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July 31, 2020
File: 19318

Mr. Riccardo Persi
34 West Avenue North (Hamilton) Incorporated
44 Hughson Street South
Hamilton, Ontario
L8N 2A7

Dear Mr. Persi,

Re: Slope Stability Assessment
Proposed Shoreline Protection, 526 Winona Road, Hamilton, Ontario

Landtek Limited (herein "*Landtek*") is pleased to submit this slope stability assessment letter report for the proposed residential development at the site identified as civic address 526 Winona Road in Stoney Creek, Ontario. Authorization to proceed with the work was received from Mr. Andrew Salomon on July 9, 2020.

This letter report has been prepared for the Client, their nominated engineers, designers, and project managers pertaining to the proposed shoreline protection to be constructed at the site identified as civic address 526 Winona Road in Hamilton, Ontario. Reliance of this report is also extended to Municipalities and Regulatory Authorities but is limited to the intended purpose of the report only.

Any use of this report other than for its intended purpose, or any further dissemination of this report other than to those parties detailed is not permitted without Landtek's prior written approval. Further details of the limitations of this report are presented in Enclosure 1.

Background

34 West is intending to develop the site for a primarily residential end use which will include an approximately 32 m wide strip of public park following along the Lake Ontario shoreline. As part of the development, a new shoreline protection system is to be constructed, to replace the existing, dilapidated block wall structure.

It is understood that the new shoreline protection system will comprise of a series of armour stone layers bedded onto rip-rap platform, incorporating the required offsets, erosion allowance and a natural soil profile slope angle of 25° (2.1H:1V) for the stable slope allowance.

This slope assessment has been issued to confirm the natural soil profile slope angle at the southernmost limit of the Shoreline Hazard Limit (i.e. the area of stable slope allowance). For the purposes of this letter report, the study area is focused on the slope area central to the lake frontage at the site.

This letter-format report was prepared in general accordance with the guidelines of the Ministry of Natural Resources (herein "*MNR*") document "*Natural Hazards Technical Guides*", and the supporting "*Geotechnical Principles for Stable Slopes*" document.

Site Characterization

The site is located in Stoney Creek, Ontario, and is centered at approximate grid reference 610200, 4786600 (UTM 17T coordinates). The approximate Geodetic elevation of the ground surface at the site ranges between approximately 78 m and 79 m. The site location is shown in Figure 1 below.

Figure 1: *Area of proposed development.*

The site is approximately 8.9 acres (3.6 hectares) in plan area. It is situated in a predominantly residential area and is bounded by Lake Ontario to the north, East Street to the east, residential and properties to the south, and Winona Road to the west.

The site is currently the location of the LIUNA Gardens Banquet Center and LIUNA Local 837 (Laborers' International Union of North America) offices and training facility, and one residential property located in the northwestern area of the site. There are also a number of outbuildings scattered across the site. The remainder of the site comprises a parking lot for the facility and a large area of maintained grassland that includes semi-mature and mature trees.

The topography of the land in the vicinity of the site is one of a gradual slope towards the north and Lake Ontario, bounding the north of the site. The shoreline is approximately 3 m to 4 m below the site.

Published Geology

Based on previous geotechnical experience for the area and a review of the existing geological publications for the site area, Ontario Geological Survey (OGS) Map P0993: "*Quaternary Geology of the Grimsby Area*", the native subsurface soil conditions in the area of the site are anticipated to consist of clayey silt to clay till, identified as a sequence of the Halton Till.

According to the OGS Map 2344 "*Paleozoic Geology of the Grimsby Area*", the superficial geology is underlain by red shale bedrock of the Queenston Formation.

Information provided by a large number of historical borehole records from within a 1 km radius from the site, and held by the OGS, generally confirms the anticipated geological conditions beneath the site. Based on the data from records for Borehole ID 649346, located approximately 300 m south of the site, the superficial soil profile confirms the presence of till deposits to a depth of at least 24.9 m.

Geomorphology

The area of the proposed park is generally shallow gradient (±2° to 3°) towards the lake and of grassed, open space. An existing protection system present along the shoreline, comprising of an approximately 3 m high concrete boulders.

It is understood from anecdotal evidence that a strip of concrete boulders was placed along the shoreline in the early 1990's, is up to 20 m in width and approximately 3 m deep at its maximum.

Field Investigation and Methodology

The investigation element of this assessment was completed as part of a larger-scale investigation for the proposed development at the site. Fieldwork for the borehole drilling works undertaken at the site by Landtek included clearance of underground services, borehole layout, borehole drilling and soil sampling. The boreholes were logged using those standard symbols and terms defined in Enclosure 2.

A total of fourteen boreholes (boreholes BH1 to BH14) were drilled between October 7th and 28th, 2019. The Geodetic elevation at each of the borehole locations was established by Landtek relative to site measurements and in reference to the site topographical survey prepared by A.T. McLaren Limited (herein *"McLaren*") and dated November 30, 2017.

