Geotechnical Engineering

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Geotechnical Investigation

Proposed Automobile Body Shop
2113 Carp Road
Ottawa, Ontario

Prepared For

BBS Construction

March 15, 2019

Report: PG4405-1
Revision 1

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Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by BBS Construction to conduct a geotechnical investigation for the proposed automobile body shop to be located at 2113 Carp Road in the City of Ottawa, Ontario (refer to Figure 1 - Key Plan in Appendix 2 of this report).

The objective of the geotechnical investigation was to:

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

❏ Provide geotechnical recommendations for the design of the proposed development including construction considerations which may affect its 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 for this geotechnical investigation.

2.0 Proposed Project

Based on the available drawing, it is our understanding that the proposed automobile body shop will consist of a single-storey, commercial slab-on-grade structure located within the southwest portion of the site. The structure will be immediately surrounded by asphalt-paved parking areas and access lanes.

The northern portion of the site will consist of a gravel automobile storage lot, while the southeastern portion of the site will remain vacant for future development.

3.0 Method of Investigation

3.1 Field Investigation

The field program for the geotechnical investigation was carried out on March 20, 2018. At that time, a total of seven (7) boreholes were drilled to a maximum depth of 6.7 m below the ground surface. The boreholes were distributed in a manner to provide general coverage of the subject site taking into consideration site features and underground utilities. The test hole locations are shown on Drawing PG4405-1 - Test Hole Location Plan included in Appendix 2.

The boreholes were advanced using a track-mounted auger drill rig operated by a two person crew. All fieldwork was conducted under the full-time supervision of Paterson personnel under the direction of a senior engineer. The test hole procedure consisted of augering to the required depths at the selected locations and sampling the overburden.

Sampling and In Situ Testing

Soil samples were recovered during drilling from the auger flights or a 50 mm diameter split-spoon sampler. The split-spoon samples were classified on site and placed in sealed plastic bags. All samples were transported to our laboratory for further examination. The depths at which the auger flight and split-spoon samples were recovered from the boreholes are depicted as AU and SS, respectively, on the Soil Profile and Test Data sheets 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.

The subsurface conditions observed in the test holes were recorded in detail in the field and are presented on the Soil Profile and Test Data sheets in Appendix 1.

Groundwater

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

3.2 Field Survey

The test hole locations and ground surface elevations were surveyed in the field by Paterson at the time of the field investigation. The ground surface elevations at the test hole locations were referenced to a temporary benchmark (TBM), consisting of the top of grate of the watermain valve located at the southwest corner of the intersection of Carp Road and Westbrook Road. A geodetic elevation of 127.18 m was provided to the TBM on the plan prepared by McIntosh Perry.

The test hole locations, ground surface elevation at each test hole location and the location of the TBM are presented in Drawing PG4405-1 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

Soil samples were recovered from the boreholes and visually examined in our laboratory to review the field logs. The results are presented on the Soil Profile and Test Data sheets in Appendix 1.

3.4 Analytical Testing

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

4.0 Observations

4.1 Surface Conditions

The subject site is bordered to the east by Carp Road, to the south by Westbrook Road to the west by vacant land followed by wetlands and to the north by single family residential dwellings, a commercial building and a Shell gas station. The site itself generally consists of three separate parcels: The southeast portion of the site is relatively flat, grass covered and used to store automotive vehicles and storage containers. The north portion of the site is currently occupied by a two-storey single family residential dwelling with associated outbuildings, driveway and landscaped areas backing onto a pond located to the west of the dwelling. The remaining west portion of the site is sparsely treed with several piles of stockpiled material.

Based on the available historical photographs of the subject site, a former pond occupied the west limits of the site prior to 2008 and was noted to be backfilled in 2009.

The site slopes gradually down from north to south, and is approximately at grade with neighbouring properties and adjacent roadways. Ditches were noted at the east and south borders of the site parallel to Carp Road and Westbrook Road, respectively.

4.2 Subsurface Profile

The subsoil profile encountered at the test hole locations during the field portion of the geotechnical investigation generally consisted of a thin layer of topsoil and/or fill overlying a compact to dense silty sand. BH 4 and BH 5 completed within the west portion of the site within the former pond encountered fill material consisting of a brown silty clay to silty sand with gravel, cobbles and trace organics extending to a depth of 1.8 and 3.2 m, respectively. Reference should be made to the aerial photographs in Figure 2 - Aerial Photograph - 1976, Figure 3 - Aerial Photograph - 1991, and Figure 4 - Aerial Photograph - 2017 which illustrate the approximate limits of the in-filled area.

Based on available geological mapping, the subject site is located in an area where the bedrock consists of limestone of the Bobcaygeon formation with an anticipated overburden drift thickness of 10 to 25 m.

Reference should be made to the Soil Profile and Test Data sheets in Appendix 1 for specific details of the soil profiles encountered at each test hole location.

