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Geotechnical Engineering

Environmental Engineering

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Materials Testing

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Noise and Vibration Studies

Geotechnical Investigation

Proposed Development
Westwood - Phase 4
Ottawa, Ontario

Prepared For

CRT Developments Inc.

Paterson Group Inc.
Consulting Engineers
154 Colonnade Road South
Ottawa (Nepean), Ontario
Canada K2E 7S8

Tel: (613) 226-7381
Fax: (613) 226-6344
www.patersongroup.ca

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Report: PG6087-1

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Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by CRT Developments Inc. to conduct a geotechnical investigation for the proposed Westwood – Phase 4 development to be located at 5500 Abbott Street and 1555 Shea Road in the City of Ottawa (refer to Figure 1 - Key Plan in Appendix 2 of this report).

The objectives of the geotechnical investigation were to:

- Determine the subsoil and groundwater conditions at this site by means of test holes.

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

2.0 Proposed Development

Based on the available drawings, the proposed development at the Phase 4 site is understood to consist primarily of single-family dwellings and townhouse blocks with associated municipal roads. An institutional development is also proposed in the central portion of the site, along with a park at the north end of the site and another in the southern portion of the site. Existing stormwater management ponds are located in the southeast corner of the site.

It is also understood that the proposed development will be municipally serviced.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field program for the geotechnical investigation was carried out on December 9, 2021 and consisted of advancing a total of 8 test pits to a maximum depth of 6.1 m below existing ground surface. The test pit locations were distributed in a manner to provide general coverage of the subject site and taking into consideration available equipment access and underground utilities. The test pit locations are shown on Drawing PG6087-1 - Test Hole Location Plan included in Appendix 2.

The test pits were advanced using a track-mounted excavator. All fieldwork was conducted under the full-time supervision of our personnel under the direction of a senior engineer. The test pit procedure consisted of excavating to the required depths at the selected locations and sampling the overburden. The test pits were backfilled with the excavated soil upon completion.

Sampling and In Situ Testing

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

The subsurface conditions observed in the test 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.

Groundwater

Where present, the depth at which groundwater was encountered at the completion of excavation was noted in the field.

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 test pit locations and ground surface elevation at each test hole location were surveyed by Paterson using a handheld GPS and referenced to a geodetic datum. The locations of the test pits and ground surface elevation at each test hole location are presented on Drawing PG6087 - 1 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

Soil samples were recovered from the subject site and visually examined in our laboratory to review the results of the field logging. A total of 1 shrinkage test, 1 grain size distribution analyses and 1 Atterberg limit test were completed on selected soil samples. The results of the testing are presented in Section 4.2 and on the Grain Size Distribution and Hydrometer Testing Results, and Atterberg Limits Testing Results sheets presented in Appendix 1.

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 samples were submitted to determine the concentration of sulphate and chloride, the resistivity, and the pH of the samples. The results are presented in Appendix 1 and are discussed further in Section 6.7.

4.0 Observations

4.1 Surface Conditions

The subject site is currently undeveloped and mostly forested, although existing stormwater management ponds are located in the southeast corner of the site. The site is bordered by a Hydro transmission line corridor to the west and north, the Westwood Phase 1, 2, and 3 developments to the east, and Fernbank Road to the south. The existing ground surface across the site is relatively level at approximate geodetic elevation 106 to 107 m.

4.2 Subsurface Profile

Generally, the subsurface soil profile at the test hole locations consists of topsoil or fill underlain by silty clay, glacial till and/or the bedrock surface.

At test pit TP 1-21, fill was observed consisting of brown silty sand to sandy silt with gravel, occasional cobbles and boulders, followed by blasted rock with some sand. The fill was not penetrated at the maximum reach of the excavation equipment at an approximate depth of 6.1 m below the existing ground surface. Based on discussions with the client, it is understood that some earthworks related to the future sanitary trunk sewer construction have already been conducted through this portion of the site, providing explanation for the deep fill present in this area, and which was not encountered in the remaining test pits.

At test pit TP 6-21, a silty clay to silt deposit was observed directly underlying the topsoil. The silty clay to silt was brown and very stiff to stiff, extending to the glacial till deposit at an approximate depth of 3.9 m. Silty clay and/or silt was not encountered in the remaining test pits.

A glacial till deposit was encountered at test pits TP 4-21 through TP 8-21 at depths ranging from approximately 0.5 to 3.9 m below the existing ground surface. The glacial till deposit was observed to consist of a compact to dense, brown or grey silty sand to sandy silt with clay, gravel, cobbles and boulders.

Practical refusal to the excavation was encountered at an approximate depth of 4.9 m at test holes TP 6-21, TP 7-21, and TP 8-21. Test pits TP 2-21, TP 3-21, TP 4-21 and TP 5-21 were terminated on bedrock surface at approximate depths of 0.5 m, 0.4 m, 1.1 m, and 3.4 m below ground surface, respectively.

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

Bedrock

Based on available geological mapping, the bedrock in the subject area consists of Paleozoic interbedded Limestone and Dolomite of the Gull River formation, with an overburden drift thickness of 1 to 10 m depth.

Atterberg Limit and Shrinkage Tests

Atterberg limits testing was completed on a recovered silty clay sample from test pit TP 6-21. The results of the Atterberg limits test are presented in Table 1 and on the Atterberg Limits Testing Results sheet in Appendix 1.

Table 1 - Atterberg Limits Results

Sample	Depth (m)	LL (%)	PL (%)	PI (%)	w (%)	Classification
TP 6-21 G2	1.0-1.1	51	28	23	51	CH

Notes: LL: Liquid Limit; PL: Plastic Limit; PI: Plasticity Index; w: water content;
CH: Inorganic Clay of High Plasticity

The results of the shrinkage limit test indicate a shrinkage limit of 25.0% and a shrinkage ratio of 1.70 at TP 6-21.

Grain Size Distribution and Hydrometer Testing

Grain size distribution (sieve and hydrometer analysis) was also completed on 1 selected soil sample. The results of the grain size analysis are summarized in Table 2 and presented on the Grain-Size Distribution and Hydrometer Testing Results sheet in Appendix 1.

Table 2 - Summary of Grain Size Distribution Analysis

Test Hole	Sample	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
TP 6-21	G3	0.0	1.7	98.3	

4.3 Groundwater

Depths of sidewall groundwater infiltration were observed during the test pit investigation on December 9, 2021. The majority of the test pits were dry upon completion, however, where groundwater infiltration was observed, the depths are provided on Table 3, on the next page. The recorded groundwater levels are also noted on the applicable Soil Profile and Test Data sheet presented in Appendix 1.

It should be noted that groundwater levels are subject to seasonal fluctuations. Therefore, the groundwater levels could vary at the time of construction.

Table 3 – Summary of Groundwater Levels

Test Hole Number	Ground Surface Elevation (m)	Measured Groundwater Level / Groundwater Infiltration for Test Pits		Dated Recorded
		Depth (m)	Elevation (m)	
TP 1-21	106.75	4.1	102.65	December 9, 2021
TP 5-21	105.87	2.1	103.77	
TP 6-21	105.24	2.4	102.84	
TP 7-21	105.81	2.1	103.71	
TP 8-21	105.21	2.1	103.11	

Note: The ground surface elevation at each borehole location was surveyed using a handheld GPS and are referenced to a geodetic datum.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is considered suitable for the proposed development. It is recommended that the proposed buildings be supported on conventional spread footings bearing on the undisturbed silty clay or glacial till, or on the clean, surface sounded bedrock.

Depending on the founding depth of proposed buildings, bedrock removal may be required to complete the basement levels and/or site servicing works. All contractors should be prepared for oversized boulder and bedrock removal.

Due to the presence of the silty clay layer, the subject site will have a permissible grade raise restriction where the silty clay was observed. The permissible grade raise recommendations are discussed in Subsection 5.3.

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

5.2 Site Grading and Preparation

Stripping Depth

Topsoil and deleterious fill, such as those containing organic materials, should be stripped from under any buildings, paved areas, pipe bedding and other settlement sensitive structures. Care should be taken not to disturb adequate bearing soils below the founding level during site preparation activities. Disturbance of the subgrade may result in having to sub-excavate the disturbed material and the placement of additional suitable fill material.

Fill Placement

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 or Granular B Type II. The imported fill material should be tested and approved prior to delivery.

The fill, where required, should be placed in maximum 300 mm thick loose lifts and compacted by suitable compaction equipment. Fill placed beneath the buildings should be compacted to a minimum of 98% of the standard Proctor maximum dry density (SPMDD).

Non-specified existing fill along with site-excavated soil could be placed as general landscaping fill where settlement of the ground surface is of minor concern. These materials should be spread in lifts with a maximum thickness of 300 mm and compacted by the tracks of the spreading equipment to minimize voids.

Non-specified existing fill and site-excavated soils are not suitable for placement as backfill against foundation walls, unless used in conjunction with a geocomposite drainage membrane, such as Miradrain G100N or Delta Drain 6000.

