	22		
		SS	9	33	25	6	66.88
						7	65.88
		SS	10	50	20	8	64.88
						9	63.88
9.75		SS	11	33	26		
End of Borehole							
(GWL @ 5.60m-Apr. 25/08)							

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

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Morrison Drive
Ottawa, Ontario

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REMARKS

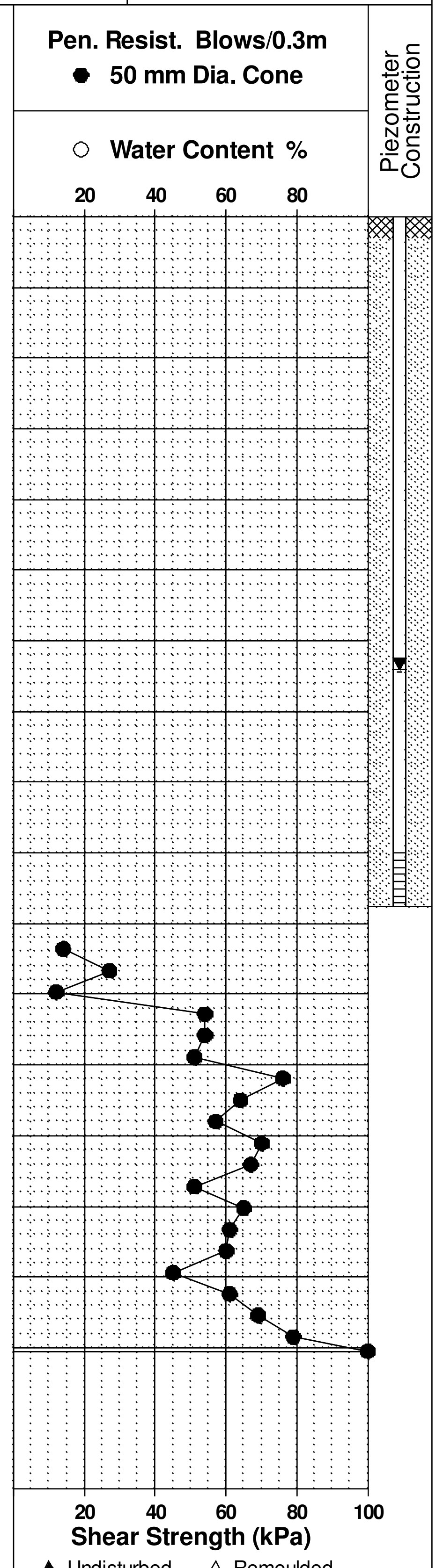
BORINGS BY CME 55 Power Auger

DATE April 16, 2008

FILE NO. PG1630

HOLE NO. BH14

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	73.00
TOPSOIL (0.15)		AU	1				
Very stiff to stiff, brown **SILTY CLAY**, some sand		SS	2	58	4	1	72.00
		SS	3	50	13	2	71.00
(3.05)		SS	4	83	10	3	70.00
Stiff, brown **CLAYEY SILT** (3.96)		SS	5	83	9		
Compact, brown **SILTY SAND**		SS	6	67	18	4	69.00
		SS	7	62	19	5	68.00
		SS	8	50	20	6	67.00
						7	66.00
		SS	9	75	19	8	65.00
(9.75)		SS	10	50	16	9	64.00
Dynamic Cone Penetration Test commenced @ 9.75m depth						10	63.00
						11	62.00
Inferred **SILTY SAND**						12	61.00
						13	60.00
						14	59.00
(GW L @ 6.41m-Apr. 25/08)						15	58.00
(16.05) End of Borehole						16	57.00
Practical refusal to DCPT @ 16.05m depth							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Morrison Drive
Ottawa, Ontario

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REMARKS

FILE NO. PG1630

HOLE NO. BH15

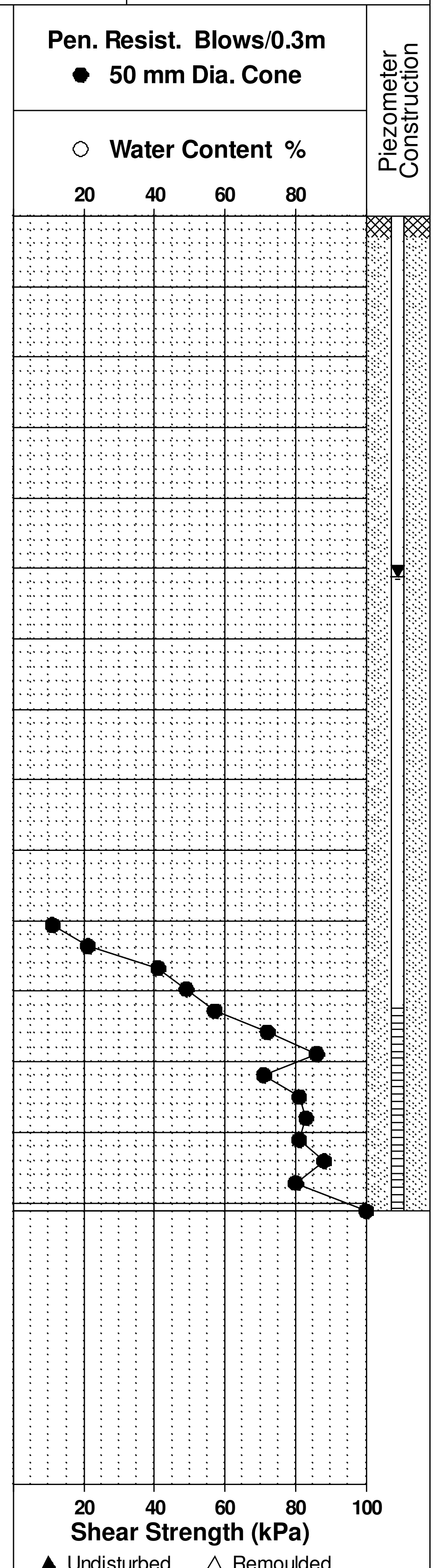
BORINGS BY CME 55 Power Auger

DATE April 16, 2008

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
TOPSOIL	0.15
Very stiff to stiff, brown **SILTY CLAY**, some sand	4.57
Stiff, brown **CLAYEY SILT**	5.03
Compact, brown **SILTY SAND**	9.75
Dynamic Cone Penetration Test commenced @ 9.75m depth Inferred **SILTY SAND**	14.12
End of Borehole Practical refusal to DCPT @ 14.12m depth (GWL @ 5.12m-Apr. 25/08)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	50	7
SS	3	50	12
SS	4	67	7
SS	5	67	6
SS	6	42	4
SS	7	83	8
SS	8	42	24
SS	9	67	22
SS	10	50	25
SS	11	50	25

