

# 2016

Ausable Bayfield Conservation Authority

Prepared by  
Aqua Solutions 5 Inc.  
Dr. Robin Davidson-Arnott  
Dr. Ryan Mulligan  
Planning Solutions Inc.  
Terraprobe Inc.



## **SHORELINE MANAGEMENT PLAN 2016 CONSULTANT RECOMMENDATION REPORT**

**AUSABLE BAYFIELD CONSERVATION AUTHORITY  
AUGUST 2016**

This report was prepared by Aqua Solutions 5 Inc., Dr. Robin Davidson-Arnott and Planning Solutions Inc. for the Ausable Bayfield Conservation Authority. Terraprobe was instrumental in developing the Landowner Fact Sheet and Dr. Ryan Mulligan from Queen's University undertook a peer review of the report and provided additional information and recommendations relating to dredging and wave assessment. The material in this document reflects the best advice and judgment of the authors in light of the data and information available at the time of preparation. Any use which a Third Party makes of this report, or any reliance on decisions to be made based on its contents, are the sole responsibility of any Third Parties. The authors accept no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions taken based on the contents of this document. Please note, air photos included in this document have been sourced from ABCA aerial photography. Those photos taken during site reconnaissance are credited to MJ Sullivan, Aqua Solutions 5 Inc.

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This Plan has been developed to provide important contextual information at the beginning with more detailed site specific technical data later in the document. This document has been formatted to encourage the reader to obtain important information quickly. Several symbols appear throughout the document as follows:



Denotes important additional information that may be of interest to the reader.



Denotes key findings of fact and important technical observations and policy approaches.

# Ausable Bayfield Conservation Authority

## Shoreline Management Plan 2016

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We also wish to acknowledge the contribution of members of the Steering Committee without whose assistance and support, this document would not have been possible.

## Preface

This document is a Consultant Report that is being submitted to the ABCA for its consideration. It documents a recommended approach for ABCA to consider and as such, has been prepared for ABCA to share with its watershed municipalities, interested stakeholders and landowners across the watershed.



## Executive Summary

This document summarizes the approach that the Ausable Bayfield Conservation Authority (ABCA) should take to **responsibly manage** the Lake Huron shoreline within its jurisdiction. Responsible management means that the ABCA is focusing first and foremost on adhering to its legislated mandate to protect human life and property from the adverse effects of natural shoreline hazards. Responsible management necessitates that the ABCA advance a policy approach that is consistent with Cabinet-approved provincial policy such that:

- **No new hazards are created;**
- **Existing hazards are not aggravated; and**
- **No adverse environmental impacts will result.**

Provincial policy places the responsibility on Ontario's 36 conservation authorities to deliver on established provincial hazard policy. In the ABCA watershed, this responsibility requires ABCA to:

- Administer its regulations issued under Section 28 of the *Conservation Authorities Act* to ensure that no new hazards are created, that existing hazards are not aggravated and that adverse environmental impacts do not result;
- Provide advice and guidance to watershed municipalities in keeping with its legislatively assigned responsibilities as an advisory agency under the *Planning Act* and in keeping with established Memoranda of Understanding and Service Level Agreements again to ensure that no new hazards are created; that existing hazards are not aggravated; and that adverse environmental impacts do not result.

This recommended Updated Shoreline Management Plan has been developed to ensure that the policies and approaches being implemented by ABCA under the *Conservation Authorities Act* and under the *Planning Act* are reflective of current provincial policy. It has also been developed and is being shared with all interested parties to provide clear direction to those who are current shoreline property owners as well as those who may be considering shoreline property as an investment.

This document has been written as a multi-purpose document, certainly to be used by those most directly impacted – the property owner – but also by those whose responsibilities include development approvals and regulatory oversight. The intention is that this one document will be used and relied on by ABCA staff and Board members, elected community officials, watershed municipal staff, landowners (existing and future) as well as individuals and/or groups interested in or concerned with shoreline management. It is also hoped that this document may offer additional insight to other conservation authorities and potentially other municipalities who may be considering updating their own Shoreline Management Plans and who may find utility in the policy approaches and philosophies that are contained herein.



So what has changed from the existing Shoreline Management Plan?

What does the average landowner need to know about the approach that is being proposed in this document?

There are a number of important changes in policy that are required. These changes in policy have resulted from the following key facts:

- The current Shoreline Management Plan (SMP) needs to be updated and revised to fully reflect existing Cabinet-approved policy direction. The science pertaining to shoreline hazards has evolved over time and so too has the provincial position respecting the identification and management of shoreline hazards;
- Climate change necessitates an important re-evaluation about the potential implications for natural shoreline processes. There is a need for greater resilience along the shoreline;
- The nature of development particularly along the Lake Huron shoreline has changed dramatically since the existing SMP was developed. The existing SMP was developed to address small-scale development and not the large complex developments that are emerging along the shoreline; and finally
- The emergence of risk management frameworks and systems thinking support the need to consider the shoreline as one entity and to recognize important upstream and downstream effects.

This Shoreline Management Plan (SMP) is based on a scientific, evidence-based approach that is strategic, thoughtful, measured and fair. The process of developing this updated SMP follows the same logic and engaged a variety of constituents including government, industry and community groups from the outset. This updated SMP has been developed by considering established provincial policy, investigating climate change implications for the Lake Huron shoreline, examining natural shoreline processes, assessing current ABCA and municipal planning policies and evaluating the approaches currently in place to address shoreline hazards in other jurisdictions across the Great Lakes Basin. The Plan that has been developed, and the management approach that is being recommended, has been tailor made for the Lake Huron shoreline within the Ausable Bayfield Conservation Authority jurisdiction.

This document advocates for a responsible shoreline management approach. Responsible management means that ABCA will be working collaboratively with provincial and municipal partners and importantly with landowners to ensure compliance with established provincial policy. It means that ABCA will be looking to reduce the risks resulting from shoreline hazards as to not only reduce the risk from the hazard but also to ensure the risk is not increased.

This document upholds many of the policies that are and have been in place at ABCA for many years. It continues to advocate for **no new development in the hazard zone** but **takes a stronger stand on minor alterations/changes to existing uses**. Under the current SMP, minor alterations are permitted in Lakeshore Area 1 and Lakeshore Area 2. Under this new SMP, it is recommended that ABCA develop a policy position to reflect a managed retreat approach so that **minor alterations will be phased out over time**. Perhaps most notably however, is the position that is recommended relating to shoreline protection works. In a marked departure from the existing Shoreline Management Plan, this document advocates for **no new ‘hard’ shoreline protection works however, consideration for ‘soft’ shoreline protection, specifically Beach Nourishment can be considered**. This position is

based on three key factors. Firstly, underwater erosion and natural shoreline process along the ABCA shoreline indicates clearly that these structures do not stop erosion processes and moreover that they can have an adverse impact on properties downdrift. Secondly, there is no legal recourse to ensure that shoreline protection works are maintained by private landowners. This in turn raises issues relating to the issue of downdrift impact which may create concerns for property owners who have chosen not to install shoreline protection works and who may be unable to financially afford to invest in shoreline protection. Third, the science suggests that there are environmental implications that accrue from shoreline protection that suggest this approach is not optimal.

In carrying out its mandated responsibilities, the ABCA will focus first on preventing damage to structures within the shoreline zone from flooding, erosion and dynamic beach hazards. A 'prevention-first' philosophy is one that the ABCA has subscribed to since the very first Shoreline Management Plan was prepared in 1994 (and updated in 2000) and is directly reflective of Cabinet-approved provincial policy. Importantly, this approach is also supported by watershed municipalities whose Official Plans recognize the importance of public safety and the need to protect property against natural hazards.

Protecting human life and property from the adverse effects of natural hazards including flooding, erosion and dynamic beaches is a legislative responsibility assigned to the ABCA. Having shoreline policies in place that are reflective of current policy, that are easy to understand and, critically, that are defensible and based on sound science, offers a vital foundation for protecting the shoreline features and functions while guiding development that is safe and sustainable.



ABCA has developed this document with the input of the community and with the assistance of a diverse group of stakeholder representatives from across the watershed including community leaders, municipal staff, technical experts, community members and importantly, landowners.

ABCA intends to implement this document in collaboration with its municipal, provincial and federal partners as well as individual landowners. Keeping people and property safe from the effects of natural shoreline hazards is an important responsibility and one that ABCA takes seriously. This updated Shoreline Management Plan focuses importantly on managing the shoreline to ensure that the public remains safe, that property damage is minimized and that shoreline areas continue to be enjoyed as important recreational spaces and places.

This updated Shoreline Management Plan provides important information about natural shoreline hazards in the ABCA watershed. Any questions concerning this updated Shoreline Management Plan may be directed to:

Ausable Bayfield Conservation Authority  
71108 Morrison Line, R R #3  
Exeter, Ontario NOM 1S5  
Phone: (519) 235-2610  
Toll Free: 1-888-286-2610

## 1.0 Background & Introduction

### 1.1 Shoreline Management: The Basics

The shoreline of Lake Huron, like the shoreline of the Great Lakes, is dynamic and in a constant state of change. Shoreline change is the result of natural processes of erosion and sand build-up as well as a response to severe storms, wind action as well as high and low water events. In certain circumstances considerable damage along the shoreline can result. In Ontario, a proactive approach to shoreline management emerged in direct response to catastrophic damage that occurred to thousands of lakeshore properties in the mid-1980's. As a result, the Ontario Minister of Natural Resources at the time delegated the responsibility for shoreline hazard management to individual conservation authorities who have jurisdiction along the shores of the Great Lakes.

Flooding, erosion and dynamic beach hazards are naturally occurring physical and ecological processes that have and will continue to shape our shoreline landscape over time. These processes include shoreline regression, erosion by waves, nearshore currents, sediment transport, wind action, water level fluctuations, ice, weathering and human or anthropogenic activities. When these natural processes have a direct and negative impact, they are viewed as hazards. In order to address these hazards, proper management of the shoreline is required. Shoreline management plans allows these hazards to be identified and importantly, they allow management actions to be developed so that the issue of natural shoreline hazards is considered from a strategic, proactive and preventive lens.

### 1.2 Shoreline Management and Conservation Authorities

Shoreline management is a provincial responsibility that has been delegated to Ontario's 36 conservation authorities. Conservation Authorities, created at the request of watershed municipalities, have been providing a number of natural hazard related services since their inception in the 1940's, 1950's and 1960's. Their raison d'être was reinforced by concerns with public safety as a result of Hurricane Hazel (1954) and the Timmins storm of 1961. More information about the legislative mandate and responsibilities of conservation authorities is provided below. The responsibility for managing natural shoreline hazards is a long and well-established responsibility of Ontario's conservation authorities and one in which conservation authorities are required to uphold and adhere to established Cabinet-approved provincial policy. The Ausable Bayfield Conservation Authority (ABCA) is one of thirty-six (36) conservation authorities in Ontario and has been assigned responsibility for shoreline management along the shores of Lake Huron. The ABCA has been carrying out these responsibilities for close to three decades.

### 1.3 Ausable Bayfield Conservation Authority: A History of Shoreline Management

In February 1988, the Ausable Bayfield Conservation Authority became the lead government commenting agency for land use planning as it relates to flooding, erosion and dynamic beach hazards along the Lake Huron shoreline, within its jurisdiction, stretching from the north end in Lot 30, Concession 1, Goderich Township to the south, including the Village of Bayfield, Townships of Stanley, Hay, Stephen and the Village of Grand Bend to the southerly limit in Bosanquet Township at

the community of Port Franks. The ABCA was directed to prepare a Shoreline Management Plan to include the shoreline of these seven municipalities and several background reports were completed including a Lake Huron Shore Process Study (completed by Reinders in 1989) which addressed the entire southeastern shore of Lake Huron, an inventory of erosion controls structures (completed by ABCA in 1990), detailed 1:2000 scale mapping for the shoreline and a report prepared by Baird Engineering in 1994 that included considerations for shore protection structures.

Ausable Bayfield Conservation Authority (ABCA) has had an approved Shoreline Management Plan in place since 1994 but has been actively involved in and responsible for shoreline management well before the plan was approved. In the ensuing 22 years, ABCA has made an ongoing commitment to manage the shoreline within its jurisdiction and to diligently address flooding, erosion and dynamic beach hazards in the ABCA watershed area. Part of ABCA's shoreline management commitment is to ensure that the Shoreline Management Plan is regularly reviewed and that the policies are relevant, robust, reflective of existing provincial policy, and are focused on promoting solutions to current and future shoreline issues.

The ABCA Shoreline Management Plan was last updated in 2000. Since that time, considerable change has taken place along the Lake Huron shoreline and the current plan needs to be updated to ensure it fully reflects existing approved legislation and policies pertaining to shoreline hazards. The current plan does not contain up-to-date mapping, nor does it reflect the fact that development pressures have increased and moreover, patterns of development have changed in the last sixteen years.

The Shoreline Management Plan is a critical tool for providing private landowners as well as provincial, municipal and conservation authority staff and Board of Directors members with clear shoreline management direction. As a consequence, it is imperative that this document provide accurate, comprehensive, easily understood and up-to-date policies that apply to the ABCA shoreline. It is for this reason that the 2016 Shoreline Management Plan has been completed.

Proper shoreline management requires the identification of existing natural hazards and the extent of these hazards. It necessitates directing development away from these unsafe areas. The extent of these hazards within the Ausable Bayfield watershed area has been determined through a Shoreline Management Plan that was first developed in 1994, updated in 2000, and has been refined through the completion of updated mapping and analysis of the existing shoreline conditions.

**It is important to note that any development adjacent to the shoreline of Lake Huron that is subject to flooding, erosion or dynamic beach processes requires a permit from the Ausable Bayfield Conservation Authority.**

#### 1.4 A New Updated Shoreline Management Plan

Shoreline Management Plans are required to be regularly reviewed and updated and importantly, are required to reflect current provincial policy and applicable law. In this regard, ABCA's existing Shoreline Management Plan was last updated in 2000 and needs to be updated to accurately reflect existing provincial policy and applicable regulations and to include appropriate policies to address current patterns of land use along the shoreline.

An updated document is needed to provide a solid foundation for integrated coastal zone management along that portion of Lake Huron that is within the jurisdictional responsibility of the Ausable Bayfield Conservation Authority.

A new updated Shoreline Management Plan is needed to incorporate current Cabinet-approved provincial policy, reflect updated mapping and science, and to provide clear direction to:

- ABCA staff and Board Members as they exercise their advisory responsibilities under the *Planning Act* and their regulatory responsibilities under The Conservation Authorities Act;
- Private landowners concerned with protecting their shoreline properties from hazards;
- Other municipal and provincial ministries and agencies responsible for emergency management and preparedness; and
- Municipalities responsible for managing risks associated with potential damage to municipal and private development along the shoreline.

This Shoreline Management Plan replaces the most recent Shoreline Management Plan Update approved by ABCA in 2000. This updated document summarizes the scope of ABCA's shoreline management mandate, responsibilities and requirements. It is expected that this updated document will be used by ABCA staff and board members, by municipal planning and building department staff, by developers and their agents, by interested and concerned individuals and groups, by industry and business operating along the Lake Huron shoreline as well as current shoreline landowners who are interested in better understanding the need to manage the risks associated with natural shoreline process.

This document provides information and guidance and has been developed to:

- Implement existing provincial policy relating to shoreline hazards;
- Assist other levels of government responsible for the lakeshore and natural hazards;
- Provide direction to watershed municipalities regarding implementation of the Shoreline Management Plan through land use planning;
- Improve understanding of natural shoreline process and the need to proactively manage natural hazards along the Lake Huron shoreline;
- Clearly articulate the ABCA's policies regarding flooding, erosion and dynamic beach hazards as well as the Authority's position on shore protection works;
- To consider the effects of climate change on natural shoreline process in ABCA's jurisdiction;
- Provide guidance and direction to ABCA in carrying out its mandated responsibilities to address natural hazards.

The study area for the 2016 Shoreline Management Plan Update is the shoreline area stretching from Port Franks in the south to Telephone Road north of Bayfield as identified in the following Figure 1.1:



Figure 1.1: ABCA SMP Study Area

The Shoreline Management Plan provides the platform for the delivery of ABCA’s shoreline Regulations and Planning programs. The purpose of the updated Shoreline Management Plan is to identify existing and anticipated issues along the shoreline and to put forward solutions in a proactive and strategic manner to address these issues. Some of the issues and challenges facing the ABCA shoreline are discussed in more detail below.

### 1.5 New Issues and New Challenges: A Changing Shoreline

The Lake Huron shoreline within the jurisdiction of the Ausable Bayfield Conservation Authority is changing. Communities are expanding and expectations for water access and beach use are on the increase, as evidenced from the community survey results secured at the beginning of the SMP process. Heightened demand for shoreline property, new and different patterns of development including larger, more complex development applications, the conversion of cottages to larger year-round use, investment in large-scale shoreline protection works to offset beach erosion suggest that the watershed and the shoreline, in particular is changing significantly. Anthropogenic change is not the only seismic shift that is occurring on the landscape. Climate change and environmental uncertainty is resulting in atmospheric instability that in turn is affecting ice cover and changing patterns of precipitation with more intense storms and longer, more frequent periods of drought. Adapting to these new and continually emerging pressures requires a renewed sense of purpose and a commitment to ongoing shoreline management. It requires an



acknowledgement that issues are becoming increasingly complex and moreover that landowners and municipal partners will play a critical role in realizing the intent and purpose of this document. For this reason and so many others, a new way of doing business is needed. Documents as important as the Shoreline Management Plan must be developed with those most directly affected.

## 1.6 A New Way of Doing Business: Engaging Those Most Directly Affected

In preparing the updated Plan, ABCA recognized early on that community engagement and involvement from a range of stakeholders and municipalities along the shoreline would be critical to create a plan based on updated mapping and science while understanding the concerns, issues, questions of the shoreline community and importantly, considering their input in preparing an updated Plan. This engagement and buy in at the community level is critical to creating a collective sense of purpose. ABCA first retained the services of a consulting team with expertise in planning and policy, community engagement, coastal engineering, coastal geomorphology and sediment transport. The consulting team and key ABCA staff formed a Project Team that met regularly to review progress, discuss issues and develop an engagement methodology and project work plan.

Given the complexities associated with shoreline management, the diversity of issues and concerns and the range of individuals and organizations with an interest in the outcome, ABCA recognized that successful development and implementation of an updated Shoreline Management Plan would require collaboration by government, industry, community groups and individuals from the shoreline area. A decision was made early on to develop the updated Shoreline Management Plan using an engagement (rather than a consultation-based) paradigm and moreover that the principles of good governance would apply.

The Ausable Bayfield Conservation Authority created a Steering Committee to oversee the development of the updated Shoreline Management Plan and drew representation from three spheres:



ABCA recognized that the updated Shoreline Management Plan would affect landowners in particular and wanted to ensure that there was landowner representation not only at key milestone dates, but on an ongoing and integral way throughout the process. Landowners were included as part of the Steering Committee which consisted of a broad spectrum of ABCA partners including:



- Ausable Bayfield Conservation Authority
- County of Huron (1)
- County of Lambton (1)
- Shoreline Residents (2)
- The Municipality of South Huron (1)
- The Municipality of Bluewater (1)
- The Municipality of Central Huron (1)
- Ontario Ministry of Natural Resources and Forestry (1)
- St. Clair Conservation Authority (1)
- Maitland Valley Conservation Authority (1)
- Shoreline Contracting Sector (1)
- Development/Home Building Sector (1)
- Members of the Consulting Team (3)

Terms of Reference for the Steering Committee were developed (see Appendix A) and, in keeping with an engagement approach, were shared first in draft with Steering Committee members. See Appendix B for more information about the role and responsibilities of the Steering Committee.

Decisions were made by the Steering Committee that a consensus-based model of decision making would be advanced and at every Steering Committee meeting, Agendas were developed and shared as 'Suggested Agendas' allowing for additional changes to be made as required and as desired by Steering Committee members. In addition, it was determined early on that there needed to be a process to invite interested members of the public to attend any of the Steering Committee meetings and at the very first meeting, Steering Committee members agreed to set aside time at each meeting to allow members of the public to make deputations, ask questions or provide input. At the July 26, 2016 Steering Committee meeting a delegation and presentation on behalf of the residents of the Melena Heights Beach Association was made to the Steering Committee.

It was decided early on that information would be shared openly with any interested member of the public. Notice of the commencement of the Shoreline Management Plan update was provided and a portal created on the ABCA website. All scientific papers were uploaded as they became available and in addition, regularly community newsletters were developed and made available to keep residents informed of progress. Copies of the News Release and Newsletters were also provided on the web site (Please see Appendix B for several of these). It was also decided that engagement of the public should follow a multi-dimensional model and that opportunity to attend meetings in person as well as to offer input through electronic web-based platforms should be provided for. Finally, it was agreed that community meetings would be convened when information was available to be shared. It was agreed that community meetings would be held once a draft Shoreline Management Plan had been prepared and moreover that two meetings would be convened along the shoreline: one to be held close to an area of cohesive bluff shoreline and one close to an area of sand dune shoreline.

It was originally anticipated that the Shoreline Management Plan (SMP) would be updated and approved by November of 2016. The Steering Committee assessed that it is important to not rush

completion of the process so finalization of the Updating of the Shoreline Management Plan (SMP) and development of local implementation policies through a draft implementation plan was extended into late 2017. Originally, public events were proposed for 2016 but those opportunities for the public to take part have been extended and will take place in 2017.

The Steering Committee wanted to make sure that shoreline residents and other interested members of the public had enough time to review and comment upon the draft plan document. After comments are received and considered by Ausable Bayfield Conservation Authority and reviewed by the Steering Committee, the ABCA will work with municipalities and other reviewing bodies to develop local implementation policies through a draft implementation plan.

The Ausable Bayfield Conservation Authority will post the Draft Updated Shoreline Management Plan (consultants' recommendation report) to its website by September 1, 2016. Ninety days will be provided for people to offer written comments. The Public is invited to provide comments until Thursday, December 01, 2016. The document will also be posted online for comment to give people easy access and give people enough time to provide comments. A printed copy of the draft plan will also be available for review at local libraries and at the ABCA office, at 71108 Morrison Line, east of Exeter, for people who do not have convenient access to the Internet.

One of the very first initiatives to be carried out involved the development of an electronic survey to ask community members for their ideas about the issues that were top of mind from a shoreline management perspective. The input received from community members proved particularly illuminating and while there were many issues that were identified by members of the public, water quality, bluff and beach erosion, environmental degradation and threats to life were identified as high priority issues to be addressed.



Key Finding: Water quality, bluff and beach erosion, environmental degradation and threats to life are the highest priority issues for watershed residents.

**Highest Priority Issues Facing the ABCA Shoreline As Identified By  
ABCA Community Members  
Initial Community Survey (October 2015 – February 2016)**



Those who provided input identified a number of geography-specific areas of concern and also requested more information about coastal geography and shoreline dynamics. A policy on shoreline protection was requested as was a science-based approach to hazard setbacks and efforts that focus on protecting the integrity of coastal processes and minimizing impacts.

Those who responded to the survey identified a number of geographic points of reference that were top of mind. These included:

- Bayfield River
- Bayfield Shoreline
- Bayfield to Grand Bend
- Durand Huronview
- Grand Bend
- Grand Bend and north
- Grand Bend north to Port Blake
- Grand Bend to Bayfield
- Grand Bend to Port Franks
- Kingsmere beach shoreline
- Kippen Road to Road 84
- Lakewood Gardens
- Maple Grove
- Norman Heights
- Norman Heights Beach
- Oakwood Park
- Old Ausable River Channel Bed
- Pavilion Road, Bluewater - North
- Pavilion Road, Bluewater - South
- Port Blake
- Port Franks - Armstrong West and Armstrong East
- Port Franks Beach
- Port Franks Island
- Port Franks to Grand Bend
- Ridgeway Gully
- Sararas Road South
- Southcott Pines
- St. Joseph
- St. Joseph south - Sararas Road South
- Turnbull Municipal Drain
- Turnbull Municipal Drain and south
- Turnbull's Grove
- Turnbull's Road north
- Windy Hill Subdivision

There were also a number of suggestions for improving the Shoreline Management Plan including ensuring the approach to shoreline management is better understood and making

the document easier to read. Some who responded also indicated that they supported the vision that was included in the 2000 document while others spoke about the importance of ensuring the shoreline is accessible and enjoyable. Additional information can be found in Appendix B, where the Newsletter #2 (May 2016) outlines a number of the summary items from the survey. An additional News Release and Newsletter #3 will be posted in September 2016 on the Web site with an update and information regarding the release of this final consulting report for review and comments.

## 2.0 The Legislative Authority, Policy and Technical Direction for Shoreline Management Planning

The Ausable Bayfield Conservation Authority derives its authority for shoreline management planning from provincial policy and legislation. Since the ABCA Shoreline Management Plan was last updated in 2000, a number of significant legislative, policy and guideline changes have been implemented relating to shoreline hazards.

Some of the more salient changes in policy and technical direction in the last sixteen years include the following:

- The Ontario Ministry of Natural Resources (now Ontario Ministry of Natural Resources and Forestry or MNRF) released a publication in 2001 titled “*Understanding Natural Hazards*” to assist members of the public as well as planning authorities to better understand the Natural Hazard Policies that were included in the Provincial Policy Statement.
- A new Provincial Policy Statement was enacted in 2014. It replaced the PPS issued March 1, 2005 and contains a number of new policy directions that pertain directly to public access to the shoreline as well as the mitigation of existing hazards and the prevention of new hazards.
- Guidelines for Developing Schedules of Regulated Areas” was jointly issued and released by the Ministry of Natural Resources and Conservation Ontario and was prepared to assist conservation authorities during the preparation of the new Regulation Schedules. These guidelines were premised on the 2001 MNR “*Understanding Natural Hazards*” document as well as the new “*Technical Guide for Great Lakes –St. Lawrence River System.*”
- Ontario Regulation 147/06 Development, Interference with Wetlands and Alterations to Shorelines and Watercourses, approved in May 2006, specifically enables ABCA to regulate the Great Lakes shoreline up to the furthest landward extent of the aggregate of the flooding, erosion and dynamic beach hazards.

While there are a number of initiatives that are in various stages of completion<sup>1</sup>, this review has focused specifically on approved and applicable policy and legislation. These are discussed more fully in the following section.

### 2.1 The Diverse Functions of Ontario’s Conservation Authorities

Ausable Bayfield Conservation Authority, like Ontario’s 36 conservation authorities, perform a number of important functions:

**Conservation authorities are corporate bodies created by the province** at the request of two or more municipalities in partnership with the province and in accordance with the requirements of the *Conservation Authorities Act* (CAA). As watershed-based resource management agencies, each conservation authority is governed by a Board of Directors

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<sup>1</sup> There are a number of reviews that are, as of this writing, underway including a review of the Conservation Authorities Act, to name a few.

whose members are appointed by municipalities located within the conservation authority's jurisdiction in accordance with the CAA.

**Conservation authorities have delegated responsibilities from the Ontario Minister of Natural Resources** (now Ontario Ministry of Natural Resources and Forestry) with respect to representing provincial interests regarding natural hazards identified in Section 3.1 of the Provincial Policy Statement, 2005 (PPS, 2014). These delegated responsibilities require CAs to review and provide comments on:

- Policy documents (Official Plans and Comprehensive Zoning By-laws) and
- Applications submitted under the Planning Act as part of the Provincial One-Window Plan Review Service.

**Conservation authorities as 'public bodies' pursuant to the *Planning Act***, are notified of policy documents and planning and development applications as prescribed under the Act. CAs may comment as per their mandate to the municipality/planning approval authority on these documents and applications.

**Conservation authorities may perform a technical advisory role to municipalities**, as determined under the terms of a service agreement with participating municipalities which may include, but is not limited to, matters related to the assessment or analysis of environmental impacts, watershed science and technical expertise associated with activities near or in the vicinity of: sensitive features such as wetlands, river and stream valleys, fish habitat or significant woodlands; hydrogeology and storm water studies; and, in some cases, septic system reviews.

**Individual conservation authorities may enter into agreements** with provincial and federal ministries and with municipalities to undertake specific regulatory/approval responsibilities (e.g. Fisheries Act Section 35; septic tank approvals under the Ontario Building Code.)

**Conservation authorities are landowners**, as outlined in the Conservation Ontario (CO)/Ontario Ministry of Natural Resources and Forestry (MNRF)/Ontario Ministry of Municipal Affairs and Housing (MMAH) Delegated Responsibilities MOU and as such, may become involved in the planning and development process, either as adjacent landowner or as a proponent/applicant.

In general, Conservation Authorities in Ontario derive their authority from legislation. This legislative authority offers important context for understanding the role of the conservation authority in managing the watershed in general, but in managing shoreline hazards and lakeshore areas generally. This legislative authority is described in detail below.