Further details pertaining to the investigation scope, methodologies and findings are provided in the following report:

- Geotechnical Investigation "*Proposed Residential Development, 526 Winona Road, Stoney Creek, Ontario*", reference 19318, dated November 29, 2019.

For this assessment, information correlated from boreholes BH1 and BHMW3 of the investigation was used, the locations and details for which are presented on the "*Borehole Location Plan*", Drawing 19318-01 and borehole logs respectively, in Enclosure 3.

Subsurface Conditions

The borehole information is generally consistent with the geological data previously detailed, with the predominant native soils comprising of clayey silt till deposits overlying red shale of the Queenston Formation.

The detailed borehole logs are presented in Enclosure 3, with the subsurface conditions encountered discussed further in the sections following.

Organic Soil and Fill Materials

An approximately 150 mm thick layer of organic soil was encountered in borehole BH1.

Fill materials were encountered in borehole BH/MW3 from ground surface and generally comprised sand and gravel to a depth of approximately 0.7 m below existing ground level.

An SPT ''N'' value of 39 indicates the fill materials to be well compacted.

Clayey Silt Till

Clayey silt till was encountered in all boreholes underlying the topsoil or fill materials and extends to a maximum depth of approximately 23.5 m below existing ground level. The silty clay till contains traces of gravel, red shale, limestone fragments and iron staining and is generally brown in colour, becoming grey at depth. Local gravels and cobbles beds were also encountered at a depth of approximately 7.6 m in borehole BH/MW3.

SPT ''N'' values ranging between 11 to 61 were reported, indicating the clayey silt till deposits to be of a stiff to hard, but generally very stiff consistency. Moisture contents in the till deposits range between 11 % and 15 %, which are as to be expected for moist soils with clay and silt as primary constituents.

Bedrock

Ultimate refusal was encountered in borehole BH/MW3 at a depth of approximately 23.5 m below existing ground level. Based on materials recovered during the drilling, borehole termination is determined to be at bedrock contact. Bedrock fragments recovered comprise generally weak and moderately weathered red shale.

Groundwater

Groundwater level measurements were taken in each of the installed monitoring wells at the site on November 7, 2019, by which time the water levels were considered stable. The water level recorded in BH/MW3 was measured at 10.0 m depth, equating to a Geodetic elevation of approximately 68.8 m.

It should be noted that groundwater conditions and surface water flow conditions are expected to vary according to the time of the year and seasonal precipitation levels. Water seepage is also expected from soil fissures above the water table.

Slope Stability Assessment

Initial Review

An initial review of the investigated slope was made using the contours and spot elevations shown on plans and drawings provided to Landtek. General design allowances and Shoreline Hazard Limit for the shoreline protection system design are presented on the Borehole Location Plan in Enclosure 3.

To facilitate the assessment, one section was established across the design Shoreline Hazard Limit and the associated design Stable Slope Allowance using the design information provided. This section is designated as the "*Line of Section*", the alignment of which is presented on the Borehole Location Plan in Enclosure 3 and is considered to represent the "*worst case scenario*".

The details of the analyses and results are discussed in the following sections.

Method of Analysis

Global slope stability analyses undertaken applies a grid and radius approach to the slip plane analysis, resulting in thousands of slices and slip surfaces being analysed using the Morgenstern-Price limit equilibrium method. From this the critical slip surface and associated Factor of Safety (herein "*FoS*") is determined.

As is the norm for modelling completed for the HCA, the analysis results were also cross-checked using the Janbu and Bishop modelling methods under the same environments and ground conditions.

Conditions and Assumptions of Analyses

Analyses were carried out for the line of section to determine whether the proposed soil profile slope angle of 25° would remain stable at the Shoreline Hazard Limit under future-exposed condition. The following conditions were incorporated into the analyses:

- Water level: Though static groundwater was encountered at depths during the investigation works, the slope will be exposed to water of Lake Ontario as an eventuality. As such, a water level of 76.4 m elevation has been applied. This represents the design 100 yr flood level; and,
- Superficial and fill soils: The minimal veneer of organic soil encountered is not considered to have a control mechanism over future slope stability as much as the reported fill soils at the site. As such, the fill soil depth has been applied to maintain the "*worst case scenario*" principal.

Slope Assessment Evaluation

Soil parameters used for this analysis are defined in Table 1 and have been correlated from site-specific data and numerous laboratory tests undertaken on samples taken elsewhere from within the lithologies encountered beneath the site.

Table 1: Soil Parameters Applied for Analysis

Soil Unit	Depth Range	Unit Weight	Cohesion Intercept (C')	Effective Angle of Internal Friction (φ')
Fill (Sand and Gravel	0.7 m	19.5 kN/m^3	5 kPa	25°
Clayey Silt Till (CL-SL-TL)	0.7 m – 3.3 m	21.0 kN/m^3	50 kPa	32°

The soil and groundwater dataset was imported into the slope stability computer program Slope/W of GeoStudio 2020 by GEOSLOPE International Limited, for stability analyses at the line of section location.