DEPTH (m)	ELEV. (m)
0	73.26
1	72.26
2	71.26
3	70.26
4	69.26
5	68.26
6	67.26
7	66.26
8	65.26
9	64.26
10	63.26
11	62.26
12	61.26
13	60.26
14	59.26



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Morrison Drive
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located centre of west property line, along Morrison Drive. Assumed geodetic elevation = 75.25m, as per plan provided by Roderick Lahey Architects Inc.

REMARKS

BORINGS BY CME 55 Power Auger

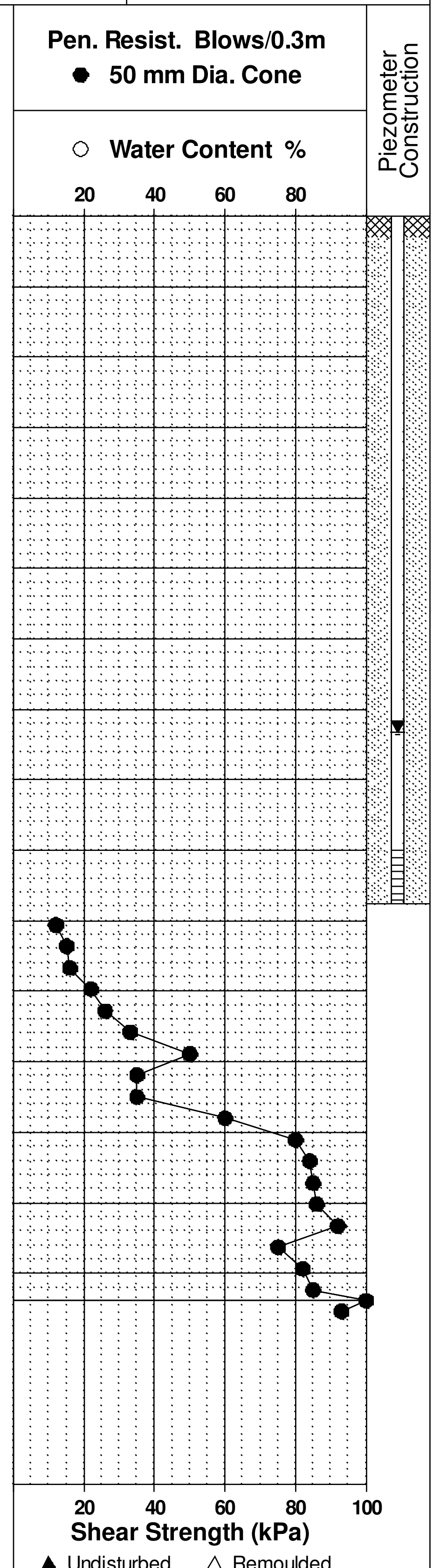
DATE April 17, 2008

FILE NO. PG1630

HOLE NO. BH16

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
Asphaltic concrete	0.08	AU	1		
FILL: Crushed stone	0.30				
FILL: Sand and gravel	0.91	SS	2	17	9
Very stiff to stiff, brown **SILTY CLAY**, trace sand	5.49	SS	3	42	6
		SS	4	75	4
		SS	5	100	5
		SS	6	100	6
		SS	7	100	10
Compact to very dense, brown **SILTY SAND**	12.19	SS	8	59	50+
		SS	9	38	74
		SS	10	35	50+
		SS	11	75	32
		SS	12	75	21
Dynamic Cone Penetration Test commenced @ 12.19m depth Inferred **SILTY SAND**	15.39				
End of Borehole Practical refusal to DCPT @ 15.39m depth (GWL @ 7.33m-Apr. 25/08)					

DEPTH (m)	ELEV. (m)
0	74.18
1	73.18
2	72.18
3	71.18
4	70.18
5	69.18
6	68.18
7	67.18
8	66.18
9	65.18
10	64.18
11	63.18
12	62.18
13	61.18
14	60.18
15	59.18



patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Morrison Drive
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located centre of west property line, along Morrison Drive. Assumed geodetic elevation = 75.25m, as per plan provided by Roderick Lahey Architects Inc.

