Wastell Homes

Slope Assessment

Project Name
George Street, Port Stanley

Project Number
LON00014790-slope

Prepared by:
exp Services Inc.
15701 Robin's Hill Road
London, ON N5V 0A5
Canada

Wastell Homes

Type of Document:
Slope Assessment

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George Street, Port Stanley

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LON00014790

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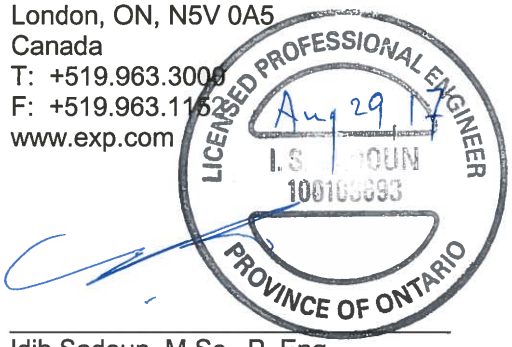

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Vickie J. Coatsworth, P. Eng.
Geotechnical Services

Date Submitted:
August 29, 2017

Legal Notification

This report was prepared by **exp** Services Inc. for the account of **Wastell Homes**

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. **Exp** Services Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this project.

Table of Contents

1.0 Introduction

As requested, **exp** Services Inc. (**exp**) has conducted a slope assessment for Area 1 located at west side of the proposed development at George Street in Port Stanley, Ontario.

At the time of writing this report, no design details are available. However, this report summarizes the results of the assessment, and provides geotechnical comments and recommendations with regards to the slope stability assessment. It should be noted that a Geotechnical Investigations were conducted at this site in November 2008 by exp (Formerly Trow), referenced LNGE00009968A.

2.0 Terms of Reference

Authorization to proceed with this investigation was received from Mr. Julian N. Novick of Wastell Homes (Client).

The purpose of the assessment was to determine the slope stability assessment and net developable site and the recommended Development Setback Limit, in accordance with the Ministry of Natural Resources Technical Guide – River & Streams Systems.

Based on a reconnaissance site visit on September 20, 2016 and previous borehole drilling nearby the crest of the slope (BH08-6), this report provides geotechnical comments and recommendations on slope stability and remedial works.

This report is provided on the basis of the terms of reference presented above, and on the assumption that the design will be in accordance with applicable codes and standards. If there are any changes in the design features relevant to the geotechnical analyses, or if any questions arise concerning geotechnical aspects of the codes and standards, this office should be contacted to review the design.

The information in this report in no way reflects on the environmental aspects of the soil. Should specific information in this regard be needed, additional testing may be required.

3.0 Subsurface Conditions (BH08-06)

3.1 Soil Stratigraphy

The detailed stratigraphy encountered in BH08-6 is detailed in the borehole log found in **Appendix A**, and summarized in the following paragraphs. It must be noted that boundaries of soil indicated in the borehole log is inferred from non-continuous sampling and observations during excavation. These boundaries are intended to reflect transition zones for the purposes of geotechnical design and should not be interpreted as exact planes of geological change.

3.1.1 Topsoil

BH08-6 was surfaced with topsoil, which approximate thickness of 400 mm.

3.1.2 Sand

Underlying the topsoil, natural sand was encountered at the borehole location. The deposit is fine to medium grain sand and generally described as brown in color. The sand contains some silt to silty. The sand was in compact and moist conditions and extended to approximate depth of 3.4 m below ground surface (bgs).

3.1.3 Silt Till

Underlying the sand layer, natural silt till was encountered at the borehole locations. The silt till deposit is generally described as brown in color and contains trace sand and gravel. The till was in dense and moist conditions and extended to exploration depth of 6.1 m bgs..The silt till is becoming grey and clayey at depth of 4.6 m bgs.

3.2 Groundwater

Detailed observation of groundwater and moisture contents of selected samples is shown on the borehole logs. Upon completion of drilling, the open borehole excavation was examined for the presence of groundwater and groundwater seepage. No groundwater or seepage was observed/recorded in the borehole. No cave in was recorded as well.

This observation is based on short-term observation during drilling, and do not reflect the stabilized groundwater table at the site.

It should be noted that the depth to the groundwater table may vary in response to climatic or seasonal conditions, and as such, may differ at the time of construction, with higher levels in wet seasons.

3.3 Site Reconnaissance

A slope review survey was carried out on September 20, 2016 along east side of Area “1”. The survey included detailed observations such as slope vegetation, old slump scars, seepage, and soil type.

The bank is covered with mature trees. Wooded areas were observed along the bank of the site. Minor bare areas, bent trees and ridges were observed at the crest, the face and the bottom of the slope. The valley floors are covered with vegetation.

Based on the exp's site review survey, no significant bare or vegetation-free stream bank, which is directly exposed to ditch flow under normal or flood flow conditions, was observed. Further observations did not reveal significant undercutting, over-steepening or high downstream sediment loading occurrence was noted but minor seepage was observed at few localised areas within the slope face.

Based on the above data, our past experience and our engineering evaluation, no evidence of significant active erosion was noticed in the area.

