Geotechnical Engineering

Environmental Engineering

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Materials Testing

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Archaeological Services

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Geotechnical Investigation

Proposed Commercial Development
5100 Kanata Avenue
Ottawa, Ontario

Prepared For

Urbandale Corporation

July 2, 2018

Report: PG4558-1

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Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by Urbandale Corporation to conduct a geotechnical investigation for the proposed commercial development located at 5100 Kanata Avenue, in the City of Ottawa, Ontario (refer to Figure 1 - Key Plan in Appendix 2).

The objectives of the geotechnical investigation were:

- ❑ to determine the subsurface soil and groundwater conditions by means of excavating test pits.
- ❑ to 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. The report contains the findings and includes geotechnical recommendations pertaining to the design and construction of the subject development as 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 for this investigation. Therefore, the present report does not address environmental issues.

2.0 Proposed Project

Based on the available conceptual drawings, it is our understanding that the proposed development will consist of several commercial slab-on-grade buildings with associated car parking, access lanes and landscaped areas.

The proposed development is further understood to be serviced by municipal water and sewer services.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field portion of the geotechnical investigation was conducted on June 20, 2018. At that time, a total of six (6) test pits were excavated to a maximum depth of 4.9 m below existing ground surface using a rubber tired back-hoe. The test holes were located in the field by Paterson personnel and distributed in a manner to provide general coverage of the proposed development taking into consideration of existing site features and underground utilities. It should be noted that previous test holes completed by others on January 7, 2010 and surveyed by Annis, O'Sullivan, Vollebekk Ltd.. The location of the test pits completed during the current investigation and previous test pits completed by others are presented on Drawing PG4558-1 - Test Hole Location Plan included in Appendix 2.

All fieldwork was conducted under the full-time supervision of Paterson personnel with the direction of a senior engineer from the geotechnical division. The test pits were excavated using a rubber tired back-hoe by advancing each test pit to the required depth and sampling the overburden.

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

Sampling and In Situ Testing

Soil samples from the test pits were recovered from the side walls of the open excavation. The grab samples were classified on site and placed in sealed plastic bags and transported to the laboratory. The depths at which the grab samples were recovered are presented as 'G' on the Soil Profile and Test Data sheets presented in Appendix 1.

Subsurface conditions observed in the test pit and hole locations were recorded in detail in the field. Refer to the Soil Profile and Test Data sheets presented in Appendix 1 for specific details of the soil profiles.

Groundwater

Groundwater infiltration levels were recorded within the open test hole upon completion of the sampling program. The groundwater observations are noted on the Soil Profile and Test Data sheets presented in Appendix 1.

Sample Storage

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

3.2 Field Survey

The test holes completed during the current geotechnical investigation were selected in the field by Paterson personnel in a manner to provide general coverage of the proposed development taking into consideration of site features and underground utilities. The ground surface elevation at the test hole locations were surveyed by Paterson personnel and referenced to a temporary benchmark (TBM), consisting of the top of spindle of the fire hydrant located on the north side of Kanata Avenue. A geodetic elevation of 108.34 m was provided for the TBM on the survey plan prepared by Annis, O'Sullivan, Vollebekk Ltd..

The location of the TBM, test holes and ground surface elevation at each test hole location are presented on Drawing PG4558-1 - Test Hole Location Plan included in Appendix 2.

3.3 Laboratory Testing

The soil samples recovered from the subject site were examined in the laboratory to review the field logs.

4.0 Observations

4.1 Surface Conditions

The subject site is currently bordered to the south by Kanata Avenue followed by All Saints Secondary School, to the west by Goulbourn Forced Road followed by single family residential dwellings (townhouses) and to the east by single family residential dwellings (townhouses). A retirement residence bordering the north property boundary is currently under construction. Currently, the site is approximately at grade with the neighbouring properties and adjacent roadways.

The site is currently vacant and has been used to stockpile access fill material generated from the nearby construction projects within the subject area. The main fill pile is within the central portion of the site and consists of a blasted rock mixed with gravel and silty sand. The west portion of the site is covered with a thin layer of crushed stone and fill piles consisting of sand, crushed stone, lumber and construction debris.

Based on available aerial photographs (included in Appendix 2), the site was stripped of trees between 1999 and 2002 and the fill piles were imported between 2002 and 2011.

4.2 Subsurface Profile

Generally, the subsurface profile observed at the test pit locations consists of loose to compact fill overlying a sound to very sound bedrock surface at depths varying between 1.8 to 4.9 m below existing ground surface. The fill material generally consisted of a mixture of silty sand, some clay and varying quantities of cobbles, boulders and fragmented bedrock throughout. A 0.7 m thick layer of compact to very dense glacial till consisting of a silty sand with clay, gravel and cobbles was encountered directly over the bedrock surface. In addition, an undisturbed loose silty sand with clay to stiff silty clay with sand was encountered directly below the fill material at a depth of 3.8 m below existing ground surface overlying the bedrock surface at a depth of 4.9 m.

Based on the bedrock elevations encountered during the previous investigation and our review of the open test holes during the current investigation, the bedrock surface varies between 100.90 m and 108.50 m (geodetic) at the test hole locations.

Based on available geological mapping, the subject site is underlain by a sound to very sound undifferentiated metamorphic and igneous bedrock with drift thickness estimated to be between 0 to 10 m.

4.3 Groundwater

Groundwater levels were measured within the open test pits upon completion of the sampling program. Perched groundwater conditions were observed at the open test holes within the overlying fill material at depths varying between 1.7 and 3.6 m below existing ground surface. The long-term groundwater table is estimated to be greater than 3 m below existing ground surface within the underlying bedrock surface.

Groundwater levels are subject to seasonal fluctuations and could vary at the time of construction.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is considered adequate for the proposed commercial development. It is expected that the proposed buildings will be founded on conventional shallow footings placed on engineered fill overlying approved existing fill and/or undisturbed, glacial till or bedrock surface.

Bedrock removal is expected to be required in areas across the site for building construction and service installation.

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

5.2 Site Grading and Preparation

Stripping Depth

Topsoil and fill, such as those containing organic or deleterious materials, should be stripped from under any buildings and other settlement sensitive structures. It is anticipated that the existing fill, free of deleterious material and significant amounts of organics, can be left in place below the proposed buildings' footprint and below the proposed parking area and access lanes. However, it is recommended that the existing fill layer be proof-rolled several times and approved by the geotechnical consultant at the time of construction. Any poor performing areas noted during the proof-rolling operation should be removed and replaced with an approved fill.

