PATERSON GROUP

memorandum

re:	**Slope Stability Assessment of Existing Slope Failure** **Existing Residential Dwelling** **1320 Grand-Chêne Court – Ottawa, Ontario**
to:	Tamarack Homes – **Mr. Mike Green** – mike.green@taggart.ca
to:	HP Urban Inc. - **Mr. Peter Hume** - peter.hume@hpurban.ca
to:	DSEL - **Mr. Braden Kaminski** - Bkaminski@dsel.ca
date:	November 13, 2023
file:	PG5201-MEMO.03

Upon your request and authorization, Paterson Group (Paterson) prepared a slope stability assessment report based on understood conditions for the aforementioned site. The present report summarizes our findings and recommendations for the subject site.

1.0 Background Information

Summary of Background

It is generally understood that the City of Ottawa has been made aware of a slope failure observed through LiDAR and topographic mapping by others (Stantec Report 121624058 dated December 13, 2021) and within the rear-yard of 1320 Grand-Chêne Court. The City acknowledged their concern for the stability of the slopes located throughout the proposed Cardinal Creek South residential development through an engineering review comments letter based on their understanding of the current slope failure.

Based on that, Paterson completed a general field review of the failure in conjunction with a desktop review of publicly available and existing historical internal data that has been obtained for the area of the failure. Paterson has undertaken this review to understand the cause of the slope failure that has occurred throughout this property with respect to our recommendations provided for the proposed residential development to the east of this existing dwelling. Further, this has been prepared to provide the City of Ottawa and the Rideau Valley Conservation Authority additional information for their review, records and action for resolving issues associated with the slope failure.

Interview with Property Owner on July 19, 2023

The current property owner of 1320 Grand-Chêne Court was contacted to discuss background information regarding the failure observed along the top of slope and within the backyard of the subject site. The property owner indicated that the failure was initially observed in April of 2014, and shortly after they had taken possession of the property. At that time, the ground surface throughout the area of the existing failure had dropped by approximately 300 mm.

The property owner indicated that the ground surface beyond the neighboring retaining wall had also failed shortly after the retaining wall was built and prior to the placement of fill in 2015. The year of construction of the retaining wall was unknown at the time of the interview.

The property owner had also indicted they had learned from the contractor who constructed the dwellings throughout Grand-Chêne Court that they had loosely dumped soil generated from the building excavations down the slope and also placed it upon the ground surface throughout the subject site. They had indicated to the property owner that they had raised the ground surface throughout the subject site significantly during that time. The property owner did not identify if their structure has suffered damages since taking ownership.

Field Review Work

A field review was conducted by Paterson personnel at the subject site. The purpose of the review was to confirm field conditions at and throughout the area of the subject site. The portion of the subject site between the rear-yard property boundary of 1320 and 1325 Grand-Chêne Court (which is currently identified in the field by an existing woven-wire fence located on the slope) and the adjacent tributary was reviewed on July 12, 2023. The portion between the rear- and side-yard of 1320 Grand-Chêne Court and the tributary was reviewed on July 19, 2023.

At the time of the investigation, hand-augering and in-situ vane testing was carried out to confirm the general subsurface profile characteristics throughout the subject site. The hand auger locations and ground surface elevations were surveyed by Paterson using a handheld GPS and are referenced to a geodetic datum. The location of the hand augers and ground surface elevations are presented on Drawing PG5201-6 - Test Hole Location Plan attached to this report. Reference may be given to photographs taken as part of our site review and attached to the present memo report.

Surface Conditions

The subject site is currently occupied by a two-storey residential dwelling which is located in the northwest corner of the property. The residential dwelling has an associated detached parking garage located in the southwest corner, and a paved driveway. The remaining portion of the subject site consists of landscaped grass and sparsely treed areas. The ground surface across the subject site is relatively flat with a downward slope along the southeast portion towards the south tributary of Cardinal Creek.

The site is bordered to the northeast by a single-storey residential dwelling with an associated paved driveway, approximately 1.0 m high retaining wall and landscaping. The subject site is bordered by residential dwellings to the north and west, by Grand-Chêne Court to the northeast, and a tributary of Cardinal Creek to the southeast.

The top of the slope failure was observed throughout the rear-yard of 1320 Grand-Chêne Court and along the top of the existing slope. The area was surveyed in the field and may be observed on Drawing PG5201-6 - Test Hole Location Plan attached to this report by the topographic shots labeled “TF-xx” and “BF-xx” denoting the top and bottom of the face of the failure, respectively. The height of the face of the failure is approximately between 400 mm and 1.2 m high across its footprint.

Additional slip surfaces were also visible along the bottom of the slope and coinciding with the watercourse within the tributary and are identified on the Drawing PG5201-6 - Test Hole Location Plan as topographic shots labeled as “topfailx”. The ground surface throughout the portion of the slope failure located within the rear-yard of 1320 Grand-Chêne Court was relatively flat at the time of our review.

Subsurface Profile

Generally, the soil profile encountered at the hand auger test hole locations completed during the field review consisted of a layer of fill underlain by a deposit of silty clay. The fill was observed to consist of brown silty clay with sand and gravel and extend approximately 900 mm below the ground surface at the area of the slope failure. Fill was encountered across the slope surface and was readily visible based on the hummocky surface along the slopes surface.

The fill was observed to be underlain by a very stiff layer of brown silty clay throughout the top and mid-portions of the slope. The lower portion of the slope, which is located adjacent to the tributary, was generally observed to consist of a relatively thin layer of brown silty clay underlain by a layer of firm to stiff grey silty clay. HA 3-23 was undertaken within the footprint of the tributary at the time of our field review.

Based on available geological mapping, bedrock in the area consists of limestone of the Bobcaygeon Formation and interbedded limestone and dolomite of the Gull River Formation. The overburden drift thickness ranges between 15 and 25 m. Based on a public well record available by the Ministry of the Environment, Conservation and Park for 1108 Old Montreal Road (located adjacent to and to the west of 1320 Grand-Chêne Court), bedrock was encountered at an approximate depth of 18.2 m below ground surface. This is expected to be representative of the depth to the bedrock surface based on geological mapping and available test hole information for investigations undertaken by Paterson throughout this area.

