the Coastal Centre

COASTAL BLUFF

Geo-Hazard Checklist

Learn to identify coastal bluff erosion and high risk areas of instability on Lake Huron's shoreline

Updated 2020

Lake Huron Centre for Coastal Conservation

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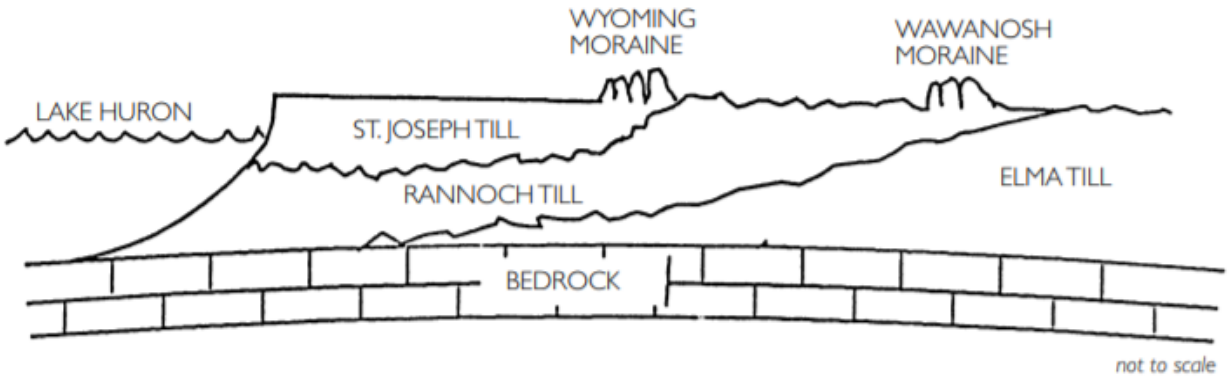
HOW TO USE THIS GUIDE

This Guide will help you to **identify erosion and unstable bluff areas**. Erosion is a natural process, our beach and dune systems rely on bluff erosion and shore processes to exist. Our beaches and dunes, in turn, protect the shoreline from storm waves and erosion. However, our actions on the landscape can signifigantly increase the rate of erosion. This Guide will help you to identify areas of risk so that you can discuss these observations with a qualified Engineer or your local Conservation Authority.

DID YOU KNOW?

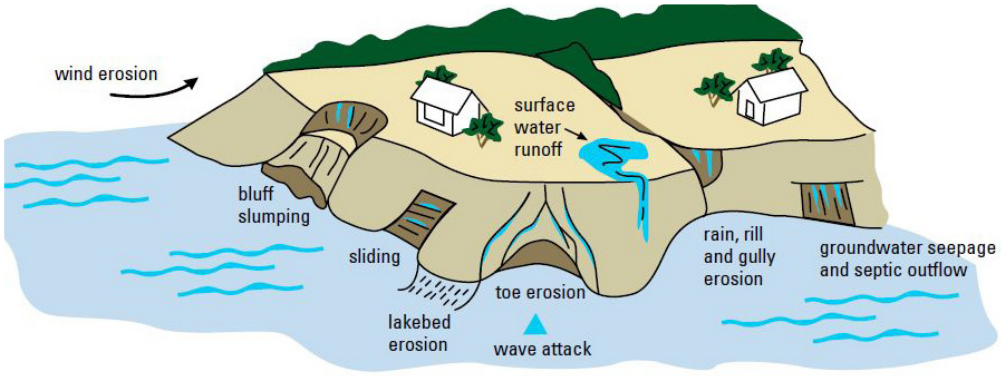
Glaciers towered above and shaped the Great Lakes during the last ice age. Lake Huron's bluffs are composed of glacial till (that's the clay, silt, sand and cobble material left behind by glaciers). The following cross section depicts Lake Huron's various till formations, which are highly prone to erosion.



INTRODUCTION

CAUSES OF COASTAL EROSION ON BLUFFS

The shoreline of Lake Huron is made up of bluffs that are over 20 metres high. It is a cohesive shoreline, consisting of sediment cliffs that are relatively non-resistant to erosion (high silt and clay content and low cobble content).



St. Joseph's Till is found in most of the exposed bluffs. Beneath is the stoney *Rannoch Till* in the shorebluffs, typically separated by a boulder horizon. The *Rannoch till, the* Bedrock, is extremely resistant to erosion. Portions of the erodible *St. Joseph's Till* are below the lake water level.