If excavated brown silty clay, free of organics and deleterious materials, is to be used to build up the subgrade level for areas to be paved, it is recommended that the material be placed under dry conditions and above freezing temperatures. The silty clay should be compacted in thin lifts to at least 95% of the material's SPMDD.

If excavated bedrock is to be used as fill, it should be suitably fragmented to produce well-graded material with a maximum particle size of 300 mm. This material should be used structurally only to build up the subgrade for pavements. Where the fill is open graded, a blinding layer of finer granular fill and/or woven geotextile may be required to prevent adjacent finer materials from migrating into the voids, with associated loss of ground and settlements. This can be assessed at the time of construction.

Bedrock Removal

Bedrock removal can be accomplished by hoe ramming where the bedrock is weathered and/or where only small quantities of the bedrock need to be removed. Sound bedrock may be removed by line drilling in conjunction with 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 the proximity of the blasting operations should be carried out 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 or 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 surrounding structures. The blasting operations should be planned and conducted under the supervision of a licensed professional engineer who is also an experienced blasting consultant.

Vibration Considerations

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

The following construction equipment could be a source of vibrations: piling rig, 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, it is recommended that all vibrations be limited.

Two parameters are used to 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).

It should be noted that these guidelines are for today’s construction standards. Considering that these guidelines are above perceptible human level and, in some cases, could be very disturbing to some people, it is recommended that a pre-construction survey be completed to minimize the risks of claims during or following the construction of the proposed buildings.

5.3 Foundation Design

Bearing Resistance Values (Conventional Spread Footings)

As noted above, based on the subsurface profile encountered in the test holes, it is recommended that the proposed buildings be founded on conventional spread footings placed on undisturbed, hard to very stiff silty clay, compact glacial till, or clean, surface sounded bedrock.

Overburden Bearing Surface

Using continuously applied loads, footings for the proposed development can be designed using the bearing resistance values presented in Table 4.

Table 4 - Bearing Resistance Values

Bearing Surface	Bearing Resistance Value at SLS (kPa)	Factored Bearing Resistance Value at ULS (kPa)
Hard to Very Stiff Brown Silty Clay	150	225
Compact Glacial Till	200	300

Note: Strip footings, up to 3 m wide, and pad footings, up to 5 m wide, can be designed for silty clay bearing mediums using the above noted bearing resistance values.

The bearing resistance values are provided on the assumption that the footings will be placed on undisturbed soil bearing surfaces. An undisturbed soil bearing surface consists of one from which all topsoil and deleterious materials, such as loose, frozen, or disturbed soil, whether in-situ or not, have been removed, prior to placement of concrete for footings.

Bedrock Bearing Surface

Footings supported on clean, surface-sounded bedrock can be designed using a bearing resistance value at ultimate limit states (ULS) of **1,000 kPa**, incorporating a geotechnical resistance factor of 0.5.

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

Bearing resistance values for footing design should be confirmed on a per lot basis by the geotechnical consultant at the time of construction.

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

Adequate lateral support is provided to sound bedrock bearing medium when a plane extending horizontally and vertically from the footing perimeter at a minimum of 1H:6V (or shallower) passes through sound bedrock or a material of the same or higher capacity as the bedrock, such as concrete. A weathered bedrock bearing medium will require a lateral support zone of 1H:3V (or shallower).

Settlement

The total and differential settlement will be dependent on characteristics of the proposed buildings. For design purposes, the total and differential settlements are estimated to be 25 to 20 mm, respectively. A post-development groundwater lowering of 0.5 m was assumed.

Footings bearing on clean, surface-sounded bedrock and designed using the above noted bearing pressures will be subjected to negligible post-construction total and differential settlements.

Bedrock/Soil Transition

Where a building is founded partly on bedrock and partly on soil, it is recommended to decrease the soil bearing resistance value by 25% for the footings placed on soil bearing media to reduce the potential long-term total and differential settlements.

At the soil/bedrock and bedrock/soil transitions, it is recommended that the upper 0.5 m of the bedrock be removed for a minimum length of 2 m (on the bedrock side) and replaced with nominally compacted OPSS Granular A or Granular B Type II material. The width of the sub-excavation should be at least the proposed footing width plus 0.5 m. Steel reinforcement, extending at least 3 m on both sides of the 2 m long transition, should be placed in the top part of the footings and foundation walls.

Permissible Grade Raise Recommendations

Where silty clay is present, a permissible grade raise restriction of **2.5 m** is recommended. The limits of the permissible grade raise for the proposed development are presented on the Drawing PG6087-2 – Permissible Grade Raise Plan in Appendix 2.

If higher than permissible grade raises are required, preloading with or without a surcharge, lightweight fill, and/or other measures should be investigated to reduce the risks of unacceptable long-term post construction total and differential settlements.

5.4 Design for Earthquakes

The site class for seismic site response can be taken as **Class C**. If a higher seismic site class is required (Class A or B), and the subject structures will have foundations within 3 m of the bedrock surface, a site-specific shear wave velocity test may be completed to accurately determine the applicable seismic site classification for foundation design of the proposed buildings, as presented in Table 4.1.8.4.A of the Ontario Building Code (OBC) 2012.

Soils underlying the subject site are not susceptible to liquefaction. Reference should be made to the latest revision of the Ontario Building Code 2012 for a full discussion of the earthquake design requirements.

5.5 Basement Slab / Slab-on-Grade Construction

With the removal of all topsoil and deleterious fill within the footprints of the proposed buildings, the native soils or bedrock surface will be considered an acceptable subgrade upon which to commence backfilling for floor slab construction.

Any soft areas should be removed and backfilled with appropriate backfill material. OPSS Granular B Types I or II, with a maximum particle size of 50 mm, are recommended for backfilling below the floor slabs (outside the zones of influence of the footings).

It is recommended that the existing fill layer, free of deleterious and organic materials, be proof-rolled several times and approved by the geotechnical consultant at the time of construction.

For structures with basement slabs, it is recommended that the upper 200 mm of subfloor fill consists of 19 mm clear crushed stone. For any structures with slab-on-grade construction, the upper 200 mm of sub-slab fill is recommended to consist of OPSS 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 a minimum of 98% of the SPMDD.

5.6 Pavement Design

Driveways, local residential roadways, and roadways with bus traffic are anticipated at this site. The proposed pavement structures are presented in Tables 5 to 7 below.

Table 5 – Recommended Pavement Structure – Driveways and at-grade car 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 6 – Recommended Pavement Structure – Local Residential Roadways

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

Table 7 – Recommended Pavement Structure – Arterial Roadways with Bus Traffic

Thickness (mm)	Material Description
40	**Wear Course –** HL-3 or Superpave 12.5 Asphaltic Concrete
50	**Upper Binder Course –** HL-8 or Superpave 19.0 Asphaltic Concrete
50	**Lower Binder Course –** HL-8 or Superpave 19.0 Asphaltic Concrete
150	**BASE –** OPSS Granular A Crushed Stone
600	**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.	

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. Weak subgrade conditions may be experienced over service trench fill materials. This may require the use of geotextile, thicker subbase or other measures that can be recommended at the time of construction as part of the field observation program.

If bedrock is encountered at the subgrade level, the total thickness of the pavement granular materials (base and subbase) could be reduced to 300 mm. The upper 300 mm of the bedrock surface should be reviewed and approved by Paterson prior to placing the base and subbase materials. Care should be exercised to ensure that the bedrock subgrade does not have depressions that will trap the water.

Minimum Performance Graded (PG) 58-34 asphalt cement should be used for this project. For residential driveways and car only parking areas, an Ontario Traffic Category A will be used. For local roadways, an Ontario traffic Category B should be used for design purposes.

The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 99% of the material's SPMDD using suitable compaction equipment.

Pavement Structure Drainage

Satisfactory performance of the pavement structure is largely dependent on 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 load carrying capacity.

Where silty clay is anticipated at subgrade level, consideration should be given to installing subdrains during the pavement construction as per City of Ottawa standards. The subdrain inverts should be approximately 300 mm below subgrade level. The subgrade surface should be crowned to promote water flow to drainage lines.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

Foundation Drainage

A perimeter foundation drainage system is recommended for each proposed structure. Each system should consist of a 100 to 150 mm diameter, geotextile-wrapped, perforated and corrugated plastic pipe which is surrounded by 150 mm of 19 mm clear crushed stone, and placed at the footing level around the exterior perimeter of each structure. Each pipe should have a positive outlet, such as gravity connection to the storm sewer.

Foundation Backfill

Backfill against the exterior sides of the foundation walls should consist of free draining, non-frost susceptible granular materials. The site excavated materials will be frost susceptible and, as such, are not recommended for re-use as backfill unless a composite drainage system (such as system Miradrain G100N or Delta Drain 6000) connected to a drainage system is provided. Imported granular materials, such as clean sand or OPSS Granular B Type I granular material should otherwise be used for this purpose.

6.2 Protection of Footings Against Frost Action

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

Exterior unheated footings, such as for isolated piers, are more prone to deleterious movement associated with frost action. These should be provided with a minimum 2.1 m thick soil cover, or an equivalent combination of soil cover and foundation insulation.

