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Novatech
240 Michael Cowpland Drive, Suite 200
Ottawa, Ontario
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Attention: Mr. Mark Bissett, P.Eng., Senior Project Manager

Re: Slope Stability Assessment and Meander Belt Setback
Proposed Residential Subdivision
1055 Klondike Road
Ottawa, Ontario

INTRODUCTION

This letter presents the results of a slope stability assessment carried out at 1055 Klondike Road in Ottawa, Ontario, as part of the geotechnical investigation for the proposed residential subdivision. Also, our comments on the meander belt hazard identified by the Mississippi Valley Conservation Authority (MVCA) are provided.

PROJECT DESCRIPTION

Plans are being prepared for the development of 1055 Klondike Road into a residential subdivision. The proposed development is still in preliminary design stages, but will consist of a residential subdivision with an internal roadway and municipal water and sewer services.

BACKGROUND

Previously, GEMTEC Consulting Engineers and Scientists Limited (GEMTEC), formerly Houle Chevrier Engineering Ltd. carried out a preliminary geotechnical investigation titled: “Preliminary Geotechnical Investigation, Proposed Residential Subdivision, 1055 Klondike Road, Ottawa, Ontario”, dated April 13, 2017. That report included a preliminary slope stability assessment and set a preliminary ‘Erosion Hazard Limit’ adjacent to the slope and creek which runs along the west to north side of this site. That report should be read in conjunction with this letter.

In March 2018, an additional 5 boreholes were advanced at the site to supplement the subsurface information gathered during the preliminary investigation. The boreholes were advanced to depths ranging from 5.9 to 10.2 metres below surface grade (elevations 68.2 to 71.8 metres, geodetic datum).

Standard penetration tests (SPT) were carried out in the boreholes and samples of the soils encountered were recovered using a 50 millimetre diameter split barrel sampler.

The field work was observed throughout by a member of our engineering staff who directed the drilling operations and logged the samples and boreholes.

Three (3) standpipe piezometers were installed at borehole locations 18-1, 18-3 and 18-5 to facilitate groundwater level measurements and sampling, if required.

Following completion of the drilling, the soil samples were returned to our laboratory for examination by a geotechnical engineer. Selected samples were submitted for moisture content, grain size distribution testing and Atterberg limits

The locations of the boreholes (preliminary and additional boreholes) are shown on the attached Erosion Hazard Limit Plan, Figure 1. The results of the additional boreholes are provided in a geotechnical report for the proposed development and have been used in this slope stability assessment.

DESCRIPTION OF SITE AND SLOPE

The west to north side of the property is bounded by a slope which descends towards an existing creek. A site reconnaissance was carried out by a member of our engineering staff on February 27, 2018. At that time, the geometry of the slope on the subject property was measured at four (4) locations (Sections 'A-A', 'B-B', 'C-C' and 'D-D', as shown on Figure 1) using our Trimble R10 GPS. The cross-sections were positioned at the site by GEMTEC personnel at key locations based on slope inclination and height. Cross sections of the slope are provided on Figures A1 to A4 inclusive, in Attachment A.

In general, the natural slopes are vegetated with grass, small shrubs, and small to large trees.

At the time of our site reconnaissance, no signs of instability were observed at the subject site (i.e., tension cracks, previous failures, bowing of the tree trunks). However, active erosion was observed at the toe of the slope adjacent to the creek.

At the request of the MVCA an assessment of the slope across the central to eastern portion of the property was assessed as it relates to the potential meander belt hazard. More specifically, GEMTEC was asked to assess the stability of this slope in the event that the creek migrates to the edge of the meander belt hazard. The geometry of this slope was determined based on topographic mapping (refer to Section 'E-E"). A cross section of the slope at this location is provided on Figure A5 in Attachment A.

REVIEW OF AVAILABLE GEOLOGY MAPS

Surficial geology maps of the Ottawa area indicate that the overburden at the site consists of offshore marine and alluvial sediments of sand, silt and clay. Bedrock geology maps indicate that the overburden deposits are underlain by interbedded sandstone and dolostone bedrock of the March formation at depths ranging from 5 to 10 metres below ground surface.

SLOPE STABILITY ASSESSMENT

General

The slope stability analysis was carried out using SLIDE, a state of the art, two dimensional limit equilibrium slope stability program at Sections 'A-A', 'B-B', 'C-C' and 'D-D'. The locations of these sections are provided on the attached Erosion Hazard Limit Plan, Figure 1 and the cross-sections are provided on Figures A1 to A4 inclusive, in Attachment A.