REMARKS

FILE NO. PG1630

HOLE NO. BH17

BORINGS BY CME 55 Power Auger **DATE** April 18, 2008

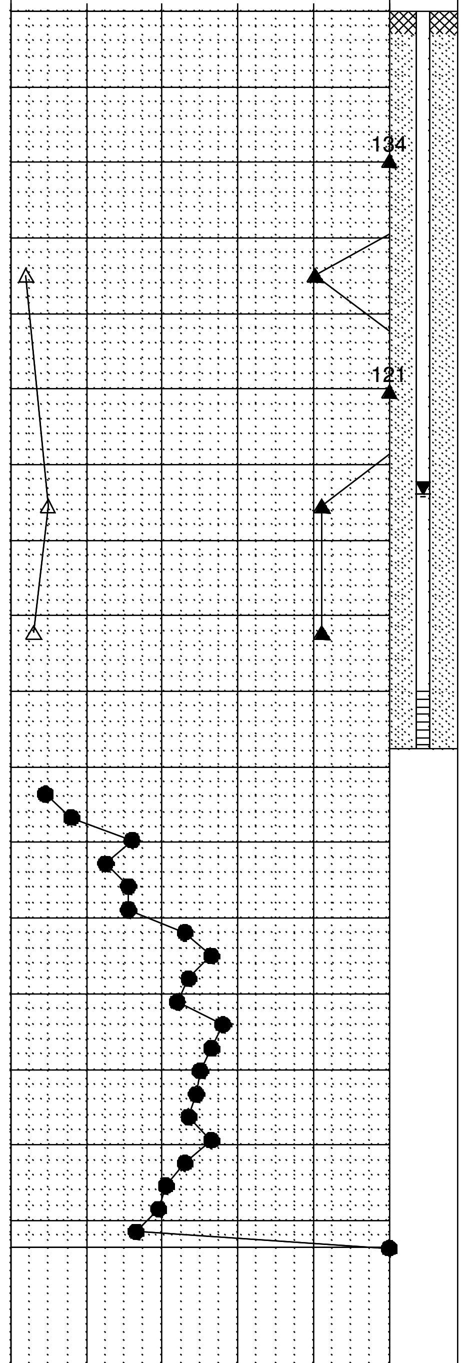
SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	76.24
TOPSOIL 0.15		AU	1				
		SS	2	58	9	1	75.24
						2	74.24
		SS	3		6		
						3	73.24
Very stiff to stiff, brown **SILTY CLAY**, trace sand							
		SS	4	100	3	4	72.24
						5	71.24
- grey by 5.5m depth		SS	5	100	1		
						6	70.24
		SS	6	100	1	7	69.24
						8	68.24
		SS	7	100	W		
9.30						9	67.24
Inferred **SILTY SAND** 9.75		SS	8	25	19		
Dynamic Cone Penetration Test commenced @ 9.75m depth						10	66.24
						11	65.24
						12	64.24
Inferred **SILTY SAND**						13	63.24
						14	62.24
						15	61.24
(GWL @ 6.39m-Apr. 25/08)						16	60.24
16.36							
End of Borehole							
Practical refusal to DCPT @ 16.36m depth							

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

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

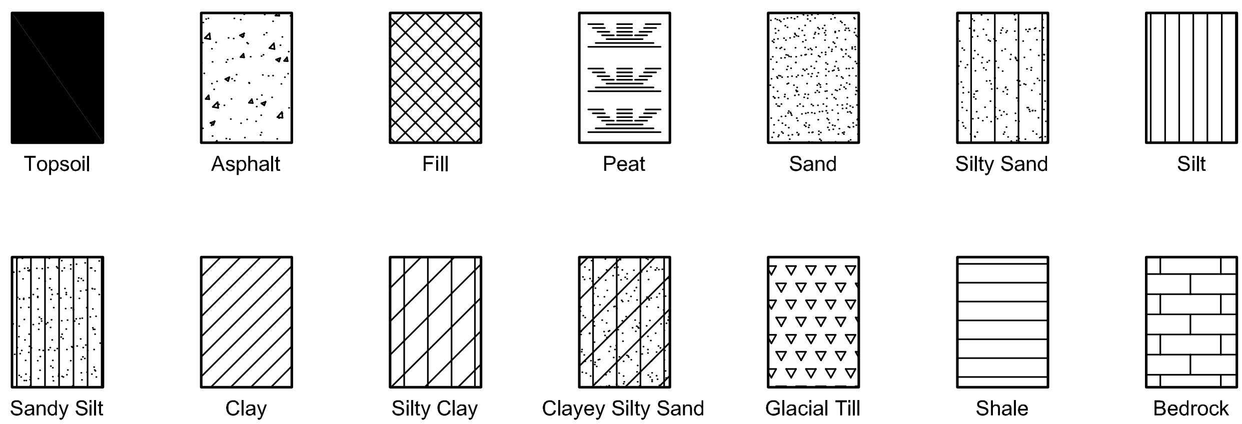
p'_o	-	Present effective overburden pressure at sample depth
p'_c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'_c)
Cc	-	Compression index (in effect at pressures above p'_c)
OC Ratio		Overconsolidaton ratio = p'_c / p'_o
Void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

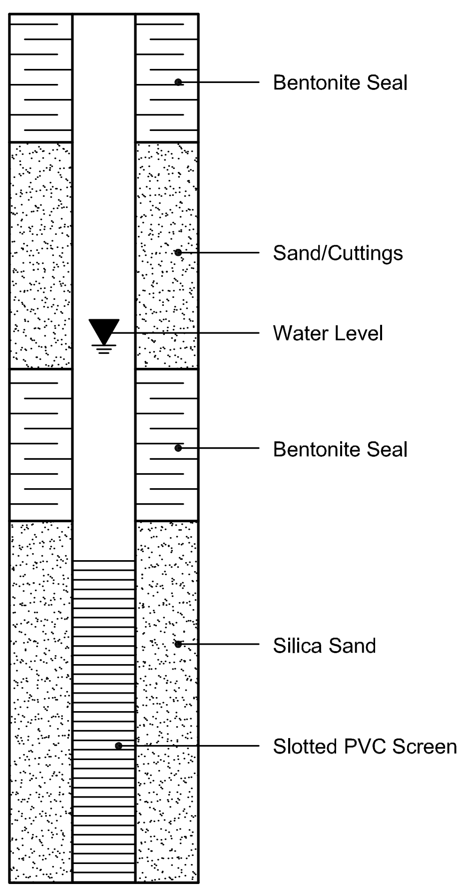
SYMBOLS AND TERMS (continued)

