



February 14, 2017

Our File Ref.: 160796

Denis Lacroix
6909 Notre Dame Street
Ottawa, Ontario
K1C 1H6

Subject: Slope Stability Analysis
6909 Notre Dame Street
Ottawa, Ontario

Pursuant to your request, LRL Associates Ltd. (LRL) completed a slope stability analysis at the above referenced location. The purpose of this analysis was to evaluate the current condition of the site and of the subject slope, and to establish if the proposed dwelling will affect the slope's stability.

1 SITE AND PROJECT DESCRIPTION

The site under investigation currently has an existing two storey house, and an attached three car garage. The property is rectangular in shape, and has 60.6 m frontage along Notre Dame Street, and has an approximate surface area of 3412 m² (0.84 acre). The south portion of the lot is considered to be relatively flat, with a slope of about 2.4 Horizontal to 1 Vertical (2.4H :1V) located at the north portion of the site. The site is civically located at 6909 Notre Dame Street in the City of Ottawa, Ontario.

It is our understanding that the west portion of the lot will be severed, and a single storey duplex with a basement will be constructed. It is assumed that the new dwelling will be serviced with the municipal utilities and services.

2 PROCEDURE

A site visit was carried out by a member of our geotechnical team on December 22, 2016. During this site visit, a limited subsurface investigation was carried out to characterize the surficial soil of the slope.

One (1) borehole was advanced near the crest of the slope using a track mounted CME 55 drill rig equipped with 200 mm diameter continuous flight hollow stem auger supplied and operated by George Downing Estate Drilling Ltd, and was extended to a depth of 8.07 m below ground service (bgs). Two (2) manual auger holes were completed to an approximate depth of 1.50 m bgs; one (1) within the slope at the midpoint, and one (1) near the toe of the slope.



Sampling of the overburden materials encountered in the borehole at the crest of the slope was carried out at regular depth intervals using a 50 mm diameter drive open conventional spoon sampler in conjunction with standard penetration testing (SPT) “N” values, and in-situ vane shear tests.

3 SLOPE DESCRIPTION

The slope under review herein is located at the north portion of the property and faces north towards a creek. It has an overall slope of about 2.4H:1.0V, with the steepest section of the slope being about 1.6H:1.0V. The length of the slope is about 18.6 m, and has a total height of about 7.1 m high. At the time of the investigation, the site was snow covered, and possible signs of erosion were unable to be detected. The slope was vegetated with mature trees.

4 SUBSURFACE CONDITIONS

A review of local surficial geology maps provided by the Department of Energy, Mines and Resources Canada suggest that the surficial geology for this area consist of blue-grey clay, silt, and silty clay; calcareous and fossiliferous at depth.

The borehole and auger holes completed during the slope stability analysis indicate the slope is comprised of fill, underlain by a stiff to very stiff deposit of silty clay.

No groundwater was encountered during our subsurface investigation. However, it should be noted that groundwater level can vary and are subject to seasonal fluctuation in response to major changes to weather events.

5 SLOPE STABILITY ANALYSES

The slope modelling program, Slide 5.0 (Rocscience), was used to implement the Bishop simplified method of slices. The slope profile for the existing slope conditions, as measured in the field was used and modeled to check the existing condition of the slope. The slope was analyzed under both the undrained (short-term failure) and drained (long-term failure) conditions.

The field measurements in conjunction with known published data of the silty clay of the Eastern Ontario region were used for selection of appropriate soil modelling parameters in the current slope stability analyses.

The results of the analyses are potentially dependent on the assumption of groundwater condition. During developing of this report, no information on the groundwater level was available throughout the year. However, as a conservative approach, the analyses were completed assuming full saturation throughout the silty clay material.

The following soil parameters were used as part of the analyses.

Soil Type	Effective cohesion (c') - KPa	Angle of internal friction (φ') - degrees	Bulk unit weight (γ _B) – kN/m ³
Drained Parameters (Long Term)			
Fill	3	29	18.5
Silty Clay	5	34	18.5
Undrained Parameters (Short Term)			
Fill	25	29	18.5
Silty Clay	90	-	18.5

The factor of safety (FoS) against slope failure was ran for the undrained and drained condition. The FoS values obtained were 1.72 and 1.53 respectively. A FoS of 1.5 or greater is considered to be safe with regard to slope stability. The designed house load was not provided (design bearing pressure at serviceability limit state) during our field investigation. However a typical value assumed to be 90 kPa for similar type of residential construction was included within the model.