The location of the hand auger test holes are shown on Drawing PG5201-6 Test Hole Location Plan, appended to this memorandum. Groundwater observations were recorded at the time of the field investigation and are noted on the Soil Profile and Test Data Sheets appended to this memo report.

2.0 Slope Stability Analysis

Field Observations

One slope cross-section was studied as the worst-case scenario as based on observed topography at the time of our site visits. The location of the cross-section location is presented on Drawing PG5201-6 - Test Hole Location Plan, attached to the current memo report. Reference may also be given to photographs taken as part of our site review and attached to this memo report.

The existing slope along the southeast boundary of the subject site was observed to slope downwards gradually towards the south tributary of Cardinal Creek. The slope was observed to be approximately 14 m high and appeared to have a profile generally shaped 3.5H:1V with local sections shaped up to a steepness of 1.5H:1V. The slope surface generally appeared to be heavily vegetated and consisted of brush and large, mature trees. The ground surface across the slope appeared to be hummocky given the previously placed fill material. Based on our observations, the fill material was within the boundary of 1320 Grand-Chêne Court, however, partially extended past the southern property limit.

The tributary located at the bottom of the slope was observed to be approximately 2 m wide and with a low-flowing watercourse with its confines. The watercourse bed consisted of grey silty clay while the sidewalls of the bank were observed to consist of stiff, brown silty clay. Active erosion was observed throughout the majority of the area located throughout the reviewed portion of the creek at the time of our review. Erosion was generally observed of shallow-slip failures, bare-soil sidewalls with a lack of vegetation and steeply cut bank edges directly against the active watercourse.

Slope Stability Analysis

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 limit equilibrium analysis 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 favoring failure. Theoretically, a factor of safety of 1.0 represents a condition where the slope is stable.

However, due to intrinsic limitations of the calculation methods and the variability of the subsoil and groundwater conditions, a factor of safety greater than one is usually required to ascertain that the risks of failure are acceptable. A minimum factor of safety of 1.5 is generally recommended for conditions where the failure of the slope would endanger permanent structures.

The cross-sections were analyzed based on assumed conditions before the occurrence of the failure. Surface conditions were analyzed based on the findings of the field observations and historical City of Ottawa LiDAR topographic contour from 2003 for assessing pre-failure topographic conditions.

The slope analysis was completed at the slope cross-section under worst-case-scenario by assessing cohesive soils under fully saturated conditions. Subsoil conditions at the cross-sections were inferred based on the hand augers completed during the site visit, nearby boreholes and general knowledge of the geology of the area.

The effective strength soil parameters used for static analysis were chosen based on the subsoil information recovered during the geotechnical investigation. The effective strength soil parameters used for static analysis are presented in Table 1 below.

Table 1 - Effective Soil and Material Parameters (Static Analysis)

Soil Layer	Unit Weight (kN/m^3)	Friction Angle (degrees)	Cohesion (kPa)
Fill	18	30	1
Brown Silty Clay Crust	17	36	9
Grey Silty Clay	16	36	12
Glacial Till	20	33	1
Bedrock	Impenetrable		

The total strength parameters for seismic analysis were chosen based on the in situ, undrained shear strengths recovered within the hand-auger test holes completed at the time of our field visit and based on our general knowledge of the area’s geology. The strength parameters used for seismic analysis at the slope cross-sections are presented in Table 2 below.

Table 2 - Total Stress Soil and Material Parameters (Seismic Analysis)			
Soil Layer	**Unit Weight (kN/m^3)**	**Friction Angle (degrees)**	**Undrained Shear Strength (kPa)**
Fill	18	30	N/A
Brown Silty Clay Crust	17	-	100
Grey Silty Clay	16	-	30 to 60
Glacial Till	20	33	N/A
Bedrock	Impenetrable		

Static Conditions Analysis

The results for the slope stability analysis at Section A are shown in Figure 1A, attached to the present memo report. The factor of safety was found to be less than 1.5 and mostly affecting the infilled portion of the slope. The lower factor of safety can be attributed to increased grade raise and surcharge along the top of the slope. Based on our review, the above-mentioned lowest factor of safety generally coincided with the location of the observed existing failure surface at the top of slope.

Seismic Loading Analysis

An analysis considering seismic loading was completed for the proposed conditions as part of the slope assessment. A horizontal seismic acceleration, K_h, of 0.16g was considered for the slopes. This acceleration is considered as half of the peak (horizontal) ground acceleration (PGA) of 0.32g defined by OBC (Ontario Building Code 2012) for the Ottawa area. A factor of safety of 1.1 is considered to be satisfactory for stability analyses including seismic loading.

Summary of Analysis Results

The cross-section models the pre-existing condition before the development of the failure at the top of slope. The results of the analysis including seismic loading are shown in Figure 1B attached to the present memo report. The factor of safety was found to be less than 1.1 along the top of slope and within the fill material. However, a factor of safety of 1.1 is present within the native overburden.

Based on the results, a limit of hazard lands setback should have been assigned to the subject lot and uncontrolled placement of fill along the top of slope and settlement sensitive structures should have not been allowed to prevent future slope failures.

3.0 Discussion and Recommendations

Based on our review, the observed slope failure is expected to have been triggered by a combination of erosion of the toe of the slope by the active watercourse at the bottom of the slope which was exacerbated by the presence of historically placed fill across the slope surface and area overlying the slope. Due to the placement of fill and other structures along the top and face of slope within the limit of hazard land setback, additional loading was induced on the slope face.

Since movement has been observed annually by the landowner at the top of the slope during spring seasons, its expected that on-going erosion at the toe of the slope is occurring and resulting in further loss of support to the previously failed section of the slope. With on-going loss of the support, the failed section of slope may be slowly sliding into the creek during periods when rates of erosion are highest, such as spring after periods of heavy snowmelt and rain.

Based on this, since there is on-going movement, efforts are recommended to be taken to further investigation the in-situ characteristics of the in-situ, undisturbed soil (expected to be located within the boundaries of the subject site and accessible by conventional drill rig equipment) and verify the stability of the remaining, intact slope. Further analysis is recommended to be undertaken to verify the stability of the existing slope and further support to the dwelling currently located at 1320 Grand-Chêne Court.