These bluffs are highly prone to erosion. Once the bedrock becomes exposed, it helps to provide long-term stability and restricts further down-cutting. In some areas, these bluffs have high recession rates, between 0.5m/yr to 2m/yr depending on the season and section of the bluff.

COASTAL BLUFF EROSION

GEOMORPHIC INDICATORS OF IMMINENT BLUFF FAILURE

Look carefully for these indicators on a bluff as they will help you to determine the level of bluff instability and recommend the appropriate action.

- **Prevalence of Ground Cracks**
- **Overland Water Flow**
- **Slumps and Landslides**
- **Narrow Beach**
- **Groundwater seepage and septic outflow**
- **No vegetation or curved or twisted trees**
- **Gullying**
- **Toe Erosion**

PREVALENCE OF GROUND CRACKS

Surface layers of a bluff tend to stretch and develop cracks as a sign of motion and instability within the bluff. These can occur either on top, near the edge of the bluff or on the slope itself; they are long and deep cracks sometimes extending below the layer of soil.

Tension cracks on the ground (Source: Maine Geological Survey, 2015)

Cracks are a sign of instablity within a bluff.

Over-steepening of the bluff can lead to lead to massive slope failures, known as slumps.

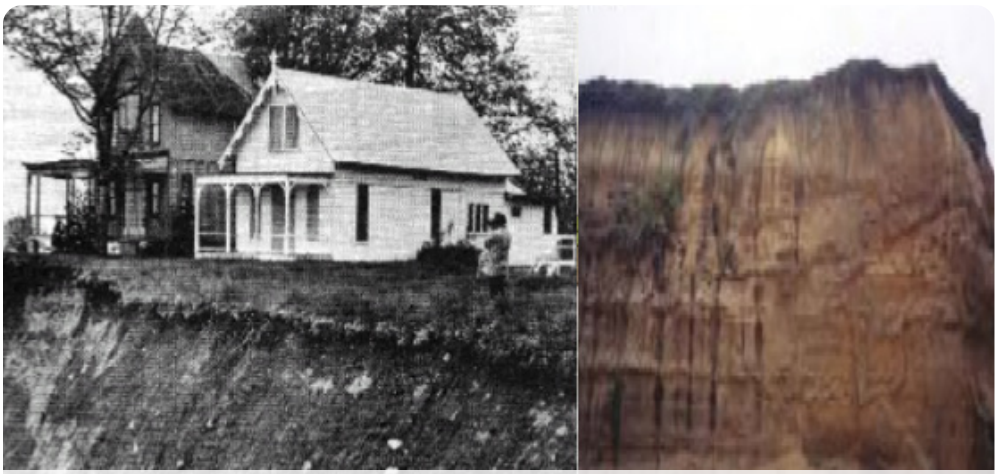
SLUMPS AND LANDSLIDES

When a mass of material slides a short distance downward in a concave movement on a bluff or gully slope, it is known as a slump. A slump can occur due to many underlying factors that indicate ground movement.

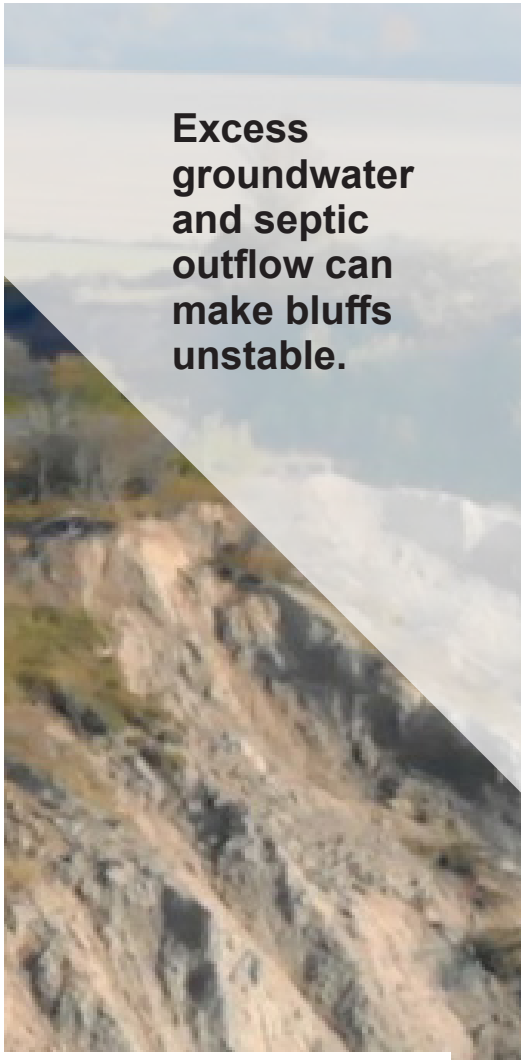
Bluff erosion taking out a house (Source: Great Lakes Now Video Episode)

GROUNDWATER SEEPAGE AND SEPTIC OUTFLOW

Excess groundwater leading to seepage or septic outflow could make a bluff highly unstable. Bluffs are often made up of unsorted materials and when the empty spaces between these are filled with water, the water acts as a lubricant and makes these particles slip away from each other, thereby causing a slope failure. Ground water seepage is pictured below.