However, foundations which are founded directly on clean, surface-sounded bedrock with no cracks or fissures, and which is approved by Paterson at the time of construction, is not considered frost susceptible and does not require soil cover.

Where the bedrock is considered frost susceptible and the soil cover is less than recommended in the preceding paragraphs, foundation insulation will need to be provided, or the frost susceptible bedrock will need to be removed and replaced with lean concrete (minimum 17 MPa 28-day strength).

6.3 Excavation Side Slopes

The side slopes of shallow excavations anticipated at this site should either be cut back at acceptable slopes or retained by shoring systems from the start of the excavation until the structure is backfilled. It is anticipated that sufficient room will be available for the greater part of the excavation to be undertaken by open-cut methods (i.e., unsupported excavations).

Unsupported Excavations

The excavation side slopes above the groundwater level extending to a maximum depth of approximately 3 m should be stable cut back at 1H:1V. Flatter slopes could be required for deeper excavations or for excavations below the groundwater level. Where such side slopes are not permissible or practical, temporary shoring systems should be used.

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.

Excavation side slopes around the building excavation should be protected from erosion by surface water and rainfall events by the use of secured tarpaulins spanning the length of the side slopes, or other means of erosion protection along their footprint. Efforts should also be made to maintain dry surfaces at the bottom of the excavation footprints and along the bottom of side slopes. Additional measures may be recommended at the time of construction by the geotechnical consultant.

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 and Standard Detail Drawings from the Department of Public Works and Services, Infrastructure Services Branch of the City of Ottawa.

The pipe bedding for sewer and water pipes placed on a relatively dry, undisturbed subgrade surface should consist of at least 150 mm of OPSS Granular A material. Where the bedding is located within the silty clay or bedrock, the thickness of the bedding material should be increased to a minimum of 300 mm. 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 or Granular B Type II with a maximum size of 25 mm. The bedding and cover materials should be placed in maximum 225 mm thick lifts compacted to 99% of the material's standard Proctor maximum dry density.

It should generally be possible to re-use the upper portion of the dry to moist (not wet) silty clay above the cover material if the excavation and filling operations are carried out in dry weather conditions. 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 reused. Any stones greater than 200 mm in their longest dimension should be removed from these materials prior to placement.

Well fractured bedrock should be acceptable as backfill for the lower portion of the trenches when the excavation is within bedrock provided the rock fill is placed only from at least 300 mm above the top of the service pipe and that all stones are 300 mm or smaller in their longest dimension.

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 potential differential frost heaving. The backfill should be placed in maximum 225 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

Based on our observations, it is anticipated that groundwater infiltration into the excavations should be low to moderate and controllable using open sumps. 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.

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 using 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 low to slightly aggressive corrosive environment.

6.8 Landscaping Considerations

Tree Planting Restrictions

Paterson completed a soils review of the site to determine the applicable tree planting setbacks, in accordance with the City of Ottawa Tree Planting in Sensitive Marine Clay Soils (2017 Guidelines). Atterberg limits testing was completed for recovered silty clay samples, where silty clay was encountered at the site. Sieve analysis testing was also completed on a selected soil sample. The above-noted test results were completed on samples taken at depths between the anticipated underside of footing elevation and a 3.5 m depth below finished grade. The results of our testing are presented in Tables 1 and 2 in Section 4.2 and in Appendix 1.

Based on the results of our review, where silty clay was encountered at test pit TP 6-21, the plasticity index was found to be less than 40%. In addition, based on the clay content found in the clay samples from the grain size distribution test results, the silty clay across the subject site is considered low to medium sensitivity clay and is not considered a sensitive marine clay.

The following tree planting setbacks are recommended for the low to medium sensitivity silty clay deposit, where silty clay was encountered. The specific limits of the tree planting setbacks are shown on Drawing PG6087-3 - Tree Planting Setback Plan. It should be noted that footings bearing upon a compact glacial till deposit or surface sounded bedrock, which is the case for the majority of the site, will not be subject to tree planting setback restrictions.

Large trees (mature height over 14 m) can be planted within the silty clay areas provided a tree to foundation setback equal to the full mature height of the tree can be provided (e.g., in a park or other green space). Tree planting setback limits may be reduced to **4.5 m** for small (mature height up to 7.5 m) and medium size trees (mature tree height 7.5 to 14 m), provided that the conditions noted below are met.

❒ The underside of footing (USF) is 2.1 m or greater below the lowest finished grade must be satisfied for footings within 10 m from the tree, as measured from the centre of the tree trunk and verified by means of the Grading Plan as indicated procedural changes below.

❒ A small tree must be provided with a minimum 25 m^3 of available soil volume while a medium tree must be provided with a minimum of 30 m^3 of available soil volume, as determined by the Landscape Architect. The developer is to ensure that the soil is generally un-compacted when backfilling in street tree planting locations.

- ☐ The tree species must be small (mature tree height up to 7.5 m) to medium size (mature tree height 7.5 m to 14 m) as confirmed by the Landscape Architect.

- ☐ The foundation walls are to be reinforced at least nominally (minimum of two upper and two lower 15M bars in the foundation wall).

- ☐ Grading surrounding the tree must promote drainage to the tree root zone (in such a manner as not to be detrimental to the tree).

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.

Aboveground Swimming Pools

The in-situ soils are considered to be acceptable for swimming pools. Above ground swimming pools must be placed at least 4 m away from the residence foundation and neighboring foundations. Otherwise, pool construction is considered routine, and can be constructed in accordance with the manufacturer`s requirements.

Aboveground Hot Tubs

Additional grading around hot tubs 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.

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.

- Complete additional test pits once the trees have been cleared from the site.
- Review detailed grading plan(s) from a geotechnical perspective.
- Observation of all bearing surfaces prior to the placement of concrete.
- 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 placing backfilling material.
- Sampling and testing of the concrete and fill materials.
- Observation of clay seal placement at specified locations.
- Field density tests to determine the level of compaction achieved.
- Sampling and testing of the bituminous concrete including mix design reviews.

All excess soils must be handled as per *Ontario Regulation 406/19: On-Site and Excess Soil Management*.

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 are in accordance with the present understanding of the project. Paterson requests permission to review the recommendations when the drawings and specifications are completed.

A soils investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from those at the test locations, Paterson requests 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 the 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 CRT Developments Inc. 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. 16, 2022
S. S. DENNIS
100519516
Scott Dennis
PROVINCE OF ONTARIO

Scott Dennis

Fernanda Carozzi, PhD. Geoph.

Scott S. Dennis, P.Eng.

Report Distribution:

☐ CRT Developments Inc. (e-mail copy)
☐ Paterson Group (1 copy)

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

GRAIN-SIZE DISTRIBUTION AND HYDROMETER TESTING RESULTS

ATTERBERG LIMIT TESTING RESULTS

SHRINKAGE TESTING RESULTS

ANALYTICAL TESTING RESULTS

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Westwood Development - Phase 4 - Fernbank Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

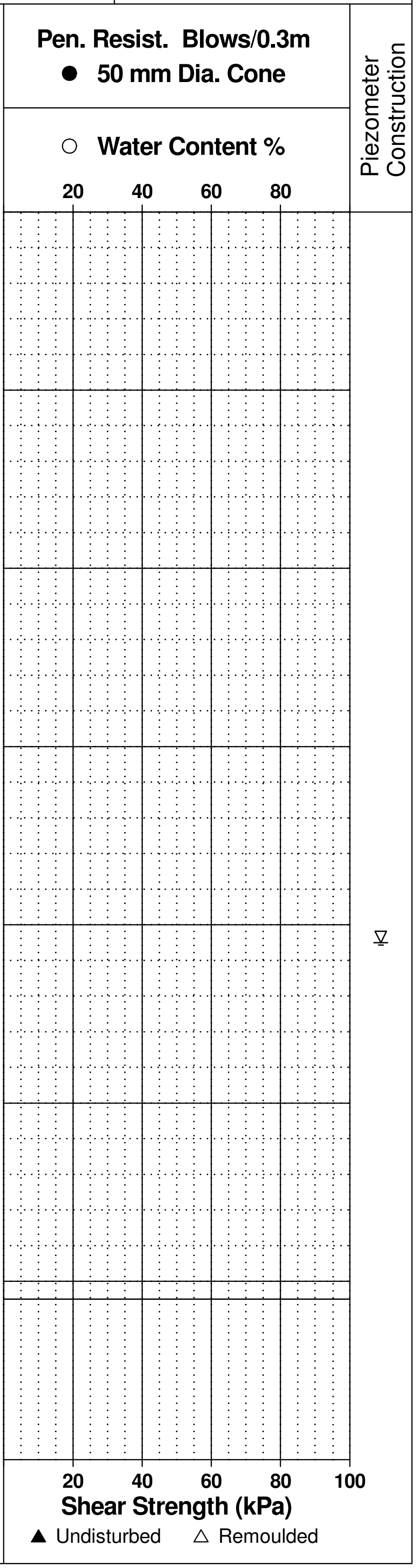
BORINGS BY Excavator

DATE December 9, 2021

FILE NO. PG6087

HOLE NO. TP 1-21

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	106.75
	▨	G	1				
FILL: Brown silty sand to sandy silt with gravel, occasional cobbles and boulders	▨					1	105.75
- grey by 0.9m depth	▨	G	2				
	▨					2	104.75
	▨	G	3				
2.50							
	▨	G	4			3	103.75
	▨	G	5				
	▨					4	102.75
FILL: Blast rock with some sand	▨					5	101.75
	▨					6	100.75
6.10							
End of Test Pit (Groundwater infiltration at 4.1m depth)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Westwood Development - Phase 4 - Fernbank Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Excavator

