May 15, 2023
File: PG5947-LET.02

Schlegel Villages
325 Max Becker Drive
Kitchener, Ontario
K2E 4H5

Attention: **Mr. Brad Schlegel**

Subject: Global Stability Analysis
Proposed Retaining Walls
1919 Riverside Drive, Ottawa, Ontario

PATERSON GROUP

Consulting Engineers
9 Auriga Drive
Ottawa, Ontario
K2E 7T9
Tel: (613) 226-7381

Geotechnical Engineering
Environmental Engineering
Hydrogeology
Materials Testing
Building Science
Rural Development Design
Retaining Wall Design
Noise and Vibration Studies

patersongroup.ca

Dear Sir,

As requested, Paterson Group Inc. (Paterson) completed a global stability analysis to determine the stability of the proposed retaining walls to be located at the aforementioned site. The following sections provide a summary of our analysis of the proposed conditions as well as design and construction considerations for the proposed retaining wall structures.

Background Information

The following grading plan prepared by McIntosh Perry was reviewed as part of our global stability analysis:

- ❏ Project No. CCO-21-2955 – Site Grading and Drainage Plan, Drawing No. C101, Revision 3, dated December 20, 2022

Based on our review, there are three (3) landscaping and one (1) cast-in-reinforced concrete retaining wall with exposed portions greater than 1.0 m.

Subsurface Profile

Based on the investigation completed on June 20 to 23, 2022 the subsurface conditions are noted as following:

Overburden

Generally, the subsurface profile at the subject site consists of an approximate 0.05 to 0.1 m thick layer of asphalt or topsoil, underlain by fill. The fill material was observed to generally consist of a brown silty sand to silty clay with gravel and crushed stone. The depth of the fill layer ranged from 0.5 to 4.9 m depth below the existing ground surface.

Underlying the fill material, a thin deposit of silty clay to silty sand was observed, and is further underlain by a deposit of glacial till. The glacial till deposit generally consists of a compact to very dense, brown to grey silty clay to silty sand with gravel, cobbles, and boulders.

Bedrock

Based on the recovered rock core, the bedrock was observed to consist of shale, with the upper 1 to 3 m of the bedrock being generally very poor to fair in quality and becoming good to excellent in quality with depth.

Based on available geological mapping, bedrock in the area of the subject site consists of shale of the Billings and Carlsbad Formations with an overburden thickness ranging from approximately 3 to 10 m.

Bearing Resistance Values

Footings placed on an undisturbed, compact to very dense glacial till, or on engineered fill which is placed and compacted directly over the undisturbed, compact to very dense glacial till, can be designed using a bearing resistance value at serviceability limit states (SLS) of **200 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **300 kPa**. A geotechnical resistance factor of 0.5 was applied to the above noted bearing resistance value at ULS.

An undisturbed soil-bearing surface consists of a surface from which all topsoil and deleterious materials, such as loose, frozen or disturbed soil, whether in situ or not, have been removed, in the dry, prior to the placement of concrete for footings. Footings designed using the bearing resistance values at SLS given above will be subjected to potential post-construction total and differential settlements of 25 and 20 mm, respectively.

Footings placed on clean, surface-sounded shale bedrock, or on lean concrete which is placed directly over the clean, surface-sounded shale bedrock, can be designed using a factored bearing resistance value at ultimate limit states (ULS) of **1,000 kPa**, incorporating a geotechnical resistance factor of 0.5.

A clean, surface-sounded bedrock-bearing surface should be free of loose materials, and have no near-surface seams, voids, fissures or open joints which can be detected from surface sounding with a rock hammer. Footings supported either on an acceptable bedrock bearing surface, or on lean concrete trenches which are placed directly on an acceptable bedrock bearing surface, and designed for the bearing resistance values provided herein, will be subjected to negligible post-construction total and differential settlements.

Based on current proposed grading plans for the project, it is expected that a significant amount of fill material will be encountered under the retaining wall along the northeast portion of the site. Consideration should be taken to sub-excavate the area and review the fill subgrade material during construction.

Global Stability Analysis

Based on the topographic survey data and details of the proposed retaining wall prepared by Mcintosh Perry and provided by the client, two cross sections considered the "worse case" scenario critical locations have been selected for global stability analysis. These sections were selected based on the retained soil and above-ground surface wall height.

The global stability analysis was modeled in Slide, a computer program which permits a two-dimensional slope stability analysis calculating several methods including the Bishop's method, which is a widely accepted slope analysis method. The program calculates a factor of safety, which represents the ratio of the forces resisting failure to forces 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 subsurface soil and groundwater conditions, a factor of safety greater than 1.0 is generally required for the failure risk to be considered acceptable.

A minimum factor of safety of 1.5 is generally recommended for conditions where the slope failure would comprise permanent structures. An analysis considering seismic loading was also completed. A horizontal acceleration of 0.16 g was considered for the sections for the seismic loading condition. A factor of safety of 1.1 is considered to be satisfactory for stability analyses including seismic loading. The retaining wall section was reviewed using the design loading according to CHBDC 2019.