Input Parameters

The soil conditions used in the stability analysis were based on the subsurface conditions encountered in the boreholes advanced as part of the preliminary geotechnical investigation and supplemental boreholes advanced at this site. For the purposes of the analysis, we have assumed that the slope is composed of clay fill material and sand underlain by native silty clay.

The slope stability analysis was carried out using clay fill material, sand and native silty clay strength parameters typical for the Ottawa area. The following table summarizes the soil parameters used in the analyses:

Table 1 - Summary of Soil Parameters

Soil Type	Effective Angle of Internal Friction, φ (degrees)	Effective Cohesion, c' (kilopascals)	Unit Weight, γ (kN/m^3)
Clay Fill Material	35	5	17.5
Sand	32	0	19
Silty Clay	33	10	17.5

The results of a stability analysis are highly dependent on the assumed groundwater conditions. We have assumed the groundwater level to be at the elevation of the existing creek and follow the native silty clay material layer as the recovered samples became wet within the native silty clay.

Existing Factor of Safety

The slope stability analysis was carried out using soil parameters, groundwater conditions and slope profiles that attempt to model the slopes in question but do not exactly represent the actual conditions. For the purposes of this study, a computed factor of safety of less than 1.0 to 1.3 is considered to represent a slope bordering on failure to marginally stable, respectively; a factor of safety of 1.3 to 1.5 is considered to indicate a slope that is less likely to fail in the long term and provides a degree of confidence against failure ranging from marginal (1.3) to adequate (1.4 and greater) should conditions vary from the assumed conditions. A factor of safety of 1.5, or greater, is considered to indicate adequate long term stability.

The slope stability analyses indicate that the existing slopes, in their current configurations, have the following factors of safety against overall rotational failure:

Table 2 – Existing Factor of Safety

Area	Cross Section	Existing Factor of Safety	Figure
1	A-A	1.4	A1
2	B-B	1.8	A2
3	C-C	1.7	A3
4	D-D	3.0	A4
5	E-E	4.2	A5

Based on the results of the analyses, the existing slopes at Sections 'B-B', 'C-C', 'D-D' and 'E-E', in their current configurations, are considered to be stable. At Section 'A-A', the calculated factor of safety against slope instability is 1.4, which is considered marginal to adequate.

A pseudo-static slope stability analysis was also carried out in an attempt to model seismic loading conditions. A seismic coefficient (k_h) of 0.20 was used in the analysis. The slope stability analysis indicates the slopes, in their current configuration, have factors of safety against instability of greater than 1.1 for pseudo-static (seismic) conditions, which is considered acceptable.

Erosion Hazard Limit

In accordance with the Ministry of Natural Resources (MNR) Technical Guide "Understanding Natural Hazards" dated 2001, the horizontal distance from a slope to the safe setback line is called the 'Erosion Hazard Limit'. The area between the Erosion Hazard Limit (i.e., safe setback line) and the crest of the slope is called 'Hazard Lands'. In accordance with MNR policy, Hazard Lands should not be developed with permanent structures, roadway areas, or any other valuable infrastructure.

The Erosion Hazard Limit consists of the following three (3) components:

Stable Slope Allowance:	Portion of the setback that ensures safety, if slumping or slope failure occurs. For stable slopes (i.e., factor of safety above 1.5) the Stable Slope Allowance is not applicable.
Toe Erosion Allowance:	Portion of the setback that ensures safety of the top of the slope in the event that a watercourse erodes or weakens the toe of the slope.
Erosion Access Allowance:	Portion of the setback needed to ensure that there is a large enough safety zone for people and vehicles to enter and exit an area during an emergency, such as a slope failure or flood. Typically, it is also included where construction vehicle access is required to repair a failed slope.

Based on the results of the slope stability analyses, the extent of the Hazard Lands, as defined by the MNR, is summarized in Table 3 and shown on Figure 1.