Proof Rolling

For the proposed parking area and access lanes, proof rolling will be required in areas where existing fill is present. The purpose of the proof rolling is to induce some of the initial settlements to reduce long term total settlements. In these deep backfilled areas, it is recommended that the subgrade surface be proof-rolled **under dry conditions** by an adequately sized roller making several passes to achieve optimum compaction levels. The compaction program should be reviewed and approved by the geotechnical consultant. In poor performing areas, consideration may be given to removing the poor performing fill and replace with an approved granular fill.

Fill Placement

Fill used for grading beneath the proposed building pad should consist of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A, Granular B Type II and/or select subgrade material. 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 buildings and concrete pad should be compacted to at least 98% of the material's 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.

If site excavated bedrock is to be placed as backfill, the bedrock should be crushed to produce a well-graded material, similar to a 150 mm minus crushed stone material and approved by the geotechnical consultant.

Bedrock Removal

Bedrock removal can be accomplished by hoe ramming where only a small quantity of the bedrock needs to be removed. Sound bedrock should be removed by line drilling and controlled blasting and/or hoe ramming.

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

As a general guideline, peak particle velocities (measured at the structures) should not exceed 25 mm/s during the blasting program to reduce the risks of damage to the existing structures.

The blasting operations should be planned and conducted under the supervision of a licensed professional engineer who is also an experienced blasting consultant.

Excavation side slopes in sound bedrock can be excavated with almost vertical side walls. Near vertical (1H:6V) slopes can be used for unfractured sound bedrock bearing media. A 1H:1V slope can be used for fractured/weathered bedrock. A minimum 1 m horizontal ledge, should remain between the overburden excavation and the bedrock surface. The ledge will provide an area to allow for potential sloughing or a stable base for the overburden shoring system.

Vibration Considerations

Construction operations are the cause of vibrations and potentially sources of nuisance to the community, therefore, means to reduce the vibration levels as much as possible should be incorporated in the construction operations to maintain a cooperative environment with the residents.

The following construction equipments could be the source of vibrations: hoe ram, compactor, dozer, crane, truck traffic, etc. Vibrations, whether caused by blasting operations or by construction operations, could be the source of detrimental vibrations on the nearby buildings and structures. Therefore, all vibrations are recommended to be limited.

Two parameters determine the permissible vibrations, namely, the maximum peak particle velocity and the frequency. For low frequency vibrations, the maximum allowable peak particle velocity is less than that for high frequency vibrations. As a guideline, the peak particle velocity should be less than 15 mm/s between frequencies of 4 to 12 Hz, and 50 mm/s above a frequency of 40 Hz (interpolate between 12 and 40 Hz). The guidelines are for current construction standards. Considering that these guidelines are above perceptible human level and, in some cases, could be very disturbing to some people, a pre-construction survey is recommended be completed to minimize the risks of claims during or following the construction of the proposed building.

5.3 Foundation Design

Bearing Resistance Values

Footings placed on a clean, surface sounded bedrock or lean concrete fill placed on surface sounded bedrock can be designed using a factored bearing resistance value at ULS of **1,500 kPa**. A geotechnical resistance factor of 0.5 was applied to the reported bearing resistance values at ULS.

A clean, surface-sounded bedrock bearing surface should be free of all soil and loose materials, and have no near surface seams, voids, fissures or open joints which can be detected from surface sounding with a rock hammer.

The bearing medium under footing-supported structures is required to be provided with adequate lateral support. Near vertical (1H:6V) slopes can be used for unfractured bedrock bearing media. A 1H:1V slope can be used for fractured/weathered bedrock.

The potential long term post-construction total and differential settlements for footings placed on surface-sounded bedrock are estimated to be negligible.

Footings placed on an undisturbed, compact sandy silt or compact glacial till or engineered fill placed over an approved existing fill can be designed using a bearing resistance value at SLS of **150 kPa** and a factored bearing resistance value at ULS of **250 kPa**. Based on the fill depth and anticipated underside of footing elevation, it is expected that the existing fill will be encountered at design footing level in areas throughout the site. The following program is recommended to provide an adequate bearing surface.

Sub-Excavation and Placement of Engineered Fill

Excavate all fill material to at least 500 mm below design underside of footing level extending at least 500 mm horizontally beyond the footing face. The sub-excavated surface should be proof rolled using a suitably sized vibratory roller. Any poor performing areas should be sub-excavated and replaced with OPSS Granular B Type II compacted to a minimum 98% of the material's SPMDD. The excavated area should be backfilled with an OPSS Granular B Type II to underside of footing. A sand and gravel (pit run) fill can be used as backfill above footing level to underside of floor slab. It is recommended that all fill material with the proposed building footprint be placed in maximum 300 mm loose lifts and compacted to 98% of its SPMDD under dry conditions and in above freezing temperatures and approved by the geotechnical consultant at the time of compaction. Alternatively, in areas where the subgrade soils are noted to be in a loose state of compactness, the subgrade could be covered by a layer of woven geotextile liner, such as Terrafix 200W or equivalent and a biaxial geogrid layer, such as Terrafix TBX2500 or equivalent, extended horizontally a minimum of 1 m beyond the footing face.

Footings founded over an engineered fill pad placed as detailed above 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 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 a loose silty sand with clay to silty clay with sand, or glacial till above the groundwater table when a plane extending horizontally and vertically from the footing perimeter a minimum of 1.5H:1V passing through in situ soil of the same or higher capacity as the bearing medium soil.

5.4 Design for Earthquakes

Foundations at the subject site can be designed using a seismic site response **Class C** as defined in the Ontario Building Code 2012 (OBC 2012; Table 4.1.8.4.A). A higher site class, such as Class A or Class B, are applicable for foundation design for the structures provided a site specific seismic shear wave velocity test is completed as per OBC 2012.

5.5 Slab on Grade Construction

With the removal of all topsoil and deleterious fill, such as those containing significant amounts of organic matter, within the footprint of the proposed buildings, undisturbed native soil surface or existing fill approved by the geotechnical consultant at the time of construction will be considered acceptable subgrade on which to commence backfilling for floor slab construction. It is recommended that the existing fill layer, free of deleterious and organic materials, be proof-rolled by a vibratory roller making several passes and approved by the geotechnical consultant at the time of construction. Any soft areas should be removed and backfilled with appropriate backfill material.

Fill placed for grading beneath the building areas should consist, unless otherwise specified, of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A, OPSS Granular B Type II or a select subgrade material. The fill should be placed in maximum 300 mm thick lifts and compacted to 98% of standard Proctor maximum dry density (SPMDD).