Based on the rating system indicated in the "Slope Stability Rating Chart" prepared by the Ontario Ministry of Natural Resources, the slope rating at the site was calculated to range from 32 to 34 at Cross Sections A-A', B-B' and C-C'. The slope ratings indicate moderate for slope instability. The slope rating charts are provided in **Appendix B**. Selected photos at A-A', B-B' and C-C' section locations are presented below.

Photograph 1:

From the toe of the slope looking towards the crest of the slope at Section A-A'.

Photograph 2:

From the mid of the slope face looking towards the crest of the slope at Section B-B'.

Photograph 3:

Looking towards the crest at the base of the slope at Section C-C''.

4.0 Slope Stability (Area 1)

4.1 Stable Slope Geometry

The stability of the existing slope was investigated for a number of different Factors of Safety (FOS). The various types of failures resulting include shallow slumping failures, medium depth rotational failures near the crest of the slope, and deep rotational failures through the entire height of the slope. The analyses were undertaken by computer methods utilizing the Slope/W computer program for select slope profiles.

The soil conditions encountered in the borehole comprises of compact sand contained some silt to silty over dense natural silt till deposit which contained trace sand and gravel (becoming clayey at depths).

The soil parameters used were conservative to build in an added safety factor for the analyses. The following table summarizes the parameters for the predominant soils which were used in **exp**'s evaluation of the stable slope configuration:

Soil Type	Density	Cohesion	Angle of Internal Friction
Sand	19.0 kN/m^3	0 kPa	30 ^{o}
Silt Till	21.5 kN/m^3	5 kPa	30^o

The design Minimum Factor of Safety from Table 4.3 of the Technical Guide – River and Stream Systems: Erosion Hazard Limit for Active Land Uses (i.e. habitable or occupied structures near slope) should be in the range of 1.3 to 1.5. A minimum factor of safety of 1.4 was used for the analysis as indicated in the report "Geotechnical Principles for Stable Slopes" prepared for the Ministry of Natural Resources.

Three cross sections A-A', B-B' and C-C' were drawn at steepest locations across the slope from south to north. The three cross section locations are shown on **Drawing No. 1** and the profiles provided on Drawing Nos. 2, 3 and 4. Slope gradient at section B-B' is steeper than other sections; therefore, slope analyses were only undertaken at this section' by computer methods utilizing the Slope/W computer program for selected slope profile. The failures at cross section B-B' were shallow to medium depth rotational failure with factor of safety of 1.7 to 1.8. These findings were in general agreement with observations of well vegetated slope which is beneficial for protection against landslides activities. The slope is considered stable. Therefore, no stable slope allowance is required at this section and for entire area.

4.2 Toe Erosion Component

Based on the valley floor width along the slope which ranged between 11 m to greater than 15 m, no evidence of active erosion and native soil encountered at the site, the existing valley floor width is considered sufficient and no toe erosion allowance is required. The toe erosion component is based on Table 3 in the Technical Guide – River and Stream Systems: Erosion Hazard Limit (2002).

4.3 Erosion Access Allowance

The Erosion Access Allowance as specified in Section 3.4 of the MNR Technical Guide is a distance of 6 m from the top of the slope. This allowance is required in order to provide access for repairs to the slope from the top of the slope. **Exp** recommends that a distance of 6 m for the erosion access allowance be provided on the table land. No permanent structures should be constructed within the 6 m of the erosion access allowance.

4.4 Erosion Hazard Limit (Area "1")

The Erosion Hazard Limit (Recommended Development Setback) is defined by the sum of the Stable Safe Slope Line plus the Toe Erosion Component plus the Erosion Access Allowance. The table below summarizes the three (3) components and the total distance back from the existing top of slope to the Recommended Development Limit Setback.

Cross Section	Toe Erosion Allowance, m	Stable Slope Allowance, m	Erosion Access Allowance, m	Erosion Hazard Limit (Development Setback) from Top of Slope, m
A-A'	0	0	6	6
B-B'	0	0	6	6
C-C'	0	0	6	6

The Recommended Development Setback Limit is shown on Drawing No.'s 1, 2, 3 and 4.

4.5 Additional Comments

The site should be graded such that additional surface water is directed away from the slope. No water from the table land should be out-letted down the slope.

Water from downspouts and perimeter weeping tile etc. should be collected in a controlled manner and directed away from the slope.

Spoils from any excavation should be removed from the site. Excavated soils should not be placed over the table land near the crest of slope.

During construction, stockpiles of materials, supplies and construction debris should be located away from the slope crest. Additional loading from stockpiled materials should be avoided in proximity to the slope crest.

Debris littering the slope should be removed and vegetation on the slope should be maintained.

Site topographical information by MTE Ltd. Ontario Land Surveyors (OLS) has been superimposed on the plan and profile drawings and labelled Drawing Nos. 1 through 3.

Drawings show the location of the Toe Erosion Allowance, Safe Slope Allowance, Erosion Access Allowance and Erosion Hazard Limit (Recommended Development).

Any structural component should be founded on competent soil below a line drawn from the toe of the slope at 3H:1V.

5.0 Slope Stability (Area “2”)

To confirm there is no an issue with a slope located on the east side of the site (Area “2”), one cross section, designated as Section D-D, was drawn across the steepest section of this slope. The cross section is shown on the Drawing 1. Based on the profile of Section D-D, the slope inclination was 3.5H:1V and flatter with approximate height ranging from 2.5 to 3.0 m . The slope has a gentle inclination and low height. Based on the above, no setback is required at this zone and no further recommendations are needed.