The following parameters were used for the slope stability analysis under static and seismic conditions:

Table 1 - Effective Soil Parameters for Global Stability Analysis

Soil Layer	Unit Weight (kN/m3)	Friction Angle (degrees)	Cohesion effective (kPa)	Cohesion Total (kPa)
Granular B Type II	22	38	0	0
Grey Silty Clay	16	33	10	60
Concrete	23.5	45	300	300
Landscaping Retaining Wall	20	50	300	300
Cast-in-Place Retaining Wall	24.5	45	500	500
Existing Fill	20	30	1	1
Clear stone	18	30	0	0
Silty Sand	18	33	1	1
Glacial Till	22	35	0	0

Soil Parameters

The soil parameters used for the global stability analysis have been extracted from the site's geotechnical investigation report. Although the parameters provided in the geotechnical investigation are considered conservative, the results of the analysis are considered acceptable from a geotechnical perspective. It should be noted that all soil parameters used in the analysis can be found in Figures 1A through 2B attached at the end of this report**.**

Analysis Results

The factor of safety for the retaining wall sections was greater than 1.5 for static conditions. Similarly, the results under seismic loading yielded a factor of safety for this section greater than 1.1. Based on these results, the retaining walls are considered to be stable under static and seismic loading, and therefore a stable slope allowance is not required.

Construction Recommendations

Drainage

A 150 mm diameter perforated drainage pipe wrapped in geotextile and surrounded on all sides by 150 mm of clear crushed stone, should be installed at the heel of the retaining wall footing. The drainage should have positive drainage to a nearby outlet such as a catch basin or other suitable drainage features such as swales. It is recommended that the outlets be spaced evenly along the retaining wall with a minimum spacing of 15 m center to center passing through the wall or connected to a nearby catch basin.

Backfill Material

The retaining wall should be backfilled with free-draining, non-frost susceptible granular backfill materials and incorporate longitudinal drains and weep holes to provide positive drainage of the backfill. For the purpose of this report, it is recommended that the wall be backfilled with either OPSS Granular B Type II or Granular A materials. The backfill should be placed within a wedge-shaped zone defined by a line drawn up and back from the back edge of the top of the footing along the rear face and bottom corner of the wall at an inclination of 1H:1V or a minimum of 600 mm behind the wall. All material should be compacted to a minimum of 98% of the material's SPMDD.

Frost Protection

Where the footings of the proposed retaining walls are proposed to be founded on bedrock, no embedment requirements will be recommended for frost protection. However, the condition of the bedrock should be assessed by the geotechnical consultant to ensure the bedrock is not frost susceptible.

For footings placed on a soil-bearing medium, it is recommended that a minimum embedment of 2.1 m be available to provide sufficient frost protection. Alternatively, the bearing medium can be sub-excavated to down to 2.1 m below finished grade or to the bedrock surface (whichever is shallower). The sub-excavation should extend a minimum 150 mm horizontally beyond the footing faces in all directions. The sub-excavated areas should be backfilled with 15 MPa lean concrete mix (28-day strength) and should extend vertically up to the design underside of footing elevation. A combination of soil cover and rigid insulation can also be considered to lessen the amount of concrete used. The thickness of the rigid insulation will be dependent on the design underside of footing elevation of the retaining wall with respect to the finished grade.

Monitoring Recommendations

It is recommended that the following be completed once the retaining wall design and course of action are determined:

- Observation of all bearing surfaces prior to backfill or placement of concrete.
- Periodic observation of the condition of unsupported excavation side slopes in excess of 3 m in height, if applicable.
- Observation of all subgrades prior to placing backfilling materials.
- Observation of the drainage system prior to backfilling.
- Field density tests to ensure the specified level of compaction was achieved.
- Periodic observation of the retaining wall installation.

It is further recommended that all bedding and backfill materials be placed under dry conditions and above freezing temperatures and approved by the geotechnical consultant at the time of construction. Precautions should be taken to ensure that the bedding material does not freeze before placement and backfill of the retaining wall base blocks, which could lead to detrimental movement within the retaining wall, once the frost leaves the bedding material.

We trust this information satisfies your requirements.

