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Environmental Engineering
Hydrogeology
Geological Engineering
Materials Testing
Building Science

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January 26, 2010
File: PG1887-LET.01R

Novatech Engineering Consultants
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario
K2M 1P6

Attention: **Mr. Adam Thompson**

Subject: **Slope Stability Analysis**
2175 Prince of Wales Drive
Ottawa, Ontario

Dear Sir,

Further to your request, Paterson Group (Paterson) has conducted a slope stability analysis and determined the limit of hazard lands for the aforementioned site. The limit of hazard lands for the subject site extends along the west side of the Rideau River and along the south side of a ravine containing a tributary watercourse to the Rideau River. The present letter summarizes our findings.

The subject site is presently undeveloped and has an approximate area of 3.23 hectares. The majority of the subject site is grassed covered and slopes gradually downward to the west towards the Rideau River. The subject site is bordered by a ravine to the north, the Rideau River to the east, Waterbend Lane followed by residential housing to the south and Prince of Wales Drive to the west. A topographic survey was completed by Paterson to provide spot grade elevations across the subject site and two (2) slope cross sections for our slope stability analysis. A previous geotechnical investigation was completed by John D. Paterson and Associates (JDPA) for the subject site with the findings presented under cover Report S2853-83 dated December 30, 1983.

1.0 Existing Slope Conditions and Soils Information

The south valley corridor wall of the drainage ravine along the north property boundary was noted to be vegetated with small brush and signs of erosion occurring at several localized outbends in the watercourse/creek channel. A 2 to 3 m wide watercourse was noted to meander throughout the valley corridor. The water depth was noted to vary between approximately 0.2 to 0.3 m.

Along the east property boundary, the west valley corridor wall of the Rideau River is undergoing active erosion within several areas, the slope was noted to have been undercut at the toe. It is expected that historical erosional activities have resulted in currently observed steep back scarp slope. Currently, the majority of the bank was vegetated with small brush and full grown trees (mainly deciduous).

The subsurface soil profile used for the slope stability analysis was based on existing test hole information and available geological mapping in the immediate area of the subject site. Generally, the soil profile at the test hole locations placed within the subject site, consists of a thin layer of topsoil overlying a sandy silt layer followed by a 1 to 3 m thick very stiff brown silty clay deposit. The silty clay layer was underlain by a sandy silt to silty sand deposit extending beyond a 12 m depth. Based on nearby borehole locations, glacial till was encountered at 18 to 20 m followed by bedrock at 25 to 30 m below ground surface. Based on available geological mapping, the bedrock surface in this area is encountered at depths varying between 15 to 25 m and consists of dolomite of the Oxford formation.

2.0 Slope Stability Analysis

The slope stability analysis was completed using the topographical survey, as well as, a current slope condition review by Paterson field personnel. Two (2) slope cross-sections were studied as the worst case scenarios. The cross section locations are presented on Drawing PG1887-1 - Site Plan attached to the present letter.

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 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 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.

Subsoil conditions at the cross-sections were inferred based on the findings at nearby borehole locations and general knowledge of the area's geology.

The results for the existing slope conditions under static loading at Sections A and B are shown in Figures 1 and 3, respectively, attached to the present letter. The overall slope stability factors of safety for the subject sections were found to be less than 1.5. The stable slope allowance from top of slope required for a slope with a minimum factor of safety of 1.5 is identified for each profile in the attached figures.

Seismic Loading Analysis

An analysis considering seismic loading was also completed. A horizontal seismic acceleration, K_h, of 0.1G was considered for the analyzed sections. A factor of safety of 1.1 is considered to be satisfactory for stability analyses including seismic loading.

The results of the analyses including seismic loading are shown in Figures 2 and 4 for the slope sections. Where the minimum factor of safety is less than 1.1, the stable slope allowance from top of slope required for the slope section is identified in the attached figures.

3.0 Limit of Hazard Lands

The limit of hazard lands includes a stable slope allowance taken from top of slope. The limit of hazard lands also includes a toe erosion and a 6 m erosion access allowance. The various allowances and the overall limit of hazard lands for the subject site are indicated on Drawing PG1887-1 - Site plan attached to the present letter.

The toe erosion allowance for the slopes was based on the nature of the soils, the observed current erosional activities and the width and location of the current watercourse. Signs of erosion were noted in areas where the existing watercourse has meandered in close proximity to the toe of the corridor wall of the north neighbouring tributary watercourse. It is considered that a toe erosion allowance of 5 m is appropriate for the tributary watercourse.

Some erosional activities were noted along the toe of the subject valley corridor wall for the Rideau River. It is considered that a toe erosion allowance of 8 m is appropriate for the subject slope along the Rideau River.

4.0 Recommendations

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 100 to 150 mm of topsoil mixed with a hardy seed or an erosional control blanket be placed across the exposed slope face.