6.0 General Comments

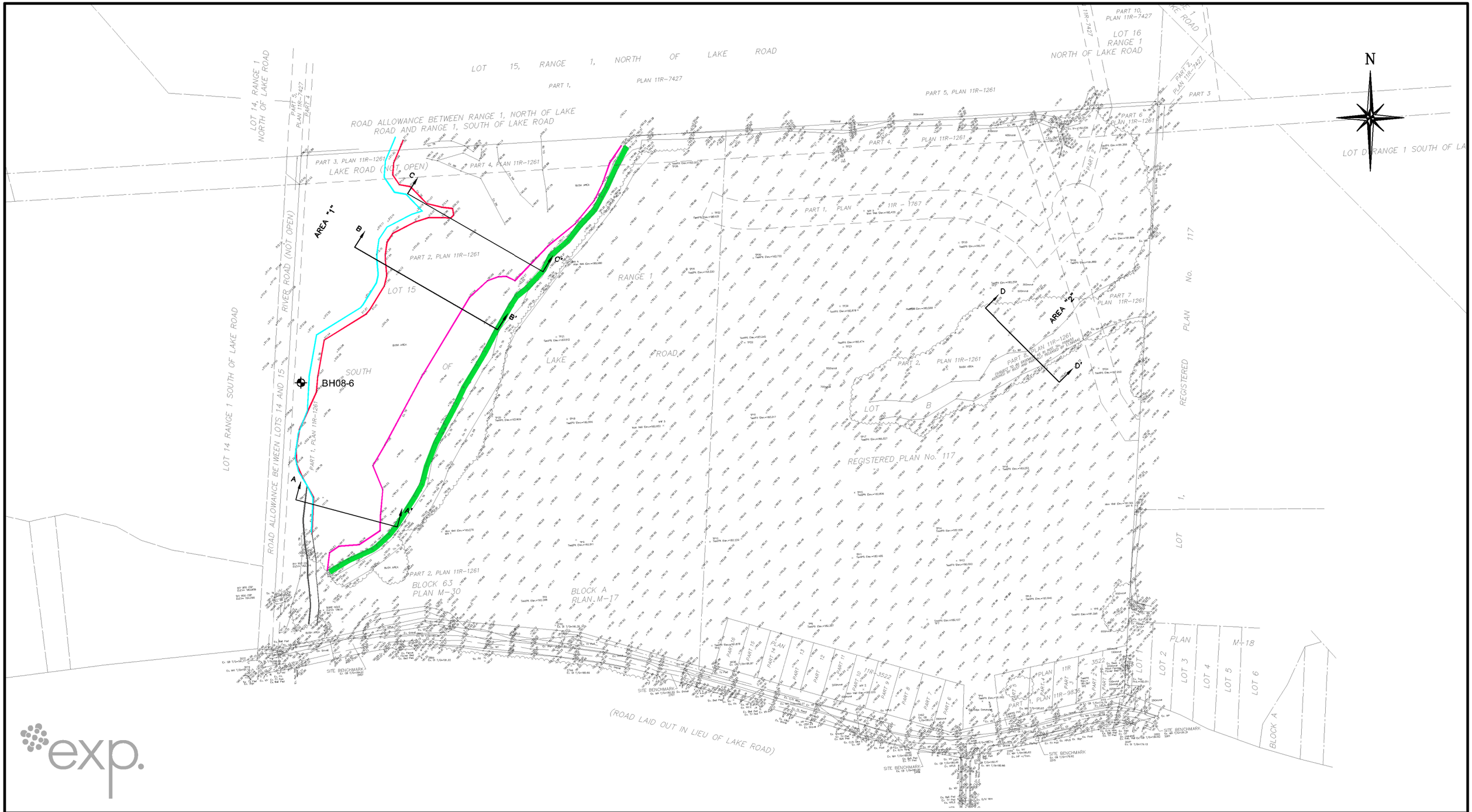
The comments given in this report are intended only for the guidance of design engineers; and should be read in conjunction with the complete package of design documents, when used during construction.

The number of test holes required to determine the localized underground conditions between test holes affecting construction costs, techniques, sequencing, equipment, scheduling, etc. would be much greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should in this light, decide on their own investigations, as well as their own interpretations of the factual borehole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

Exp Services Inc. should be retained for a general review of the final design and specifications to verify that this report has been properly interpreted and implemented. If not afforded the privilege of making this review, **exp** Services Inc. will assume no responsibility for interpretation of the recommendations in this report. In the event that variations in soil or groundwater conditions are encountered onsite, it is recommended that **exp** be contacted to review the findings and confirm the suitability of recommendations provided in this report.

We trust that this report is satisfactory to your present requirements and we look forward to assisting you in the completion of this project. Should you have any questions, please contact the office at your convenience.

Drawings



NOTES:

1. The site plan was reproduced from drawing provided by client and should be read in conjunction with exp Slope Assessment Report LON-00014790-SLOPE dated October, 2 2016.