Source: modified from Hampton & Griggs, 2004 and DEPA, U., 2001



Excess groundwater and septic outflow can make bluffs unstable.

Gullies are prone to slumps and landslides as they get wider and deeper with time.

GULLYING

Water from increased drainage from farm fields, urbanized development, rain, and storm events cut into the clay soil of the bluffs; thereby creating gullies. Gullies get wider and deeper with time and are prone to slumps and landslides along their sides that increases the amount of erosion.

Aerial view of large gullies (Source: modified from The Lake Huron Centre for Coastal Conservation - Gullies, n.d.)

OVERLAND WATER FLOW

Overland flow causing rills. Source: modified from Williams, H., n.d.

As excess water flows down the bluff, it picks up velocity, causing rills.

When the farms, lawns and gardens, situated on a bluff are watered, or when it rains, the excessive water is left to flow down the slope. As the water flows down the bluff, it picks up velocity and drags along silt and stones with it; thereby creating rills along the face and causing recession of the bluff.

NARROW BEACH

Beaches that are less than 20 metres wide with no natural protection such as boulders or ice cover during the winter, may be insufficient to prevent wave energy from reaching the base of the bluff, causing erosion. Extremely narrow beaches offer little protection to the bluff from wave impacts and erosion.

Source: modified from LHCCC

Narrow beaches are insufficient to prevent waves from reaching the base of the bluff.

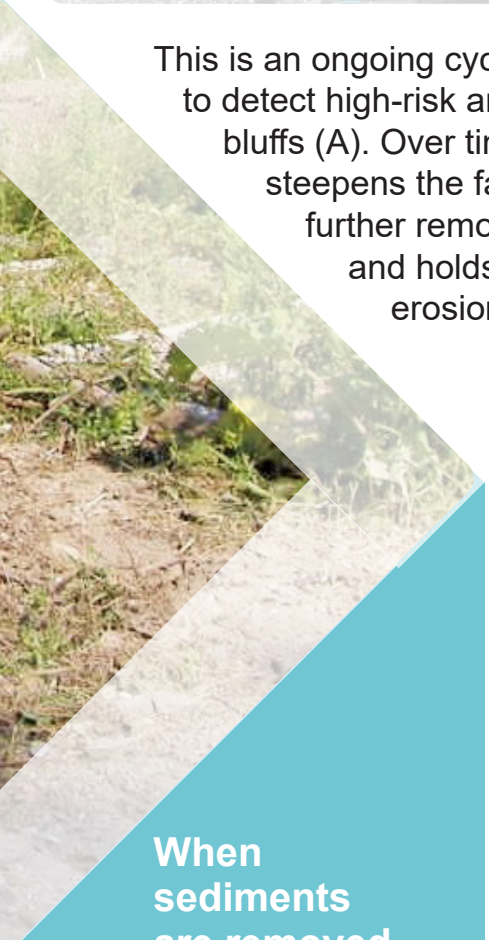
TOE EROSION

The continuous action of waves hitting the toe of the bluff causes the removal of sediments. This undercutting increases over time, over-steepening the slope and making the bluff unstable, until a point when the bluff no longer has the strength nor resistance and fails.