Current analysis based on the cursory information attained by Paterson suggests the current slope is stable (i.e., FoS is greater than 1.0, but should be assigned a stable slope setback to achieve a minimum FoS of 1.5). However, given the on-going active movement of the disturbed section of the slope by toe erosion, it is possible the existing failure plane can develop further towards the building footprint and result in the loss of additional land and/or structures. Due to the limited field information available for this assessment, additional information attained by boreholes should be attained to verify the in-situ characteristics of the slope profile.

The depth of the failure plane may be able to be confirmed by undertaking boreholes throughout the top of the plateau and area of movement along the top of the slope. However, given the overall instability being experienced in this area, this may be hazardous and unreasonable given the site’s conditions. Further, it is expected that conventional sampling techniques may not be able to determine this depth with a high degree of certainty given the nature of the saturated nature of the clay soils throughout this area.

Depending on the outcome of the additional analysis, instability of the slope may be able to be resolved by a combination of efforts. On-going erosion may be able to be mitigated by the implementation of erosion protection throughout the area of 1320 and 1325 Grand-Chêne Court. This would resolve on-going loss of support at the toe of the slope and further movements in the slope surface extending into the rear-yard of the subject site.

Further, if it is found that the existing grade is higher than considered tolerable for the underlying clay deposit, consideration could be given to replacing the existing fill with lightweight fill and/or removing a portion of the existing fill to reduce the surcharge being imparted onto the underlying clay deposit.

It is recommended to restrict the potential for any grade raise or landscaping work that could result in raising the ground surface throughout the 1320 and 1325 Grand-Chêne Court parcels until further investigations and analysis have been completed to verify the in-situ soil characteristics.

We trust that the current submission meets your requirements.

Best Regards,

Paterson Group Inc.

LICENSED PROFESSIONAL ENGINEER
November 13, 2023
F. I. ABOU-SEIDO
100156744
PROVINCE OF ONTARIO

Drew Petahtegoose, P.Eng.

Faisal I. Abou-Seido, P.Eng.

Attachments:

- ❒ Soil Profile and Test Data Sheets
- ❒ Slope Stability Analysis Sections
- ❒ Photographs from Site Visit
- ❒ Drawing PG5201-6 - Test Hole Location Plan

SOIL PROFILE AND TEST DATA

GEOTECHNICAL INVESTIGATION

1320 Grand-Chêne Court, Ottawa, Ontario

PATERSON GROUP

DATUM: Geodetic **EASTING:** 385456.7 **NORTHING:** 5039640 **ELEVATION:** 75.98

PROJECT: Existing Residential Dwelling

BORINGS BY: Hand Auger

REMARKS:

DATE: July 19, 2023

FILE NO. PG5201

HOLE NO. HA 1-23

SAMPLE DESCRIPTION	STRATA PLOT	SAMPLE No.	SAMPLE Type	SAMPLE % RECOVERY	N VALUE or RQD	WATER CONTENT %	DEPTH (m)	Remoulded Shear Strength (kPa) 0 25 50 75 100	Peak Shear Strength (kPa) 0 25 50 75 100	Pen. Resist. Blows/0.3m (50 mm Dia. Cone) 0 25 50 75 100	Piezometer Construction
Ground Surface EL 75.98 m							0				No Data
TOPSOIL 0.1 m EL 75.88 m											
FILL: Brown silty clay with sand and gravel 0.9 m EL 75.08 m							1				
Very stiff, brown SILTY CLAY								88	(198)		
1.8 m EL 74.18 m								72	(160)		
End of Hand Auger Hole							2				
Hand auger hole terminated at extent of hand auger within in-situ, undisturbed, very stiff, brown silty clay.											
(GWL at 0.85m depth based on field observation)							3				

SOIL PROFILE AND TEST DATA

GEOTECHNICAL INVESTIGATION

1320 Grand-Chêne Court, Ottawa, Ontario

PATERSON GROUP

DATUM: Geodetic **EASTING:** 385457.9 **NORTHING:** 5039618 **ELEVATION:** 72.69

PROJECT: Existing Residential Dwelling

BORINGS BY: Hand Auger

REMARKS:

DATE: July 12, 2023

FILE NO. PG5201

HOLE NO. HA 2-23

SAMPLE DESCRIPTION	STRATA PLOT	SAMPLE No.	SAMPLE Type	SAMPLE % RECOVERY	N VALUE or RQD	WATER CONTENT %	DEPTH (m)	Remoulded Shear Strength (kPa) 0 25 50 75 100	Peak Shear Strength (kPa) 0 25 50 75 100	Pen. Resist. Blows/0.3m (50 mm Dia. Cone) 0 25 50 75 100	Piezometer Construction
Ground Surface EL 72.69 m											
TOPSOIL 0.1 m EL 72.59 m							0				No Data
FILL: Brown silty clay with sand gravel 0.6 m EL 72.09 m											
Very stiff, brown SILTY CLAY 1.8 m EL 70.89 m							1	60	(112)		
End of Hand Auger Hole							2				
Hand auger hole terminated at extent of hand auger within in-situ, undisturbed, very stiff, brown silty clay.							3				