## 2.2 Legislative Authority

### 2.2.1 The Conservation Authorities Act

The *Conservation Authorities Act* (CAA) assigns a broad set of responsibilities to all Conservation Authorities across Ontario. Originally passed in 1946, the Act (Section 20) requires all conservation authorities to design a program(s) to further the conservation,

restoration and management of natural resources that fall within a specific conservation authority jurisdiction. It defines the objects of a Conservation Authority as follows:

*Section 20: The objects of an authority are to establish and undertake, in the areas over which it has jurisdiction, a program designed to further the conservation, restoration, development and management of natural resources other than gas, oil, coal and minerals.*

The Act provides further direction as to how the objects of a CA are to be achieved, as outlined in Section 21 of the Act:

*Section 21: For the purposes of accomplishing its objects, an authority has power*

*(a) To study and investigate the watershed and to determine a program whereby the natural resources of the watershed may be conserved, restored, developed and managed.<sup>2</sup>*

In addition, the Act bestows regulatory responsibilities on conservation authorities under Section 28 of the Act:

*Section 28:*

*(1) Subject to the approval of the Minister, an authority may make regulations applicable in the area under its jurisdiction,*

- a. Restricting and regulating the use of water in or from rivers, streams, inland lakes, ponds, wetlands and natural or artificially constructed depressions in rivers or streams;*
- b. Prohibiting, regulating or requiring the permission of the authority for straightening, changing, diverting or interfering in any way with the existing channel of a river, creek, stream or watercourse, or for changing or interfering in any way with a wetland;*
- c. Prohibiting or regulating or requiring the permission of the Authority for development if, in the opinion of the Authority, the control of flooding, erosion, dynamic beaches or pollution or the conservation of land may be affected by development.*
- d. Providing for the appointment of officers to enforce any regulation made under this section or Section 29;*
- e. Providing for the appointment of persons to act as officers with all the powers and duties of officers to enforce any regulation made under this section.*

Under Section 28, conservation authorities across Ontario are empowered to prepare Regulations, commonly referred to as the “Regulation of Development, Interference with

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<sup>2</sup> Under Section 21, CAs may also purchase, acquire or dispose of personal property; use lands that are owned or controlled by the authority for purposes that are in keeping with its objects and as it considers proper; use lands owned or controlled by the authority for park or other purposes and erect or permit to be erected, buildings, booths and facilities; charge fees for services approved by the Minister; collaborate and enter into agreements with ministries and agencies of government, municipal councils, local boards and other organizations.

Wetlands, and Alterations to Shorelines and Watercourses” (Generic or Content Regulation).<sup>3</sup>

Significant changes were made to Section 28 when the CAA was amended as part of the Red Tape Reduction Act in 1998 and as a result, Regulations passed under the Act were consistent across the province and in alignment with provincial policy. Ontario Regulation 97/04 was passed under the CAA and outlines the requirements and the content for a regulation pertaining to hazardous lands (updated in 2011) for each individual conservation authority. For the coastlines of the Great Lakes, the limit of hazardous lands is defined as the furthest landward extent of the following:

- **Coastal Flooding:** the 100 year flood level plus an allowance determined by the Authority for wave uprush and other water related hazards.
- **Erosion:** The predicted long-term stable slope measured from the existing toe of slope or from the predicted location of the toe of slope as the location may have shifted as a result of shoreline erosion over a 100 year period.
- **Dynamic Beach:** An allowance to accommodate dynamic beach movements over time, as determined by the Authority.
- **Other Areas:** An additional allowance determined by the Authority, not to exceed 15 m, can be added to the flooding, erosion and dynamic beach regulations.

Additional technical information for establishing the boundaries of hazardous lands adjacent to the coastline of the Great Lakes are provided by Conservation Ontario and MNRF (2005) in a document entitled Guidelines for Developing Schedules of Regulated Areas. Additional technical information used to define hazardous lands and supplement the information in Ontario Regulation 97/04 is provided, including the following details relevant to this SMP:

- **Coastal Flooding:** In the absence of detailed technical information, the wave uprush limit is 15 metres (m) measured horizontally from the 100 year flood level;
- **Erosion:** The 100-year erosion allowance must be determined with a minimum of 35 years of data and in the absence of detailed site-specific data, the stable slope angle is 3:1 (H:V);
- **Dynamic Beach:** In the absence of detailed technical information, a dynamic beach is the sum of the 100-year flood level, 15 metres (m) wave uprush limit and an additional 30 m allowance for the dynamic nature of beach movements.

Every conservation authority has generic regulations as mandated by Ontario Regulation 97/04. These generic regulations are subject to the approval of the Ontario Minister of Natural Resources and Forestry, and enable conservation authorities to make regulations prohibiting, regulating, or requiring proponents to secure permission from the Authority for development that in the opinion of the Authority could affect flooding, erosion, dynamic beaches, pollution or the conservation of land. Across Ontario, each conservation authority has developed individual regulations that govern certain activities in and adjacent to watercourses (including valley lands), wetlands, shorelines or inland lakes and the Great Lakes-St. Lawrence River System and other hazardous lands.

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Ausable Bayfield Conservation Authority administers Regulation 147/06.

#### 2.2.1.1 Ontario Regulation 147/06

ABCA has administered the Fill, Construction and Alteration to Watercourse Regulation since 1984, which controlled:

- a. Placing of fill and grading,
- b. Construction of buildings and structures, and
- c. Alteration of watercourses.

On May 1, 2004, the *Regulation of "Development, Interference with Wetlands and Alterations to Shorelines and Watercourses"* (Ontario Regulation 97/04) was approved by the Province under Subsection 28(1) of the *Conservation Authorities Act*. This regulation, referred to as the Generic Regulation, stipulates the criteria by which each conservation authority must establish its updated regulated area or '*Regulation Limit*'.

ABCA and the Province of Ontario enacted Ontario Regulation 147/06 in May 2006 which gave the Authority the ability to regulate:

- a. River and stream systems affected by *erosion hazards*;
- b. Shorelines (up to the furthest landward extent of the aggregate of the *flooding*,
- c. *Erosion and dynamic beach hazards* plus an allowance of up to 15 metres), and;
- d. Lands adjacent to:
  - i) wetlands (up to 120 metres)
  - ii) valleys (up to 15 metres from stable top of bank)
  - iii) flood plains (up to 15 metres beyond the flooding hazard limit)

Ontario Regulation 147/06 has been reviewed to inform the content of this updated Shoreline Management Plan. An excerpt from OR 147/06 including the provisions that apply to shoreline has been included below:

**Excerpt from: The Ausable Bayfield Conservation Authority's regulation is the '*Regulation for Development, Interference with Wetlands and Alterations to Shorelines and Watercourses*' (Ontario Regulation 147/06)**  
**(An Excerpt From OR 147/06 pertaining to the shoreline)**

*Section 2 of this regulation states:*

**2. (1)** *Subject to section 3, no person shall undertake development, or permit another person to undertake development in or on the areas within the jurisdiction of the Authority that are:*

- a) *adjacent or close to the shoreline of the Great Lakes-St. Lawrence River System or to inland lakes that may be affected by flooding, erosion or dynamic beach hazards, including the area from the furthest offshore extent of the Authority's boundary to the furthest landward extent of the aggregate of the following distances:*
  - i. *the 100 year flood level, plus a 15-metre allowance for wave uprush and other water-related hazards;*

- ii. *the predicted long term stable slope projected from the existing stable toe of the slope or from the predicted location of the toe of the slope as that location may have shifted as a result of shoreline erosion over a 100-year period;*
  - iii. *where a dynamic beach is associated with the waterfront lands, a 30-metre allowance inland to accommodate dynamic beach movement, and;*
  - iv. *the lesser of an allowance of 15 metres inland or the landward extent of Lakeshore Area 2 as defined in the most recent document entitled “Ausable Bayfield Conservation Authority Shoreline Management Plan” available at the head office of the Authority;*
- c) *hazardous lands;*
- d) *wetlands; or*
- e) *other areas where development could interfere with the hydrologic function of a wetland, including areas within 120 metres of all provincially significant wetlands, and areas within 30 metres of all other wetlands. O. Reg. 147/06, s.2 (1); O.Reg. 49/13, s.1(1-3).*

*Section 3 of the Regulation allows the ABCA to grant permission in or on the areas described in Section 2 if, in its opinion, the control of flooding, erosion, dynamic beaches, pollution or the conservation of land will not be affected by the development. The permission of the Authority shall be given in writing, with or without conditions.*

*Section 6 of the Regulation allows the ABCA to grant permission to straighten, change, divert or interfere with the existing channel of a river, creek, stream or watercourse or to change or interfere with a wetland. The permission of the Authority shall be given in writing, with or without conditions.*

#### *Flood event standards*

*11. The applicable flood event standards used to determine the maximum susceptibility to flooding of lands or areas within the watersheds in the area of jurisdiction of the Authority are the Hurricane Hazel Flood Event Standard, the 100 year Flood Event Standard and the 100 year flood level plus wave uprush, described in Schedule 1. O. Reg. 147/06, s. 11.*

### 2.2.2 The Planning Act

Section 3(1) of the *Planning Act* provides for the issuance of policy statements on matters relating to municipal planning that are of provincial interest (e.g. PPS, 2014). Through the Minister of Natural Resources’ delegation letter and accompanying Memorandum of Understanding (MOU), specific responsibilities have been delegated to conservation authorities to ensure that development application decisions made pursuant to The *Planning Act* are consistent with the natural hazard policies of the Provincial Policy Statement, 2014. More information about the Ontario Provincial Policy Statement, 2014 is provided in the section that follows.

The Memorandum of Understanding (MOU) with the Ontario Ministry of Municipal Affairs and Housing (MMAH) and the Ministry of Natural Resources and Forestry (MNRF) clarifies the role of conservation authorities under the One Window Planning System. Conservation

authorities were delegated natural hazard responsibilities by the Minister of Natural Resources in April 1995. Natural hazards include:

- Floodplain management;
- Hazardous slopes;
- Great Lakes shorelines; and
- Unstable soils and erosion.

In keeping with Section 3(5) of the *Planning Act*, decisions of Municipal Council, Local Boards, Planning Board, Ministers of the Crown, Agencies, Boards and Commissions “shall be consistent with” provincial policy statements in effect and further, that decisions conform to established provincial plans (e.g. Greenbelt Plan, Growth Plan for the Greater Golden Horseshoe, Oak Ridges Moraine Conservation Plan, etc.) Section 26 of the *Planning Act* requires municipalities to review Official Plans every five years to ensure that Municipal Official Plans conform to provincial plans and reflect established provincial policy and are consistent with provincial policy statements issued under Section 3(1).

## 2.3 Other Legislation

In addition to the *Conservation Authorities Act* and the *Planning Act*, conservation authorities may have additional responsibilities under other pieces of legislation that may impact decisions affecting shoreline management. In addition, there may be other authorizations, permits or approvals that may be required from other agencies. Proponents who are considering undertaking any works along the shoreline are encouraged to contact the ABCA and the municipality involved to determine what additional legislative provisions, permissions and approvals may be required.

## 2.4 Policy Direction

### 2.4.1 Ontario Provincial Policy Statement (MMAH, 2014)

Released in 2014, the new Provincial Policy Statement<sup>4</sup> (PPS) issued under section 3 of the *Planning Act* articulates the government’s policies on land use planning. The 2014 PPS applies province wide and introduced an important change in policy direction with profound emphasis on building strong healthy communities, promoting the wise use and management of resources and protecting public health and safety. For the first time, extensive reference is made to the notion of efficient development patterns and land use (e.g. smart growth) and the need to consider climate change impacts and promote resilient communities. The PPS contains a number of important references that pertain directly to shoreline management. Some of the more pertinent references include:

- Avoiding development and land use patterns which may cause environmental or public health and safety concerns (1.1.1–d);
- Promoting cost-effective development patterns and standards to minimize land consumption and servicing costs (1.1.1–e);
- Providing public access to shorelines (1.5.1-c);

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<sup>4</sup> The 2014 Provincial Policy Statement replaced the Provincial Policy Statement, 2005.

- Recognizing provincial parks, conservation reserves, and other protected areas, and minimizing negative impacts on these areas (1.5.1–d);
- Natural features and areas shall be protected for the long term (2.1.1);
- Development and site alteration shall not be permitted in...significant coastal wetlands (2.1.4);
- Planning authorities shall protect, improve or restore the quality and quantity of water by...using the watershed as the ecologically meaningful scale for integrated and long-term planning, which can be a foundation for considering cumulative impacts of development (2.2.1);

The importance of protecting Ontario residents and communities from coastal hazards is outlined in detail in Section 3.0 of the 2014 PPS, which states *inter alia*:

- Development shall generally be directed to areas outside of hazardous areas adjacent to the shorelines of the Great Lakes – St. Lawrence River System and large inland lakes which are impacted by flooding hazards, erosion hazards and/or dynamic beach hazards (3.1.1-a);
- Development and site alteration shall not be permitted within...the dynamic beach hazard (3.1.2-a);
- Planning authorities shall consider the potential impacts of climate change that may increase the risk associated with natural hazards (3.1.3);

The Provincial Policy Statement provides a critical foundation as it articulates Cabinet approved policy and requires that. The Shoreline Management Plan must reflect the direction provided in the PPS.

#### 2.4.3 Huron and Lambton County Official Plans

Both the Huron County and Lambton County Official Plans recognize the importance of planning for and with the natural environment.

##### Lambton County Official Plan

While the County of Lambton OP is currently in development, the draft OP contains strong policy direction that supports the principles of prevention, protection and education. Excerpts from the Draft OP follow:

#### **County of Lambton Draft Official Plan – Policy Except**

##### 8.7 Environmental Constraints

Goal: To prevent property damage and potential loss of life by preventing new development from encroaching into areas subject to Environmental Constraints including areas prone to flooding, dynamic beaches, erosion, unstable lands and groundwater recharge areas.

Policies:

8.7.1 New development will generally be directed away from areas with known or suspected Environmental Constraints. Environmental Constraints include:

- a) Flooding, erosion, and dynamic beach hazards related to the Great Lakes System;

- b) Flooding and erosion hazards related to rivers and streams;
- c) Hazardous sites related to marine clay soils, organic soils; and,
- d) High water table areas and groundwater recharge areas.

8.7.2 The County will assist local municipalities to develop policies that will not allow development and site alteration within:

- a) The dynamic beach hazard;

8.7.3 Local municipalities will develop policies that address existing development on Environmental Constraint lands and provide options to address the issues of building repair and maintenance, minor building additions and interior alterations, and the maintenance and repair of appropriate shore protection. It is not the intent of the County Official Plan to unduly restrict these activities where environmental constraints have been identified.

8.7.4 The County will assist local municipalities to develop policies that ensure that development and site alteration can occur in Environmental Constraint lands and associated sites if all the following can be achieved:

- a) all policies are met with respect to any coincidental natural heritage features;
- b) hazards can be safely addressed and development and site alteration is carried out in accordance with floodproofing, protection, and access standards and procedures such as those related to coastal and geotechnical engineering practices;
- c) new hazards are not created and existing hazards are not aggravated;
- d) no adverse environmental impacts will result;
- e) vehicle and pedestrian access is available during times of flooding, erosion, and other emergencies (unless the site access is appropriate for the nature of development); and
- f) the proposed use is not an institutional use, essential emergency services, or operations related to the disposal, manufacture, treatment or storage of hazardous substances.

8.7.5 Where detailed information regarding known environmental constraints or their extent is not available, the onus will be on the proponent to provide suitable documentation to satisfy the conditions of development or site alteration in Environmental Constraint lands.

8.7.6 Local municipalities will prepare appropriate zoning provisions for Environmental Constraint Areas that:

- a) prohibit uses other than agriculture, conservation, forestry and wildlife management;
- b) prohibit buildings or structures except where they are intended for flood or erosion control or are normally associated with protection works, bank stabilization projects or electric power structures; and,
- c) impose development setbacks in relation to the severity of existing and potential environmental hazards.

8.7.7 For development fronting on the Great Lakes System shorelines, the Conservation Authorities are encouraged to implement regulations under the Conservation Authorities Act and require development setbacks that are based on the type and scale of development proposed and adequate to address flooding, dynamic beach, unstable lands, and erosion concerns.

8.7.8 For development fronting on the Great Lakes System shorelines, local municipalities are encouraged to establish policies and regulations that consider proximity to and severity of a hazard as outlined in the applicable Conservation Authority's Shoreline Management Plan.

In particular, local municipalities will address the types and scale of development permitted within the hazard limit. Within existing residential areas municipalities will develop policies for addressing development on vacant lots, renovation and replacement of existing dwellings, accessory uses, and lot creation.

8.7.9 The County encourages the implementation of regulations under the Conservation Authorities Act with respect to development, interference with wetlands and alterations to shorelines and watercourses by the Conservation Authorities.

8.7.10 The Conservation Authorities are encouraged to improve the quality of data with which hazard lines are delineated. Especially in areas where flood lines are based on coarse elevation data, when the Conservation Authorities assess development from a hazard perspective, they are encouraged to assess development using a flexible and streamlined process.

8.7.11 Development will be directed to locate out of flood plains defined by the Regional Storm event (a one zone management approach). If this is not desirable, Provincial policy allows development between the 1:100 year flood line and the Regional Storm line provided adequate floodproofing measures are incorporated and the approval of the Conservation Authority is obtained (a two zone management approach). If neither approach is feasible and the economic well-being of the community is threatened, Provincial Policy allows for the development of Special Policy Areas in consultation with the applicable Conservation Authority.

8.7.12 New development will be required to locate outside of areas of long-term erosion and instability unless the nature of the problem has been recognized, remediation techniques employed, and the hazard addressed. The proponent is responsible for the completion of such investigations.

8.7.13 The standard that will be used to identify areas subject to long-term erosion is based on 100 year erosion criteria plus an allowance for slope stability and an allowance to allow machinery access to the site.

8.7.14 The County may participate with other agencies in identifying possible locations along the lakeshore and river fronts where visual and physical access can be established for public enjoyment.

8.7.15 Development setbacks are encouraged as the preferred method for protecting new development in Environmental Constraint Areas as opposed to relying on structural or non-structural protection measures that require maintenance and upgrading over time. 8.7.16 Implementation of the Environmental Constraint policies of this Plan shall take into

consideration the variability of weather and climate in the short and long-term and the possibility of their ranging outside of recorded norms.

### **Huron County Official Plan**

The Huron County OP recognizes the important commitment that exists at the community level to protect and enhance natural landscapes and the importance of improving water quality and sustaining natural and biological resources.

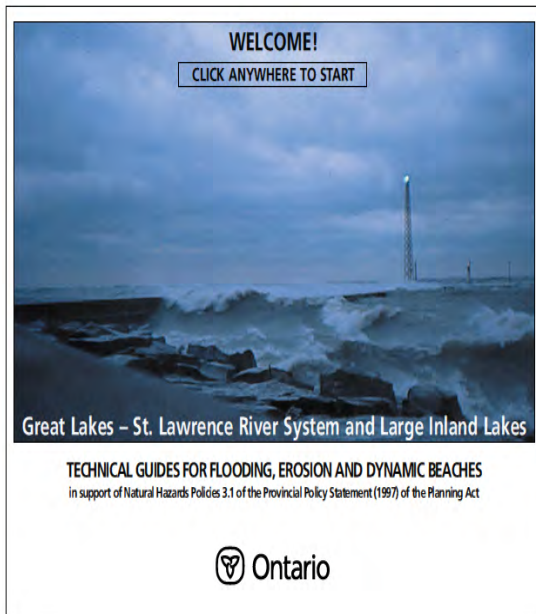
## **7.2 Protect and Enhance Lake Huron and Lakeshore**

Lake Huron and its shoreline are important because of the recreational, residential, ecological and tourism services they provide. The goal of the community is to protect, enhance and restore the quality of the lake and shoreline and public access to Lake Huron. Development can place considerable stress on the lakeshore environment. This stress requires that future development consider existing development and demonstrate environmental sensitivity. All existing and proposed development is encouraged to minimize negative impacts and improve the natural condition of Lake Huron and its shoreline through stewardship and community partnerships. Environmentally Sensitive Development The goal of the community is to ensure that all development and the servicing of rural and urban areas is based on principles of environmental sustainability and the protection of the environment.

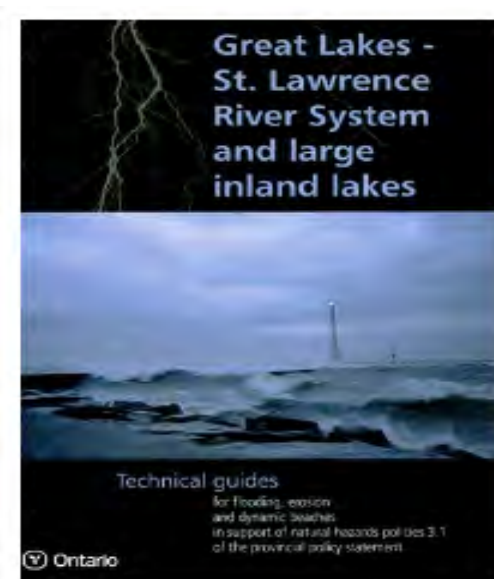
### **7.3.5 Lakeshore Residential Area**

- 1) The Lakeshore Residential Area includes a mixture of seasonal and year-round residential communities that are valued because of the proximity to Lake Huron, the quality of existing development, and the quality recreational experience. Development in this area must respect these attributes, demonstrate environmental sensitivity, and develop subject to the provision of adequate services in accordance with local Official Plans.
- 2) Development in Lakeshore Residential Areas will be limited to residential uses.
- 3) Lakeshore Residential Area development adjacent to existing fully or partially serviced Settlement Areas will be contiguous and connected to municipal water and/or sewer services.
- 4) Expansion of the Lakeshore Residential Area shall only be considered subject to a supportive comprehensive review in accordance with policy 7.3.3.2, and in accordance with the Agricultural (Section 2), Natural Environment (Section 6), Cultural Heritage (Section 3.3.4), and Servicing (Section 7.3.4) policies of this Plan. (Minister's Modification 38)
- 5) Public access to the Lake Huron shoreline will be preserved and will be required for new developments.

## 2.5 Technical Guidance & Direction



The technical basis and approach for defining and applying the hazard limits for flooding, erosion and dynamic beaches as noted earlier is provided by the *Technical Guide for Flooding, Erosion and Dynamic Beaches, Great Lakes – St. Lawrence River System and Large Inland Lakes (MNR, 2001)*. The approach, as outlined in the Technical Guide has, with some modifications over time, been incorporated and reflected in subsequent documents including Ontario Regulation 94/07 (“Generic Regulation”), Guidelines for Developing Schedules of Regulated Areas (MNR/CO, 2005) and Guidelines to Support Conservation Authority Administration of the ‘Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation (MNR/CO, 2008). These methodologies have been applied in this study and are described more fully below.



Additional information and direction is also contained in the following Technical Guidelines that offer more detailed engineering, geotechnical and scientific principles, practices and procedures for addressing the identification and management of flooding, erosion and dynamic beach hazards:

- ❖ Technical Guide for Great Lakes – St. Lawrence River Shorelines, Flooding, Erosion and Dynamic Beaches
- ❖ Technical Guide for Large Inland Lakes Shorelines
- ❖ Technical Guide for Hazardous Sites
- ❖ Stable Slopes – Geotechnical Principles
- ❖ Wave Uprush and Overtopping
- ❖ Beach and Dune Management Guide

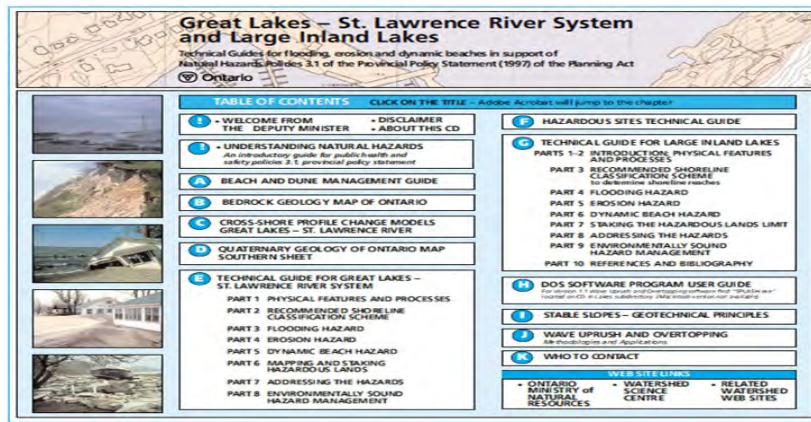




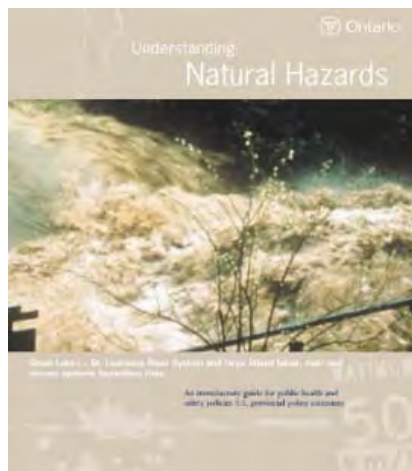
## Want More Information?

For those who may be interested, the Natural Hazards Technical Guides are available on a Compact Disc (CD's), for the Great Lakes – St. Lawrence River System and Large Inland Lakes. The Hazardous Sites Technical Guide is also contained on the CD.

The “Great Lakes - St. Lawrence River System and Large Inland Lakes, River and Stream Systems Hazardous Sites” CD can be purchased on line at the following Trent University Publications web site: <http://www.trentu.ca/iws/bookstore.php>. The cost for the CD-ROM is \$40.00 CAD (plus \$7.50 S&H PST and GST).



A copy of the shoreline sections of the ‘Understanding Natural Hazards’ (2001) has also been provided on the CD, however a free download of the entire document is also available on the MNRF Publications website at the following web link: [http://www.trentu.ca/iws/documents/GLSLRS\\_UnderstandingNaturalHazard\\_Intro.pdf](http://www.trentu.ca/iws/documents/GLSLRS_UnderstandingNaturalHazard_Intro.pdf)



The legislative and policy framework as well as technical guidance and direction governing shoreline management in Ontario provides a critical backdrop for establishing the vision, goals, objectives and governing principles of the updated Shoreline Management Plan.

### 3.0 A New Vision, Goals, Objectives and Principles

In developing this updated Shoreline Management Plan, ABCA is guided by Cabinet approved provincial policy and objectives, notably to minimize risks to life, property damage and social disruption and to encourage an integrated approach to shoreline management.

The Ausable Bayfield Conservation Authority, in following this Shoreline Management Plan will be guided by the following Vision Statement:

#### *Vision Statement for the ABCA Shoreline*

**A safe, enjoyable,  
responsibly  
managed,  
environmentally  
sound and resilient  
shoreline.**

**Responsible  
Management  
...**

**Clear  
Consistent  
Predictable**

#### ABCA Operating Philosophy

**No new hazards are  
created**

**Existing hazards are  
not aggravated**

**No adverse  
environmental  
impacts will result**

#### **A safe, enjoyable, responsibly managed, environmentally sound and resilient shoreline.**

To realize this vision, ABCA will be guided by the need to manage the shoreline responsibly. **Responsible Management** means:

- Providing **clear policy direction** to those who are most directly affected as well as to those who will be responsible for implementation;
- Working collaboratively with landowners and municipal partners
- Interpreting and applying policies in a **clear, consistent and predictable** manner across the entire ABCA shoreline; and
- Working in collaboration with municipal watershed partners and landowners to ensure that the risks associated with natural hazards are reduced over time.

In promoting responsible management of the shoreline, ABCA will be guided in all of its actions to ensure that:

- **No new hazards are created;**
- **Existing hazards are not aggravated;**
- **No adverse environmental impacts result.**

These three requirements are mandated by the province and all of the policies in this Shoreline Management Plan are premised on the need to ensure that these three conditions are met.

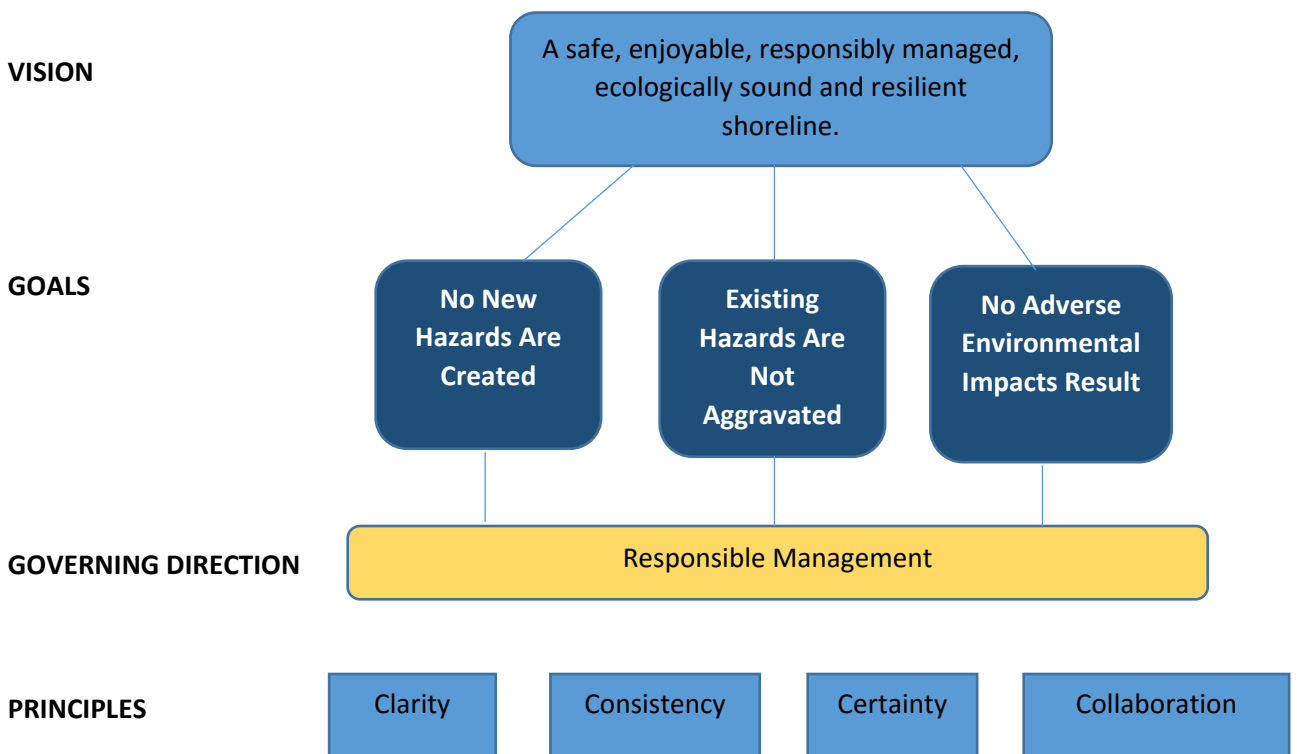
In carrying out its mandated responsibilities, ABCA will focus on achieving the following key objectives:

- Minimizing the potential for loss of life or property damage along the shoreline.
- Directing development away from natural shoreline hazards.
- Enhancing awareness by members of the public of the natural hazards associated with the Lake Huron shoreline.
- Minimizing public expenditures resulting from damage and emergency operations associated with flooding, erosion and dynamic beach hazards.

