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Status: Final
February 10, 2021

Reference # 13516.101.L2.Rev1_Goderich Shoreline Slope Grading

RE: GODERICH - SHORELINE SLOPE GRADING

Executive Summary

The shoreline erosion hazard limit development setback at Goderich Community South was determined based on an erosion allowance measured from the natural toe of bluff slope and a stable slope allowance. The erosion allowance is based on the natural recession of the bluff and does not include the construction of hard engineering structures at the shoreline. The natural recession of the bluff would continue to supply littoral material to downdrift shorelines. The eroding bluff would be at a steeper inclination than the stable slope, posing an ongoing risk to users of the waterfront. It is proposed to regrade the steep bluff now to the stable slope and place the excavated native material at the shore edge at the toe of the bluff, where the native material would continue to contribute to the natural littoral system. The bluff regrading is expected to result in a similar volume of natural material naturally available to downdrift shorelines, although the supply will occur at a different rate over time. It is not expected that the recession at the site will be altered in the long term. The regrading of the native material to the toe of the bluff does not permit altering the erosion allowance determination based on the existing toe of bluff slope.

Introduction

W.F. Baird & Associates Coastal Engineers Ltd. (Baird) was retained by 1695538 Ontario Inc. (Mr. Rob Wood) to provide a professional opinion regarding their proposed plan to regrade the existing shoreline bluff slope at Goderich Community South (i.e., placing native material from regraded bluffs into the lake at the toe of slope).

Scope of Study

The scope of the study is as follows:

1. Review existing shoreline conditions based on Baird's previous work in the area and analysis of bluff recession at the site. Due to COVID travel restrictions, the scope did not include a visit the site. Baird is familiar with the site, having completed detailed shoreline recession rate analysis of the area.

2. Review relevant policies and guidelines of Maitland Valley Conservation Authority (MVCA) and Ministry of Natural Resources and Forestry (MNRF) Technical Guide and other technical literature and reports.
3. Assess the proposed slope regrading plan in the context of the intent of the policies and guidelines and the potential impact of the grading on the shoreline based on available data and Baird's understanding of the general shoreline processes. The assessment is based on the plans and proposed grading sections provided by the owner. The assessment does not include any detailed sediment transport or erosion analysis or numerical modelling. The scope does not include a geotechnical assessment or analysis of the slope.
4. Submit assessment in letter-type report.

The above scope of work (terms of reference) was submitted in advance to MVCA (January 7, 2021) for review and comment. MVCA took no exception to the terms of reference (pers. comm., telephone conversation Stephen Jackson, MVCA and Mark Kolberg, Baird, January 15, 2021).

Site Location and Proposed Bluff Regrading

The site is located about 2 kilometres south of Goderich Harbour (Figure 1). The proposed area of bluff regrading extends from the north limit of the property southwards about 300 m to a prominent gully (Figure 2). Figure 3 presents a section of the bluff. Figure 4 shows a view of a potion of the bluff in 2016. The bluff height is approximately 29 m. From the topographic contours in Figure 2, it is estimated that the existing slope is typically about 1(vertical):1.9(horizontal).

