Geotechnical Investigation

Proposed Residential Development

Arcadia – Stage 6
Campeau Drive - Ottawa

Prepared for Minto Communities

Report: PG5648-1 Revision 4 dated June 30, 2022

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1.0 Introduction

Paterson Group (Paterson) was commissioned by Minto Communities to conduct a geotechnical investigation for Stage 6 of the Arcadia Development on Campeau Drive, 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 pits.
- ❑ Provide geotechnical recommendations pertaining to the 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.

2.0 Proposed Development

It is understood that Stage 6 of the proposed development will consist of townhouses, condominiums, residential dwellings with attached garages, underground parking, associated driveways, garage access ramps, local roadways and landscaping areas.

It is further understood that blocks which consist of one-level basement for underground parking are located at the north portion and the northeast portion of the site. In accordance with what is known, the proposed development will be serviced by future municipal water, sanitary and storm services.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field program for the current geotechnical investigation was carried out on December 17, 2020 and consisted of advancing a total of eight (8) boreholes to a maximum depth of 6.7 m below existing ground surface. The test hole locations were distributed in a manner to provide general coverage of the subject site and taking into consideration underground utilities and site features. Multiple historical geotechnical investigations were completed within the subject site by this firm between 2005 and 2013. The current test holes locations along with the relevant historical test hole locations are shown on Drawing PG5648-1 - Test Hole Location Plan included in Appendix 2.

The current test holes were completed using a low clearance drill rig operated by a two-person crew. All fieldwork was conducted under the full-time supervision of Paterson personnel under the direction of a senior engineer. The drilling procedure consisted of drilling to the required depths at the selected locations, and sampling and testing the overburden.

Sampling and In Situ Testing

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

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

Undrained shear strength testing was conducted in cohesive soils using a field vane apparatus.

The thickness of the sensitive silty clay deposit was evaluated by a dynamic cone penetration testing (DCPT) completed at BH 4-20. The DCPT consists of driving a steel drill rod, equipped with a 50 mm diameter cone at the tip, using a 63.5 kg hammer falling from a height of 760 mm. The number of blows required to drive the cone into the soil is recorded for each 300 mm increment.

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 in Appendix 1 of this report.

Sample Storage

All samples will be stored in the laboratory for a period of one (1) month after the issuance of this report. They will then be discarded unless we are otherwise directed.

Groundwater

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

3.2 Field Survey

The test hole locations were selected by Paterson to provide general coverage of the proposed development, taking into consideration the existing site features and underground utilities. The test hole locations and ground surface elevation at each test hole location were surveyed by Paterson personnel using a high precision handheld GPS and referenced to a geodetic datum. The location of the test holes and ground surface elevation at each test hole location are presented on Drawing PG5648-1 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

The soil samples recovered from the subject site were examined in our laboratory to review the results of the field logging.

A total of three (3) soil samples collected during our investigations were submitted for grain size distribution analysis and hydrometer testing. The grain size distribution and hydrometer testing results are presented in Table 1 - Grain Size Distribution and in Appendix 1, and are further discussed in Section 4.

A total of five (5) representative soil samples were submitted for Atterberg limit testing during our investigations. The results of the Atterberg limit testing are presented in Table 2 - Summary of Atterberg Limits and in Appendix 1, and are further discussed in Sections 4 and 6.

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.

3.4 Analytical Testing

One (1) soil sample was submitted for analytical testing to assess the corrosion potential for exposed ferrous metals and the potential of sulphate attacks against subsurface concrete structures. The sample was 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 Subsection 6.8.

4.0 Observations

4.1 Surface Conditions

The majority of the subject site is currently undeveloped with a gravel road crossing the site from the center to the west and north property lines. Generally, the ground surface across the subject site slopes down towards the east and north with an elevation difference of 2 to 2.5 m. It was also noted that multiple topsoil fill piles varying in height between 3 and 7.5 m were scattered across the subject site. Based on field observations and the attached aerial photographs (Figure 12 to 14), it is expected that the majority of the topsoil layer across the subject site was recently stripped and stockpiled within the aforementioned fill piles. The approximate locations and heights of the stripped topsoil piles are presented in Drawing PG5648-1 - Test Hole Location Plan in Appendix 1.

Based on historical information gathered between 2005 and the present time, it has been determined that the subject site has been in-filled with site excavated material from the previous stages (1 through 4). The fill thickness ranges from 1 to 3.5 m placed and compacted above the original ground surface. Further discussion on the fill is summarized in Subsection 4.2.

The subject site is bordered to the north by the future extension of Campeau Drive followed by Arcadia Stage 5, to the east by an agricultural land which is the future location of a storm water management pond, to the south by Feedmill creek and to the west by a future development stage.

4.2 Subsurface Profile

Overburden

It is understood that the topsoil layer was recently stripped from the majority of Stage 6 of the subject site. The subsurface profile encountered at the test hole locations generally consists of a fill layer overlying a very stiff to stiff brown silty clay layer and a stiff to firm grey silty clay deposit. The fill generally consists of silty sand and/or silty clay with sand, gravel, cobbles and organic matter. The fill thickness was observed to range from 1.5 m and up to 3 m below existing grade. Practical refusal to DCPT was encountered in BH 4-20 on inferred bedrock at a depth of 21m below existing ground surface.

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

Bedrock

Based on available geological mapping, the underlying bedrock consists of interbedded limestone and shale of the Verulam formation with an anticipated overburden thickness of 10 to 25 m.

Grain Size Distribution and Hydrometer Testing Results

The results of the three (3) soil samples submitted for grain size analysis and hydrometer testing are summarized in Table 1.

Table 1 - Grain Size Distribution				
Test Hole	**Sample**	**Gravel (%)**	**Sand (%)**	**Silt and Clay (%)**
BH 1-20	SS2	1.2	13.8	85
BH 1-20	SS6	0	1.9	98.1
BH 8-20	SS2	0	5.1	94.9

Atterberg Limit Testing Results

Five (5) silty clay samples were submitted for Atterberg Limits testing during the course of the investigation. The results are summarized in Table 2 below and on the Atterberg Limits results sheets in Appendix 1.

Table 2 - Summary of Atterberg Limits Tests				
Test Hole	**Sample No.**	**Liquid Limit (%)**	**Plastic Limit (%)**	**Plasticity Index (%)**
BH 1-20	SS6	49	22	28
BH 2-20	SS5	45	21	23
BH 4-20	SS4	42	17	25
BH 6-20	SS3	52	22	31
BH 8-20	SS4	69	33	36

Shrinkage Limit Testing Results

The results of the shrinkage testing of BH2 – SS2 resulted in a shrinkage limit of 19.59% with a shrinkage ratio of 1.86.

4.3 Groundwater

Groundwater levels were measured during the current investigation on December 17, 2020 within the installed standpipes. Based on field observations, groundwater levels were recorded during the field program. The measured ground water levels are presented on the Soil Profile and Test Data sheets in Appendix 1.
Long-term groundwater levels can also be estimated based on the observed color and consistency of the recovered soil samples. Based on these observations, the long-term groundwater table can be expected at approximately 3 to 4 m below existing ground surface.

It should be noted that groundwater levels are subject to seasonal fluctuations and therefore could vary during time of construction.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is considered suitable for the proposed development. It is expected that the proposed buildings will be founded over conventional shallow footings placed over an undisturbed stiff to firm brown silty clay bearing surface or engineered fill placed over an undisturbed, brown silty clay bearing surface.

Due to the presence of the sensitive silty clay layer, the proposed development will be subjected to grade raise restrictions. If a higher permissible grade raise is required, preloading with or without surcharge, lightweight fill and/or other measures should be investigated to reduce the risks of unacceptable long-term post construction and differential settlements.

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

5.2 Site Grading and Preparation

Stripping Depth

Topsoil and deleterious fill, such as those containing organic materials, or construction debris/remnants should be stripped from under any buildings, paved areas, pipe bedding and other settlement sensitive structures. Under paved areas, existing construction remnants, such as foundation walls, pipe ducts, etc., should be excavated to a minimum depth of 1 m below final grade.

It is important to note that due to the presence of a 2 to 3 m thick layer of fill overlying the native soils, it is expected that sub-excavation of the existing fill will be required within the footprint of the proposed residential dwellings. Where the fill is free of organic matter, the fill may be left in place provided the fill is reviewed and approved by Paterson at the time of construction.

Where the fill is deemed acceptable, sub-excavation of the existing fill down to the native subgrade will only be required to be completed below the proposed footings including the lateral support zone of each footing. Any fill left in place will be required to be proof-rolled using suitable compaction equipment in dry conditions and above freezing temperatures. The compaction efforts should also be reviewed and approved by Paterson personnel at the time of construction.

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

Non-specified existing fill along with site-excavated soil could be placed as general landscaping fill where 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.

Protection of Subgrade and Bearing Surfaces

It is expected that site grading and preparation will consist of stripping of the soils containing significant amounts of organic materials and existing topsoil piles above design underside of footing elevation. The contractor should take appropriate precautions to avoid disturbing the subgrade and bearing surfaces from construction and worker traffic. Disturbance of the subgrade may result in having to sub-excavate the disturbed material and the placement of additional fill.

5.3 Foundation Design

Protection of Subgrade and Bearing Surfaces

Using continuously applied loads, footings for the proposed buildings placed over an undisturbed stiff silty clay crust, firm grey silty clay or engineered fill placed over an undisturbed silty clay crust bearing surface can be designed using the bearing resistance values presented in Table 3.

Table 3 - Bearing Resistance Values		
Bearing Surface	**Bearing Resistance Value at SLS (kPa)**	**Factored Bearing Resistance Value at ULS (kPa)**
Very Stiff to Stiff Silty Clay Crust	150	225
Firm Grey Silty Clay	75	150
Engineered Fill Over Silty Clay Crust	150	225
Note: Strip footings, up to 2 m wide, and pad footings, up to 5 m wide, placed over a silty clay bearing surface can be designed 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, 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 the in-situ bearing medium soils above the groundwater table when a plane extending down and out from the bottom edge of the footing at a minimum of 1.5H:1V passes only through in situ soil of the same or higher capacity as the bearing medium soil.

Permissible Grade Raise and Settlements

Due to the presence of the silty clay deposit, a permissible grade raise restriction is recommended. The recommended grade raise restrictions are shown on Drawing PG5648-2 - Permissible Grade Raise Plan included in Appendix 2. A post-development groundwater lowering of 0.5 m was considered in our permissible grade raise calculations.

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.

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

The potential post construction total and differential settlements are dependent on the position of the long-term groundwater level when buildings are situated over deposits of compressible silty clay. Efforts can be made to reduce the impacts of the proposed development on the long-term groundwater level by placing clay dykes in the service trenches, reducing the sizes of paved areas, leaving green spaces to allow for groundwater recharge or limiting planting of trees to areas away from the buildings. However, it is not economically possible to control the groundwater level.

To reduce potential long-term liabilities, consideration should be given to accounting for a larger groundwater lowering and to provide means to reduce long term groundwater lowering (e.g. clay dykes, restriction on planting around the dwellings, etc). Buildings on silty clay deposits increases the likelihood of movements and therefore of cracking. The use of steel reinforcement in foundations placed at key structural locations will tend to reduce foundation cracking compared to unreinforced foundations.

5.4 Design for Earthquakes

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

5.5 Basement Floor Slab

With the removal of all topsoil and deleterious fill, containing organic matter, within the footprints of the proposed buildings, undisturbed native soil surface will be considered acceptable subgrade on which to commence backfilling for floor slab construction. Any soft areas should be removed and backfilled with appropriate backfill material. OPSS Granular B Type II, with a maximum particle size of 50 mm, are recommended for backfilling below the floor slab. It is recommended that the upper 200 mm of sub-slab fill consist of 19 mm clear crushed stone.

5.6 Pavement Design

Car only parking areas, local and collector roadways are anticipated at this site. The proposed pavement structures are shown in Tables 4, 5 and 6.

Table 4 - Recommended Pavement Structure - Driveways

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.	

Table 5 - Recommended Pavement Structure - Local Residential Roadways

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

Table 6 - Recommended Pavement Structure - Roadways with Bus Traffic

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

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, which will require the use of a woven geotextile liner, such as Terratrack 200 or equivalent, as well as, an additional 300 to 600 mm thick granular layer, consisting of a 150 mm minus, well graded granular fill or crushed concrete, to provide adequate construction access.

The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 98% of the material's SPMDD using suitable vibratory equipment. Minimum Performance Graded (PG) 58-34 asphalt cement should be used for this project.

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.

Due to the low permeability of the subgrade materials 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 the drainage lines

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

A perimeter foundation drainage system is recommended for proposed structures. The system should consist of a 150 mm diameter, geotextile-wrapped, perforated, corrugated, plastic pipe, surrounded on all sides by 150 mm of 10 mm clear crushed stone, placed at the footing level around the exterior perimeter of the structure. The pipe should have a positive outlet, such as a gravity connection to the storm sewer or sump pit.

Backfill against the exterior sides of the foundation walls should consist of free-draining, non-frost susceptible granular materials. The site materials will be frost susceptible and, as such, are not recommended for re-use as backfill unless placed in conjunction with a composite drainage system (such as system Platon or Miradrain G100N) connected to a drainage system.

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 1.5 m thick soil cover (or equivalent) should be provided in this regard.

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

6.3 Excavation Side Slopes

The excavation for the proposed development will be mostly through a silty clay fill or a native silty clay. Above the groundwater level, for excavations to depths of approximately 3 m, the excavation side slopes should be stable in the short term at 1H:1V. Flatter slopes could be required for deeper excavations or for excavation below the groundwater level. Where such side slopes are not permissible or practical, temporary shoring should be used. The subsoil at this site is considered to be mainly a Type 2 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects.

The slope cross-sections recommended above are for temporary slopes. Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should be kept away from the excavation sides. Slopes in excess of 3 m in height should be periodically inspected by the geotechnical consultant in order to detect if the slopes are exhibiting signs of distress. It is recommended that a trench box approved by a structural engineer 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 City of Ottawa.

It is expected that the invert level of the municipal services will be installed at or below the long-term groundwater level within the native silty clay deposit. Due to the low permeability of the silty clay deposit, it is expected that minimal groundwater infiltration will occur during installation work. It is expected that groundwater infiltration will be handled by suitably sized submersible pumps. Groundwater infiltration is not expected provided that best construction practices are followed for the sewer pipe installation work and that the sewers are installed as per design requirements.

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 firm grey silty clay, the thickness of the bedding material should be increased to a minimum of 300 mm. The material should be placed in maximum 300 mm thick lifts and compacted to a minimum of 95% of its SPMDD. The bedding material should extend at least to the spring line of the pipe.

The cover material, which should consist of OPSS Granular A, should extend from the spring line of the pipe to at least 300 mm above the obvert of the pipe. The material should be placed in maximum 300 mm thick lifts and compacted to a minimum of 95% of its SPMDD.

Generally, it should be possible to re-use the moist (not wet) brown silty clay and silty clay with sand above the cover material if the excavation and filling operations are carried out in dry weather conditions. Wet silty clay and silty clay with sand materials will be difficult to re-use, as the high water contents make compacting impractical without an extensive drying period.
Where hard surface areas are considered above the trench backfill, the trench backfill material within the frost zone (about 1.8 m below finished grade) should match the soils exposed at the trench walls to minimize differential frost heaving. The trench backfill should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 95% of the material's SPMDD.

Clay Seals

To reduce long-term lowering of the groundwater at this site, clay seals should be provided within the service trenches excavated through the silty clay deposit. The seals should be at least 1.5 m long (in the trench direction) and should extend from trench wall to trench wall. The seals should extend from the frost line and fully penetrate the bedding, subbedding and cover material. The barriers should consist of relatively dry and compactable brown silty clay placed in maximum 225 mm thick loose layers and compacted to a minimum of 95% of the SPMDD. The clay seals should be placed at the site boundaries and at strategic locations at no more than 60 m intervals in the service trenches excavated through the silty clay deposit

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. The contractor should be prepared to direct water away from all bearing surfaces and subgrades, regardless of the source, to prevent disturbance to the founding medium.

A temporary Ministry of the Environment, 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 (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

The subsurface conditions at this site mostly consist of frost susceptible materials. In presence of water and freezing conditions ice could form within the soil mass. Heaving and settlement upon thawing could occur. Precautions should be taken if winter construction is considered for this project.

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

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

6.7 Landscaping Considerations

Tree Planting Setbacks

In accordance with the City of Ottawa Tree Planting in Sensitive Marine Clay Soils (2017 Guidelines), Paterson completed a soils review of the site to determine applicable tree planting setbacks. Atterberg limits testing was completed for recovered silty clay samples at selected locations throughout the subject site. Grain size distribution and Sieve analysis testing was also completed on selected soil samples. The above noted test results were completed between design 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 Subsection 4.1 and in Appendix1.

Since the modified plasticity limit (PI) does not exceed 40%, large trees (mature height over 14 m) can be planted at the subject site 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).

According to the City of Ottawa Tree Planting Guidelines, tree planting setback limits may be reduced to 4.5 m for small (mature tree height up to 7.5m) and medium size trees (mature tree height 7.5 m to 14 m) provided that the following conditions are met:

- The underside of footing (USF) extends to 2.1 m or greater below the lowest finished grade within 10 m from the tree, as measured from the center of the tree trunk and verified by means of the Grading Plan as indicated procedural changes below. **However, due to the thickness of the fill material within the subject site, this condition is not required as the native silty clay material is well below the proposed underside of footing elevations (at least 1 m below proposed USF levels).**

- A small tree must be provided with a minimum of 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 surround the tree must promote drainage to the tree root zone (in such a manner as not to be detrimental to the tree).

In-Ground Swimming Pools

The in-situ soils are considered to be acceptable for the installation of in-ground swimming pools. The soil removed to accommodate an in-ground swimming pool weighs more than the water filled in-ground pool. Therefore, no additional load is being applied to the underlying sensitive clays.

Aboveground Swimming Pools, Hot Tubs and Exterior Decks

If consideration is given to construction of an above ground swimming pool, a hot tub or an exterior deck, a geotechnical consultant should be retained by the homeowner to review the site conditions. No additional grading should be placed around the exterior structure. The swimming pool should be located at least 3 m away from the existing foundation to avoid adding localized loading to the foundation and the hot tub should be located at least 2 m away from the existing foundation. Otherwise, construction is considered routine, and can be constructed in accordance with the manufacturer's specifications.