Best Regards,

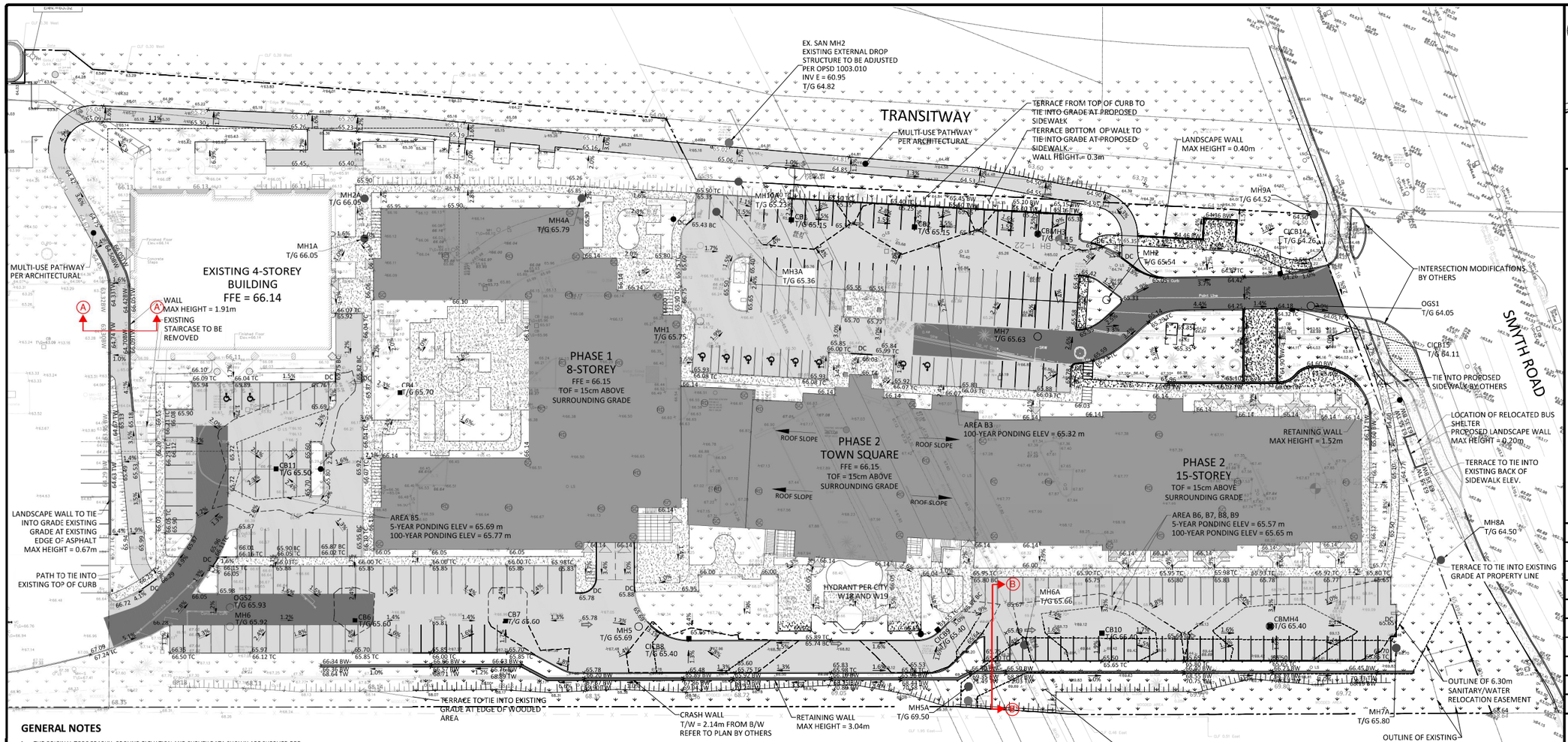
Paterson Group Inc.

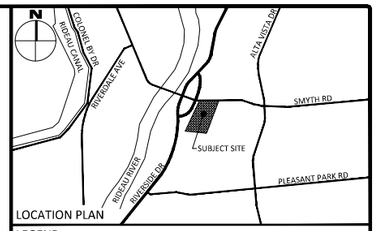
Balaji Nirmala, M.Eng.

Joey R. Villeneuve, M.A.Sc., P.Eng

Attachment

- ❏ Global Stability Sections
- ❏ Cross Sections Markup Plan





LOCATION PLAN

LEGEND

- PROPERTY LINE
- BARRIER CURB & CURB DEPRESSION (DC)
- PROPOSED ASPHALT
- PROPOSED HEAVY DUTY ASPHALT
- CONCRETE WALKWAY
- STORM MANHOLE (MH#)
- CATCHBASIN, CURB INLET OR DITCH INLET (CB, CICB, DI)
- LANDSCAPE CATCHBASIN (ECB, TCB)
- SANITARY MANHOLE (MH#A)
- PERFORATED PIPE
- WATER VALVE/CHAMBER
- PROPOSED FIRE HYDRANT PER CITY W18 & W19
- WATER WELL LOCATION (W)
- PROPOSED BOLLARD
- PROPOSED WALL
- ROOF DRAIN AND SCUPPER LOCATION (RD, SCP)
- CENTRELINE OF SWALE
- CENTRELINE OF DITCH
- SLOPING AT 3:1 UNLESS SPECIFIED
- PROPOSED ELEVATION / EXISTING ELEVATION (95.94 / 93.20)
- SWALE ELEVATION (95.94 SW)
- TOP/BOTTOM WALL FACE ELEVATIONS (TW/100.50 BW/90.50)
- EMERGENCY OVERLAND FLOW ROUTE
- SILT FENCE BARRIER PER OPSD 219.110
- STRAW BALE CHECK DAM PER OPSD 219.180
- INLET SEDIMENT CONTROL DEVICE
- BUILDING ENTRANCE OVERHEAD DOOR (O/H)
- REDUCER
- SIAMESE CONNECTION (FDC)

FOR REVIEW ONLY
NOT FOR CONSTRUCTION

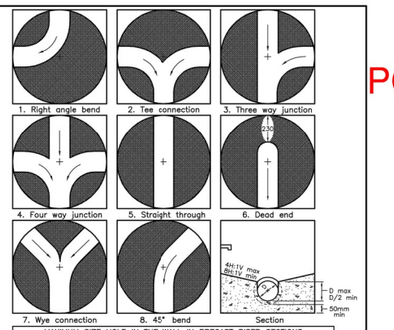
No.	Revisions	Date
3	ISSUED FOR REVIEW	DEC 20, 2022
2	ISSUED FOR REVIEW	APR 8, 2022
1	ISSUED FOR REVIEW	NOV 2, 2021

Check and verify all dimensions before proceeding with the work — Do not scale drawings