The evaluation of slope stability was carried out with respect to potential shallow and deep-seated failure planes and the associated FoS under natural (i.e. unloaded or current) and loaded (i.e. applying a load of approximately 50 kPa to the slope to represent the shoreline protection structure).

Copies of all modelling profiles are presented as Drawings 19318-02 to 19318-04 in Enclosure 4. The results of the analyses for the Line of Section are summarized in Table 2.

Table 2: Results of Slope Stability Analyses

Slope Section	Slope		Factor of Safety		
	Angle	Height	Morgenstern-Price	Janbu	Bishop
Line of Section	25°	4.2 m	6.453	5.759	6.465

The typical FoS used for engineering design associated with slopes ranges between 1.3 to 1.5, and the HCA generally requires a minimum FoS of 1.5 for long term conditions (effective stress).

As shown in Table 2, the FoS calculated for global slope stability of the natural slope exceeds the minimum FoS requirements prescribed by the HCA using all modelling methods. This indicates the proposed slope angle of 25° for the native soil profile will be stable.

Discussion and Conclusions

Based on the analysis results, the global stability of a slope in the clayey silt till will remain stable at an angle of 25°. It is therefore considered, from a geotechnical perspective, that the proposed stable slope allowance of 9.0 m is adequate and will not have an adverse affect such that the global stability of the future slope is compromised.

Closure

The Limitations of Report, as stated in Enclosure 1, are an integral part of this report.

We trust that this letter report is satisfactory for your purposes at this time. If you have any questions please do not hesitate to contact our office.

Yours sincerely,
LANDTEK LIMITED

James Dann, B.Eng. (Hons)
Manager, Geotechnical Projects

Ralph Di Cienzo, P. Eng.
Consulting Engineer

Encs:

Enclosure 1: Limitations of Report
Enclosure 2: Symbols and Terms Used in the Report
Enclosure 3: Drawing 19318-01 "*Borehole Location Plan*" and Borehole Logs
Enclosure 4: Slope Modelling Profiles

ENCLOSURE 1

Limitations of Report

LIMITATIONS OF REPORT

The conclusions and recommendations given in this report are based on information determined at the borehole locations. Subsurface and ground water conditions between and beyond the Boreholes may be different from those encountered at the borehole locations, and conditions may become apparent during construction that could not be detected or anticipated at the time of the geotechnical investigation. It is recommended practice that Landtek be retained during construction to confirm that the subsurface conditions throughout the site are consistent with the conditions encountered in the Boreholes.

The comments made in this report on potential construction problems and possible remedial methods are intended only for the guidance of the designer. The number of Boreholes may not be sufficient to determine all the factors that may influence construction methods and costs. For example, the thickness and quality of surficial topsoil or fill layers may vary markedly and unpredictably. Additionally, bedrock contact depths throughout the site may vary significantly from what was encountered at the exact borehole locations. Contractors bidding on the project, or undertaking construction on the site should make their own interpretation of the factual borehole information, and establish their own conclusions as to how the subsurface conditions may affect their work.

The survey elevations in the report were obtained by Landtek Limited or others, and are strictly for use by Landtek in the preparation of the geotechnical report. The elevations should not be used by any other parties for any other purpose.

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. Landtek Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

This report does not reflect environmental issues or concerns related to the property unless otherwise stated in the report. The design recommendations given in the report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, it is recommended that Landtek Limited be retained during the final design stage to verify that the design is consistent with the report recommendations, and that the assumptions made in the report are still valid.

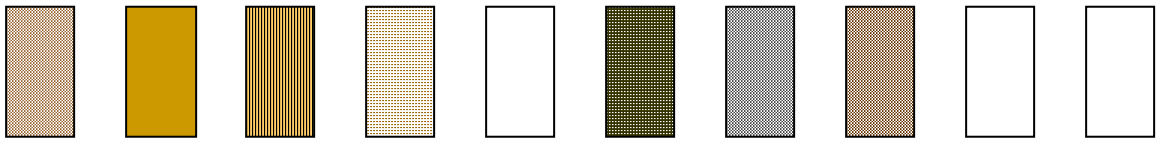
ENCLOSURE 2

Symbols and Terms Used in the Report

SYMBOLS AND TERMS USED IN THE REPORT

ORGANIC

CLAY SILT SAND GRAVEL FILL SOIL PEAT TILL SHALE LIMESTONE



RELATIVE PROPORTIONS

Term	**Range**
Trace	0 - 5%
A Little	5 – 15%
Some	15 – 30%
With	30 – 50%

CLASSIFICATION BY PARTICLE SIZE

Boulder ---------- > 200 mm
Cobble ---------- 80 mm – 200 mm
Gravel -
Coarse ---------- 19 mm – 80 mm
Fine ---------- 4.75 mm – 19 mm
Sand -
Coarse ---------- 4.75 mm – 2 mm
Medium -------- 2 mm – 0.425 mm
Fine ---------- 0.425 mm – 0.75 mm
Silt ---------- 0.075 mm – 0.002 mm
Clay ---------- < 0.002 mm