Figure 1: Location of Goderich South Community

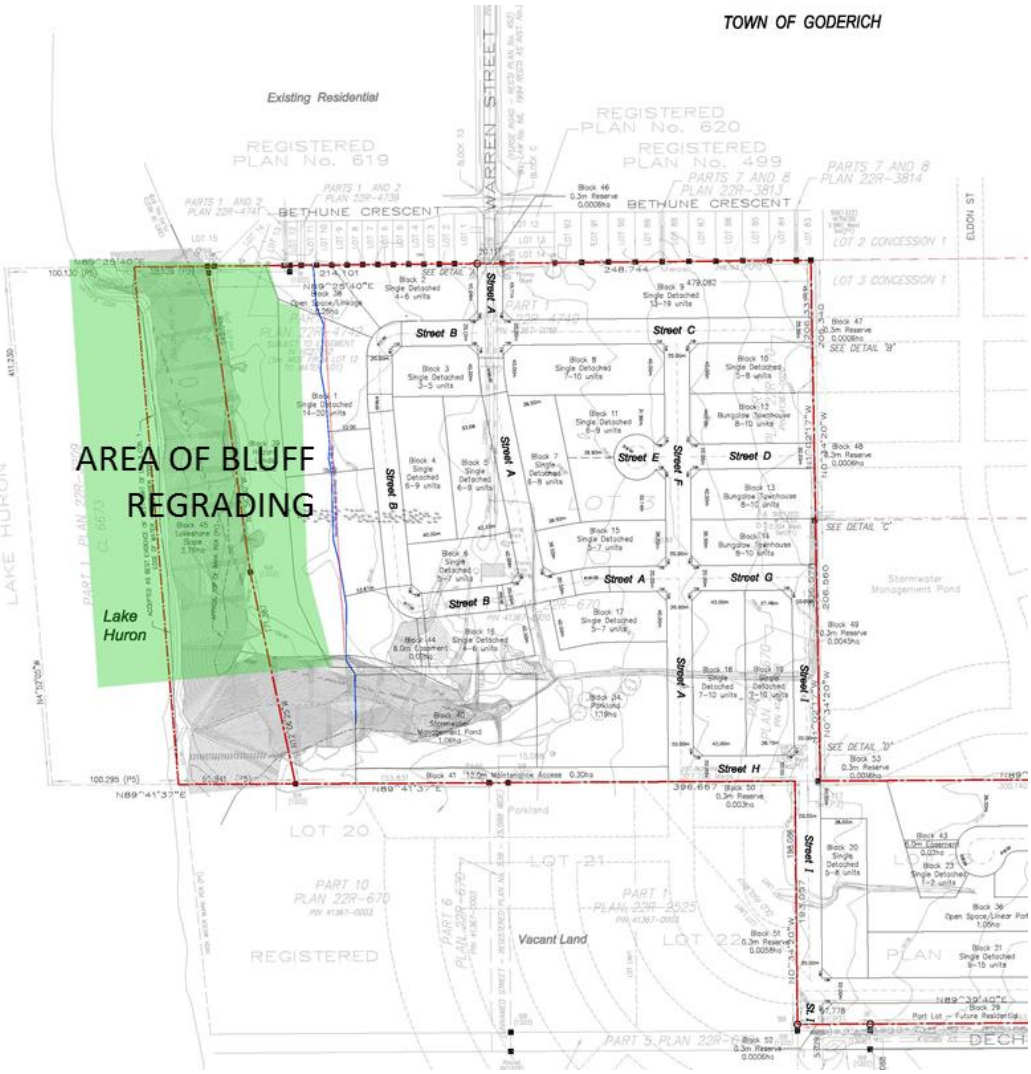

Figure 2: Goderich South Community area of proposed bluff regrading (highlighted by green shading)

