Appendix E

Shoreline Slope Stability Risks and Hazards Fact Sheet

(Terraprobe Inc.)

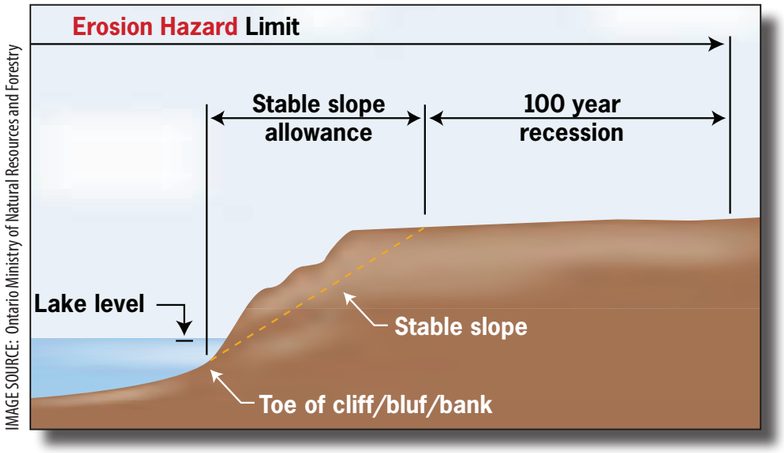

IMAGE SOURCE: Ontario Ministry of Natural Resources and Forestry

Erosion Hazard Limit and New Development

New developments are generally directed to be outside of the Erosion Hazard Limit to avoid the risks associated with slope instability and erosion hazards.

The Erosion Hazard Limit is established based on Stable Slope Allowance, Average Annual Recession, and Erosion Allowance as described below:

1. **Stable Slope Allowance (Stable Slope Inclination Setback)** is a horizontal allowance measured landward from the toe of the shoreline cliff, bluff, or bank. It is:

   a) Dependent on slope soil types, soil strengths, and groundwater conditions

   b) Assumed to be three times the height of cliff/bluff in absence of site-specific study, or, is determined by a detailed site investigation (boreholes) and analysis (typically minimum Factor of Safety of 1.5 required)

2. **Average Annual Recession**

   The average annual recession rate is an average rate of erosion of the shoreline per year for a site where there is at least 35 years of reliable recession information available.

3. **Erosion Allowance**

   Where there is no reliable recession information, the Province of Ontario suggests a setback distance to allow for 30-metre erosion allowance along the Great Lakes.

NOTE: The Ausable Bayfield Conservation Authority has calculated the Erosion Hazard Limit for areas along the Lake Huron Shoreline within the ABCA jurisdiction and documented this in its Shoreline Management Plan (SMP). Contact ABCA to obtain further information for your area.

Access Allowance:

In addition, there may be a requirement for an access allowance to allow for safe access around structures during initial construction and long-term maintenance of shoreline slope, property and structures. Typically 6 metres is required.

Notes:

- **1.** This fact sheet and the information included in it pertain to slope stability considerations. Additional setbacks and considerations may be applicable for the determination of shoreline hazards, risks, and erosion hazard limit.

- **2.** The information provided in this fact sheet is for general information purposes only and is not intended to preclude and/or replace the requirement of a property-specific slope stability and coastal investigation/assessment designed to adequately assess potential risks to the property, structures and the occupants.

Terms:

Cohesive shorelines

- The term cohesive shoreline is used to describe coasts developed in relatively weak sediments which include some silt and clay (to provide the cohesion). Coastal erosion results in the development of cliffs which are called cohesive bluffs to distinguish them from the traditional cliffs formed in hard bedrock.

Recession

- Long-term recession of the shoreline is a permanent reduction of the shoreline. Beach erosion may take place and be followed by accretion. Shoreline recession, on the other hand, is a permanent change or impact.

References:

- Geotechnical Principles for Stable Slopes: Terraprobe Limited
- Slope Stability & Erosion Risks – A Regulatory Perspective: B. Singh, M.A.Sc., P. Eng.
- MNRF Guide – Understanding Natural Hazards, Great Lakes - St. Lawrence River System and large inland lakes, river and stream systems and hazardous sites.
- Ontario Regulation 147/06

For more information:

To find out more, please contact Ausable Bayfield Conservation Authority at **519-235-2610** or toll-free **1-888-286-2610** or visit **abca.on.ca** for staff email contacts.

Contact us:

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Slope instability indicators include displaced posts and fences, poles, monuments, guardrails, broken or displaced retaining walls, and stairs, among other indicators mentioned in this fact sheet. Please read the Recommended Management Practices panel inside.

Ausable Bayfield Conservation Authority (ABCA)

Shoreline Slope Stability Risks and Hazards

Fact Sheet for Property Owners

Purpose of fact sheet:

The Lake Huron shoreline is a spectacular feature. It is enjoyed by many as a place to visit, work, recreate, and live. As a result, much of the shoreline has been developed. Recently, many seasonal residences have evolved into permanent homes. Portions of this shoreline, however are subject to erosion and bluff instability.

This fact sheet has been created to inform shoreline property owners of:

- Indicators of potential bluff instability and associated risks
- Best management practices for bluff stability and shoreline areas; and
- Sources of additional information.