ABCA is committed to ensuring that human life and property is protected to the extent possible from the negative impacts of naturally occurring physical processes along the shoreline and further that public access to the shoreline for recreational purposes is encouraged and supported. ABCA has developed its position on shoreline protection works based on science-based evidence and moving forward will be diligent in taking the position that non-structural protection is preferable to structure protection measures.

## Ausable Bayfield Conservation Authority

### Shoreline Management Plan 2016 Vision, Goals & Guiding Principle



## 4.0 Shoreline Description

### 4.1 Coastal Processes and ABCA Shoreline Description

The Ausable-Bayfield Conservation Authority has jurisdiction over the 60 km length of shoreline extending southward from Sideroad 30 in Goderich Township to Port Franks (see Figure 1.1). Within this, Pinery Provincial Park and the former Ipperwash Provincial Park and the former Camp Ipperwash are not included in the jurisdiction of the ABCA. The shoreline lies entirely within a littoral cell that extends southward from the artificial headlands provided by the harbour jetties at Goderich to Kettle Point.

The littoral cell can be divided into a northern section characterized by bluffs up to 18 metres high formed in cohesive till which are fronted by narrow beaches of mixed sand and gravel; and a section extending southward from about Country Road #83 which is characterized by sandy beach and dune systems and bluffs are either landward of the dunes or disappear altogether near Grand Bend (See Figure 4.4).. The northern part is largely erosional and supplies sediment to the southern part which is an area dominated by net deposition. A detailed report covering coastal processes, sediment supply and longshore sediment transport, as well as reach descriptions can be found in a report on the Lake Huron shoreline prepared by Reinders and Associates (1989) and some of this material is summarized in Section 3.2 of the ABCA Shoreline Management Plan, 2nd Edition, 2000. The information provided in that document is still largely current and relevant, and only a brief overview is provided here.

Bedrock near the shoreline is overlain by two glacial tills deposited by ice moving generally eastward out of the Lake Huron Basin towards the end of the last (Wisconsinan) glaciation on the order of 25-15 000 years ago. The Rannoch till, which overlies bedrock, is likely close to the surface along the shoreline in a few places (Figure 4.1). It is relatively stony and thus when exposed can form a rocky cover that is resistant to erosion by waves. It is possible that the two small promontories of Rocky Point and Dewey Point south of Bayfield (Figure 4.2) occur because of an outcrop of the Rannoch Till in the nearshore. The St. Joseph till forms the bluffs along the shoreline as well as outcropping in the nearshore out to water depths exceeding 6 m. It has a composition of about 86% silt and clay, with the remainder being sand, gravel and cobbles. It is relatively hard and strong because it was over consolidated by the weight of the ice during deposition and while the stone content is less than the Rannoch Till it can still lead to the formation of a lag cover of cobbles in places in the nearshore. Near Grand Bend the accumulation of sand buries the till in the nearshore and the shoreline becomes dominated by sandy beaches and dunes with modern dunes near the lake and older dunes related to post glacial lake levels behind them (Figure 4.2). Because of losses of sand inland over the dunes and offshore into deeper water the stability of the shoreline in this area depends on a continuing supply of sand from nearshore bluff and gully erosion in the northern section.

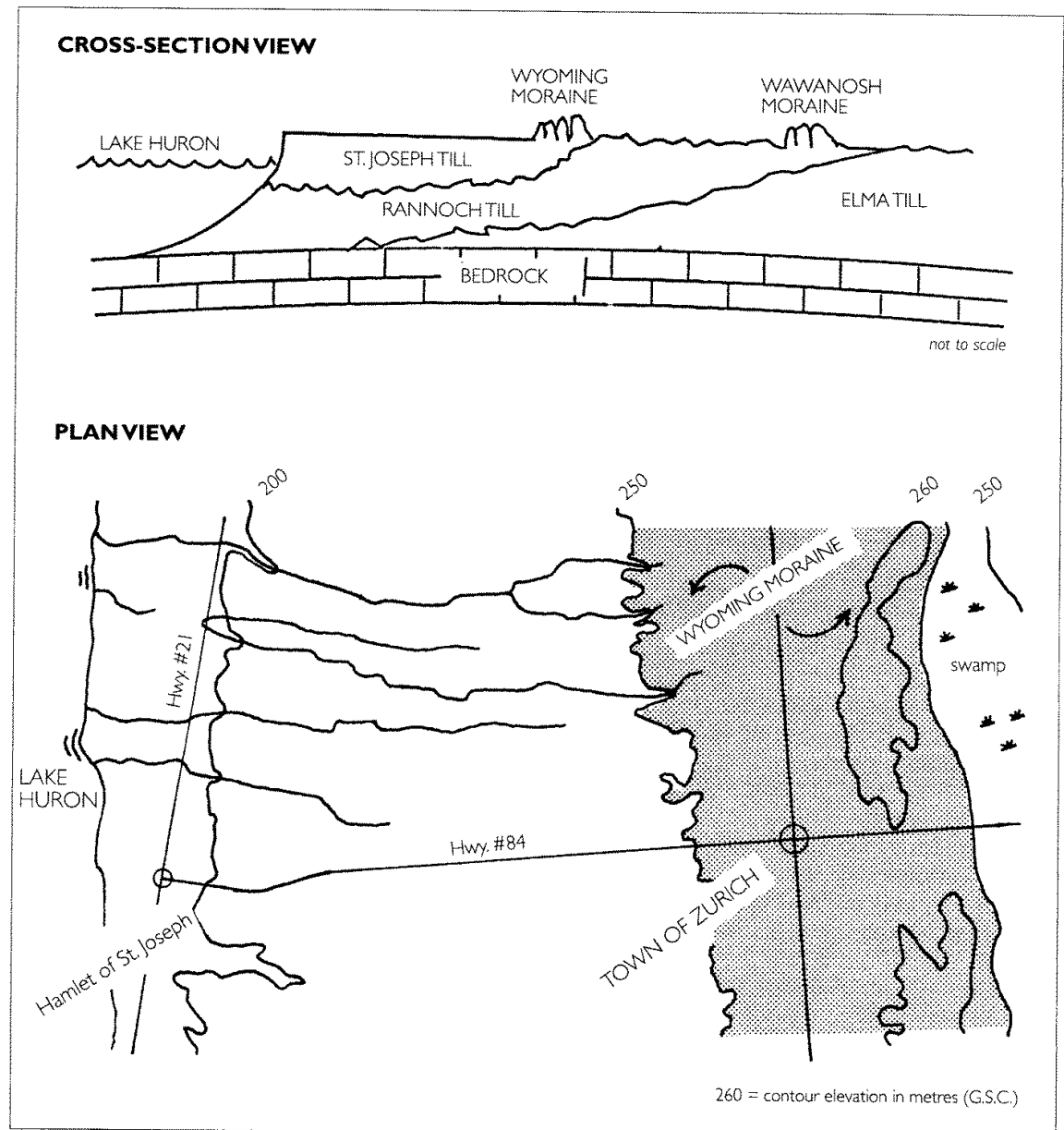


Figure 4.1: Cross-section and plan views of the glacial tills and their relation to bedrock in the ABCA area (from Reinders, 1989).

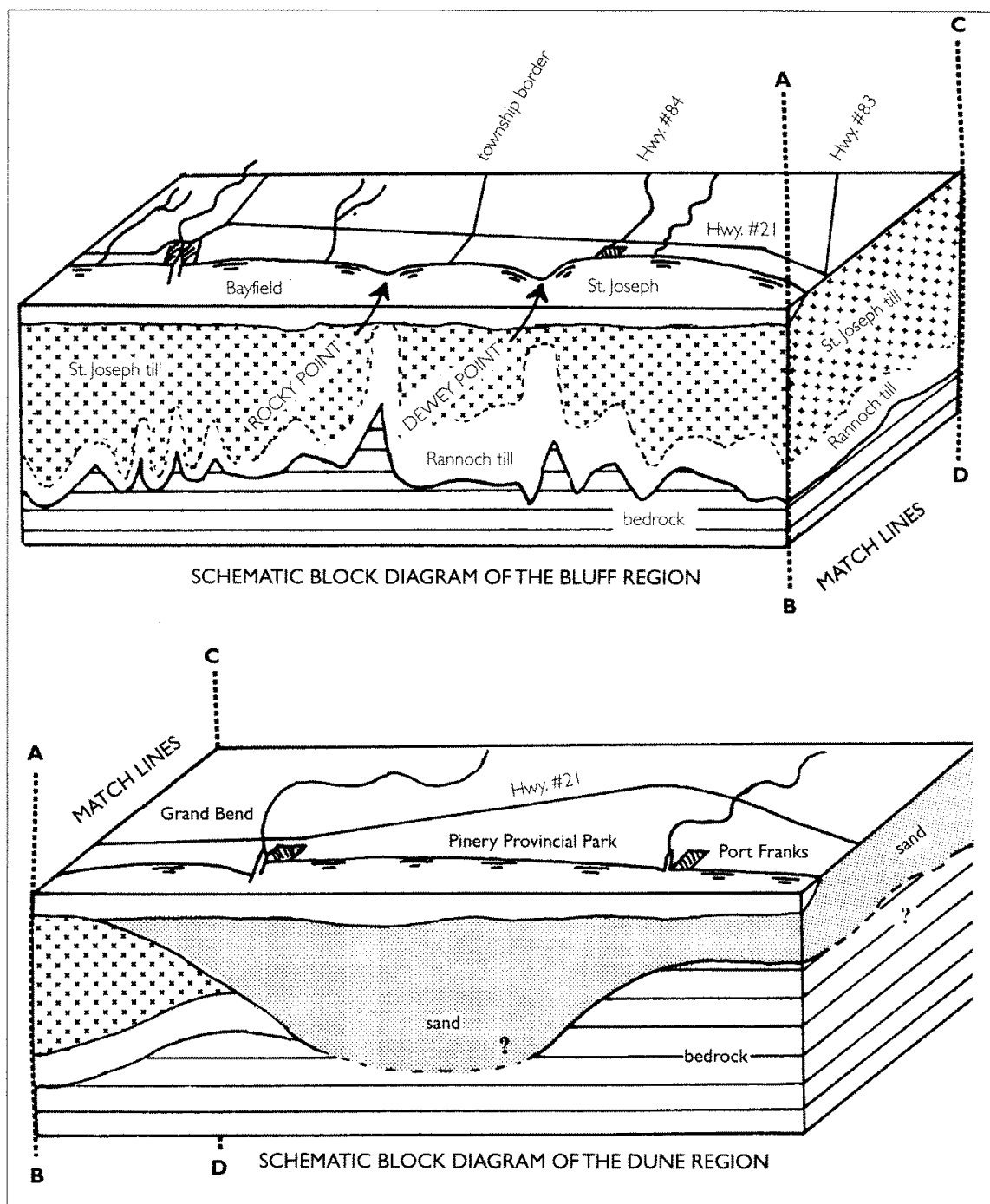


Figure 4.2: Schematic block diagrams of the northern cohesive bluff shoreline and southern sandy beach and dune shoreline within the ABCA jurisdiction (from Reinders, 1989)



Erosion of the glacial till bluffs in the northern section is initiated by wave action at the toe of the bluffs which undercuts and thus steepens the bluff slope. Toe erosion occurs primarily during storm events which is accompanied by large waves and by storm surge – an increase in the lake level near the

beach as a result of onshore winds and wave breaking. Erosion is facilitated by weathering of the till by freeze-thaw action in the winter as well as wetting and drying which reduces the resistance of the till to wave forces. It is also enhanced by abrasion by sand and gravel picked up by the waves. Toe erosion occurs primarily during periods of high lake level in areas where the recession rate is low to moderate, but may occur most years in areas where the beach is very narrow due to high bluff recession rates. Erosion of the till also occurs underwater due to wave action and it is now understood that continuing underwater erosion controls how much wave energy reaches the bluff toe and thus ultimately determines the rate of bluff recession (see Appendix for more information).



Bluff slopes recede because of the initiation of shallow slumps and slides, especially during snowmelt in the spring or during heavy rainfall events. Heavy rains also erode the slope through the flow of water down the slope and the development of rills and shallow gulleys. The effects of rainfall are greatly reduced by the presence of a continuous vegetation cover which shelters the soil from raindrop impact and helps to slow the flow of water down the slope. Gulleys develop in places along the bluff coast because of erosion by small streams flowing down the steep bluff slope. Over time the gulleys extend inland producing unstable slopes on either side and bluff erosion is enhanced at the mouth of the gully where it reaches the coast.



Sediment is supplied to the coast from erosion of the bluffs, underwater erosion and by rivers and streams. Fine material (silt and clay) is maintained in suspension by wave action and eventually settles out in deep water. In general sediments on the beach and in the shallow nearshore are greater than about 0.1 millimetres (mm) in diameter – sand size and larger. **Because about 85% of the sediments in the St. Joseph Till are finer than this only 15% of the eroded material actually contributes to beach sediments.** Whenever waves approach the coast at an angle sediments on the beach and in the nearshore are transported alongshore in the direction that the waves are traveling. On the ABCA coasts therefore sediment is transported either northward or southward. Along the Lake Huron shoreline south of Kincardine, including the ABCA shoreline, the net direction of sand transport is to the south, reflecting the much larger waves from the N and NW produced by the long fetch distance over which wind waves are generated and by the greater intensity of storms from this direction. Northerly transport occurs on days with winds from the S and SW, but winds from these directions are less frequent, and the waves they generate are much smaller because of the short fetch in this direction and lower wind speeds. The wave climate for the ABCA shoreline was hindcast from historical wind data as part of a study for the Ontario Ministry of Natural Resources by Philpot Associates (1988). Recently the US Army Corps of Engineers (2013) has produced a Wave Information Study in which hourly wind data is used to model wave height and direction over the period 1980 -2013 along all the US coasts, including the US and Canadian shorelines of the Great Lakes. Information from points (stations) can be downloaded from <http://wis.usace.army.mil/>. Average annual values for wind speed and direction, and for significant wave height and direction for a point offshore and to the north of Grand Bend are shown in Figure 4.3. They illustrate that while winds from the SW are important, waves from the northwest and north-northwest are dominant in terms of height and frequency of occurrence with modal wave height and period greater than 3 m and seconds respectively during intense storms.



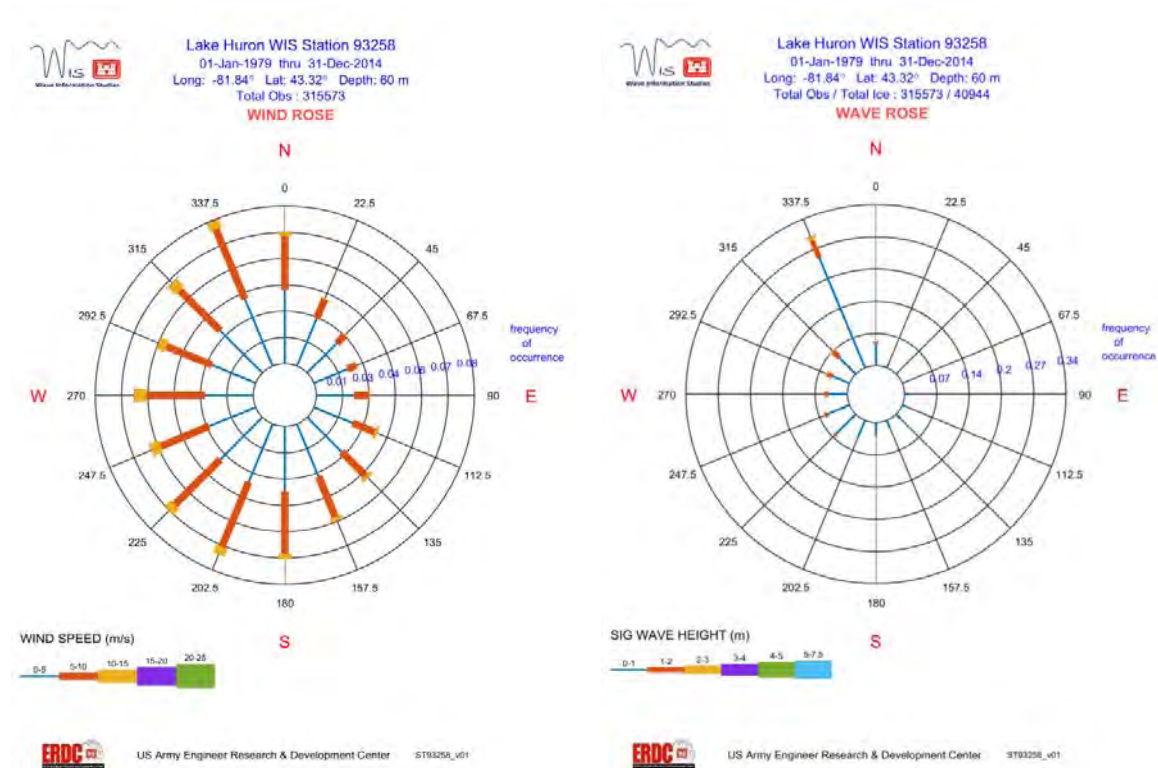


Figure 4.3: Wind speed and hindcast wave height roses for a station off Grand Bend. US Army Corps of Engineers, 2013.

It is this that controls the net southward movement of sediment from Goderich towards Grand Bend. Data from the WIS study are derived from a third (3<sup>rd</sup>) generation wave hindcast model and thus are more suitable for use by sediment transport models such as Mike 21 and Delft3D than the Philpott data. They could be used to provide updated predictions of the sediment transport patterns within the ABCA boundaries.

The shoreline from Goderich to Kettle Point constitutes a single littoral cell (Reinders, 1989) and within this four sub-cells were recognized (Figure 4.4). Sub-cell 1 just south of Goderich is entirely within the Maitland Valley Conservation Authority jurisdiction. Sub-cells 2, 3 and 4 are defined by downdrift boundaries at Bayfield, Grand Bend and Kettle Point. At Bayfield the average annual supply of sand and gravel from updrift is estimated to be about 21,000 m<sup>3</sup>. It is assumed that the file beach at Bayfield is completely filled and no further northward growth is anticipated so that the volume of sand bypassing the structures is similar to that arriving from updrift. Sediment supplied from bluff, nearshore and gully erosion from the shoreline south of Bayfield is estimated to be a bit more than 40 000 m<sup>3</sup> and thus about 65 000 m<sup>3</sup> annually is deposited over the area south of Country Road #83 (Reinders, 1989). The file beach at Grand Bend may also be filled and little northward extension can be anticipated. At both Bayfield and Grand Bend diversion of sand around the jetties results in a sand-starved area immediately downdrift.





Figure 4.4: Littoral Cell & Subcells Within ABCA shoreline

The actual rate of transport alongshore depends on the amount of available sediment and on small changes in local shoreline orientation, changes in wave direction close to shore due to shoals, and the presence of small headlands such as those at Rocky Point and Dewey Point. These changes are reflected in part in variations in the thickness of beach sediments and the width of the beach alongshore, but no detailed modelling of this exists based on the available wave data. North of Grand Bend around Lakewood Gardens the shoreline orientation begins to change until it is oriented towards the west-northwest and thus closer to perpendicular to the dominant wave direction. As a result the rate of longshore sediment transport slows down and it is this that leads to net deposition of sand and the development of the wide beaches and sand dune systems that exist from Oakwood through Pinery Provincial Park and on to Port Franks. Sand transport is interrupted at Bayfield and Grand Bend as a result of the jetties that extend lakeward to help maintain the entrances to the small harbours there.

### **Coastal Zone:**

Within the littoral cells, the coastal zone is defined further by looking at the profile of the land/lake interaction zone. This coastal zone is broken down into the following zones:

- Onshore;
- Backshore;
- Nearshore; and
- Offshore.

Lake/land interactions generally occur in an area defined as the shoreline zone (Figure 4.5) and is normally divided into three distinct units:

- The **onshore** is the area landward of and generally beyond the limit of wave action by a particular water body. This may include shoreline bluffs, sand dune fields, wetlands, and areas subject to occasional inundation.
- The **backshore zone** extends from the landward limit of the nearshore to the point of development of vegetation or change in physiography (i.e., where the bluff or dune starts). The backshore zone is typically only affected during severe storms particularly at high water.
- The **nearshore zone** is an indefinite zone extending from just beyond the breakers zone to the landward limit of the swash zone or the landward limit of the foreshore zone. The swash zone (See Figure 4.6) is the portion of the nearshore zone in which the beach face is alternatively covered by the uprush of the wave swash and exposed by the backwash. The foreshore is the sloping portion of the beach profile lying between the berm crest, or in the absence of a berm crest, the upper limit of wave swash, and the lower limit of the backrush of wave swash. The term foreshore is often nearly synonymous with the beach face but is commonly more inclusive, containing also some of the flat portion of the beach profile below the beach face.

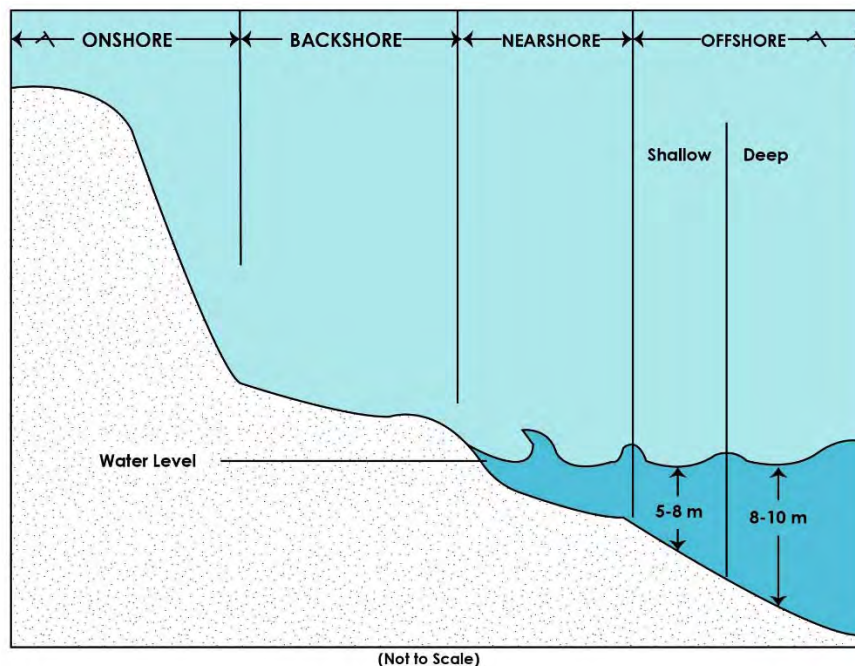
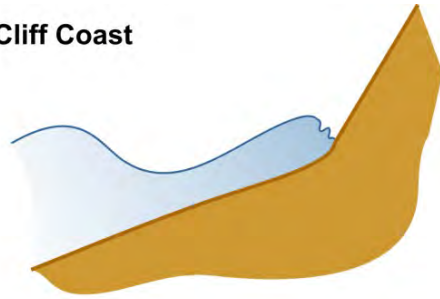
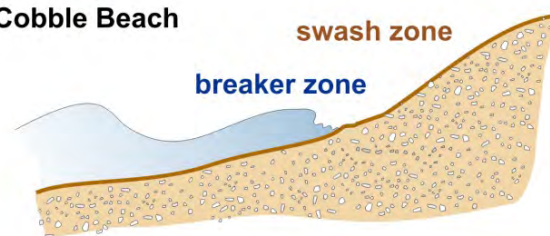


Figure 4.5: From MNR Technical Guide-Part 1: Figure A1.2.1 Definition of the Shoreline Zone Page A1-2-2 (2001)

**1. Cliff Coast**



**2. Cobble Beach**



**3a. Sandy Beach (planar)**



**3b. Sandy Beach (barred)**

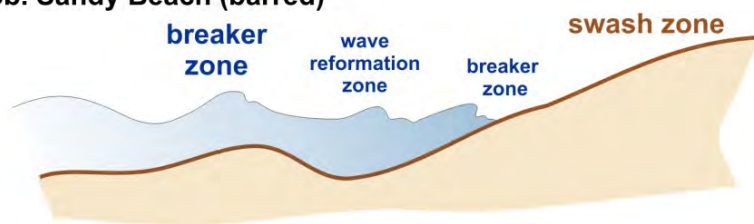


Figure 4.6: Wave breaking and surf zone development on steep and gentle beaches (Source: Davidson- - Arnott, 2010, Figure 5.12).

An understanding of these zones is important when the assessment of the processes and the impacts are carried out along the shoreline.

### **Onshore Impact Area:**

The existing surface features of the onshore area, including relief and terrain may be changed as a result of a shoreline management practice. The placement of fill and/or the construction of bluff stabilization structures will directly occupy or cover a portion of the onshore area and displace the natural terrain and relief. Occupying the onshore area may result in an **altered onshore topography (changes terrain and materials)**.

A bluff shoreline that is actively eroding is not at a stable slope condition. The toe of the slope is constantly being undercut thus maintaining an oversteepened condition. Once the toe of the slope is stabilized, the crest of the slope will continue to retreat until it reaches a stable slope condition thus resulting in an **altered onshore topography (changes terrain and materials)**.

If the bluff is stabilized, the natural **sediment supply to the littoral system will be lost, which will affect the input of sediments into the littoral system.**

### **Backshore, Nearshore and Offshore Impact Area:**

The littoral zone is composed of the backshore, nearshore and shallow offshore (i.e., 5-8 metres) which in total extends from the landward limit of storm wave action on a bluff or beach offshore to the maximum depth at which wave action can effectively transport sediment on the lakebed (i.e., roughly 5-8 metres in the Great Lakes).

The "shoreline" is generally defined as the intersection of the stillwater line with the land. Changes or movement of the "shoreline" lakeward or landward can be influenced by a number of factors. Primarily, the shoreline position is determined by the level of water with respect to the level of the adjacent land and by the erosion and accretion processes which occur.

Littoral processes are the result of interactions among winds, waves, currents, water levels, sediment supply and other phenomena in the littoral zone. The dominant processes leading to erosion, sediment transport and deposition within the littoral zone are associated with sediment supply, waves and wave-generated currents. These in turn control the resultant quantity movement of sediment alongshore and on-offshore. Modifications to these littoral processes can result from changes in sediment supply (e.g., protection of updrift bluffs, construction of harbour jetties), changes in lake levels and/or by the presence of ice during the winter months.

On erodible bedrock and cohesive shorelines, the material which comprises the controlling substrate (i.e., predominant material) of the nearshore lakebed is subject to **irreversible downcutting (i.e., downwards erosion) and subsequent long term shoreline recession**. On dynamic beach shorelines, the shoreline may either be eroding or accreting depending on the supply of sediments, wave action and water levels.

#### 4.2 The ABCA Shoreline - Field Observations

Shoreline field observations were carried out over a two-day period in September (29<sup>th</sup> & 30<sup>th</sup>), 2015. At each site photographic records were captured, catalogued and provided to the ABCA. Please see the following map Figure 4.7 with the site locations that were visited.