STRATA PLOT

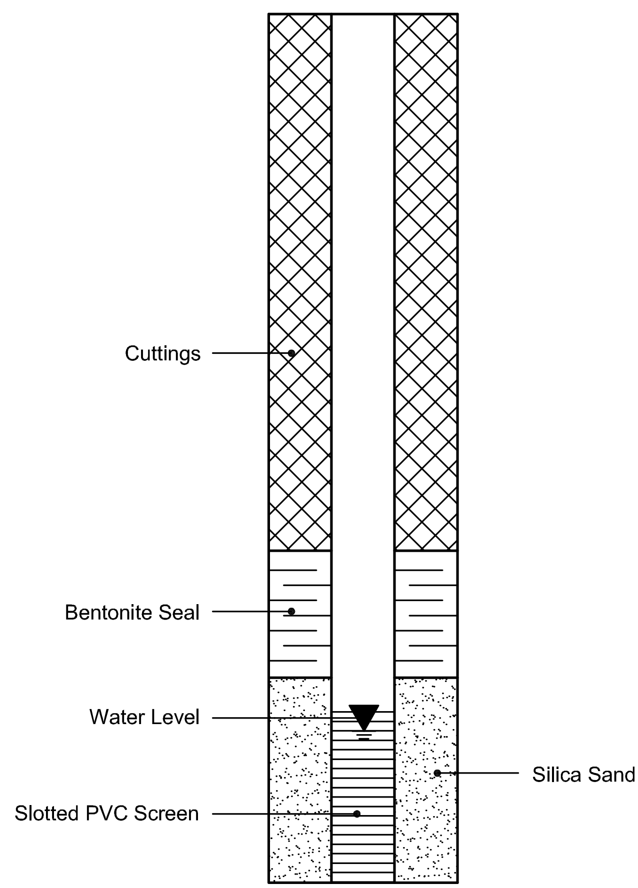


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



PARACEL
LABORATORIES LTD.

Order #: 0816171

Certificate of Analysis

Report Date: 23-Apr-2008
Order Date: 18-Apr-2008

Client: **Paterson Group Consulting Engineers**

Client PO: 6263 Project Description: PG 1630

	MDL/Units	BH 16 - SS 5	-	-	-
Client ID:		BH 16 - SS 5	-	-	-
Sample Date:		17-Apr-08	-	-	-
Sample ID:		0816171-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	70.8	-	-	-
General Inorganics					
pH	0.05 pH Units	6.78	-	-	-
Resistivity	0.10 Ohm.m	26.6	-	-	-
Anions					
Chloride	5 ug/g dry	92	-	-	-
Sulphate	5 ug/g dry	50	-	-	-