6.8 Corrosion Potential and Sulphate

The results of analytical testing show that the sulphate content is slightly higher than 0.1%. This result is indicative that MS Moderate Sulphate Resistant 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 severe to very aggressive corrosive environment.

6.9 Slope Stability Analysis

Field Observations

The subject section of Feedmill Creek is located with a 4 to 45 m wide valley corridor with a 1.5 to 3 m high valley wall. The valley corridor is less defined within the east portion of the site, where the walls are close to 2 m or less. It was noted that the majority of the slope face was densely covered with mature trees, saplings, bushes and grass along the southwest portion. An area of bouldery fill was noted along the north bank at approximately 80 to 100 m northeast of Huntmar Drive. Also, a beaver dam was noted within the watercourse approximately 180 m northeast of Huntmar Drive. The northeast section of the valley corridor is mainly grass covered along top of slope with bushes and trees sparsely populated along the bank face. Tree and plant roots were noted to be protruding from the exposed bank face along the majority of the watercourse. Some sloughing and minor undercutting along the lower portion of the bank face was noted where the watercourse had meandering in close contact with the valley wall.

Slope Stability Analysis

A slope stability analysis was completed by Paterson for the subject slope. Five (5) slope sections were analysed based on information obtained by Paterson field personnel and topographical mapping from the City of Ottawa.

The analysis of the stability of the slope was carried out using SLIDE, a computer program which permits a two-dimensional slope stability analysis using several methods including the Bishop's method, which is a widely used and accepted analysis method. The program calculates a factor of safety, which represents the ratio of the forces resisting failure to those favouring failure. Theoretically, a factor of safety of 1.0 represents a condition where the slope is stable. However, due to intrinsic limitations of the calculation methods and the variability of the subsoil and groundwater conditions, a factor of safety greater than one is usually required to ascertain the risks of failure are acceptable. A minimum factor of safety of 1.5 is generally recommended for conditions where the failure of the slope would endanger permanent structures. Under seismic loading, a minimum factor of safety of 1.1 is considered to be satisfactory.

The sections were analysed taking into account a groundwater level at ground surface. Subsoil conditions at the cross-sections were inferred based on the findings at nearby borehole locations and general knowledge of the area's geology.

Static Conditions Analysis

The results for the existing slope conditions at Sections A to E are shown in Figures 2, 4, 6, 8 and 10, respectively, and are attached to the present letter. The results of the slope stability analysis indicate that all sections, except Section E are considered stable from a geotechnical perspective. Therefore, Section E requires a 2.9 m stable slope allowance. The stable slope allowance is included in the limit of hazard lands setback line.

Seismic Loading Analysis

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

The results of the analysis including seismic loading are shown in Figures 3, 5, 7, 9 and 11 for the slope sections. The overall slope stability factors of safety for the subject sections when considering a seismic loading were found to be greater than 1.1. Based on these results, the slopes are considered to be stable under seismic loading.

Limit of Hazard Lands

Typically, the limit of hazard lands setback is comprised of a stable slope allowance, toe erosion, and 6 m erosion access allowance. It should be noted that based on our analysis results, the majority of the slope is considered stable. The limit of hazard lands designation line for the subject site is indicated on Drawing PG5648-3 – Limit of Hazard Lands Setback Plan in Appendix 2.

The toe erosion allowance for the valley corridor wall slopes was based on the cohesive nature of the soils, the observed current erosional activities and the width and location of the current watercourse. Signs of erosion were noted along the existing watercourse, especially where the watercourse has meandered in close proximity to the toe of the corridor wall. It is considered that a toe erosion allowance of 6 m is appropriate for the corridor walls confining the existing watercourse. The toe erosion allowance should be applied from the top of stable slope, where the watercourse has meandered to within 10 m of the slope toe. The toe erosion allowance should be taken from the bank full water's edge in areas, where the watercourse is greater than 10 m from the toe of the existing slope. The toe erosion allowance should be applied from the top of stable slope.

The existing vegetation on the slope face should not be removed as it contributes to the stability of the slope and reduces erosion. If the existing vegetation needs to be removed, it is recommended that a 100 to 150 mm of topsoil mixed with a hardy seed or an erosional control blanket be placed across the exposed slope face.

It should also be noted that a meander belt allowance was not considered in our analysis. Meander belt allowances normally only apply to unconfined water systems and terrain-dependent water systems consisting of cohesionless materials, such as sands.

7.0 Recommendations

It is recommended that the following be completed once the master plan and site development are determined:

- ❑ Review of the 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 backfilling.
- ❑ Field density tests to determine the level of compaction achieved.
- ❑ Sampling and testing of the bituminous concrete including mix design reviews.

A report confirming that these works have been conducted in general accordance with our recommendations could be issued upon the completion of a satisfactory inspection program by the geotechnical consultant.

8.0 Statement of Limitations

The recommendations made in this report are in accordance with Paterson's present understanding of the project. Paterson requests permission to review the grading plan once available. Paterson's recommendations should be reviewed when the drawings and specifications are complete.

The client should be aware that any information pertaining to soils and the test hole log are furnished as a matter of general information only. Test hole descriptions or logs are not to be interpreted as descriptive of conditions at locations other than those of the test holes.

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 to be notified 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 Minto Communities or their agent(s) is not authorized without review by this firm for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

LICENSED PROFESSIONAL ENGINEER
June 30, 2022
F. I. ABOU-SEIDO
100156744
PROVINCE OF ONTARIO

Yashar Ziaeimehr, M.Eng.

Faisal I. Abou-Seido, P.Eng.

Report Distribution:

- ❑ Minto Communities (3 copies)
- ❑ Paterson Group (1 copy)

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

ATTERBERG LIMITS TESTING RESULTS

GRAIN SIZE DISTRIBUTION SHEETS

ANALYTICAL TESTING RESULTS

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development
Arcadia Stage 6 - Campeau Dr - Ottawa, Ontario

DATUM Geodetic

REMARKS

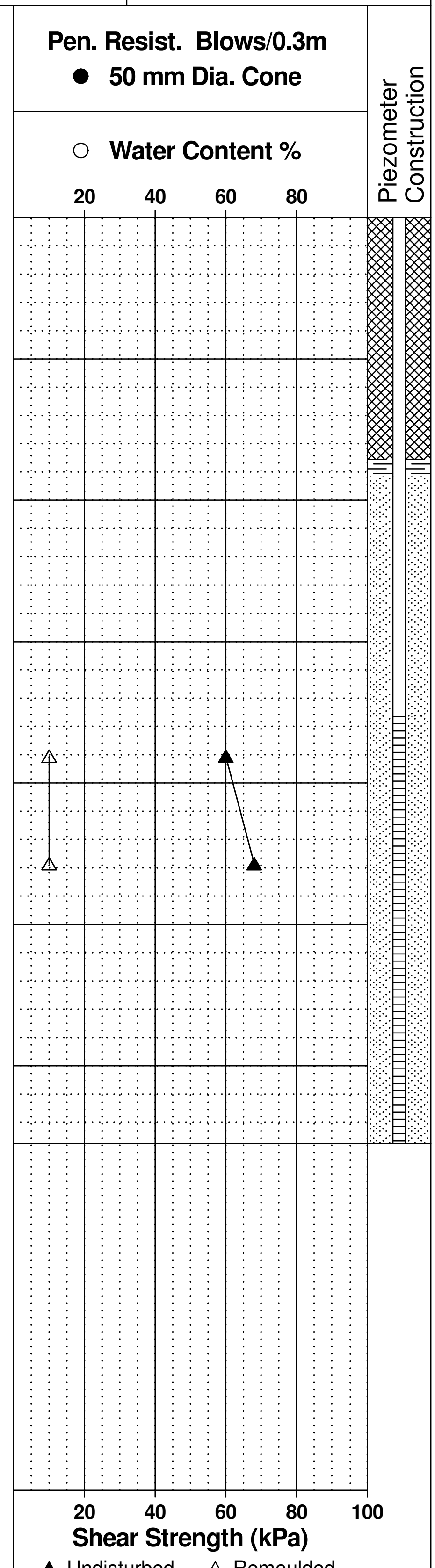
BORINGS BY CME-55 Low Clearance Drill

DATE 2020 December 17

FILE NO. PG5648

HOLE NO. BH 1-20

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	95.61
FILL: Brown silty sand to silty clay with sand, gravel, organics and roots -Decreasing in sand content with depth	2.29	AU	1				
		SS	2	38	14	1	94.61
		SS	3	67	19	2	93.61
Stiff brown **SILTY CLAY** - Some silt seams encoutered throughout	4.57	SS	4	13	4	3	92.61
		SS	5	42	3	4	91.61
Firm grey **SILTY CLAY** with silt seams	6.55					5	90.61
						6	89.61
End of Borehole (GWL based on site observations at 5.33 m depth - Dec 17, 2020)							



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FILE NO. PG5648

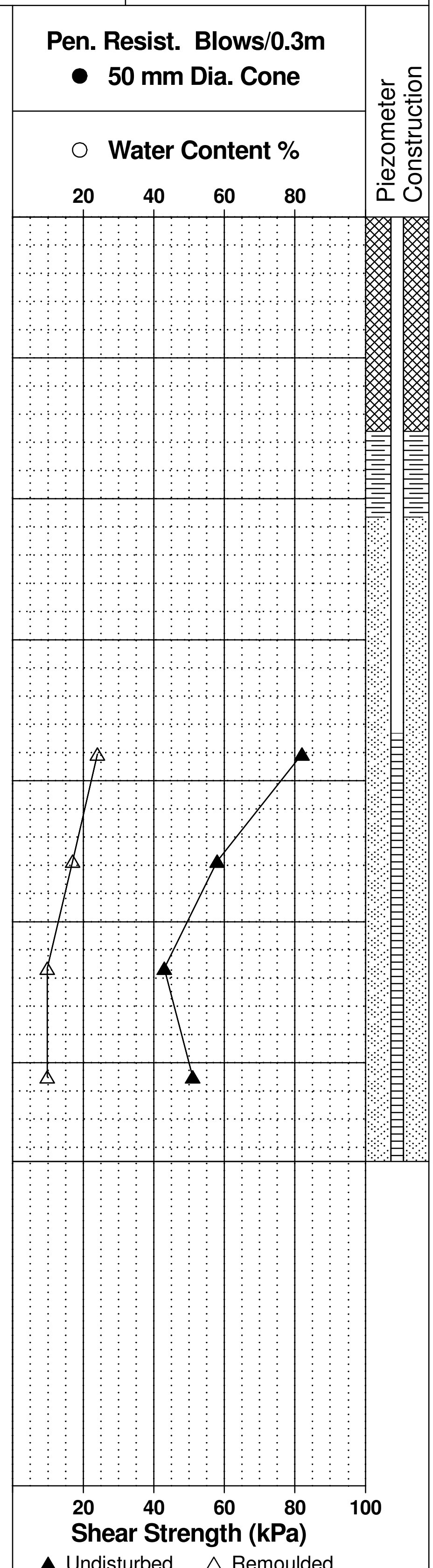
REMARKS

HOLE NO. BH 2-20

BORINGS BY CME-55 Low Clearance Drill

DATE 2020 December 17

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	96.80
FILL: Brown silty sand to silty clay with sand, crushed stone, cobbles and trace roots	AU	1				
	SS	2	46	24	1	95.80
	SS	3	4	9	2	94.80
2.59	SS	4	25	5		
Stiff to firm grey **SILTY CLAY**	SS	5	100	6	3	93.80
					4	92.80
					5	91.80
					6	90.80
6.70						
End of Borehole						
(GWL based on site observations at 3.81 m depth - Dec 17, 2020)						



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REMARKS

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DATE 2020 December 17

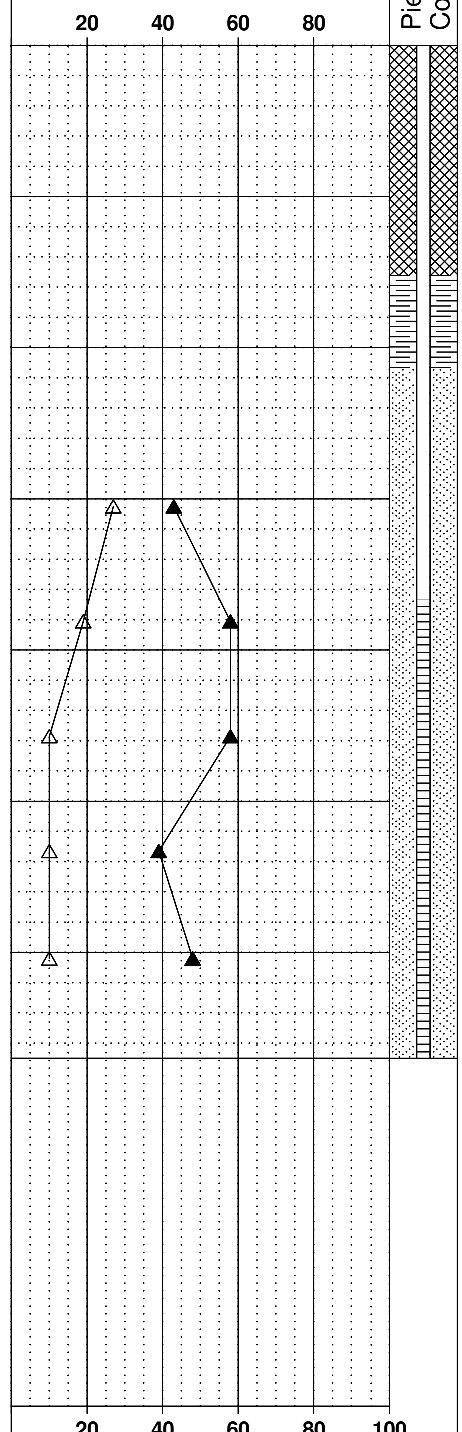
FILE NO. PG5648

HOLE NO. BH 3-20

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	96.58
FILL: Brown silty clay with trace with sand, trace gravel, cobbles and organics		AU	1				
		SS	2	58	13	1	95.58
1.40							
Stiff to firm brown **SILTY CLAY** trace sand		SS	3	0	7	2	94.58
		SS	4	42	3	3	93.58
						4	92.58
4.57							
Firm grey **SILTY CLAY**						5	91.58
						6	90.58
6.70							
End of Borehole							
(GWL based on site observations at 4.57 m depth - Dec 17, 2020)							

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

Piezometer Construction



Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development
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FILE NO. PG5648

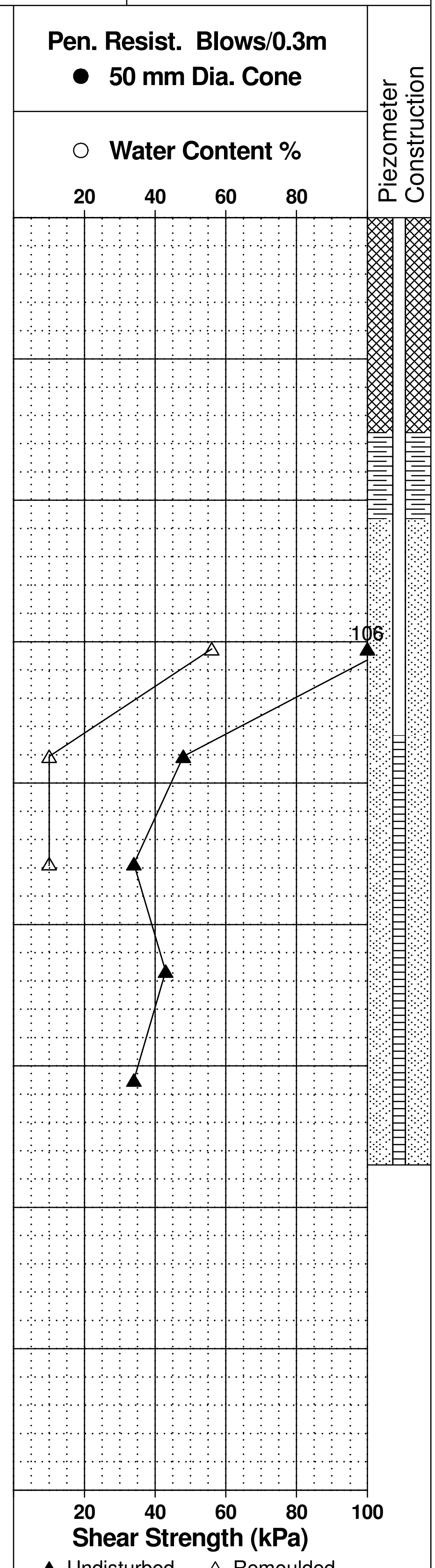
REMARKS

HOLE NO. BH 4-20

BORINGS BY CME-55 Low Clearance Drill

DATE 2020 December 17

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	96.79
FILL: Brown silty sand some gravel, trace cobbles, boulders, organics and roots	AU	1				
	SS	2	16	8	1	95.79
	SS	3	9	5		
2.10					2	94.79
Stiff to firm stiff brown **SILTY CLAY**	SS	4	30	4		
					3	93.79
- Grey by 3.81 m depth					4	92.79
					5	91.79
					6	90.79
6.70						
Dynamic Cone Penetration Test Commenced at 6.70 m depth. Pushed cone through inferred **SILTY CLAY**					7	89.79
					8	88.79
					9	87.79



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development
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FILE NO. PG5648

REMARKS

HOLE NO. BH 4-20

BORINGS BY CME-55 Low Clearance Drill **DATE** 2020 December 17

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									
						9	87.79		
						10	86.79		
						11	85.79		
Inferred **SILTY CLAY**						12	84.79		
						13	83.79		
						14	82.79		
						15	81.79		
						16	80.79		
						17	79.79		
						18	78.79		