DENSITY OF NON-COHESIVE SOILS

Descriptive Term	**Relative Density**	**Standard Penetration Test**
Very Loose	0 – 15%	0 – 4 Blows Per 300 mm Penetration
Loose	15 – 35%	4 – 10 Blows Per 300 mm Penetration
Compact	35 – 65%	10 – 30 Blows Per 300 mm Penetration
Dense	65 – 85%	30 – 50 Blows Per 300 mm Penetration
Very Dense	85 – 100%	Over 50 Blows Per 300 mm Penetration

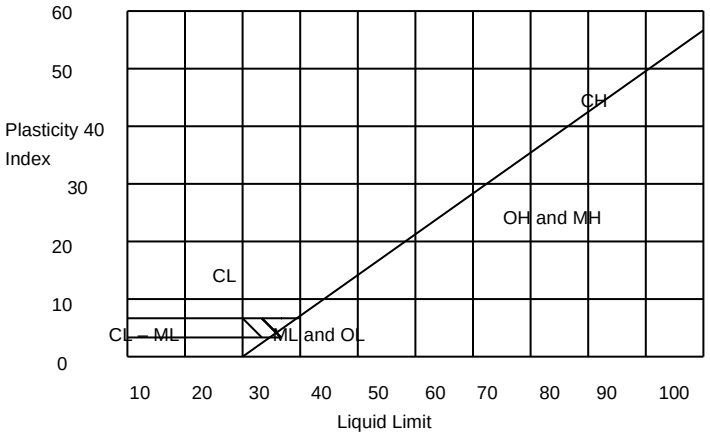
CONSISTENCY OF COHESIVE SOILS

Descriptive Term	**Undrained Shear Strength kPa (psf)**	**N Value Standard Penetration Test**	**Remarks**
Very Soft	< 12 (< 250)	< 2	Can penetrate with fist
Soft	12 – 25 (250 – 500)	2 – 4	Can indent with fist
Firm	25 – 50 (500 –1000)	4 – 8	Can penetrate with thumb
Stiff	50 – 100 (1000 – 2000)	8 – 15	Can indent with thumb
Very Stiff	100 – 200 (2000 – 4000)	15 – 30	Can indent with thumb-nail
Hard	> 200 (> 4000)	> 30	Can indent with thumb-nail

Notes: 1. Relative density determined by standard laboratory tests.
2. N value – blows/300 mm penetration of a 623 N (140 Lb.) hammer falling 760 mm (30 in.) on a 50 mm O.D. split spoon soil sampler. The split spoon sampler is driven 450 mm (18 in.) or 610 mm (24 in.). The “N” value is the Standard Penetration Test (SPT) value and is normally taken as the number of blows to advance the sampler the last 300 mm.

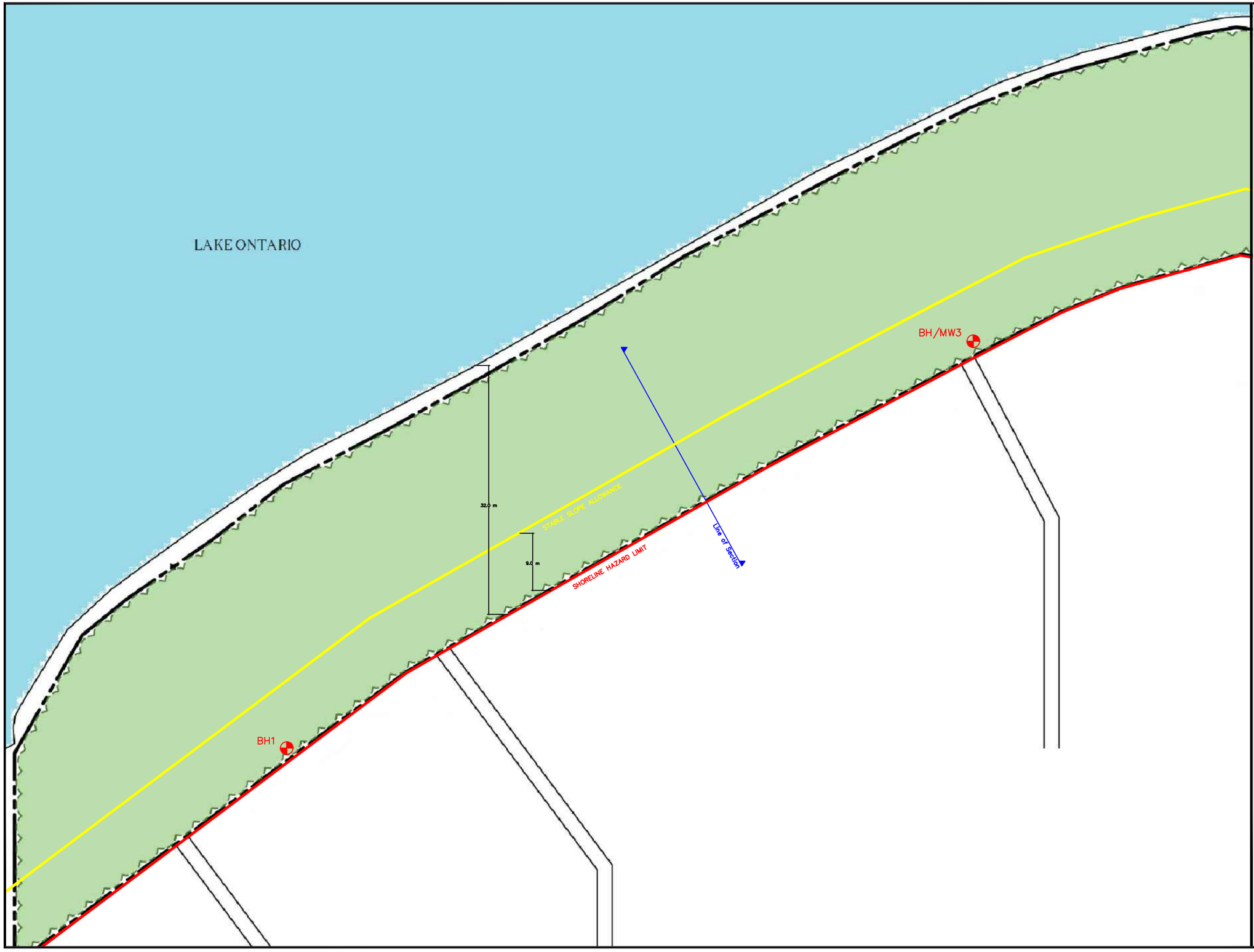
CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES
ASTM Designation: D 2487 - 69 AND D 2488 – 69
(Unified Soil Classification System)