SCALE 1 : 400
0 10 20 30 40 Metres

GENERAL NOTES

1. THE ORIGINAL TOPOGRAPHY, GROUND ELEVATION AND SURVEY DATA SHOWN ARE SUPPLIED FOR INFORMATION PURPOSES ONLY, AND IMPLY NO GUARANTEE OF ACCURACY. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO VERIFY ALL INFORMATION SHOWN.
2. THIS PLAN IS NOT A CADASTRAL SURVEY SHOWING LEGAL PROPERTY BOUNDARIES AND EASEMENTS. THE PROPERTY BOUNDARIES SHOWN HEREON HAVE BEEN DERIVED INFORMATION SUPPLIED BY (OR SHOWN ON) FARLEY, SMITH & DENIS SURVEYING LTD. SURVEY PLAN #639-20, DATED NOVEMBER 27, 2020 AND CANNOT BE RELIED UPON TO BE ACCURATE OR COMPLETE. THE PRECISE LOCATION OF THE CURRENT PROPERTY BOUNDARIES AND EASEMENTS CAN ONLY BE DETERMINED BY AN UP-TO-DATE LAND TITLES SEARCH AND A SUBSEQUENT CADASTRAL SURVEY PERFORMED AND CERTIFIED BY AN ONTARIO LAND SURVEYOR.
3. THE CONTRACTOR IS TO OBTAIN AND PAY FOR ALL NECESSARY PERMITS AND APPROVALS FROM THE CITY BEFORE COMMENCING CONSTRUCTION.
4. THE CONTRACTOR IS RESPONSIBLE FOR ALL LAYOUT.
5. THE CONTRACTOR IS TO DETERMINE THE EXACT LOCATION, SIZE, MATERIAL AND ELEVATION OF ALL EXISTING UTILITIES PRIOR TO COMMENCING CONSTRUCTION. PROTECT AND ASSUME ALL RESPONSIBILITY FOR EXPOSING UTILITIES WHETHER OR NOT SHOWN ON THESE DRAWINGS. IF THERE IS ANY DISCREPANCY THE CONTRACTOR IS TO NOTIFY THE ENGINEER PROMPTLY.
6. RESTORE ALL TRENCHES AND SURFACES OF PUBLIC ROAD ALLOWANCES TO CONDITION EQUAL OR BETTER THAN ORIGINAL CONDITION AND TO THE SATISFACTION OF THE CITY AUTHORITIES.
7. EXCAVATE AND DISPOSE OF ALL EXCESS EXCAVATED MATERIAL, SUCH AS ASPHALT, CURBING AND DEBRIS, OFF SITE AS DIRECTED BY THE ENGINEER AND THE CITY.
8. TOPSOIL TO BE STRIPPED AND STOCKPILED FOR REHABILITATION. CLEAN FILL TO BE PLACED IN FILL AREAS AND COMPACTED TO 95% STANDARD PROCTOR DENSITY.
9. ALL DISTURBED AREAS TO BE RESTORED TO ORIGINAL CONDITION OR BETTER UNLESS OTHERWISE SPECIFIED.
10. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL TRAFFIC CONTROL AND SAFETY MEASURES DURING THE CONSTRUCTION PERIOD, INCLUDING THE SUPPLY, INSTALLATION, AND REMOVAL OF ALL NECESSARY SIGNAGE, DELINEATORS, MARKERS AND BARRIERS.
11. DO NOT ALTER GRADING OF THE SITE WITHOUT PRIOR APPROVAL OF THE CITY.
12. ALL ROADWAY, PARKING LOT, AND GRADING WORKS TO BE UNDERTAKEN IN ACCORDANCE WITH CITY STANDARDS AND SPECIFICATIONS. THE CONTRACTOR IS TO PROVIDE POSITIVE DRAINAGE AWAY FROM THE BUILDING.
13. CONTACT THE CITY FOR INSPECTION OF ROUGH GRADING OF PARKING LOTS, ROADWAYS AND LANDSCAPED AREAS PRIOR TO PLACEMENT OF ASPHALT AND TOPSOIL. ALL DEFICIENCIES NOTED SHALL BE RECTIFIED TO THE CITY SATISFACTION PRIOR TO PLACEMENT OF ANY ASPHALT, TOPSOIL, SEED & MULCH AND/OR SOD.
14. CONTACT THE CITY FOR INSPECTION OF ROUGH GRADING OF PARKING LOTS, ROADWAYS AND LANDSCAPED AREAS PRIOR TO PLACEMENT OF ASPHALT AND TOPSOIL. ALL DEFICIENCIES NOTED SHALL BE RECTIFIED TO THE CITY SATISFACTION PRIOR TO PLACEMENT OF ANY ASPHALT, TOPSOIL, SEED & MULCH AND/OR SOD.
15. ALL DIMENSIONS AND INVERTS MUST BE VERIFIED PRIOR TO CONSTRUCTION, IF THERE IS ANY DISCREPANCY THE CONTRACTOR IS TO NOTIFY THE ENGINEER PROMPTLY.
16. ELECTRICAL, GAS, TELEPHONE AND TELEVISION SERVICE LOCATIONS ARE SUBJECT TO THE INDIVIDUAL AGENCY:
    - ELECTRICAL SERVICE - HYDRO OTTAWA,
    - GAS SERVICE - ENBRIDGE,
    - TELEPHONE SERVICE - BELL CANADA,
    - TELEVISION SERVICE - ROGERS.
17. INSTALLATION TO BE IN ACCORDANCE WITH CURRENT CODES AND STANDARDS OF APPROVAL AGENCIES HYDRO OTTAWA, BELL AND THE CITY.
18. ALL PROPOSED CURB SHALL BE CONCRETE BARRIER CURB UNLESS SPECIFIED.
19. ALL EXISTING REDUNDANT PRIVATE APPROACHES FRONTING THIS DEVELOPMENT MUST BE REMOVED TO THE SATISFACTION OF THE CITY.
20. NO EXCESS DRAINAGE, EITHER DURING OR AFTER CONSTRUCTION, IS TO BE DIRECTED TOWARDS NEIGHBORING PROPERTIES.
21. NO ALTERATION OF EXISTING GRADES AND DRAINAGE PATTERNS ON PROPERTY BOUNDARIES.
22. THIS PLAN MUST BE READ IN CONJUNCTION WITH THE GEOTECHNICAL REPORT COMPLETED BY PATERSON GROUP AND DATE JULY 18, 2022