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

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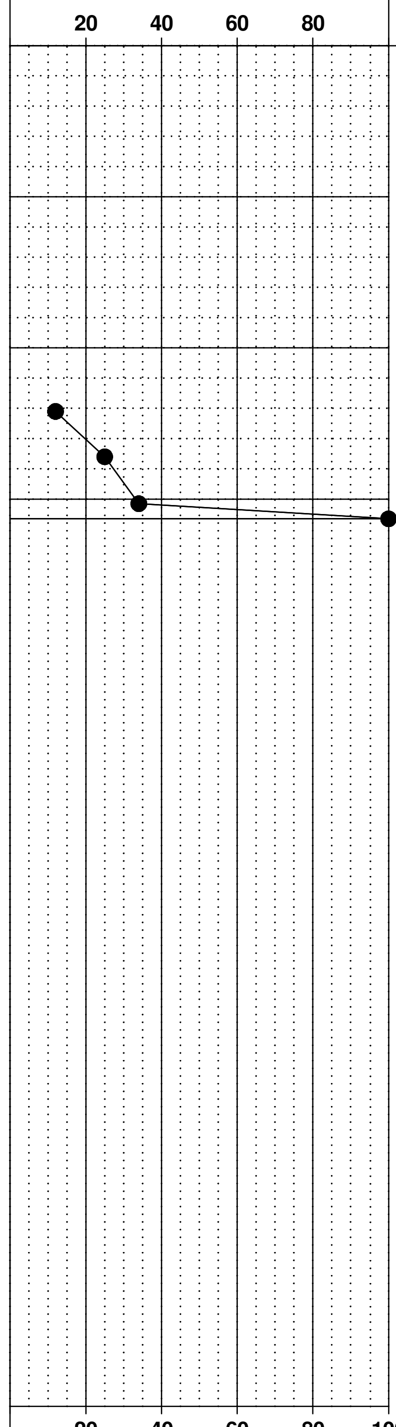
DATE 2020 December 17

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	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						18	78.79		
Inferred **SILTY CLAY**						19	77.79		
						20	76.79		
20.93						21	75.79		
End of Borehole Practical refusal to DCPT at 20.93 m depth (GWL based on site observations at 4.57 m depth - Dec 17, 2020)									



Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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REMARKS

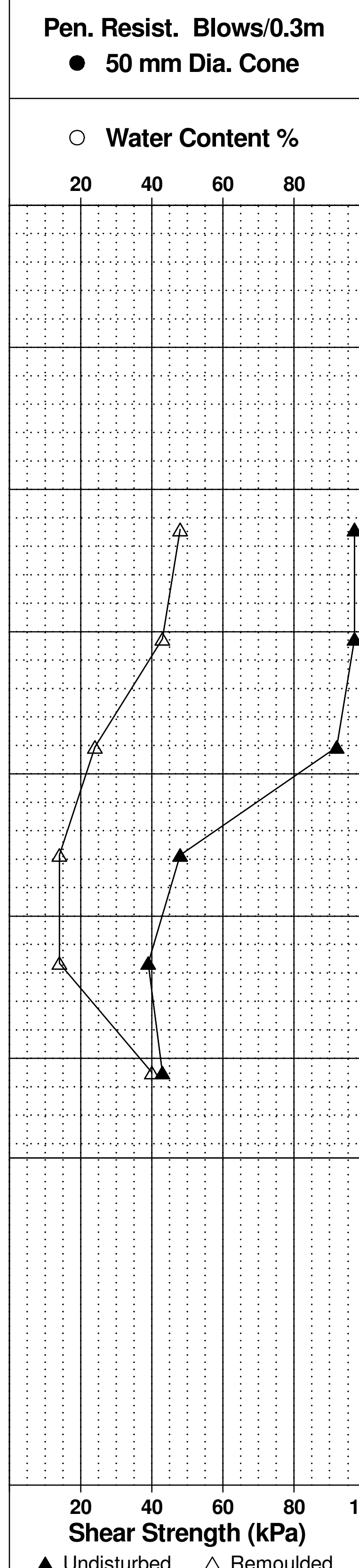
BORINGS BY CME-55 Low Clearance Drill

DATE 2020 December 17

FILE NO. PG5648

HOLE NO. BH 5-20

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	96.80
FILL: Brown silty clay with sand, gravel, cobbles trace organics (0.33)		AU	1				
Stiff to firm brown **SILTY CLAY**		SS	2	42	6	1	95.80
		SS	3	46	5	2	94.80
						3	93.80
(4.57)						4	92.80
Firm grey **SILTY CLAY**						5	91.80
(6.70)						6	90.80
End of Borehole							
(GWL based on site observations at 4.57 m depth - Dec 17, 2020)							



Piezometer Construction

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Proposed Residential Development
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REMARKS

BORINGS BY CME-55 Low Clearance Drill

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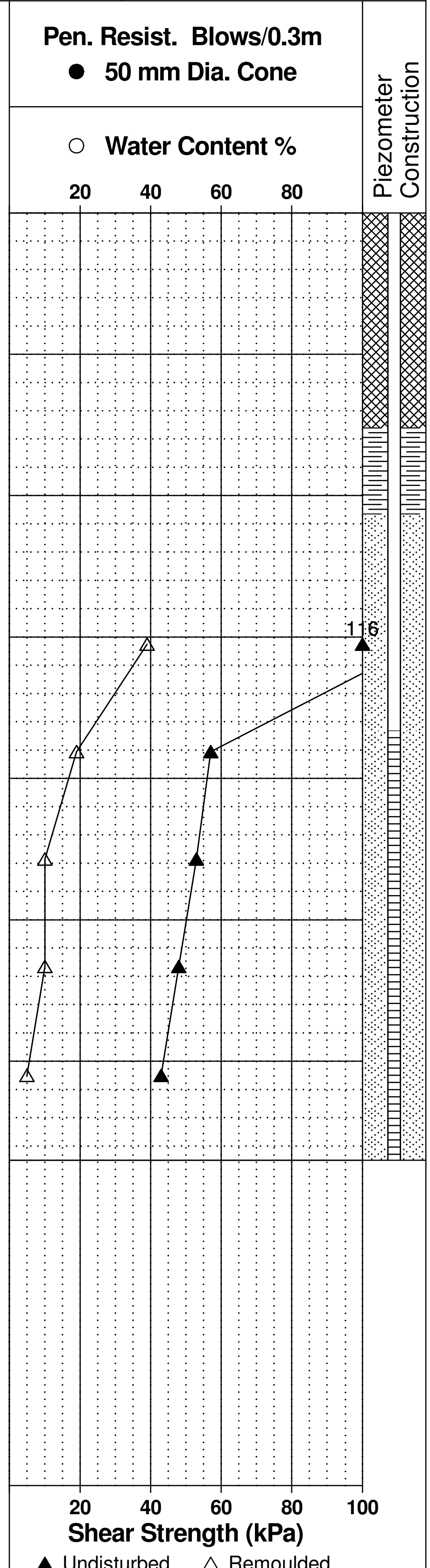
FILE NO. PG5648

HOLE NO. BH 6-20

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	97.77
FILL: Brown silty clay with sand, some gravel, trace organics		AU	1				
		SS	2	16	5	1	96.77
1.37							
Very stiff to stiff brown **SILTY CLAY**		SS	3	63	10		
						2	95.77
		SS	4	16	7		
						3	94.77
- Firm and grey by 3.81 m depth							
						4	93.77
						5	92.77
						6	91.77
6.70							
End of Borehole							
(GWL based on site observations at 4.57 m depth - Dec 17, 2020)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
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FILE NO. PG5648

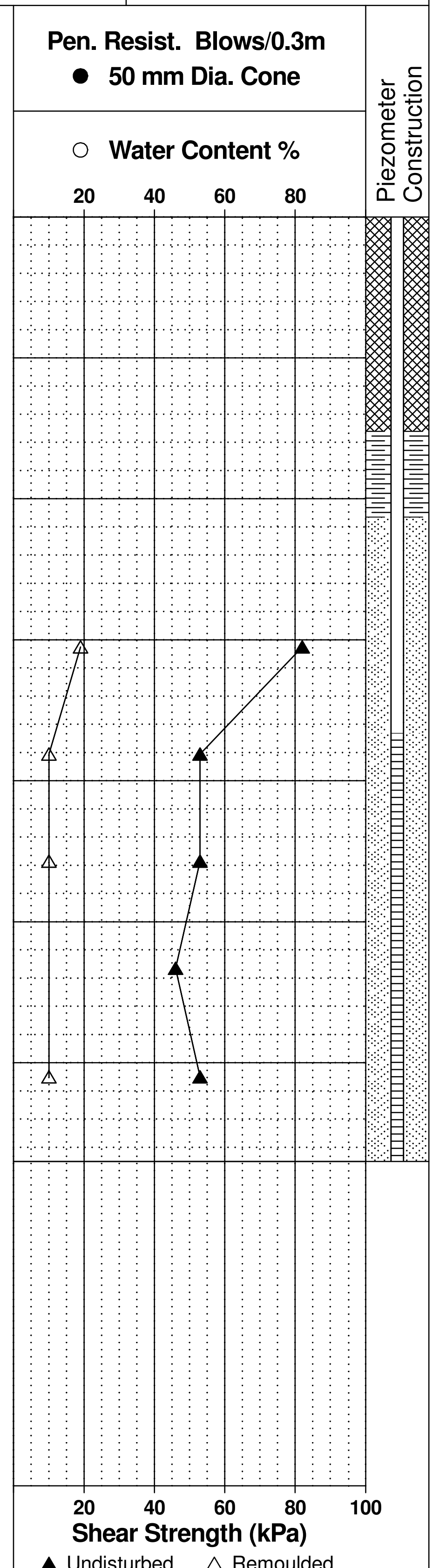
REMARKS

HOLE NO. BH 7-20

BORINGS BY CME-55 Low Clearance Drill **DATE** 2020 December 17

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	97.63
FILL: Brown silty sand with gravel, cobbles, trace clay and roots (to 0.40)	AU	1				
FILL: Brown silty clay some sand (to 1.37)	SS	2	50	13	1	96.63
Stiff to firm brown **SILTY CLAY** (to 3.81)	SS	3	100	8	2	95.63
	SS	4	100	6	3	94.63
Stiff to firm grey **SILTY CLAY** (to 6.70)					4	93.63
					5	92.63
					6	91.63
End of Borehole						

(GWL based on site observations at 3.81 m depth - Dec 17, 2020)



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SOIL PROFILE AND TEST DATA

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BORINGS BY CME-55 Low Clearance Drill

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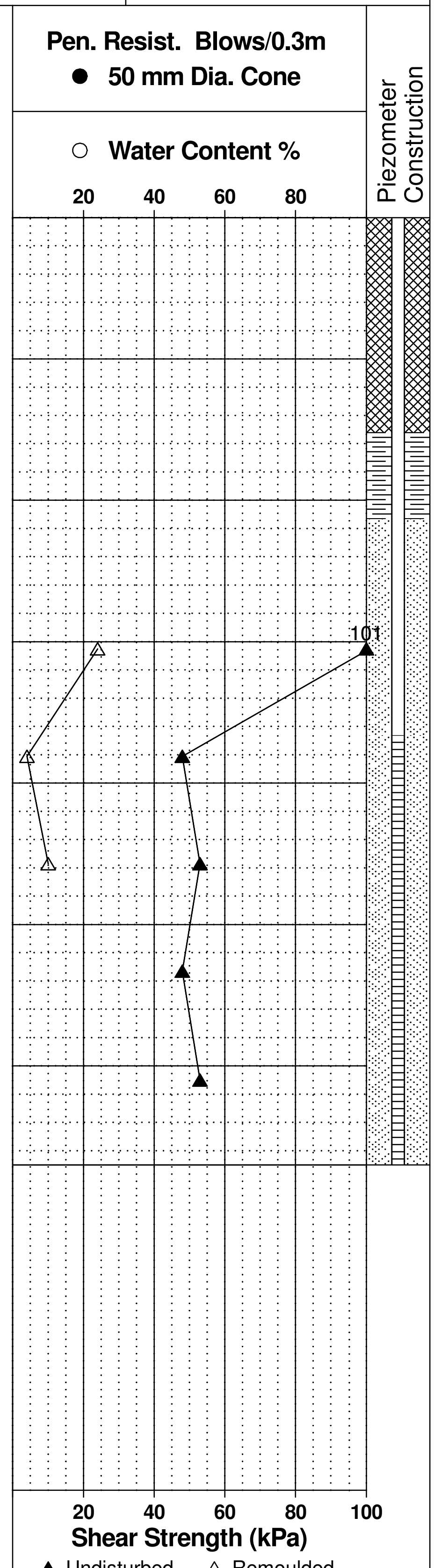
FILE NO. PG5648

HOLE NO. BH 8-20

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
FILL: Brown silty clay with sand, crushed stone, gravel, cobbles, and boulders	0.66	AU	1		
FILL: Brown silty clay trace gravel and sand	0.85	SS	2	54	16
Very stiff to stiff brown **SILTY CLAY**	3.81	SS	3	92	12
		SS	4	96	5
Stiff to firm grey **SILTY CLAY**	6.70				
End of Borehole					

(GWL based on site observations at 3.81 m depth - Dec 17, 2020)

DEPTH (m)	ELEV. (m)
0	98.07
1	97.07
2	96.07
3	95.07
4	94.07
5	93.07
6	92.07



SYMBOLS AND TERMS

SOIL DESCRIPTION

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

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

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

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

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

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

SYMBOLS AND TERMS (continued)

SOIL DESCRIPTION (continued)

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

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

ROCK DESCRIPTION

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

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

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

SAMPLE TYPES

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

SYMBOLS AND TERMS (continued)

PLASTICITY LIMITS AND GRAIN SIZE DISTRIBUTION

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

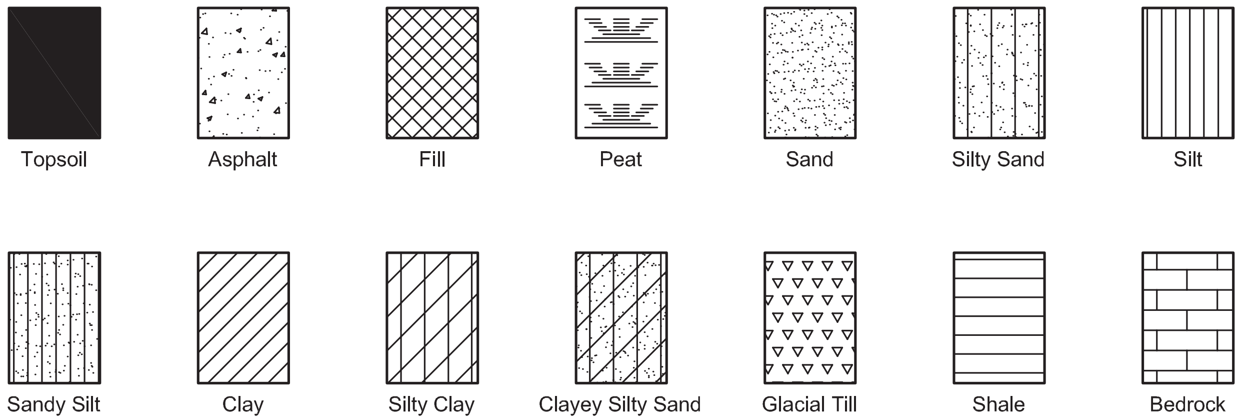
p'_o	-	Present effective overburden pressure at sample depth
p'_c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'_c)
Cc	-	Compression index (in effect at pressures above p'_c)
OC Ratio		Overconsolidaton ratio = p'_c / p'_o
Void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

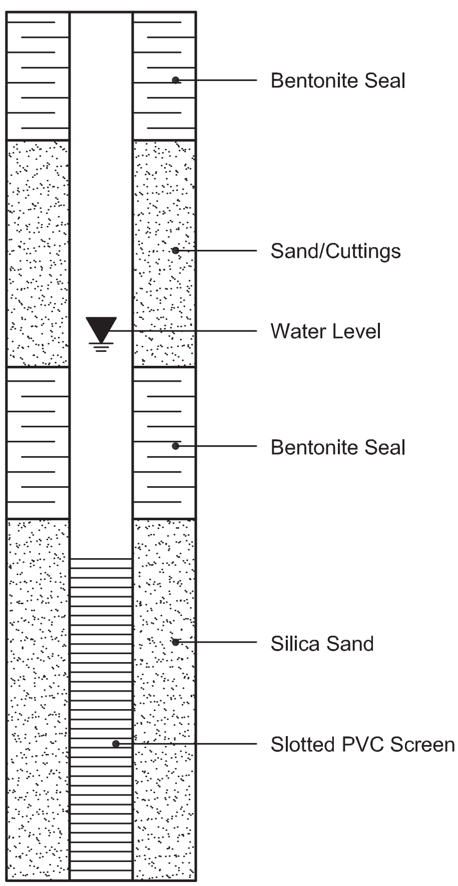
SYMBOLS AND TERMS (continued)

STRATA PLOT

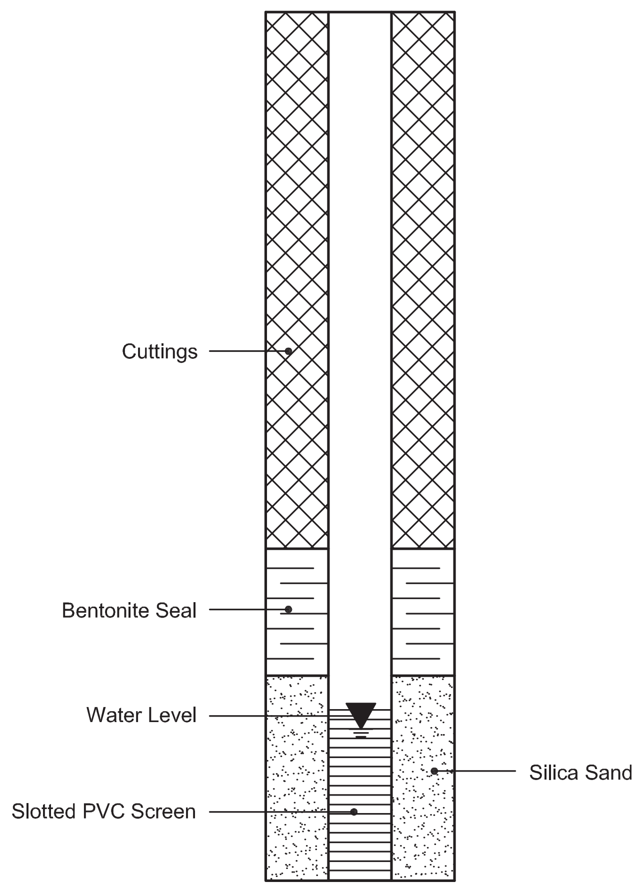


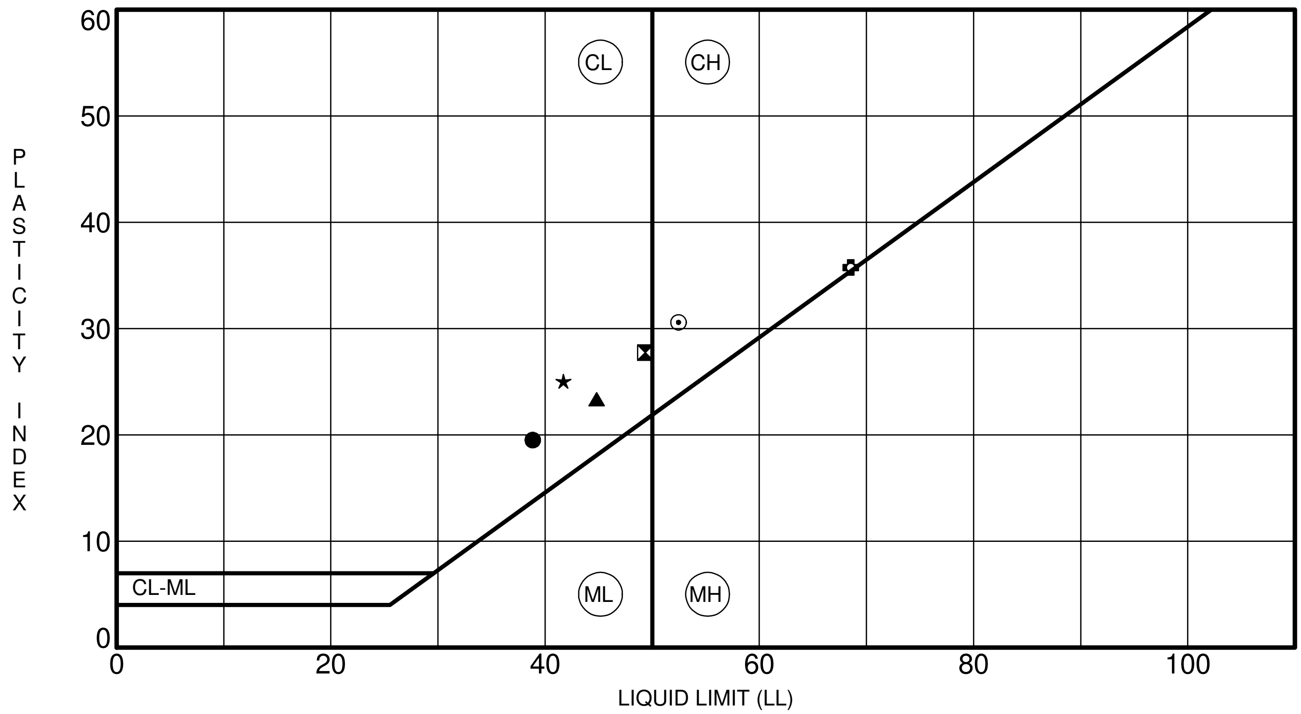
MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