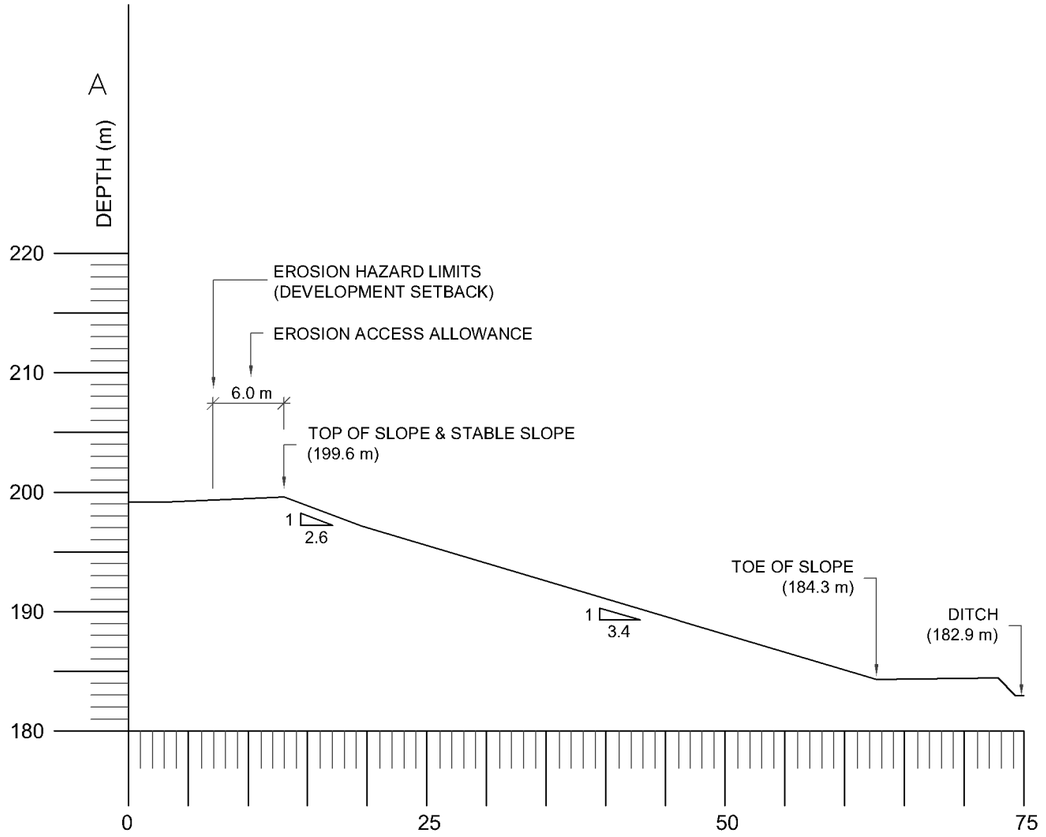
EROSION HAZARD LIMIT (DEVELOPMENT SETBACK)
TOP OF SLOPE
TOE OF SLOPE
DITCH

Slope Assessment

Proposed Residential Development

George Street, Port Stanley, Ontario

CLIENT	Wastell House
TITLE	Site Plan
DRAWN BY	J.T.
REVIEWED BY	I.S.
	exp Services Inc. 15701 Robin's Hill Road, London, ON, N5V 0A5
DATE	June 2017
SCALE	1:2500
PROJECT NO.	LON-00014790-GE
DWG.	201