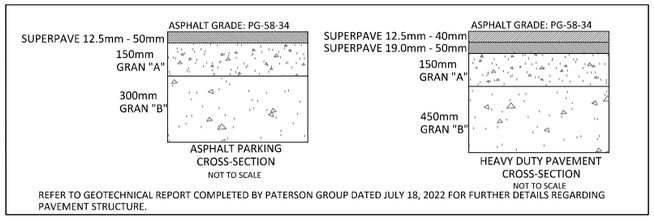


MAXIMUM SIZE HOLE IN THE WALL IN PRECAST RISER SECTIONS

Maintenance Hole Diameter	No. 1–4	No. 5 and 6	No. 8	No.7	
				Inlet Hole	Outlet Hole
1200	700	860	780	700	860
1500	860	1220	960	860	1170
1800	1220	1485	1220	1220	1485
2400	1485	2020	1760	1485	2020
3000	1930	2450	2300	1930	2450
3600	2470	3085	2730	2470	3085

NOTES:
1 Slopes shall be maintained from the outlet hole opening for top of benching.
A Concrete for benching shall be 30MPa.
B When benching is hand-finished, it shall be given wood float finish, channel shall be given steel trowel finish.
C Benching slope and height shall be as specified.
D When specified, maintenance holes that are 1200mm in diameter with a uniform channel for 200 or 250mm pipe may be prebenched at the manufacturer with standardized benching slope and channel orientation.
E All dimensions are nominal.
F All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING	Nov 2014	Rev 4
MAINTENANCE HOLE BENCHING AND PIPE OPENING ALTERNATIVES		OPSD 701.021



REFER TO GEOTECHNICAL REPORT COMPLETED BY PATERSON GROUP DATED JULY 18, 2022 FOR FURTHER DETAILS REGARDING PAVEMENT STRUCTURE.

McINTOSH PERRY
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Stamp:

Client:
RBJ SCHLEGEL HOLDINGS
325 MAX BECKER DRIVE SUITE 201
KITCHENER, ON N2E 4H5

Project:
SCHLEGEL VILLAGES OTTAWA
1919 RIVERSIDE DRIVE

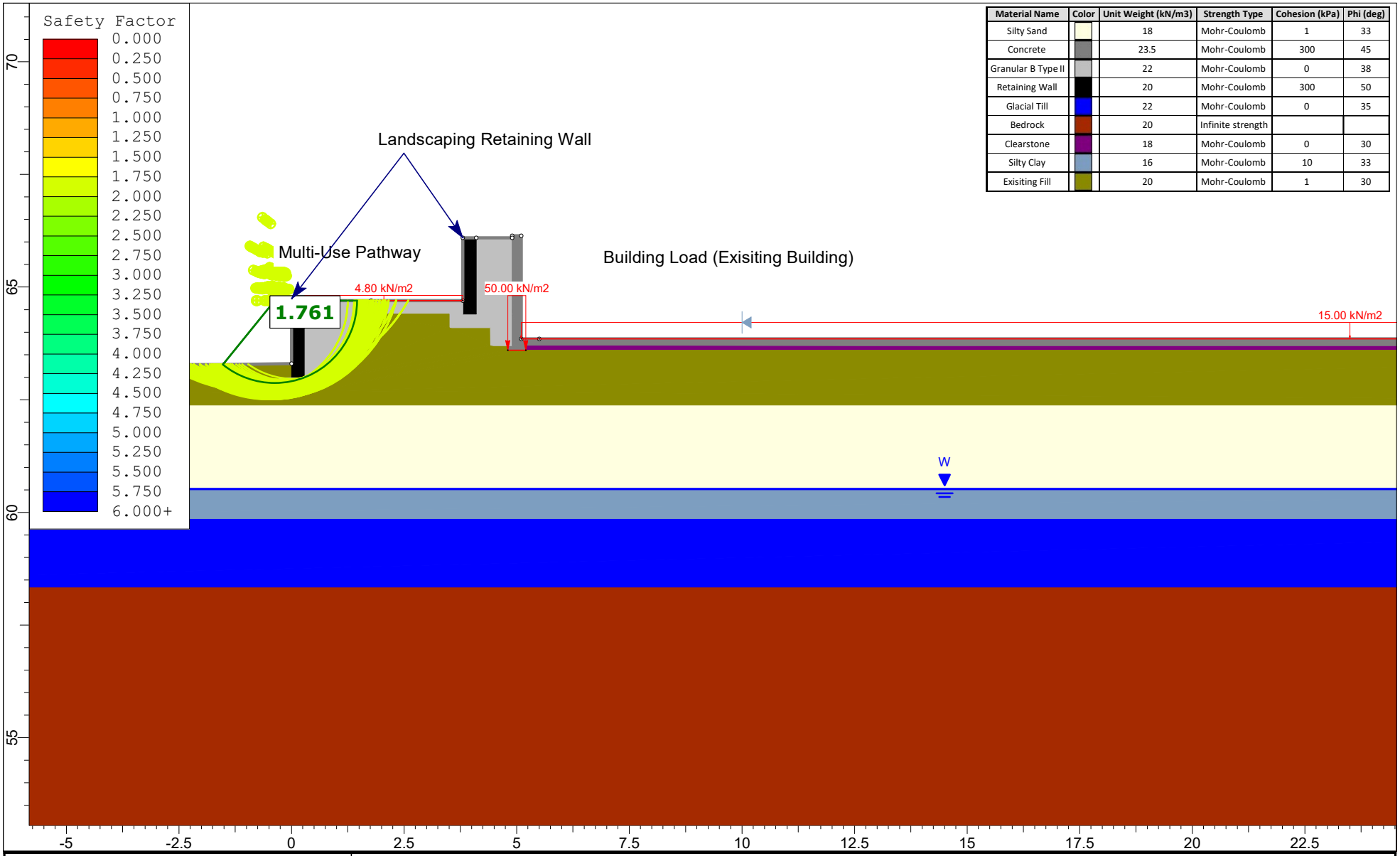
Drawing Title:
SITE GRADING AND DRAINAGE PLAN