5.0 Statement of Limitations

The information gathered for this report is based on a soils investigation, which is a limited sampling of a site. Should any conditions at the site be encountered which differ from those at the test hole locations, we request that we be notified immediately in order to permit reassessment of our 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 Mr. Scott Thomson or Novatech Engineering 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.

We trust that this letter satisfies your requirements.

Sincerely,

Paterson Group Inc.

Richard Groniger, Technologist.

David J. Gilbert, P.Eng.

Attachments:

- ❑ Figures 1 to 4 - Slope Stability Analysis
- ❑ Soil and Profile Test Data sheets (JDPA)
- ❑ Drawing PG1887-1 - Site Plan

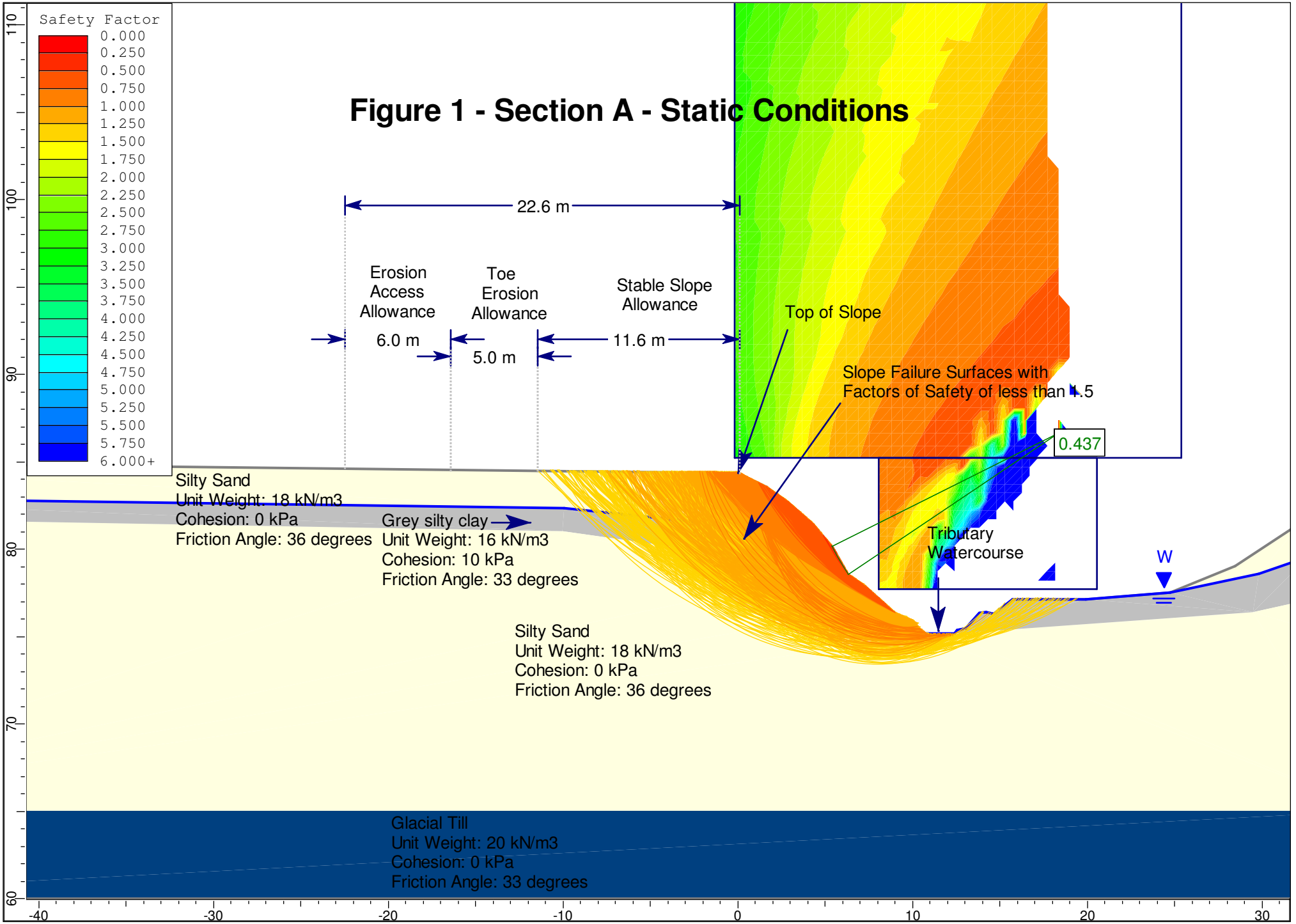
Figure 1 - Section A - Static Conditions
Safety Factor
0.000
0.250
0.500
0.750
1.000
1.250
1.500
1.750
2.000
2.250
2.500
2.750
3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
22.6 m
Erosion Access Allowance
6.0 m
Toe Erosion Allowance
5.0 m
Stable Slope Allowance
11.6 m
Top of Slope
Slope Failure Surfaces with Factors of Safety of less than 1.5
0.437
Tributary Watercourse
W
Silty Sand
Unit Weight: 18 kN/m3
Cohesion: 0 kPa
Friction Angle: 36 degrees
Grey silty clay
Unit Weight: 16 kN/m3
Cohesion: 10 kPa
Friction Angle: 33 degrees
Silty Sand
Unit Weight: 18 kN/m3
Cohesion: 0 kPa
Friction Angle: 36 degrees
Glacial Till
Unit Weight: 20 kN/m3
Cohesion: 0 kPa
Friction Angle: 33 degrees
110
100
90
80
70
60
-40
-30
-20
-10
0
10
20
30