5.6 Pavement Structure

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

Table 1 - Recommended Pavement Structure - Car Only Parking Areas

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

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

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

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

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

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

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

From a geotechnical perspective, a perimeter foundation drainage system is optional for the proposed slab on grade buildings provided that a free draining non-frost susceptible granular material is placed against the foundation wall where sidewalks are present. If installed, 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 structures. 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 majority of the site excavated materials will be frost susceptible and are not recommended for placement as backfill against the foundation walls, unless placed in conjunction with a drainage geocomposite, such as Miradrain G100N or Delta Drain 6000, connected to the perimeter foundation drainage system. Otherwise, imported granular materials, such as clean sand or OPSS Granular B Type I granular material, should otherwise 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.

Frost Susceptibility of Bedrock

When bedrock is encountered above the proposed founding depth and soil frost cover is less than the 1.5 m, the abovenoted soil cover depths can be reduced provided that the geotechnical consultant reviews the bedrock surface and confirms that the bedrock is not frost susceptible (ie.- free of any significant soil in-fillled voids and/or fractures). If the bedrock is considered to be **non-frost susceptible**, the footings can be poured directly on the bedrock without any further frost protective measures.

6.3 Excavation Side Slopes

The excavation side slopes in the overburden material should either be excavated at acceptable slopes or retained by shoring systems from the beginning of the excavation until the structure is backfilled.

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

Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should maintain safe working distance from the excavation sides.

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

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

Near vertical (1H:6V) slopes can be used for unfractured bedrock bearing media. A 1H:1V slope can be used for fractured/weathered bedrock. If almost vertical side slopes are to be constructed all loose rock and blocks with unfavourable weak planes are removed or stabilized with rock anchors prior to completing work.

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.

A minimum 150 mm of OPSS Granular A should be placed for bedding for sewer or water pipes when placed on soil subgrade. If the bedding is placed on bedrock, the thickness of the bedding should be increased to 300 mm for sewer pipes. The bedding should extend to the spring line of the pipe. Cover material, from the spring line to a minimum of 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 and compacted to 95% of the SPMDD.

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

Based on the soil profile encountered, the subgrade for the underground municipal services will be placed in both bedrock and in overburden soils. The subgrade medium is recommended to be inspected in the field to determine how steeply the bedrock surface, where encountered, drops off. A transition zone should be provided where the bedrock slopes at more than 3H:1V. At specific locations, the bedrock should be excavated and extra bedding be placed to provide a 3H:1V (or shallower) transition from the bedrock subgrade towards the soil subgrade. The transition zone should reduce the propensity for bending stress to occur in the service pipes.

Trench backfill material within the frost zone (about 1.8 m below finished grade) should match the soils exposed at the trench walls to reduce potential differential frost heaving. The trench backfill should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 95% of the SPMDD.

6.5 Groundwater Control

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

For typical ground or surface water volumes, being pumped during the construction phase, 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 MOECC review of the PTTW application.

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.

6.6 Winter Construction

If winter construction is considered for this project, precautions should be provided for frost protection. The subsurface soil conditions mainly consist of frost susceptible materials. In presence of water and freezing conditions ice could form within the soil mass. Heaving and settlement upon thawing could occur.

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

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

7.0 Recommendations

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

- ❑ Observation of all bearing surfaces prior to the placement of concrete.
- ❑ Sampling and testing of the concrete and granular fill materials placed.
- ❑ 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 construction has been conducted in general accordance with the recommendations could be issued upon the completion of a satisfactory inspection program by the geotechnical consultant.

8.0 Statement of Limitations

The recommendations are in accordance with the present understanding of the project. Paterson requests permission to review the grading plan once available and the 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 the test locations, Paterson requests notification immediately in order to permit reassessment of the 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 the Urbandale Development 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.

Richard Groniger, C. Tech.

July 2, 2018

David J. Gilbert, P.Eng.

Report Distribution

- ❏ Urbandale Corporation (3 copies)
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APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development - 5100 Kanata Ave.
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located on Kanata Avenue. Geodetic elevation = 108.34m.

REMARKS

BORINGS BY Backhoe

DATE June 20, 2018

FILE NO. PG4558

HOLE NO. TP 1

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									
TOPSOIL — 0.20						0	106.12		
FILL: Compact to loose, brown sand with plastic and patio stone — 1.30		G	1			1	105.12		
GLACIAL TILL: Compact to very dense, grey silty sand with clay, gravel, cobbles, boulders — 2.00		G	2			2	104.12		⊻
End of Test Pit TP terminated on bedrock surface at 2.00m depth (GWL @ 1.9m depth based on field observations)									

Shear Strength (kPa): 20, 40, 60, 80, 100

▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development - 5100 Kanata Ave.
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located on Kanata Avenue. Geodetic elevation = 108.34m.

REMARKS

BORINGS BY Backhoe

DATE June 20, 2018

FILE NO. PG4558

HOLE NO. TP 2

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 %	Piezometer Construction
GROUND SURFACE						0	106.45		
FILL: Blast rock (to 0.70)									
FILL: Compact, grey-brown sandy clay, some silt, gravel, cobbles (0.70 to 2.40)		G	1			1	105.45		
						2	104.45		
FILL: Topsoil, organics, tree branches (2.40 to 2.50)									
FILL: Stiff, grey-brown silty clay with sand (2.50 to 3.80)		G	2			3	103.45		∇
Loose, grey **SILTY SAND** with clay to stiff **SILTY CLAY** with sand (3.80 to 4.90)		G	3			4	102.45		
End of Test Pit (4.90)									

TP terminated on bedrock surface at 4.90m depth

(GWL @ 3.6m depth based on field observations)

Pen. Resist. / Water Content scale: 20, 40, 60, 80

Shear Strength (kPa): 20, 40, 60, 80, 100

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development - 5100 Kanata Ave.
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located on Kanata Avenue. Geodetic elevation = 108.34m.

REMARKS

BORINGS BY Backhoe

DATE June 20, 2018

FILE NO. PG4558

HOLE NO. TP 3

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 %	Piezometer Construction
GROUND SURFACE						0	107.97		
FILL: Blast rock with silty sand, gravel, cobbles, boulders		G	1						
0.60									
		G	2						
		G	3			1	106.97		
FILL: Compact to dense, brown silty sand, some clay, gravel, cobbles, asphalt, metal		G	4						
						2	105.97		
2.70									
FILL: Compact, light brown silty sand with clay, some sand, gravel, cobbles		G	5			3	104.97		
3.50									
TOPSOIL 3.60		G	6						

End of Test Pit

TP terminated on bedrock surface at 3.60m depth

(GWL @ 1.9m depth based on field observations)

Water Content % axis: 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development - 5100 Kanata Ave.
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located on Kanata Avenue. Geodetic elevation = 108.34m.