DATE December 9, 2021

FILE NO. PG6087

HOLE NO. TP 2-21

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % 20 40 60 80	Piezometer Construction
GROUND SURFACE						0	107.97		
TOPSOIL 0.40		G	1						
Poor to good quality **BEDROCK** 0.50		G	2						
End of Test Pit (TP dry upon completion)									

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
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DATUM Geodetic

REMARKS

BORINGS BY Excavator

DATE December 9, 2021

FILE NO. PG6087

HOLE NO. TP 3-21

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % 20 40 60 80	Piezometer Construction
GROUND SURFACE						0	107.48		
TOPSOIL 0.40	■	☒ G	1						
End of Test Pit TP terminated on bedrock surface at 0.40m depth (TP dry upon completion)									

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

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Westwood Development - Phase 4 - Fernbank Road
Ottawa, Ontario

DATUM Geodetic

FILE NO. PG6087

REMARKS

HOLE NO. TP 4-21

BORINGS BY Excavator

DATE December 9, 2021

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0	107.14	
TOPSOIL 0.50	■	⧖ G	1					
GLACIAL TILL: Compact to dense, brown silty sand to sandy silt with gravel, cobbles and boulders, trace clay 1.10	^^^	⧖ G	2			1	106.14	
End of Test Pit TP terminated on bedrock surface at 1.10m depth (TP dry upon completion)								

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

○ Water Content %

20 40 60 80

20 40 60 80 100
Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Westwood Development - Phase 4 - Fernbank Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Excavator

DATE December 9, 2021

FILE NO. PG6087

HOLE NO. TP 5-21

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	105.87		
TOPSOIL		G	1						
0.50									
GLACIAL TILL: Compact to dense, brown silty sand to sandy silt with clay, gravel, cobbles and boulders						1	104.87		
		G	2						
- grey by 2.1m depth						2	103.87		▽
		G	3						
						3	102.87		
3.40									

End of Test Pit

TP terminated on bedrock surface at 3.40m depth.

(Groundwater infiltration at 2.1m depth)

Water Content %: 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Westwood Development - Phase 4 - Fernbank Road
Ottawa, Ontario

DATUM Geodetic

FILE NO. **PG6087**

REMARKS

HOLE NO. **TP 6-21**

BORINGS BY Excavator

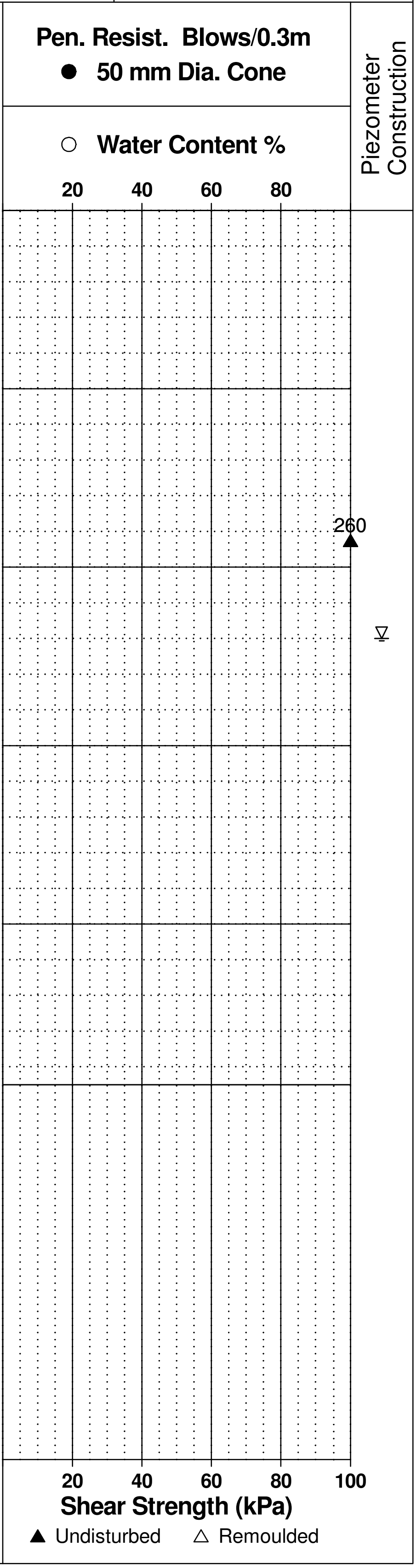
DATE December 9, 2021

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	105.24
TOPSOIL		G	1				
0.60							
		G	2			1	104.24
Hard to very stiff, brown **SILTY CLAY**							
						2	103.24
		G	3				
2.40							
Hard, brown **SILT**						3	102.24
		G	4				
3.85							
						4	101.24
GLACIAL TILL: Compact to dense, grey clayey silt to silty clay with sand, gravel, cobbles and boulders							
4.90		G	5				

End of Test Pit

Practical refusal to excavation on boulders at 4.90m depth

(Groundwater infiltration at 2.4m depth)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Westwood Development - Phase 4 - Fernbank Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Excavator

DATE December 9, 2021

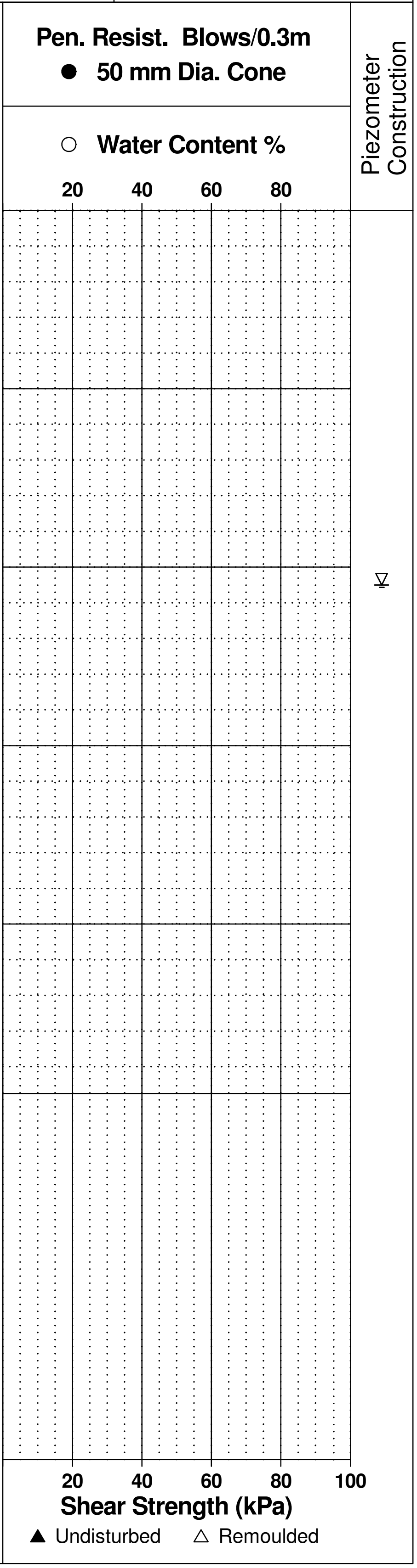
FILE NO. PG6087

HOLE NO. TP 7-21

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	105.81
TOPSOIL	G	1				
0.60						
					1	104.81
	G	2				
					2	103.81
	G	3				
GLACIAL TILL: Compact to dense, brown silty sand with gravel, cobbles and boulders, some clay						
					3	102.81
- grey by 3.9m depth					4	101.81
	G	4				
4.95						
End of Test Pit						

Practical refusal to excavation on boulders at 4.95m depth.