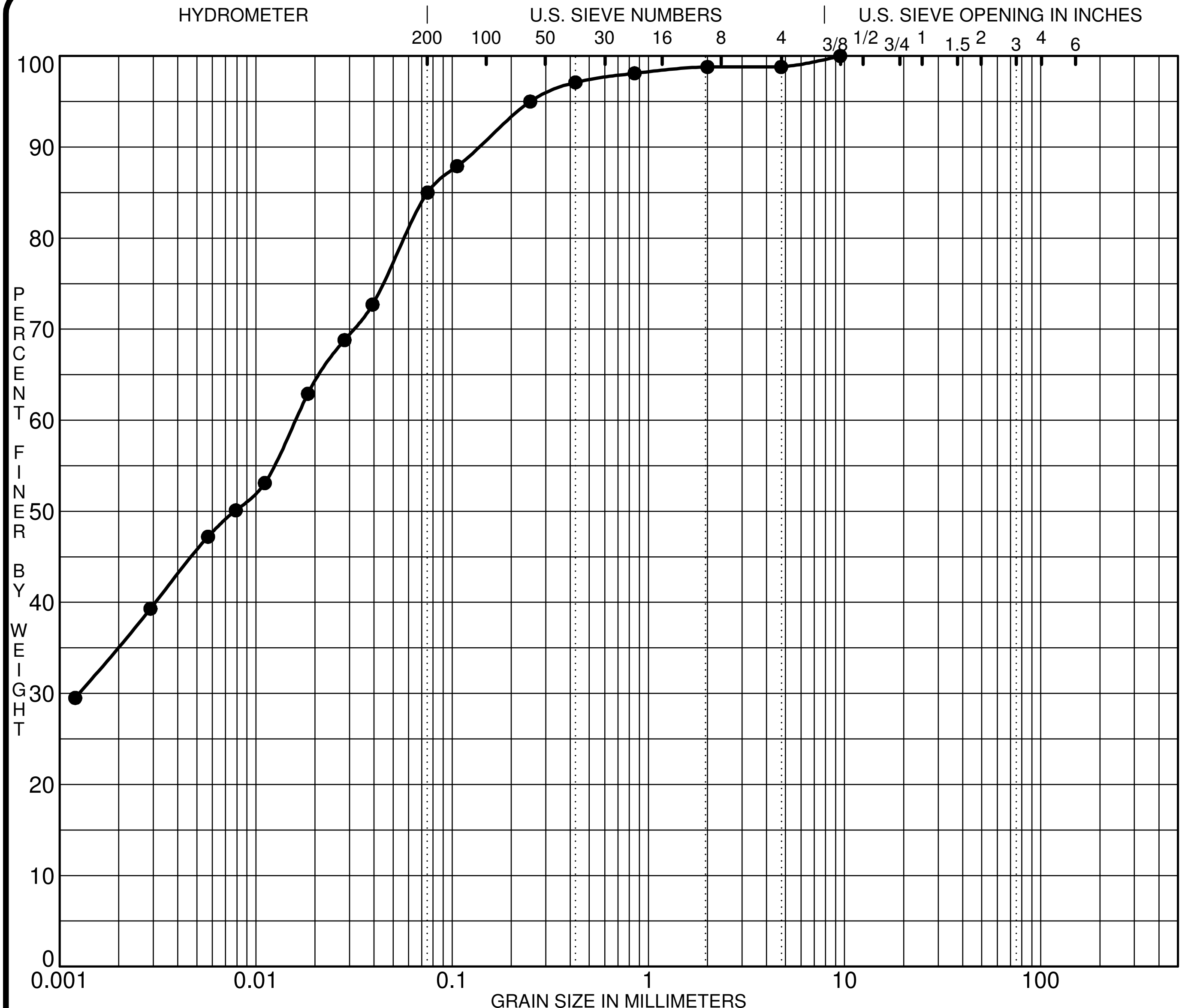


	Specimen Identification	LL	PL	PI	Fines	Classification
●	**BH 1-20 SS2**	**39**	**19**	**20**	**85.0**	**CL - Inorganic clays of low plasticity**
⧗	**BH 1-20 SS6**	**49**	**22**	**28**	**98.1**	**CL - Inorganic clays of low plasticity**
▲	**BH 2-20 SS5**	**45**	**21**	**23**		**CL - Inorganic clays of low plasticity**
★	**BH 4-20 SS4**	**42**	**17**	**25**		**CL - Inorganic clays of low plasticity**
⊙	**BH 6-20 SS3**	**52**	**22**	**31**		**CL - Inorganic clays of low plasticity**
✿	**BH 8-20 SS4**	**69**	**33**	**36**		**CL - Inorganic clays of low plasticity**

CLIENT	**Minto Communities Inc.**	FILE NO.	**PG5648**
PROJECT	**Geotechnical Investigation - Proposed Residential Development - Arcadia Stg 6 -**	DATE	**17 Dec 20**

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

ATTERBERG LIMITS' RESULTS



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	**BH 1-20 SS2**	**CL - Inorganic clays of low plasticity**		**39**	**19**	**20**		

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH 1-20 SS2**	**9.50**	**0.02**	**0.001**		**1.2**	**13.8**	**85.0**	

CLIENT **Minto Communities Inc.**

FILE NO. **PG5648**

PROJECT **Geotechnical Investigation - Proposed Residential Development - Arcadia Stg 6**

DATE **17 Dec 20**

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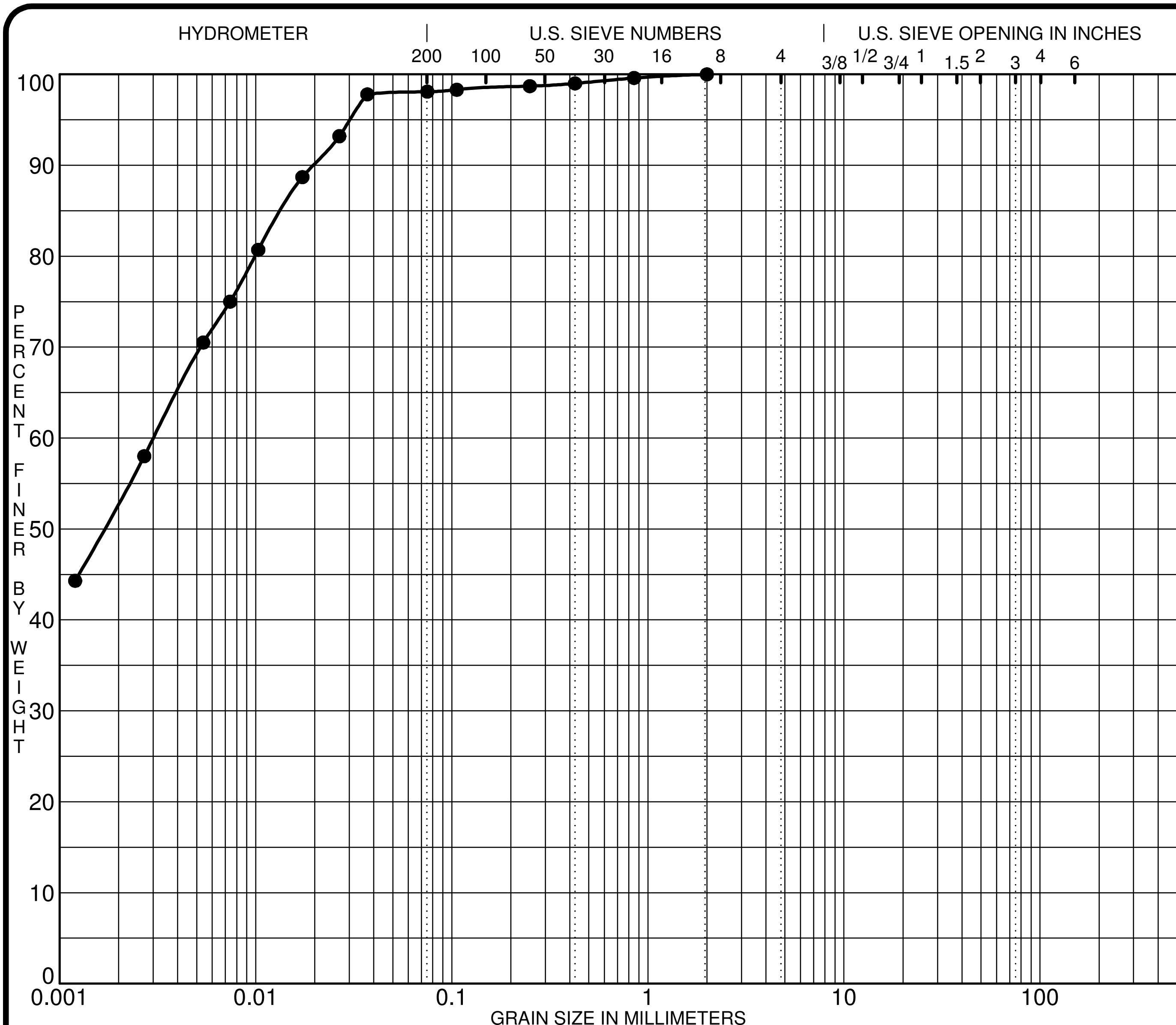
GRAIN SIZE DISTRIBUTION



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	**BH 1-20 SS6**	**CL - Inorganic clays of low plasticity**		**49**	**22**	**28**		

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH 1-20 SS6**	**2.00**	**0.00**			**0.0**	**1.9**	**98.1**	

CLIENT **Minto Communities Inc.**

FILE NO. **PG5648**

PROJECT **Geotechnical Investigation - Proposed Residential Development - Arcadia Stg 6**

DATE **17 Dec 20**

patersongroup **Consulting Engineers**

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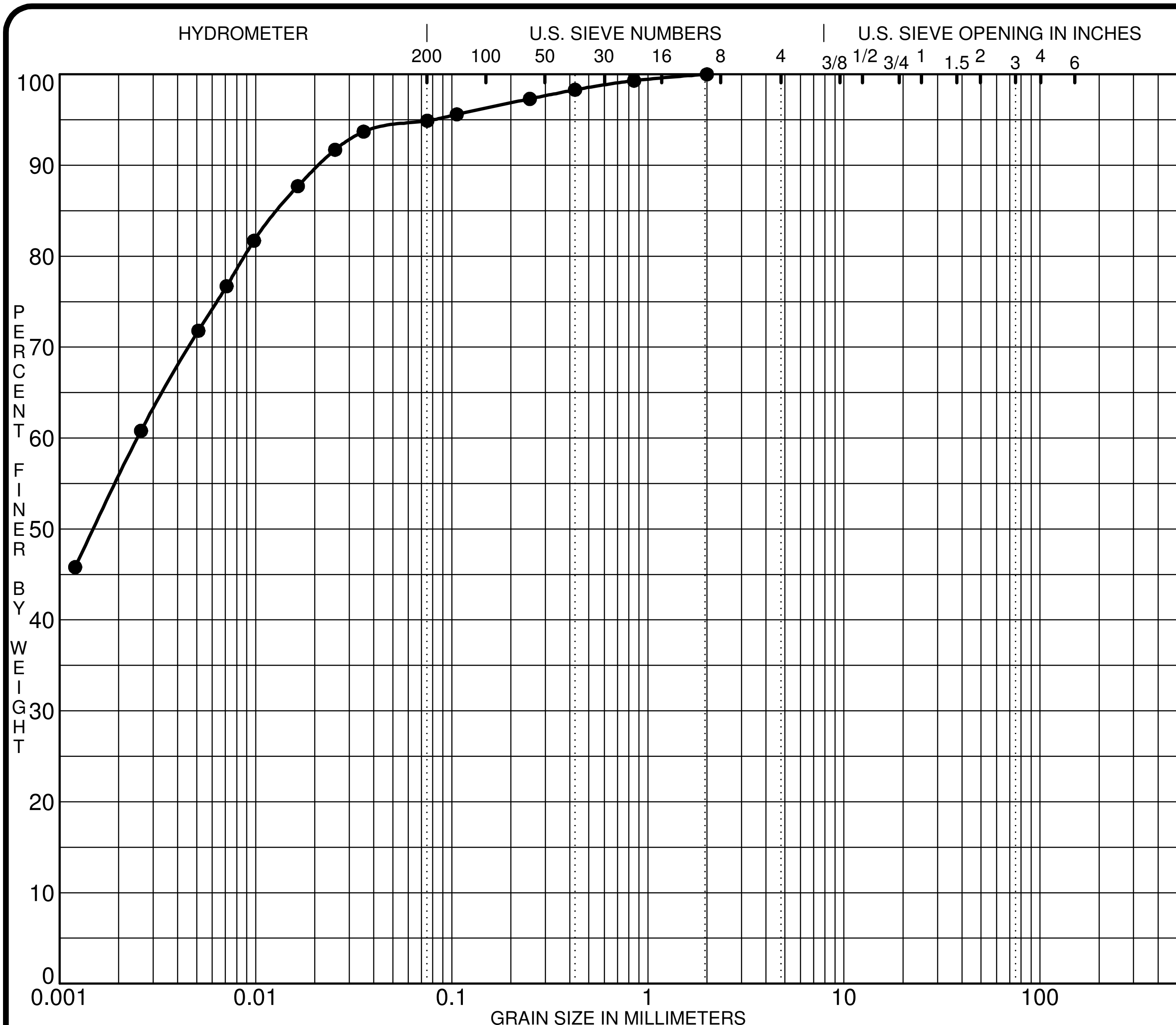
GRAIN SIZE DISTRIBUTION



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	**BH 8-20 SS2**	**CL - Inorganic clays of low plasticity**						

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH 8-20 SS2**	**2.00**	**0.00**			**0.0**	**5.1**	**94.9**	

CLIENT **Minto Communities Inc.**

FILE NO. **PG5648**

PROJECT **Geotechnical Investigation - Proposed Residential Development - Arcadia Stg 6**

DATE **17 Dec 20**

patersongroup **Consulting Engineers**

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GRAIN SIZE DISTRIBUTION

PARACEL LABORATORIES LTD.