Major Divisions			Group Symbols	Typical Names	Classification Criteria		
Coarse-grained soils More than 50% retained on No. 200 sieve *	Gravels 50% or more of coarse fraction retained on No. 4 sieve	Clean gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	Classification on basis of percentage of fines Less than 5% pass No. 200 sieve . . . . . GW, GP, SW, SP More than 12% pass No. 200 sieve . . . . . GM, GC, SM, SC 5 to 12% pass No.200 sieve . . . . . Borderline classifications requiring use of dual symbols	C_u=D60/D10 greater than 4; $C_z = (D30)^2/(D10xD60)$ between 1 and 3	
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines		Not meeting both criteria for GW	
		Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
	Sands More than 50% of coarse fraction passes No. 4 sieve	Clean Sands	SW	Well-graded sands and gravelly sands, little or no fines		C_u=D60/D10 greater than 6; $C_z = (D30)^2/(D10xD60)$ between 1 and 3	
			SP	Poorly graded sands and gravelly sands, little or no fines		Not meeting both criteria for SW	
		Sands with fines	SM	Silty sands, sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
Fine-grained soils 50% or more passes No. 200 sieve *	Silts and clays Liquid limit 50% or less		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands	Plasticity Chart For classification of fine-grained soils and fine fraction of coarse-grained soils. Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols. Equation of A-line: PI=0.73 (LL-20)		
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silts			
			OL	Organic silts and organic silts of low plasticity			
	Silts and clays Liquid limit greater than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts			
			CH	Inorganic clays of high plasticity, fat clays			
			OH	Organic clays of medium to high plasticity			
	Highly organic soils		Pt	Peat, much and other highly organic soils	* Based on the material passing the 3 in. (76mm) sieve.		



ENCLOSURE 3

Drawing 19318-01: Borehole Location Plan
Borehole Logs for BH1 and BH/MW3



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project location

Approximate location of boreholes drilled by Landtek Limited on October 22 and 25, 2019.

revisions/ submissions

#	date	description
1	2020-07-31	issued for report

client
34 West Avenue North (Hamilton) Incorporated

municipality
The Corporation of the City of Hamilton

project
Slope Assessment
526 Winona Road

sheet
Borehole Location Plan

date: July 31, 2020
drawn: IA
checked: JAD
project #: 19318
scale: 1:500

19318-01

LANDTEK LIMITED

BH 1

Project No.:	19318	Drill Date:	October 25, 2019
Project:	Geotechnical Investigation	Drill Method:	[x] solid stem [ ] hollow stem [ ] vibratory
Location:	526 Winona Road, Hamilton, Ontario	Datum:	Geodetic (Approximate)

Material Description	Symbol	Elev. / Depth	Sample No.	Sample Type	Scale (m)	SPT "N" Value	Soil Moisture (%)	GWL	Monitor Details	Test Data
Ground Surface		79.1								
±150 mm of topsoil		0.0								
CLAYEY SILT TILL: trace gravel, trace shale, brown, very stiff to hard, moist			1	SS		48	10			
			2	SS		34	12			
3.0 m to 6.0 m: stiff			3	SS		15	13			
			4	SS		11	15			
			5	SS		20	11			
			6	SS		22	11			
			7	SS		24	12			
		66.5	8	SS		21	14			
BOREHOLE TERMINATED		12.6								