4.3 Groundwater

Groundwater levels were measured in the boreholes on April 6, 2018. The measured groundwater level (GWL) readings are presented in Table 1 and in the Soil Profile and Test Data sheets in Appendix 1. The long-term groundwater level can also be estimated from the observed colour and consistency of the recovered soil samples. Based on these observations, it is estimated that the long-term groundwater table can be expected at approximately 4 to 5 m below existing ground surface. It should be noted that groundwater levels are subject to seasonal fluctuations. Therefore, the groundwater level could vary at the time of construction.

Table 1 - Summary of Groundwater Level Readings

Borehole Number	Ground Elevation (m)	Groundwater Levels		Recording Date
		Depth (m)	Elevation (m)	
BH 1	127.60	Dry	-	April 6, 2018
BH 2	127.64	Dry	-	April 6, 2018
BH 3	128.14	Dry	-	April 6, 2018
BH 4	129.18	Dry	-	April 6, 2018
BH 5	128.09	Dry	-	April 6, 2018
BH 6	130.16	1.98	128.18	April 6, 2018
BH 7	127.45	Dry	-	April 6, 2018

Note: The ground surface elevations at the test hole locations were referenced to a temporary benchmark (TBM), consisting of the top of grate of the watermain valve located at the southwest corner of the intersection of Carp Road and Westbrook Road. A geodetic elevation of 127.18 m was provided to the TBM on the plan prepared by McIntosh Perry.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is adequate for the proposed automobile body shop. It is expected that this proposed commercial slab-on-grade building will be founded on conventional shallow footings bearing on an undisturbed, compact silty sand bearing surface, or, where encountered at the underside of footing, on the existing fill prepared in accordance with the "Subgrade Improvement Program for Foundations" as approved by the geotechnical consultant at the time of construction.

The above and other considerations are further discussed in the following sections.

5.2 Site Grading and Preparation

Stripping Depth

Topsoil and any fill containing significant amounts of deleterious or organic materials should be stripped from under the proposed building and any other settlement sensitive structures. Existing fill should be reviewed by the geotechnical consultant at the time of construction to confirm if the material can remain in place. Care should be taken not to disturb adequate bearing soils below the founding level during site preparation activities. Any soft areas should be removed and replaced in accordance with the following fill placement recommendations.

Existing foundation walls and other construction debris should be entirely removed from within the 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 beneath the building footprints, 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 thick and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the building area 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 at least compacted 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 or below settlement sensitive structures, such as concrete sidewalks and exterior concrete entrance areas.

Subgrade Improvement Program for Foundations

The following subgrade improvement program is recommended for areas where fill, free of significant amounts of deleterious materials, is encountered at the underside of footing elevation.

The bearing surface at the design underside of footing level should first be sub-excavated at least 500 mm below footing level extending at least 1 m beyond the outside face of the footing.

The footing subgrade should then be proof-compacted with a vibratory drum roller or large vibratory plate compactor. Any poor performing areas should be removed and replaced with an OPSS Granular B Type II material placed in maximum 300 mm loose lifts and compacted by a vibratory drum roller making several passes and witnessed by the geotechnical consultant.

If the subgrade surface is noted to be flexing during the proof-rolling program, a woven geotextile liner, such as Terratrack 200 or equivalent, should be placed across the sub-excavated subgrade surface. Also, a biaxial geogrid, such as Geosynthetics Systems TBX 2200 or equivalent, could be placed over the geotextile liner for areas where the subgrade requires additional reinforcement.

The sub-excavated area should then be in-filled with engineered fill, such as OPSS Granular B Type II, placed in maximum 300 mm loose lifts and compacted by a vibratory drum roller making several passes and witnessed by the geotechnical consultant.

5.3 Foundation Design

Conventional Shallow Footings

Footings placed on an undisturbed, compact silty sand bearing surface, or on the existing fill prepared in accordance with the "Subgrade Improvement Program for Foundations", can be designed using a bearing resistance value at serviceability limit states (SLS) of **175 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **250 kPa**. A geotechnical resistance factor of 0.5 was applied to the reported bearing resistance value at ULS.

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

An undisturbed soil bearing surface consists of a surface from which all topsoil and deleterious materials, such as loose, frozen or disturbed soil, whether in situ or not, have been removed, in the dry, prior to the placement of concrete for footings.

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 compact silty sand and engineered fill above the groundwater table when a plane extending down and out from the bottom edge of the footing at a minimum of 1.5H:1V passes only through in situ soil of the same or higher capacity as the bearing medium soil.

5.4 Design for Earthquakes

The site class for seismic site response can be taken as **Class D**. Soils underlying the subject site are not susceptible to liquefaction. Reference should be made to the latest revision of the Ontario Building Code (OBC) 2012 for a full discussion of the earthquake design requirements.