Scale:	1:400
Drawn By:	R.R.R.
Checked By:	A.J.G.
Designed By:	A.J.G.
Project Number:	CCO-21-2955
Drawing Number:	C101

D07-12-21-0170

18600

PG5947 - LET.02 - Global Stability Analysis - Cross Section Markup Plan

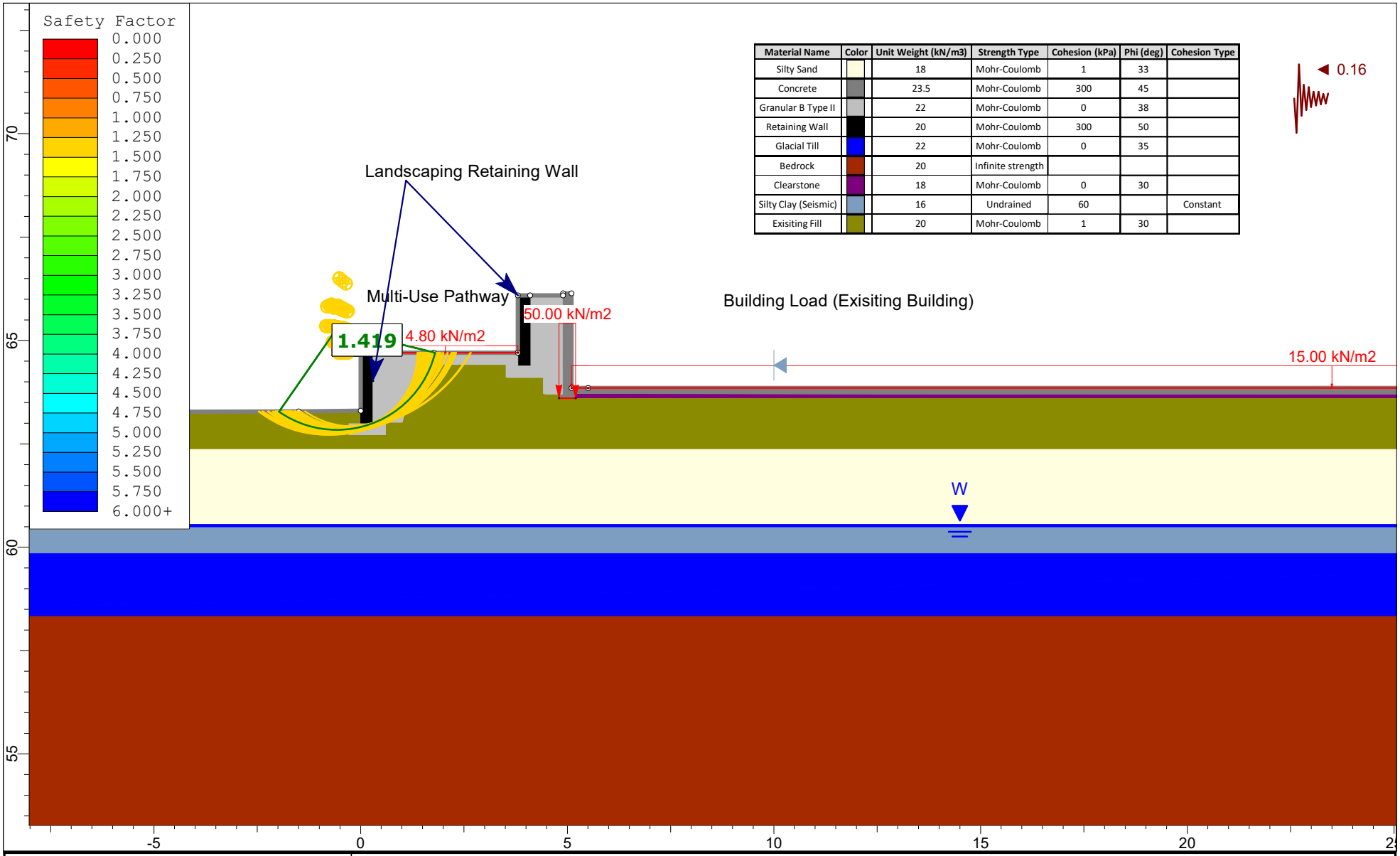


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)
Silty Sand		18	Mohr-Coulomb	1	33
Concrete		23.5	Mohr-Coulomb	300	45
Granular B Type II		22	Mohr-Coulomb	0	38
Retaining Wall		20	Mohr-Coulomb	300	50
Glacial Till		22	Mohr-Coulomb	0	35