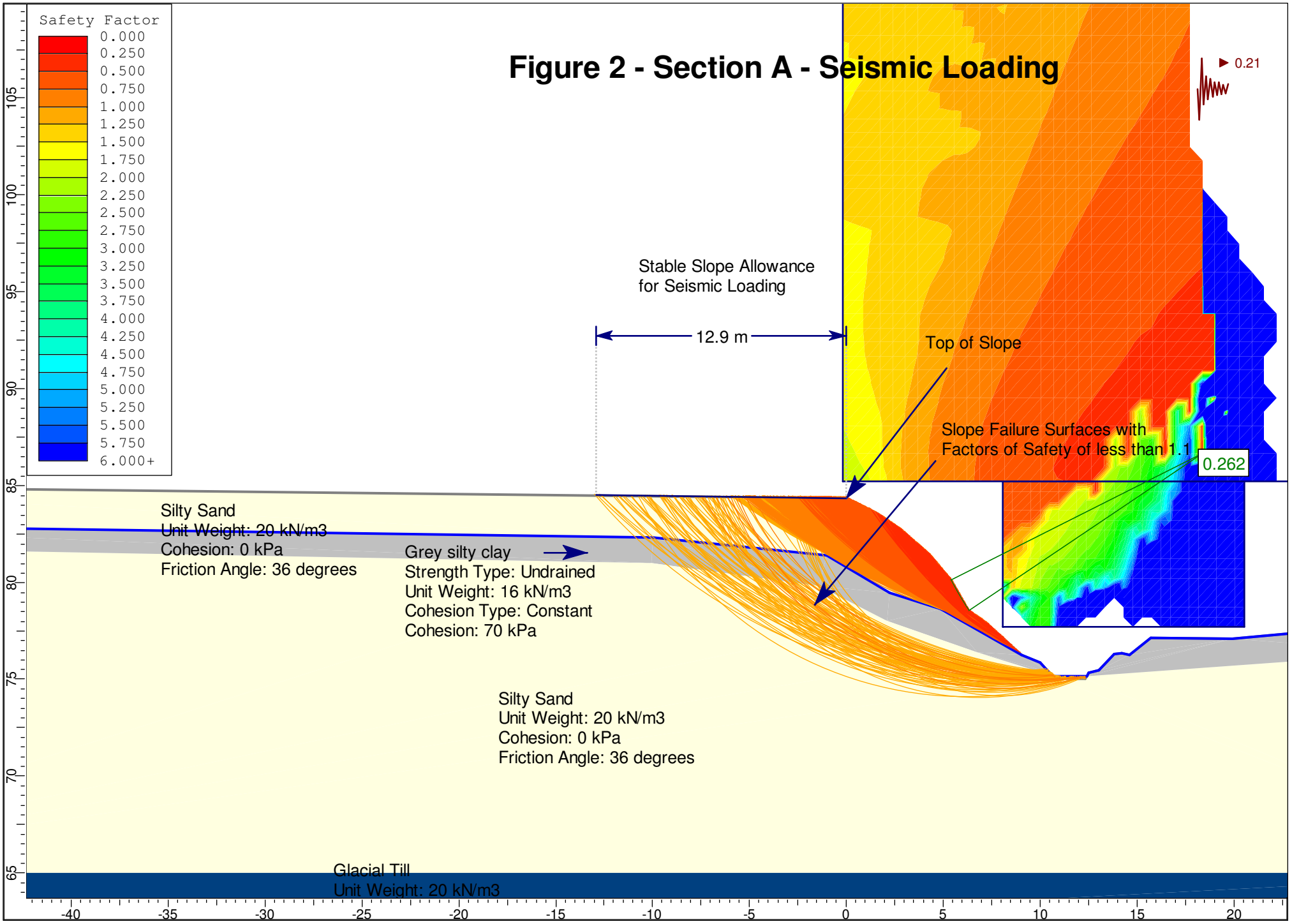
Figure 2 - Section A - Seismic Loading
Safety Factor
0.000
0.250
0.500
0.750
1.000
1.250
1.500
1.750
2.000
2.250
2.500
2.750
3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
0.21
Stable Slope Allowance
for Seismic Loading
12.9 m
Top of Slope
Slope Failure Surfaces with
Factors of Safety of less than 1.1
0.262
Silty Sand
Unit Weight: 20 kN/m3
Cohesion: 0 kPa
Friction Angle: 36 degrees
Grey silty clay
Strength Type: Undrained
Unit Weight: 16 kN/m3
Cohesion Type: Constant
Cohesion: 70 kPa
Silty Sand
Unit Weight: 20 kN/m3
Cohesion: 0 kPa
Friction Angle: 36 degrees
Glacial Till
Unit Weight: 20 kN/m3
105
100
95
90
85
80
75
70
65
-40
-35
-30
-25
-20
-15
-10
-5
0
5
10
15
20