5.5 Slab on Grade Construction

With the removal of all topsoil and fill, containing significant amounts of deleterious or organic materials, the undisturbed, compact silty sand or existing fill subgrade approved by the geotechnical consultant at the time of excavation will be considered an acceptable subgrade surface on which to commence backfilling for slab-on-grade construction. Where the subgrade consists of the existing fill, a vibratory drum roller should complete several passes over the subgrade surface as a proof-rolling program. Any poor performing areas should be removed and reinstated with an engineered fill, such as Granular B Type II.

It is recommended that the upper 200 mm of sub-floor fill consist of OPSS Granular A crushed stone. All backfill materials required to raise grade within the footprint of the proposed building 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 areas, access lanes and heavy truck parking 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 or Superpave 12.5 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
300	**SUBBASE** - OPSS Granular B Type II
	SUBGRADE - Either fill, in situ soil, or OPSS Granular B Type I or II material placed over in situ soil or fill

Table 3 - Recommended Pavement Structure
Access Lanes and Heavy Truck Parking Areas

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

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

If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated and replaced with OPSS Granular B Type 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 material's SPMDD using suitable vibratory equipment.

Its expected that the majority of the car parking areas will remain gravel covered and should follow the structure shown in Table 4. It is possible that this area may require annual maintenance, such as regrading and padding in poor performing areas.

Table 4 - Recommended Pavement Structure
Access Lanes and Heavy Truck Parking Areas

Thickness (mm)	Material Description
150	**BASE** - OPSS Granular A Crushed Stone
400	**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

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

A perimeter foundation drainage system is recommended for the proposed building. 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 underside of 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, such as clean sand or OPSS Granular B Type I granular material. The greater part of the site excavated materials will be frost susceptible and, as such, are not recommended for re-use as backfill against the foundation walls. A drainage geocomposite, such as Miradrain G100N or Delta Drain 6000, connected to the perimeter foundation drainage system is recommended.

Backfill material below sidewalk subgrade areas or other settlement sensitive structures should consist of free draining, non-frost susceptible material placed in maximum 300 mm thick loose lifts and compacted to at least 95% of its SMPDD under dry and above freezing conditions.

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.

Exterior unheated footings, such as those for 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.

6.3 Excavation 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 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects.

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

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

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

Bedding and backfill materials should be in accordance with the most recent Material Specifications & Standard Detail Drawings from the Department of Public Works and Services, Infrastructure Services Branch of the City of Ottawa.

At least 150 mm of OPSS Granular A should be used for bedding for sewer and water pipes when placed on soil subgrade. The bedding should extend to the spring line of the pipe. Cover material, from the spring line to at least 300 mm above the obvert of the pipe should consist of OPSS Granular A (concrete or PSM PVC pipes) or sand (concrete pipe). The bedding and cover materials should be placed in maximum 225 mm thick lifts compacted to a minimum of 95% of the material’s SPMDD.

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

6.5 Groundwater Control

Groundwater Control for Building Construction

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.

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 shallow excavations.

Permit to Take Water

A temporary Ministry of the Environment, Conservation, and Parks (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 (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, an EASR will not be allowed as a temporary dewatering measure while awaiting the MECP review of the PTTW application.

6.6 Winter Construction

Precautions must be taken if winter construction is considered for this project.

The subsoil conditions at this site consist of frost susceptible materials. In the presence of water and freezing conditions, ice could form within the soil mass. Heaving and settlement upon thawing could occur.

In the event of construction during below zero temperatures, the founding stratum should be protected from freezing temperatures by the use of straw, propane heaters and tarpaulins or other suitable means. 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 founding level.

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

6.7 Corrosion Potential and Sulphate

The results of analytical testing show that the sulphate content is less than 0.1%. This result is indicative that Type 10 Portland cement (normal cement) would be appropriate for this site. The chloride content and the pH of the sample indicate that they are not significant factors in creating a corrosive environment for exposed ferrous metals at this site, whereas the resistivity is indicative of a none-aggressive to slightly aggressive corrosive environment.

6.8 Infiltration System Recommendations

It is understood that the proposed development will include a stormwater infiltration system. As noted above, the boreholes completed at the site encountered a compact to very dense silty sand underlying the fill layer. Based on our groundwater observations at the borehole locations and our experience with soils of this type, we anticipate an infiltration rate of 75 to 150 mm/hr. A factor of safety of 2.5 should be used when calculating the design infiltration rate.

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 made in this report are in accordance with our present understanding of the project. We request that we be permitted to review our recommendations when the drawings and specifications are complete.

A geotechnical investigation of this nature is a limited sampling of a site. The recommendations are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around the test locations. The extent of the limited area depends on the soil, bedrock and groundwater conditions, as well the history of the site reflecting natural, construction, and other activities. Should any conditions at the site be encountered which differ from those at the test locations, we request notification immediately in order to permit reassessment of our recommendations.