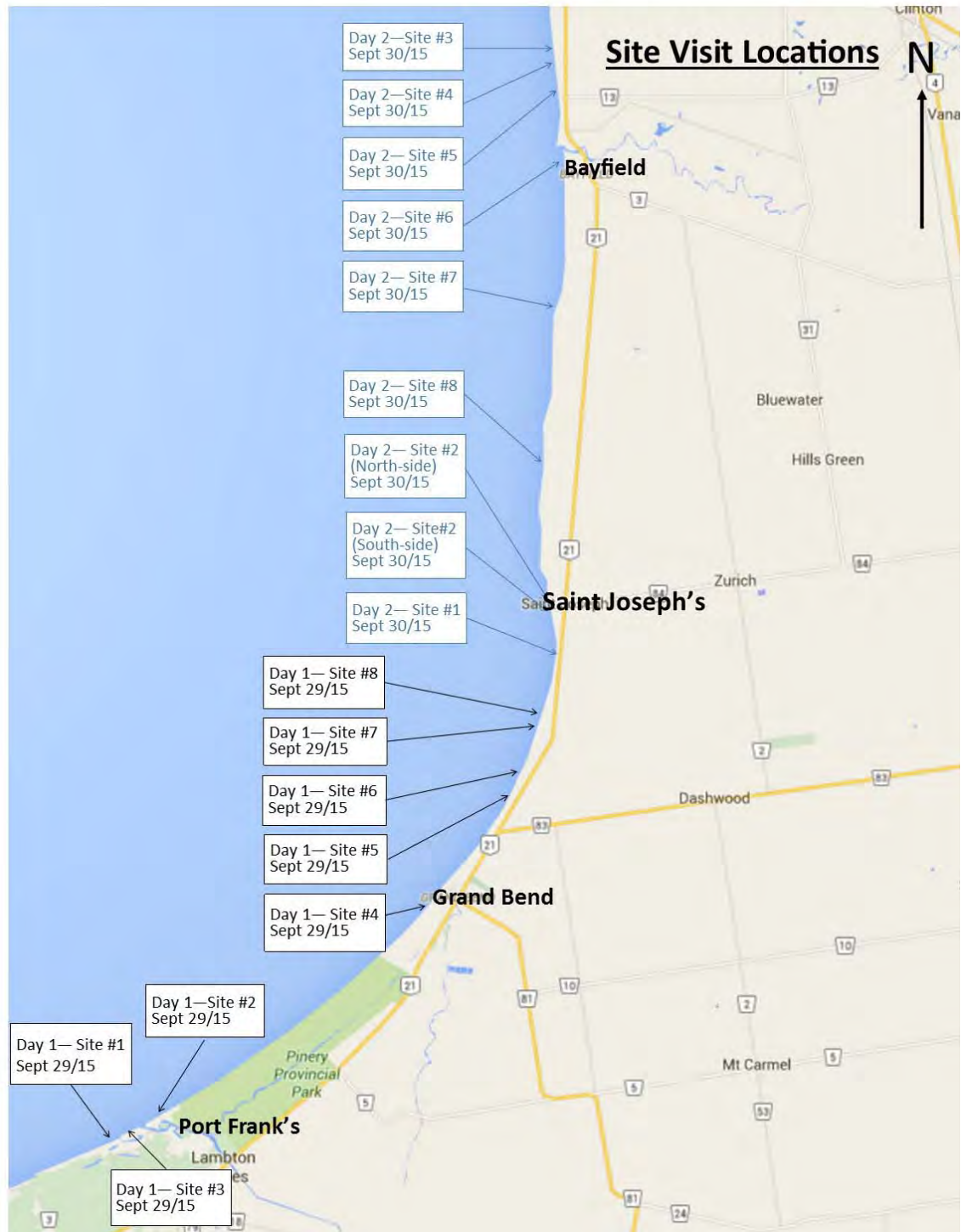


Figure 4.7: Site Visit Locations



Day one was devoted to examining flooding and dynamic beach hazards as well as several sites where erosion hazards were identified with bluffs and unstable slopes (e.g. Poplar Beach).



Dynamic Beach Transitioning to Erosion Area with Structures



Natural Dynamic Beach Dune System



Transition zones from the Dynamic Beach to the Erosion Hazard areas.

Day two focused specifically on the erosion hazards associated with bluffs and unstable slopes. ABCA identified the shoreline field site locations and focused site visits in particular on priority areas as well as areas that would demonstrate different conditions along the shoreline. In addition, locations were selected that were accessible.



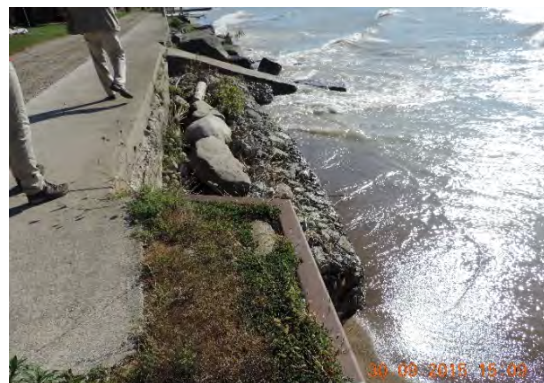
Erosion along shoreline (trees in water)



Erosion along beach shoreline



Steel Walls at base of steep slope



Insufficient structure, failure of gabions.





Erosion at the base of slopes.



Grass systems being undermined and removed.



The field visits confirmed the presence of a variety of shoreline protection works as well as a number of piecemeal and ad hoc shoreline works.



Ad-hoc, piecemeal shoreline protection works.



Ad-hoc, inconsistent, piecemeal shoreline protection works.





As evidenced by these photographs, shoreline protection works varied widely in form and composition. Some consisted of poured concrete over stones, randomly piled concrete rubble and stone. Many consisted of poorer quality materials, many of insufficient size.



Dumped concrete rubble and stone.



Randomly dumped stone at the toe of the steep slope.



Poor quality materials (e.g. bricks, concrete rubble) of insufficient size remain from being washed out.





Consistent maintenance of shoreline protection works was not evident along the shoreline and there were many instances where deteriorated gabion baskets and wooden frames with insufficient or undersized rock materials prevailed.



Insufficient materials were along some areas.



Outflanked and deteriorated gabion baskets.



Deteriorated wooden frames.



Deteriorated structures, emptied of materials.



Shoreline protection works were frequently constructed for one property and there was evidence to suggest that there is a general lack of coordination regarding the installation of shoreline protection works across property boundaries. This was evident in a number of locations along the ABCA shoreline.



Flanking and lack of coordination between properties of shoreline protection works.



There was evidence of shoreline protection works failures along the shoreline. There was also evidence of slope instability.





Lack of coordination and consistency of shoreline protection works between properties, and evidence of instability is indicated in the following photograph.



#### 4.3 Recession Rates

Systematic collection of recession data was first carried within the ABCA jurisdiction, and indeed for the whole of the lower Great Lakes shoreline in Ontario as part of the Canada/Ontario Shore Damage Survey. Bluff recession data were collected photogrammetrically based on 1973 photos and ones from 1952-55 at points spaced less than 10 km apart. Additional data from surveys between 1973 and 1975 were also compiled. Surveys of some lines were carried out by Environment Canada (now Environment and Climate Change Canada) for a number of years. See Appendix D for details on the assessment process.

Shoreline mapping for the ABCA was carried out using 1988 aerial photography at a scale of 1:2000. Physical features necessary for determining recession rates, such as the toe of bluff, top of bluff and dune toe were readily identifiable and could be mapped along the shoreline. Recession rates for the first Shoreline Management Plan were determined by comparing the position of the bluff toe in 1988 with that from a survey carried out in July and August of 1935 by the Department of Lands and Forests, Province of Ontario. Because recession rates vary temporally, particularly in response to fluctuating lake level, estimates of the average annual recession rate from which the 100 year erosion limit are determined should be based on a suitably long record.

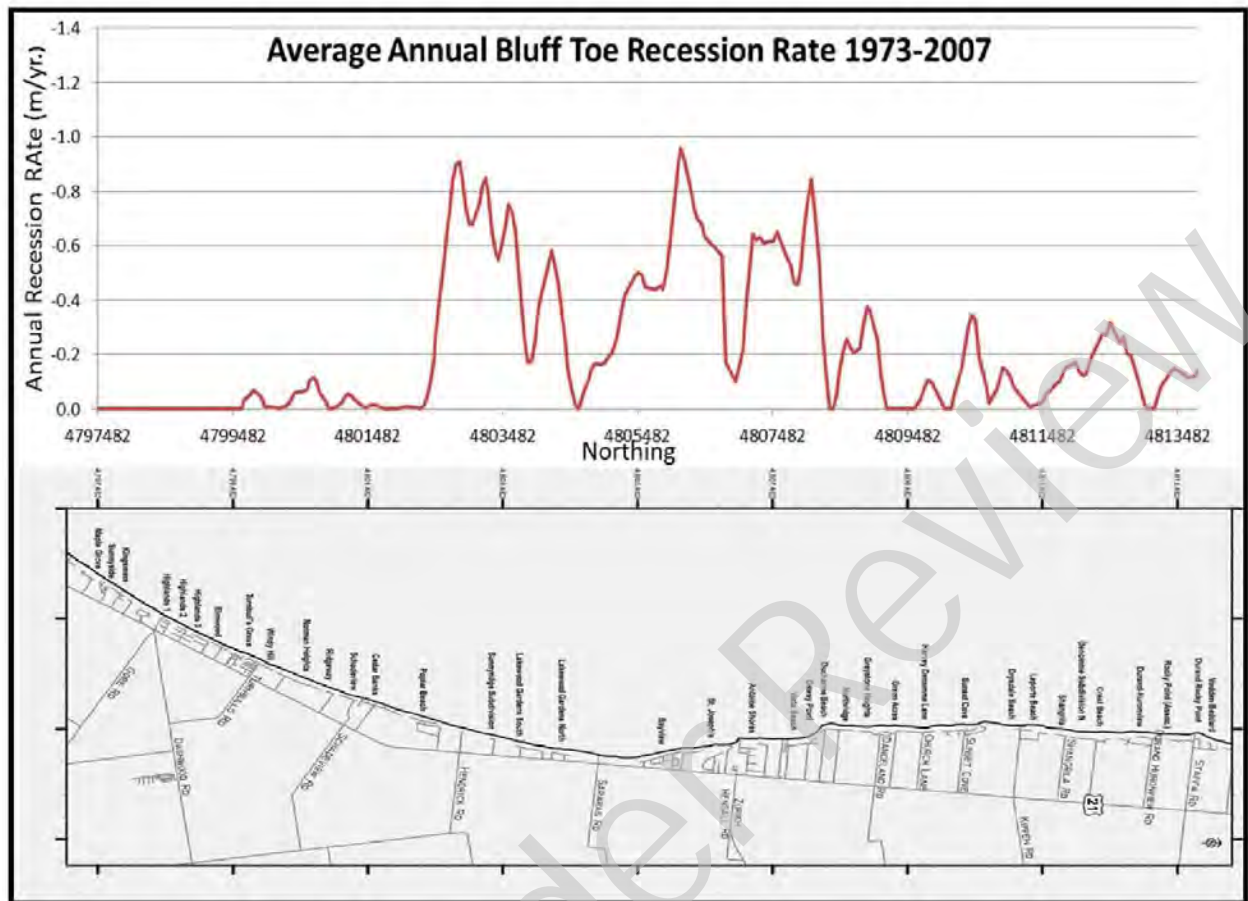


For the SMP update, **the measurements are based on changes over 34 years.** In addition however, the data on which the recession rates are calculated are based on more recent data from 1973-2007, which are in fact more indicative of present occurrence rates.

One of the assumptions of using historical recession rates to predict future recession is that the processes controlling recession during the measurement period are the same as those expected in the future. It is now 80 years since the 1935 survey was carried out and in that time there have been considerable human impacts on the shoreline within the ABCA jurisdiction and within the littoral cell to the north. As a result it was decided to obtain a new set of recession data using a more contemporary timespan. The ABCA now has mapping based on 2007 digital orthophotos that provide a good estimate of the bluff toe and bluff crest positions. Existing aerial photography from the 1960s and 1970s could be used to construct the historic shoreline from which recession rates can be calculated. However, these photos would need to be orthorectified and this requires establishing the position of a suitable number of control points which may be difficult and expensive. Instead it was decided to use the mosaics made from photography flown in 1973 and printed in the Canada/Ontario Shore Damage Survey which provides a 34 year time frame for determining recession. While determining the shoreline change rate using the 1973 photography proved more difficult than originally anticipated satisfactory data were retrieved. Shoreline change between 1973 and 2007 was determined for the section of bluff shoreline extending from the northern ABCA boundary southward to Maple Grove. Recession was calculated for transects with a nominal spacing of 50 metres, except where gulleys intersected the shoreline. The recession data were then used to calculate the raw average annual recession rate. Finally, the raw data were smoothed using a weighted running mean to produce the smoothed average annual recession rate which provides a suitable basis for predicting the 100 year recession limit required for setback planning. The smoothed average rates for the shoreline north of Grand Bend are shown in Figure 4.8a & 4.8b). Details of the process used to obtain the recession data are provided in Appendix F.

Figure 4.8 a) The ABCA northern section of the cohesive bluff shoreline

Figure 4.8 b) The ABCA southern section of the cohesive bluff shoreline



As new ortho photography and potentially Light Detection and Ranging (LiDAR) becomes available it will be possible to use the 1988 mapping as the starting point for calculating bluff toe recession because the bluff toe is incorporated in a Geographic Information System (GIS) as a digital layer, and the mapping is more accurate than for the 1973 data. While recession of the bluff toe provides the best indicator of long-term recession rates, recession of the top of bluff may also be useful, particularly in assessing the risk to properties that are close to the bluff edge. These data are available for the period 1988-2007.

### Key Findings:

The recession rate calculations indicate that rates of recession are varied along the shoreline from low ( $0\text{--}0.3\text{ m/y}^{-1}$ ), to moderate  $0.3\text{--}0.7\text{ m/y}^{-1}$  and, in a few specific locations to substantial ( $0.7\text{--}1.2\text{ m/a}^{-1}$ ).

Average Recession (m/yr.)	Annual Rate	% of Cohesive Shoreline	ABCA Bluff	MNRF Classification
>1.2		0		High
0.71-1.2		6.1		Substantial
0.31-0.7		22.2		Moderate
0.01-0.3		71.7		Low



The shoreline is **stable** where sufficient sediment has accumulated to produce wide beaches that protect the bluff toe from erosion and extends far enough lakeward to protect the till from underwater erosion. This occurs for about 1 km along the filet beach north of Bayfield Harbour (see Figure 4.9) and again in the south towards Grand Bend just north of Oakwood.

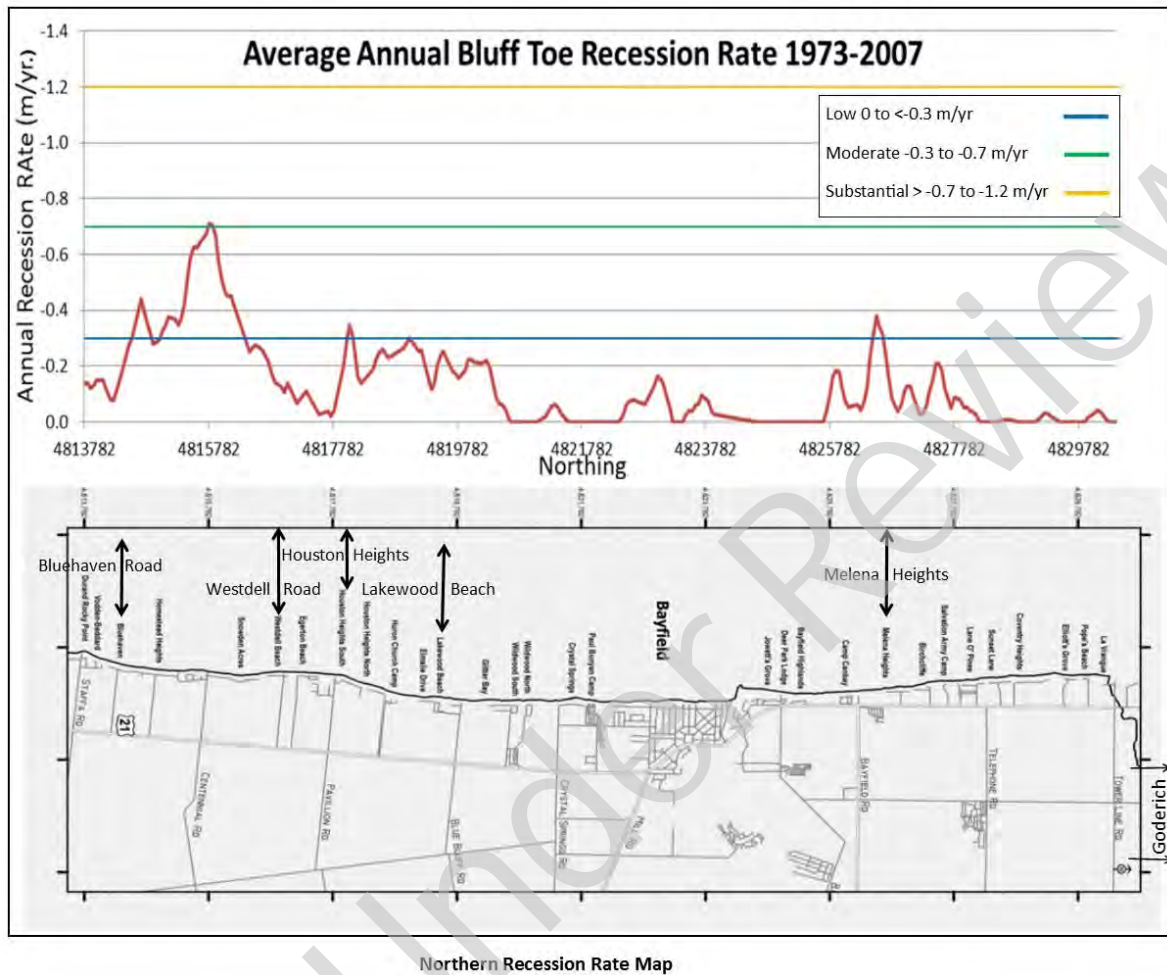


Figure 4.9: Filet Beach North of Bayfield Harbour

Sections of shoreline with **low recession rates** (See Figure 4.10 a) – Northern Recession Rate Map) are quite common in the 12.5 km of shoreline from the northern boundary of the ABCA to Pavilion Road about 6.5 km south of Bayfield areas. They are also found in a few areas south of Pavillion Road. Shorelines with a low recession rate are usually associated with wider beaches which offer some protection against erosion of the bluff toe and reduced rates of underwater erosion. The presence of these wider beaches likely reflects a reduced rate of longshore sediment transport at these locations. In addition low recession rates are found at two locations south of Bayfield, Stoney Point and Dewey Point, where there are outcrops of the stony Rannoch Till which also acts to reduce underwater erosion.

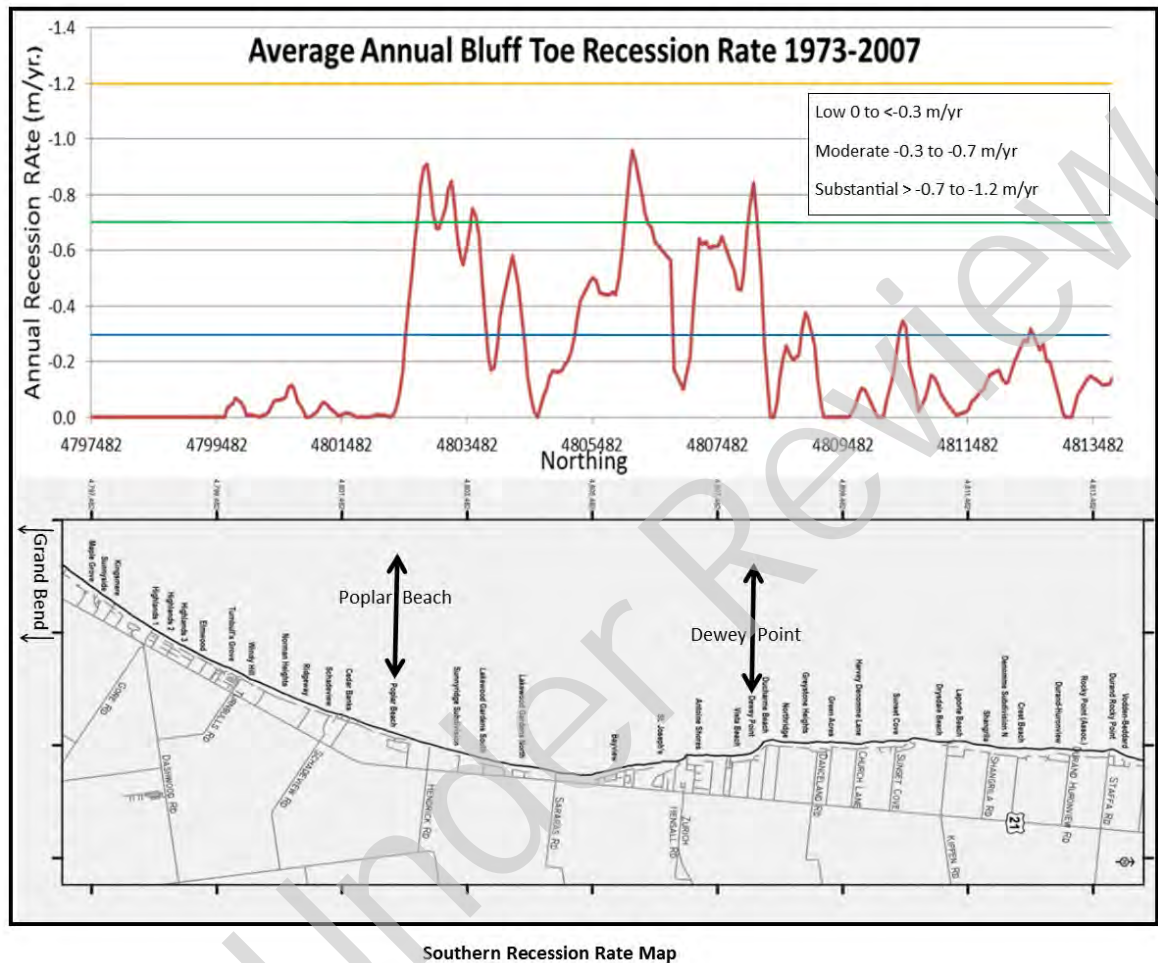


Figure 4.10 a): Northern Recession Rate Map – Average Annual Bluff Toe Recession Rates 1973 – 2007



There are short sections with **moderate recession rates** in the area north of Pavillion Road, notably around Melena Heights (north of Bayfield) and Lakewood Beach to Houston Heights (south of Bayfield). See Figure 4.10 b): Southern Recession Rate Map. South of Pavilion Road the overall recession rate increases and there are more extensive areas with moderate erosion, notably between Westdell Road and Bluehaven Road, and most of the shoreline between Danceland Road and Poplar Beach Road. These section are characterized by narrow beaches and likely less sediment to protect against underwater erosion. Sections of shoreline with **substantial recession rates** occur only between Danceland Road and Poplar Beach Road.

Figure 4.10 b): Southern Recession Rate Map – Average Annual Bluff Toe Recession Rates 1973-2007



#### 4.4 Lake Level & Lake Level Fluctuations

Lakes Michigan and Huron are effectively at the same level and for practical purposes they are treated the same for monitoring of lake level over periods of days months or years. Water levels in Lakes Huron/Michigan, like all of the Great Lakes, fluctuate over periods of hours to decades. Short-term fluctuations reflect the effects of winds which produce a set down of water on the upwind side of the lake and a set-up or storm surge on the downwind side with a magnitude on the order of 0.3-0.6 metres (m) during significant storm events. When the wind shifts direction seiches, or water level oscillations, can occur with a period of hours and a magnitude of a few centimetres to 20-30 centimetres (cm).

Fluctuations over days, months and years reflect the effects of net basin supply, which is an accounting of all the inputs and outputs of water to and from the lakes and the surrounding watershed. Inputs to the lakes comes from precipitation on the lake surface, inflows from rivers and streams draining into the lakes, and the inflow from Lake Superior down the St. Mary's River. Outputs from the lake include evaporation from the lake surface and outflow down the St. Clair River. The outflow from Lake Superior is regulated at the locks at Sault Ste. Marie but there is no regulation at the exit to the St. Clair River. A small amount of water (<2% of the outflow to the St. Clair River) is diverted to the Mississippi system at Chicago. About 41% of the input comes from precipitation on the lake itself, 31% from stream inflow and 28% from Lake Superior. Nearly 70% of the output is accounted for by flow down the St. Clair and 30% is lost through evaporation. Seasonal and longer term fluctuation are controlled primarily by changes in precipitation and evaporation within the basin. However, because of the significance of the inflow from Lake Superior as a proportion of the total inflow, Lake Huron/Michigan lake levels also reflect fluctuations in precipitation and evaporation within that basin. The periods of high lake level in H/M usually reflect a coincidence of large amounts of precipitation in both basins and vice-versa for very low lake levels.

Mean monthly average lake level for Lake Huron/Michigan are shown in Figure 4.11 for the period January 1918 to May 2016. Annual changes which are usually 0.3-0.6 m reflect seasonal effects on the timing of precipitation, runoff and evaporation. Generally the highest lake level occurs in late June through to early August, reflecting high runoff from snow melt within the basin and later as a result of the slightly later melt in Lake Superior and the delay in routing the water from the upper lake. Recent observations suggest that peak level is occurring a bit earlier than in the earlier part of the 20<sup>th</sup> century, likely reflecting earlier timing of spring melt in both Lake Huron and Lake Superior. The lowest levels usually occur in December and January when lake evaporation is highest due to the relatively cold air and warm lake. Evaporation is reduced when there is a substantial ice cover in mid-winter and possibly as a result of restricted outflow due to ice jams at the entrance to the St. Clair River.



Figure 4.11: Lake Huron/Michigan mean monthly lake level January, 1918-May, 2016

Figure 4.12 is extracted from the Environment Canada (now Environment and Climate Change Canada) Monthly Water Level Bulletin which provides a record of mean monthly lake level for a period of about two years as well as historical data and a 6 month forecast of probable levels. The grey line shows the historic mean lake level with seasonal variations showing that lake level is usually lowest in the winter months of January or February and highest in June or July. The upper red and lower blue dashes show the highest and lowest mean monthly values recorded and the year in which they occurred. The highest mean monthly water level recorded is 177.5 in October of 1986 and the lowest is 175.58 in March 1964 giving a maximum range of just under 2 m. Slightly higher and lower daily and hourly values will have been recorded due primarily to wind events. While the period from about 2000 until the end of 2012 was low for an extended time (Figure 3), the lowest point was just slightly higher than the lowest ever recorded and levels rose very quickly following this, through 2014, 2015 and into 2016. While the fluctuations are quite irregular, the maximum and minimum values appear to be relatively similar across the 100 year record. As described in detail in Appendix E, recent projections are for mean lake level to remain relatively stable over the next 80-100 years, with higher evaporation in the basin being compensated for by increased winter precipitation.

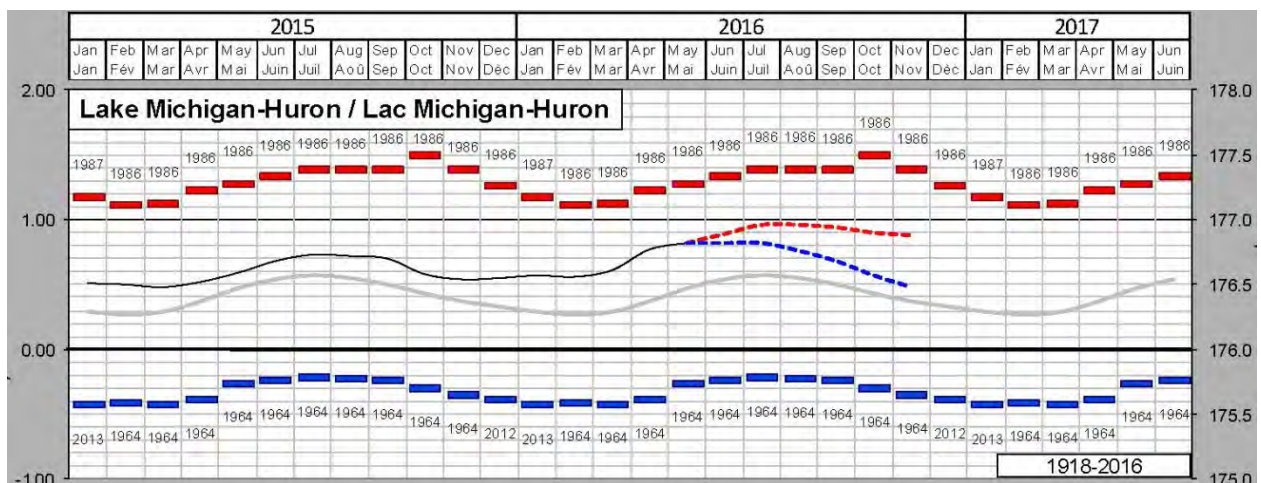


Figure 4.12: Environment and Climate Change Canada- Monthly Water Level Bulletin

Fluctuating lake levels have a significant effect on shore processes. Periods of low lake level are associated with wider beaches, less bluff toe erosion and more sand supply to coastal dunes while high lake levels are associated with narrower beaches and more frequent erosion of the bluff toe and sand dunes during periods of high lake level. Depending on the level of wave activity there may be a lag in the shoreward movement of sediment if there is a quick rise in lake level with the result that the beach or bluff toe may be subject to grater effects from an intense storm than might occur a few months later when the nearshore profile has had time to adjust. The Climate Change Anticipated Impacts- Discussion Paper provides further details in Appendix E.



Fluctuating lake levels affect shoreline processes, with wider beaches, less bluff toe erosion and more sand supply to embryo dunes and foredunes during periods of low lake level and narrower beaches and more frequent erosion of the foredune and bluff toe during periods of high lake level. Depending on the level of wave activity there may be a lag in the shoreward movement of sediment if there is a quick rise in lake level with the result that the beach or bluff toe may be subject to greater effects from an intense storm than might occur a few months later when the nearshore profile has had time to adjust.