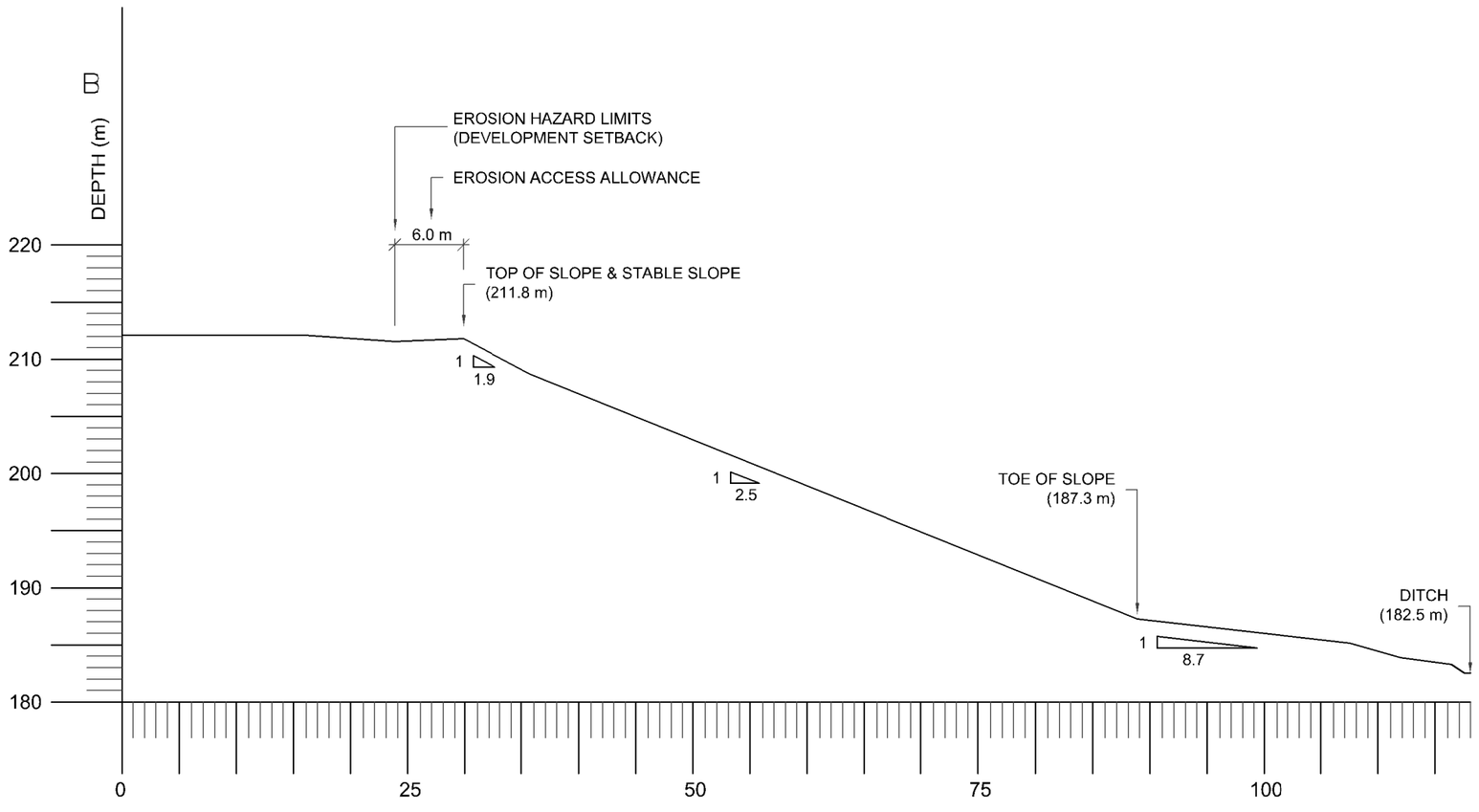
SECTION A-A'

NOTES:

1. The site plan was reproduced from drawing provided by client and should be read in conjunction with exp Slope Assessment Report LON-00014790-SLOPE dated October, 2 2016.

Slope Assessment
Proposed Residential Development
George Street, Port Stanley, Ontario

CLIENT	387476 Ontario Ltd.
TITLE	SECTION A-A'
DRAWN BY	J.T.
REVIEWED BY	I.S.
	exp Services Inc. 15701 Robin's Hill Road, London, ON, N5V 0A5
DATE	June 2017
SCALE	1:500
PROJECT NO.	LON-00014790-GE
DWG.	202



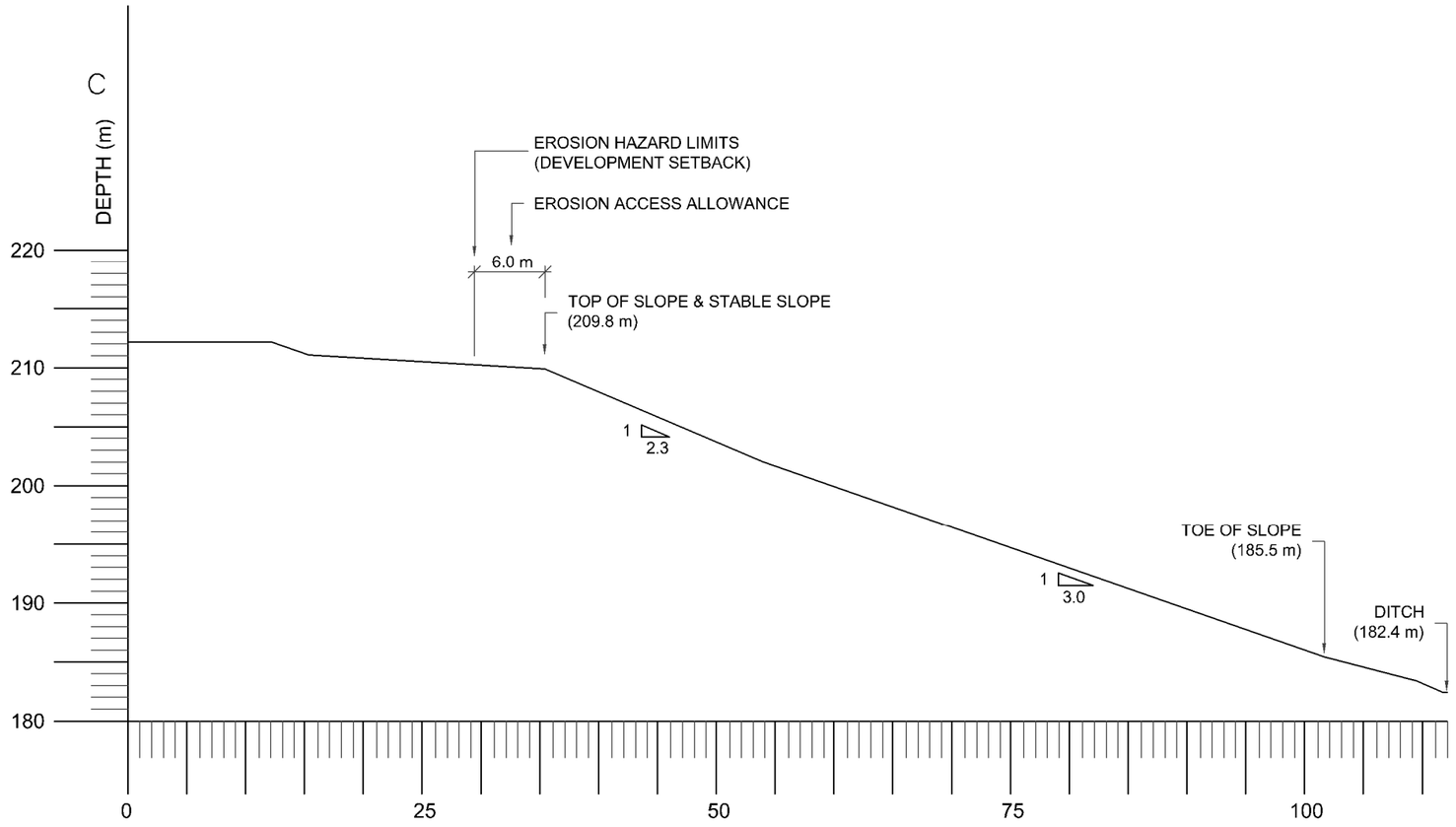
SECTION B-B'