Table 3 – Erosion Hazard Limit (Safe Setback Distance)

Area	Section	Component			Erosion Hazard Limit[4] (metres)
		Stable Slope Allowance[1] (metres)	Toe Erosion Allowance[2] (metres)	Erosion Access Allowance (metres)	
1	A-A	1.25 (refer to Figure A1)	8	6	15.25
2	B-B	-	8	-	8
3	C-C	-	8	-	8
4	D-D	-	8	-	8
5[4] (refer to Figure 1)	-	-	8	-	8
6[5]	E-E	-	-	-	27.5

Notes:

1) The Stable Slope Allowance, as described in the MNR procedures, is the area between the crest of the slope and the location where a factor of safety of greater than 1.5 against slope failure is calculated. Where the current factor of safety is greater than 1.5, the stable slope allowance is not required. For the purposes of this study, the stable slope allowance is measured from the top of the slope.
2) In accordance with MNR documents, where active erosion was observed (Sections 'A-A', 'B-B', 'C-C' and 'D-D'), an allowance of 8 metres was used to account for erosion at the toe of the slopes. This is the maximum in the range provided for clayey soils in the MNR technical guide.
3) The MNR procedures include the application of a 6 metre wide Erosion Access Allowance. This setback has been applied in areas where the factor of safety is less than 1.5.
4) The positions of the toe and crest of the slope have been extrapolated based on the cross-sections used as part of the slope stability assessment, contour mapping and site observations during our site reconnaissance. As a worst case scenario, active toe erosion has been assumed, therefore an allowance of 8 metres should be used to account for erosion at the toe of the slope in this area.
5) Area 6 includes a 27.5 metre setback from the creek, which is half of the 55 metre Meander Belt width determined as part of previous studies by others. From a geotechnical perspective, there are no slope stability concerns in this area.

The Erosion Hazard Limit has been applied at the crest of the slope in accordance with procedures outlined in the City of Ottawa document titled "Slope Stability Guidelines for Development Applications in the City of Ottawa", dated December 2004 (refer to Figure 13, Method B - Engineering Analysis, as opposed to Figure 13 Method A - MNR Method).

As indicated above, an Erosion Access Allowance has not been included in areas where the factor of safety is greater than 1.5. This is rationalized by the fact that the intent of the erosion access allowance is to permit entry and exit in the event of a failure and to allow access for repair equipment. If the slope is deemed to be globally stable in the long term, this access is not considered necessary. It is pointed out that the current plans include a pathway along the edge of the Hazard Lands, which will provide a further buffer between the development and the crest of the slope. It is noted that information provided in paragraph 2 on page 25 of the City of Ottawa document titled "Slope Stability Guidelines for Development Applications in the City of Ottawa", dated December 2004" indicates that an Erosion Access Allowance need not be included in areas where the development will not preclude access to the slope.

In areas where an Erosion Access Allowance has been included (Area 1), exercise stations, pathways, and some grade raise filling etc. could be considered within this 6 metre setback provided that the proposed works do not prevent access to/from the top of a slope during an emergency and that any proposed raise are reviewed by geotechnical personnel.

As previously indicated, Hazard Lands should not be developed with permanent structures or any other valuable infrastructure. In our opinion, tree plantings and park benches would be acceptable within the Erosion Hazard Limit.

MEANDER BELT HAZARD

As discussed above, the MVCA indicated that the Meander Belt for Shirley's Brook be considered as part of our determination of an appropriate setback. A setback related to the meander belt is required where the creek is in an unconfined condition. The MVCA indicated that they would consider the creek to be unconfined at the northeast corner of the development. The Ontario Regulation 153/06 drawing for 1055 Klondike, provided to us by the MVCA indicates a meander belt width of 85 metres. However, the MVCA indicated that previous studies by others had resulted in a reduction of the belt width to 55 metres. The Kanata North Community Design Plan indicates this 55 metre belt width for the northeast portion of the subject site on Figure 3.17 titled "Existing Floodplain Limits", dated May 2016.

Based on the above information, we have included a 27.5 metre setback (half of the belt width) on the attached Figure 1 for the portion of the site where the MVCA indicated that the creek is unconfined. Also, as indicated above, we have carried out a slope stability assessment for the slope across the central portion of the site in the event that the creek migrates to the boundary of the meander belt width. The results of this assessment indicate that there are no concerns with the stability of the slope in this area (factor of safety of 4.2).

ADDITIONAL CONSIDERATIONS

As part of the proposed plans, the existing vegetation and trees along the slope should be maintained, to ensure the stability of the slope is not affected.

As part of the overall site grading, no additional surface water should be directed towards the slope. If unavoidable, a means of reducing surface water velocity (e.g., rain gardens) and/or some form of erosion control measures (e.g., rip-rap) should be provided.

It is also recommended that the final plans and finished grades for any proposed development adjacent to the slope be reviewed by the geotechnical engineer to ensure that the guidelines provided in this report have been interpreted as intended.

We trust this letter provides sufficient information for your present purposes. If you have any questions please do not hesitate to contact our office.