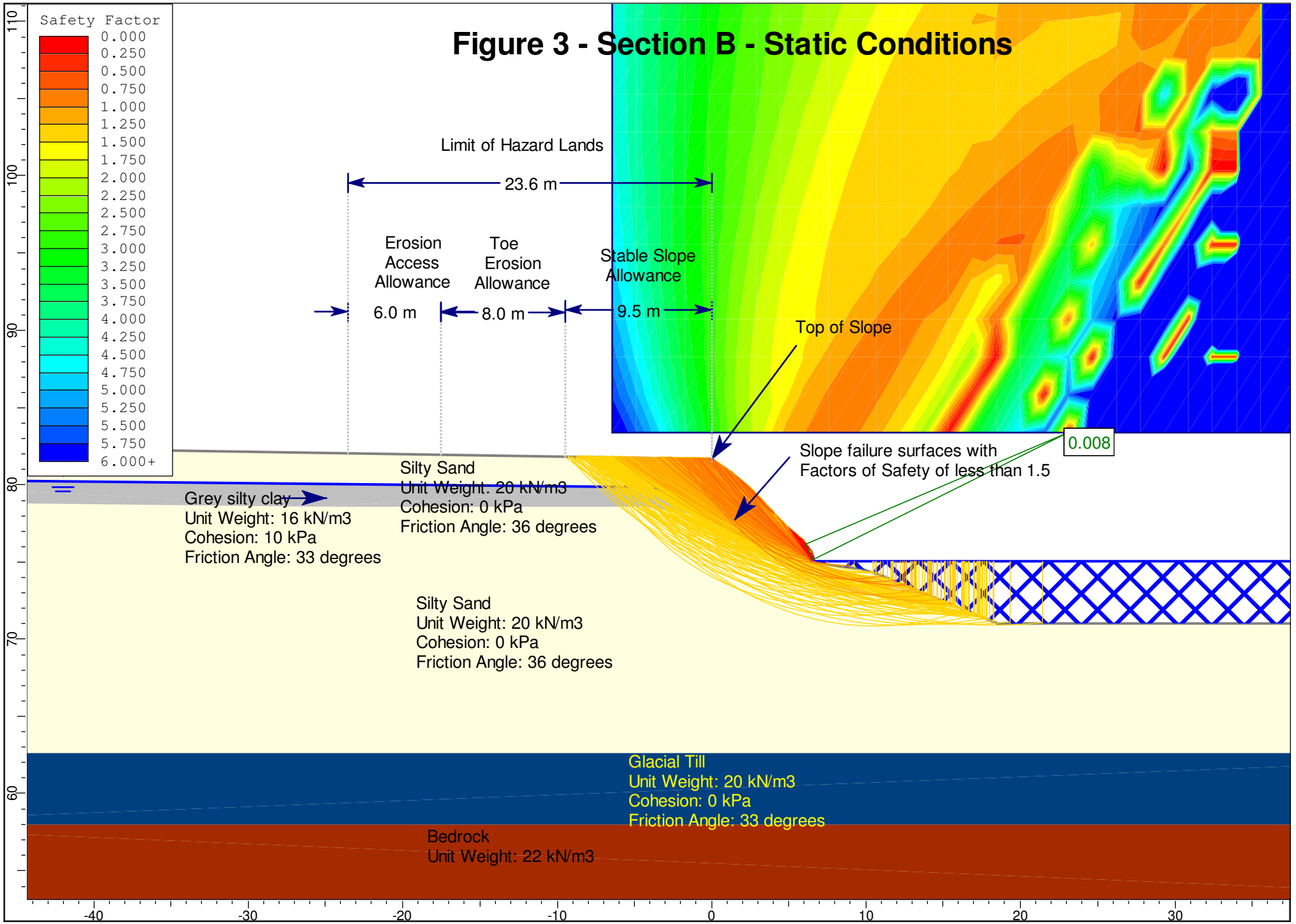
Figure 3 - Section B - Static Conditions
Safety Factor
0.000
0.250
0.500
0.750
1.000
1.250
1.500
1.750
2.000
2.250
2.500
2.750
3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
Limit of Hazard Lands
23.6 m
Erosion Access Allowance
6.0 m
Toe Erosion Allowance
8.0 m
Stable Slope Allowance
9.5 m
Top of Slope
0.008
Slope failure surfaces with Factors of Safety of less than 1.5
Silty Sand
Unit Weight: 20 kN/m3
Cohesion: 0 kPa
Friction Angle: 36 degrees
Grey silty clay
Unit Weight: 16 kN/m3
Cohesion: 10 kPa
Friction Angle: 33 degrees
Silty Sand
Unit Weight: 20 kN/m3
Cohesion: 0 kPa
Friction Angle: 36 degrees
Glacial Till
Unit Weight: 20 kN/m3
Cohesion: 0 kPa
Friction Angle: 33 degrees
Bedrock
Unit Weight: 22 kN/m3
110
100
90
80
70
60
-40
-30
-20
-10
0
10
20
30