APPENDIX 2

FIGURES 1 TO 4 - GLOBAL STABILITY SECTIONS

FIGURE 5 - KEY PLAN

DRAWING PG1630-1 - TEST HOLE LOCATION PLAN

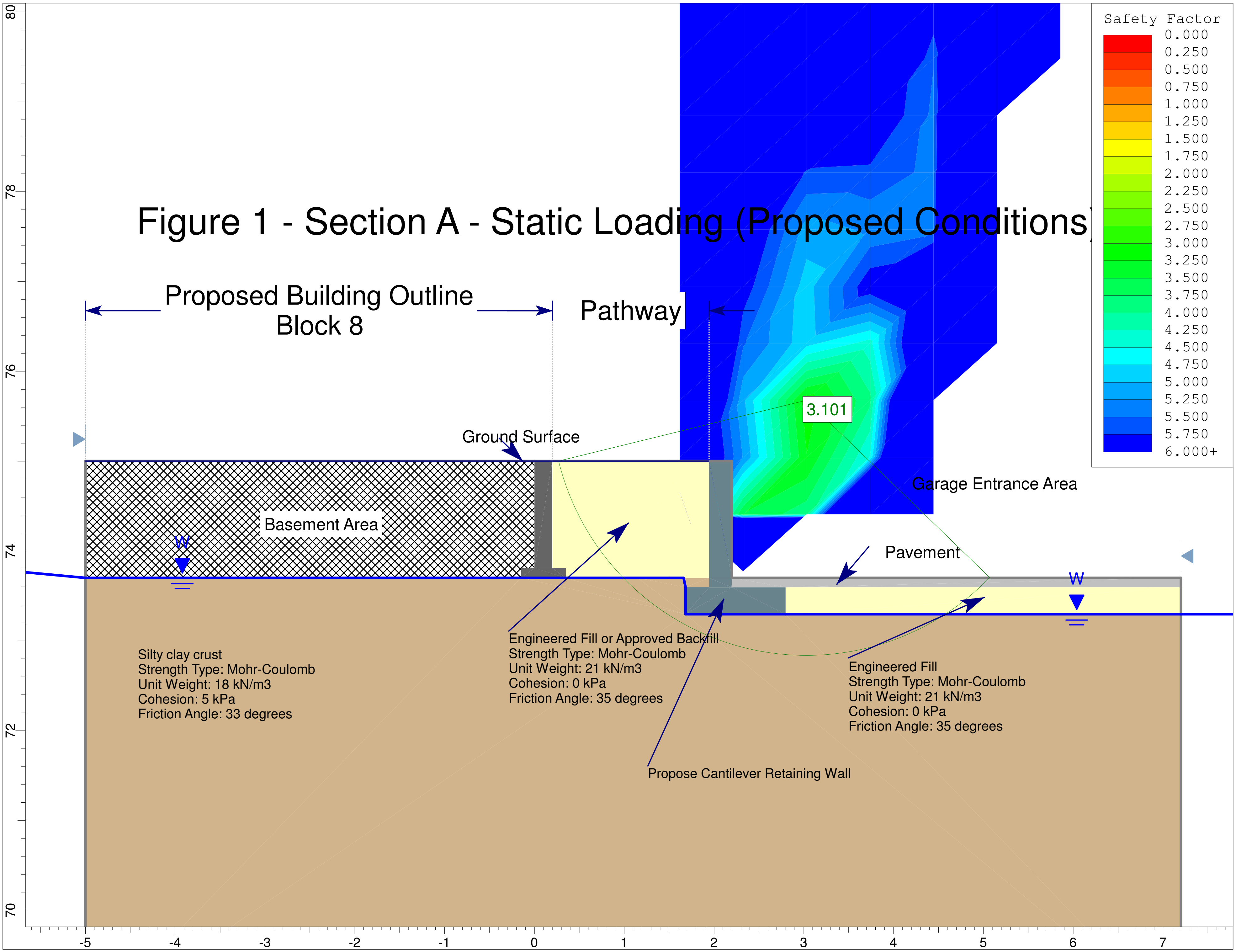


Figure 1 - Section A - Static Loading (Proposed Conditions)
Proposed Building Outline
Block 8
Pathway
Ground Surface
Basement Area
Garage Entrance Area
Pavement
3.101
W
Silty clay crust
Strength Type: Mohr-Coulomb
Unit Weight: 18 kN/m3
Cohesion: 5 kPa
Friction Angle: 33 degrees
Engineered Fill or Approved Backfill
Strength Type: Mohr-Coulomb
Unit Weight: 21 kN/m3
Cohesion: 0 kPa
Friction Angle: 35 degrees
Engineered Fill
Strength Type: Mohr-Coulomb
Unit Weight: 21 kN/m3
Cohesion: 0 kPa
Friction Angle: 35 degrees
Propose Cantilever Retaining Wall
Safety Factor
0.000
0.250
0.500
0.750
1.000
1.250
1.500
1.750
2.000
2.250
2.500
2.750
3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
80
78
76
74
72
70
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
7

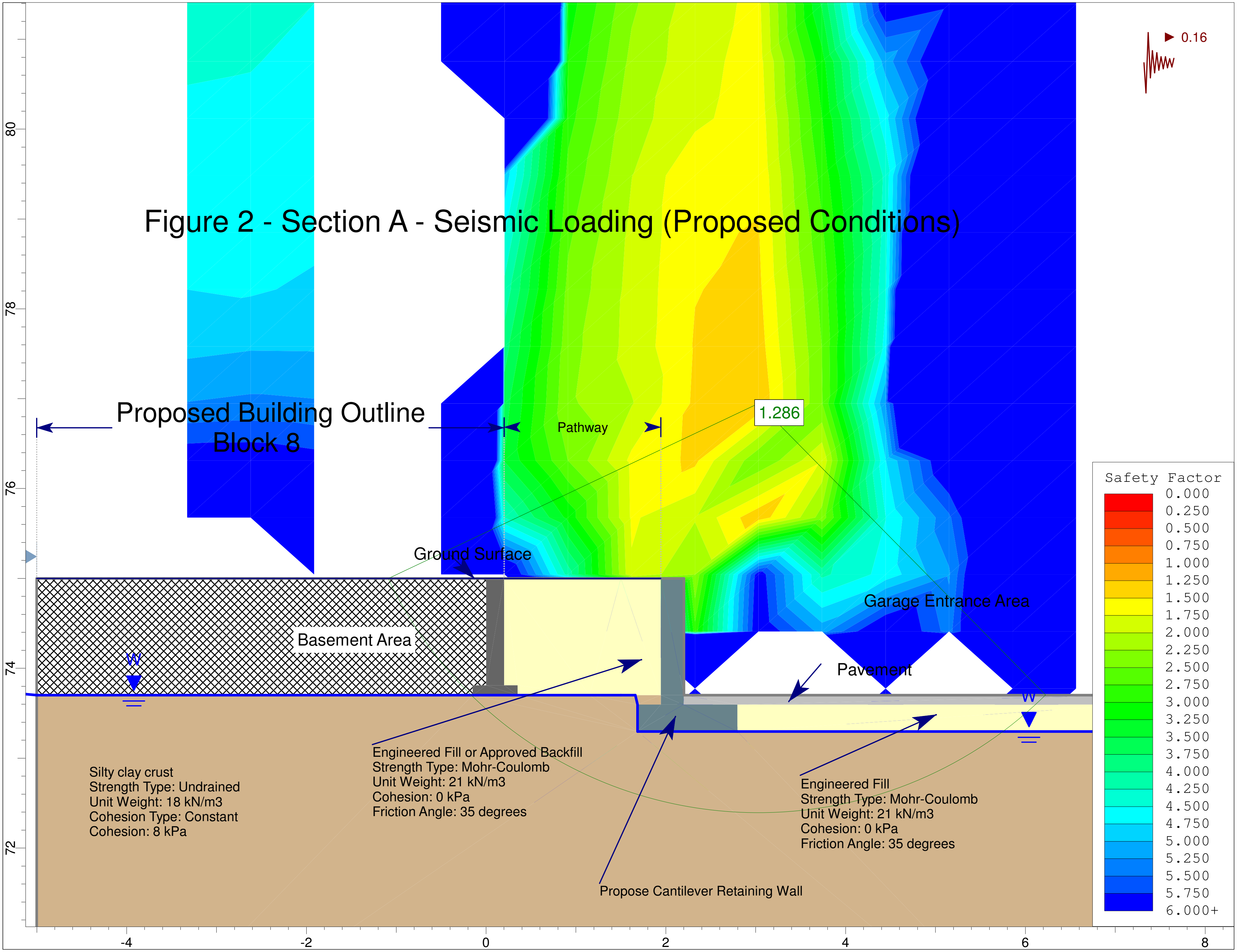
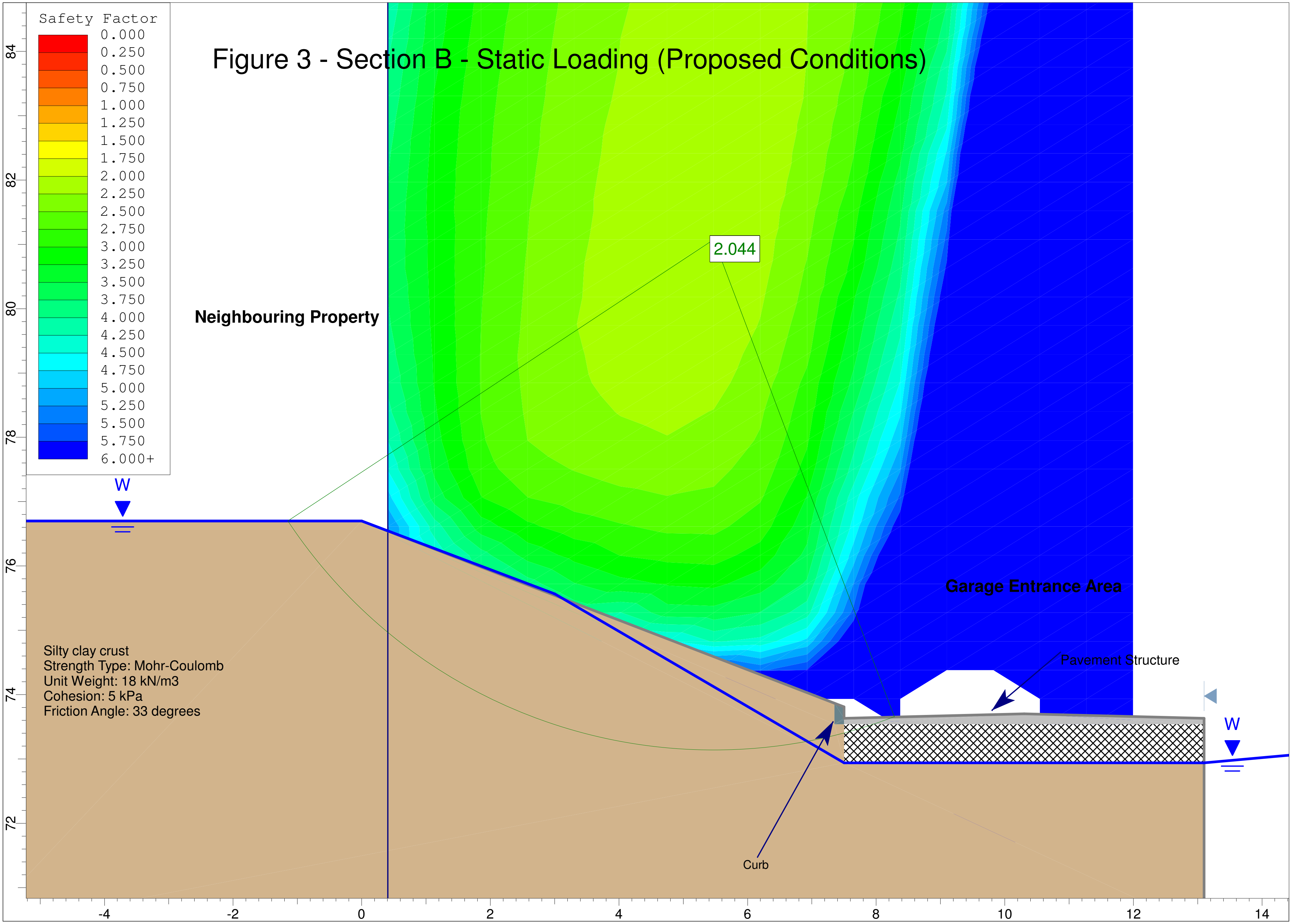