SOIL PROFILE AND TEST DATA

GEOTECHNICAL INVESTIGATION

1320 Grand-Chêne Court, Ottawa, Ontario

PATERSON GROUP

DATUM: Geodetic **EASTING:** 385501.7 **NORTHING:** 5039601 **ELEVATION:** 63.02

PROJECT: Existing Residential Dwelling

BORINGS BY: Hand Auger

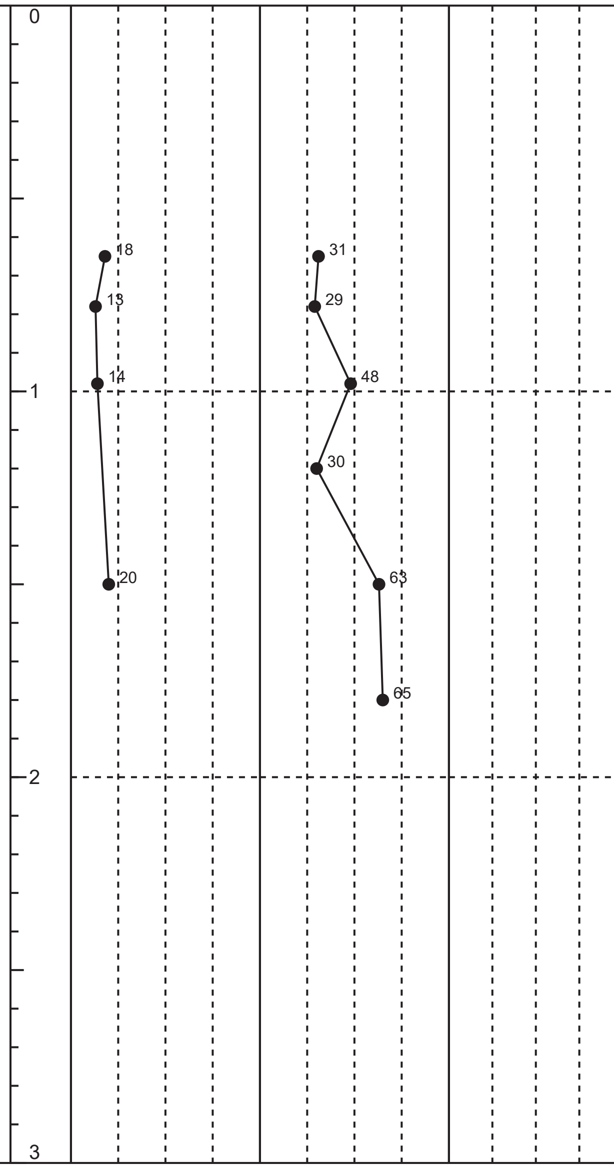
REMARKS:

DATE: July 12, 2023

FILE NO. **PG5201**

HOLE NO. HA 3-23

SAMPLE DESCRIPTION	STRATA PLOT	SAMPLE No.	SAMPLE Type	SAMPLE % RECOVERY	N VALUE or RQD	WATER CONTENT %	DEPTH (m)	Remoulded Shear Strength (kPa) 0 25 50 75 100	Peak Shear Strength (kPa) 0 25 50 75 100	Pen. Resist. Blows/0.3m (50 mm Dia. Cone) 0 25 50 75 100	Piezometer Construction
Ground Surface EL 63.02 m											
Firm to stiff, grey SILTY CLAY							0 – 1.8	18, 13, 14, 20	31, 29, 48, 30, 63, 65		No Data
1.8 m EL 61.22 m											
End of Hand Auger Hole Hand auger hole terminated at extent of hand auger within in-situ, undisturbed, stiff, grey silty clay. Hand auger hole undertaken at edge of and beside active watercourse and within confines of existing creek.							2 – 3				



DISCLAIMER: THE DATA PRESENTED IN THIS LOG IS THE PROPERTY OF PATERSON GROUP AND THE CLIENT FOR WHO IT WAS PRODUCED. THIS LOG SHOULD BE READ IN CONJUNCTION WITH ITS CORRESPONDING REPORT. PATERSON GROUP IS NOT RESPONSIBLE FOR THE UNAUTHORIZED USE OF THIS DATA.

316 6e

Ministry of the Environment
Ontario

The Ontario Water Resources Act
WATER WELL RECORD

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 1518331 MUNICIP 15011 CON ØF 01

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
Carleton	Cumberland	1 O S. O.F.I	028 Pt 28 8

[redacted] . Pierre St. Cumberland, Ont.

DATE COMPLETED: DAY 03 MO 06 YR 83

[redacted] 37499 RC 4 ELEVATION 0280 RC 4 BASIN CODE 26

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	TO
yellow	clay			0	23
blue	clay			23	60
grey	limestone			60	65
grey	"			65	66

31 0023505 | 0060305 | 0066215

32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
0066	1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	TO
6¼ 06	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	188	+2	0066
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.) | DIAMETER INCHES | LENGTH FEET
MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD: air — 1 ☒ PUMP 2 ☐ BAILER
PUMPING RATE: 0024 GPM
DURATION OF PUMPING: 01 HOURS 00 MINS

STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
050 FEET	060 FEET	050 FEET	050 FEET	050 FEET	050 FEET

WATER LEVELS DURING: 1 ☐ PUMPING 2 ☒ RECOVERY

IF FLOWING GIVE RATE: GPM
PUMP INTAKE SET AT: 60 FEET
WATER AT END OF TEST: 1 ☒ CLEAR 2 ☐ CLOUDY
RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP
RECOMMENDED PUMP SETTING: 060 FEET
RECOMMENDED PUMPING RATE: 0024 GPM

FINAL STATUS OF WELL 1

1 ☒ WATER SUPPLY 2 ☐ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL 5 ☐ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED, POOR QUALITY 7 ☐ UNFINISHED

WATER USE 01

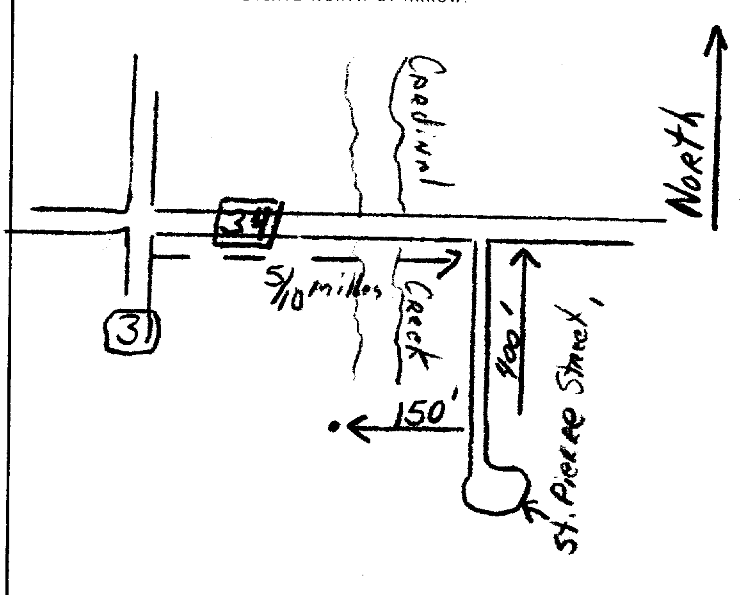
1 ☒ DOMESTIC 2 ☐ STOCK 3 ☐ IRRIGATION 4 ☐ INDUSTRIAL ☐ OTHER 5 ☐ COMMERCIAL 6 ☐ MUNICIPAL 7 ☐ PUBLIC SUPPLY 8 ☐ COOLING OR AIR CONDITIONING 9 ☐ NOT USED