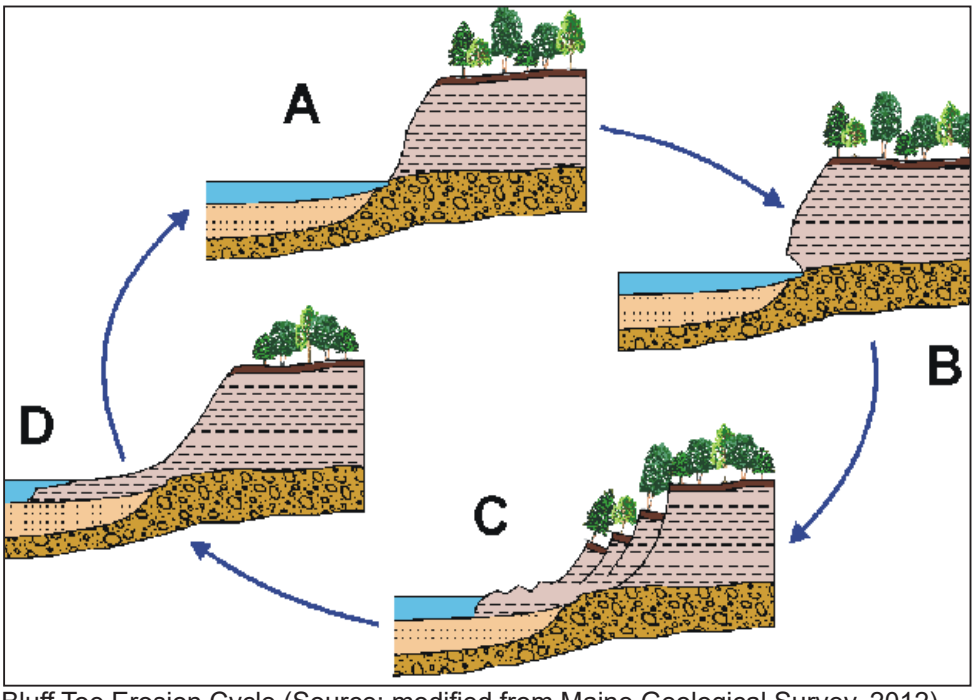
Toe cutback of a bluff. (Source: modified from LHCCC).

Continuous wave action undercuts the bluff and steepens the slope over time.

This is an ongoing cycle and therefore, toe erosion is one of the most important indicators to detect high-risk areas. As lake levels rise and fall, waves erode the base of coastal bluffs (A). Over time, this erosion removes material from the base of a bluff and steepens the face (B). The coastal bluff starts to destabilize, as ground water further removes materials, and the bluff fails (C). The material eventually slumps and holds the bluff in place with a gentler profile (D). This cycle will repeat as erosion continues to cut into the base of coastal bluffs.



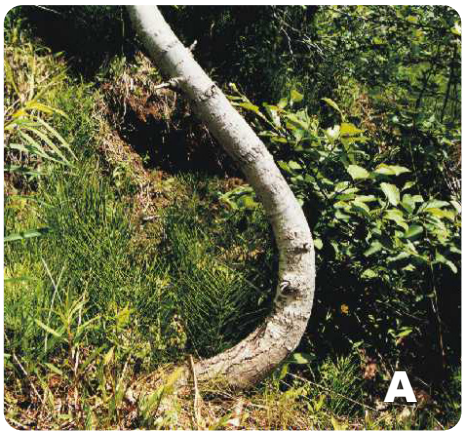
When sediments are removed, the bluff is no longer in equilibrium.



Bluff Toe Erosion Cycle (Source: modified from Maine Geological Survey, 2012)

CURVED AND TILTED TREES ON SLOPES

Tree trunks that are curved near the base (A) may signify downslope movement or “soil creep”. The trunks curve because the tree continues to grow towards the sun as the downslope movement occurs. Trees on the slope may also become tilted (B) because of toe undercutting of the bluff. This makes the bluff unstable and causes landslides, which tilt the trees towards or away from the lake. These are important indicators of bluff instability.



Source: Maine Geological Survey, 2015

Photo: MVCA

Un-vegetated bluff slopes are extremely prone to erosion.