#### 4.5 Slope Stability Considerations

Following the site visits and shoreline reconnaissance, a number of concerns emerged about the number of structures currently located within the Erosion Hazard Limit. The following schematic (Figure 4.13) provides a visual representation of the Erosion Hazard limit:

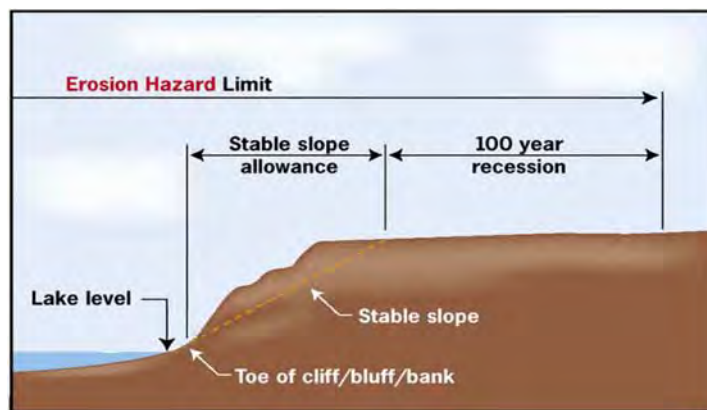


Figure 4.13: Erosion Hazard Limit - Source: MNRF, Understanding Natural Hazards (2001).

Lakeshore Area 1 was defined in the 2000 SMP as the area lying within a 3 to 1 stable slope allowance and lakeward. The extent of Lakeshore Area 1 was defined more than 20 years ago. Since that time, the nature of development along the Lake Huron shoreline has changed dramatically. Larger, more complex development applications are being submitted and there has been an ensuing increase in the demand for and interest in shoreline property ownership. In addition to changing patterns of development, changes to the average annual temperatures in the region as a result of climate instability have and are expected to impact lake temperatures, lake-effect snowfall, winter ice cover and fish habitat.





Climate change is expected to bring with it changing patterns of precipitation, an increase in the number of storm events, a longer ice-free season with large waves and storm surges which in turn is expected to drive larger volumes of longshore sediment transport and an increase in the downcutting of the nearshore and erosion of the bluff toe along cohesive shorelines. Site visits provided evidence of the contribution that climate change has made - as demonstrated in the following photographs:



An increase in the erosion of the toe of slope areas is evident and as a result of this evidence, it was recommended to ABCA that further investigation be carried out to assess the level of risk that these buildings may be exposed to.



Homes are extremely close to an eroding shoreline and unstable bluff and a further geotechnical investigation has been recommended to qualify and quantify the safety issues, and the extent of these problems.



In order to address the concerns, ABCA completed an initial GIS review of the structures that are lake ward of the 3:1 stable slope. **Please note – this consisted of a mapping exercise only and has not been validated with on-site field work.** This work was carried out in April 2016 by ABCA staff and it was determined that there are approximately 873 structures within Lakeshore Area 1 in the Municipality of Bluewater and the Municipality of Central Huron in the ABCA watershed.



Approximately 376 of these are accessory buildings and approximately 497 are habitable dwellings. Details about the approximate number of dwelling units and accessory buildings that encroach within 5 metres, 10 metres and 15 metres of the top of bank are summarized in the following table:

Distance to Top of Bank	Total Number of Dwelling Units	Total Number of Accessory Buildings/ Structures	Total Buildings	Additional Comments
5 m	108	126	234	Structures within 5 metres of the top of bank are <u>generally scattered along the shoreline</u> rather than being clustered in specific subdivisions.
10 m	153	55	208	Structures within 10 and 15 metres of the top of bank are <u>generally clustered in specific subdivisions</u> rather than being scattered along the shoreline.
15 m	274	83	357	

In order however to fully understand the scope and degree of risk, it is important to define the number of habitable and non-habitable buildings and structures that are located within the hazard. When considering the Slope Stability Component of the erosion hazard, it was determined that the following number of buildings and structures (both habitable and non-habitable) were located within the Stable Slope Allowance:

Hazard	Total Number of Structures	Total Number of Dwellings
Bluffs	1835	1150

**When considering the entire erosion hazard area, the 100 year recession rate allowance plus the Stable Slope allowance needs to be included in a full assessment.**

To provide important information to property owners about potential slope failure, ABCA retained the services of Terraprobe who were commissioned to develop a Riparian Landowner Fact Sheet. A copy of the Fact Sheet has been included in Appendix J. The Fact Sheet provides important information about early warning signs of potential slope failure.

This issue of slope stability was brought to the attention of the SMP Steering Committee and the Councils of Bluewater and Central Huron, ABCA Board of Directors.



#### 4.6 Potential Effects of Climate Change

Under the 2014 provisions of the Provincial Policy Statement Conservations Authorities were given the mandate to consider the potential impacts of climate change on that may increase the risk associated with natural hazards (see Section 3.1.3). A detailed review of the present understanding of potential climate change in the Great Lakes Basin and an assessment of the potential impact on processes and shoreline hazards within the ABCA shoreline is provided in Appendix E, and a summary of the key points from this is given here.

There is general agreement that average temperatures over the next century will increase by 2-7 °C with winter temperatures increasing more than summer temperatures. This will increase the average temperature of Lake Huron and the number of days with severe heat. It will also lead to a decrease in the proportion of precipitation occurring as snow. In terms of coastal processes the most important change will be a continued decrease in the extent and duration of winter ice cover. As a result, winter storms that in the past did not generate waves because of the presence of ice will now be able to do so and this will lead to an increase on the order of 10-30% in the potential rate of erosion on the cohesive coast both underwater and of the bluff toe. Longshore sediment transport rates will also increase and so the protection provided to the bluffs by beaches may also decrease, though this effect may be partially offset by increased supply.

Agreement on the effects on precipitation is not as good as for temperature, but most recent modelling suggests that precipitation in the northern half of the basin – mainly Lake Huron/Michigan and Lake Superior – will increase by up to 20%. The most significant effect of this is that the mean lake level is now forecast to remain similar to the past 100 years, with increased evaporation being offset by the increased precipitation. There will likely be an increase in the frequency of intense rainfall events which may lead to more rapid erosion of the bluff face and may also have implications for water quality. Increased winter storm events may also lead to more frequent erosion of coastal dunes and the potential for the maximum limit of wave erosion inland to increase.

In summary, climate change impacts on temperature and precipitation have the potential to increase the severity of flooding and dynamic beach hazards and to increase the rate at which bluff recession takes place along the ABCA shoreline and this will require both continued updating of data on coastal processes and bluff recession and caution in assessing the risks to people and property. **The potential implications of climate change have informed the recommended policy updates.**

## 5.0 Understanding Shoreline Hazards

Hazardous lands are defined in the Provincial Policy Statement (MMAH, 2014) as “property or lands that could be unsafe for development due to naturally occurring processes. Along the shorelines of the Great Lakes - St. Lawrence River System, this means the land, including that covered by water, between the international boundary, where applicable, and the furthest landward limit of the flooding hazard, erosion hazard or dynamic beach hazard limits...” The PPS defines Hazardous sites as “property or lands that could be unsafe for development and site alteration due to naturally occurring hazards. These may include unstable soils (sensitive marine clays [leda], organic soils) or unstable bedrock (karst topography).” (MMAH, PPS, 2014)

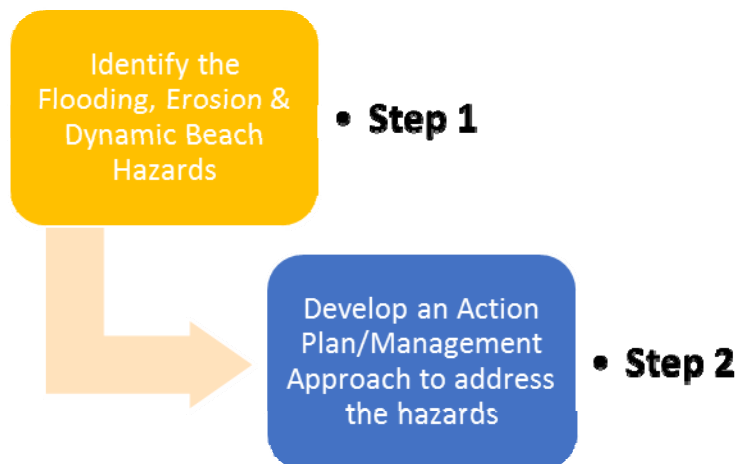


On Lake Huron, lake level fluctuations, storm events and related natural processes continuously reshape the coastal zone through flooding, erosion and accretion of sand and sediment. These processes are an integral part of the natural ecosystem. Interference with these processes can result in increased flooding and/or erosion risks.

Between 1985-1986, property owners on the Great Lakes coasts experienced record high lake levels. The high lake levels, combined with a number of severe storms caused substantial damages to public and private properties and established the need for the Province to consider management options that would address long term flooding and erosion problems.

In response, a shoreline management process was introduced to assist conservation authorities in dealing with these local hazard issues. A shoreline hazard system was developed to provide a consistent, technically sound and viable approach for identifying the hazards, based on the type of shoreline, and associated natural process. Shoreline management involves a logical two-step approach that requires:

1. The identification of erosion, flooding and dynamic beach hazards; and
2. The development of an action plan to address these hazards.



The extent of the hazardous lands are to be mapped under the assumption that there are no shoreline protection works and the hazard is defined by delineating the farthest combined landward extent of the three key shoreline natural hazards: flooding hazards, erosion hazards and dynamic beach hazards.

A brief summary chart of the three **flooding hazards, erosion hazards and dynamic beach hazards** is provided in the following Table.

**Hazardous Lands:**

**Great Lakes- St. Lawrence River System & Large Inland Lakes**

Area of provincial interest based on the furthest landward limit of:

**Flooding Hazards** involving the combined influence of:

Lake levels – *100 year flood level\**; PLUS

**Flood allowance** involving the combined influence of wave uprush and other water related hazards – **15 metres\*** (Great Lakes), or 5 metres\* (connecting channels, *large inland lakes*)

**Dynamic Beach Hazards** involving the combined influence of:

**Flooding** – *involving 100 year flood level\* plus 15 metres\** (Great Lakes), or *100 year flood level\**

*5 metres\** (connecting channels, *large inland lakes*); PLUS

**Dynamic beach allowance** – **30 metres\*** (Great Lakes), or **15 metres\*** (*large inland lakes*),

**Erosion Hazards** involving the combined influence of (two step process):

Step 1: select one of:

**Stable slope (3:1 slope\*)**; PLUS **recession rate allowance (100 times the average annual recession rate where a minimum of 35 years of reliable recession rate information is used)**;

OR

**Stable slope (3:1 slope\*)**; PLUS **erosion allowance (30 metres\*** (Great Lakes) or **15 metres\*** (*large inland lakes*) where there is insufficient recession rate information);

Step 2: whichever is the greater of:

Step 1 selection OR

**Erosion allowance** (30 metres\* (Great Lakes) or 15 metres\* (*large inland lakes*) measured from the first lakeward break in slope

---

Note: \* flexibility exists to recognize local conditions by undertaking studies using accepted engineering, geotechnical and/or scientific studies

\*\* see the supporting MNR Technical Guides for more detailed information and implementation approaches  
Table 1, page 5 of the January 1997 OMNR Natural Hazards Training Manual Version 1.0. Provincial Policy Statement, Public Health and Safety Policies 3.1

Erosion hazards, flooding hazards and dynamic beach hazards are discussed in detail in the sections that follow.

## 5.1 Erosion Hazard

### Definition of Erosion Hazard

Erosion Hazard means “the loss of land, due to human or natural processes, that poses a threat to life and property.

### Calculating the Erosion Hazard Limit

The erosion hazard limit is determined using considerations that include the 100 year erosion rate (the average annual rate of recession extended over a one hundred year time span), an allowance for slope stability, and an erosion/erosion access allowance.”

Source: PPS, Definitions (2014)

### 5.1.1 Calculating the Erosion Hazard Limit

The erosion hazard limit along the Great Lakes - St. Lawrence River system is defined to include two components: a stable slope allowance, and an average annual recession rate allowance.

#### Stable Slope Allowance<sup>5</sup>:

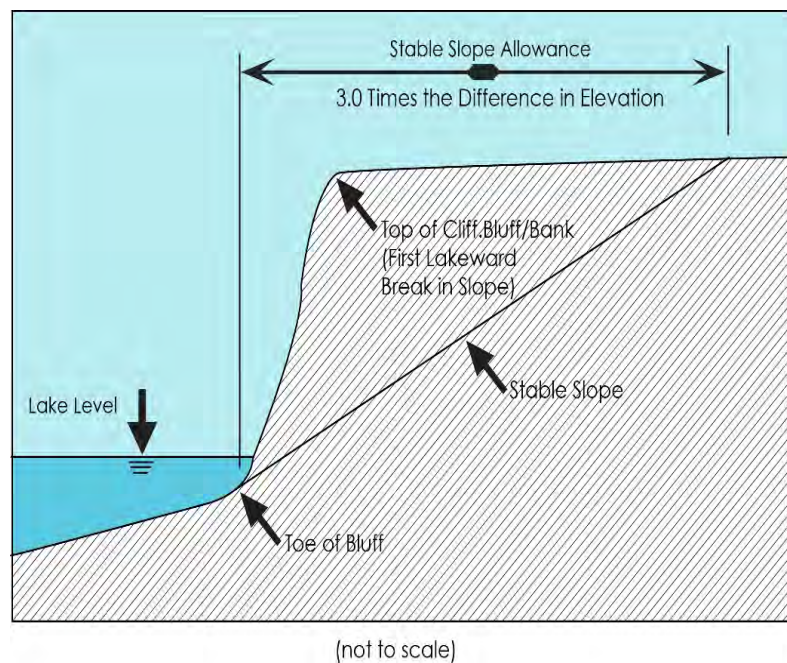


Figure 5.1: Stable Slope Allowance

<sup>5</sup> Source: MNRF Understanding the Natural Hazards and Technical Guide (2001).

The Stable Slope Allowance in Figure 5.1 (Stable Slope Inclination Setback) is a horizontal allowance measured landward from the toe of the shoreline cliff, bluff or bank. It is dependent on slope soil types, soil strengths, and ground water conditions. Slope height is the difference in elevation between the toe of the shoreline cliff, bluff or bank and the top of the bank. It can be assumed as a default inclination of 3 times the height of cliff/bluff in the absence of a site specific study, or it is determined by a detailed site investigation (e.g. boreholes) and analysis whereby a typically minimum Factor of

Safety of 1.5 is required. Site specific modelling and analysis could establish a stable slope inclination steeper than the default value of 3 horizontal to 1 vertical (3:1), or approximately 18 degrees.



The top (crest) of Slope indicates the slope instability.

Details on the calculation of the Erosion Hazard is referenced in the ABCA Policy and Procedures Manual and in Part 4 of the MNR Technical Guide document.

#### **Average Annual Recession Rate**

The average annual recession rate allowance is intended to account for the distance (measured horizontally in metres) of erosion that is likely to occur within 100 years from the present. In the absence of a minimum of 35 years of data, the Province of Ontario recommends the use of a 30 metre setback from the stable slope allowance. Consideration is also required to leave room for safe access, in order to enable a waterfront property owner to access the shoreline and conduct repairs and maintenance should the slope fail or weaken.



Most shorelines are erosion-prone, even if they consist of soft bedrock materials (e.g. shale, limestone etc.), however within the ABCA jurisdiction the soils consist of erodible cohesive materials.





Eroding Cohesive Materials.

Erosion Hazards as noted above, means the loss of land, due to human or natural processes, that poses a threat to life and property.

The erosion hazard limit is determined using the two components of;

- 100 year erosion rate (the average annual rate of recession extended over a hundred year time span), plus
- An allowance for slope stability (3:1 in absence of a study).

The Erosion Hazard limit as defined in the Understanding the Natural Hazards (MNR 2001) and the MNR Technical Guide (2001) applies the Stable Slope Allowance first and then the recession allowance. The approach used in the Generic Regulation is similar but the recession allowance is applied first and then the stable slope allowance is applied second. The slope stable slope allowance was applied first along the ABCA shoreline because of the safety issues associated with the bluff slopes which are immediately at risk and impacting the safety of the shoreline properties, while the recession rates are an ongoing process and are essentially spread out over a 100 years.

A three-step process is used to calculate the erosion allowance, (See Figure 5.2) as follows:

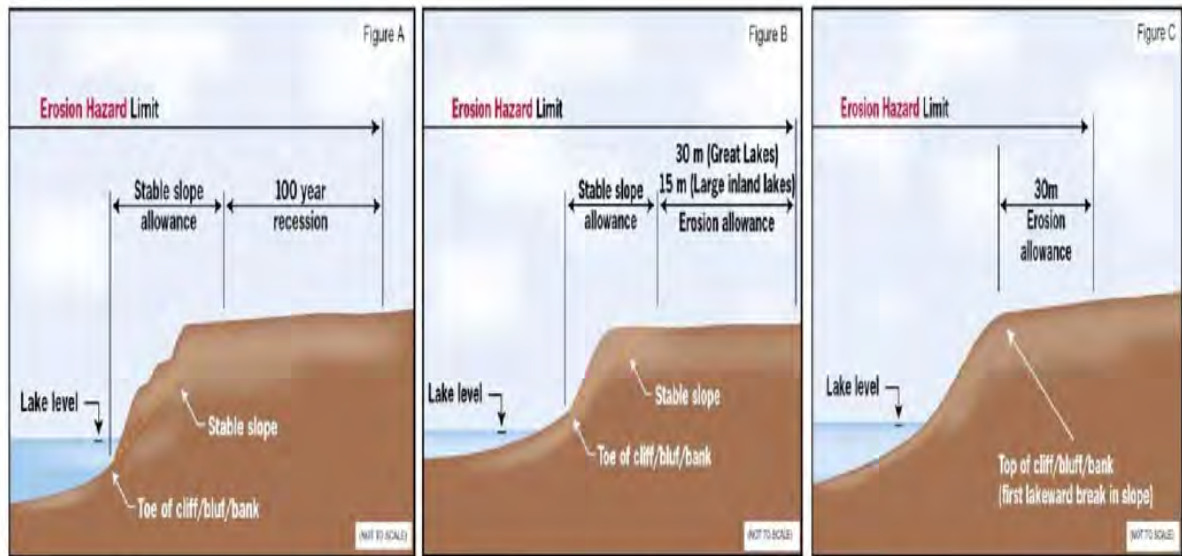
**Step One:** One of two options is selected based on whether or not sufficient recession rate information (e.g. minimum 35 years of reliable recession rate information) exists.

Option	Details	Method of Calculation
1	Where sufficient recession rate data exists (35 years+)	Measure the stable slope allowance and add to it the average annual rate of recession (where there is a site specific study and/or minimum of 35 years of reliable recession information available) times 100. Measure inland from the toe of the shoreline cliff, bluff, or bank. See Figure A below; or
2	Where there is insufficient recession rate data	Measure the stable slope allowance and add to it an erosion allowance of 30 metres (on the Great Lakes-St. Lawrence River system) where there is insufficient recession rate information See Figure B below.

**Step Two:** Where the existing slopes are flatter than a stable slope allowance and there is no reliable recession rate information (minimum 35 years of data) measure a 30-metre erosion allowance for the Great Lakes-St. Lawrence River system, measured toward the land from the top of the shoreline cliff, bluff or bank or the first landward break in slope. See Figure C below.

**Step Three:** Compare the measurement from Step One with that of the Step Two.

**The measurement that is the greatest (highest number) represents the Erosion Hazard Limit.**



**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.

The **greatest measurement** of the calculations above is the governing limit of the erosion hazard.

Figure 5.2: is from MNR Understanding the Natural Hazards and Technical Guide Documents. (2001)

### Stable Slope Allowance – Geotechnical Principles Guide

The standard slope stability allowance of 3:1 (horizontal: vertical) was used over the ABCA study area. The 3:1 (horizontal: vertical) is calculated by multiplying three times the height of the bluff and measuring this distance from the toe of the bluff. The “Stable Slopes – Geotechnical Principles” Guide(1998) was provided by MNRF to also give detailed guidance on what the geotechnical requirements are when using the option to determine from a site specific study the individual stable slope allowance at a particular site rather than applying the standard 3:1 (horizontal: vertical) slope.

The ‘Factor of Safety’ component was introduced to take into consideration the type of development and the level of risk associated with this development. Depending on the Type of Development and land use being considered on the site, MNRF developed Table 4.3 - Part 4 Technical Guide (pp. 4-31) (2001) for professional geotechnical engineers when carrying out detailed site specific studies to determine the slope stability setback at a specific site.

**Table 5.1 Design Minimum Factors of Safety:**

LAND-USES		DESIGN FACTOR SAFETY	MINIMUM OF
A	<b>PASSIVE:</b> No buildings near slope: farm field, bush, forest, timberland, woods, wasteland, badlands, tundra	1.10	
B	<b>LIGHT:</b> no habitable structures near slope: recreational parks, golf courses, buried small utilities, tile beds, barns, garages, swimming pools, sheds, satellite dishes, dog houses	1.20 to 1.30	
C	<b>ACTIVE:</b> habitable or occupied structures near slope: residential, commercial, and industrial buildings, retaining walls, storage/warehousing of non-hazardous substances	1.30 to 1.50	
D	<b>INFRASTRUCTURE and PUBLIC USE:</b> public use structures or buildings (i.e., hospitals, schools, stadiums), cemeteries, bridges, high voltage power transmission lines, towers, storage/warehousing of hazardous material, waste management material.	1.40 to 1.50	

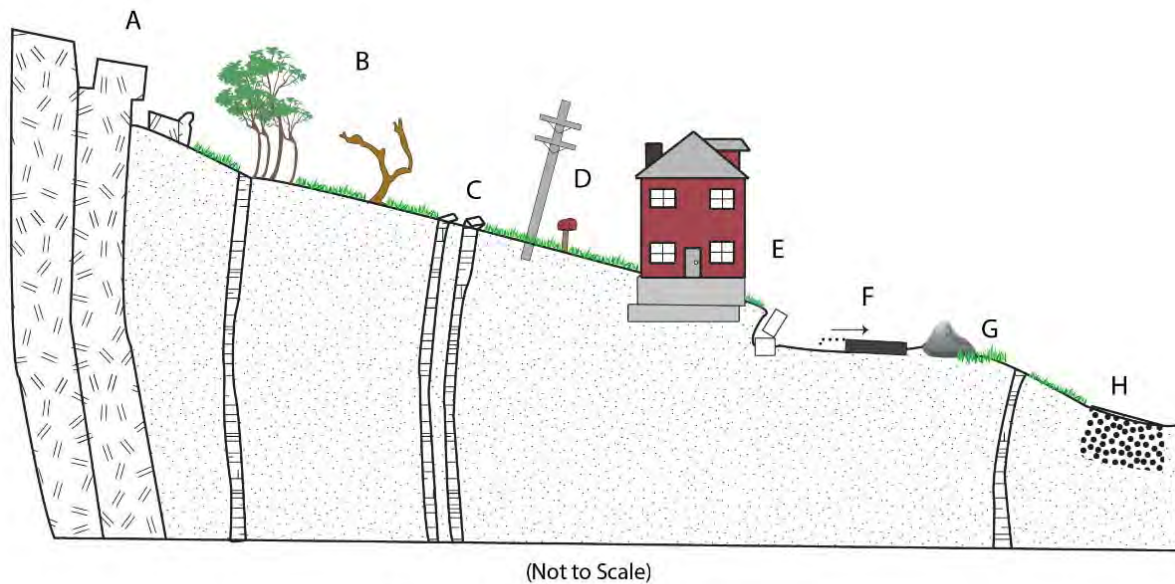
Source: MNR Technical Guide Part 4, Pages 4-31, (2001)

Additional technical references and material have been included in Table 7.4 (page 100) of the “*Geotechnical Principles for Stable Slopes*” Technical Guide (1997) document. A field sheet is available to provide definitive direction regarding the information to be collected at site visits. This information in turn, would allow the ‘Slope Stability Rating Chart’ to be completed to identify the level of study that would be required from any geotechnical engineer who would assess the site for a reduction or increase in the slope stability setback. More information may be found in Appendix I.

As mentioned a process was also developed to assist the reviewer in the determination of the ‘level of study’ that would be required if the proponent or a government agency decided they would like to do a site specific study to reduce or increase the stable slope allowance. The detailed level of study would need to be carried out by a qualified professional geotechnical engineer with specific experience in slope stability assessment. Appendix I provides additional details from Part 4 of the MNR Technical Guide.

The MNR Technical Guide- Part 4, Figure 4.14, page 4-19 (2001) outlines some of the common indicators of movement within a slope, (e.g. movement of blocks, trees with curved trunks and concave upslope, downslope bending and drag of bedded rock, displaced posts, poles, broken or displaced retaining walls and foundations).





#### Common Evidences of Creep:

- |  |  |
|--|--|
| A) Moved Joint Blocks  | E) Broken or displaced retaining walls and foundations |
| B) Trees with curved trunks concave upslope                    | F) Road and railroads moved out of alignment           |
| C) Downslope bending and drag of bedding rock, weathered veins | G) Turf rolls downslope from creeping boulders         |
| D) Displaced posts, poles, and monuments                       | H) Stone-line at approximate base of creeping soil     |

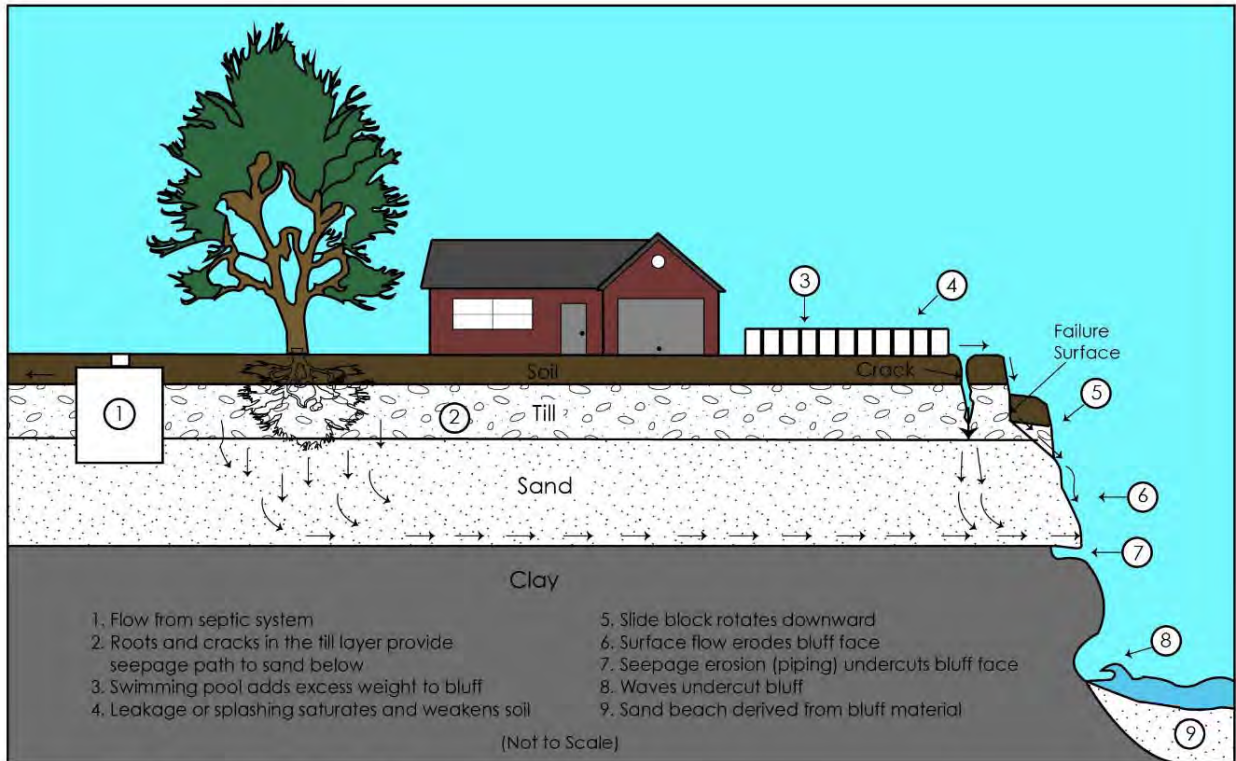
A and C represent rock-creep; all other features shown are due to soil-creep

Source MNRF Technical Guide- Part 4, Figure 4.14, page 4-19 (2001)

Figure 5.3: Evidences of Soil Creep

Figure 5.3 above shows visible signs of rock and soil creep. In determining the erosion potential of a particular site, consideration must be given to the fact that due to the cyclical nature of shoreline erosion, current potentially hazardous slopes do not always display evidence of past slope failures. In addition, some shoreline locations may not have experienced any recent failures, or conversely, where old failures have occurred they may have been small in magnitude or size and are now disguised by vegetation and surface or toe erosion.

The following schematic, Figure 5.4, taken from the MNR Technical Guide- Part 4, Figure 4.8, and pages 4-12 (2001) illustrates erosion due to wave forces at the toe of the bluff/cliff/bank, groundwater, surface water and other water sources.



Source MNRF Technical Guide- Part 4, Figure 4.8, page 4-12 (2001)

Figure 5.4: Other water sources causing drainage issues.

The erosion of soil and rock along a shoreline is dependent on numerous factors, some of which are; the soil components, the result of continuous wave action, ice, freezing and thawing, and wind. Erosion creates a hazard for humans when the land occupied by our 'permanent' buildings and structures erodes into the water; this can occur quite suddenly or over a long period of time. The Province of Ontario has determined that 100 years is a reasonable length of time to account for the determination of an average annual recession rate.