SPT "N" Value: 0 25 50 75 100

Soil Moisture (%): 0 25 50

Scale (m): 0.0 -0.5 -1.0 -1.5 -2.0 -2.5 -3.0 -3.5 -4.0 -4.5 -5.0 -5.5 -6.0 -6.5 -7.0 -7.5 -8.0 -8.5 -9.0 -9.5 -10.0 -10.5 -11.0 -11.5 -12.0 -12.5 -13.0 -13.5 -14.0 -14.5 -15.0

Notes: 1. Groundwater not encountered

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

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LANDTEK LIMITED

BH/MW 3

Project No.:	19318	Drill Date:	October 22, 2019
Project:	Geotechnical Investigation	Drill Method:	[ ] solid stem [x] hollow stem [ ] vibratory
Location:	526 Winona Road, Hamilton, Ontario	Datum:	Geodetic (Approximate)

Material Description	Elev. Depth	Samples No.	Samples Type	SPT "N" Value	Soil Moisture (%)	Test Data
Ground Surface	78.8					Flush Mount
FILL: sand and gravel, trace silt, brown, dense, damp	0.0 / 78.1	1	SS	39	9	
	0.7	2	SS	42	13	
CLAYEY SILT TILL: trace gravel, trace shale, brown, hard, moist		3	SS	61	14	
		4	SS	42	14	bentonite backfill
4.5 m to 23.5 m: very stiff		5	SS	17	15	
6.0 m to 23.5 m: grey		6	SS	21	13	sand backfill to 6.81 m
7.6 m to 9.0 m: trace cobbles		7	SS	20	14	7.41 m 3.0 m of slotted 50 mm dia. PVC pipe
		8	SS	23	15	WL = 10.0 m Nov. 7, 2019
						10.41 m
		9	SS	20	14	bentonite backfill
	55.3					
BOREHOLE TERMINATED ON PRESUMED BEDROCK	23.5					23.5 m

SPT "N" Value scale: 0 25 50 75 100 (Scale (m): 0.0 to -25.0)

Soil Moisture (%) scale: 0 25 50

GWL

Monitor Details

Notes: 1. Water level reading: WL at 10.0 m depth on November 7, 2019

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

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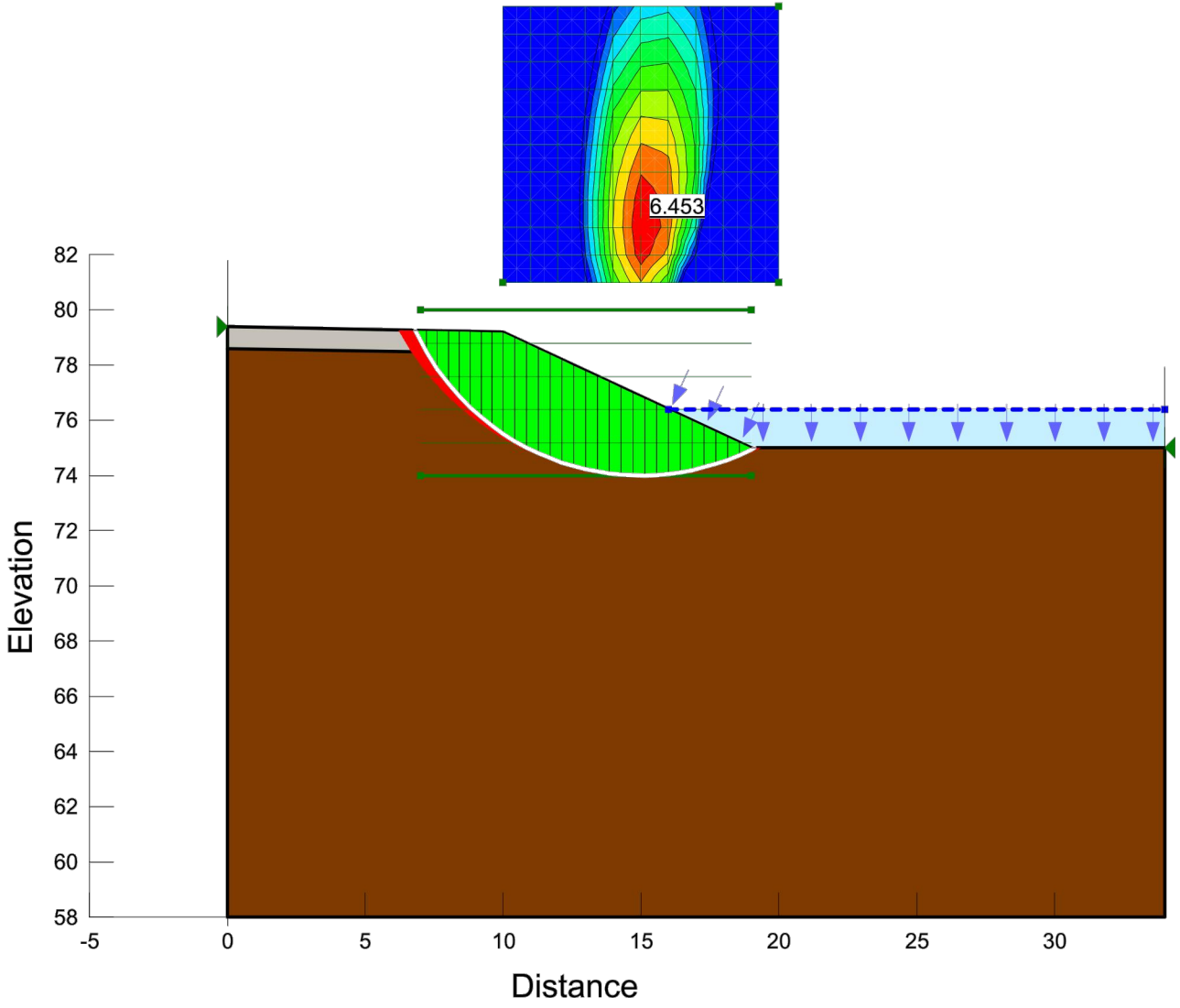
ENCLOSURE 4