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 BBS Construction or their agent(s) is not authorized without review by Paterson Group for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

LICENSED PROFESSIONAL ENGINEER
Mar. 15, 2019
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PROVINCE OF ONTARIO

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Report Distribution:

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APPENDIX 1

SOIL PROFILE & TEST DATA SHEETS

SYMBOLS AND TERMS

ANALYTICAL TEST RESULTS

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Car Dealership - Carp Road at Westbrook Rd.
Ottawa, Ontario

DATUM TBM - Top of grate of watermain valve located at the southwest corner of the intersection of Westbrook Road and Carp Road. Geodetic elevation = 127.18m, as per plan provided by McIntosh Perry.

REMARKS

BORINGS BY CME 55 Power Auger

DATE March 20, 2018

FILE NO. PG4405

HOLE NO. BH 1

SOIL DESCRIPTION	Strata depth (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	127.60
FILL: Crushed stone with silt and sand	0.15						
FILL: Brown silty sand, trace gravel and cobbles	0.53	AU	1				
Dense, brown **SILTY SAND**		SS	2	58	37	1	126.60
		SS	3	100	31	2	125.60
		SS	4	83	23		
		SS	5	75	32	3	124.60
		SS	6	67	24	4	123.60
		SS	7	75	30	5	122.60
		SS	8	100	48	6	121.60
	6.70	SS	9	75	46		
End of Borehole							
(BH dry to 2.91m depth - April 6, 2018)							

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
Prop. Car Dealership - Carp Road at Westbrook Rd.
Ottawa, Ontario

DATUM TBM - Top of grate of watermain valve located at the southwest corner of the intersection of Westbrook Road and Carp Road. Geodetic elevation = 127.18m, as per plan provided by McIntosh Perry.

REMARKS

BORINGS BY CME 55 Power Auger

DATE March 20, 2018

FILE NO. PG4405

HOLE NO. BH 2

SOIL DESCRIPTION	Depth of change (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	127.64
FILL: Crushed stone with silt and sand	0.18						
FILL: Brown silty sand, trace gravel, cobbles and boulders	0.89	AU	1				
Dense to very dense, brown **SILTY SAND**		SS	2	67	37	1	126.64
		SS	3	92	50+	2	125.64
		SS	4	79	45		
		SS	5	50	44	3	124.64
		SS	6	75	20	4	123.64
		SS	7	71	38	5	122.64
		SS	8	83	29	6	121.64
	6.35	SS	9	10	50+		
End of Borehole							
(BH dry to 6.0m depth - April 6, 2018)							

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
Prop. Car Dealership - Carp Road at Westbrook Rd.
Ottawa, Ontario

DATUM TBM - Top of grate of watermain valve located at the southwest corner of the intersection of Westbrook Road and Carp Road. Geodetic elevation = 127.18m, as per plan provided by McIntosh Perry.

REMARKS

BORINGS BY CME 55 Power Auger

DATE March 20, 2018

FILE NO. PG4405

HOLE NO. BH 3

SOIL DESCRIPTION	Strata depth (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	128.14
FILL: Crushed stone with silt and sand	0.20	AU	1				
FILL: Brown silty sand with gravel, cobbles and boulders	0.99						
Dense, brown **SILTY SAND**		SS	2	83	41	1	127.14
		SS	3	67	23	2	126.14
		SS	4	58	33	3	125.14
		SS	5	54	31	4	124.14
		SS	6	67	37	5	123.14
	6.70	SS	7	71	38	6	122.14
End of Borehole (BH dry to 5.87m depth - April 6, 2018)							

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

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

Piezometer Construction

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Car Dealership - Carp Road at Westbrook Rd.
Ottawa, Ontario

DATUM TBM - Top of grate of watermain valve located at the southwest corner of the intersection of Westbrook Road and Carp Road. Geodetic elevation = 127.18m, as per plan provided by McIntosh Perry.

REMARKS

FILE NO. PG4405

HOLE NO. BH 4

BORINGS BY CME 55 Power Auger **DATE** March 20, 2018

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	129.18
FILL: Topsoil with organics, some gravel, cobbles and boulders 0.41		AU	1				
FILL: Brown silty sad, some gravel, cobbles, trace boulders		SS	2	50	44	1	128.18
1.83		SS	3	67	40	2	127.18
Dense to very dense, brown **SILTY SAND**		SS	4	58	36	3	126.18
3.66		SS	5	71	50+		
End of Borehole (BH dry to 2.88m depth - April 6, 2018)							

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

○ Water Content %

20 40 60 80

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

Piezometer Construction

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Car Dealership - Carp Road at Westbrook Rd.
Ottawa, Ontario

DATUM TBM - Top of grate of watermain valve located at the southwest corner of the intersection of Westbrook Road and Carp Road. Geodetic elevation = 127.18m,
REMARKS as per plan provided by McIntosh Perry.