### Looking for More Information About Typical Signs of Slope Instability?

The following information includes some of the typical slope instability signs (presented in Terraprobe Riparian Fact Sheet for Landowners, 2016 and the MNR Technical Guide - Part 4). There may be other or no evidence of slope instability at all prior to a slope slide depending upon the site specific conditions. However there may be a number of indicators of instability which do indicate movement or instability of the slope.

#### 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). 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 Tree Trunks

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 Crack



A tension crack formation close to the top of slope may indicate a pending slope failure. A tension crack is a void/crack 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 hydrostatic pressure as well as the 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. are generally indicative of soil movement. Slumps and scarp 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.

The following photograph indicates a number of visible slope instability indicators occurring along the ABCA shoreline.



## Other Indicators

In general, there are a number of visible indicators of erosion which can be determined through a site investigation. A number of the more common visible indicators include:

Visible Indicator	Details
<b>bare slopes</b>	indicates erosion in the area is too rapid for plant growth to take hold
<b>hummocks on a bluff slope</b>	indicative of earth flow; look for lumpy, uneven slopes
<b>bare scarps</b>	indicative of slumping; look for bare, vertical or near vertical faces on a vegetated slope
<b>leaning trees or trees with curved trunks</b>	indicative of soil creeping down a slope face; in addition, dead trees near the edge of the bluff often suggests broken roots or loss of root support through soil creep or erosion
<b>displaced fence lines or other linear, man-made features</b>	may be indicative of soil creep
<b>springs, seeps, or bands of vegetation adapted to wet soils</b>	are generally indicative of a saturated soil or sedimentary layer which may, therefore, be susceptible to landsliding
<b>hummocks at the toe of a bluff</b>	can be indicative of an earth flow; look for topographic anomalies
<b>soil cracks, tension cracks and separations on top of the bluff or on slope face</b>	may indicate slow mass movement and potential slumping
<b>an undercut slope toe</b>	indicates an unstable slope condition
<b>leaning or stepped protection works</b>	can indicate a lowering of the foreshore which in time could undermine the slope toe creating an unstable condition
<b>presence of slumped material in the nearshore and a scalloped bluff face</b>	is direct evidence of a recent slope failure



Presence of slumped material with fallen trees along the shoreline in the nearshore. Photograph taken during site reconnaissance September 30<sup>th</sup>, 2015.





Undermining, breaking off and slumped materials along the eroding ABCA shoreline.

Some other slope instability indicators may include displaced posts/fences, stair cases, poles, monuments, guardrails, broken/displaced retaining walls, roads/rail lines out of alignment as indicated in the following photographs.



The requirements for the level of geotechnical study that is required depending on the severity of the slope stability issues are provided. Details on how to determine what level of study is required and supporting Field sheets are all also provided in MNR Technical Guide - Part 4 (2001). Please see Appendix I for this supporting documentation.

	SLOPE INSTABILITY RATING	RATING VALUES TOTAL	INVESTIGATION REQUIREMENTS
1.	Low potential	<24	Site Inspection only, confirmation, report letter
2.	Slight potential	25-35	Site Inspection and surveying, preliminary study, detailed report
3.	Moderate potential	>35	Borehole Investigation, piezometers, lab tests, surveying, detailed report
Notes:	<p>a) This chart does not apply to rock slopes or to Leda Clay slopes (e.g. Ottawa area)</p> <p>b) Choose only one from each category by circling rating value; compare total rating value with above requirements</p> <p>c) If there is a water body (i.e. stream, creek, river, pond, bay, lake) at the slope toe: the potential for toe erosion and undercutting should be evaluated in detail and protection provided if required.</p> <p>d) Refer to Section 2 for information on identifying soil types.</p>		

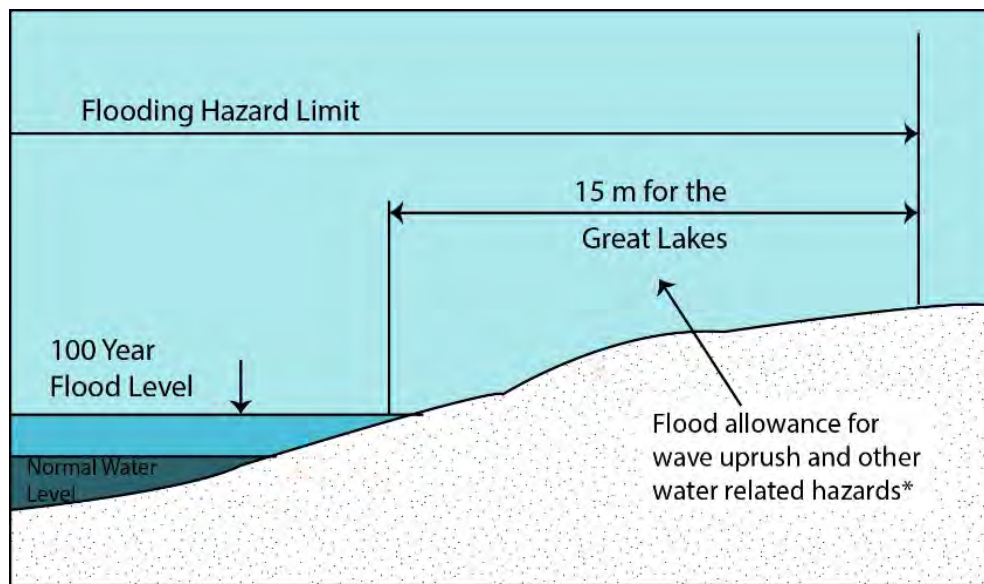
MNR Technical Guide, (2001) Erosion Hazard Part 4 - Page 4-29

## 5.2 Flood Hazard

### Definition of Flood Hazards

Flood Hazard is defined by the combination of the 100 year flood level and the flood allowance for wave uprush and other water related hazards.

The Flood Hazard is referenced in the ABCA Policy and Procedures Manual and in Part 3 of the MNRF Technical Guide document. The Ontario Ministry of Natural Resources or MNR (now Ontario Ministry of Natural Resources and Forestry or MNRF) has defined the 1:100 year flood levels on each part of the system. These are based on statistical analysis of historical levels, as well as an allowance for wind setup.



\*On connecting channels and large inland lakes, the allowance for wave uprush and other water related hazards is 5m, measure horizontally from the 100 year flood level.

Figure 5.5: Flooding Hazard Limit for the Great Lakes Coastline

Source: MNRF, Understanding Natural Hazards (2001).

Wave Uprush is caused by waves breaking onto a shoreline with water spreading inland into areas that are not normally inundated. During a major storm, powerful waves may damage shore protection works, flood buildings, and quickly erode soil. To account for wave uprush, overtopping and other water-related hazards, the Province recommends a 15 metre setback from the 1:100 year flood level on Lake Huron and the Great Lakes. There is an allowance for the option to prepare specific coastal engineering studies to allow for individual areas or site conditions. The standards set by the MNRF Technical Guide are minimums but detailed coastal studies may be carried out on a specific area by qualified coastal engineers and geomorphologists to adjust these standards for specific areas of study.





As has been noted in Section 3.6, water levels on the Great Lakes may be affected by climate change, which may alter the volume of water (and therefore the water level) in the basin, as well as the frequency and/or severity of major storms (either more or less). For this reason, the defined 1:100 year flood levels may require adjustment in the future, as knowledge about climate change evolves.

More information about the potential implications of climate change on Lake Huron shoreline process may be found in Section 4.6 and in Appendix F which contains a Discussion Paper (Appendix E) authored by Dr. Robin Davidson-Arnott.

### 5.2.1 Calculating the Flood Hazard

Calculation of the flood hazard requires that consideration be given to three factors:

1. 100-year flood level
2. Flood allowance for wave uprush
3. Flood allowance for other water related hazards

#### 1. 100 Year Flood Level:

The 100-year flood level is the minimum design flood criteria standard in Ontario. It consists of the sum of the mean lake level and the storm surge with a combined probability of the 100 year return period. This means that on average, it has a 1 percent probability of occurring in any given year or on average, once every 100 years. Detailed information about how to calculate flooding and wave uprush may be found in the MNR Technical Guide Part 3 – Flooding Hazards (2001).

The 100 year flood level as determined by MNRF (1989), and which may be found in MNRF Technical Guide Part 3 – Flooding Hazards (2001) for the ABCA section of Lake Huron, Figure 5.6 & Figure 5.7 as follows:

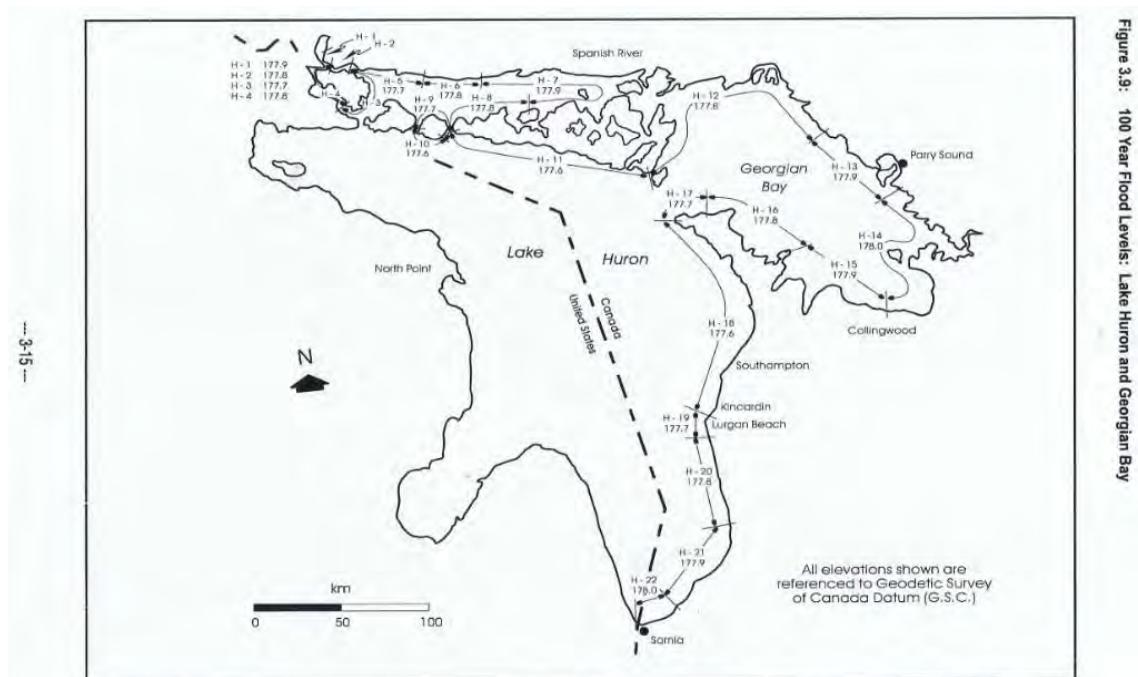


Figure 5.6: MNR 100 year Flood Levels for Lake Huron



Figure 5.7: MNR 100 year Flood Levels for ABCA area



## 2. Wave Uprush and Overtopping

Along shorelines subject to wave action, winds can drive water farther inland, beyond the 100-year flood level limit. This area covered by wave uprush must be added to the area covered by the 100-year flood level.

Along irregular shorelines, or where there are docks, shoreline protection and/or other structures, consideration must be given to wave overtopping, that is the effect of waves hitting vertical surfaces and sending spray inland. In addition, consideration must also be given to calculating the area affected when particularly strong waves overtop breakwalls, bluffs or other shoreline structures that act as barriers and ponding occurs. The ponding limit (Figure 5.8) is to be determined by a study using accepted engineering and scientific principles.

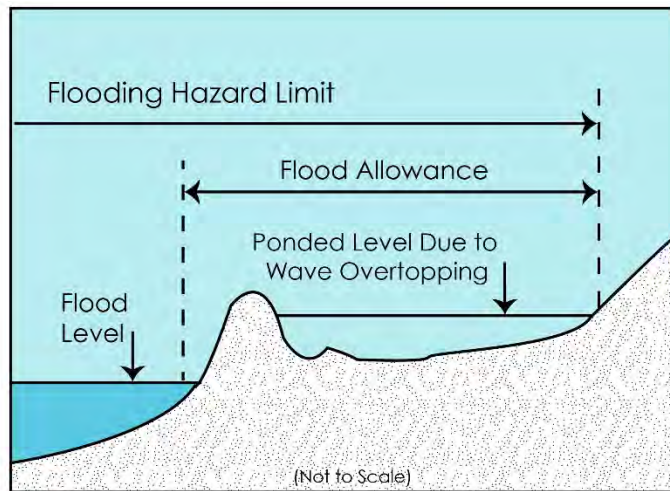


Figure 5.8: Flooding Hazard - From MNRF Figure 4.2 Flooding Hazard Limit With Wave Overtopping



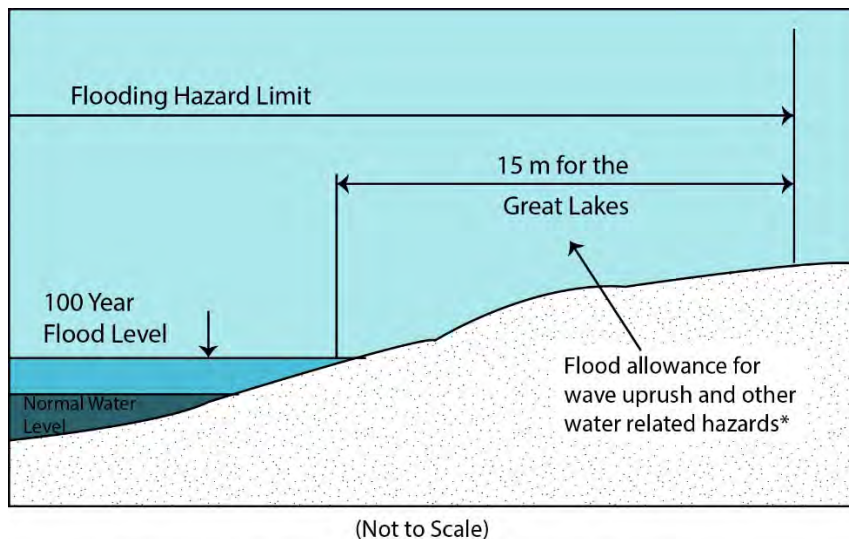
Wave Overtopping and ponding behind structures.

### 3. Other Water-Related Hazards

Other water related hazards are also required to be taken into consideration as there are other factors that can magnify the flood hazard. These other water related hazards include

- Ship-generated waves
- Ice piling. Ice pushed up onto the shore can tear out banks and other natural protection, destroy buildings. In some cases along the Great Lakes, ice has piled up more than five metres high and pushed 45 metres inland.
- Ice jamming. The build-up of large chunks of ice where lakes flow into connecting channels and rivers flow into lakes can scour the shore, destroy buildings and threaten lives. The jamming can also block water flow and raise water levels, sometimes rapidly, causing flooding.

Where specific technical information (from studies) is not available, the province requires a minimum of 15 metres, measured horizontally from the 100 year Flood level to be included for wave uprush and other water related hazards. Figure 5.9 below illustrates this requirement.



\*On connecting channels and large inland lakes, the allowance for wave uprush and other water related hazards is 5m, measure horizontally from the 100 year flood level.

Figure 5.9: Flooding Hazard - Source: MNRF, Understanding Natural Hazards (2001).

Where the 15 metre allowances is considered to be either too large or too small, a study may be carried out by professionally qualified coastal engineer or coastal geomorphologist. The flooding hazard limit would then be determined by relying on:

- 1) The 100-year flood level, plus
- 2) The flood allowance for wave uprush and other water-related hazards as determined by a site-specific study conducted by a professionally qualified coastal engineer or coastal geomorphologist.

Wave uprush may overtop banks or protection works and the water may collect, or pond, beyond the 100-year flood level, thereby causing a long-term flooding hazard. This is why the overtopping allowance is also considered when determining the wave uprush/overtopping and other water related hazards allowance.

### 5.2.2 Floodproofing

Floodproofing is generally defined as a combination of structural changes and/or adjustments incorporated into the basic design and/or construction or alteration of individual buildings, structures or properties subject to flooding hazards so as to reduce the risk of flood damages, including wave uprush and other water related hazards along the shorelines of the Great Lakes - St. Lawrence River System. It is acknowledged that this term is somewhat misleading, in the sense that total protection from flood damage cannot be assured. Although there is provision in the PPS for Floodproofing, they are not common along the ABCA shoreline.

### 5.3 Dynamic Beach Hazard

Under the Provincial Policy Statement the Dynamic Beach Hazard recognizes the need to take into account the processes associated with high lake levels and large waves produced by storms that cause erosion of sandy beach and dune systems as well as the wave and wind processes that lead to the rebuilding of the beach and dune during the months and years between these major events. The identification of a Dynamic Beach hazard developed out of increased understanding of the controls on the dynamics of sandy beach and dune systems and especially the interaction between them.

#### 5.3.1 Understanding Dynamic Beaches

Under a storm event, especially during periods of high lake level, waves erode the upper beach and the foredune and the beach/dune sediments will be carried lakeward and deposited in the nearshore on bars. In turn, wave breaking on the bars is intensified, thus reducing the wave energy reaching the beach and dune (Figure 5.11 a). During the low energy periods following storms waves bring the sediment onshore leading to a build-up of the beach and winds transport sand into the dune system over a period of years where it is trapped by vegetation and leads to a build-up of the dune (Figure 5.11 b). During periods of low lake level moderate storms may only erode the beach but during periods of high lake level and especially during an intense storm wave erosion may extend 10-30 metres into the dune (Figure 5.11 a). Erosion by waves may occur in a matter of hours but rebuilding of the beach may take many months and rebuilding of the dunes by wind may take a decade (Figure 5.11 b).

Figure 5.11 a)





Figure 5.11 b)



Figure 5.11 a & Figure 5.11 b): Erosion and recovery from a large storm, Long Point Provincial Park, Lake Erie: a) photograph taken after the storm of December 2, 1985 showing erosion of the foredune by 15-20 m. Note the tree stumps on the beach and the narrow, flat beach; b) the same site in 2008 showing a wider, higher beach and accretion of the foredune by wind completely burying the old dune scarp. Note that the lake level is considerably lower in 2008 than in 1985 thus permitting the foredune to build lakeward.

This natural cycle of beach and dune erosion and accretion is indicated in Figure 5.12.

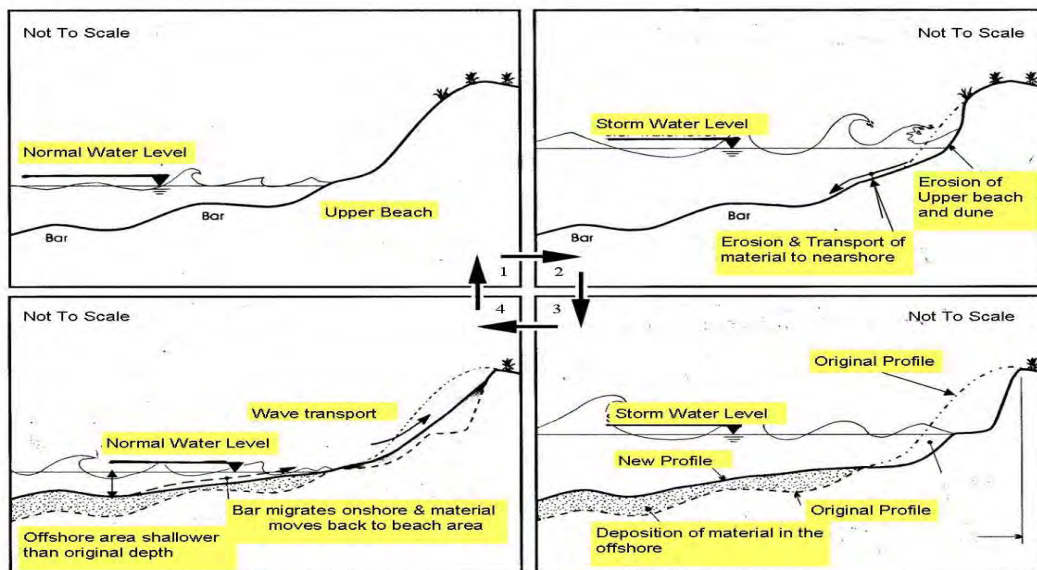


Figure 5.12: the cycle of beach and dune erosion and accretion. Source from MNRF Technical Guide-Part 5 (2001).



The landward extent of erosion by waves during a storm depends on the mean lake level, the height of the surge produced by the storm winds, the height and period of the storm waves, and the beach width and height of the foredune. There are still a lot of uncertainties in models used to predict beach and dune erosion during storms and thus tests were made during the development of the Technical Guidelines to determine an appropriate setback distance. One of those test sites was at Oakwood, just north of Grand Bend where the maximum dune erosion during the high lake level periods of 1972 and 1985-86 was identifiable on aerial photographs and in the field (Figure 5.13). These tests showed that a horizontal setback of 30 m beyond the regulatory flood standard (100 year flood elevation + 15 metres for wave uprush) was sufficient to delineate the area subject to wave erosion during the largest storm events.



Figure 5.13: The test site at Oakwood used to determine the limit of wave erosion during major storms associated with periods of high lake level. Measurements here show that the maximum erosion is accommodated within a 30 m distance landward of the Regulatory Flood Standard. There is no long-term recession at this site.

The beach/dune system itself provides a natural barrier that protects the area landward of it against flooding and erosion hazards during storms as well as a reservoir of sand that acts to replenish the beach and nearshore. The Provincial Dynamic Beach Allowance recognizes the need to keep development away from this zone both to protect development against the hazard (Figure 5.14 a) and to prevent such development from impeding the natural processes that rebuild and maintain the beach and dune system following storm events (Figure 5.14 b).

Figure 5.14 a)



Figure 5.14 b)

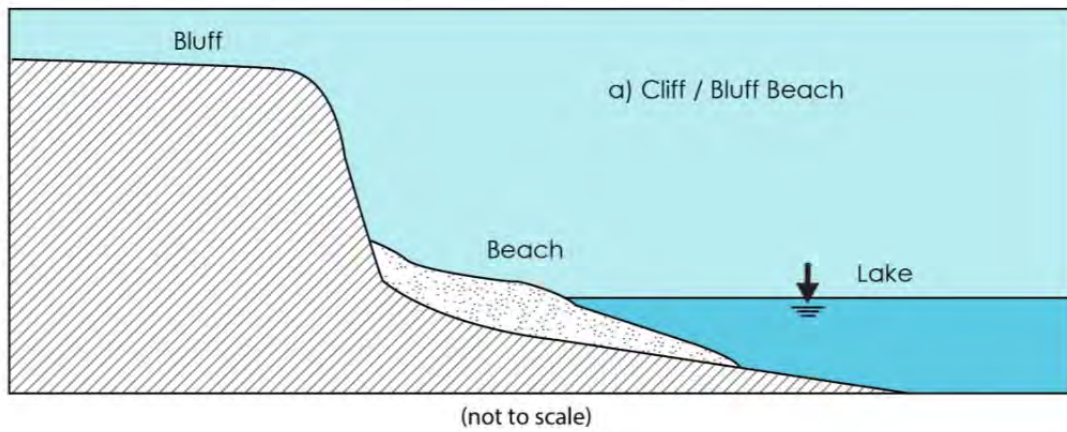


Figure 5.14: Dynamic beach and development: a) development is located behind the foredune at this location permitting the beach and dune system to operate naturally and keeping structures out of the hazard zone; b) development is located within the hazard zone requiring the use of a seawall which restricts the beach width and prevents development of a natural sand dune.

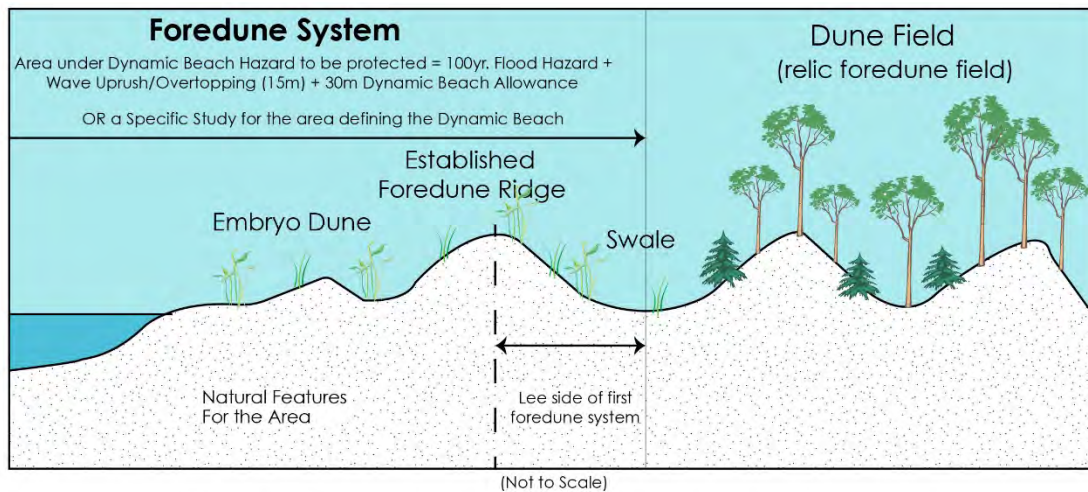
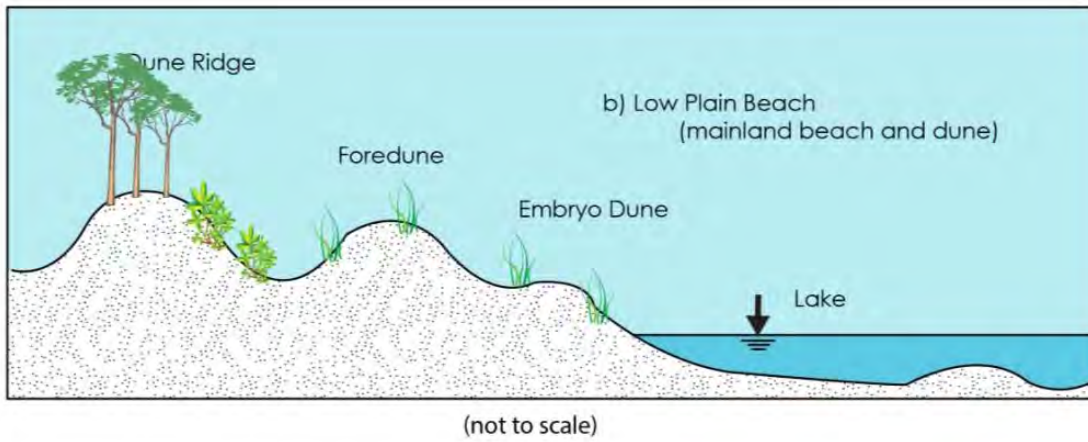
### 5.3.2 Definition and Mapping of the Dynamic Beach Hazard

The term 'dynamic beach' is used in the MNR Technical Guide (Part 5 pages 5-10) to describe beach profiles that undergo changes on a broad range of time scales in response to changing wind, wave and water level conditions and to changes in the rate of sediment supply. The Provincial scheme recognizes three main types of dynamic beach: Figure 6.16 a) Cliff/Bluff Beach; b) Low Plain Beach (mainland beach and dune); and c) Barrier Beach. a) Cliff/Bluff Beach;





b) Low Plain Beach (mainland beach and dune);



Base Figure taken from Davison-Arnott, Robin, 2010. Introduction to Coastal Process and Geomorphology, Cambridge University Press, ISBN #978-0-521-69671-5 Paperback. Pg. 232,

and the c) Barrier Beach Systems. Barrier beaches are not found along the ABCA shoreline.

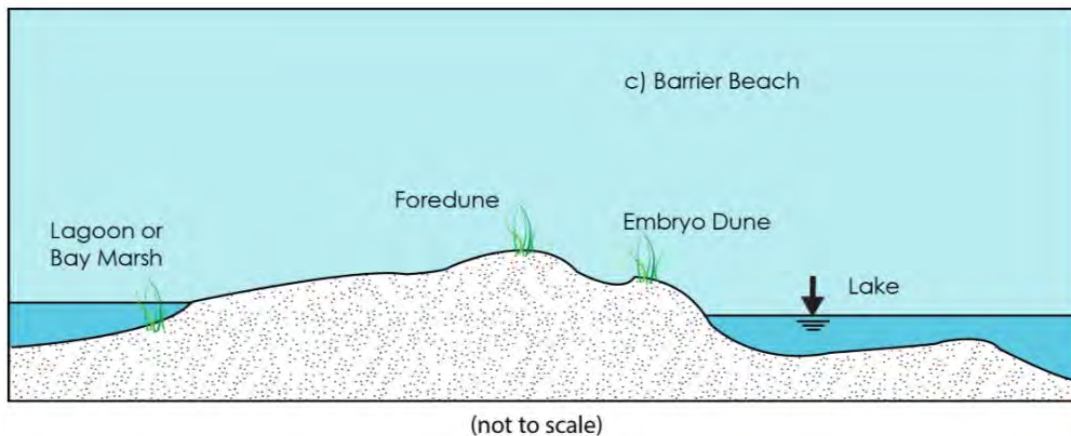


Figure 5.16: Schematic of the three main types of dynamic beach

All beaches along the ABCA shoreline are exposed to sufficient wave action and lake level fluctuations that they qualify as dynamic. Where beaches consist of sand and/or gravel overlying bedrock or cohesive sediments (Cliff/Bluff Beaches) a minimum width, alongshore length and thickness of sediments is necessary for the processes of erosion and accretion to be sufficiently large to meet the requirements of dynamic beach.