Bedrock		20	Infinite strength		
Clearstone		18	Mohr-Coulomb	0	30
Silty Clay		16	Mohr-Coulomb	10	33
Exisiting Fill		20	Mohr-Coulomb	1	30

PATERSON GROUP

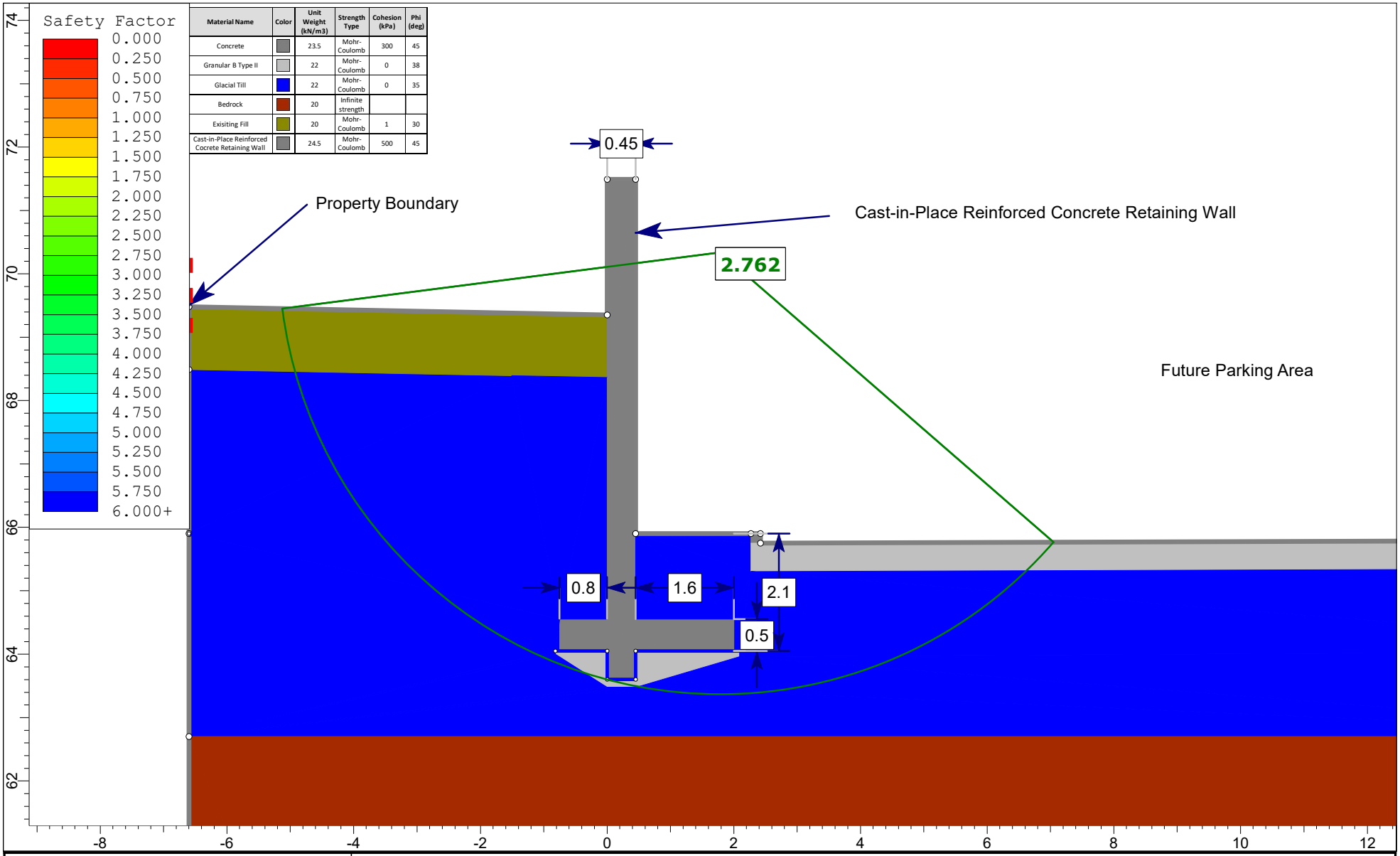
SLIDEINTERPRET 9.025

Project	**Schlegel Villages Global Stability Analysis 1919 Riverside Drive, Ottawa, Ontario**		
Figure No.	**Figure 1A - Slope Section A - Proposed Conditions - Static Loading - Landscaping Wall**		
Drawn By	BN	*Company*	Paterson Group
Date	2023-05-15	*File Name*	PG5947-LET.02