Order #: 2102475

Certificate of Analysis

Client: Paterson Group Consulting Engineers

Client PO:

Report Date: 13-Jan-2021

Order Date: 8-Jan-2021

Project Description: PG5648

	Client ID:	BH7-SS2	-	-	-
	Sample Date:	18-Dec-20 09:00	-	-	-
	Sample ID:	2102475-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	80.1	-	-	-
General Inorganics					
pH	0.05 pH Units	7.59	-	-	-
Resistivity	0.10 Ohm.m	28.1	-	-	-
Anions					
Chloride	5 ug/g dry	33	-	-	-
Sulphate	5 ug/g dry	154	-	-	-

APPENDIX 2

FIGURE 1 - KEY PLAN

FIGURES 2-11 – SLOPE STABILITY ANALYSIS SECTIONS

FIGURES 12-14 – HISTORICAL AERIAL PHOTOGRAPHS

DRAWING PG5648-1 – TEST HOLE LOCATION PLAN

DRAWING PG5648-2 – PERMISSIBLE GRADE RAISE PLAN

DRAWING PG5648-3 – LIMIT OF HAZARD LANDS SETBACKS (INCLUDES 4 SUB-DRAWINGS 3A THROUGH 3D)

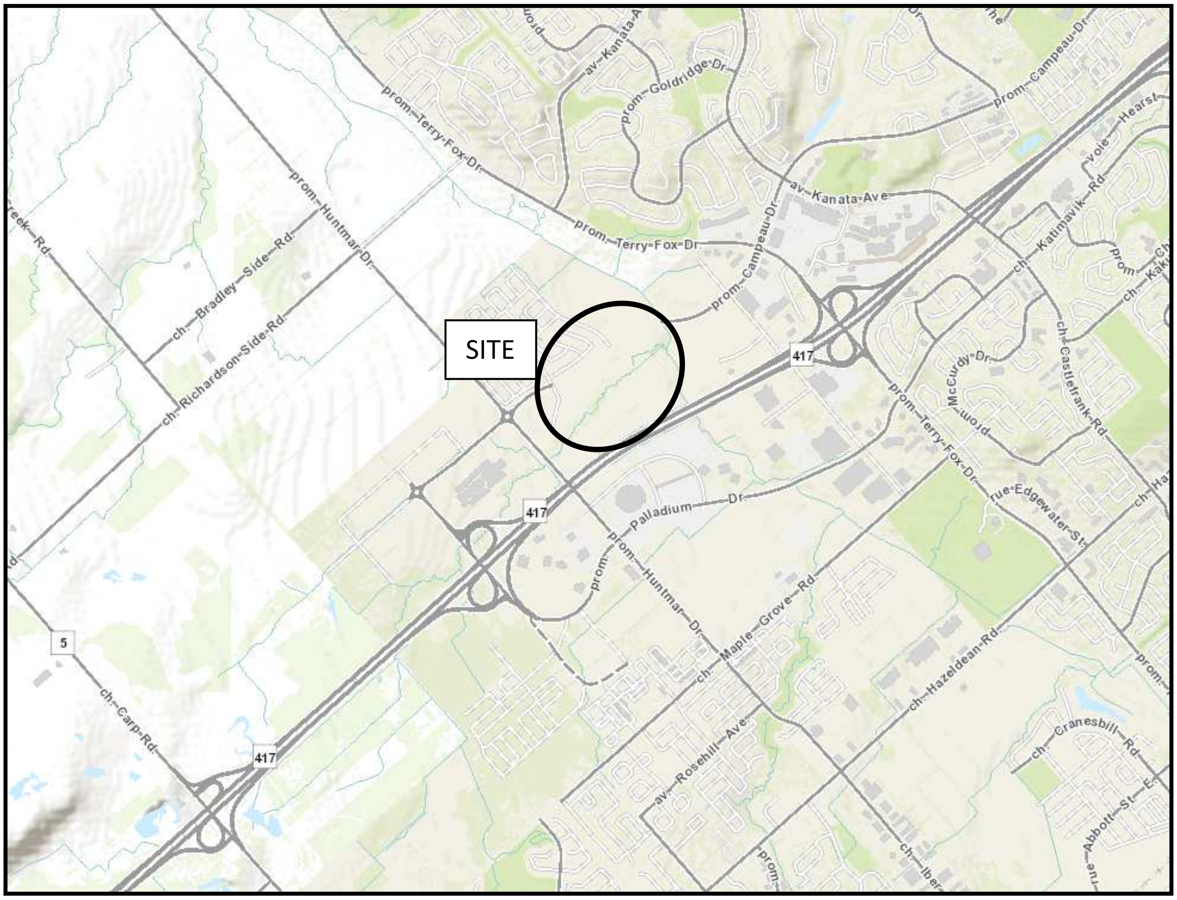


FIGURE 1

KEY PLAN

PATERSON GROUP

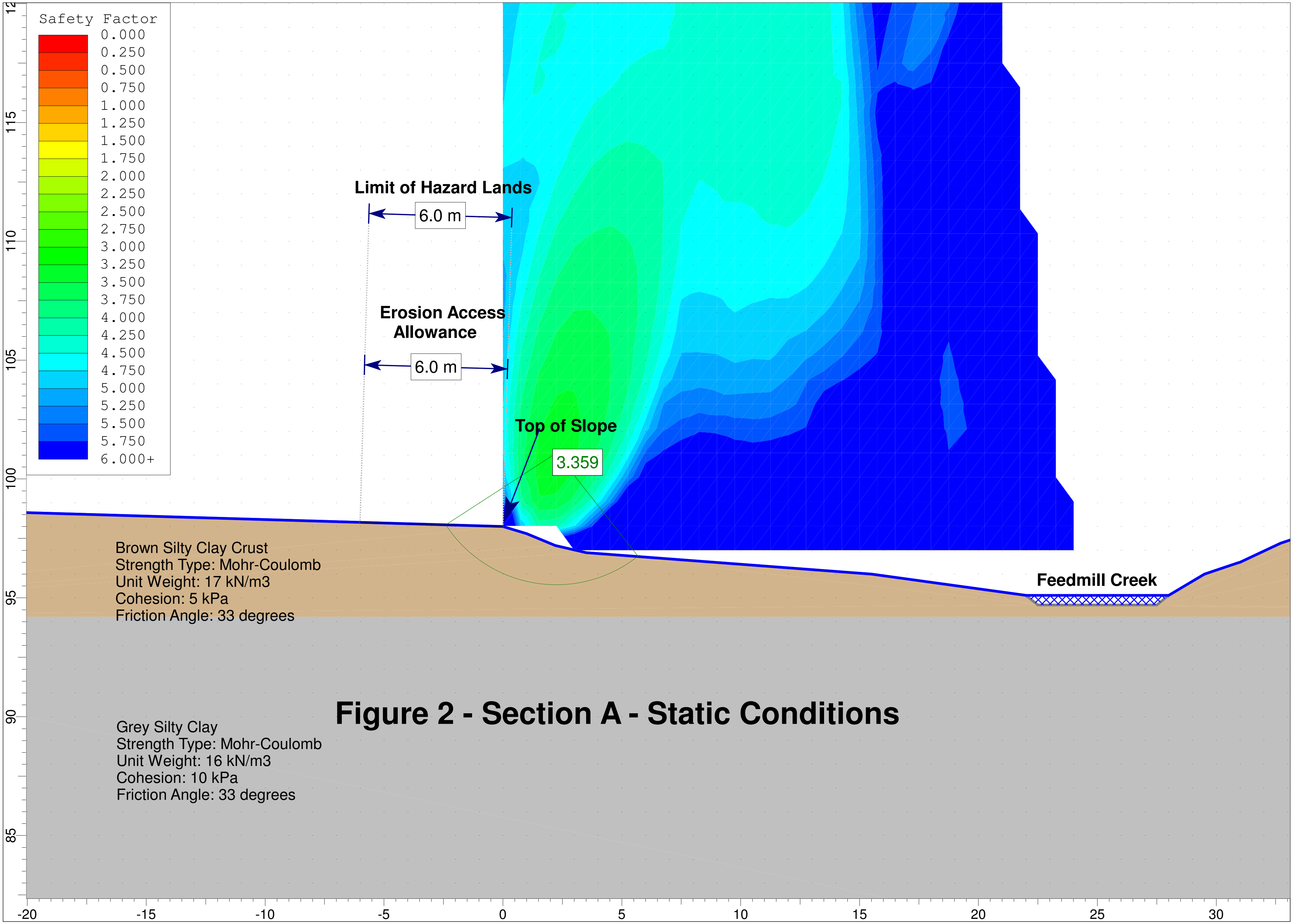


Figure 2 - Section A - Static Conditions

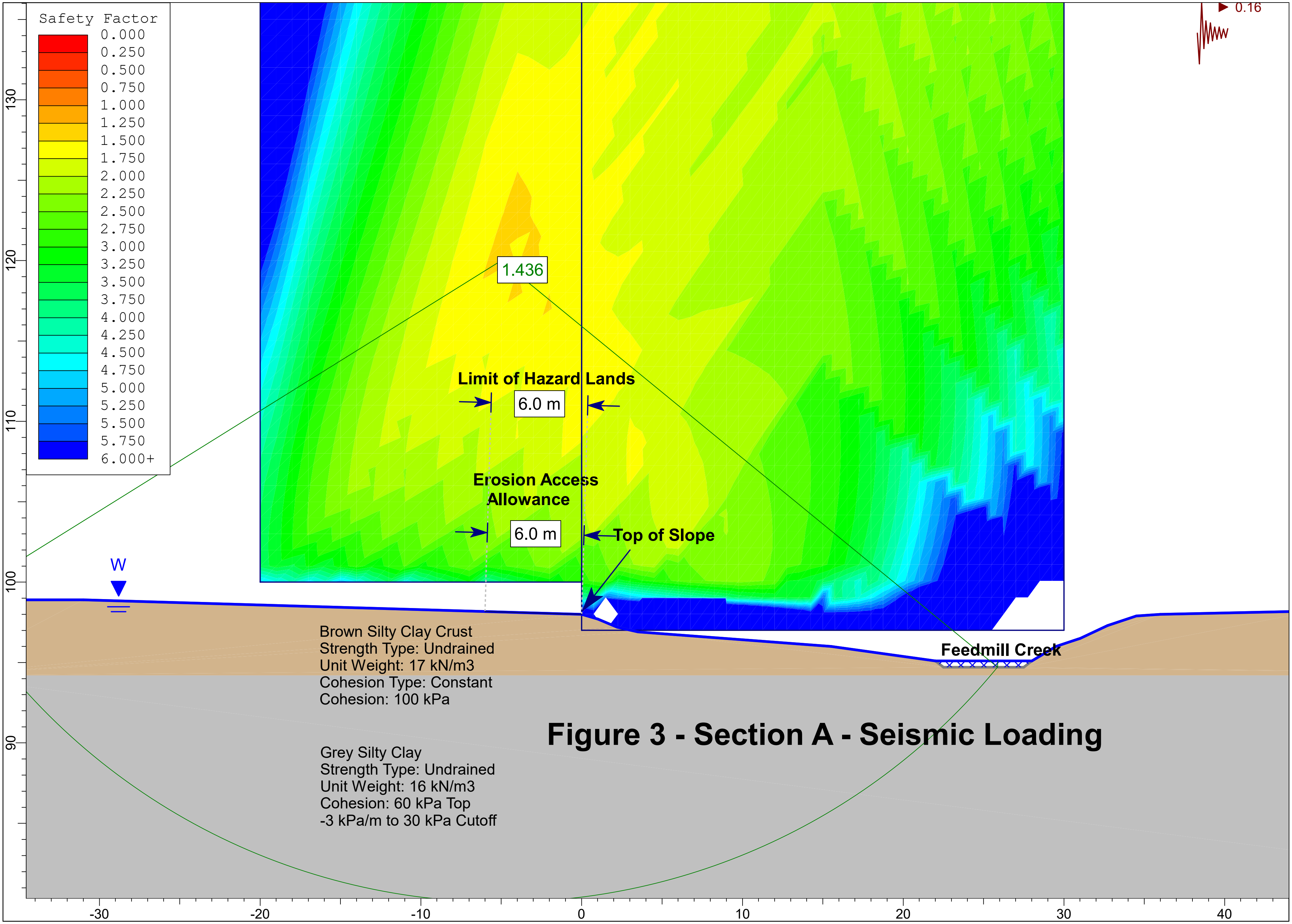


Figure 3 - Section A - Seismic Loading

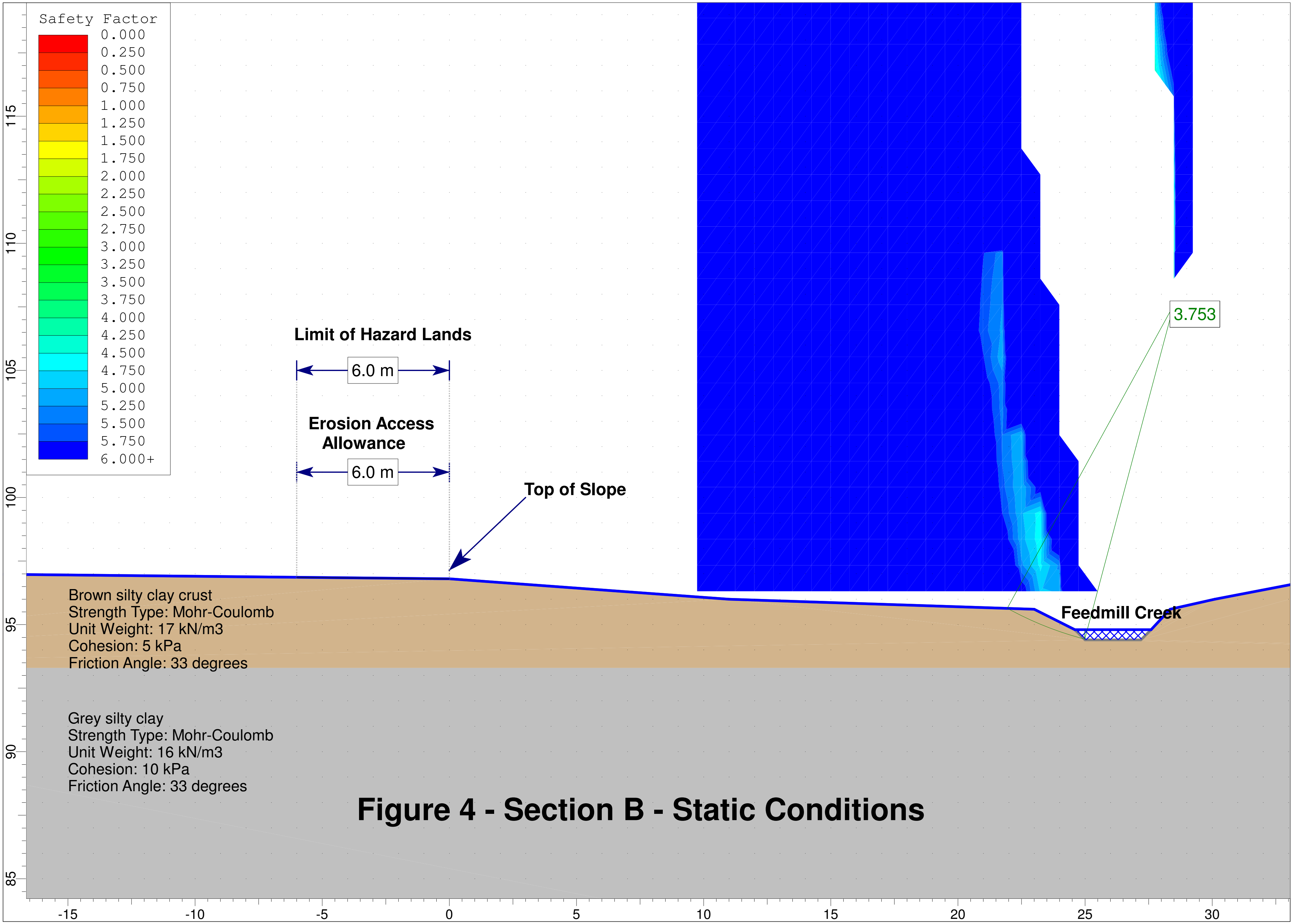


Figure 4 - Section B - Static Conditions

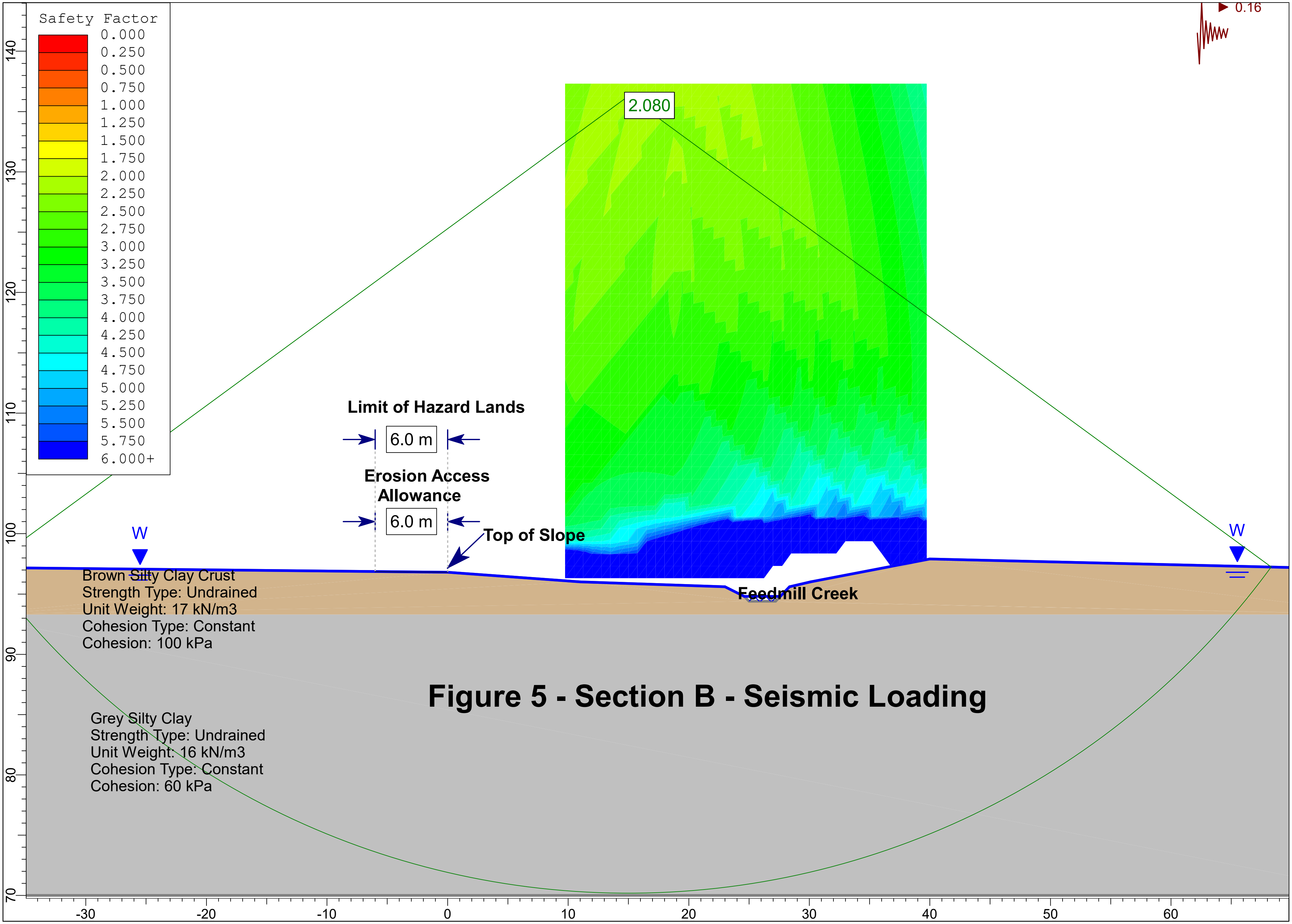


Figure 5 - Section B - Seismic Loading

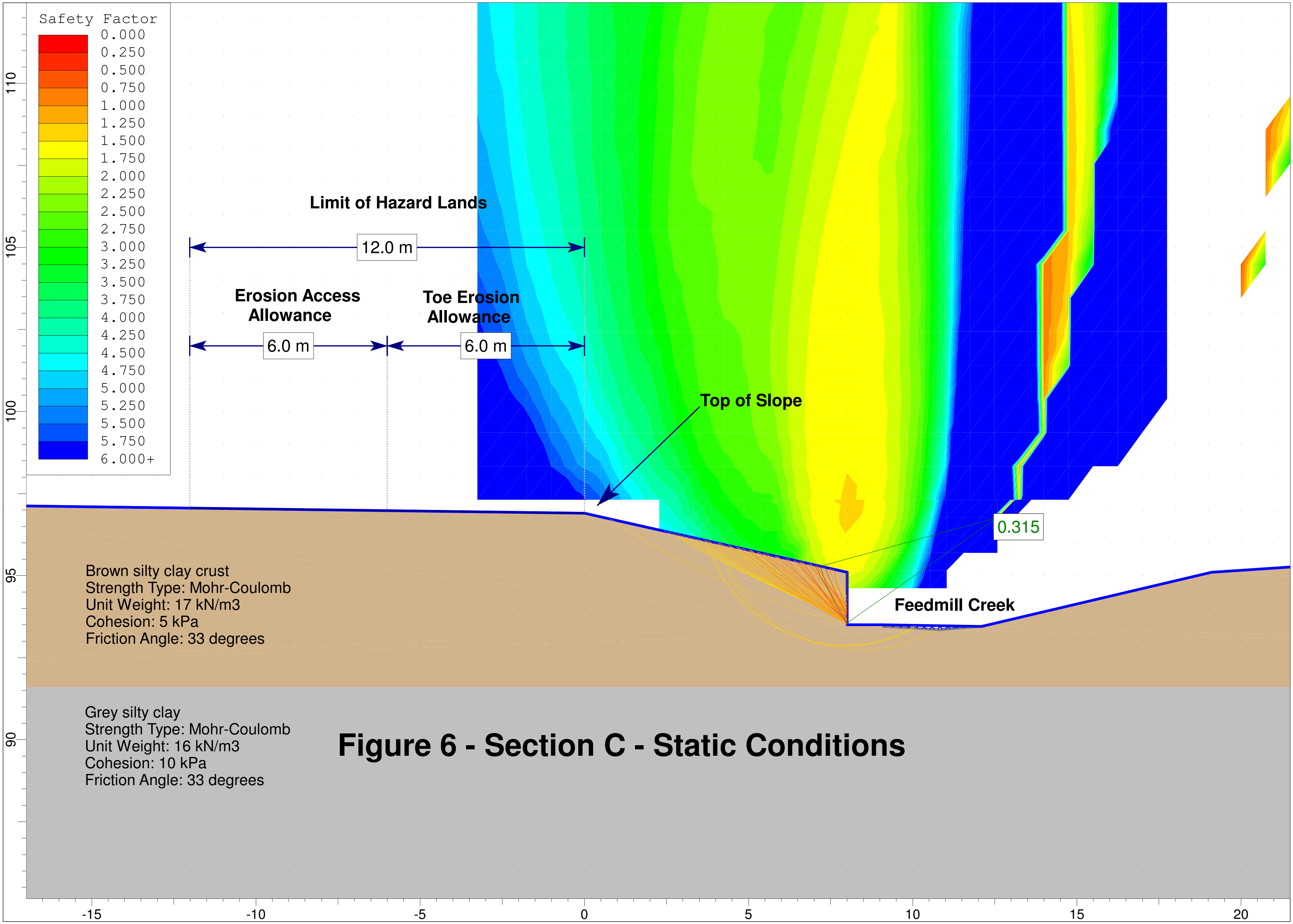