(Groundwater infiltration at 2.1m depth)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Westwood Development - Phase 4 - Fernbank Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Excavator

DATE December 9, 2021

FILE NO. PG6087

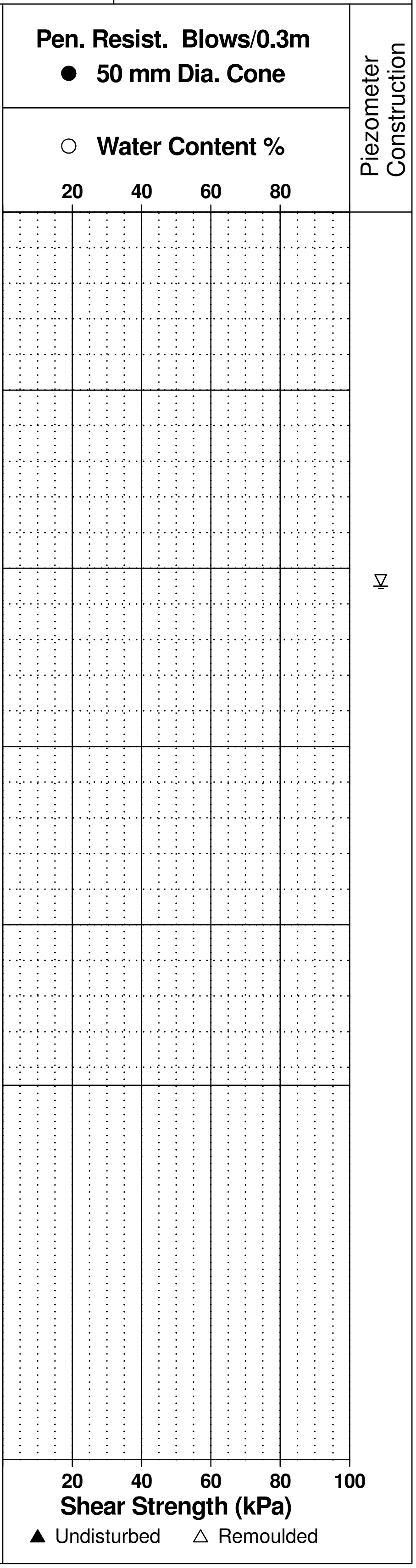
HOLE NO. TP 8-21

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	105.21
TOPSOIL 0.60		G	1				
GLACIAL TILL: Loose to dense, browns ilty sand with gravel, cobbles and boulders, trace clay		G	2			1	104.21
		G	3			2	103.21
		G	4			3	102.21
						4	101.21
4.90		G	5				

End of Test Pit

Practical refusal to excavation on boulders at 4.90m depth.

(Groundwater infiltration at 2.1m depth)



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)

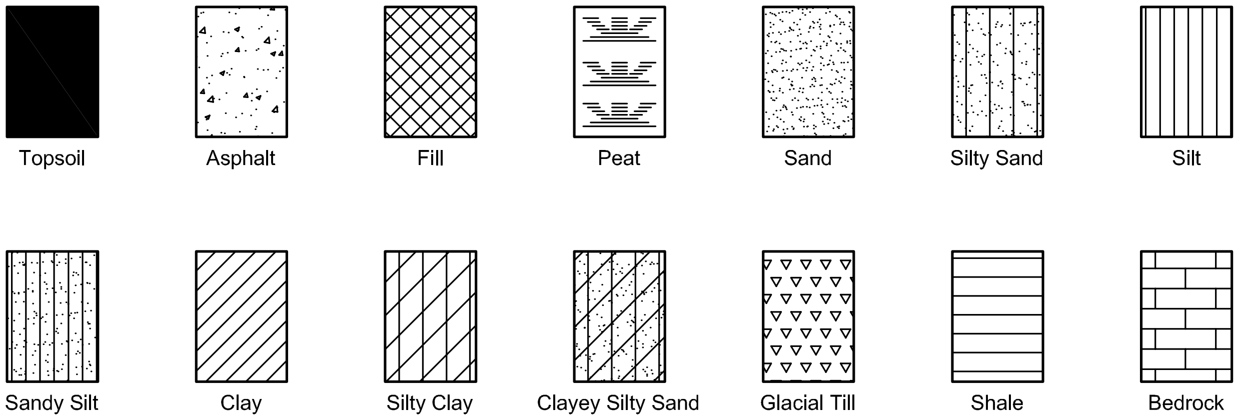
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

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.

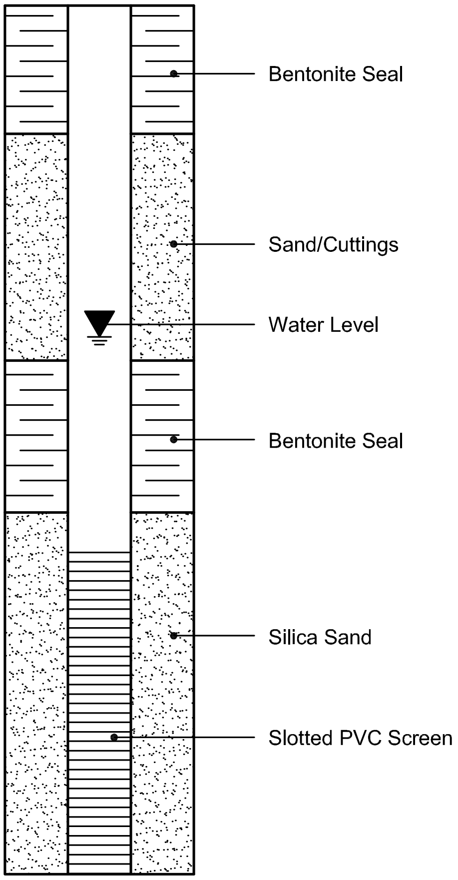
SYMBOLS AND TERMS (continued)

STRATA PLOT

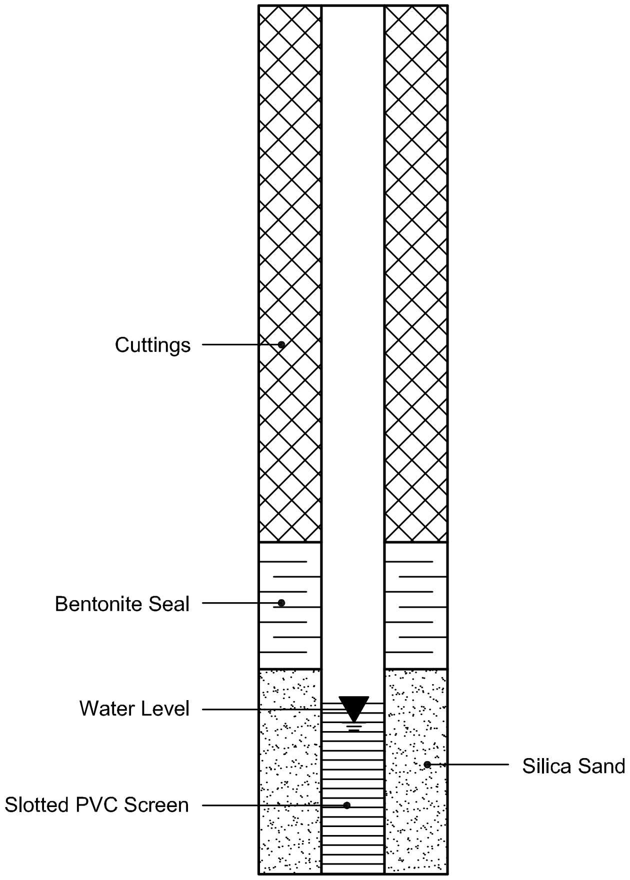


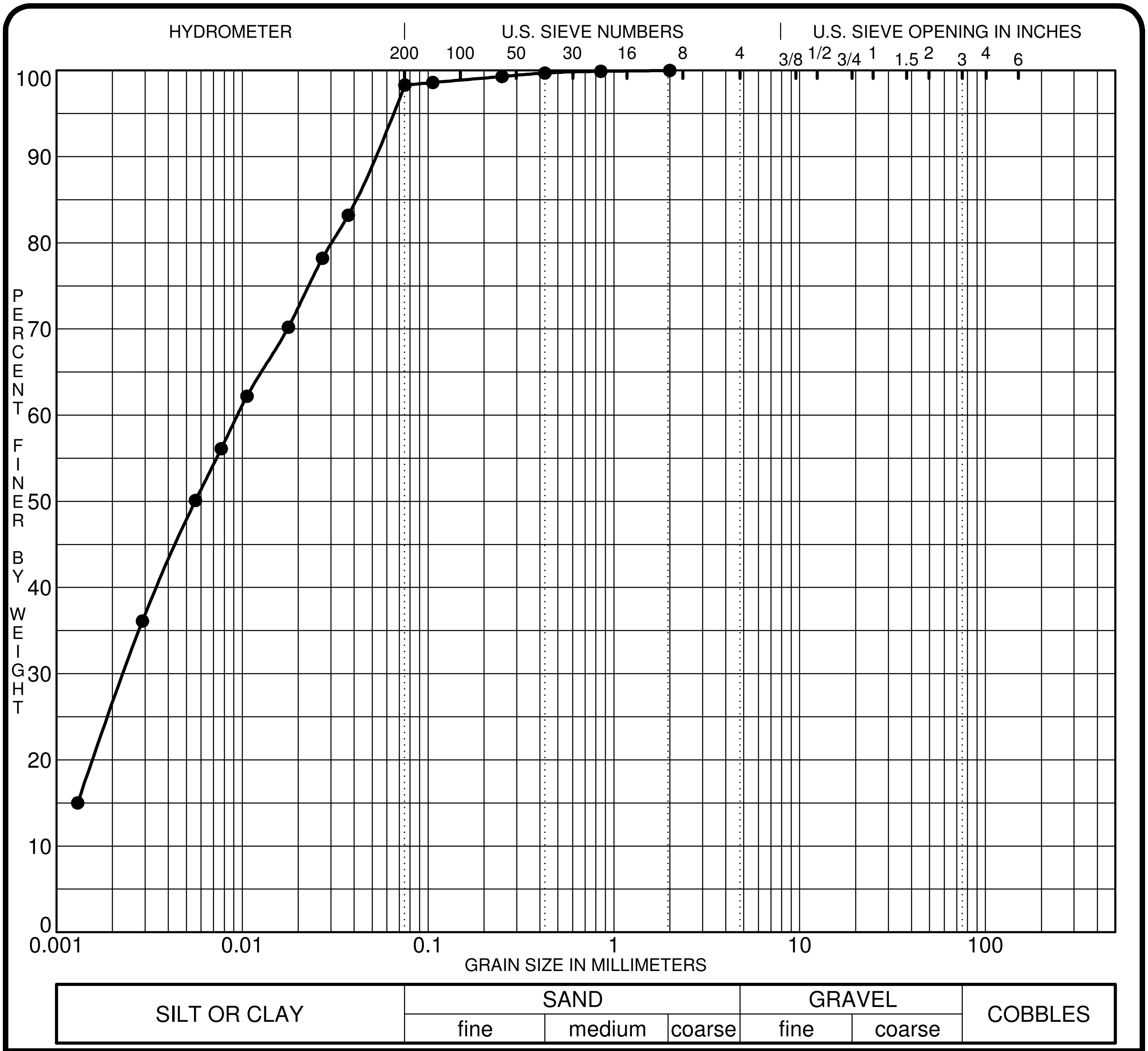
MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION





	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	**TP 6-21**	**G3**	**CH - Inorganic clays of high plasticity**						
☒									
▲									
★									

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**TP 6-21**	**G3**	**2.00**	**0.01**	**0.002**		**0.0**	**1.7**	**98.3**	
☒										
▲										
★										

CLIENT **CRT Developments Inc.**

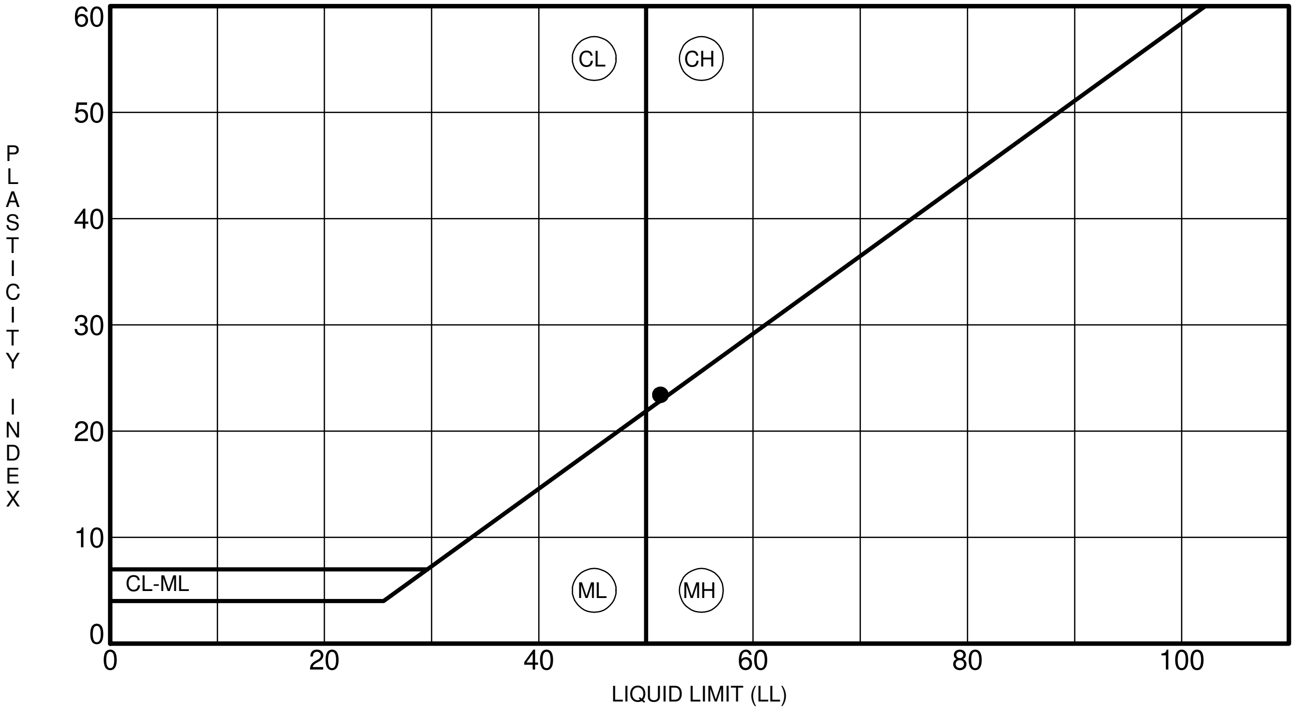
PROJECT **Geotechnical Investigation - Westwood**
Development - Phase 4 - Fernbank Road

FILE NO. **PG6087**

DATE **9 Dec 21**

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

GRAIN SIZE DISTRIBUTION



	Specimen Identification		LL	PL	PI	Fines	Classification
●	**TP 6-21**	**G2**	**51**	**28**	**23**		**CH - Inorganic clays of high plasticity**

CLIENT **CRT Developments Inc.**

FILE NO. **PG6087**

PROJECT **Geotechnical Investigation - Westwood Development - Phase 4 - Fernbank Road**

DATE **9 Dec 21**

patersongroup **Consulting Engineers**

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

ATTERBERG LIMITS' RESULTS

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Linear Shrinkage
ASTM D4943-02

CLIENT:	CRT Development	DEPTH	-	FILE NO.:	PG6087
PROJECT:	Westwood Kanata	BH OR TP No:	TP6-21 GS2	DATE SAMPLED	14-Dec
LAB No:	31446	TESTED BY:	DJ / CP / CS	DATE RECEIVED	15-Dec
SAMPLED BY:	PB	DATE REPORTED:	22-Dec-21	DATE TESTED	16-Dec

LABORATORY INFORMATION & TEST RESULTS

Moisture	**No. of Blows(4)**	**Calibration (Two Trials)**	**Tin NO.(x24)**	
Tare	4.99	Tin	4.84	4.84
Soil Pat Wet + Tare	67.93	Tin + Grease	4.99	4.99
Soil Pat Wet	62.94	Glass	48.97	48.97
Soil Pat Dry + Tare	43.55	Tin + Glass + Water	91.36	91.32
Soil Pat Dry	38.56	Volume	37.40	37.36
Moisture	**63.23**	**Average Volume**	**37.38**	

Soil Pat + String	38.74
Soil Pat + Wax + String in Air	40.8
Soil Pat + Wax + String in Water	15.83
Volume Of Pat (Vdx)	24.97

RESULTS:

Shrinkage Limit	**25.04**
Shrinkage Ratio	**1.702**
Volumetric Shrinkage	**64.994**
Linear Shrinkage	**15.371**

REVIEWED BY:	**Curtis Beadow**	**Joe Forsyth, P. Eng.**

Certificate of Analysis

Client: Paterson Group Consulting Engineers

Client PO: 33218

Report Date: 15-Dec-2021

Order Date: 10-Dec-2021

Project Description: PG6087

	Client ID:	TP5-21 GS2 (1.2-1.3m)	-	-	-
	Sample Date:	09-Dec-21 09:00	-	-	-
	Sample ID:	2150554-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	86.8	-	-	-
General Inorganics					
pH	0.05 pH Units	7.34	-	-	-
Resistivity	0.10 Ohm.m	74.5	-	-	-
Anions					
Chloride	5 ug/g dry	7	-	-	-
Sulphate	5 ug/g dry	12	-	-	-