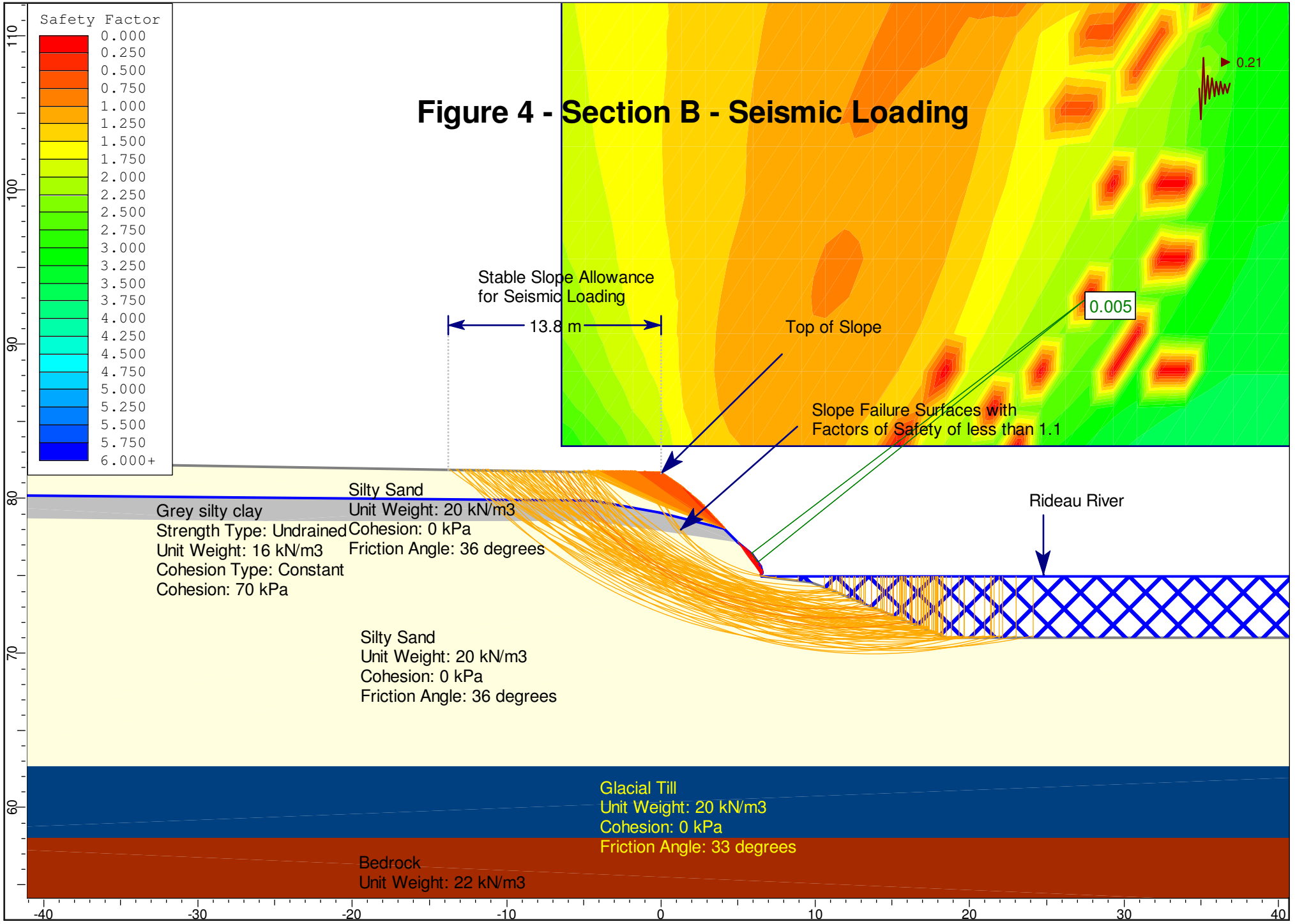

Figure 4 - Section B - Seismic Loading

SOIL PROFILE AND TEST DATA

Proposed Residential Subdivision
South 1/2 Lot 26, Concession "A", R.F.
Nepean, Ontario