METHOD OF DRILLING 4

1 ☐ CABLE TOOL 2 ☐ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☒ ROTARY (AIR) 5 ☐ AIR PERCUSSION 6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



DRILLERS REMARKS

CONTRACTOR

NAME OF WELL CONTRACTOR: G. Charbonneau+Son Drilling Ltd — LICENCE NUMBER 1504
ADDRESS: R.R. 2, Box 194, Orleans, Ont. K1C 1T1
NAME OF DRILLER OR BORER: Raymond Charbonneau — LICENCE NUMBER
SIGNATURE OF CONTRACTOR: [signature]
SUBMISSION DATE: DAY 03 MO 06 YR 83

OFFICE USE ONLY

DATA SOURCE 1 | CONTRACTOR 1504 | DATE RECEIVED 050883
DATE OF INSPECTION | INSPECTOR
REMARKS
CSS. ES

MINISTRY OF THE ENVIRONMENT COPY

FORM NO. 0506-4-77 FORM 7

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 = $(D30)^2 / (D10 \times D60)$
Cu	-	Uniformity coefficient = D60 / D10

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

CONSOLIDATION TEST

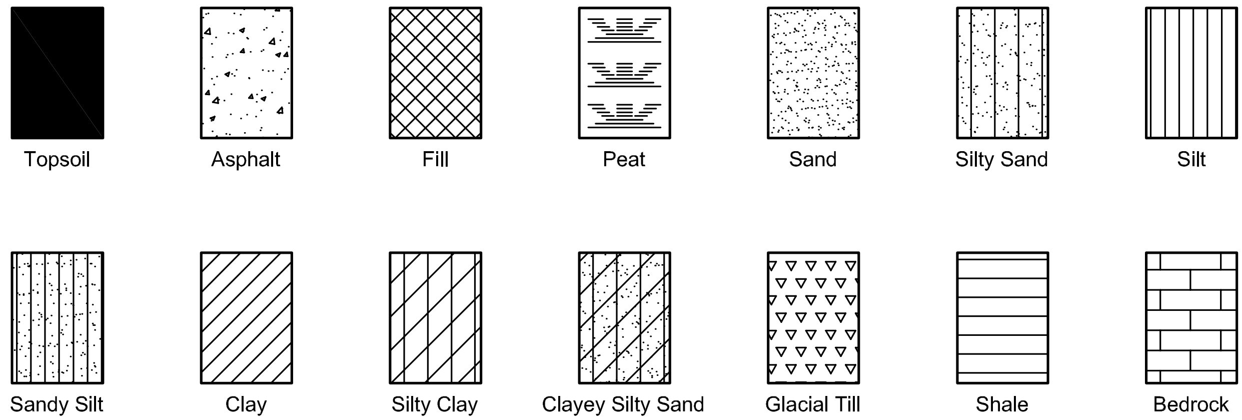
p'_o	-	Present effective overburden pressure at sample depth
p'_c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'_c)
Cc	-	Compression index (in effect at pressures above p'_c)
OC Ratio		Overconsolidaton ratio = p'_c / p'_o
Void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

PERMEABILITY TEST

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

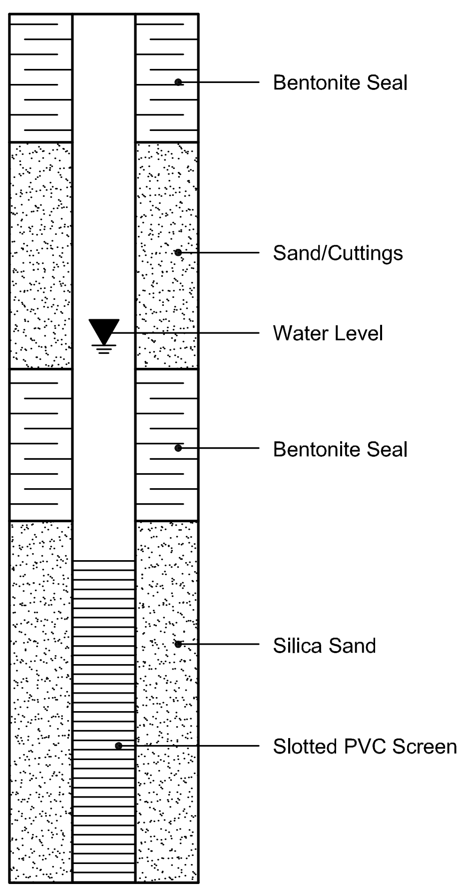
SYMBOLS AND TERMS (continued)