FILE NO. PG4405

HOLE NO. BH 5

BORINGS BY CME 55 Power Auger **DATE** March 20, 2018

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	128.09
FILL: Brown silty sand, some gravel, cobbles and boulders, trace organics	AU	1				
	SS	2	17	16	1	127.09
1.45						
FILL: Brown silty clay, some sand, trace gravel, cobbles, boulders and organics	SS	3	12	13	2	126.09
	SS	4	12	12	3	125.09
3.20						
Compact, brown **SILTY SAND**	SS	5	67	13		
3.66						

End of Borehole

(BH dry to 2.55m depth - April 6, 2018)

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
Prop. Car Dealership - Carp Road at Westbrook Rd.
Ottawa, Ontario

DATUM TBM - Top of grate of watermain valve located at the southwest corner of the intersection of Westbrook Road and Carp Road. Geodetic elevation = 127.18m,

REMARKS as per plan provided by McIntosh Perry.

BORINGS BY CME 55 Power Auger

DATE March 20, 2018

FILE NO. PG4405

HOLE NO. BH 6

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20 40 60 80)	Piezometer Construction
GROUND SURFACE						0	130.16		
TOPSOIL 0.10		AU	1						
Dense, brown **SILTY SAND,** trace gravel, cobbles and boulders		SS	2	25	41	1	129.16		
		SS	3	58	47	2	128.16		
		SS	4	40	50+				
3.48		SS	5	35	50+	3	127.16		
End of Borehole (BH dry to 1.98m depth - April 6, 2018)									

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. Car Dealership - Carp Road at Westbrook Rd.
Ottawa, Ontario

DATUM TBM - Top of grate of watermain valve located at the southwest corner of the intersection of Westbrook Road and Carp Road. Geodetic elevation = 127.18m,
REMARKS as per plan provided by McIntosh Perry.

BORINGS BY CME 55 Power Auger **DATE** March 20, 2018

FILE NO. PG4405
HOLE NO. BH 7

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
FILL: Crushed stone with silt and sand	0.23	AU	1		
FILL: Brown silty sand, trace gravel, cobbles and boulders	1.12	SS	2	50	39
Dense to compact, brown **SILTY SAND**	3.66	SS	3	50	31
		SS	4	54	24
		SS	5	67	27
End of Borehole					

(BH dry to 2.97m depth - April 6, 2018)

DEPTH (m)	ELEV. (m)
0	127.45
1	126.45
2	125.45
3	124.45

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

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

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

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

SYMBOLS AND TERMS (continued)

SOIL DESCRIPTION (continued)

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

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

ROCK DESCRIPTION

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

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

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

SAMPLE TYPES

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

SYMBOLS AND TERMS (continued)

PLASTICITY LIMITS AND GRAIN SIZE DISTRIBUTION

WC%	-	Natural water content or water content of sample, %
LL	-	Liquid Limit, % (water content above which soil behaves as a liquid)
PL	-	Plastic Limit, % (water content above which soil behaves plastically)
PI	-	Plasticity Index, % (difference between LL and PL)
Dxx	-	Grain size at which xx% of the soil, by weight, is of finer grain sizes These grain size descriptions are not used below 0.075 mm grain size
D10	-	Grain size at which 10% of the soil is finer (effective grain size)
D60	-	Grain size at which 60% of the soil is finer
Cc	-	Concavity coefficient = $(D30)^2 / (D10 \times D60)$
Cu	-	Uniformity coefficient = $D60 / D10$

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

CONSOLIDATION TEST

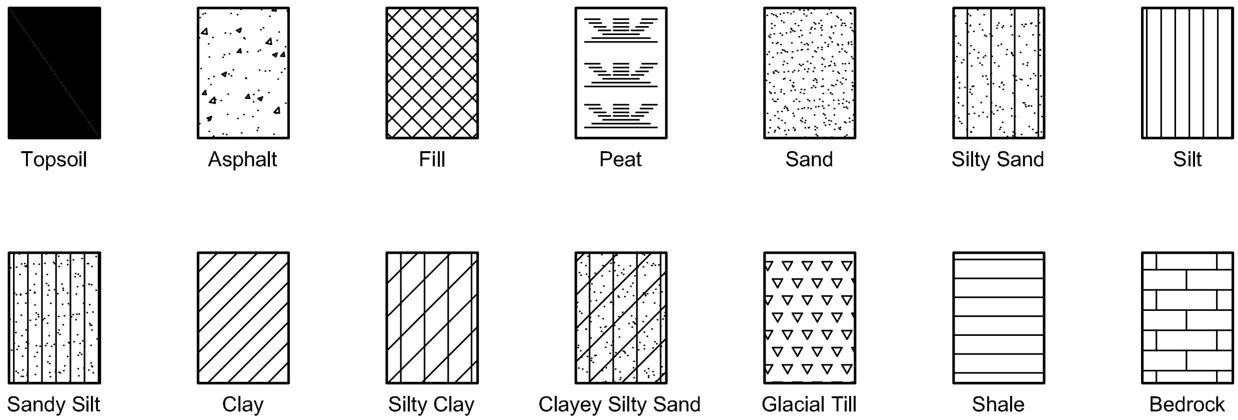
p'_o	-	Present effective overburden pressure at sample depth
p'_c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'_c)
Cc	-	Compression index (in effect at pressures above p'_c)
OC Ratio		Overconsolidaton ratio = p'_c / p'_o
Void Ratio		Initial sample void ratio = volume of voids / volume of solids
Wo	-	Initial water content (at start of consolidation test)