These results indicate that the current condition of the slope will remain stable for both the undrained condition (short-term) and drained condition (long-term).

The model results are attached for your reference.

6 SETBACK REQUIREMENTS

In accordance with the Ministry of Natural Resources (MNR) Technical Guide and Slope Stability Guidelines for Development Applications in the City of Ottawa, 2012, the Limit of Hazard Land consist of three components as follows:

Limit of Hazard Land = Stable Slope Allowance + Toe Erosion Allowance + Erosion Access Allowance.

The Stable Slope Allowance, as described in MNR Technical Guideline, is the area where a factor of safety is typically 1.5 against overall rotational failure. As indicated in the enclosed figures, the existing slope stability analyses shown in the current profile have a factor of safety 1.72 (>1.5) against failure in undrained condition (short-term) and 1.53 (>1.5) in drained condition (long-term). Therefore, stable slope allowance as indicated the MNR Technical Guide is not required at this site.

During our limited field observation, no active erosion at or near the slope toe was observed. Toe Erosion Allowance for clay soils with indication of active erosion is suggested at between 5.0 and 8.0 m. If there is no erosion, A Toe Erosion Allowance between 1.0 and 4.0 m is suggested depending on river/creek width. Based on our limited field observation, a Toe Erosion Allowance of minimum 1.0 is considered to be satisfactory at this site.

The MNR Technical Guide also includes the application of 6.0 m wide Erosion Access Allowance to allow the access for equipment to repair or reconstruct the slope in the event of damage from possible failure.

7 CONCLUSIONS/RECOMMENDATIONS

Pursuant to our slope stability assessment at the slope location and condition, the slope in its current state will be stable and safe. Regardless of the results however, the following recommendations should be adhered to ensure the long term stability of the slope.

With the suggested slope gradient, a minimum 7.0 m setback allowance is suggested for erosion access allowance and toe erosion allowance and no structural load or construction shall take place within this setback. A relatively flatter slope with reduced setback than what is recommended may be possible, provided that a more intensive investigation on the groundwater table and physical properties of soil stratigraphy is to be conducted. Additional recommendations include:

- The existing trees and vegetation cover near and within the existing slope should not be disturbed any more than is absolutely necessary to develop house, as it promotes stability and erosion control to the slope. Existing mature trees, if any, should be protected and

maintained throughout the sloped profile. The addition of deep rooted vegetation at or near the crest can be considered for stability or protection against erosion with surface run-off.

- If it is decided that grade raises are needed, LRL must be contacted to ensure that the results of this report are still applicable.
- Any site drainage should be diverted away from the slope and/or the slope should be protected from erosion to ensure that the slope profile does not change with time. Drainage outlets, if any shall be protected with riprap over approved geotextile to eliminate erosion in the slope.
- No backfill or excavated material shall be placed within the 7.0 m setback.
- The slope profile outside should not be modified in any way as part of the proposed development. If modifications to the current slope profile are proposed beyond what was presented, LRL should be consulted to ensure that the results of this report are still valid.
- If any additional structures are considered to be constructed beyond what was indicated/proposed, LRL should be consulted to ensure that the results of this report are still valid.

8 GENERAL COMMENTS AND LIMITATIONS OF REPORT

The conclusion and recommendations are provided in this report are based on subsoil properties at the auger and boreholes locations. The material reflects in this report are best judgement in light of information obtained from localized auger holes and information available with LRL at the time of report preparation.

This report is prepared for and is intended solely for its client and authorized engineers. Unless otherwise agreed in writing, no portion of this report, or any part thereof may be used or decisions made based on it by separate entity, are the responsibility of such entity. LRL accepts no responsibility for damage, if any, suffered by any separate entity as a result of decisions made or suffered from illegal use of this report. The findings are relevant for the date of the site investigation and any changes on the ground profile or subsurface condition at later date, LRL should be retained to review and for further recommendations.

We trust this report provides sufficient information for your present purposes. If you have any questions concerning this report or if we may be of further services to you, please do not hesitate to contact our office.