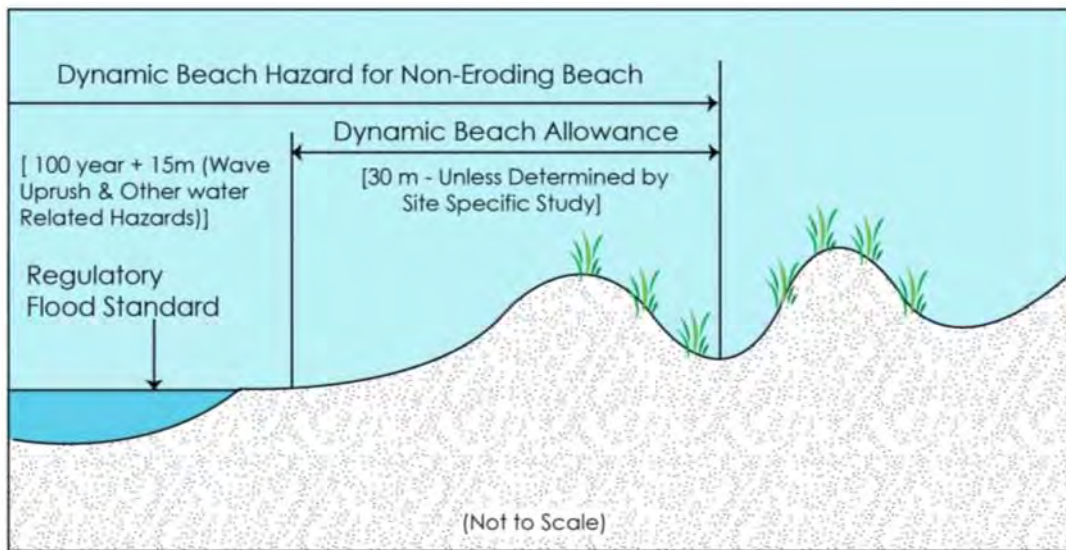
The MNR Technical Guide requirements for the Classification of a Dynamic Beach must have all of the following;

- minimum values of: width = 10 metres;
- length = 100 metres,
- thickness = 0.3 metres; and
- the fetch is more than 5 kilometres.

Where the bluff is sufficiently far landward that the toe is no longer subject to wave action, as is the case for example along much of the file beaches north of Grand Bend and Bayfield, it is treated simply as a mainland dynamic beach. However, when the bluff toe is within the zone that is subject to flooding and wave uprush then the area is subject to both a dynamic beach hazard and an erosional cohesive bluff hazard with the bluff toe marking the landward limit of the dynamic beach hazard.

In the case of a mainland dynamic beach, the dynamic beach hazard is calculated first by determining the location of the 100 year flood elevation and then a 15 m horizontal allowance for wave uprush (the flood hazard limit), and then a 30 m horizontal dynamic beach allowance (Figure 5.17 a).

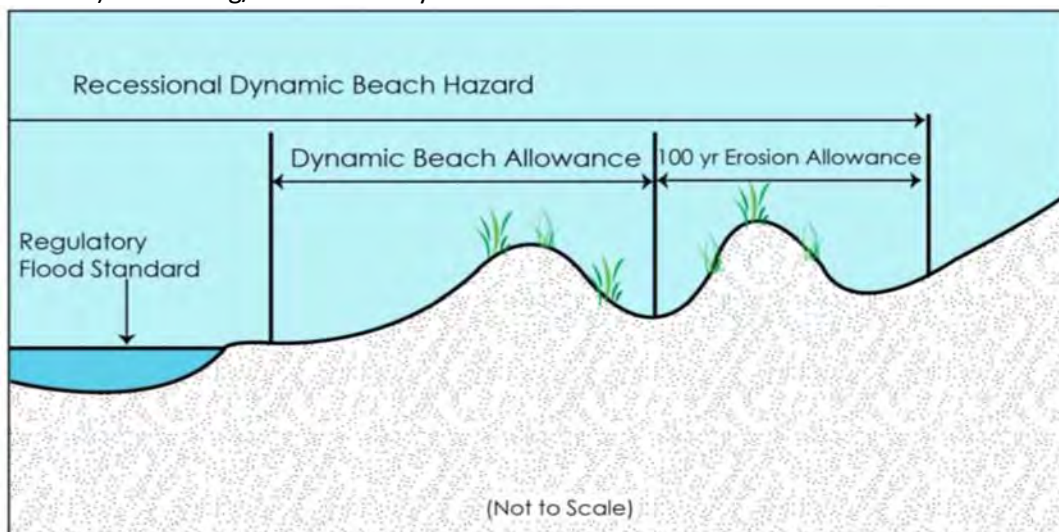
Figure 5. 17 a) A Non-eroding Dynamic Beach



From: Dr. Robin Davidson-Arnott, Department of Geography, University of Guelph, rdarnott@uoguelph.ca

Similar to the case for an eroding cohesive bluff, where there is long-term recession of the shoreline an erosion allowance must be calculated which is equal to 100 x the average annual recession rate (Figure 5.17 b). The distance of 30 metres for the dynamic beach setback may be changed (increased or decreased) if a study by an accepted coastal engineer or coastal geomorphologist shows that it is appropriate.

Figure 5. 17 b) An Eroding/Recessional Dynamic Beach:



From: Dr. Robin Davidson-Arnott, Department of Geography, University of Guelph, rdarnott@uoguelph





The beaches along the ABCA shoreline offer tremendous value economically, socially and ecologically. As was evident in the initial community survey, promoting greater public access to beach and shoreline areas and protecting beaches from erosion are top-of-mind concerns for community members. It is important that the beaches be carefully managed and protected to ensure that they can continue to be enjoyed for future generations. Many of these beaches are unique in that they constitute a dynamic beach hazard which recognizes that the interface between the land and water creates a dynamic environment as a result of wave erosion during storms and water level fluctuations.

Where a dynamic beach exists lakeward of an eroding cohesive bluff (Figure 5.18) then the regulations for dynamic beach apply to the area lakeward of the bluff toe (Figure 5.19), including restrictions on all new development. The erosional hazard consisting of the stable slope allowance and an erosion allowance is then applied to the area landward of the bluff toe (Figure 5.20).



Figure 5.18: Oblique aerial photograph of a portion of the ABCA shoreline south of Bayfield showing a dynamic beach backed by an eroding cohesive bluff.

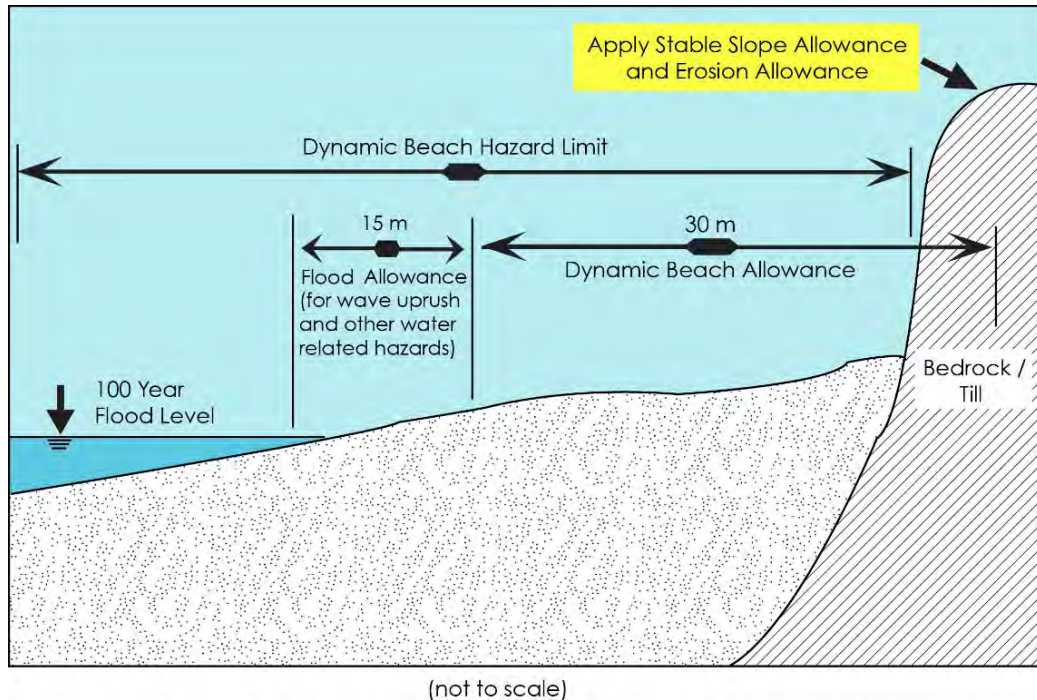


Figure 5.19: Schematic of the location of the dynamic beach hazard limit on and eroding cohesive bluff shoreline. The bluff/cliff limits the Dynamic Beach Allowance and requires that the Erosion Hazard criteria be applied along with the Dynamic Beach Hazard (from MNR Technical Guide (Figure 5.6) Page5-12.

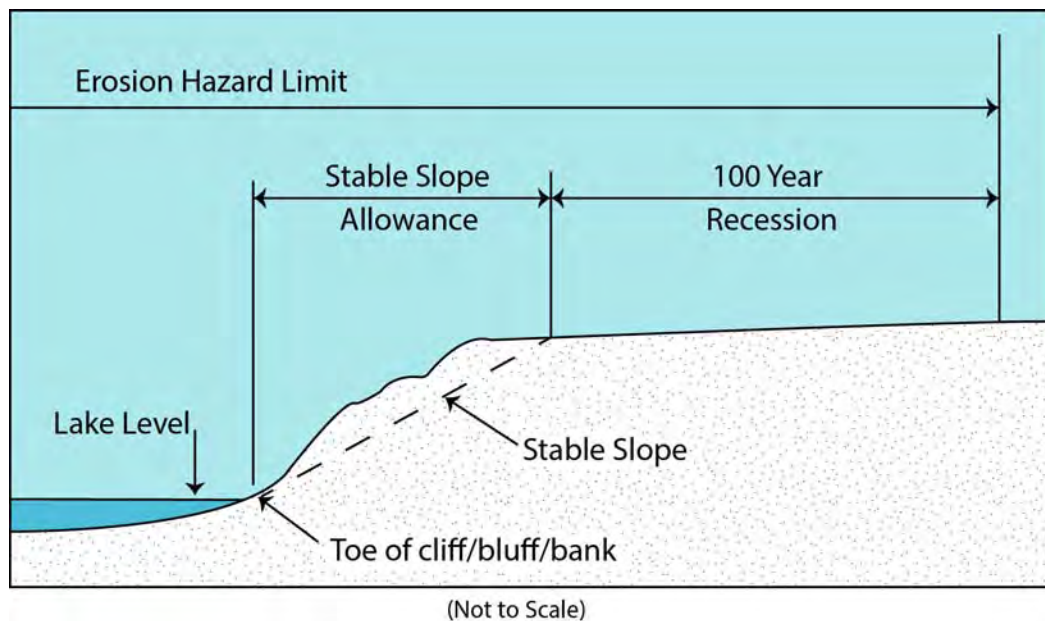


Figure 5.20: Erosion Hazard criteria must also be applied along with the Dynamic Beach Hazard (from MNR Technical Guide.

In the vicinity of large creeks and river mouths, such as at Port Franks, movement of the location of the river mouth makes for greater complexity and it may be necessary to extend the dynamic beach allowance to accommodate the additional beach and dune dynamics. This is best done on a case-by-case basis taking into account the historical limits of this movement.

## 5.4 Defining Lakeshore Area 1 and 2

In the ABCA SMP 2000, it was recognized that incorporating the provincial policies which reflect the lakeshore's hazardous nature can be a complex task. Therefore the ABCA classified the shoreline into Lakeshore Area 1 and Lakeshore Area 2 to assist in the implementation of their mapping and development guidelines.

In order to provide consistency with the previous SMP and mapping, the current update has continued with this same nomenclature and partitions but the definitions have been updated to take into account current provincial policies and the ABCA *Regulation for Development, Interference with Wetlands and Alterations to Shorelines and Watercourses*' (Ontario Regulation 147/06).

The heading from the Development Chart (see Charts in Section 7.8 ABCA Shoreline Development Guidelines) which outlines a summary of the various Lakeshore Area 1 and 2 categories is provided below.

Lakeshore Area 1			Lakeshore Area 2		
Flood		Dynamic Beach	Erosion	Dynamic Beach	Erosion
100 Year Flood Allowance	15 m (Wave Uprush + OWRH)	100 year flood level + 15 m (Wave Uprush+OWRH) + 15 m* (ABCA Specific Allowance)	Stable Slope Allowance 3:1	Defined Portion of DBH - 30 m	Erosion Allowance = 100 x AARR + 15 m** (ABCA Specific Allowance)

\*NOTE: The additional ABCA 15m allowance\*, consists of a Specific ABCA Dynamic Beach Allowance.

\*\*NOTE: The additional ABCA 15m allowance\*\*, is a Specific ABCA Allowance consisting of an Access Allowance of 6m plus provision for any recent erosion changes.

The following definitions have been used:

### 1) Lakeshore Area 1

**Flood Hazard** – That area of the shoreline landward (or inland) from the water's edge, including the 100-year flood level plus wave uprush and Other Water Related Hazards (OWRH) setback (which is 15m in the absence of a site specific study). This is also known as the Regulatory Flood Standard.

**Erosion Hazard** - That area of the shoreline landward (or inland) from the water's edge, including the stable slope line (3H:1V), from the toe of the lakebank.

**Dynamic Beach Hazard** - That area landward (or inland) from the water's edge including the *100-year flood level* plus a distance of 30 metres measured horizontally. This 30 metres includes the 15 Wave Uprush and Other Water Related Hazards (OWRH) plus an additional ABCA 15 m allowance\*. It is part of the active beach zone and portion of the dune complex which would be affected by wave action during the 100-year plus wave uprush event (or historical storm event causing dune cliffing or erosion).

\*The additional 15m allowance, consists of a specific ABCA Dynamic Beach Allowance.

## 2) Lakeshore Area 2

**Flood Hazard** – not applicable

**Erosion Hazard** - That area of the shoreline located landward (or inland) from Lakeshore Area 1 extending landward **to the greater of**; a 100 year erosion setback (based on the 100 year Average Annual Recession Rate) or 30 m, plus an additional 15 metre allowance **\*\* OR** a measured distance of 45 metres from the top of the unaltered lake bluff.

**\*\*** The additional 15m allowance, consists of an Access Allowance of 6 m plus provision for any recent erosion changes.

**Dynamic Beach Hazard** - That area landward (or inland) from Lakeshore Area 1 plus the *Defined Portion of the Dynamic Beach* which is a distance of 30 metres. This 30 m is called the “*Defined Portion of the Dynamic Beach*” and is also part of the active beach zone and portion of the dune complex which would be affected by wave action during the 100-year plus wave uprush event (or historical storm event causing dune cliffing or erosion).

## 6.0 Special Considerations

### 6.1 Public Safety

Public safety impacts need to be given careful consideration in light of the risk to life during emergency situations. Existing provincial policy, articulated in Section 3.1.6 of the PPS (page 31, PPS 2014) notes the following:

*“development and site alteration may be permitted in those portions of hazardous lands and hazardous sites where the effects and risk to public safety are minor, could be mitigated in accordance with provincial standards, and where all of the following are demonstrated and achieved:*

- a) development and site alteration is carried out in accordance with floodproofing standards, protection works standards, and **access standards**;*
- b) vehicles and people have a way of safely entering and exiting the area during times of flooding, erosion and other emergencies...”**



What is the Access Standard?

The access requirement is to allow for safe access (ingress and egress) during times of erosion emergencies on a property and also includes providing access for both emergency and regular maintenance equipment to allow suitable access for regular maintenance, repairs, future rehabilitation or replacement of slope stability or shoreline protection works. The access allowance should also include being able to travel through the property to the lake and along the shoreline.





The minimum recommended access allowance as provided for in the MNRF Technical Guide is 6 metres. It is recommended that a 6 metre access allowance be applied for the ABCA shoreline.

## 6.2 Emergency Access

Ontario's Emergency Management Act defines an emergency as "a situation or an impending situation caused by the forces of nature, an accident, an intentional act or otherwise that constitutes a danger of major proportions to life and property." In keeping with the Emergency Management and Civil Protection Act, R.S.O., 1990, c.E.9, it is a mandatory requirement for all Ontario municipalities to have Emergency Management Programs based on local hazards and risks which are regulated by Emergency Management Ontario.

Working closely with municipal partners, ABCA has provided hazard maps to representatives from the Police, Fire and Emergency Management Services. Digital mapping for the Stable Slope Allowance and the Erosion Hazard Limit will be delivered by county and municipal governments as well as to emergency responders. While the County of Huron and the County of Lambton each have Emergency Response Plans in place, these plans focus more prominently on the individual and collective role of community leaders and emergency response agencies in the event of an emergency situation that requires a collaborative response.

Any potential for significant property damage or risk to human life should be taken into account and an appropriate plan put in place to address these issues both strategically and proactively (e.g. through the Huron Ready notification system). **Consideration should be given to ensuring that any Emergency Preparedness Plans include notification to shoreline land owners of the hazards and risks associated with buildings and activities that may be subject to natural shoreline hazards.**

The following highlights some additional recommended emergency responses for properties located along the shoreline hazard areas.

### **Flooding Hazard Areas:**

ABCA is responsible for providing warnings of potential flood events that may pose a threat to watershed residents. Based on watershed conditions, warnings may be sent to watershed municipalities who have the responsibility to react to ensure resident safety.

### **Erosion Hazard Areas:**

Any observation of potential slope instability **should immediately be brought to the attention of ABCA and Municipal authority.**

- Appropriate safety fence should be installed and maintained by the property owner (e.g. Municipality or private landowner) 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 professional geotechnical engineer and regulatory agencies.



The configuration of the slope should not be altered without prior consultation with a professional qualified geotechnical engineer and approval from the appropriate authorities.

### 6.3 No Authority to Require Inspection and Maintenance of Shoreline Protection Works



There is no legislative authority to enable ABCA to require property owners to regularly inspect and maintain any existing shoreline protection structures. Field reconnaissance confirmed (as noted previously) that there are many instances where shoreline protection works have not been maintained. This is an important consideration given the potential implications for adjacent property damage that may result from shoreline structural failures either during storm events, or over time.



During intense storm events these structures may fail through toe erosion, overtopping and/or flanking thus leading to damage or destruction of buildings behind and adjacent to the failed structure. This failure can occur very rapidly during a storm, thus posing a hazard to the safety of people occupying the buildings in areas adjacent to where the original failure occurred.

## 7.0 Managing Shoreline Hazards Responsibly

### 7.1 Overall Management Philosophy and Approach – To Manage Responsibly

This section outlines the management approach to address both existing and future shoreline development along the ABCA shoreline. The management approach is consistent with the vision, guiding principle and key objectives of the Shoreline Management Plan and are a direct reflection of established provincial policy.

As has been established at the outset, the overall management philosophy and approach is premised on a “managing responsibly” philosophy and practice.

Provincial policy direction is clear: no new hazards are to be created; existing hazards are not to be aggravated and adverse environmental impacts are not to result. Given the number of structures located in the erosion hazard limit alone, the approach that is recommended is one that advocates for responsible management along the entire ABCA shoreline. This requires a strategic approach that looks to eliminate the risk to human life and property damage over time by ensuring that buildings and structures are located outside of the hazard. This approach is one that is upheld by existing provincial policy, supported by legislation and the mandate assigned to conservation authorities and confirmed in existing municipal planning documents.

The approach and overall philosophy supports:

1. A **clear** science-based approach and commitment to ongoing monitoring and identification of hazards.
2. A **prevention-first** philosophy that reduces the risk to natural hazards over time.
3. **Collaboration through voluntary compliance** by affected landowners by encouraging the location of existing buildings and structures outside of areas subject to erosion, flooding and dynamic beach hazards.
4. **Consistency** across the entire shoreline and the treatment of development – existing and new – the same.

The recommended management approach focuses on the importance of engaging landowners and working collaboratively with municipal partners to ensure that there is clarity, consistency, certainty and collaboration moving forward. It is premised on the need to recognize the changing nature of the shoreline and the need to advance a responsible management approach to ensure that the shoreline remains accessible, ecologically intact, enjoyable and safe for all.



What is different from current practice? What should the ABCA be doing differently?

At the present time, ABCA does not permit new development in areas susceptible to flooding, erosion or dynamic beach hazards. Alterations to existing structures however have been permitted in the Lakeshore Area 1 and 2 and these have, over time, been assessed on an individual case-by-

case basis. Moving forward, it is recommended that ABCA continue to deny permits for all new development in areas that are subject to flooding, erosion and dynamic beach hazards but it is also recommended that ABCA deny applications for permits that include alterations to existing structures. This marked departure from current practice is necessary to ensure that ABCA is upholding established provincial policy which requires the authority to ensure that:

- No new hazards are created;
- Existing hazards are not aggravated; and
- Adverse environmental impacts do not result.

## 7.2 Managing the Erosion Hazard Responsibly

Shoreline bluffs subject to wave action at the slope toe, commonly experience cycles of erosion and slope instability leading to crest recession. The wave action undercuts and locally over-steepens the slope toe. The over-steepened slope results in local slumping which progresses up the slope. The slumping is a natural phenomenon which helps flattening of the slope to eventually achieve a stable inclination and establish vegetation provided the toe erosion is stopped and addressed. **Slope stabilization may not be feasible on some shorelines such as cohesive shores due to continuous undercutting and erosion occurring offshore (under water) which may impact the long-term stability of the slope.**



On the ABCA cohesive shores, the long term stabilization of the toe of the bluff/slope with shoreline protection works, may also not be feasible because of this continual offshore undercutting and erosion. A qualified professional geotechnical engineer should be consulted to determine the site specific slope stability issues and determine if protection works are possible for the site.

Within the Provincial Policy the shoreline hazard zone for both Cohesive Bluff and Dynamic Beach includes provision for a setback equal to 100 times the average annual recession rate based on an analysis of historical shoreline recession rates. All new development is to be located landward of this setback. The 100-year planning horizon is designed to provide a reasonable lifespan for the use of private dwellings and associated infrastructure and it thus forms an important element of a strategy of Managed Retreat (MR) as a long-term way of addressing the hazard posed by ongoing erosion and shoreline recession. This approach permits the maintenance of the amenities provided to the general public by beaches within the ABCA shoreline for the foreseeable future.

The following Sections 7.2.1 and 7.2.2 outline the impacts on the coastal zone and the lake/land interactions for bluff stabilization and shoreline protection works. It discusses the various zones within this area (i.e. onshore, backshore, nearshore and offshore) as they are extremely important in defining the type of impacts which occur within those individual zones and whether or not the impacts will be too great to allow structures (hard or soft techniques) within those zones. Further general environmental considerations have also been included and can be found in Section 7.9. It is the assessment of the impacts on both the natural process and the environment that is key in carrying out the requirements of Section 3.1.7 of the PPS. The following highlights the relevant units from Section 3.1.7 of the PPS that are key to ensure the appropriate implementation of these requirements.

From Section 3.1.7, Further to policy 3.1.6, and except as prohibited in policies 3.1.2 and 3.1.5, *development* and *site alteration* may be permitted in those portions of *hazardous lands* and *hazardous sites* where the effects and risk to public safety are minor, could be mitigated in accordance with provincial standards, and where all of the following are demonstrated and achieved:

- c) *development* and *site alteration* is carried out in accordance with *floodproofing standards*, ***protection works standards***, and *access standards*;
- d) vehicles and people have a way of safely entering and exiting the area during times of flooding, erosion and other emergencies;
- e) **new hazards are not created and existing hazards are not aggravated;**
- f) **No adverse environmental impacts will result."**

### 7.2.1 Bluff Stabilization Works



On their own, bluff stabilization measures are insufficient to address an erosion hazard on a shoreline that is eroding due to wave action and the downcutting associated with the cohesive soils in the ABCA jurisdiction. However they may be considered as a method to temporarily delay the slope instability aspects of the erosion processes.

Specific bluff works may be considered to assist in **temporarily** providing some stabilization of the bluffs.



Some of the bluff measures that may be permitted include the following:

- planting stabilizing vegetation on the bluff slope,
- controlling drainage of the surface runoff and/or
- the groundwater flow, and/or
- the regrading of the slope.



More information about these measures is provided below:

**Planting stabilizing vegetation on the bluff slope - Vegetation and bioengineering**

Vegetation can be used to help temporarily stabilize soil on the face of a slope by anchoring the soil with the root mass and by reducing the velocity of the surface runoff flow (see the following Figure 7.1). It can improve the visual quality of a shoreline area and provide wildlife habitat.

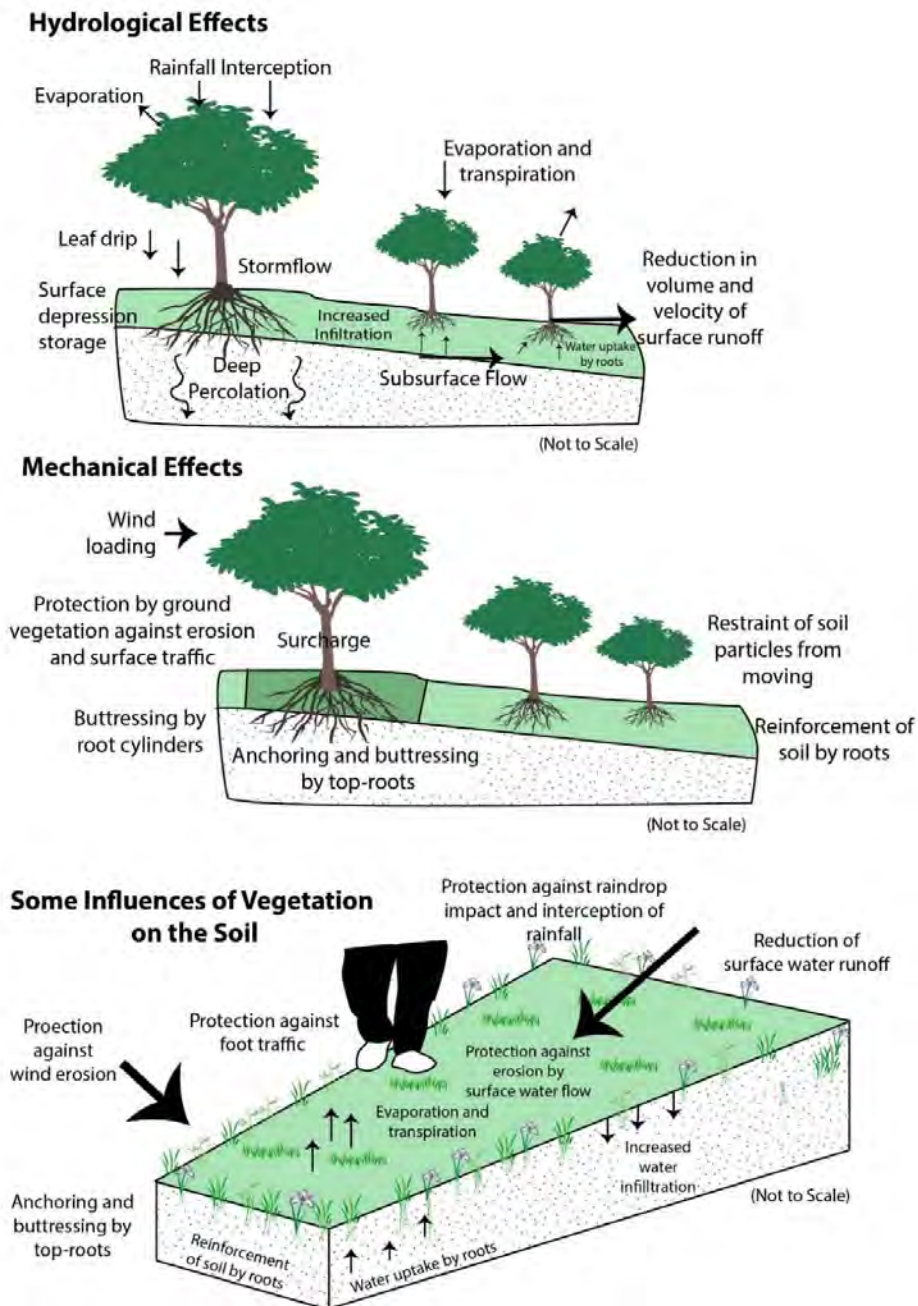


Figure 7.1 from MNRF Technical Guide Part 4: Erosion Hazards, Figure 4.13, The Importance in Vegetation Controlling Surface Erosion Pp. 4-17(2001).



Bioengineering combines structural measures with live plant materials in order to stabilize the slope face (see the following Figures 7.2 & Figure 7.3). Native plant species which are compatible with the local flora should be used.