Greg Davidson, B.Eng., E.I.T.

Brent Wiebe, P.Eng.
Senior Geotechnical Engineer

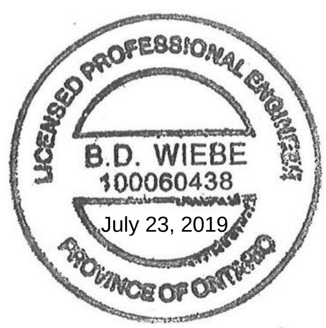

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Figure 1
Attachment A

LEGEND

- BH 18-1 77.61 — BOREHOLE (current investigation by GEMTEC); GROUND SURFACE ELEVATION IN METRES GEODETIC DATUM
- BH 17-1 78.30 — BOREHOLE (previous investigation by GEMTEC, formerly Houle Chevrier Engineering Ltd.(2017))
- 72.52 — ELEVATION (current investigation by GEMTEC)
- A A — SLOPE CROSS SECTION (current investigation by GEMTEC)
- TOE/ CREST OF SLOPE
- EROSION HAZARD LIMIT

AREA	STABLE SLOPE ALLOWANCE	TOE EROSION ALLOWANCE	EROSION ACCESS ALLOWANCE	EROSION HAZARD LIMIT
1	1.25 m	8 m	6 m	15.25 m
2	0 m	8 m	0 m	14 m
3	0 m	8 m	0 m	14 m
4	0 m	8 m	0 m	14 m
5[1]	0 m	8 m	0 m	14 m
6	SETBACK BASED ON MEANDER BELT			

NOTE:

1) The position of the toe and crest of the slope in Area 5 has been extrapolated based on the cross-sections used as part of the slope stability assessment and site observations during our site reconnaissance. The Erosion Hazard Limit in this area has been extrapolated and assumes worst case scenario for the conditions observed at this site.

Scale 1:1500

0 30 60 90m

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Client	Project
NOVATECH	64153.85

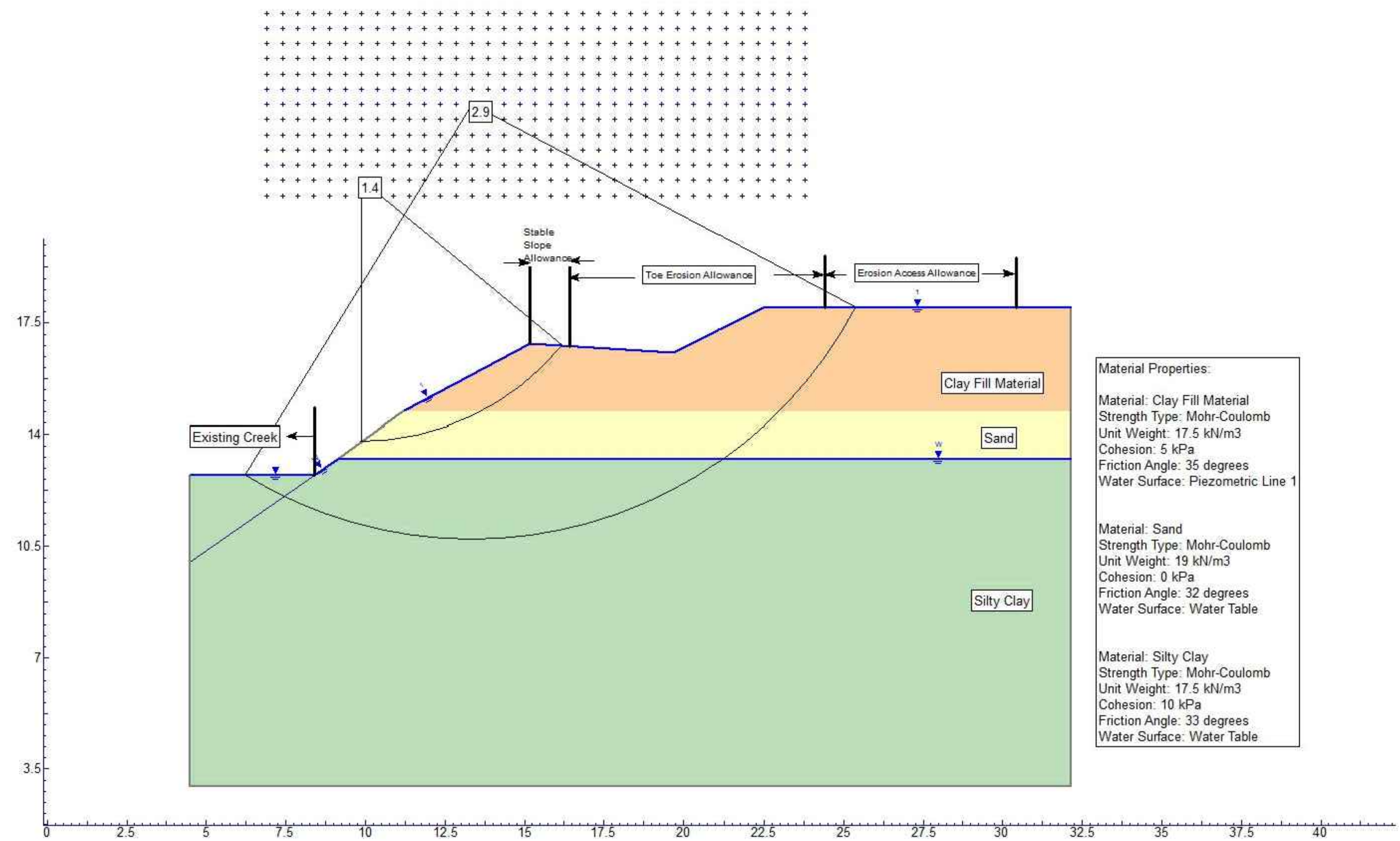
Location: 1055 KLONDIKE ROAD, OTTAWA, ONTARIO