Figure 2 - Section A - Seismic Loading (Proposed Conditions)
0.16
Proposed Building Outline
Block 8
Pathway
1.286
Ground Surface
Basement Area
Garage Entrance Area
Pavement
W
W
Silty clay crust
Strength Type: Undrained
Unit Weight: 18 kN/m3
Cohesion Type: Constant
Cohesion: 8 kPa
Engineered Fill or Approved Backfill
Strength Type: Mohr-Coulomb
Unit Weight: 21 kN/m3
Cohesion: 0 kPa
Friction Angle: 35 degrees
Engineered Fill
Strength Type: Mohr-Coulomb
Unit Weight: 21 kN/m3
Cohesion: 0 kPa
Friction Angle: 35 degrees
Propose Cantilever Retaining Wall
Safety Factor
0.000
0.250
0.500
0.750
1.000
1.250
1.500
1.750
2.000
2.250
2.500
2.750
3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
80
78
76
74
72
-4
-2
0
2
4
6
8


Safety Factor
0.000
0.250
0.500
0.750
1.000
1.250
1.500
1.750
2.000
2.250
2.500
2.750
3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
Figure 3 - Section B - Static Loading (Proposed Conditions)
2.044
Neighbouring Property
Garage Entrance Area
Pavement Structure
Curb
W
W
Silty clay crust
Strength Type: Mohr-Coulomb
Unit Weight: 18 kN/m3
Cohesion: 5 kPa
Friction Angle: 33 degrees
84
82
80
78
76
74
72
-4
-2
0
2
4
6
8
10
12
14