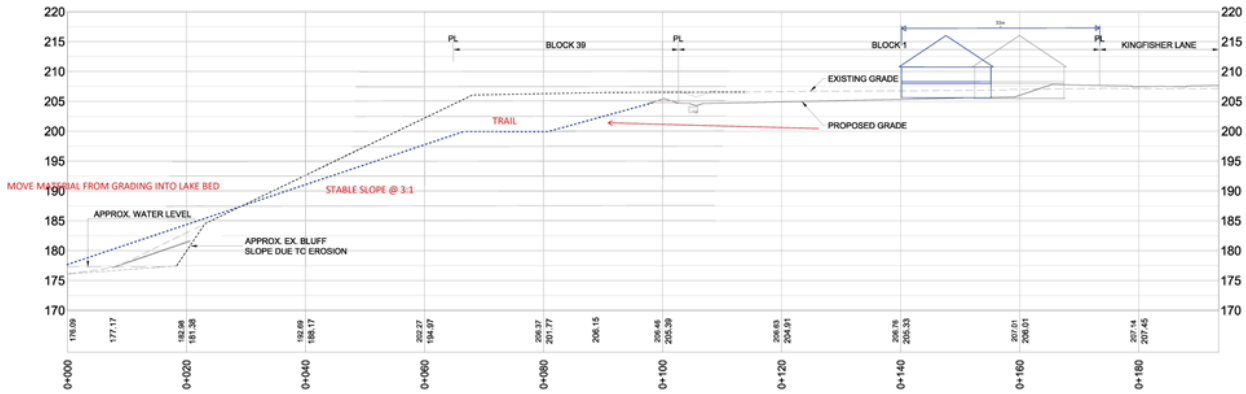

Figure 3: Typical bluff section, showing proposed regrading plan

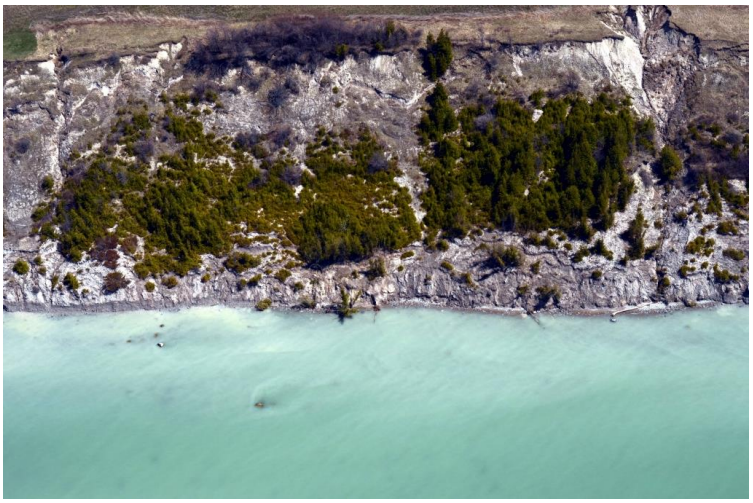

Figure 4: View of bluff shore at site, 2016-04-20

Shoreline Processes

The shoreline is characterized by a cohesive till bluff, fronted by a narrow beach of mixed sand and gravel, and is erosional (Figure 4). The orientation of the shoreline is north-south. The till contains differing proportions of clay, silt, sand, and gravel in the soil matrix. Based on the borehole data in the site geotechnical report[1], it is estimated that 16% of the bluff material at the site is larger than sieve #200 (0.074 mm; fine sand). An earlier Baird report[2] described the typical bluff composition as a silty clay till and a silty clay unit from the top of the bluff down to approximately elevation 177 metres; a hard clayey silt till from 177 m down to 173 m; and bedrock at 173 m. Analysis of the stratigraphic sections showed the portion of the bluff from the water level to the top of bluff to be St. Joseph till (a fine-grained till with 39% clay, 50% silt, 11% sand). The lower unit is Rannoch till (a very stoney till with 23% clay, 56% silt, 21% sand). The surface of the Rannoch till is at about the lake level; significantly, it contains numerous boulders and stones, which, once the fines are winnowed away by erosion, are left to partially armour the lakebed.

The bluffs south of Goderich Harbour have historically been eroding because of continued downcutting erosion of the nearshore lakebed profile and wave action undercutting the toe of the bluffs, which eventually leads to bluff instability and slumping and crest recession. The slumped material, or talus, is then removed by wave action and the process continues. Erosion of the bluffs and nearshore lakebed, along with erosion of the shoreline gullies, supplies sediment (clay, silt, sand, and gravel) to the shore zone. These materials are transported by wave action and currents. The finer sediments (clay and silt particles) are carried in suspension, and tend to deposit offshore in deeper water, while the coarser sediments (sand and gravel) are transported along the shoreline and can form beaches and dunes and nearshore bars where shore orientation and wave climate provide the necessary conditions.

Although much of the visible erosion (i.e., bluff recession above the water line) occurs during periods of high-water levels, the controlling process of nearshore erosion continues at all water levels, including during low water periods; however, the distribution of erosion across the nearshore zone varies with fluctuating water levels.

[1] LVM (2014) Slope Stability Investigation, Goderich South Community, Goderich, Ontario, Geotechnical Engineering Report, Ref. No. 161-P-0004986-1-GE-R-0001-00, April 14.
[2] Baird & Associates, 1990. Results of a Coastal Engineering Analysis of Possible Future Shoreline Development at Sully Property, Final report, October.