STRATA PLOT

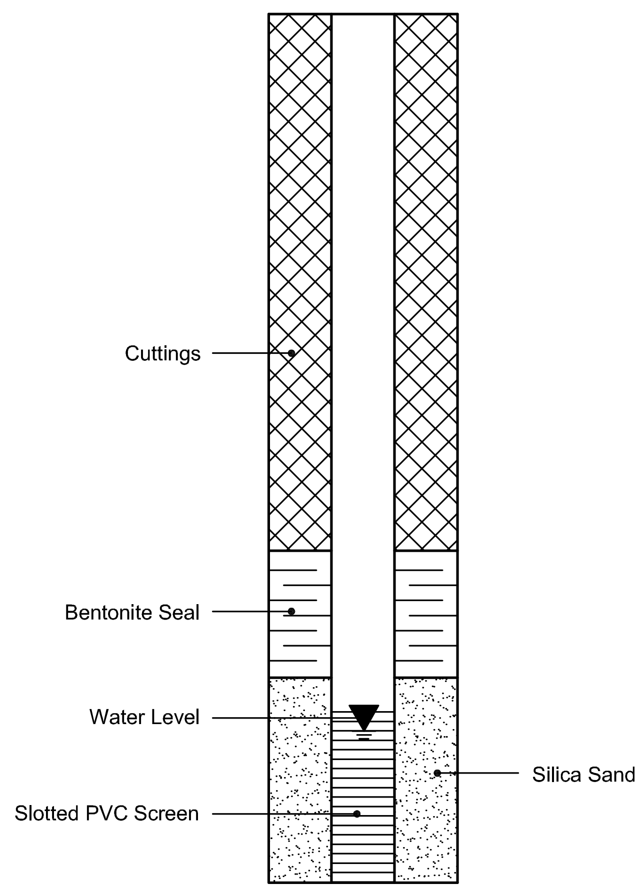


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



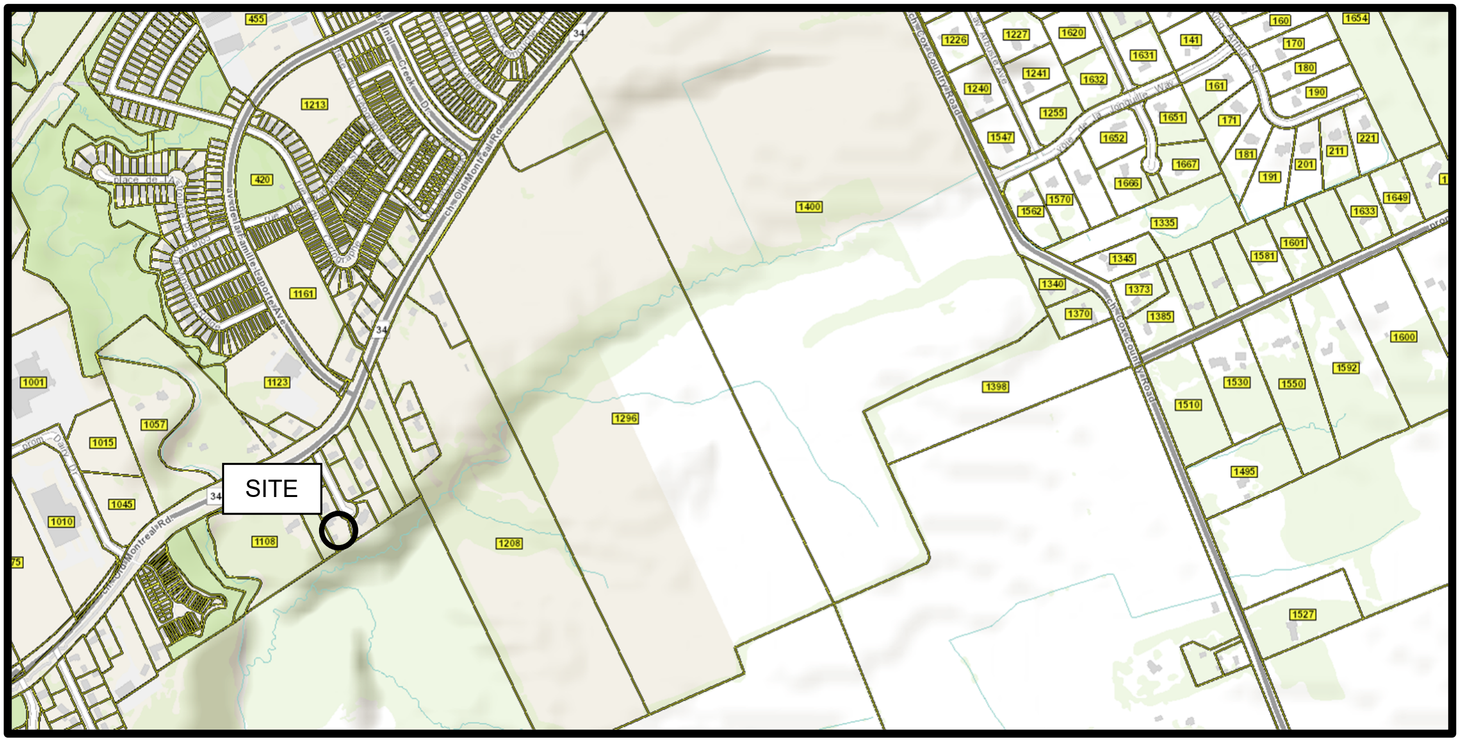


FIGURE 1

KEY PLAN

PATERSON GROUP

Photographs from Site Visit – July 12 & 19, 2023

Photo 1: Photograph of failure observed along the top of slope at the property site. Photo taken from 1325 Grand Chêne Court. Photograph provided by the property owner.