Drwn by	Chkd by	
P.C.	G.D.	EROSION HAZARD LIMIT PLAN

Date	Rev.	
JULY 2019	2	FIGURE 1

ATTACHMENT A

Slope Stability Analysis
Figures A1 to A5



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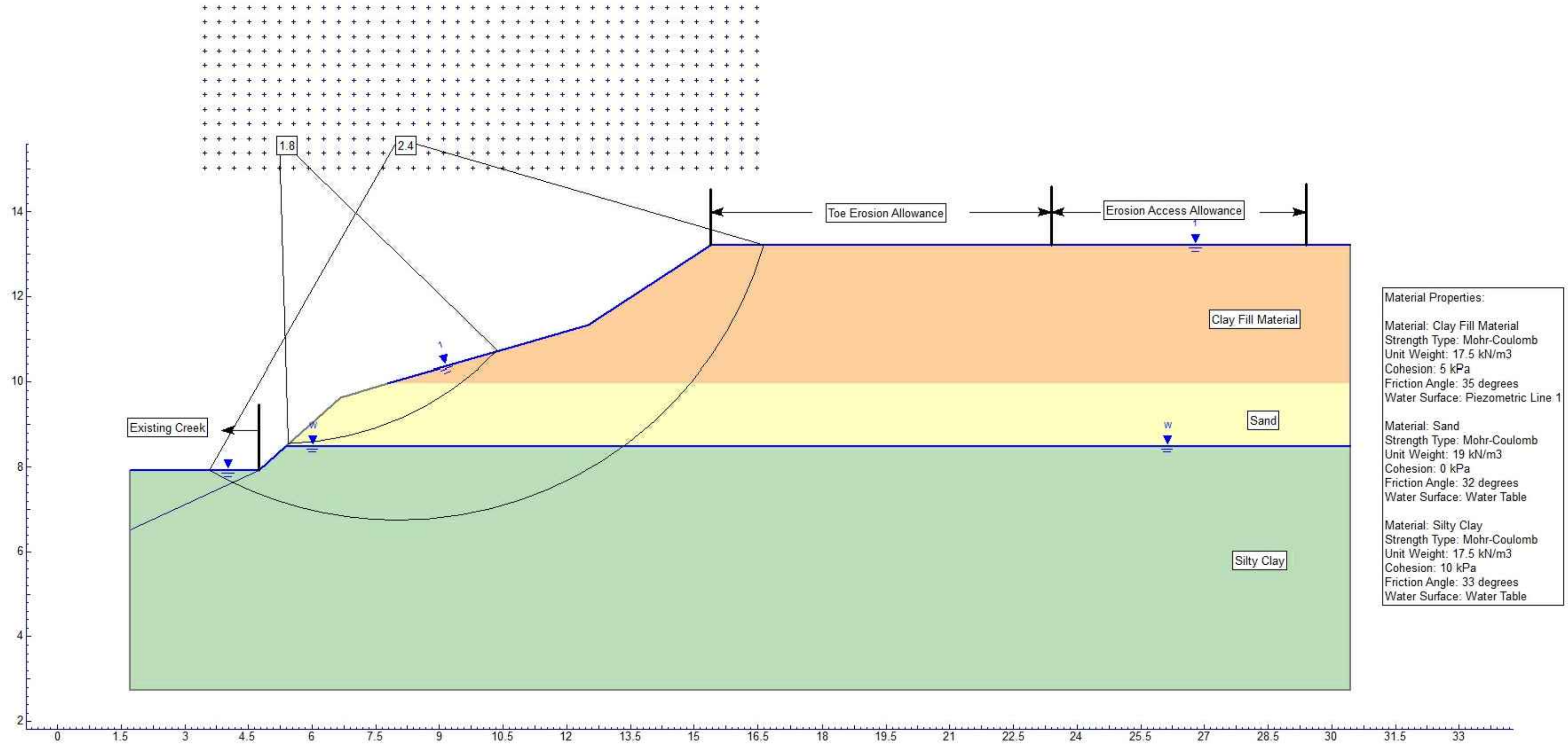
SLOPE STABILITY ASSESSMENT
1055 KLONDIKE ROAD
OTTAWA, ONTARIO