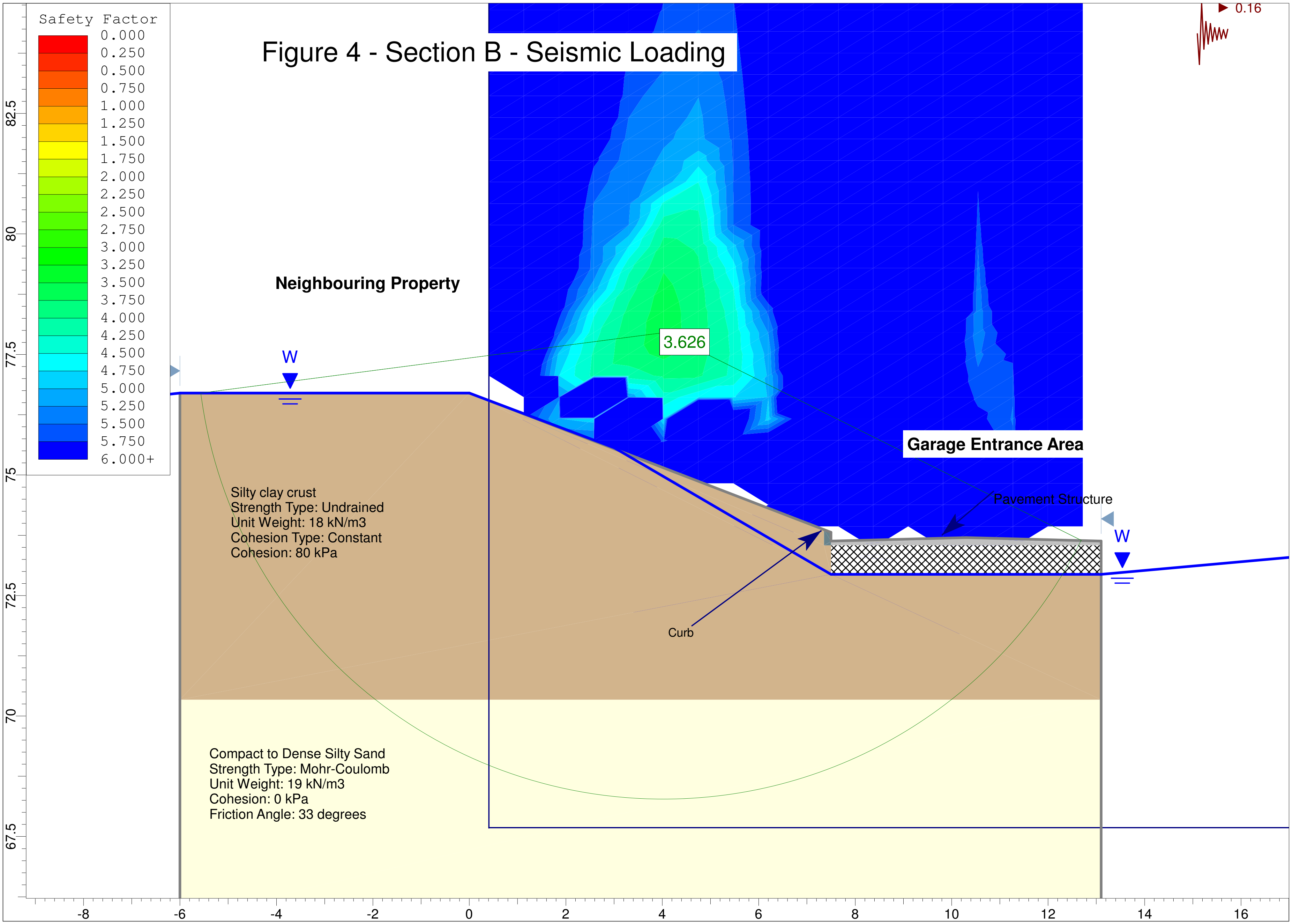


Figure 4 - Section B - Seismic Loading
Safety Factor
0.000
0.250
0.500
0.750
1.000
1.250
1.500
1.750
2.000
2.250
2.500
2.750
3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
0.16
Neighbouring Property
3.626
W
Garage Entrance Area
Pavement Structure
Curb
Silty clay crust
Strength Type: Undrained
Unit Weight: 18 kN/m3
Cohesion Type: Constant
Cohesion: 80 kPa
Compact to Dense Silty Sand
Strength Type: Mohr-Coulomb
Unit Weight: 19 kN/m3
Cohesion: 0 kPa
Friction Angle: 33 degrees
82.5
80
77.5
75
72.5
70
67.5
-8
-6
-4
-2
0
2
4
6
8
10
12
14
16