Slope Modelling Profiles



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project location

revisions/ submissions

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1	2020-07-31	issued for report

client
34 West Avenue North (Hamilton) Incorporated

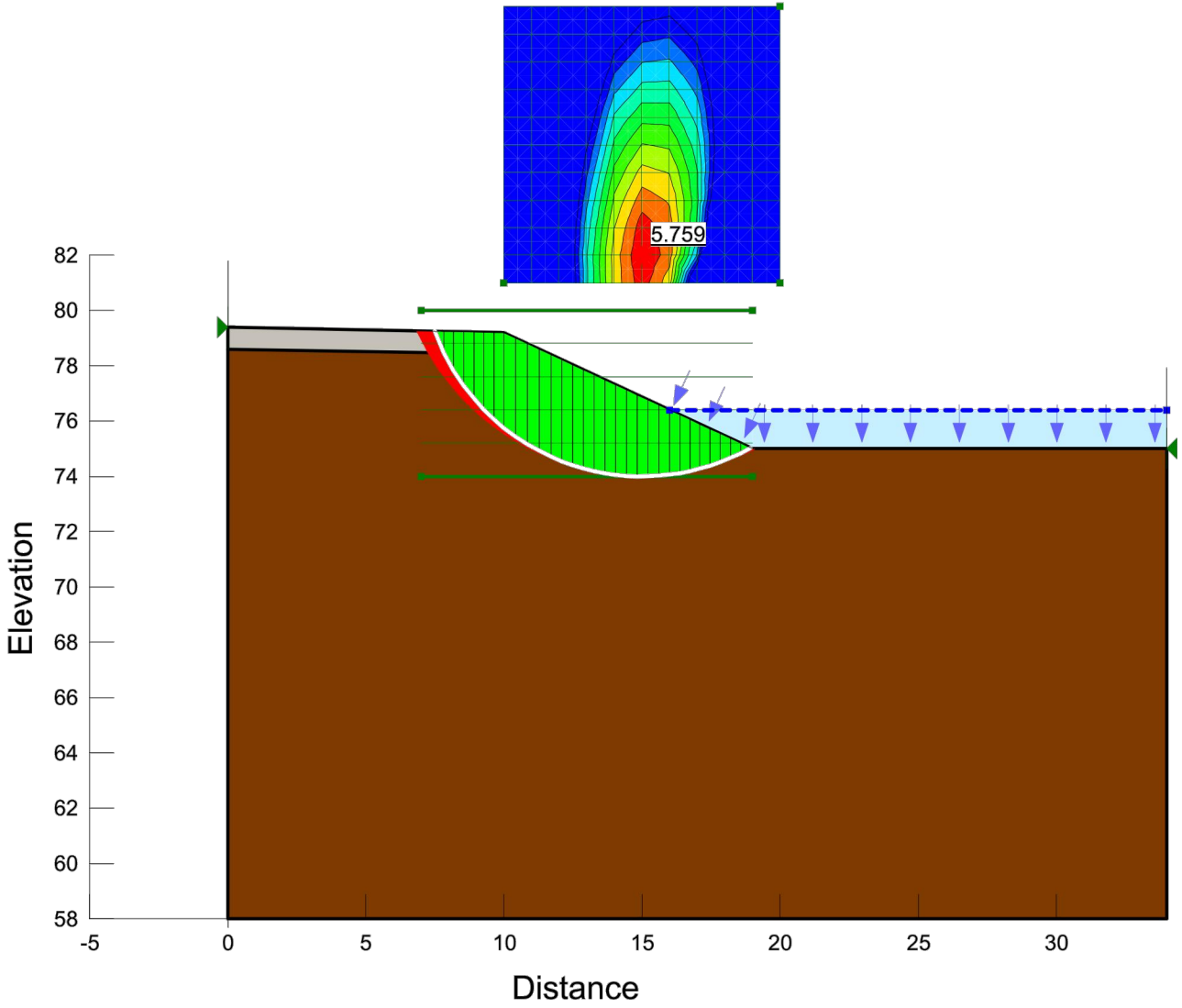
municipality
The Corporation of the City of Hamilton