Figure 6 - Section C - Static Conditions

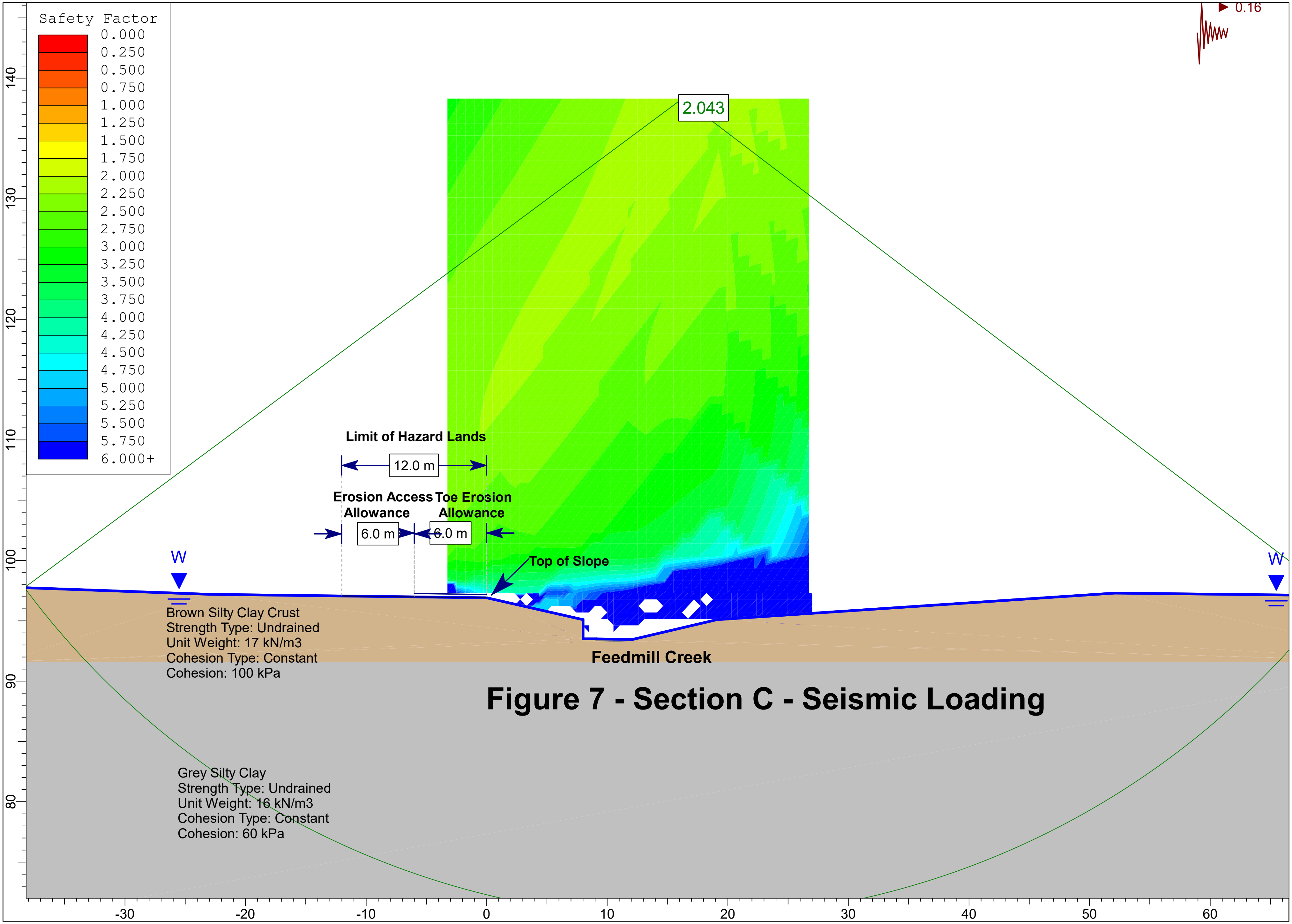


Figure 7 - Section C - Seismic Loading

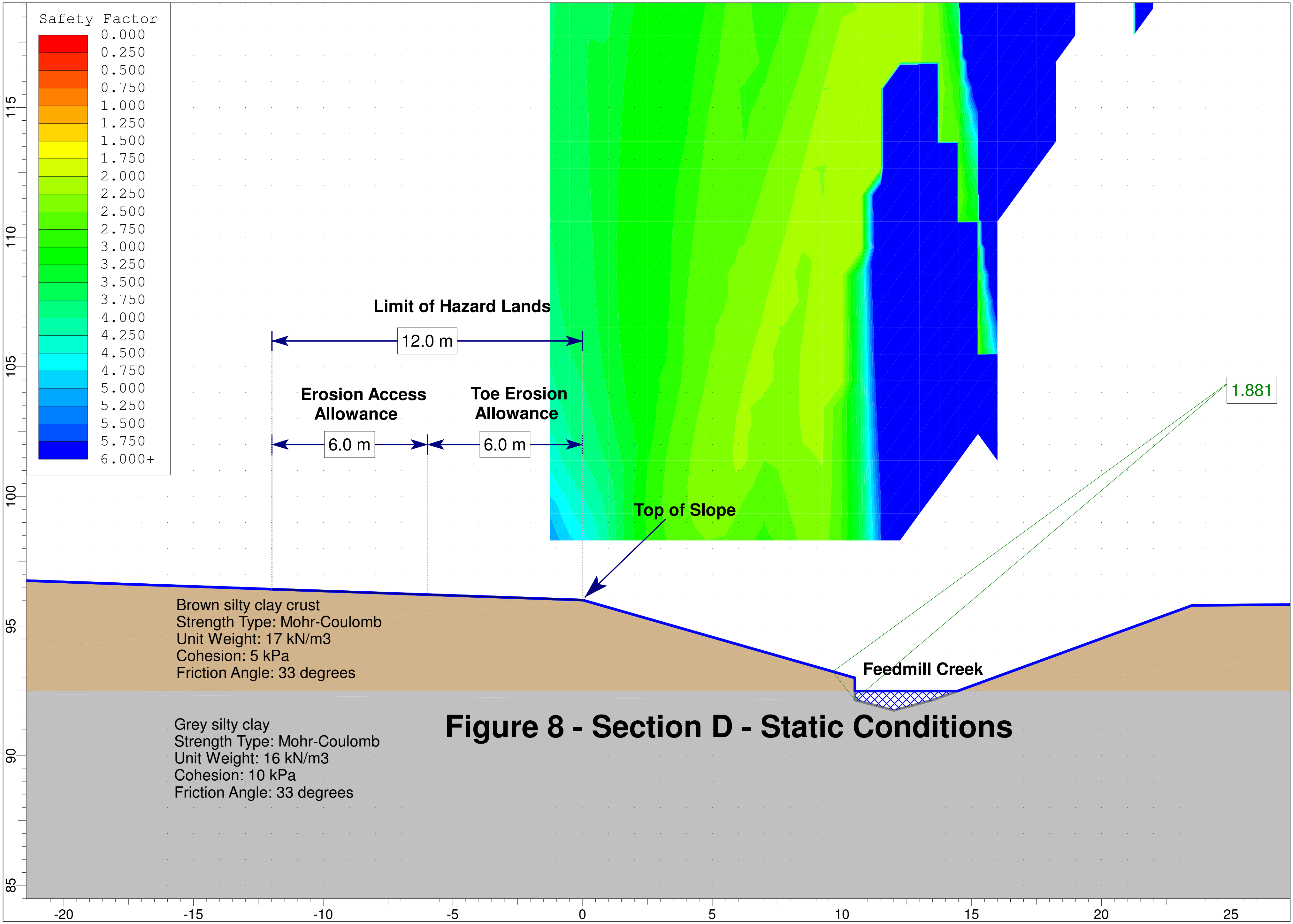


Figure 8 - Section D - Static Conditions

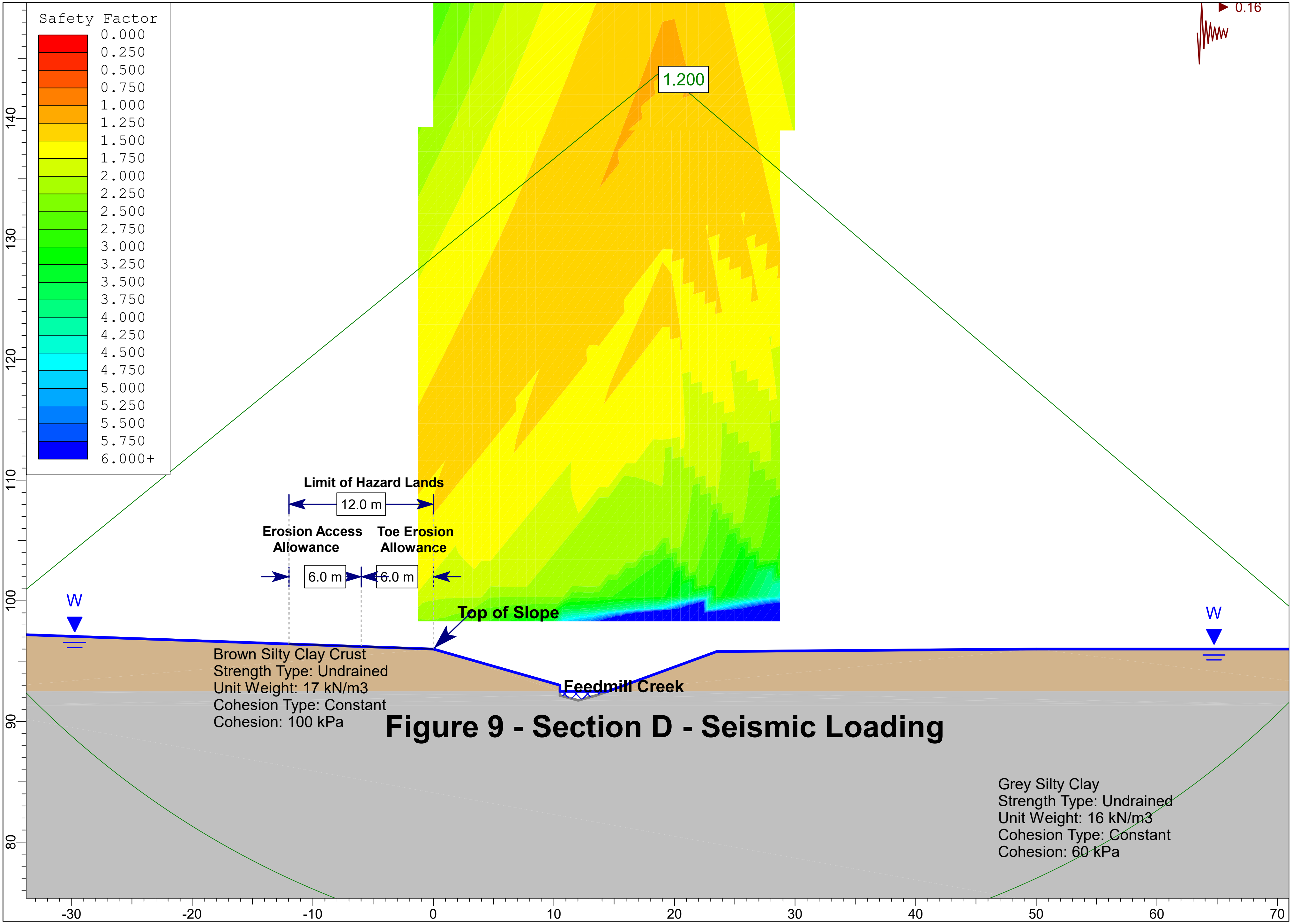


Figure 9 - Section D - Seismic Loading

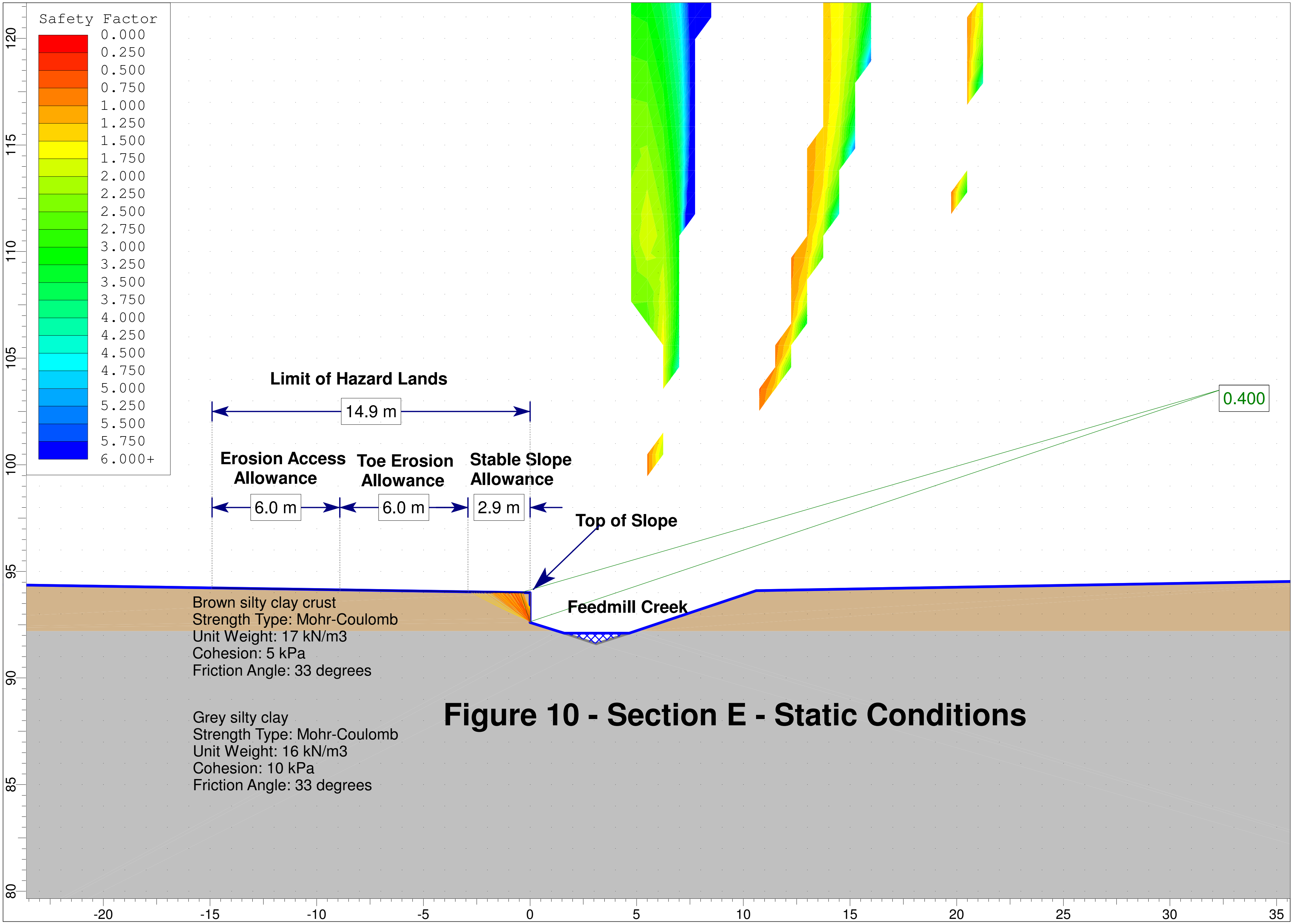


Figure 10 - Section E - Static Conditions

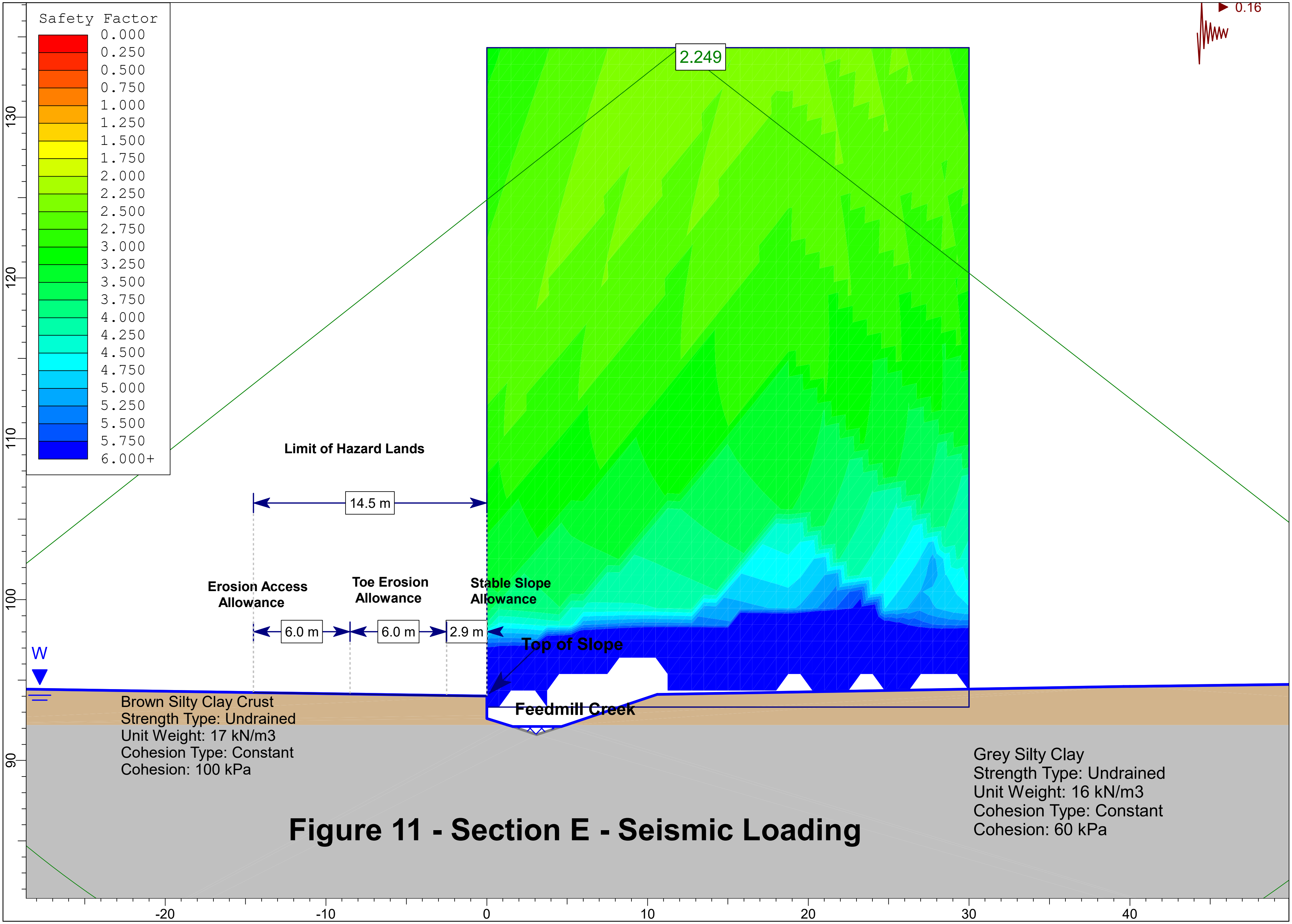


Figure 11 - Section E - Seismic Loading

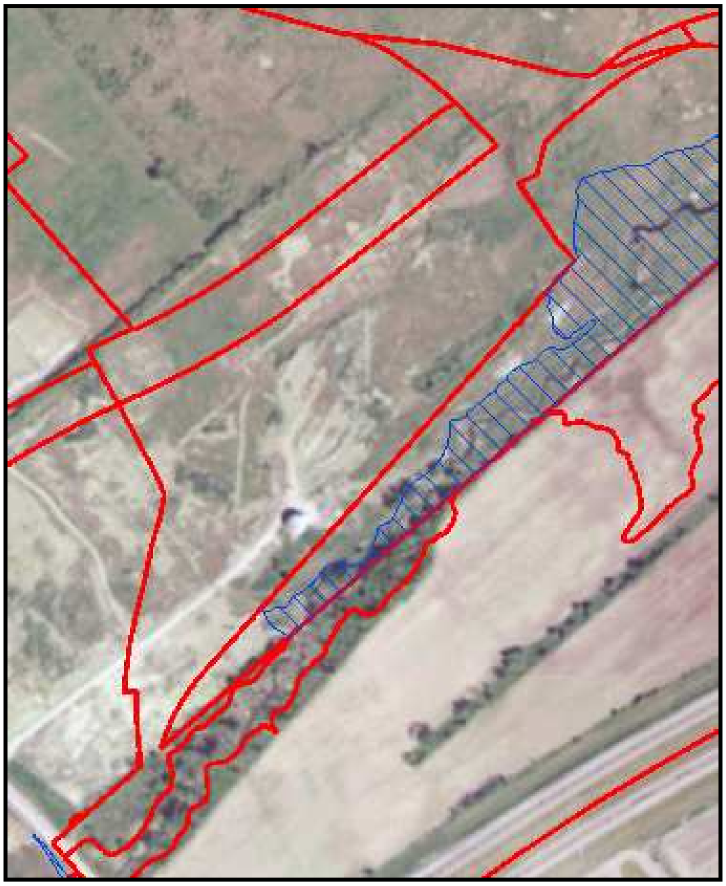


FIGURE 12

AERIAL PHOTO – 1999

PATERSON GROUP

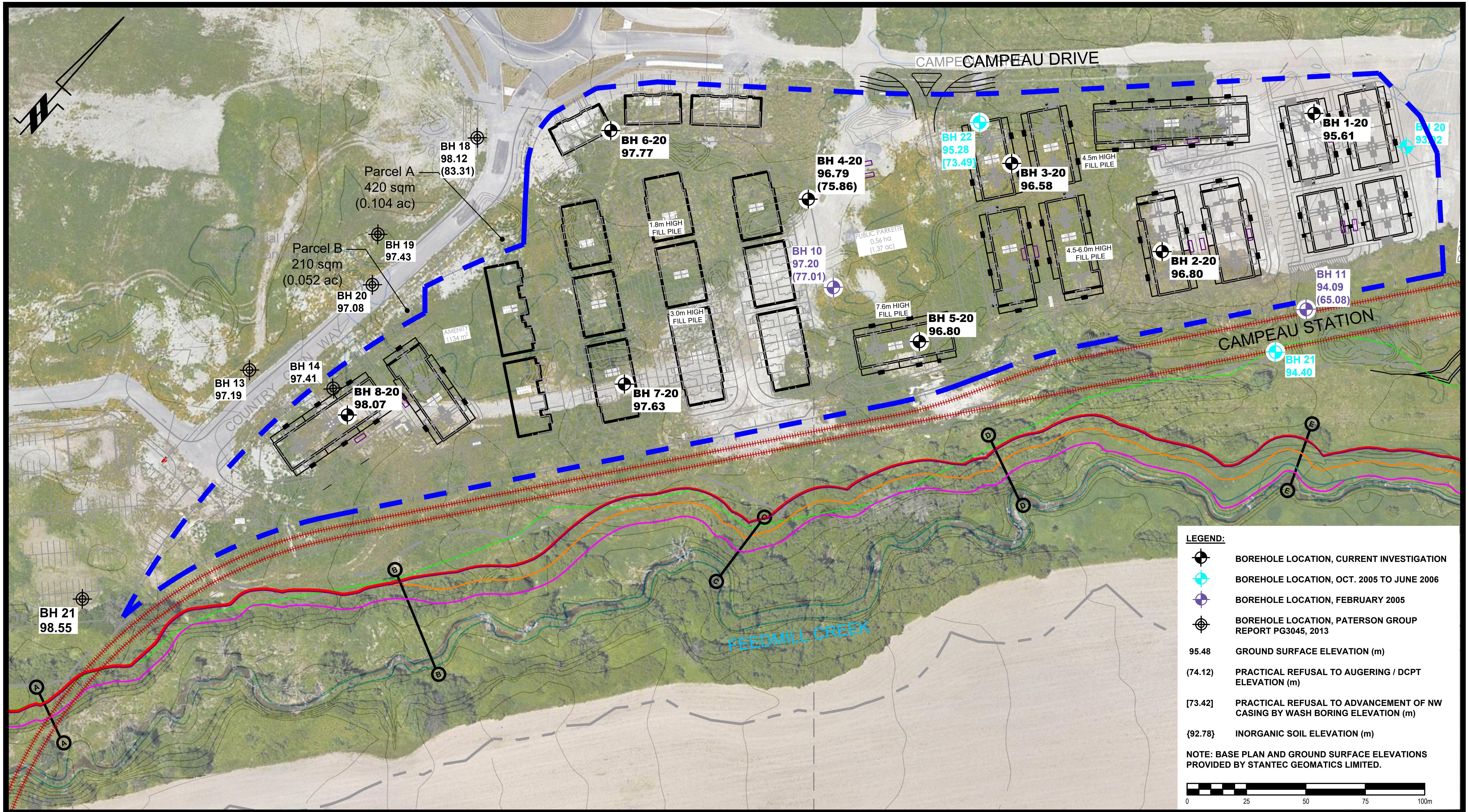
FIGURE 13

AERIAL PHOTO – 2008

FIGURE 14

AERIAL PHOTO – 2019

PATERSON GROUP



PATERSON GROUP
9 AURIGA DRIVE
OTTAWA, ON
K2E 7S9
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL
4	UPDATED TO LATEST CONCEPTUAL PLAN	27/06/2022	NP
3	UPDATED TO LATEST CONCEPTUAL PLAN	01/02/2022	FA
2	UPDATED NEW LIMIT OF HAZARD LANDS	20/01/2022	FA
1	UPDATED TO LATEST CONCEPTUAL PLAN	16/09/2021	FA

MINTO COMMUNITIES

GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT - ARCADIA - STAGE 6

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:1500	Date: 01/2021
Drawn by: RCG	Report No.: PG5648
Checked by: MS	Dwg. No.: PG5648-1
Approved by: FA	Revision No.: 4