It has been estimated by Reinders[3] that approximately 72% of the supply of sand and gravel to the nearshore area comes from bluff erosion, 10% from gully erosion, 17% from lakebed erosion, and 1% from creeks and rivers. This material is transported alongshore by wave-induced currents. The magnitude of this transport is a function of the wave conditions (principally wave height and direction), water depth close to the shoreline and availability of sediments. Due to the wave climate and shoreline orientation in this area, the net transport is from north to south, although reversals do occur in response to individual storms. The Ausable-Bayfield Conservation Authority Shoreline Management Plan[4] identified that the site is at the northern limit of littoral sub-cell 2 (Figure 5). The net longshore transport in sub-cell 2 is towards the south. At the shoreline, the available wave energy to transport sand and gravel typically exceeds the available supply of sand and gravel, resulting in narrow and transient beaches only.

The average annual recession rate for the site was previously determined by Baird[5] using GIS-based analysis of aerial photographs from 1955 and 2015 (Figure 6). With the large gully near the middle of the recession rate study area creating a gap in the transects, and the slightly curved nature of the shoreline, the transects were grouped into two smaller north and south sections of shoreline. At the north section (area of this study), the first eight transects immediately adjacent to protected shoreline were excluded to provide a more conservative recession rate. The transects represent 60 years of shoreline bluff retreat. The transect measurements were averaged and annualized to calculate an average annual recession rate (AARR). For the north section (Transects 8 to 27), which is the study site, the measured recession over 60 years was as follows: average value 15.1 m; one standard deviation 5.9 m; average plus one standard deviation 21.0 m. The AARR plus one standard deviation is 0.35 m/year. Due to variability in the recession rates, it is recommended to use the average rate plus one standard deviation for regulatory setback purposes. The average plus one standard deviation includes about seven out of ten of the values measured. The average rate on its own means that one-half the recession values are greater. For estimating the long-term contribution of bluff material to the littoral system, the average value of 0.25 m/year is used. These average annual rates represent the average rate over the long-term; natural erosion is episodic (some years with no top of bluff retreat, followed by bluff slumping episode).

The geotechnical investigation for the site determined the stable slope inclination of the shoreline bluff is 1(vertical):2.8(horizontal)[6].

Shoreline Hazard Limit

In keeping with MVCA policy[7], the shoreline erosion hazard limit development setback at Goderich Community South was determined by others based on an erosion allowance measured from the natural toe of bluff slope and a stable slope allowance. The erosion allowance is based on the natural recession of the bluff and does not include the construction of hard engineering structures at the shoreline. Locating the development beyond the erosion hazard limit without the inclusion of shoreline protection at the shore, which would reduce the contribution of sediment supply to the downdrift littoral cells to the south, is consistent with MVCA policies: MVCA does not support measures which harden the shoreline.

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[3] Reinders, F.J. and Associates,1989. Lake Huron Shoreline Processes Study for: Ausable Bayfield Conservation Authority, Maitland Valley Conservation Authority, St. Clair Region Conservation Authority, Saugeen Valley Conservation Authority.
[4] Shoreline Management Plan 2019, Ausable Bayfield Conservation Authority prepared by Baird & Associates, Rev 2, February 28
[5] Technical Review of Estimating Shoreline Recession Rates 1973-2015, Maitland Valley Conservation Authority, report prepared by Baird & Associates, Rev.0 20/11/2017
[6] LVM (2014) Slope Stability Investigation, Goderich South Community, Goderich, Ontario, Geotechnical Engineering Report, Ref. No. 161-P-0004986-1-GE-R-0001-00, April 14
[7] Maitland Valley Conservation Authority, Policies and Procedures for Compliance with the Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation, Ontario Regulation 164/06, Revised July 12th, 2016