NOTES:

1. The site plan was reproduced from drawing provided by client and should be read in conjunction with exp Slope Assessment Report LON-00014790-SLOPE dated October, 2 2016.

Slope Assessment
Proposed Residential Development
George Street, Port Stanley, Ontario

CLIENT: 387476 Ontario Ltd.			
TITLE: SECTION B-B'			
DRAWN BY: J.T.	REVIEWED BY: I.S.		
exp Services Inc. 15701 Robin's Hill Road, London, ON, N5V 0A5			
DATE: June 2017	SCALE: 1:500	PROJECT NO.: LON-00014790-GE	DWG: 203



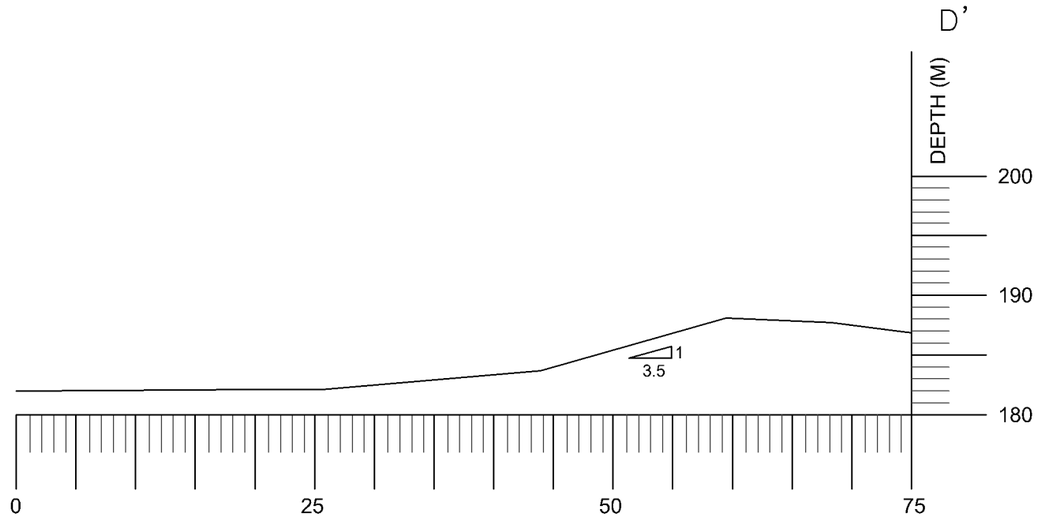
SECTION C-C'

NOTES:

1. The site plan was reproduced from drawing provided by client and should be read in conjunction with exp Slope Assessment Report LON-00014790-SLOPE dated October, 2016.

Slope Assessment
Proposed Residential Development
George Street, Port Stanley, Ontario

CLIENT: 387476 Ontario Ltd.			
TITLE: SECTION C-C'			
DRAWN BY: J.T.	REVIEWED BY: I.S.		
exp Services Inc. 15701 Robin's Hill Road, London, ON, N5V 0A5			
DATE: June 2017	SCALE: 1:500	PROJECT NO.: LON-00014790-GE	DWG.: 204



SECTION D-D'

NOTES:

1. The site plan was reproduced from drawing provided by client and should be read in conjunction with exp Slope Assessment Report LON-00014790-SLOPE dated October, 2016.