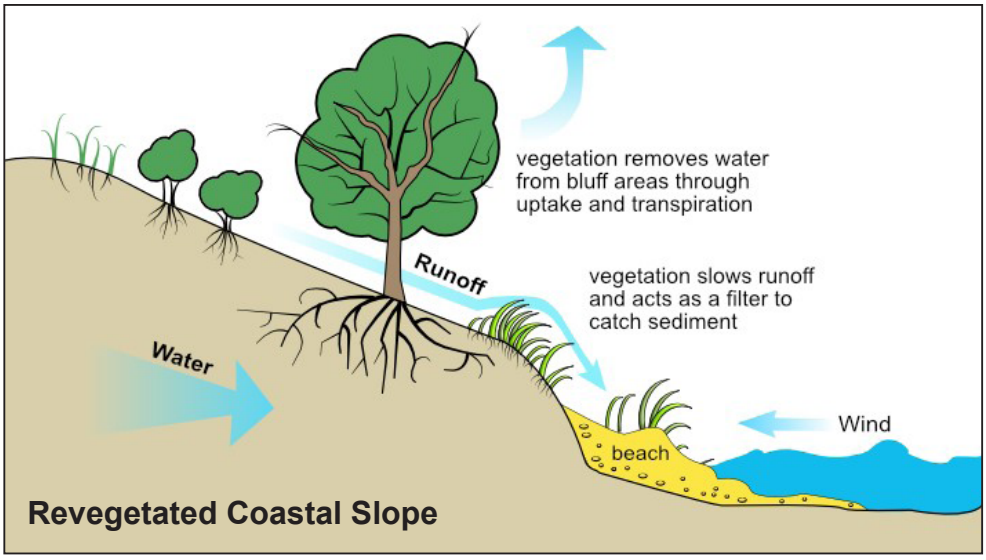
NO VEGETATION ON THE SLOPE

Limited or no vegetation on the slope is a strong indicator of active erosion of the bluff. Without vegetation to hold the soil in place, the slope is prone to wind and water erosion, gullying, mass wasting, slumps, and landslides.

Source: modified from LHCCC

COASTAL BLUFF EROSION

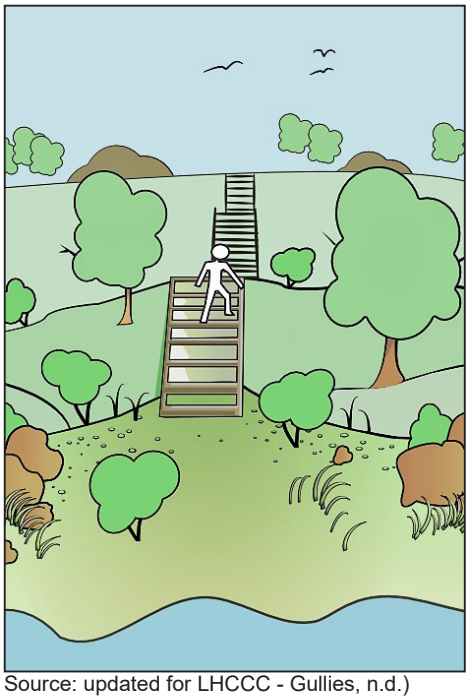
Erosion is a natural phenomenon; it cannot be stopped. However, the rate of erosion can be increased or decreased depending on anthropogenic activities.



Source: updated for LHCCC - Gullies, n.d.)

Removal of vegetation from the slope of the bluff leads to extensive and rapid erosion of the bluff face. Vegetation should not be cleared as it anchors the soil of the slope, protects the slope from extreme erosion during heavy rainfall, and removes excessive water in the ground through transpiration.

Land use is extremely important. Excess water from lawns, paths, and driveways flowing down the bluff, or walkways on the face of the bluff, could rapidly increase the rate of erosion. Additional weight from buildings on the bluff (including pools) may increase the risk of slump/landslide.



Source: updated for LHCCC - Gullies, n.d.)

Bluffs that are stable may become unstable over time because of natural processes and anthropogenic activities.

INDICATORS OF A STABLE BLUFF

Gentle Bluff

A gentle slope of the bluff face indicates that the bluff is more stable compared to a steeper slope

Well Vegetated Bluff

Healthy vegetation on the bluff face such as trees, shrubs, grasses, etc. would imply stability of the bluff

Wide Sediment / Ledge Zone

A wide beach with a natural “protection” such as a ledge/boulders/sediments would dissipate the energy of the on-coming waves thereby decreasing wave action at the toe of the bluff

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APPENDIX

CHECKLIST FOR GEOMORPHIC INDICATORS

The following checklist could be used by the property owners to assess their bluffs and look for the visual cues mentioned.

If any of the indicators are present, please complete the checklist. Take a picture of the visual cue, and you may wish to contact your local Conservation Authority or a qualified soils engineer to discuss your observations and concerns.

Indicator for an Unstable Bluff		Present? Yes/No	If present, photo taken? Yes/No
1	Prevalence of Ground Cracks		
2	Slump/Landslide		
3	Ground water seepage and Septic outflow		
4	Gullying		
5	Overland water flow		
6	Narrow Beach (<20m)		
7	Bluff Toe Erosion		
8	Type of Vegetation:		
	Curved and tilted trees on slope		
	No vegetation on the slope		
	Total		

Indicator for a Stable Bluff		Present? Yes/No	If present, photo taken? Yes/No
9	Gentle Slope		
10	Well Vegetated Slope		
11	Wide sediment/ledge zone		
	Total		

The Lake Huron Centre for Coastal Conservation has produced several guides and factsheets on coastal stewardship topics and Best Management Practices (BMPs)

www.lakehuron.ca

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