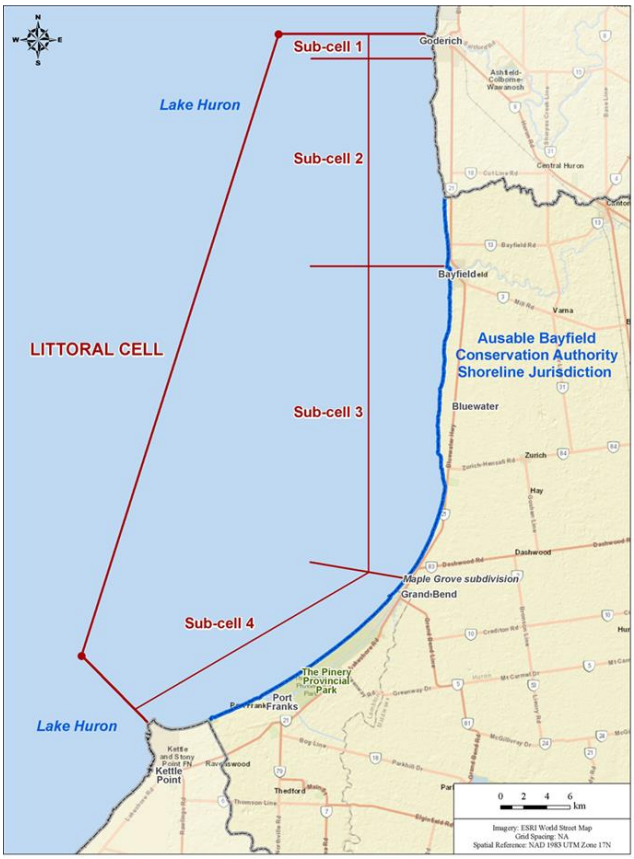

Figure 5: Littoral Sub-cells

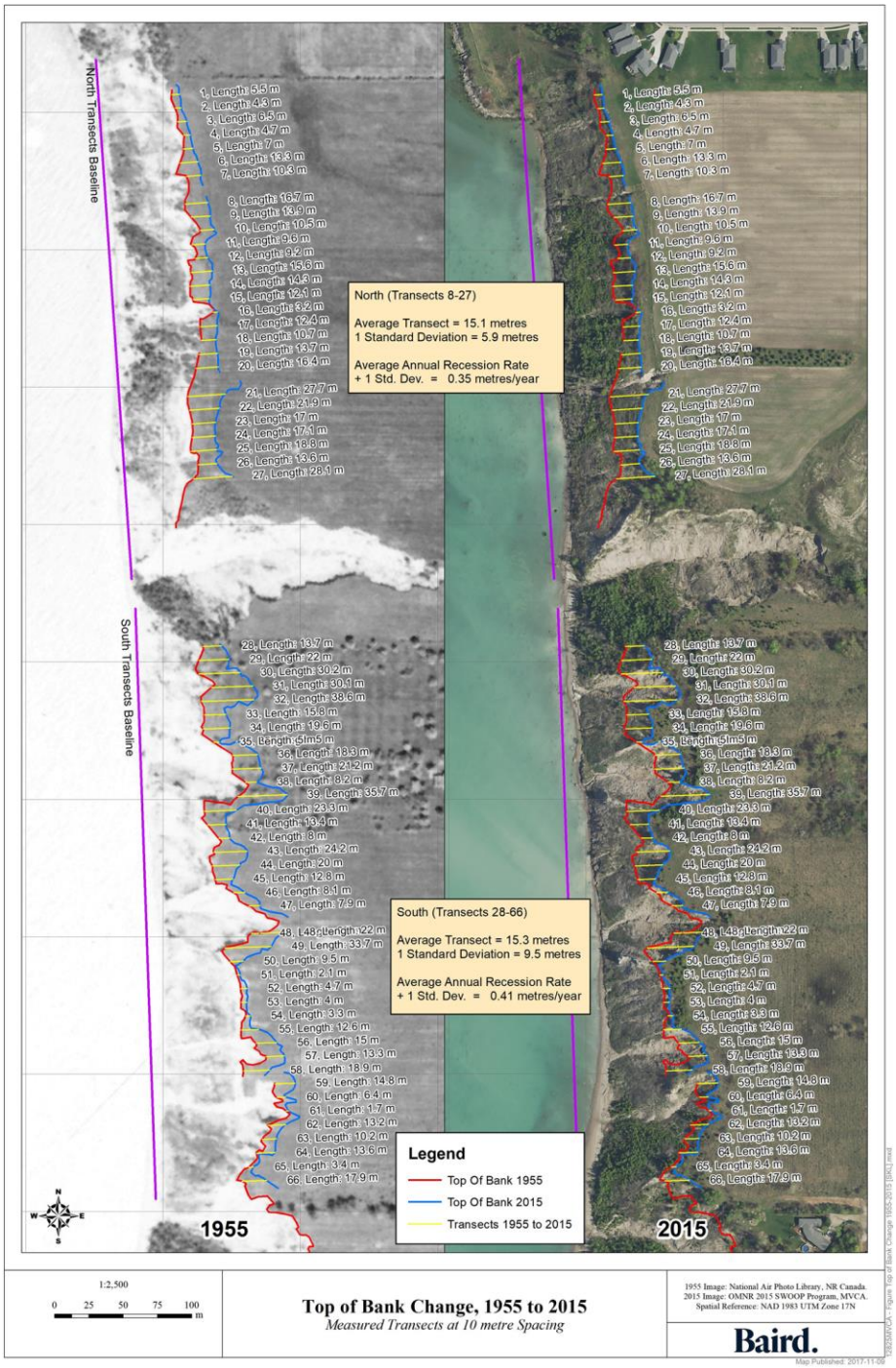

Figure 6: Top of bank change, 1955 to 2015, Concession 1, Lots 3 and 4

Proposed Bluff Regrading

By not having shoreline protection at the site and allowing the natural bluff to erode, the site will continue to contribute sediment material to the littoral system and help maintain the existing sand beaches to the south. However, as the natural cycle of wave-induced toe erosion and bluff slumping occurs, the eroding bluff will at most times be at a steeper inclination (i.e., "unstable" slope) than the stable slope allowance. The eroding, oversteepened slope poses an ongoing risk to users of the waterfront and affords little in the way of useable space (e.g., walking trails). The proposed development plan is to regrade the steep bluff to the stable slope inclination now, to create a more useable, safer public space. The excavated native material from the upper part of the bluff slope would be placed at the shore edge at the toe of the bluff, where it would continue to serve as a sediment supply to the natural littoral system.

The area of the bluff regrading is shown in Figure 2. A typical section of the proposed bluff regrading plan, including a trail, is presented in Figure 3. Based on the existing 1:1.9 slope and the stable slope of 1:2.8, it is estimated that about 460 m^3/m of bluff material would be excavated from the upper slope and placed at the water's edge at the toe; the existing toe of slope would be covered but otherwise undisturbed. It should be noted that the regrading of the native material to the toe of the bluff does not permit altering the shoreline erosion hazard allowance determination based on the existing location of the toe of bluff slope.