PERMEABILITY TEST

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

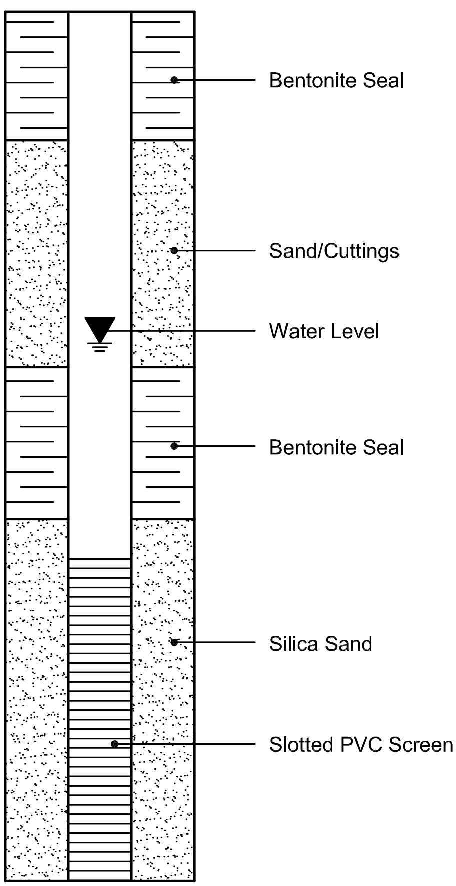
SYMBOLS AND TERMS (continued)

STRATA PLOT

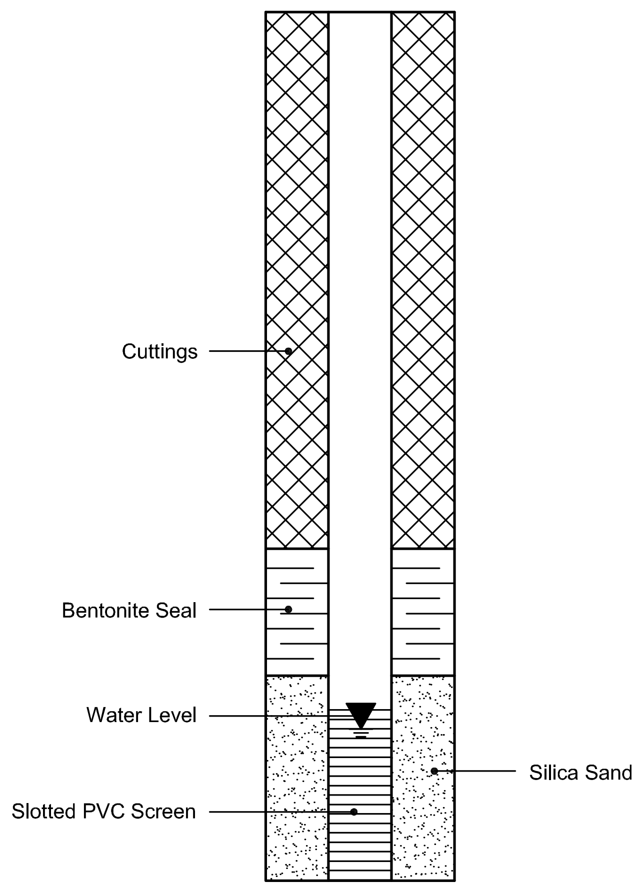


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



	Client ID:	BH3-SS3	-	-	-
	Sample Date:	03/20/2018 09:00	-	-	-
	Sample ID:	1812535-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	97.5	-	-	-
General Inorganics					
pH	0.05 pH Units	7.45	-	-	-
Resistivity	0.10 Ohm.m	127	-	-	-
Anions					
Chloride	5 ug/g dry	8	-	-	-
Sulphate	5 ug/g dry	<5	-	-	-