Slope Assessment
Proposed Residential Development
George Street, Port Stanley, Ontario

CLIENT: 387476 Ontario Ltd.			
TITLE: SECTION D-D'			
DRAWN BY: J.T.	REVIEWED BY: I.S.		
exp. **exp** Services Inc. 15701 Robin's Hill Road, London, ON, N5V 0A5			
DATE: June 2017	SCALE: 1:500	PROJECT NO.: LON-00014790-GE	DWG.: 205

Appendix A
Borehole Logs

Depth (m)	Moisture Content (%)	Penetrometer (kg/cm^2)	Soil Description
BH 08-5			
0.0 – 0.3			TOPSOIL – black, silty loam, loose, moist
0.3 – 5.2		1.5	SANDY SILT – brown, fine grained, trace clay, loose to compact, very moist to wet
0.8	19.3		
2.3	24.6		-some clay, loose, wet
3.8	25.6		-becoming grey
5.2 – 6.1			-becoming CLAYEY SILT, soft, wet below 5.2m depth
6.1	40.4		
			BOREHOLE TERMINATED at 6.1 m depth *Groundwater measured at 3.1 m depth upon completion*
BH 08-6			
0.0 – 0.4			TOPSOIL – black, silty loam, loose, moist
0.4 – 2.3			SAND – brown, fine to medium grained, compact, moist
0.8	11.1		-some silt to silty
2.3	13.7		
2.3 – 3.4			
3.4 – 4.6		3.5	SILT TILL – brown, trace sand and gravel, dense, moist
3.8	16.0		
4.6 – 6.1		2.0	-becoming grey and clayey
6.1	14.6		
			BOREHOLE TERMINATED at 6.1 m depth *Open and dry upon completion*
BH 08-7			
0.0 – 0.4			TOPSOIL – black, silty loam, loose, moist
0.4 – 0.8		1.0	CLAYEY SILT – brown, trace sand and gravel, stiff, moist
0.8	22.0		
0.8 – 1.8		4.0	SILT TILL – brown, trace sand and gravel, dense, moist
1.8 – 4.6		3.5	-some silt layering
2.3	16.4		
3.8	15.7		
4.6 – 6.1		2.5	-becoming grey and clayey
6.1	14.8		
			BOREHOLE TERMINATED at 6.1 m depth *Open and dry upon completion*

Appendix B
Slope Stability Charts

Slope Stability Rating Chart at Section A-A'

Geotechnical Principles for Stable Slopes,
Ontario Ministry of Natural Resources

Site Location: George Street	**Project No.: LON-00014790**
Town/City: Port Stanley, ON	**Inspection Date: Sept 20, 2016**
Inspected by: David Leech	**Weather: Sunny, 21 degrees**

	Rating Value	
	Possible	**Actual**
Slope Inclination		
18 degrees or less (3H:1V or flatter)	0	0
18 to 26 degrees (2H:1V to more than 3H:1V)	6	
More than 26 degrees (steeper than 2H:1V)	16	
Soil Stratigraphy		
shale / limestone / granite (bedrock)	0	
sand, gravel	6	
glacial till	9	
clay, silt	12	12
fill	16	
leda clay	24	
Seepage from Slope Face		
none, or near bottom only	0	
near mid-slope only	6	6
near crest only, or from several levels	12	
Slope Height		
2 m or less	0	
2.1 to 5 m	2	
5.1 to 10 m	4	
more than 10 m	8	8
Vegetation Cover on Slope Face		
well vegetated: heavy shrubs or forested with mature trees	0	0
light vegetation: mostly grass, weeds, occasional trees, shrubs	4	
no vegetation: bare	8	
Table Land Drainage		
table land flat, no apparent drainage over slope	0	0
minor drainage over slope, no active erosion	2	
drainage over slope, active erosion, gullies	4	
Proximity of Watercourse to Slope Toe		
15 metres or more from slope toe	0	
less than 15 metres from slope toe	6	6
Previous Landslide Activity		
No	0	0
Yes	6	
Slope Instability Rating	**Total:**	**32**

Low Potential	< 24	Site Inspection only, confirmation, report letter
Slight Potential	25-35	Site Inspection and surveying, preliminary study, detailed report
Moderate Potential	> 35	BH Investigation, piezometers, lab tests, surveying, detailed report

Notes: This chart does not apply to rock slopes or Leda Clay slopes.
Choose only one from each category, compare total rating value with above requirements.
Is there a water body (stream, creek, river, pond, bay, lake) at the toe of slope? Yes

_____

If YES - the potential for toe erosion and undercutting should be evaluated in detail.

Slope Stability Rating Chart at Section B-B'

Geotechnical Principles for Stable Slopes,
Ontario Ministry of Natural Resources

Site Location: George Street	**Project No.: LON-00014790**
Town/City: Port Stanley, ON	**Inspection Date: Sept 20, 2016**
Inspected by: David Leech	**Weather: Sunny, 21 degrees**

	Rating Value Possible	Actual
Slope Inclination		
18 degrees or less (3H:1V or flatter)	0	
18 to 26 degrees (2H:1V to more than 3H:1V)	6	6
More than 26 degrees (steeper than 2H:1V)	16	
Soil Stratigraphy		
shale / limestone / granite (bedrock)	0	
sand, gravel	6	
glacial till	9	
clay, silt	12	12
fill	16	
leda clay	24	
Seepage from Slope Face		
none, or near bottom only	0	
near mid-slope only	6	6
near crest only, or from several levels	12	
Slope Height		
2 m or less	0	
2.1 to 5 m	2	
5.1 to 10 m	4	
more than 10 m	8	8
Vegetation Cover on Slope Face		
well vegetated: heavy shrubs or forested with mature trees	0	0
light vegetation: mostly grass, weeds, occasional trees, shrubs	4	
no vegetation: bare	8	
Table Land Drainage		
table land flat, no apparent drainage over slope	0	
minor drainage over slope, no active erosion	2	2
drainage over slope, active erosion, gullies	4	
Proximity of Watercourse to Slope Toe		
15 metres or more from slope toe	0	0
less than 15 metres from slope toe	6	
Previous Landslide Activity		
No	0	0
Yes	6	
Slope Instability Rating	**Total:**	**34**