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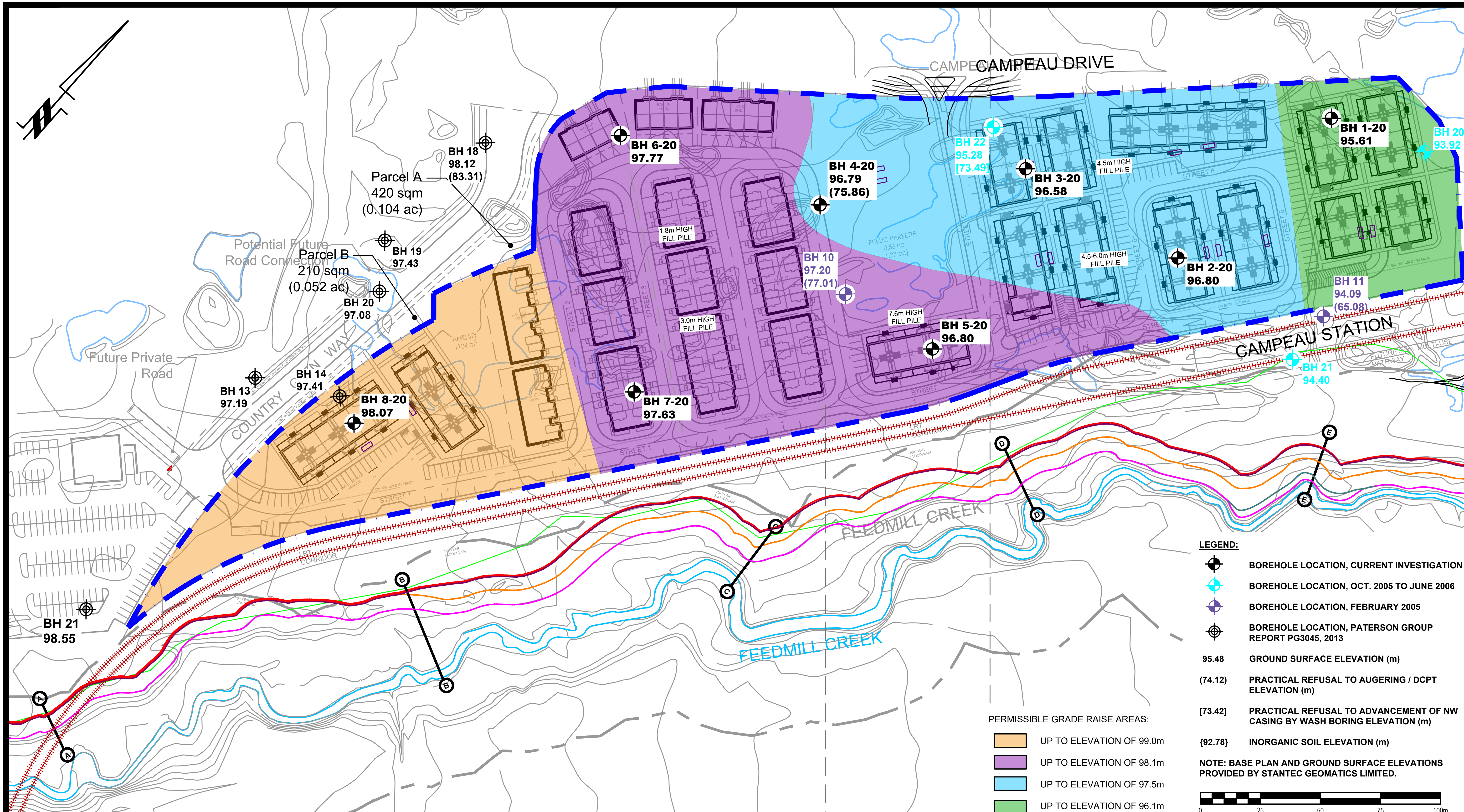

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TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL
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3	UPDATED TO LATEST CONCEPTUAL PLAN	01/02/2022	FA
2	UPDATED NEW LIMIT OF HAZARD LANDS	20/01/2022	FA
1	UPDATED TO LATEST CONCEPTUAL PLAN	16/09/2021	FA

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GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT - ARCADIA - STAGE 6
OTTAWA, ONTARIO

Title:
PERMISSIBLE GRADE RAISE PLAN

Scale: 1:1500	Date: 01/2021
Drawn by: RCG	Report No.: PG5648
Checked by: MS	Dwg. No.: PG5648-2
Approved by: FA	Revision No.: 4

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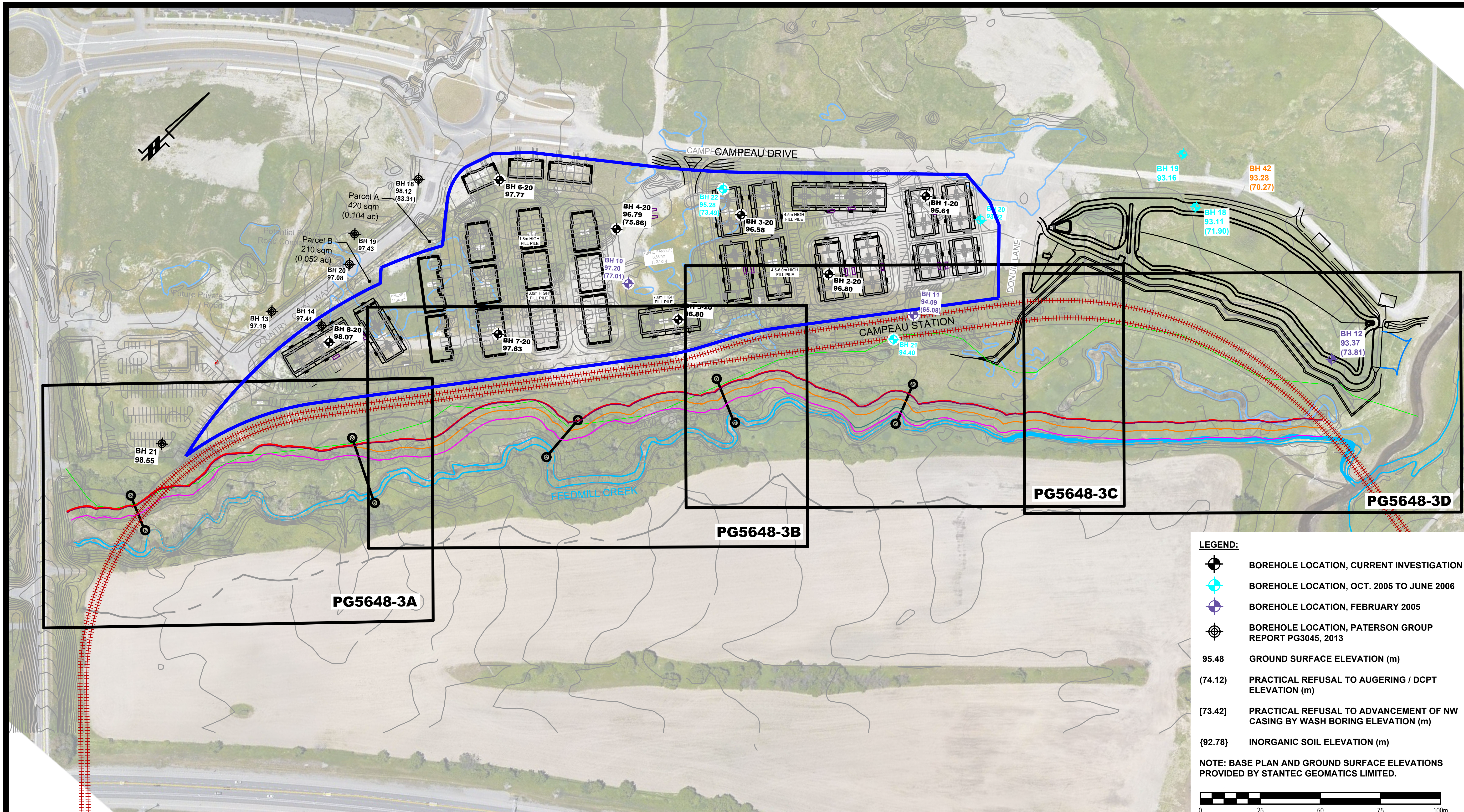

LEGEND:

- BOREHOLE LOCATION, CURRENT INVESTIGATION
- BOREHOLE LOCATION, OCT. 2005 TO JUNE 2006
- BOREHOLE LOCATION, FEBRUARY 2005
- BOREHOLE LOCATION, PATERSON GROUP REPORT PG3045, 2013

95.48	GROUND SURFACE ELEVATION (m)
(74.12)	PRACTICAL REFUSAL TO AUGERING / DCPT ELEVATION (m)
[73.42]	PRACTICAL REFUSAL TO ADVANCEMENT OF NW CASING BY WASH BORING ELEVATION (m)
{92.78}	INORGANIC SOIL ELEVATION (m)

NOTE: BASE PLAN AND GROUND SURFACE ELEVATIONS PROVIDED BY STANTEC GEOMATICS LIMITED.