JOHN D. PATERSON & ASSOCIATES LTD.
Consulting Engineers & Geologists
Soil Investigations
Inspection & Testing Services
Damage Claims

Offices & Laboratory
1479 Laperriere Ave.
Ottawa, Canada K1Z 7S8
Telephone (613) 728-3505

SHEET NO. 1 OF 3
HOLE NO. BH 1
GROUND SURFACE 86.04 BOTTOM HOLE 73.84
BEDROCK _____ GROUNDWATER DRY

DESCRIPTION	LEGEND	SAMPLE TYPE	SAMPLE NUMBER	ELEV. / DEPTH
Ground Surface				86.04
250 mm TOPSOIL over a compact grey interbedded FINE SAND and SANDY SILT 0.8		G	1	0.00
		SS	2	0.80
Very stiff to stiff fissured olive grey SILTY CLAY with pinkish grey banding containing fine sand seams		TW	3	1.60
		TW	4	
		TW	5	2.40
3.6		TW	6	3.20
				82.04
Compact brown SILTY FINE SAND containing clayey silt seams approximately 5 mm thick		SS	7	4.00
		SS	8	
5.5		SS	9	4.80
Very dense grey SANDY SILT containing silty fine sand seams		SS	10	5.60
6.7		SS	11	6.40
		SS	12	
		SS	13	7.20
				78.04
		SS	14	8.00
		SS	15	8.80
Dense pale grey FINE SAND with some hairlike black banding. Becoming coarser with depth.		SS	16	
		SS	17	9.60
		SS	18	10.40
		SS	19	11.20
				74.04
12.2		SS	20	12.00
Borehole terminated in sand				12.80

Θ WATER CONTENT %
10 20 30 40 50 60 70 80

UNIT WEIGHT kN/m³
■
5 10 15 20

SHEAR STRENGTH (kPa)
▲ UNDISTURBED
△ REMOULDED
20 40 60 80 100 120 140
(psf) 1000 2000 3000

STANDARD (N) PENETRATION TEST
OPENETRATION RESISTANCE
20 40 60 80
BLOWS/0.3m.

WATER LEVEL

SOIL PROFILE AND TEST DATA

Proposed Residential Subdivision
South 1/2 Lot 26, Concession "A", R.F.
Nepean, Ontario

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Ottawa, Canada K1Z 7S8
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SHEET NO. 2 OF 3
HOLE NO. BH 2
GROUND SURFACE 80.59 BOTTOM HOLE 71.59
BEDROCK _____ GROUNDWATER DRY

DESCRIPTION	LEGEND	SAMPLE TYPE	SAMPLE NUMBER	ELEV. / DEPTH
Ground Surface				80.59
300 mm TOPSOIL over a loose brown SANDY SILT interbedded with layers of clayey silt and fine sand.		G	21	0.00
		SS	22	0.80
		SS	23	1.60
2.2		SS	24	
Stiff fissured olive grey SILTY CLAY		SS	25	2.40
2.9		SS	26	3.20
		TW	27	76.59 4.00
Compact grey FINE SANDY SILT with a trace of clay		SS	28	
		SS	29	4.80
6.1		SS	30	5.60
		SS	31	6.40
		SS	32	7.20
Dense light brown to grey SILTY FINE SAND		SS	33	72.59 8.00
		SS	34	
9.0				8.80
Borehole terminated in silty fine sand				9.60
				10.40

WATER CONTENT %
10 20 30 40 50 60 70 80

UNIT WEIGHT kN/m^3 ■
5 10 15 20

SHEAR STRENGTH (kPa)
▲ UNDISTURBED
△ REMOULDED
20 40 60 80 100 120 140
(psf) 1000 2000 3000

STANDARD (N) PENETRATION TEST
o—o PENETRATION RESISTANCE
20 40 60 80
BLOWS/0.3m.