Low Potential	< 24	Site Inspection only, confirmation, report letter
Slight Potential	25-35	Site Inspection and surveying, preliminary study, detailed report
Moderate Potential	> 35	BH Investigation, piezometers, lab tests, surveying, detailed report

Notes: This chart does not apply to rock slopes or Leda Clay slopes.
Choose only one from each category, compare total rating value with above requirements.
Is there a water body (stream, creek, river, pond, bay, lake) at the toe of slope? Yes

_____

If YES - the potential for toe erosion and undercutting should be evaluated in detail.

Slope Stability Rating Chart at Section C-C'

Geotechnical Principles for Stable Slopes,
Ontario Ministry of Natural Resources

Site Location: George Street	**Project No.: LON-00014790**
Town/City: Port Stanley, ON	**Inspection Date: Sept 20, 2016**
Inspected by: David Leech	**Weather: Sunny, 21 degrees**

	Rating Value	
	Possible	**Actual**
Slope Inclination		
18 degrees or less (3H:1V or flatter)	0	0
18 to 26 degrees (2H:1V to more than 3H:1V)	6	
More than 26 degrees (steeper than 2H:1V)	16	
Soil Stratigraphy		
shale / limestone / granite (bedrock)	0	
sand, gravel	6	
glacial till	9	
clay, silt	12	12
fill	16	
leda clay	24	
Seepage from Slope Face		
none, or near bottom only	0	
near mid-slope only	6	6
near crest only, or from several levels	12	
Slope Height		
2 m or less	0	
2.1 to 5 m	2	
5.1 to 10 m	4	
more than 10 m	8	8
Vegetation Cover on Slope Face		
well vegetated: heavy shrubs or forested with mature trees	0	0
light vegetation: mostly grass, weeds, occasional trees, shrubs	4	
no vegetation: bare	8	
Table Land Drainage		
table land flat, no apparent drainage over slope	0	
minor drainage over slope, no active erosion	2	2
drainage over slope, active erosion, gullies	4	
Proximity of Watercourse to Slope Toe		
15 metres or more from slope toe	0	
less than 15 metres from slope toe	6	6
Previous Landslide Activity		
No	0	0
Yes	6	
Slope Instability Rating	**Total:**	**34**

Low Potential	< 24	Site Inspection only, confirmation, report letter
Slight Potential	25-35	Site Inspection and surveying, preliminary study, detailed report
Moderate Potential	> 35	BH Investigation, piezometers, lab tests, surveying, detailed report

Notes: This chart does not apply to rock slopes or Leda Clay slopes.
Choose only one from each category, compare total rating value with above requirements.
Is there a water body (stream, creek, river, pond, bay, lake) at the toe of slope? Yes

_____

If YES - the potential for toe erosion and undercutting should be evaluated in detail.

Appendix C
Typical Erosion Hazard Limit

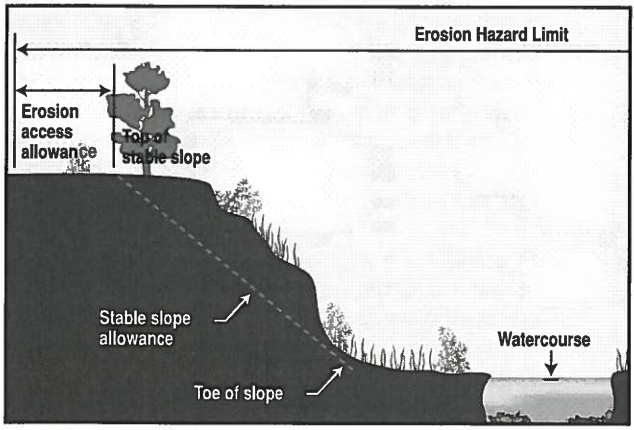


Figure 95 a Confined System, Erosion hazard limit where toe of valley slope is located more than 15 metres from the watercourse

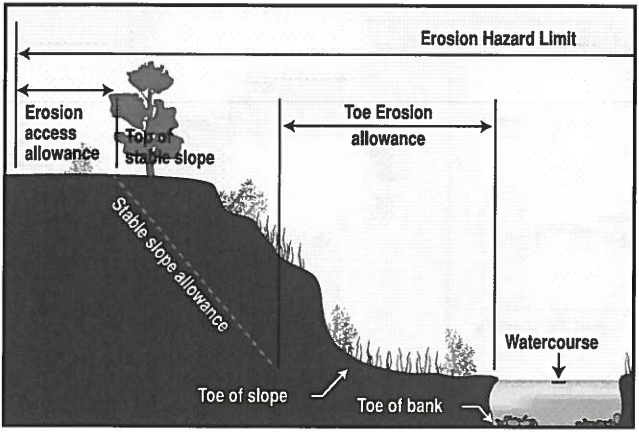


Figure 95 b Confined System, Erosion hazard limit where toe of valley slope is located less than 15 metres from the watercourse