REMARKS

BORINGS BY Backhoe

DATE June 20, 2018

FILE NO. PG4558

HOLE NO. TP 4

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20 40 60 80)	Piezometer Construction
GROUND SURFACE						0	107.01		
FILL: Crushed stone — 0.20		G	1						
FILL: Loose fine sand, some silt — 0.60		G	2						
FILL: Compact, brown silty sand with gravel, cobbles, boulders, organics — 1.80						1	106.01		
End of Test Pit TP terminated on bedrock surface at 1.80m depth (TP dry upon completion)									

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers
154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development - 5100 Kanata Ave.
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located on Kanata Avenue. Geodetic elevation = 108.34m.

REMARKS

BORINGS BY Backhoe

DATE June 20, 2018

FILE NO. PG4558

HOLE NO. TP 5

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	107.37		
FILL: Compact, brown silty sand with gravel, cobbles, boulders, fragmented bedrock		G	1						
						1	106.37		
		G	2						
						2	105.37		
2.50									
End of Test Pit TP terminated on bedrock surface at 2.50m depth (TP dry upon completion)									

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development - 5100 Kanata Ave.
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located on Kanata Avenue. Geodetic elevation = 108.34m.

REMARKS

BORINGS BY Backhoe

DATE June 20, 2018

FILE NO. PG4558

HOLE NO. TP 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	106.01		
FILL: Compact to dense blast rock with boulders, cobbles, gravel and sand		G	1			1	105.01		▽
1.80									
End of Test Pit TP terminated on inferred bedrock surface at 1.80m depth (GWL @ 1.7m depth based on field observations)									

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

SYMBOLS AND TERMS

SOIL DESCRIPTION

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

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

The standard terminology to describe the strength of cohesionless soils is the relative density, usually inferred from the results of the Standard Penetration Test (SPT) 'N' value. The SPT N value is the number of blows of a 63.5 kg hammer, falling 760 mm, required to drive a 51 mm O.D. split spoon sampler 300 mm into the soil after an initial penetration of 150 mm.

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

The standard terminology to describe the strength of cohesive soils is the consistency, which is based on the undisturbed undrained shear strength as measured by the in situ or laboratory vane tests, penetrometer tests, unconfined compression tests, or occasionally by Standard Penetration Tests.

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

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

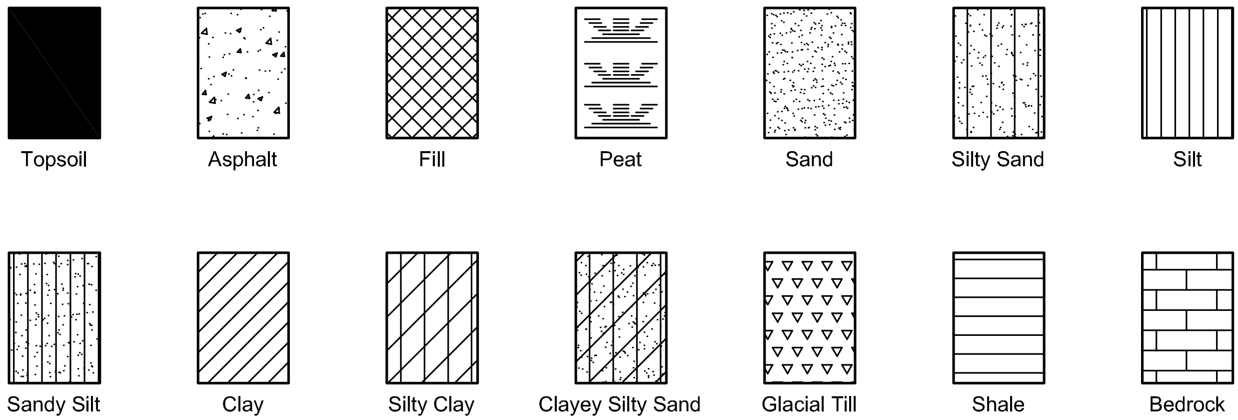
p'_o	-	Present effective overburden pressure at sample depth
p'_c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'_c)
Cc	-	Compression index (in effect at pressures above p'_c)
OC Ratio		Overconsolidaton ratio = p'_c / p'_o
Void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

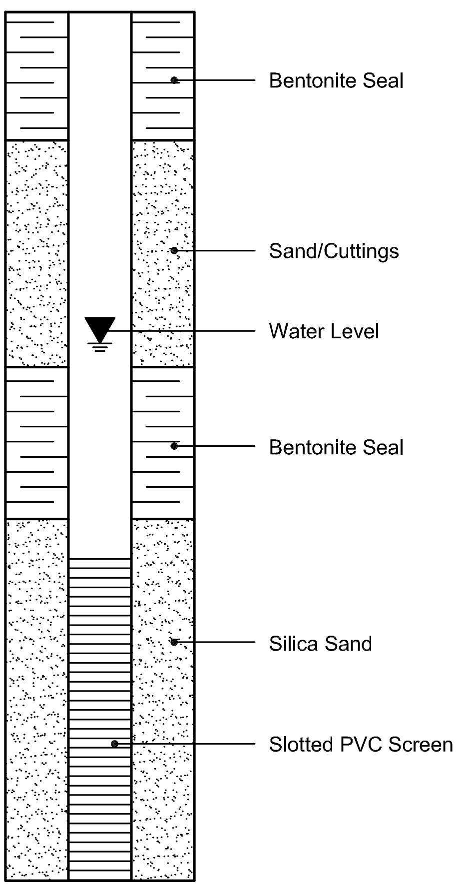
SYMBOLS AND TERMS (continued)