PATERSON GROUP	*Project*	**Schlegel Villages Global Stability Analysis 1919 Riverside Drive, Ottawa, Ontario**	
	Figure No.	**Figure 1B - Slope Section A - Proposed Conditions - Seismic Loading - Landscaping Wall**	
	Drawn By	BN	***Company*** Paterson Group
	Date	2023-05-15	***File Name*** PG5947-LET.02

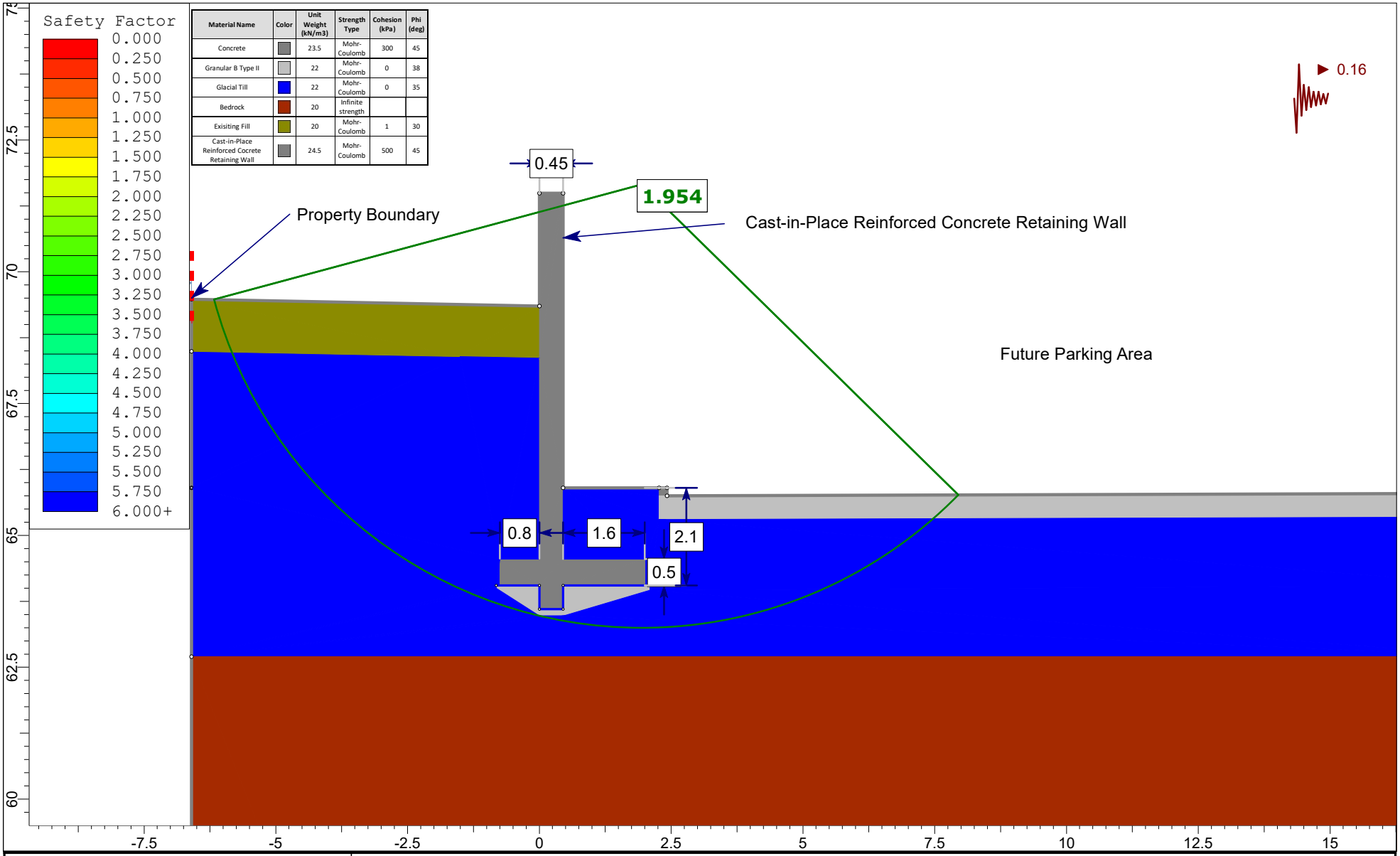
SLIDEINTERPRET 9.025



PATERSON GROUP

SLIDEINTERPRET 9.025

Project	**Schlegel Villages Global Stability Analysis 1919 Riverside Drive, Ottawa, Ontario**		
Figure No.	**Figure 2A - Slope Section B - Proposed Conditions - Static Loading - Crash Wall**		
Drawn By	BN	*Company*	Paterson Group
Date	2023-05-15	*File Name*	PG5947-LET.02



PATERSON GROUP

SLIDEINTERPRET 9.025

Project	**Schlegel Villages Global Stability Analysis 1919 Riverside Drive, Ottawa, Ontario**		
Figure No.	**Figure 2B - Slope Section B - Proposed Conditions - Seismic Loading - Crash Wall**		
Drawn By	BN	***Company***	Paterson Group
Date	2023-05-15	***File Name***	PG5947-LET.02