Yours truly,

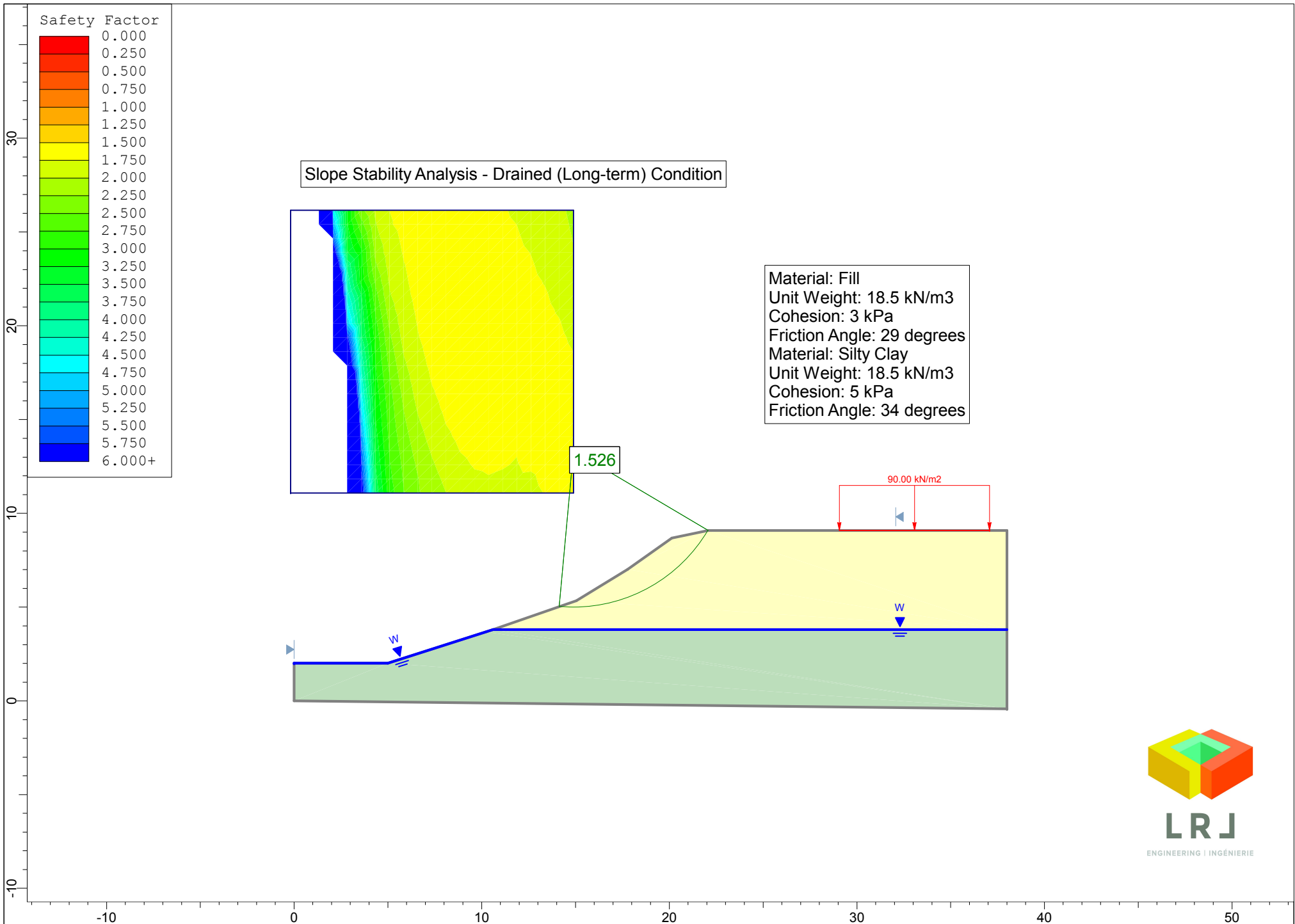
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Encl. Slope Stability Analysis Results
Photographs







SITE VISIT PHOTOGRAPHS

Our File Ref.: 160796

Client: Denis Lacroix

Project: Slope Stability – Proposed House

Site Location: 6909 Notre Dame Street, Ottawa ON

Photograph No. 1	 A photograph showing a snowy slope covered in a dense forest of bare trees. The snow is piled up, and the trees are thin and dark against the white background.
Date: 2/14/2017	
Description View of slope from crest.	

Photograph No. 2	 A photograph showing a snowy slope covered in a dense forest of bare trees. The snow is piled up, and the trees are thin and dark against the white background.
Date: 2/14/2017	
Description View of slope from toe.	