APPENDIX 2

FIGURE 1 – KEY PLAN

DRAWING PG6087-1 – TEST HOLE LOCATION PLAN

DRAWING PG6087-2 – PERMISSIBLE GRADE RAISE PLAN

DRAWING PG6087-3 – TREE PLANTING SETBACK RECOMMENDATIONS

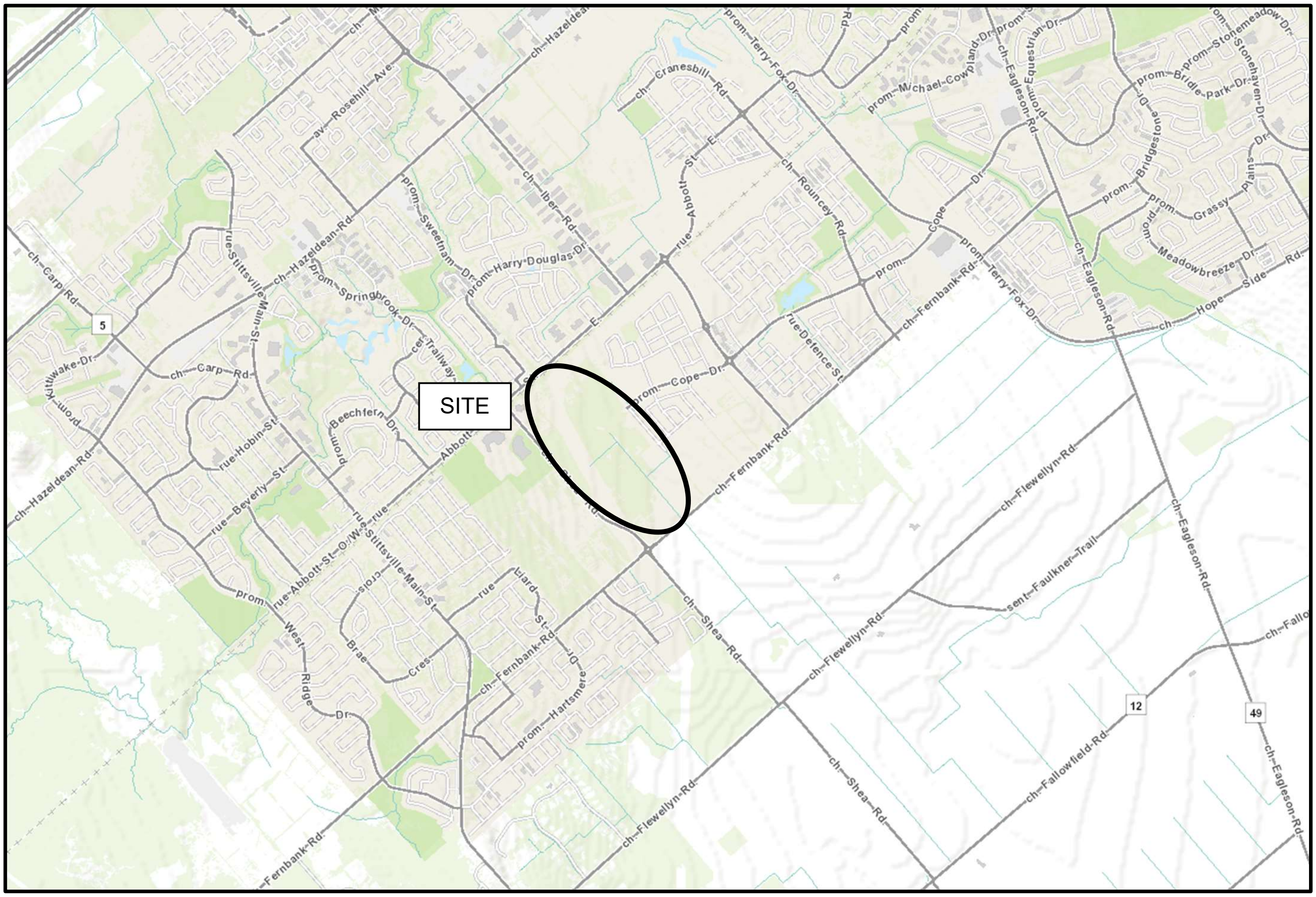

FIGURE 1

KEY PLAN

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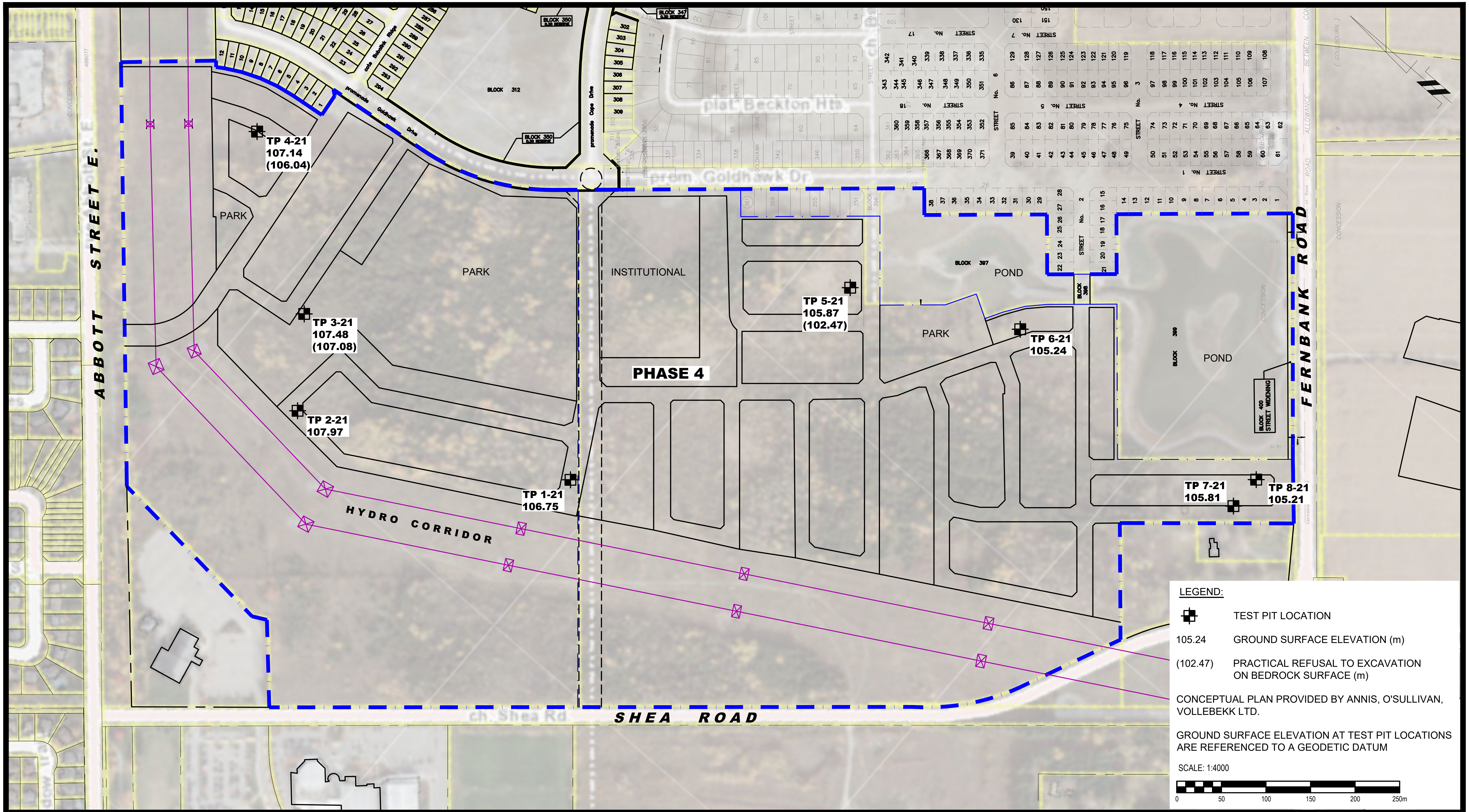

LEGEND:

✚	TEST PIT LOCATION
105.24	GROUND SURFACE ELEVATION (m)
(102.47)	PRACTICAL REFUSAL TO EXCAVATION ON BEDROCK SURFACE (m)

CONCEPTUAL PLAN PROVIDED BY ANNIS, O'SULLIVAN, VOLLEBEKK LTD.

GROUND SURFACE ELEVATION AT TEST PIT LOCATIONS ARE REFERENCED TO A GEODETIC DATUM

SCALE: 1:4000

0 50 100 150 200 250m

patersongroup
consulting engineers

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

NO.	REVISIONS	DATE	INITIAL

CRT DEVELOPMENTS INC.

GEOTECHNICAL INVESTIGATION
WESTWOOD DEVELOPMENT - PHASE 4 - FERNBANK ROAD

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:4000	Date: 02/2022
Drawn by: YA	Report No.: PG6087-1
Checked by: FC	Dwg. No.: PG6087-1
Approved by: SD	Revision No.:

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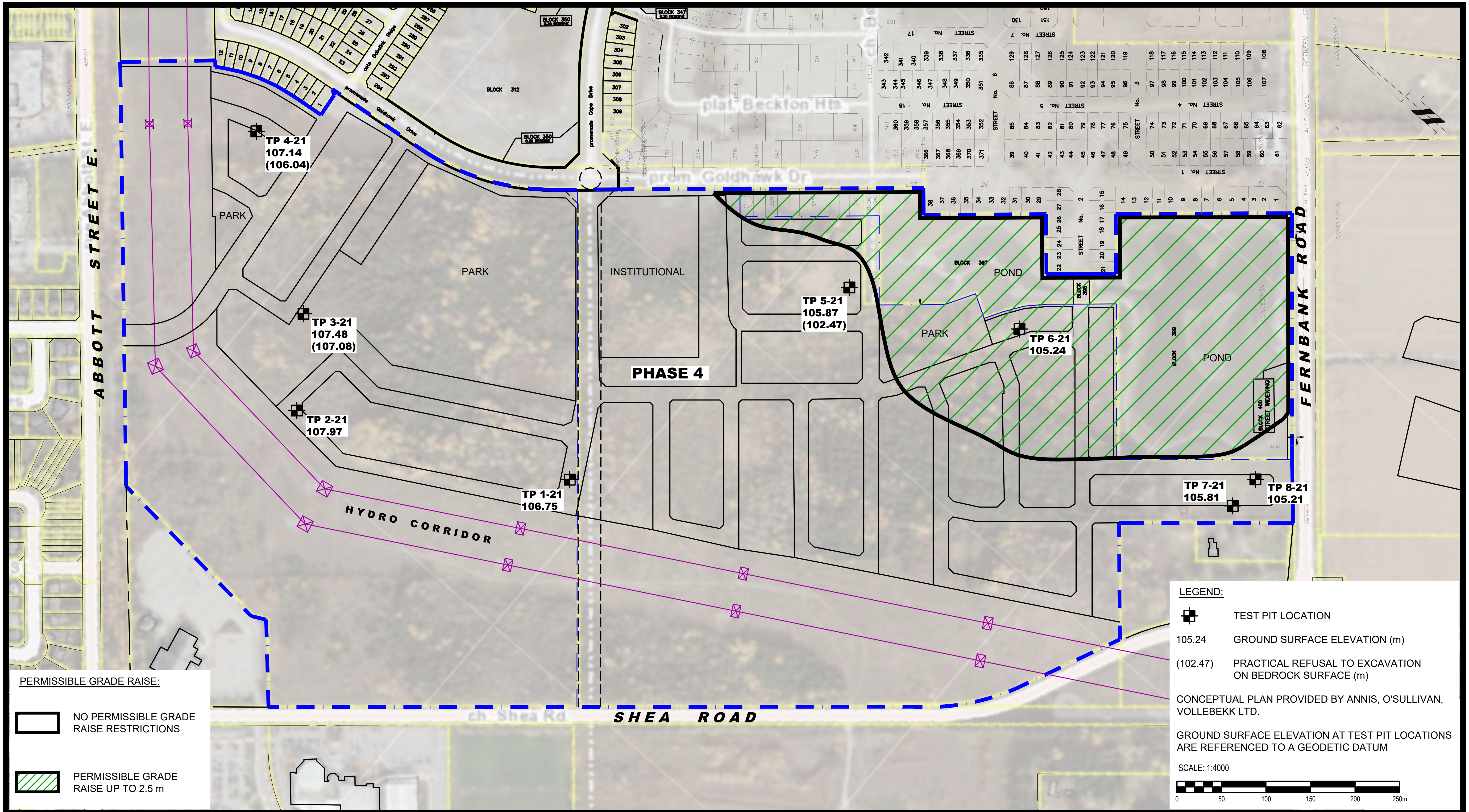

PERMISSIBLE GRADE RAISE:

☐	NO PERMISSIBLE GRADE RAISE RESTRICTIONS
▨	PERMISSIBLE GRADE RAISE UP TO 2.5 m

LEGEND:

✚	TEST PIT LOCATION
105.24	GROUND SURFACE ELEVATION (m)
(102.47)	PRACTICAL REFUSAL TO EXCAVATION ON BEDROCK SURFACE (m)

CONCEPTUAL PLAN PROVIDED BY ANNIS, O'SULLIVAN, VOLLEBEKK LTD.

GROUND SURFACE ELEVATION AT TEST PIT LOCATIONS ARE REFERENCED TO A GEODETIC DATUM

SCALE: 1:4000

0 50 100 150 200 250m

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CRT DEVELOPMENTS INC.

GEOTECHNICAL INVESTIGATION
WESTWOOD DEVELOPMENT - PHASE 4 - FERNBANK ROAD

OTTAWA, ONTARIO

Title:

PERMISSIBLE GRADE RAISE PLAN

Scale: 1:4000	Date: 02/2022
Drawn by: YA	Report No.: PG6087-1
Checked by: FC	Dwg. No.: PG6087-2
Approved by: SD	Revision No.:

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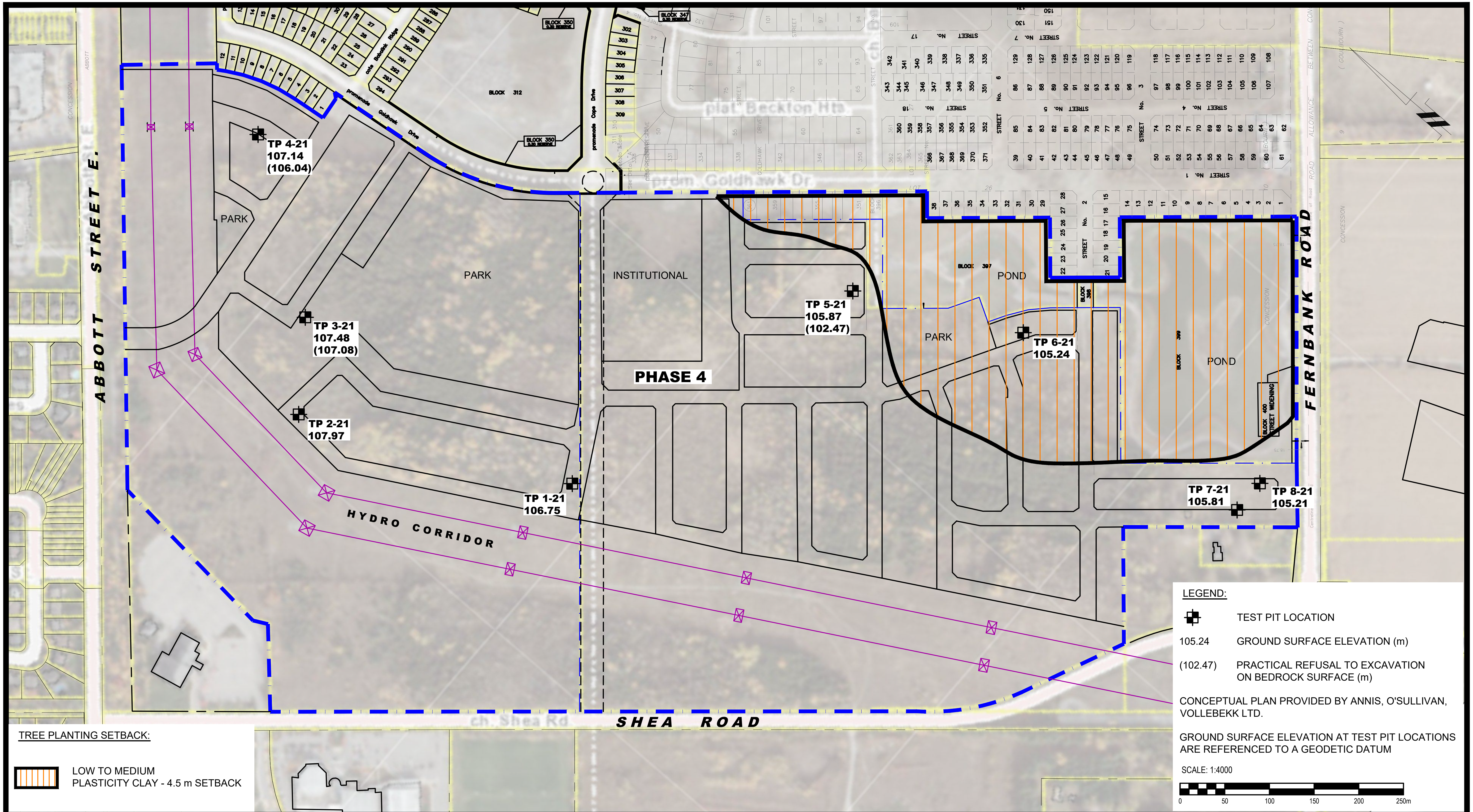

TREE PLANTING SETBACK:

▥	LOW TO MEDIUM PLASTICITY CLAY - 4.5 m SETBACK

LEGEND:

⌖	TEST PIT LOCATION
105.24	GROUND SURFACE ELEVATION (m)
(102.47)	PRACTICAL REFUSAL TO EXCAVATION ON BEDROCK SURFACE (m)

CONCEPTUAL PLAN PROVIDED BY ANNIS, O'SULLIVAN, VOLLEBEKK LTD.

GROUND SURFACE ELEVATION AT TEST PIT LOCATIONS ARE REFERENCED TO A GEODETIC DATUM

SCALE: 1:4000

0 50 100 150 200 250m

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Ottawa, Ontario K2E 7J5
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CRT DEVELOPMENTS INC.

GEOTECHNICAL INVESTIGATION
WESTWOOD DEVELOPMENT - PHASE 4 - FERNBANK ROAD

OTTAWA, ONTARIO

Title:

TREE PLANTING SETBACK RECOMMENDATIONS

Scale: 1:4000	Date: 02/2022
Drawn by: YA	Report No.: PG6087-1
Checked by: FC	Dwg. No.: PG6087-3
Approved by: SD	Revision No.:

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