WATER LEVEL

SOIL PROFILE AND TEST DATA

Proposed Residential Subdivision
South 1/2 Lot 26, Concession "A", R.F.
Nepean, Ontario

JOHN D. PATERSON & ASSOCIATES LTD.
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Damage Claims

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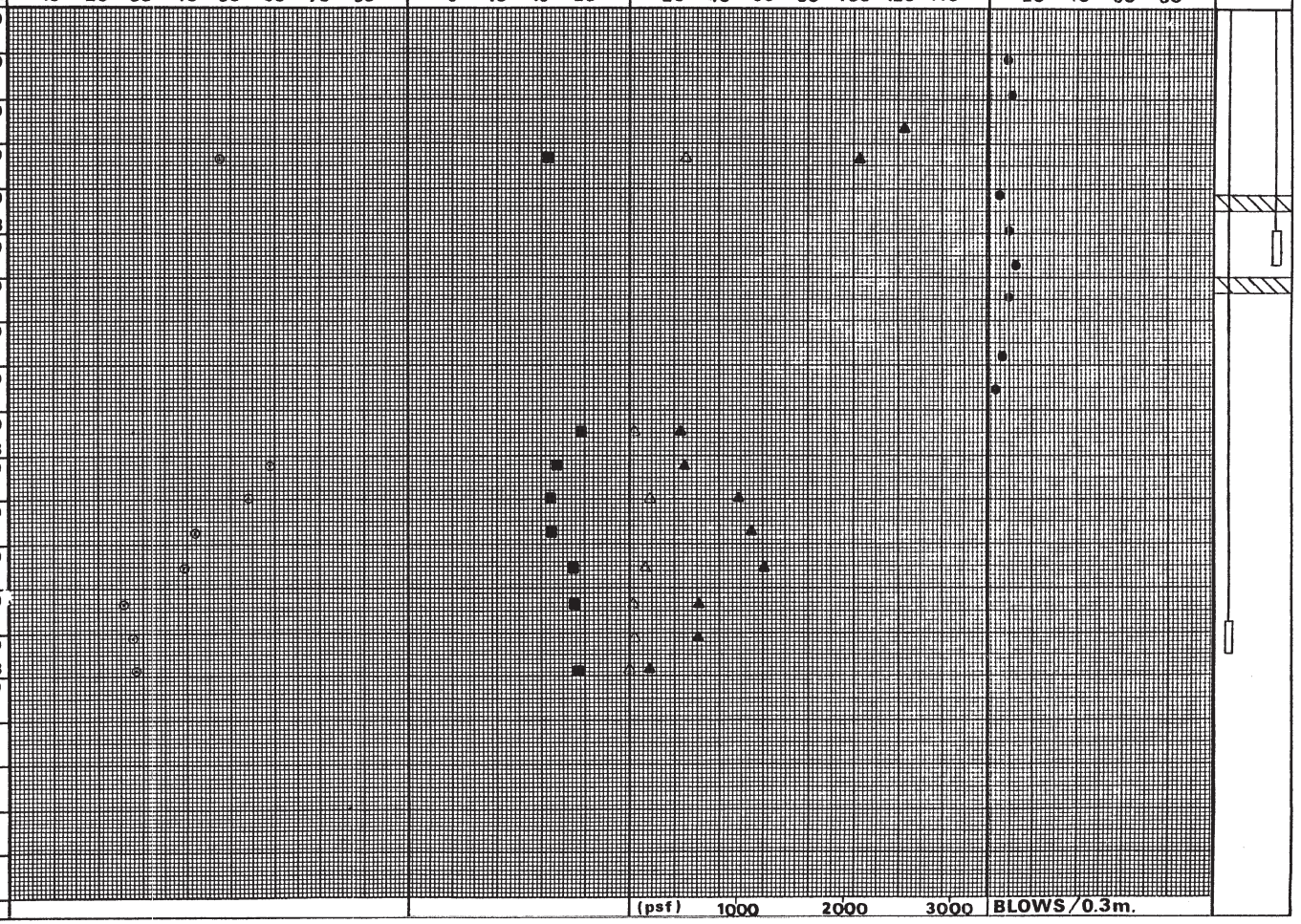
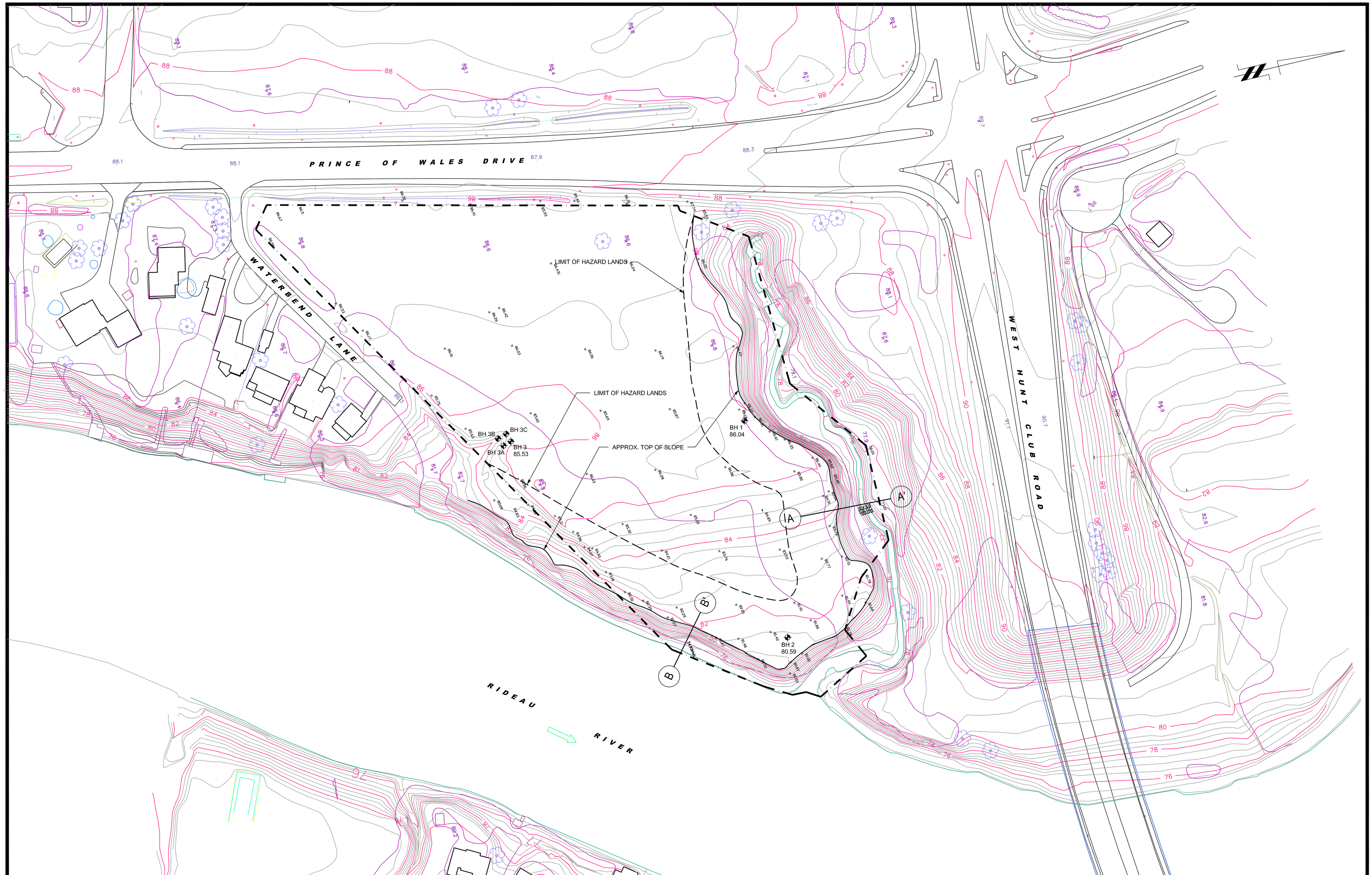
Ottawa, Canada K1Z 7S8
Telephone (613) 728-3505