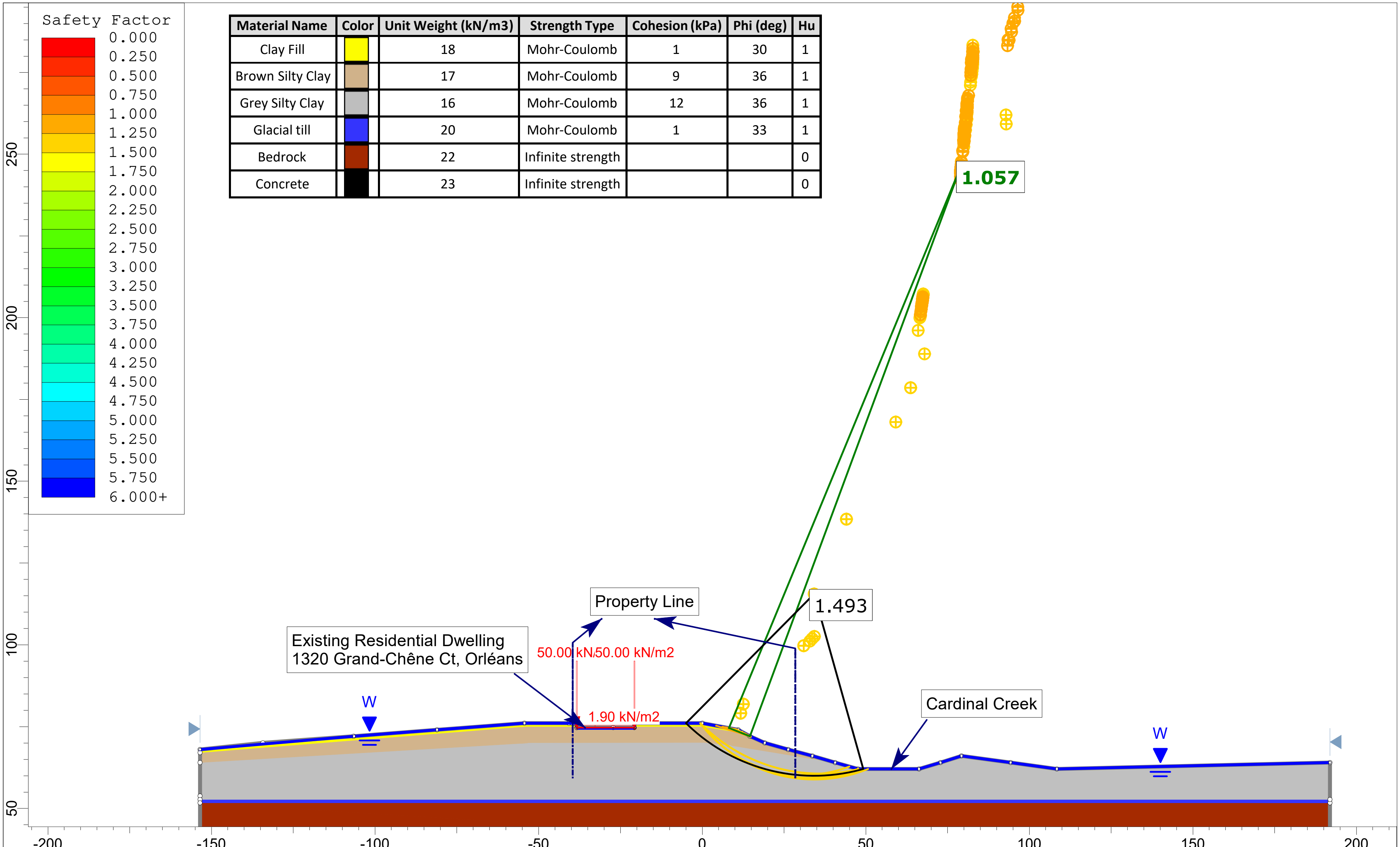
Photo 2: Photograph of failure observed along the top of slope at the property site. Photo taken from the southwest portion of the subject site. Photograph provided by the property owner.

Photographs from Site Visit – July 12 & 19, 2023

Photo 3: Photograph along the slope face, facing northeast. The photograph depicts the presence of mature vegetation. The face of slope can be observed to consist of brown silty clay.

Photo 4: Photograph of the face of slope indicating the presence of mature vegetation. The face of slope is observed to consist mostly of brown silty clay.

Photo 5: Photograph of the toe of slope and along the north tributary to Cardinal Creek. The toe of slope is observed to consist of grey silty clay with minor signs of erosion.

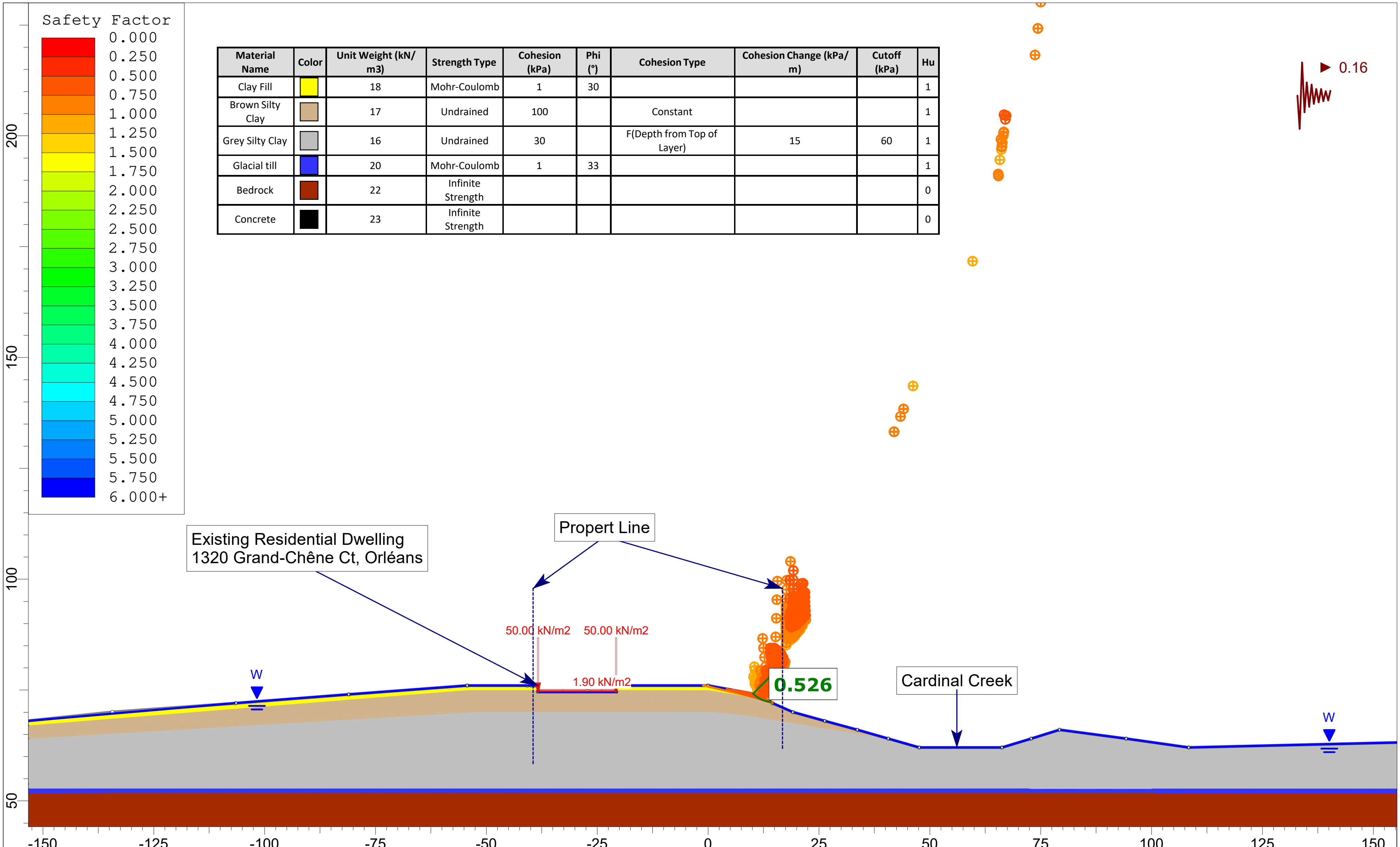


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Hu
Clay Fill		18	Mohr-Coulomb	1	30	1
Brown Silty Clay		17	Mohr-Coulomb	9	36	1
Grey Silty Clay		16	Mohr-Coulomb	12	36	1
Glacial till		20	Mohr-Coulomb	1	33	1
Bedrock		22	Infinite strength			0
Concrete		23	Infinite strength			0