The native material to be placed at the toe is material that would have, over time, naturally fallen into the lake as the bluff retreated. At an average annual recession rate of 0.25 m/year, about 7.3 m^3/year of bluff material would slump from the 29 m high bluff down to the shore where the available wave energy would readily move the finer-grained portion offshore and sand and gravel portion along the shore, in the net direction towards the south.

Assessment of Impacts

Over time, it is expected that the bluff regrading will result in a similar volume of natural material available to downdrift shorelines, although the timing of the supply will have been modified. The regraded material is being maintained in the littoral system and will continue to supply downdrift beaches. Bulk placement of the regraded bluff material is considered like a "beach nourishment" approach.

It is not expected that the recession rate at the site will be altered in the long term by the regrading. The composition of the native consolidated materials in the nearshore and at the toe of the bluff, which are exposed to wave forces resulting in erosion, are not being altered by the bluff regrading. Once the regraded material placed at the toe of the bluff is moved alongshore and offshore, the existing nearshore and toe of bluff will continue to resist erosion in a similar way as would naturally occur.

Regrading the bluff will facilitate further bluff stabilization measures such as planting vegetation on the slope, and controlling drainage, runoff, and groundwater flow[8].

We trust this is sufficient and meets with your approval. If you have any questions or comments, please do not hesitate to contact me directly.

[8] Ministry of Natural Resources (MNR), 2001a. Technical Guide for Flooding, Erosion and Dynamic Beaches, Great Lakes – St. Lawrence River System and Large Inland Lakes. CD-ROM Published by the Watershed Science Centre, Trent University, Peterborough, Ontario for the Ontario Ministry of Natural Resources.

Regards,

Digitally signed by Mark Kolberg
Date: 2021.02.10 20:22:07 -05'00'

Mark Kolberg, P.Eng. | Principal
Baird & Associates

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