APPENDIX 2

FIGURE 1 - KEY PLAN

FIGURE 2 - AERIAL PHOTOGRAPH - 1976

FIGURE 3 - AERIAL PHOTOGRAPH - 1991

FIGURE 4 - AERIAL PHOTOGRAPH - 2017

DRAWING PG4405-1 - TEST HOLE LOCATION PLAN

FIGURE 1

KEY PLAN

FIGURE 2

Aerial Photograph - 1976

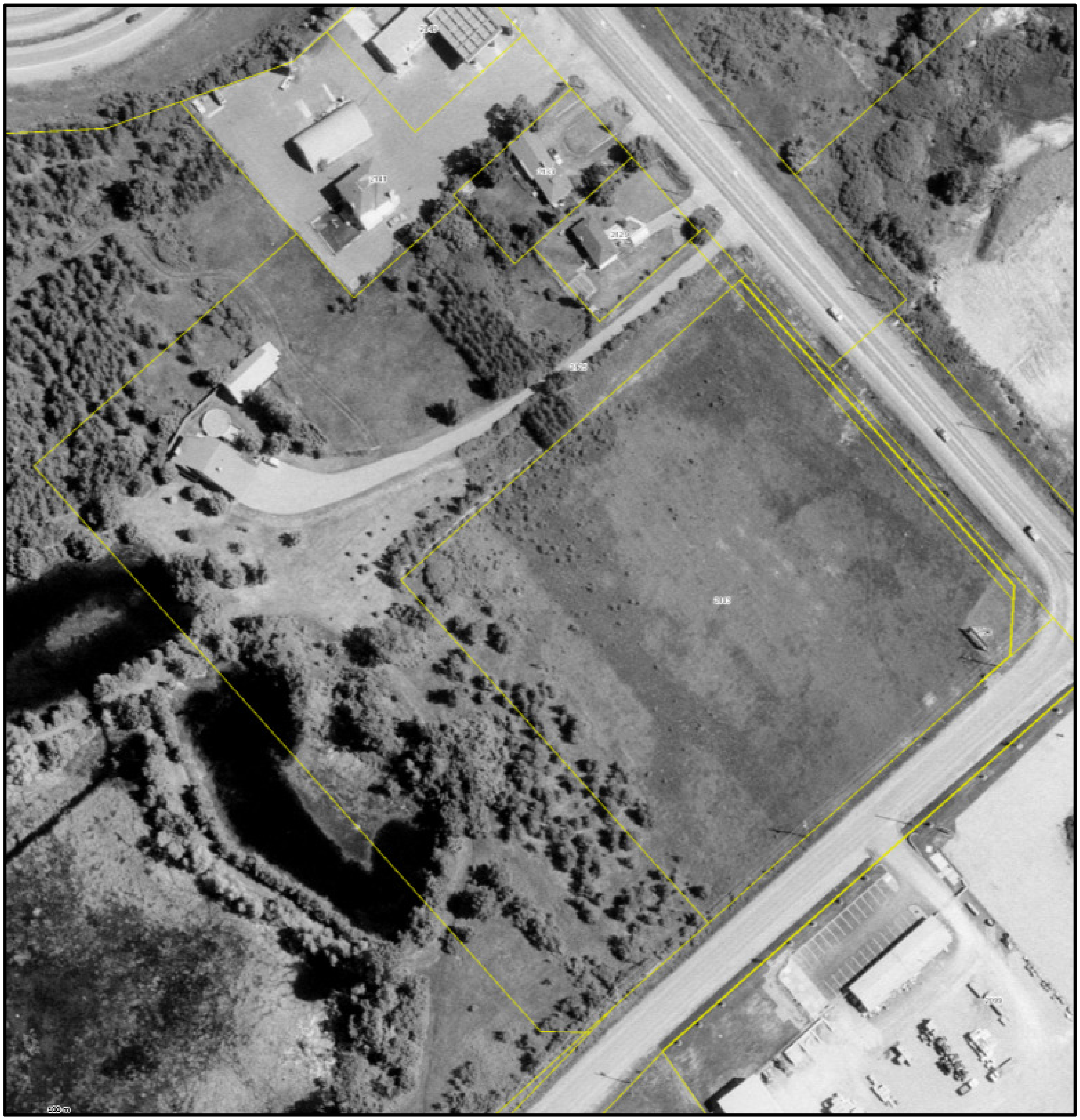
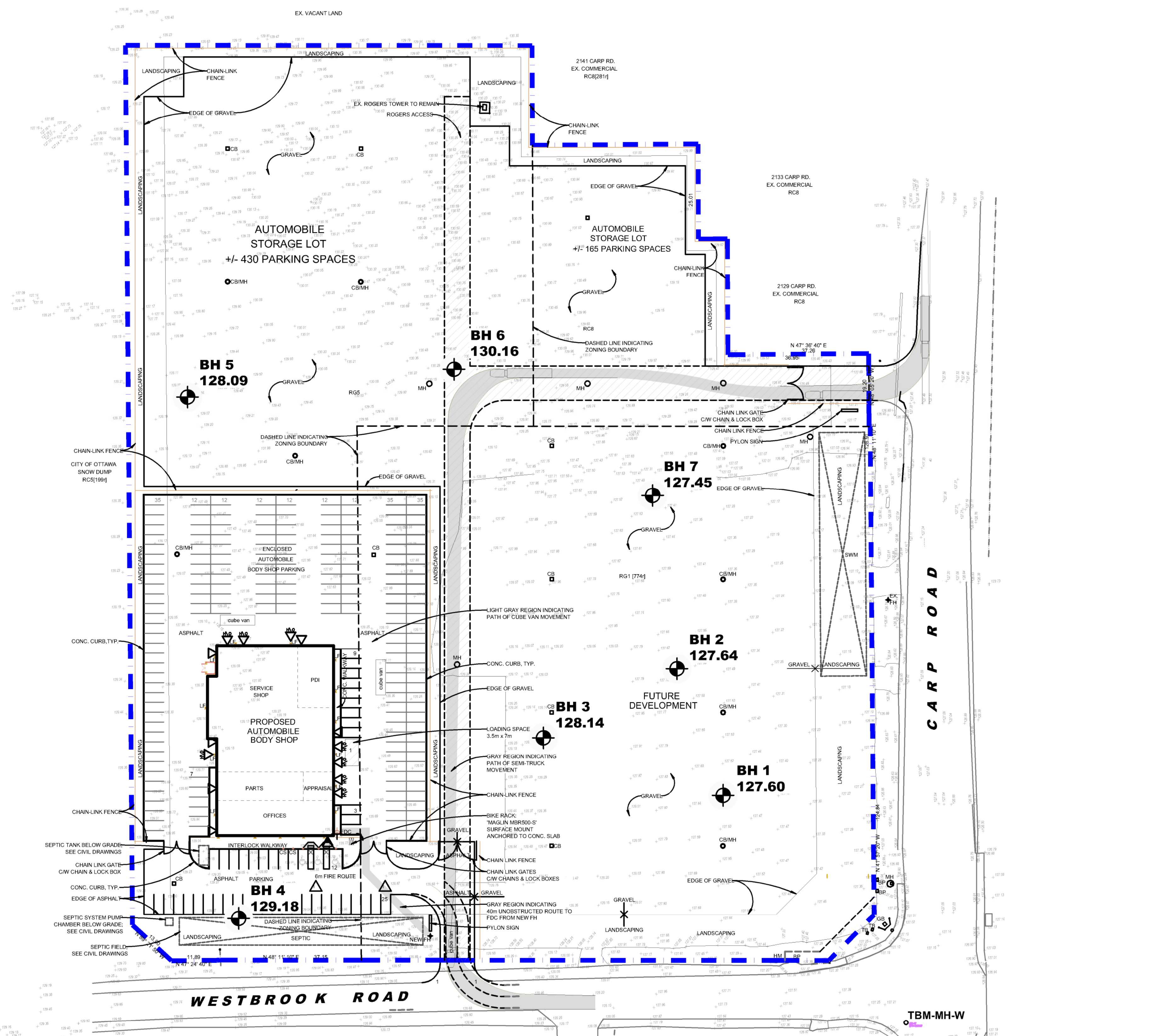