FIGURE A1

File No.
64153.85

Existing Slope
(Section 'A-A')



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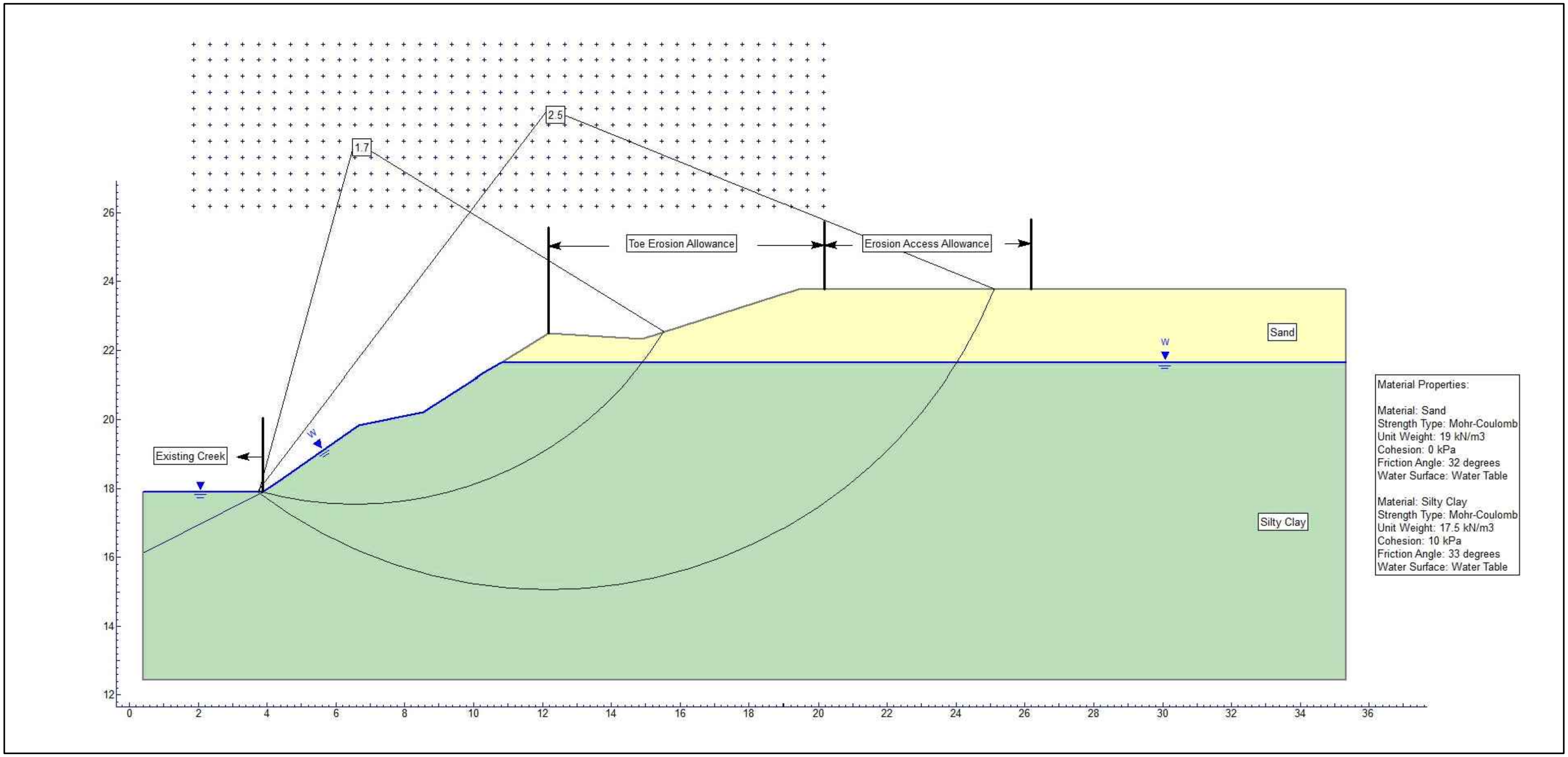
SLOPE STABILITY ASSESSMENT
1055 KLONDIKE ROAD
OTTAWA, ONTARIO