STRATA PLOT

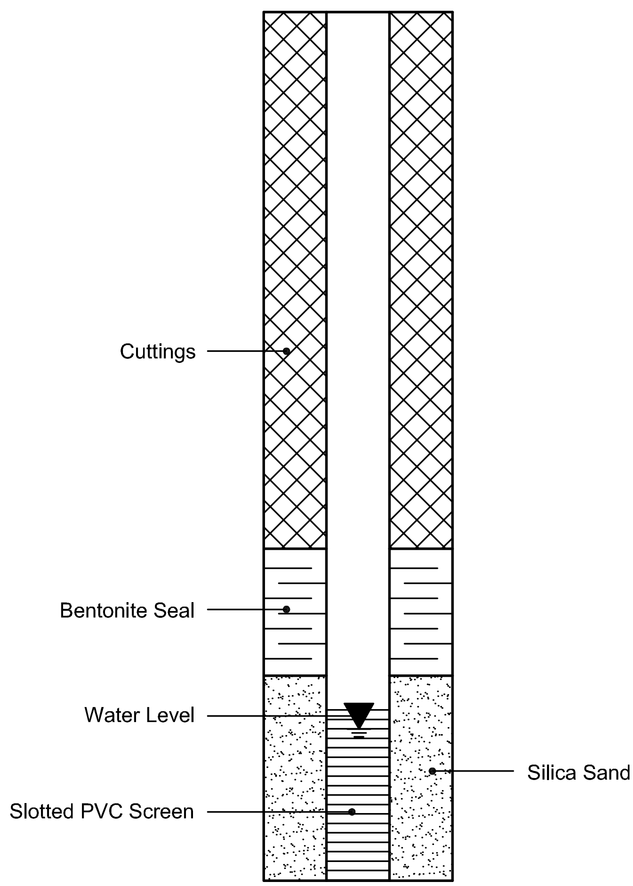


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



APPENDIX 2

FIGURE 1 - KEY PLAN

FIGURE 2 to 6 - AERIAL PHOTOGRAPHS

DRAWING PG4558-1 - TEST HOLE LOCATION PLAN