0 25 50 75 100m

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MINTO COMMUNITIES

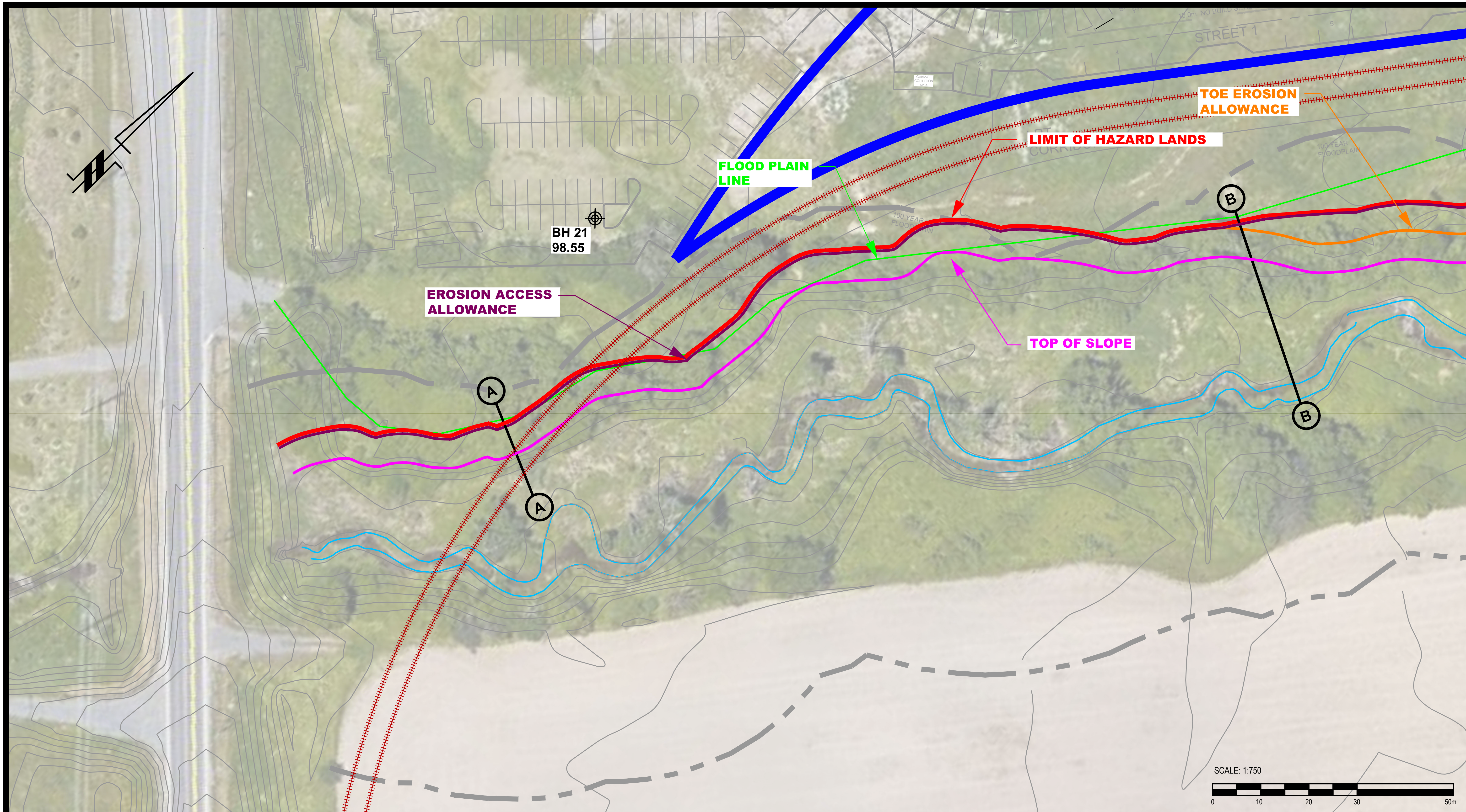
GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT - ARCADIA - STAGE 6

OTTAWA, ONTARIO

Title:

LIMIT OF HAZARD LANDS - KEY PLAN

Scale: 1:1500	Date: 01/2021
Drawn by: RCG	Report No.: PG5648
Checked by: MS	Dwg. No.: PG5648-3
Approved by: FA	Revision No.: 4



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MINTO COMMUNITIES

GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT - ARCADIA - STAGE 6

OTTAWA, ONTARIO

Title:

LIMIT OF HAZARD LANDS - A

Scale: 1:750	Date: 01/2021
Drawn by: RCG	Report No.: PG5648
Checked by: MS	Dwg. No.: PG5648-3A
Approved by: FA	Revision No.: 4

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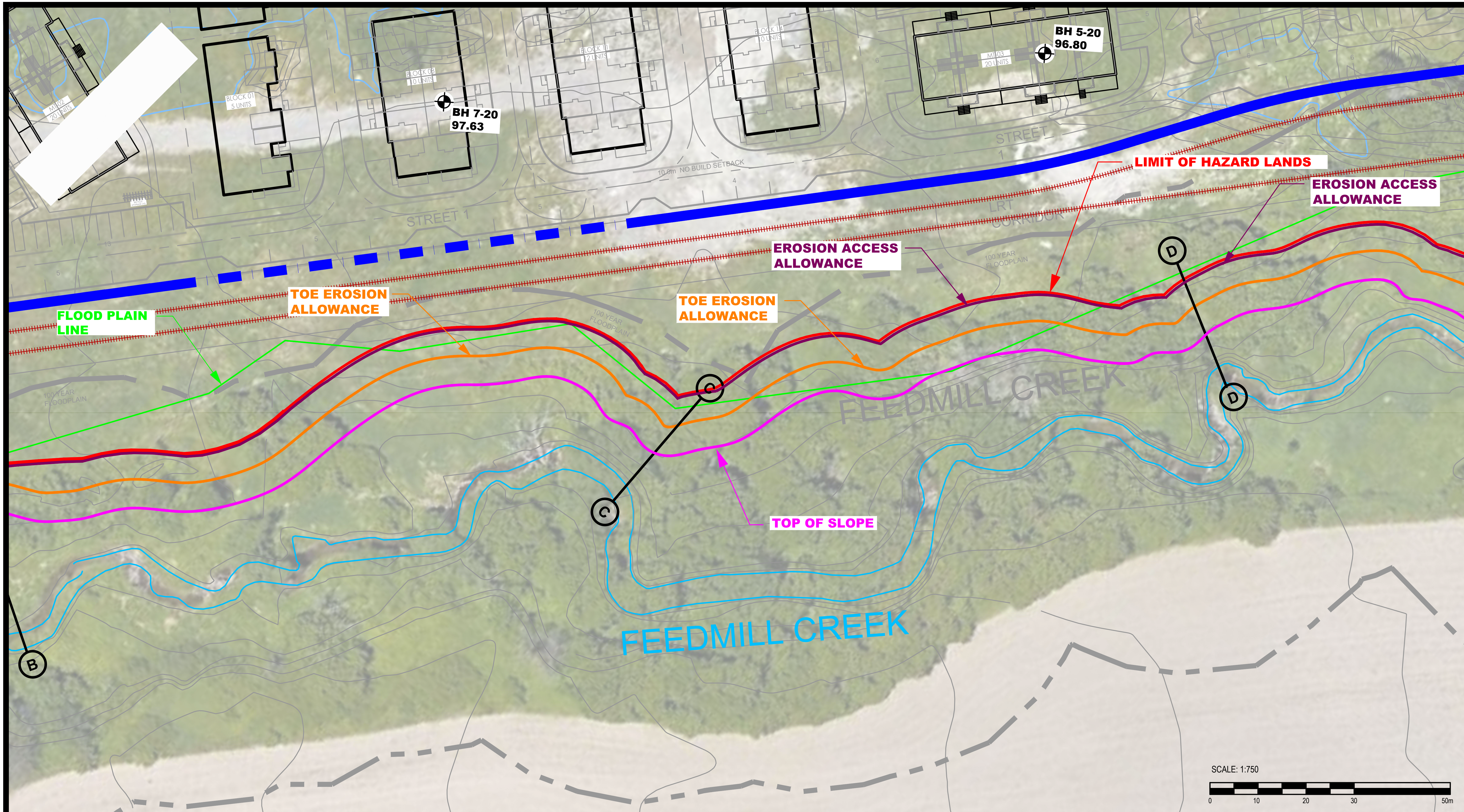

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NO.	REVISIONS	DATE	INITIAL
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2	UPDATED NEW LIMIT OF HAZARD LANDS	20/01/2022	FA
1	UPDATED TO LATEST CONCEPTUAL PLAN	16/09/2021	FA

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GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT - ARCADIA - STAGE 6

OTTAWA, ONTARIO

Title:

LIMIT OF HAZARD LANDS - B

Scale: 1:750

Date: 01/2021

Drawn by: RCG

Report No.: PG5648

Checked by: MS

Dwg. No.: PG5648-3B

Approved by: FA

Revision No.: 4

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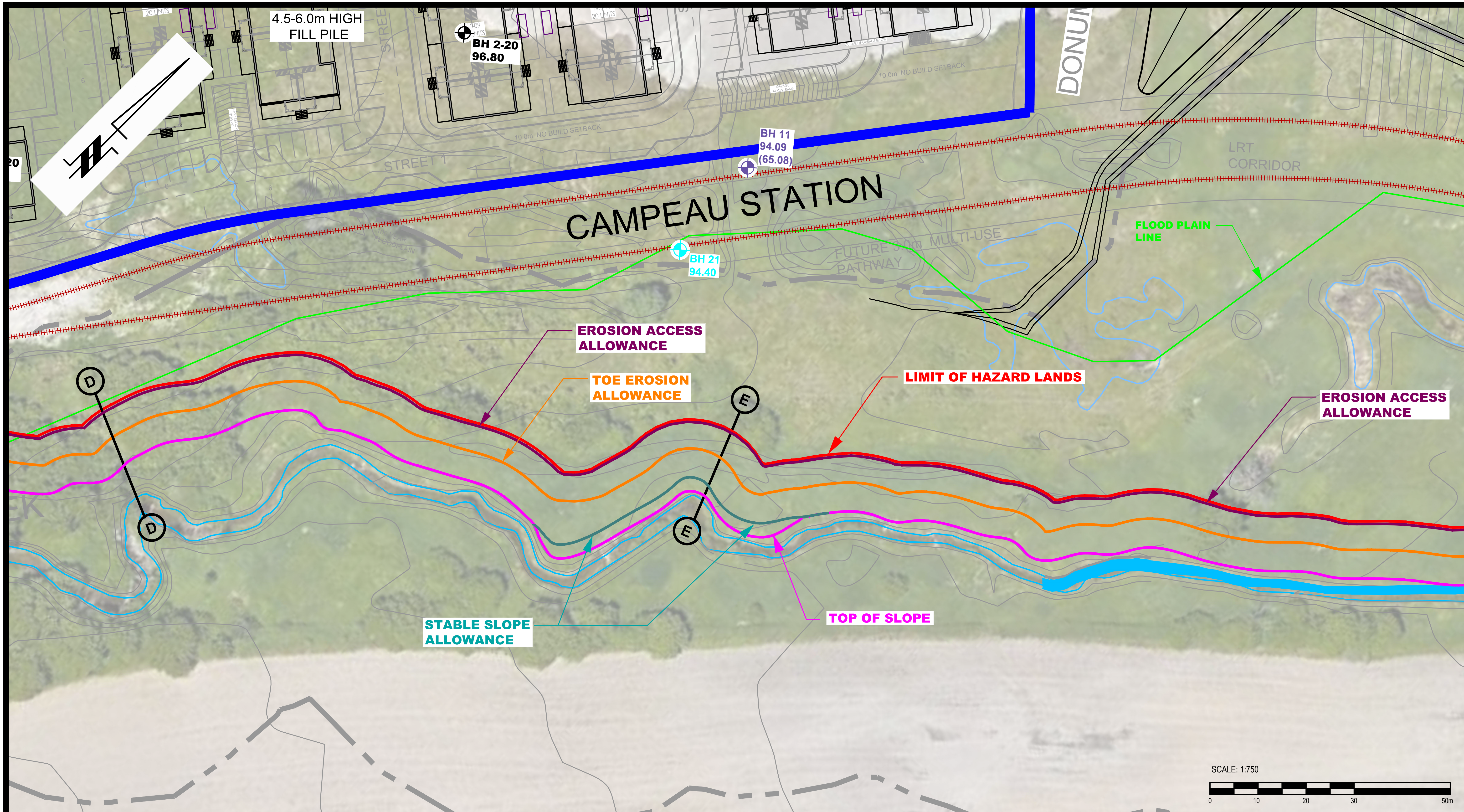

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1	UPDATED TO LATEST CONCEPTUAL PLAN	16/09/2021	FA

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GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT - ARCADIA - STAGE 6

OTTAWA, ONTARIO

Title:

LIMIT OF HAZARD LANDS - C

Scale: 1:750	Date: 01/2021
Drawn by: RCG	Report No.: PG5648
Checked by: MS	Dwg. No.: PG5648-3C
Approved by: FA	Revision No.: 4

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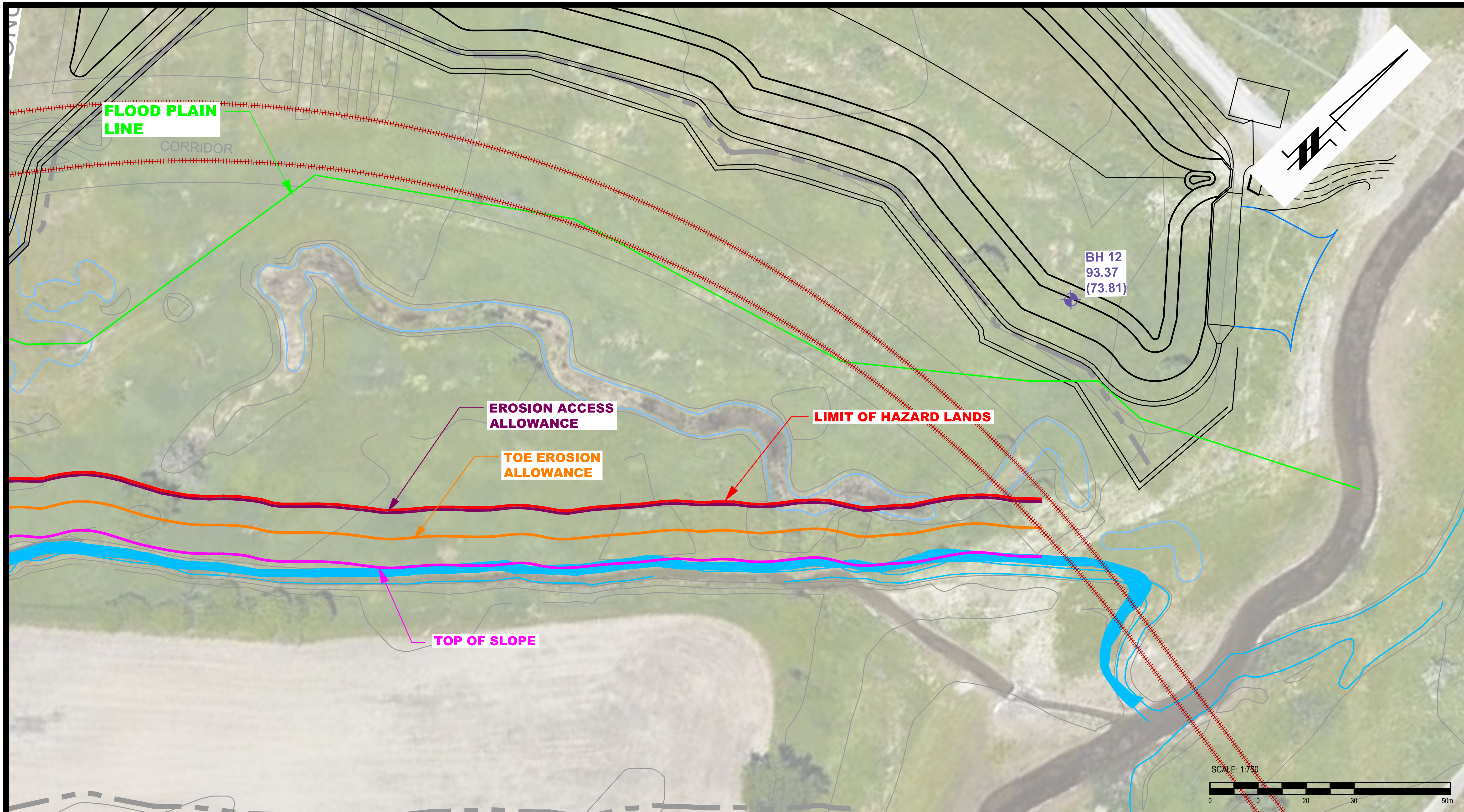

NO.	REVISIONS	DATE	INITIAL
4	UPDATED TO LATEST CONCEPTUAL PLAN	27/06/2022	NP
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PROPOSED RESIDENTIAL DEVELOPMENT - ARCADIA - STAGE 6

OTTAWA, ONTARIO

Title:

LIMIT OF HAZARD LANDS - D

Scale: 1:750	Date: 01/2021
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Checked by: MS	Dwg. No.: PG5648-3D
Approved by: FA	Revision No.: 4

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