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Consulting Geotechnical & Environmental Engineering
Construction Materials, Inspection & Testing

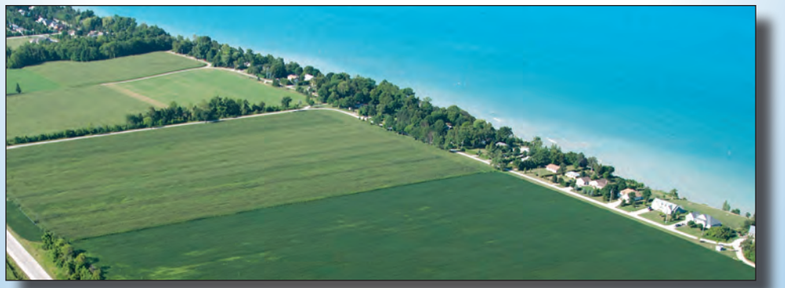
About the Lake Huron Shoreline

Much of the Lake Huron shoreline, within the Ausable Bayfield Conservation Authority (ABCA) jurisdiction, is bluff. The bluff material is made of silt, clay, sand and small rock and was first deposited by glaciers. This is known as a cohesive shoreline. Erosion of this material by Lake Huron has created the tall bluffs.

These shoreline bluffs have been eroding for thousands of years and continue to be subject to wave action at their toe or base. This leads to cycles of erosion and slope instability. This, in turn, results in recession or erosion at the top of the slope. The wave action undercuts and locally over-steepens the slope toe.

This over-steepening of the slope results in slumping which works up to the slope crest. This slumping is a natural phenomenon which helps flatten the slope. The slumping eventually achieves a stable angle for vegetation to establish – provided that the toe erosion is stopped and addressed. Unfortunately, addressing toe erosion may not be feasible on some cohesive shores. This is due to continuous underwater erosion which can take place offshore.

(The term cohesive shoreline is used to describe coasts developed in relatively weak sediments which include some silt and clay to provide the cohesion. Coastal erosion results in the development of cliffs which are called cohesive bluffs to distinguish them from the traditional cliffs formed in hard bedrock.)



Typical Signs of Slope Instability

There may be some or no signs of slope instability at all prior to a slope slide, depending on site-specific conditions. However, here are typical slope instability signs:

Bare slope areas (no vegetation)

- Lack or loss of vegetation is a typical sign of over-steepened slope. Vegetation establishment is relatively difficult on steep slopes (generally steeper than 2 horizontal to 1 vertical).
- A recent formation of bare area or loss of vegetation on a slope may indicate a slump, soil erosion or formation of an over-steepening zone.

Bent Trees

- Bent and bowed trees may be due to slope soil creep, however, it may also be due to initial root development and twisting or bowing growth in response to reaching for sunlight.

Tension cracks

- A tension crack formation close to the top of slope may indicate a pending slope failure.
- A tension crack is a void that generally runs parallel to the slope face. It can significantly affect the future stability of the slope because a crack filled with water reduces the stability due to the hydrostatic pressure.
- Ice formation within the crack during sub-zero temperature expands and loosens the slope soil in the vicinity.

Irregular Slope Surfaces, Slumps, Scarps, Bumps, Bulges

- A presence of irregular slope surfaces such as slumps, scarps, bumps, bulges, etc. generally indicates a soil movement.
- Slumps and scarps result in an over-steepened (even near vertical) and bare zone at the 'head' or 'crown' where the sliding mass has separated from the slope.
- A slump or slide may also result in tension cracks above the slide.

Other Indicators

Other slope instability indicators include:

- Displaced posts/fences, poles, monuments, guardrails, broken/ displaced retaining walls, and stairs.

Recommended Management Practices

DOs and DON'Ts along the Shoreline

Here are recommended management practices for properties located along the shoreline bluff:

Do:

- Any observation of severe slope instability should immediately be brought to the attention of the local municipality and conservation authority. A safety fence should be installed and maintained near the slope crest in the areas of slope failures, over-steepened and near vertical scarps to keep occupants/people away until the condition has been assessed by a qualified engineer.
- Property use should be conducted in a manner which does not result in surface erosion of the slope. In particular, site grading and drainage should prevent direct concentrated or channelized surface runoff from flowing directly over the slope. Water drainage from down-spouts, sumps, swimming pools, road drainage, and the like, should not be permitted to flow over the slope. Minor sheet flow may be acceptable. If water is collected at the slope crest, it should be safely discharged to the bottom of the slope by suitable piping.
- Consult with ABCA prior to removing vegetation on the slope.
- Maintain the lake bank in a natural state with native plants and vegetation.
- Maintain tiled or piped drainage systems in proper working condition to help prevent surface erosion and/or seeps on the lake bank.
- Monitor the condition of the bank regularly for signs of erosion and instability.
- Leave root systems intact in circumstances where tree removal is necessary.
- Undertake maintenance activities by hand where possible and avoid disruption of the lake bank with machinery or heavier equipment.
- All approvals and permits must be secured from ABCA prior to any site alteration.

Don't:

- In order to promote vegetation growth on the slope face, yard and other waste must not be discarded over the slope.
- The configuration of the slope should not be altered without prior consultation with a professional geotechnical engineer and approval from the local conservation authority.
- Do not remove trees unless removal is warranted and approved by authorities.
- On cohesive shores, the long-term stabilization of a bluff/slope with shoreline protection works, may not be practical due to erosion occurring underwater offshore. The ABCA, a professional geotechnical engineer, and a qualified professional coastal engineer should be consulted to determine the site-specific issues for the feasibility of any proposed coastal protection works.