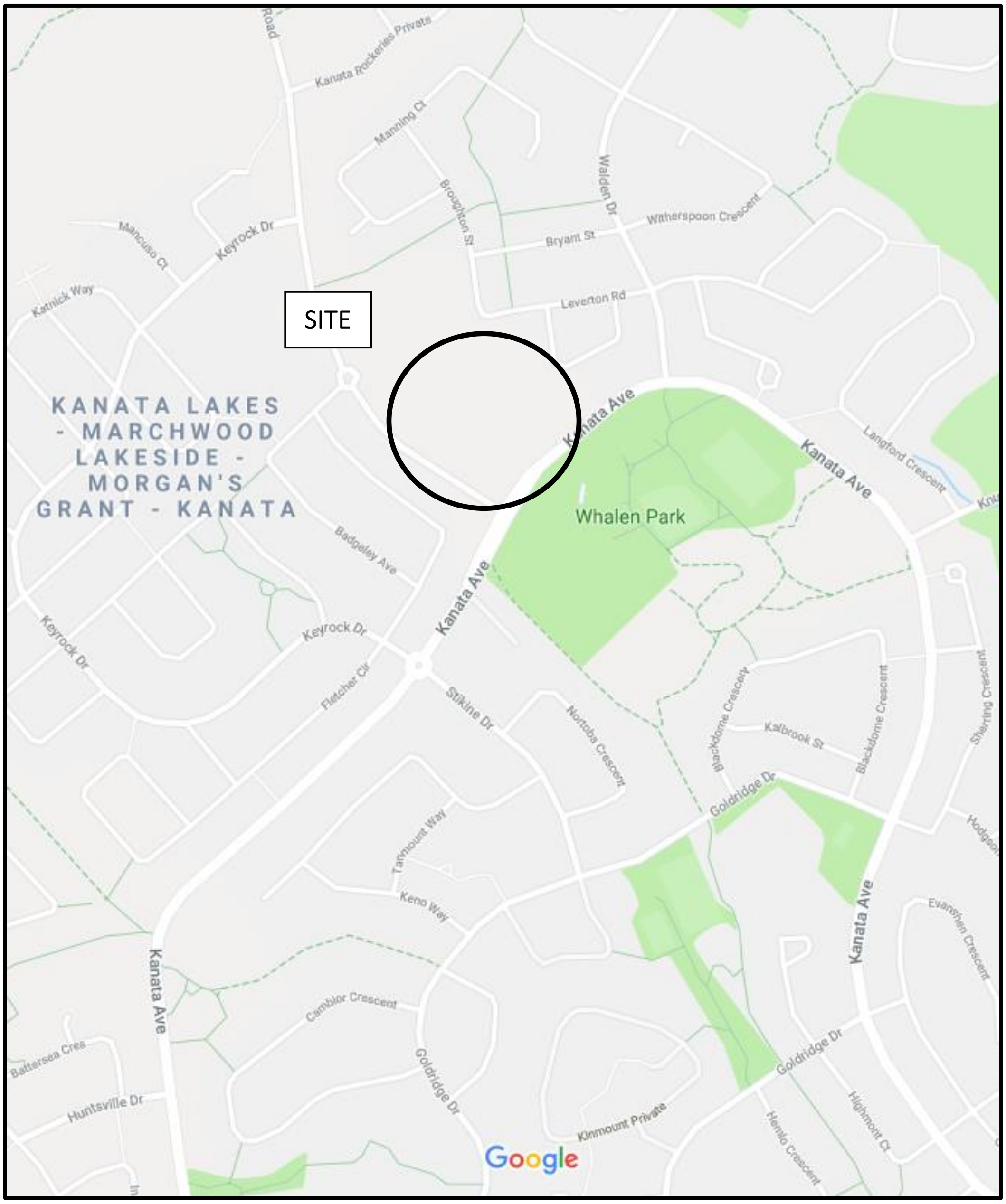


FIGURE 1

KEY PLAN

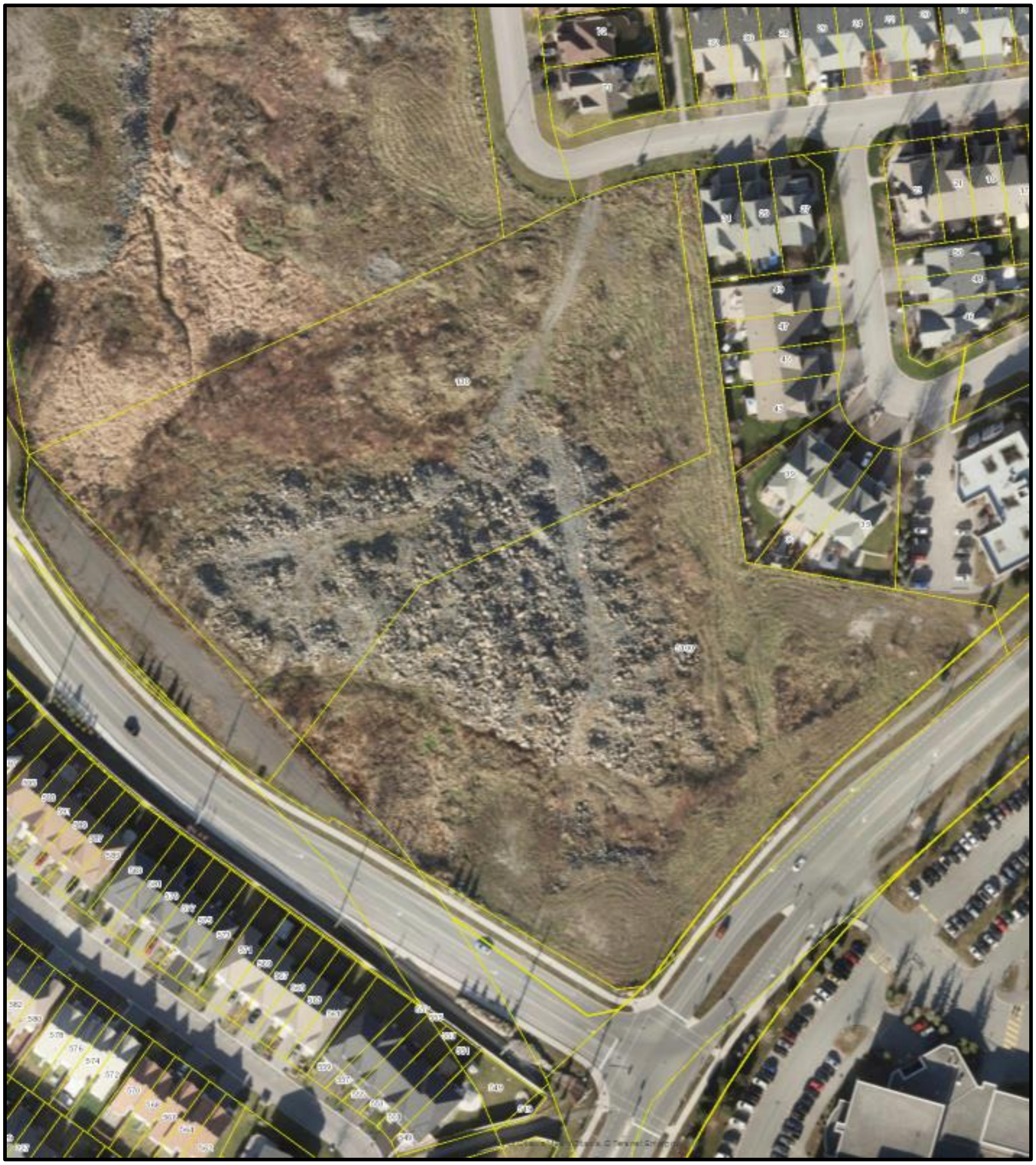


FIGURE 2

Aerial Photograph - 2015

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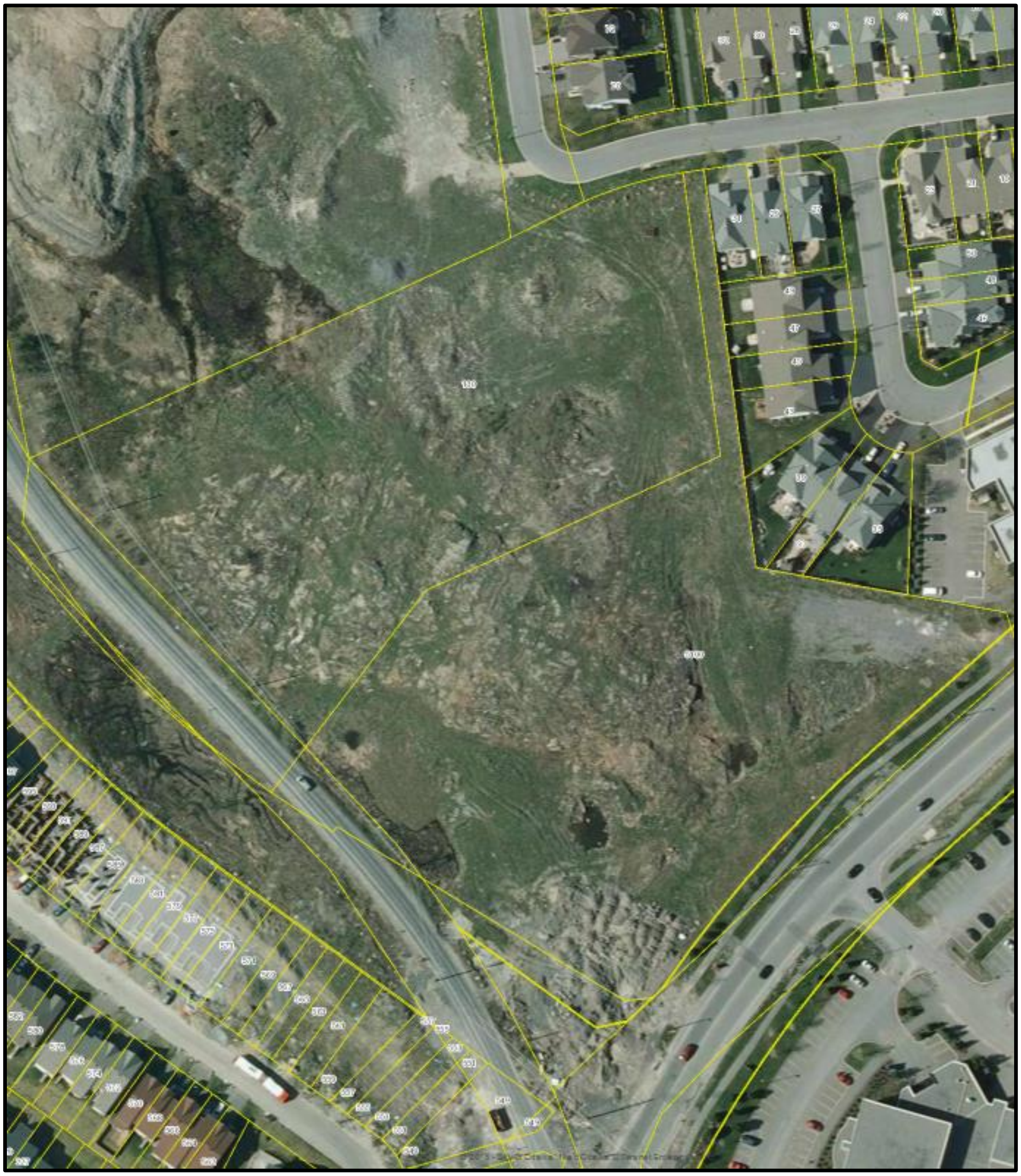