project
Slope Assessment
526 Winona Road

sheet
Slope Model - Morgenstern-Price
Natural Slope

date: July 31, 2020
drawn: IA
checked: JAD
project #: 19318
scale: as shown

19318-02



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revisions/ submissions

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1	2020-07-31	issued for report

client
34 West Avenue North (Hamilton) Incorporated

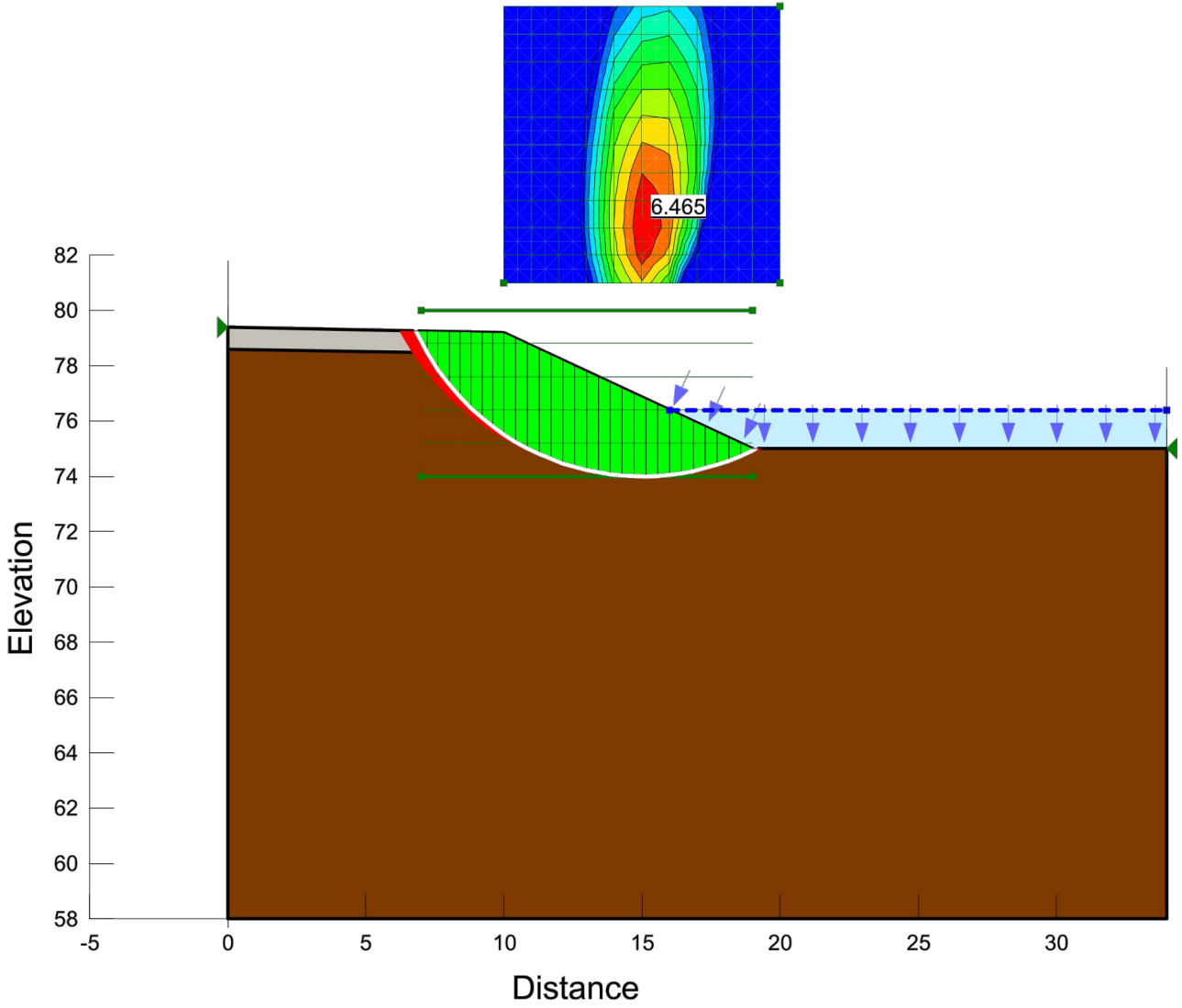
municipality
The Corporation of the City of Hamilton

project
Slope Assessment
526 Winona Road

sheet
Slope Model - Janbu
Natural Slope

date: July 31, 2020
drawn: IA
checked: JAD
project #: 19318
scale: as shown

19318-03



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municipality
The Corporation of the City of Hamilton

project
Slope Assessment
526 Winona Road

sheet
Slope Model - Bishop
Natural Slope

date: July 31, 2020
drawn: IA
checked: JAD
project #: 19318
scale: as shown

19318-04