PATERSON GROUP

SLIDEINTERPRET 9.025

Project	PG5201- 1320 Grand-Chene Ct, Orleans		
Cross Section	PP	*Scenario*	Static Condition
Drawn By	EA	*Company*	Tamarack Homes
Date	8/31/2023	*File Name*	Geotechnial Investigation

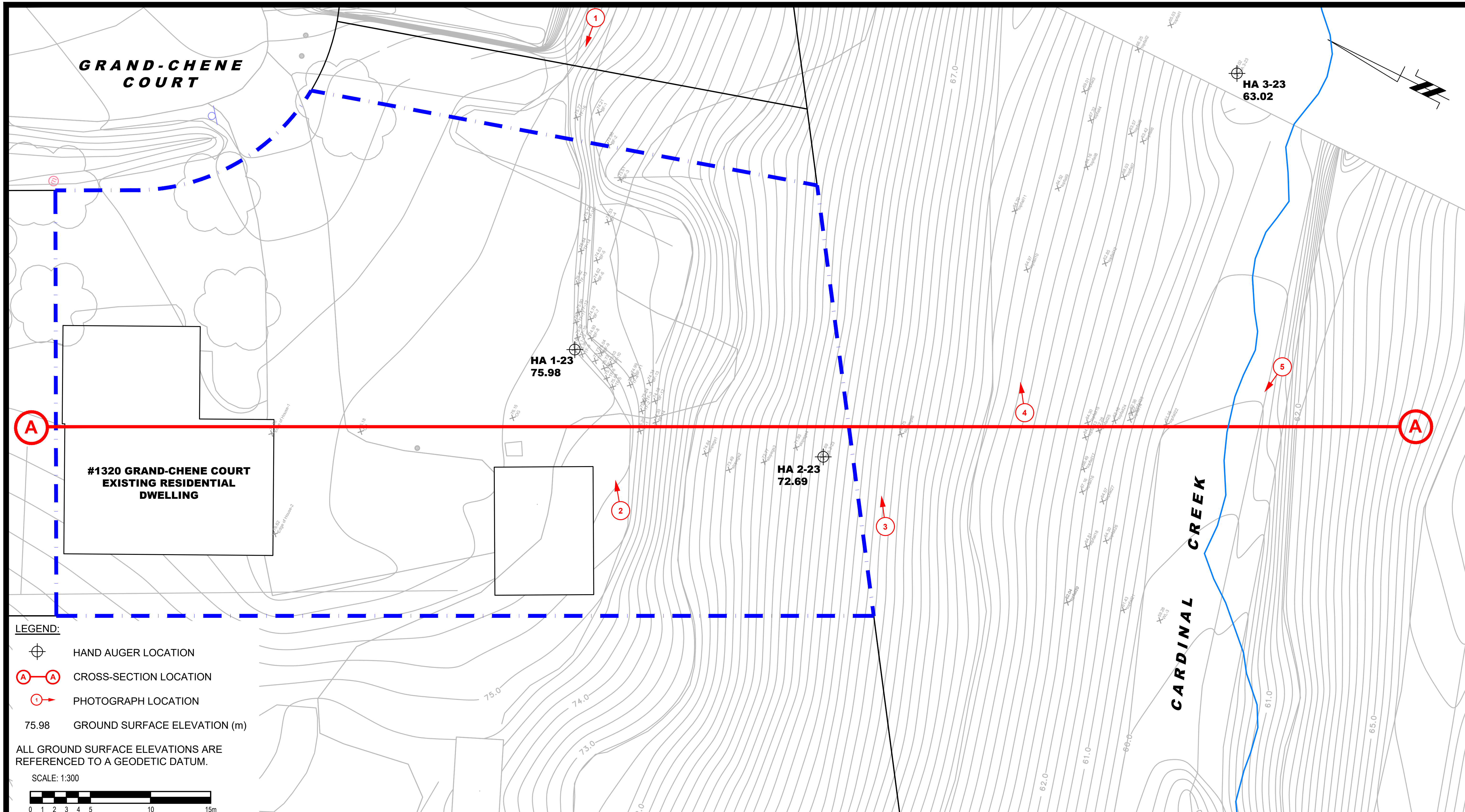


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Cohesion Type	Cohesion Change (kPa/m)	Cutoff (kPa)	Hu
Clay Fill		18	Mohr-Coulomb	1	30				1
Brown Silty Clay		17	Undrained	100		Constant			1
Grey Silty Clay		16	Undrained	30		F(Depth from Top of Layer)	15	60	1
Glacial till		20	Mohr-Coulomb	1	33				1
Bedrock		22	Infinite Strength						0
Concrete		23	Infinite Strength						0

PATERSON GROUP

SLIDEINTERPRET 9.031

Project	PG5201 - 1320 Grand-Chene Ct, Orleans		
Cross Section	PP	*Scenario*	Seismic Condition
Drawn By	EA	*Company*	Tamarack Homes
Date	11/16/2023	*File Name*	Geotechnial Investigation



PATERSON GROUP
9 AURIGA DRIVE
OTTAWA, ON
K2E 7T9
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL

TAGGART INVESTMENTS

GEOTECHNICAL INVESTIGATION
EXISTING RESIDENTIAL DWELLING
1320 GRAND-CHENE COURT

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:300	Date: 09/2023
Drawn by: NFRV	Report No.: PG5201-1
Checked by: FC	Dwg. No.: PG5201-6
Approved by: FA	Revision No.:

p:\autocad drawings\geotechnical\pg52xx\pg5201\pg5201-6 thlp.dwg