FIGURE 3

Aerial Photograph - 2011

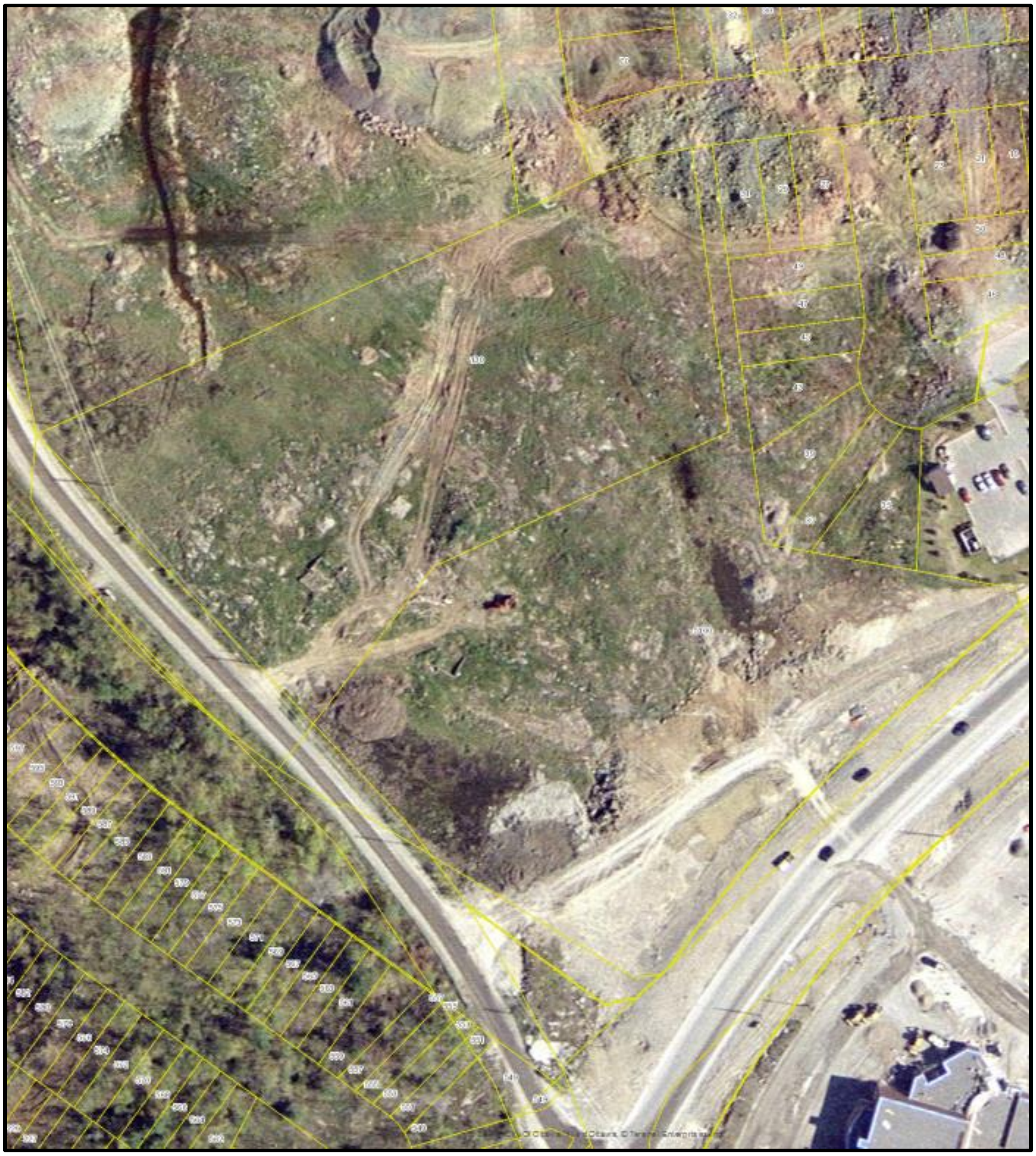


FIGURE 4

Aerial Photograph - 2002

FIGURE 5

Aerial Photograph - 1999

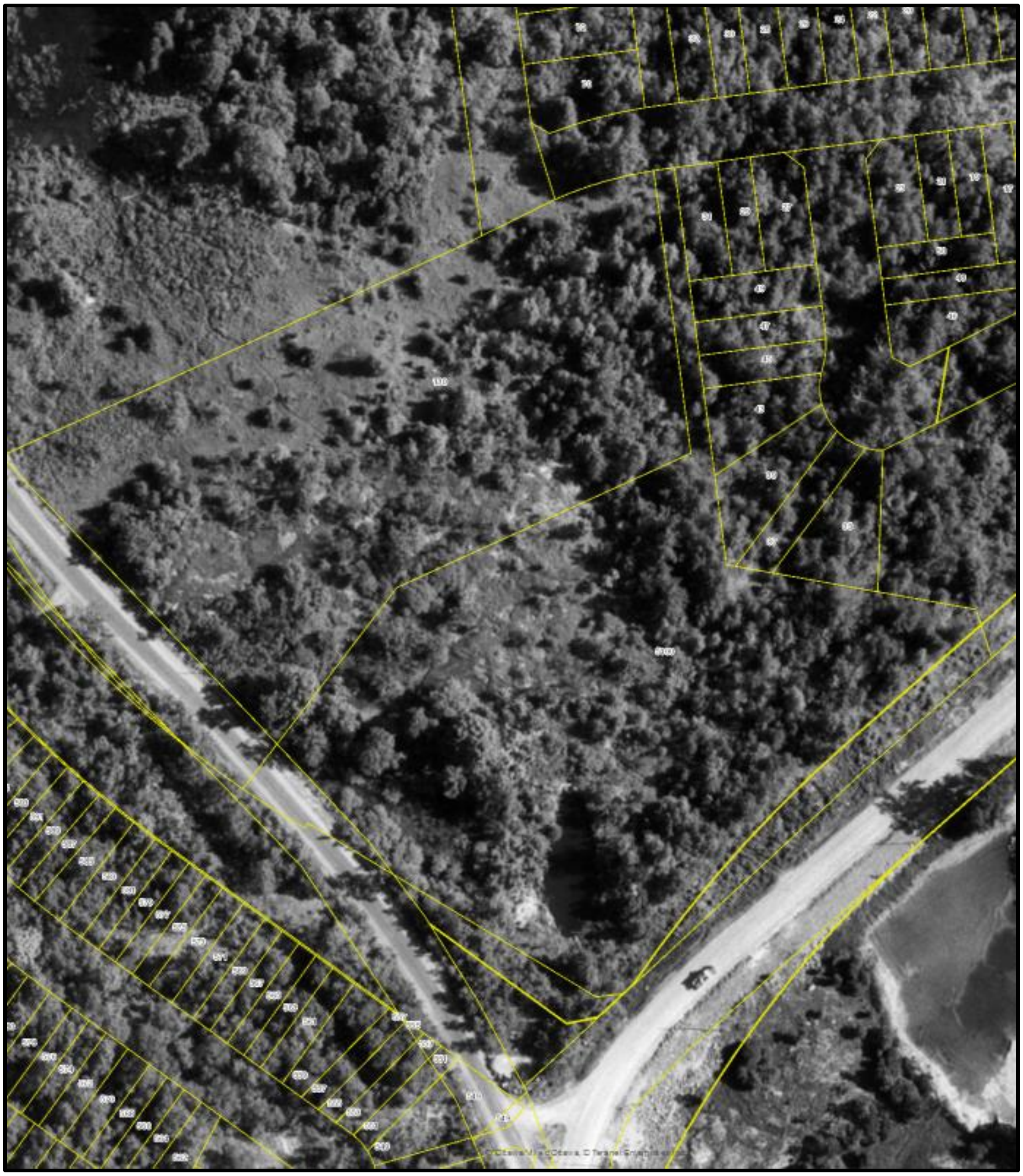
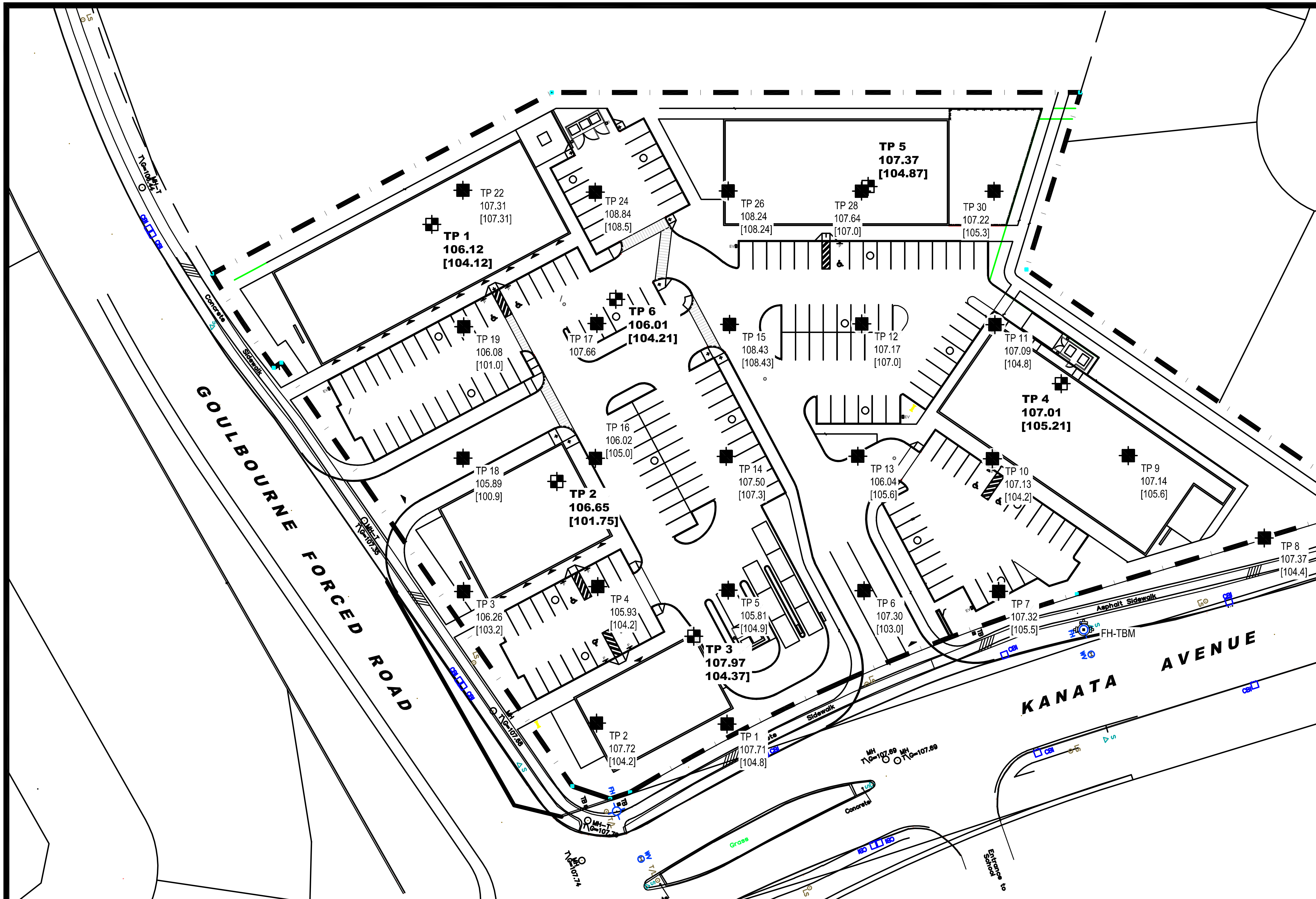


FIGURE 6

Aerial Photograph - 1991



LEGEND:

- TEST PIT LOCATION, CURRENT INVESTIGATION
- TEST PIT LOCATION BY OTHERS

107.37 GROUND SURFACE ELEVATION (m)

[104.4] BEDROCK SURFACE ELEVATION (m)

TBM (CURRENT INVESTIGATION) - TOP SPINDLE OF FIRE HYDRANT. GEODETIC ELEVATION = 108.34m, AS PER TOPO PLAN PREPARED BY ANNIS, O'SULLIVAN, VOLLEBEKK LTD.

BASE PLAN PROVIDED BY DREDGE LEAHY ARCHITECTS INC.

TEST PIT LOCATIONS, GROUND SURFACE AND BEDROCK ELEVATIONS BY OTHERS WERE SURVEYED BY ANNIS, O'SULLIVAN, VOLLEBEKK LTD.

SCALE: 1:750

0 10 20 30 50m

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NO.	REVISIONS	DATE	INITIAL
0			

URBANDALE CORPORATION

GEOTECHNICAL INVESTIGATION
PROP. COMMERCIAL DEVELOPMENT - 5100 KANATA AVENUE

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:750	Date: 06/2018
Drawn by: MPG	Report No.: PG4558-1
Checked by: RG	Dwg. No.: PG4558-1
Approved by: DJG	Revision No.: 0

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