FIGURE A2

File No.
64153.85

Existing Slope
(Section 'B-B')



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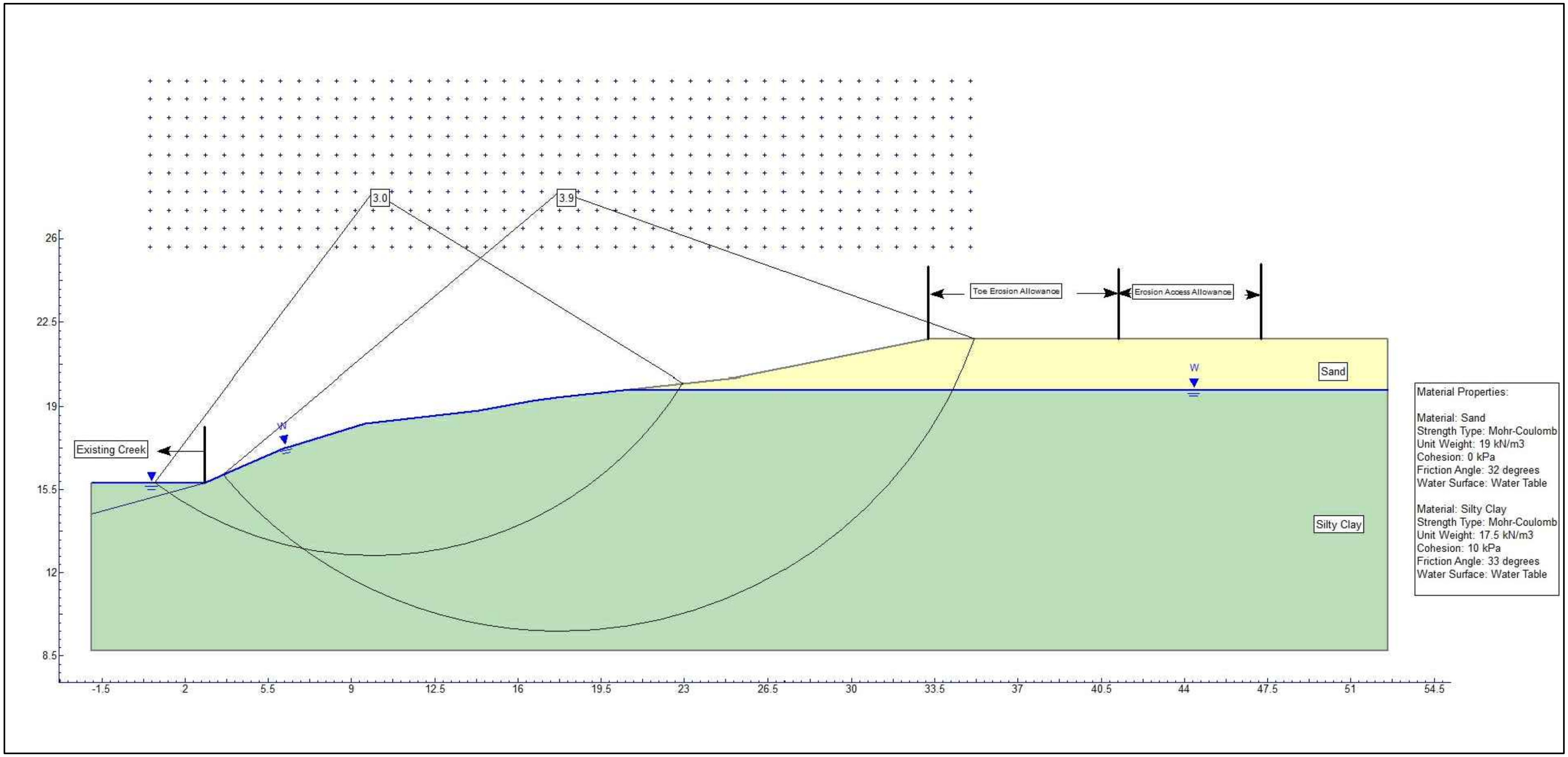
SLOPE STABILITY ASSESSMENT
1055 KLONDIKE ROAD
OTTAWA, ONTARIO