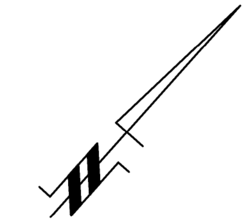
FIGURE 3

Aerial Photograph - 1991

FIGURE 4

Aerial Photograph - 2017





LEGEND:

BOREHOLE LOCATION

121.25 GROUND SURFACE ELEVATION (m)

TBM - TOP OF GRATE WATERMAIN VALVE LOCATED AT THE SOUTHWEST CORNER OF THE INTERSECTION OF WESTBROOK ROAD AND CARP ROAD. GEODETIC ELEVATION OF 127.18 WAS PROVIDED BY MCINTOSH PERRY.

BASE PLAN PROVIDED BY KWC ARCHITECTS INC.

SCALE: 1:1250

0 5 10 15 20 25 50 75m

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NO.	REVISIONS	DATE	INITIAL
1	UPDATED TO LATEST BASE PLAN	13/03/2019	SD

BBS CONSTRUCTION

GEOTECHNICAL INVESTIGATION
PROPOSED AUTOMOTIVE BODYSHOP - 2113 CARP ROAD

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:1250	**Date:** 03/2018
Drawn by: RCG	**Report No.:** PG4405-1
Checked by: RG	**Dwg. No.:** PG4405-1
Approved by: DJG	**Revision No.:** 1

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