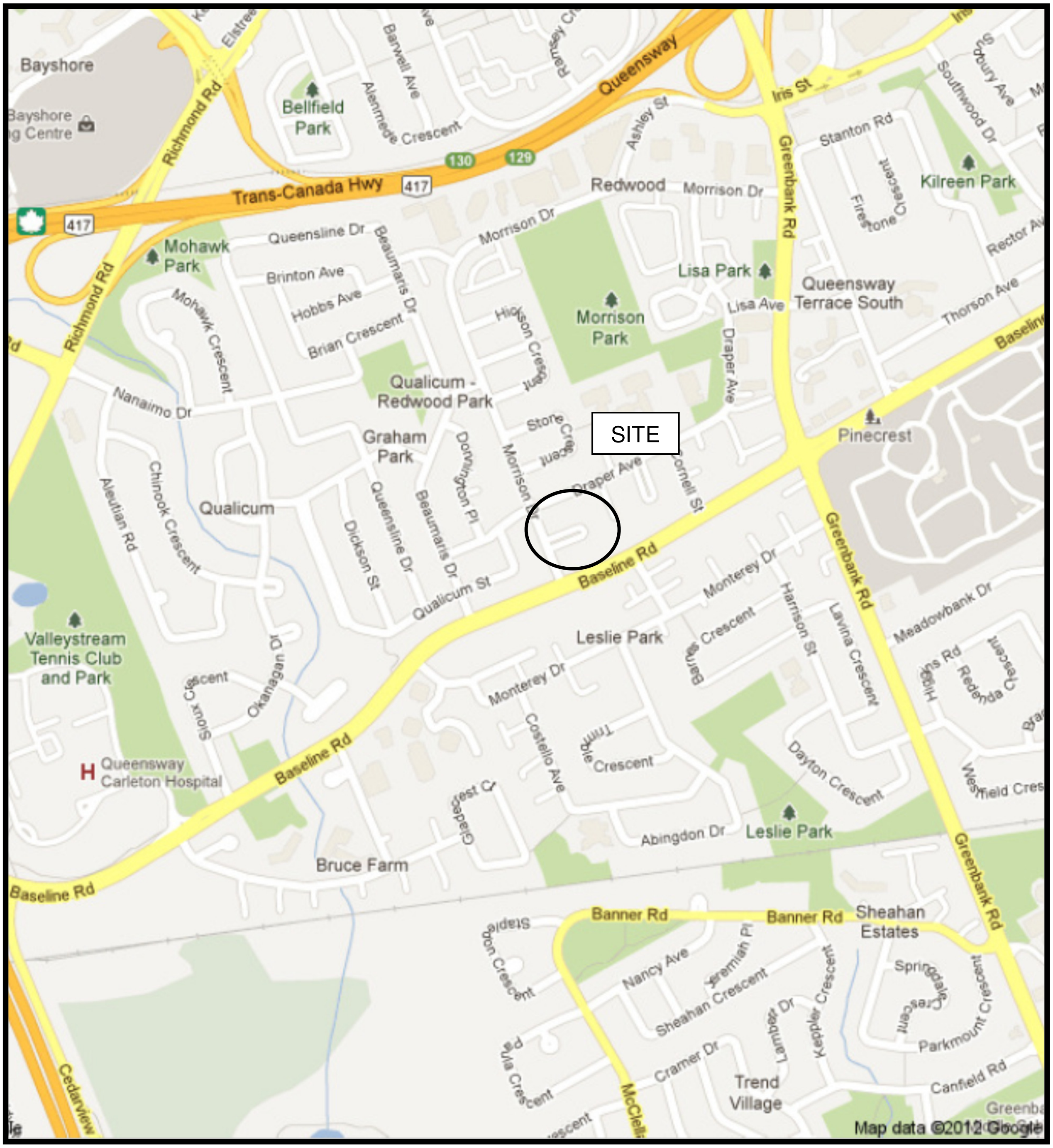
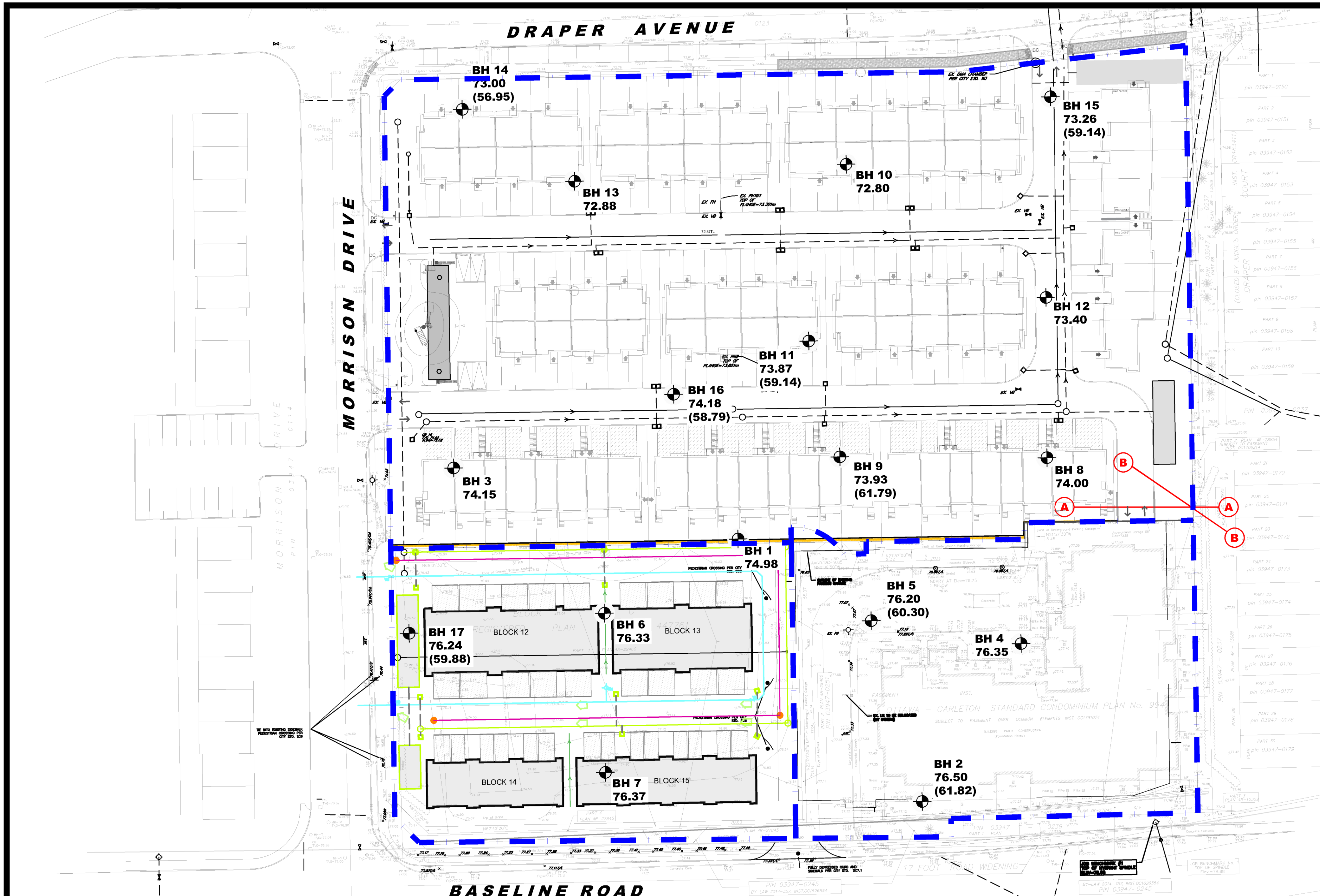


FIGURE 5

KEY PLAN

patersongroup



LEGEND:

⊕	BOREHOLE LOCATION
76.20	GROUND SURFACE ELEVATION (m)
(60.30)	PRACTICAL DCPT REFUSAL ELEV. (m)
A—A	GLOBAL STABILITY CROSS-SECTION

TBM - TOP SPINDLE OF FIRE HYDRANT. ASSUMED GEODETIC ELEVATION = 75.25m, AS PER PLAN PROVIDED BY RODERICK LAHEY ARCHITECTS INC.

BASE PLAN PROVIDED BY RODERICK LAHEY ARCHITECTS INC.

SCALE: 1:750

0 10 20 30 50m

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patersongroup
consulting engineers

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

NO.	REVISIONS	DATE	INITIAL

GREATWISE DEVELOPMENTS

GEOTECHNICAL INVESTIGATION
PROP. RESIDENTIAL DEVELOPMENT - PHASE 3-2
2795 BASELINE ROAD

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:750	Date: 02/2019
Drawn by: RCG	Report No.: PG1630-4
Checked by: FA	Dwg. No.: PG1630-3
Approved by: DJG	Revision No.: 0