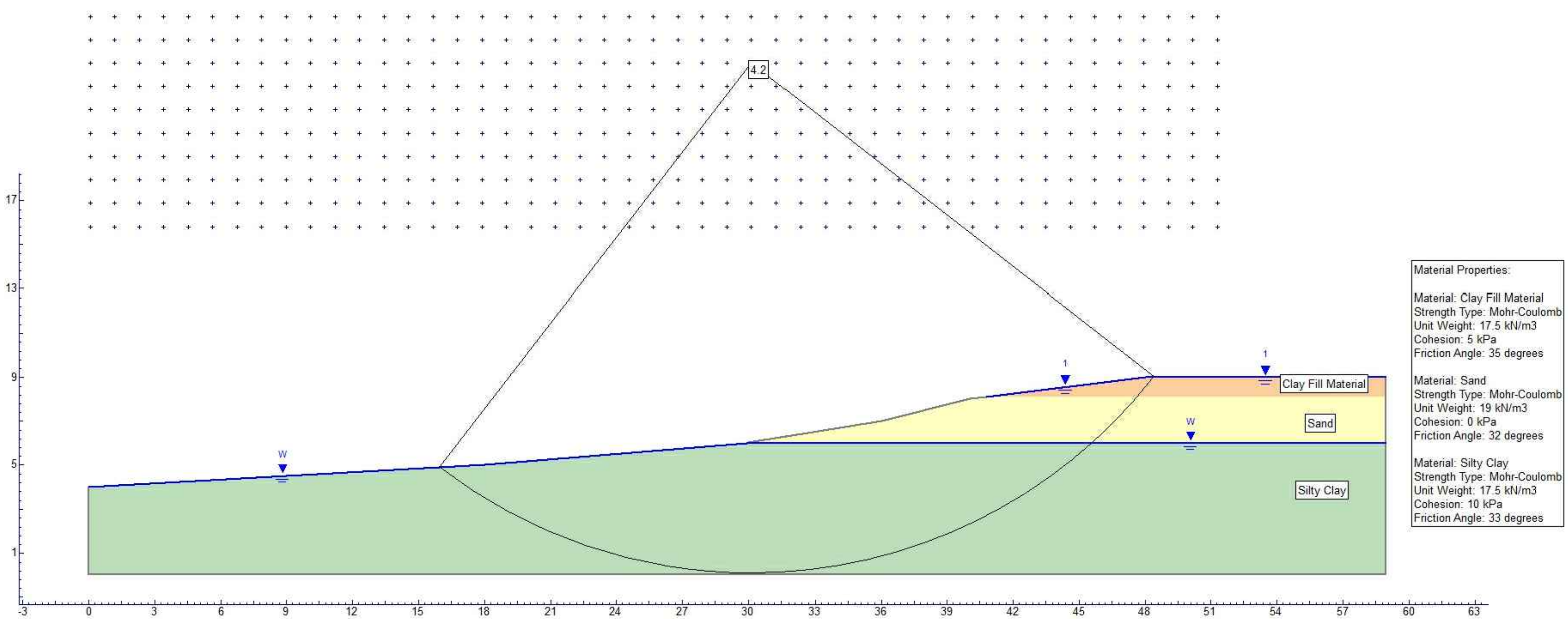
FIGURE A3

File No.
64153.85

Existing Slope
(Section 'C-C')



GEMTEC CONSULTING ENGINEERS AND SCIENTISTS 32 Steacie Drive, Ottawa, ON T: (613) 836-1422 | www.gemtec.ca | gemtec@gemtec.ca	Project SLOPE STABILITY ASSESSMENT 1055 KLONDIKE ROAD OTTAWA, ONTARIO	**FIGURE A4** File No. 64153.85	Existing Slope (Section 'D-D')



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SLOPE STABILITY ASSESSMENT
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FIGURE A5

File No.
64153.85

Existing Slope
(Section 'E-E')