SHEET NO. 3 OF 3
HOLE NO. BH 3
GROUND SURFACE 85.53 BOTTOM HOLE 73.33
BEDROCK _____ GROUNDWATER DRY

DESCRIPTION	LEGEND	SAMPLE TYPE	SAMPLE NUMBER	ELEV. / DEPTH
Ground Surface				85.53
250 mm TOPSOIL over a loose brown SANDY SILT interbedded with clayey silt & sand		G	35	0.00
0.8		SS	36	0.80
Stiff olive grey fissured SILTY CLAY containing brown fine sand seams at 50 mm ± intervals		SS	37	1.60
		TW	38	2.40
		TW	39	3.20
3.3		SS	40	81.53
		SS	41	4.00
		SS	42	4.80
		SS	43	5.60
Compact brown SILTY FINE SAND containing clayey silt seams		SS	44	6.40
		SS	45	7.20
		TW	46	77.53
7.9		TW	47	8.00
Firm to stiff grey fissured SILTY CLAY with occasional fine sand lenses and containing fine sand seams		TW	48	8.80
		TW	49	9.60
9.8		TW	50	10.40
STRATIFIED SILT: grey compact layers of silty sand, sandy silt and stiff silty clay		TW	51	11.20
		TW	52	73.53
		TW	53	12.00
12.2				
Borehole terminated in silt				





LEGEND:

- BOREHOLE LOCATION, PREVIOUS INVESTIGATION (JDPA REPORT NO. S2853-83)
- 86.04 GROUND SURFACE ELEVATION (m)
- (A)—(A) CROSS-SECTION LOCATION

NO.	REVISIONS	DATE	INITIAL

patersongroup
consulting engineers
28 Concourse Gate, Unit 1, Ottawa, Ontario K2E 7T7

SCALE:	1: 750
DESIGN:	RG
DRAWN:	MPG
CHECKED:	DG
DATE:	01/2010

SLOPE STABILITY ANALYSIS
2175 PRINCE OF WALES DRIVE
OTTAWA, ONTARIO

DWG. NO. PG1887–1

NOVATECH ENGINEERING CONSULTANTS LTD.

SITE PLAN

A1