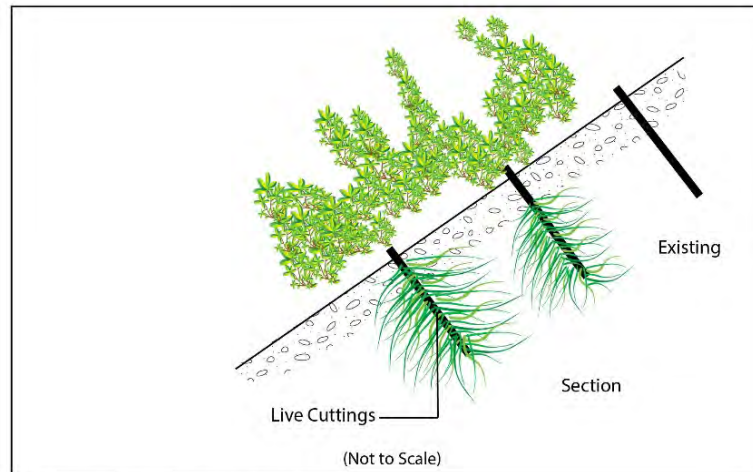
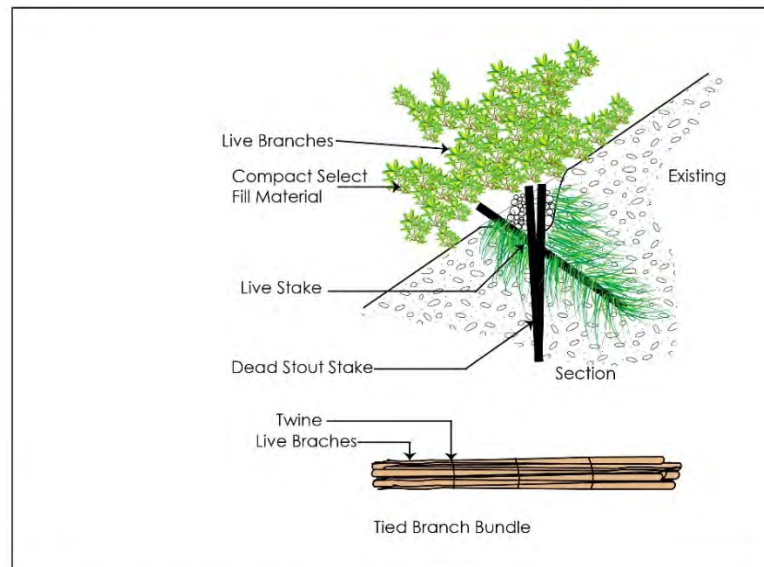


Figure 117 - Live Staking (from Gray and Sotir, 1996)

Figure 7.2: Bioengineering Live Staking - Source: Gray & Sortir: Figure 117, MNRF- Terraprobe, Geotechnical Principles for Stable Slopes (1997) Page 140



Gray and Sortir: Page 141 - Wattling Figure 119 (1996)

Figure 7.3: Bioengineering Wattling - Source: Gray & Sortir: Figure 119, MNRF-Terraprobe, Geotechnical Principles for Stable Slopes (1997) Page 141

In order to promote vegetation growth on the slope face, yard and other waste must not be discarded over the slope. All drainage should be directed away from the bluff slope and/or bluff face. Site grading and drainage should prevent direct concentrated or channelized surface runoff from flowing directly over the slope. Other sources of water that need to be controlled (e.g., not freely discharged down the slope face) include lawn sprinkling, downspouts, swimming pool drainage and leaks and possibly septic systems should not be permitted to flow over the slope.

**Surface drainage.** The erosive effects of surface drainage on a slope can be reduced by directing water away from the slope (see the following Figure 7.4) or by providing an erosion resistant swale or channel which conveys the water down the slope face in a controlled manner.

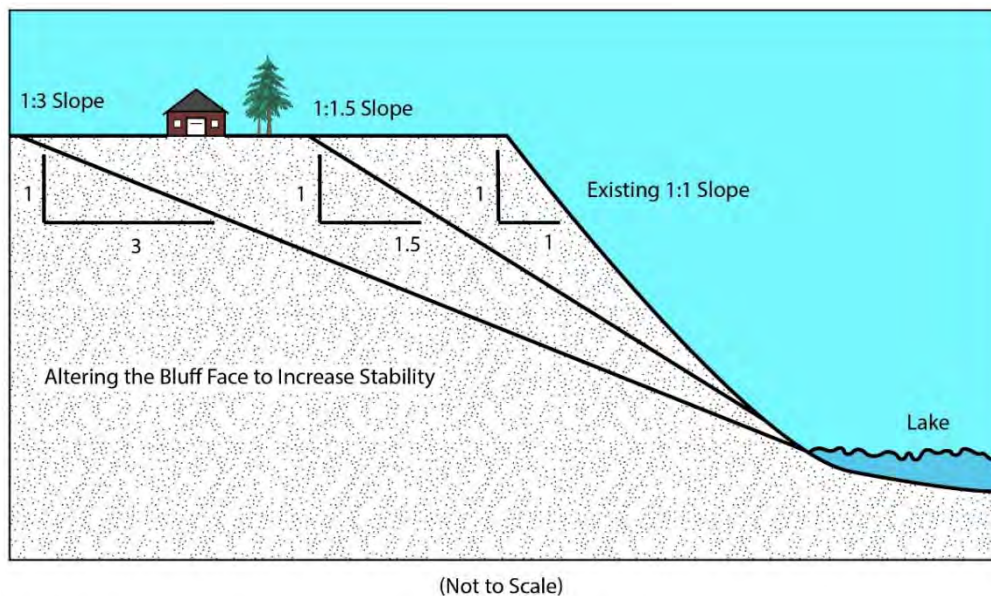


Figure 7.4: Surface Drainage Issues, From MNRF – Figure 34, Terraprobe, Geotechnical Principles for Stable Slopes (1997) Page 37

**Internal drainage improvements.** Where internal drainage (groundwater) is causing bluff erosion and instability, the drainage can be improved by interceptor drains, french drains or tile drains.

**Regrading slope.**

Where the existing bluff is oversteep and unstable, the bluff can be regraded to a flatter slope (see the following Figure 7.5). Regrading is often accompanied by drainage improvements and revegetation.



MNR - Technial Guide - Part 4: Regrading Slope Page 7-20 -- Figure 7.9 (2001)

Figure 7.5 – Regrading Slope Source MNRF Technical Guide – Part 7, Pg. 7-20 (2001)

Further guidance and details on bluff measures can be found in MNRF Technical Guide Part 4: Erosion Hazards, Terraprobe Inc., pp.7-13 & 7-19 (2001).

### 7.2.2 Shoreline Protection Works

Within the ABCA jurisdiction, cohesive bluffs are present along much of the shoreline from the northern boundary to an area between Poplar Beach Road and Oakwood. As is noted in Section 4.3, bluff recession occurs along much of this shoreline at low to moderate rates, with some substantially higher rates on the order of 0.6-0.9 m/y. A wide range of privately constructed shore protection can be found along the shoreline, and much of it is poorly constructed, not maintained and has suffered damage or destruction in the past. Because of underwater erosion of the cohesive till, recession will be an ongoing hazard for hundreds of years to come (see Appendix F). It has been recognized for some time that the continuing underwater erosion is an issue for the design of successful shore protection structures since deepening in front of the structure will ultimately destroy the foundations – this is described in some detail in the report by Baird and Associates (1994) prepared for the ABCA first Shoreline Management Plan.

In general, shore protection structures constructed by private shore property owners offer protection for a limited time, they are typically ad-hoc, not coordinated with other properties works and there are not consistently maintained. Examples of some of the problems associated with private shore protection structures are to be found along the shoreline within the ABCA jurisdiction and are illustrated in Section 4.2. The ABCA Shoreline – Field Observations. The report by Baird and Associates (1994) also details the potential impacts of all types of structure on the coastal environment and on the erosion rates downdrift.

If Municipal or government marine structure (e.g. jetty, marina's, breakwaters) exist and they are owned by the Municipality or other government agency it is assumed that the cost of maintenance may be the responsibility of this public agency. Then additional works could be considered as a result of any problems created by these existing works since the agency has the responsibility to not only rectify any negative impacts on landowners, but also to maintain any works which are constructed.

**We recommend that construction of 'hard' shoreline protection structures by private landowners not be permitted on the cohesive bluff coast within the jurisdiction of the ABCA and the rationale for this can be summarized as follows:**

1. Hard shore protection structures work best when they are designed by a qualified coastal engineer for the particular coastal conditions, constructed of uniform materials, are continuous alongshore, and are properly tied in to the substrate. Private shore protection along the ABCA coast generally does not meet any of these criteria. They are often unsuited for the environmental conditions, are put in at different times, vary in materials and construction, are poorly tied in alongshore and to the base of the bluff, and thus their lifespan is shortened because of failure of the structures during storms and/or failure of adjacent protection.
2. Private shore protection is often poorly maintained and so is vulnerable when there is a sudden rise in lake level as occurred in 2015. In addition, it is often poorly designed to accommodate the downcutting in the nearshore that occurs continuously and is subject to

- overtopping by waves during periods of high lake level. Practice in the Great Lakes has typically shown that the most durable and effective structure is an armourstone revetment with protection extending onto the nearshore profile beyond its base. Such structures are very expensive compared to the value of properties along the ABCA cohesive bluff coast and hence the benefit/cost ratio is often highly uneconomic.
3. The ABCA has no authority to require landowners to put in shore protection or to maintain it, and therefore no ability to ensure that a properly designed and effective scheme for shore protection is put in place along a section shoreline. Moreover, it has no ability to ensure that such a scheme meets the requirements of the established provincial policy that: No new hazards are created, existing hazards are not aggravated, and adverse environmental impacts do not result.
  4. The presence of structures can have two forms of impacts on adjacent properties: updrift structures can increase erosion on the adjacent downdrift property by refraction of waves around vertical structures whenever the structures are subject to wave attack. Both vertical structures and groynes can also divert sediment away from the downdrift adjacent property thus reducing the protective beach cover layer of material. Thus, the construction of shore protection can create or increase the erosion hazard for properties immediately downdrift.
  5. The presence of shore protection will lead to a reduction in sediment supply to the coast from bluff recession. This can increase the erosion hazard for downdrift properties along the cohesive coast because it diminishes the protection afforded by the presence of sediments on the beach and in the shallow nearshore zone. In turn this promotes an increase in the rate of toe erosion at those sections of the shoreline where the presence of the sediment cover acts to keep recession rates low. It may also lead in some critical areas to a switch from stability to one of erosion. It will ultimately also have an impact on the stability of the beach and dune systems at Bayfield, Grand Bend and Pinery Provincial Park.
  6. Because of the effect of ongoing erosion underwater and reduced sediment supply from updrift the width of the beach in front of shore parallel structures is reduced so that increasingly water is at the base of the structure and the longshore continuity of the beach is reduced. This has the effect of reducing the amenity/recreational value of the shoreline for all residents and has an impact on the habitat the beach provides for many terrestrial species but also on the waterfowl and shorebirds.
  7. While the impact of shore protection at an individual property is small, the ABCA must consider that shore protection has already been put in place along a substantial portion of the shoreline and that the potential exists for it to be extended to the whole of the cohesive bluff shoreline. The effect on the coastal environment of permitting shore protection along many kilometers of shoreline is likely very severe and should warrant a full Environmental Impact study to ensure that it is compatible with the Provincial policy.

#### **Public Shoreline Areas:**

An exception to the policy of no shore protection structures may be considered where it is necessary to protect public works, infrastructure or buildings that cannot be removed or located in a non-hazardous place. Examples of this might be sections of road that cannot be relocated immediately and are needed to provide for public and/or emergency access, or facilities such as pumping stations, water intake or filtration plants that must be located close to the lake. Shore protection may also be needed to protect private property where erosion, or increased erosion, has resulted from large public facilities such as the jetties used to protect the entrance to the harbours at Bayfield and Grand



Bend. If 'soft' alternatives are not feasible (e.g. Beach Nourishment), then it may be necessary to use structures to provide the protection. In these cases the structures must be designed by a qualified professional coastal engineer and the municipality or other appropriate government agency that will bear the cost of construction and maintenance.

#### **Non-structural measures: Beach Nourishment**

Beach nourishment is perhaps the best known of so-called 'soft' measures to protect against shoreline erosion. It acts by adding sediment of an appropriate mean and range of size to the beach and/or shallow nearshore in front of an eroding shoreline. Generally environmental impacts at the location and downdrift are considered to be low or insignificant, but this should be confirmed by an environmental assessment when the coastal engineering design is carried out. The other key component is that an appropriate source of sediment needs be located and no environmental impacts occur as a result of the removal of this source material. Nourishing the beach in front of an eroding bluff may reduce the rate of toe erosion for a limited time. However, because of ongoing longshore sediment transport the nourished material will only stay in place for a matter of days to months, with the length of time that protection is afforded increasing with the volume of the nourishment and length of shoreline over which it is dispersed. Nevertheless nourishment may provide a feasible method for reducing toe erosion for a limited time, e.g., during a period of very high lake level, and its effectiveness may be enhanced if is applied over a distance that includes multiple shoreline properties. It is recommended that the ABCA permit beach nourishment projects to protect private properties provided they are designed by a qualified professional coastal engineer and that the nourished sediment is appropriate for the environment. The sediment should be confirmed by an environmental assessment and no environmental impacts occur as a result of removal from its source or placement along the shoreline. Please see Appendix K for further information.

**It is recommended that beach nourishment be considered by ABCA as an accepted measure to protect these shoreline areas against erosion. Beach nourishment will likely only be practical where it is carried out by a number of landowners collaboratively.**

The following chart, Figure 7.6 is taken from Dr. J.W. Kamphuis, (Introduction to Coastal Engineering and Management, 2000) and provides a general summary of some of the impacts that the various types of shoreline structures can have on the nearshore, backshore and onshore areas.

Management Procedure								Influence	Impact
Nourishment	Fill	Dike	Revetment	Seawall	Groins	Headlands	Offshore Breakwaters		
			x	x	x	x	x	Decreases sediment supply	Increases long-term erosion
x								Increases sediment supply	Decreases long-term erosion
x					x	x	x	Impedes littoral transport	Accretion/erosion
					x	x	x	Diverts sediment to deep water	Increases erosion downdrift
						x	x	Impedes cross-shore transport	Decreases beach movement
			x	x	x	x	x	Increases reflection	Localized scour
			x	x	x	x	x	Concentrates wave action	Localized scour
						x	x	Decreases wave exposure	Decreases circulation
x			x	x	x			Occupies backshore	Alters backshore topography
x					x	x	x	Occupies nearshore	Alters nearshore topography
	x	X						Occupies onshore	Alters onshore topography
x	x	X	x	x	x	x	x	Alters onshore terrain	Alters onshore topography
	x	X	x	x				Disrupts drainage	Alters water flow



Figure 7.6: Impact of Structural Shore Management Practices - From J.W. Kamphuis, Introduction to Coastal Engineering and Management, Page 250, Table 10.17:, (2000)

In summary, the use of 'hard' shore protection structures on the cohesive bluff shoreline within the ABCA shoreline is not recommended given that it is not in keeping with established provincial policy (i.e., no new hazards are created; existing hazards are not aggravated; and no adverse environmental impacts will result) and raises issues of potential liability with respect to downdrift impacts. However it is recommended that 'soft' protection in the form of beach nourishment can be considered as an accepted measure to protect these shoreline areas.

### 7.3 Managing the Flooding Hazard Responsibly

There are several locations along the cohesive bluff shoreline, such as along Drysdale Beach Road (see Photos below Figure 7.7) and Sandy Beach Road, where habitable buildings are located at the base of the bluff and may be subject to flooding due to wave uprush during periods of high lake level.



Figure 7.7: Drysdale Beach Road with development located along the toe of the bluff.

These structures are primarily situated on a dynamic beach and thus subject to erosion of the beach during periods of high lake level. In some cases they are close to the flood hazard limit and many have some form of shore protection. In general these areas are best dealt with under the dynamic beach hazard within the flooding hazard component and in some cases, are also located within the dynamic beach hazard.

The area around the mouths of the Ausable River (Figure 7.8) and Mud Creek at Port Franks is highly dynamic as a result of shifting of the river channel (Mud Creek Figure 7.9) and the interaction of the discharge of the Ausable River with sand transport along the shoreline.



Figure 7.8: Development around the Mouth of the Ausable River



Figure 7.9: Development around Mouth of Mud Creek

Some developments close to the shoreline are subject to flooding from the river which may be exacerbated by the back-up of water during high lake level and strong onshore winds. Shoreline movement may also be related to dredging of the mouth of the Ausable River. The situation is a complex one and in some areas hazard management may require an appropriate study to determine the best approach to hazard management.

#### 7.4 Managing the Dynamic Beach Hazard Responsibly

In keeping with provincial policy, all new development is set back landward of the dynamic beach hazard limit and this has resulted in the development of a well-vegetated dune zone in front of dwellings in the Oakwood area north of Grand Bend and also south of the harbor at Grand Bend to the border with Pinery Provincial Park as well as cottages around Port Franks

(Figure 7.10). It is recommended that ABCA develop and post a consistent set of guidelines with respect to beach access trails and limits to the size and location of structures such as decks, gazebos and boat storage and the area permitted to be cleared of vegetation.

Access paths should be no more than 2 m wide. They may be simply left as bare sand, or they may be covered with bark chips, plastic mesh or similar material. A wooden boardwalk may be used instead of a path but it should not be raised more than 0.5 m above the sand bed. Simple rail platforms for seasonal storage of small watercraft such as canoes, kayaks and sailboards may be placed 5 m landward of the edge of vegetation but larger structures such as decks and roofed storage must be placed at least 15 m landward of the vegetation line and should not exceed 16 square metres in area.

Good stewardship should be encouraged to ensure that the beach and dune, and the protection they provide, is maintained. The Port Franks Beach and Dune Stewardship Guide (Lake Huron Centre for Coastal Conservation, 2008: <http://lakehuron.ca/uploads/pdf/Beach.Stewardship.Guide.for.Port.Franks-2008.pdf>) provides an excellent guide to all landowners on sandy beach and dunes within the ABCA shoreline. Please see the Development Guidelines chart.



Figure 7.10: Setback of dwellings beyond the dynamic beach hazard limit has permitted the persistence of a well-vegetated foredune which provides protection to the area landward.



## 7.5 Responsible Management Where More Than One Hazard Applies

Along the entire shoreline the ABCA has completed the evaluation process of assessing all three of the hazards (Flooding, Erosion and Dynamic Beach) and created Hazard mapping for their entire jurisdiction. In areas where there are more than one hazard, and where the outlets of rivers, gullies or creeks meet the lake, then all of the hazards of both systems need to be assessed, evaluated and mapped. The governing hazard will be the furthest landward limit of all the applicable hazards. See the Figure 7.11 below for an example of how this is done in a river mouth outlet situation.

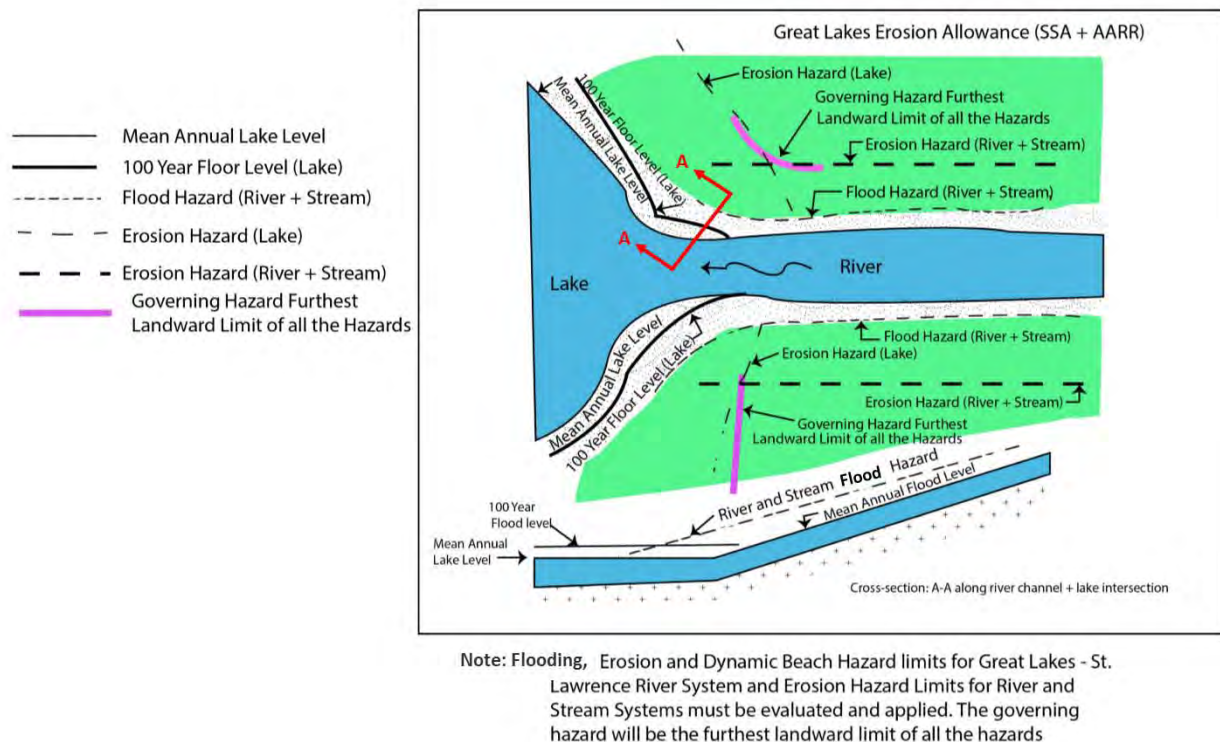


Figure 7.11: Overlap and Governing Hazard of furthest Landward Limit - Source MNRF Natural Hazard Training Manual. Page 53 (1997).

In keeping with approved provincial policy, in areas of the ABCA shoreline where more than one hazard applies, it is recommended that the conservation authority apply the most restrictive approach. This has been carried out by the ABCA and the summary Hazard mapping has been provided in Appendix C.

## 7.6 Best Management Practices – Bluff Best Management Practices

Best management practices for bluff situations include the following:



It is imperative that any signs of slope instability are brought to the immediate attention of the ABCA and the municipality.



All approvals and permits must be secured from applicable regulatory authorities prior to any site alteration.



The configuration of the slope should not be altered without prior consultation with a professional qualified geotechnical engineer and approval from the appropriate authorities.



Appropriate safety fencing 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 professional geotechnical engineer and mandated regulatory agencies.



The 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, but a minor sheet flow may be acceptable.



In order to promote vegetation growth on the slope face, yard and other waste must not be discarded over the slope.



A temporary silt fence should be erected and maintained around or downside of any work area during construction as approved by regulatory agencies.



Coordination with adjacent properties to eliminate imposing any impacts on neighboring properties is extremely important.



## 7.7 Dune Beach Best Management Practices

Readers are directed to the Port Franks Beach and Dune Stewardship Guide provides an excellent guide to all landowners on sandy beach and dunes within the ABCA shoreline. For more information about important stewardship and best management practices this guide can be found at the following link; <http://lakehuron.ca/uploads/pdf/Beach.Stewardship.Guide.for.Port.Franks-2008.pdf>. 'Port Franks Beach and Dune Stewardship Guide' by Huron Centre for Coastal Conservation, (2008).

## 7.8 ABCA Shoreline Development Guidelines

The following shoreline development guidelines are recommended for existing and new development:

ABCA Updated Shoreline Management Plan 2016  
**Consultant Recommended Shoreline Development Guidelines**

Development Activity Permitted (Yes/No)	Lakeshore Area 1			Lakeshore Area 2		
	Flood		Dynamic Beach	Erosion	Dynamic Beach	Erosion
	100 Year Flood Allowance	15 m (Wave Uprush + OWRH)	100 year flood level + 15 m (Wave Uprush+OWRH) + 15 m* (ABCA Specific Allowance)	Stable Slope Allowance 3:1	Defined Portion of DBH - 30 m	Erosion Allowance = 100 x AARR + 15 m** (ABCA Specific Allowance)
<b>Existing Development</b>						
Additions (including external alterations) to existing habitable dwellings, unattached garages, accessory buildings and/or boat houses	No	No	No	No	No	Yes, provided: (i) the addition is minor <sup>7</sup> ; and (ii) condition <sup>8</sup> is met; and (iii) transitional provision <sup>2</sup> applies.
External repairs and/or maintenance which is not like for like to existing buildings or structures (no intensification of use and no additional dwelling units) <sup>1</sup>	No	No	No	No	Yes but apply transitional provisions <sup>2</sup>	Yes, provided transitional provision <sup>2</sup> or <sup>3</sup> applies.
Interior alterations (renovations, repairs) to existing habitable and non-habitable buildings and structures including unattached garages and/or accessory buildings provided no increase in habitable space <sup>4</sup>	Yes	Yes	Yes	Yes	Yes	Yes
Rebuilding of destroyed habitable or non-habitable building or structure whether destroyed by natural shoreline hazard or other factors <sup>5</sup>	No	No	No	No	No	Yes, provided: (i) condition <sup>8</sup> is met; and (ii) transitional provision <sup>2</sup> applies

<sup>1</sup> Intensification means conversion of existing use, a change from single family to multi-family use and/or the conversion of accessory buildings and structures to habitable space. Intensified can also mean the change of use of space from non-habitable (e.g. exterior sun room/deck) to habitable (e.g. enclosed sun room/deck, bedroom etc.)

<sup>2</sup> ABCA to identify sunset clause for additions, alterations, repairs and/or maintenance (e.g. 10 years) after which none permitted in Lakeshore Area 2.

<sup>3</sup> ABCA to identify sunset clause for additions, alterations, repairs and/or maintenance (e.g. something other than 10 years) after which none permitted in Lakeshore Area 2.

<sup>4</sup> Encourage relocation outside of the hazard over time through voluntary landowner compliance.

<sup>5</sup> Existing and new development are subject to the same development guidelines.

Development Activity Permitted (Yes/No)	Lakeshore Area 1			Lakeshore Area 2		
	Flood		Dynamic Beach	Erosion	Dynamic Beach	Erosion
	100 Year Flood Allowance	15 m (Wave Uprush + OWRH)	100 year flood level + 15 m (Wave Uprush+OWRH)+ 15 m* (ABCA Specific Allowance)	Stable Slope Allowance 3:1	Defined Portion of DBH - 30 m	Erosion Allowance = 100 x AARR+ 15 m** (ABCA Specific Allowance)
Existing Development (Continued)						
Relocation of habitable dwellings away from the shoreline	Yes	Yes	Yes	Yes	Yes	Yes
Relocation of accessory buildings or structures away from the shoreline including unattached garages, accessory buildings or structures	Yes	Yes	Yes	Yes	Yes	Yes
Expansion of existing septic systems	No	No	No	No	No	No
Repairs and/or maintenance to existing septic systems	Yes but apply transitional provision <sup>2</sup>	Yes but apply transitional provision <sup>2</sup>	Yes but apply transitional provision <sup>2</sup>	Yes but apply transitional provision <sup>2</sup>	Yes but apply transitional provision <sup>2</sup>	Yes provided transitional provision applies <sup>2</sup>
Alterations or repairs to existing swimming Pools	No	No	No	No	Yes but apply transitional provision <sup>2</sup>	Yes, provided condition <sup>9</sup> is met; and transitional provision <sup>2</sup> applies.

<sup>6</sup> Intensified use means conversion of existing seasonal to year-round use, a change from single family to multi-family use and/or the conversion of accessory buildings and structures to habitable space. Intensified can also mean the change of use of space from non-habitable (e.g. exterior sun room/deck) to habitable (e.g. enclosed sun room/deck, bedroom etc.)

<sup>7</sup> Minor additions: less than 30% of area of existing dwellings/footprint (excluding the garage(s). An example would be if 30% was 9m<sup>2</sup> allowed on the ground floor, or it could allow 4.5 m<sup>2</sup> on 2 floors.

<sup>8</sup> Permitted provided: the erosion rates are <0.3 m/yr or 1) a minimum setback of 7.5 m from stable slope crest; and 2) it does not increase occupancy of existing structure; and 3) maintenance access to existing protection works is not diminished.

<sup>9</sup> Permitted provided (for Pools): the erosion rates are <0.3 m/yr or 1) a minimum setback of 7.5 m from stable slope crest; and 2) drainage is addressed; 3) maintenance access to existing protection works is not decreased; and 4) existing ingress/egress is not reduced.

<sup>10</sup> Advise landowner of erosion risk. Permitted provided safety concerns due to erosion hazards are addressed considering site conditions and nature and use of structure and maintenance access to any existing protection works is not decreased. It is recommended if any structure is within 5 m of stable slope crest, that surcharge effects on slope stability be assessed by a geotechnical engineer. Provided no adverse environmental impacts will result.

<sup>11</sup> Seasonal/temporary/removal Frames or Ramps to hold sail boat/canoe/ boards etc. provided no adverse impacts to dune areas or the environment.



Development Activity Permitted (Yes/No)	Lakeshore Area 1				Lakeshore Area 2	
	Flood		Dynamic Beach	Erosion	Dynamic Beach	Erosion
	100 Year Flood Allowance	15 m (Wave Uprush + OWRH)	100 year flood level + 15 m (Wave Uprush+OWRH)+ 15 m* (ABCA Specific Allowance)	Stable Slope Allowance 3:1	Defined Portion of DBH - 30 m	Erosion Allowance = 100 x AARR+ 15 m** (ABCA Specific Allowance)
Existing Development (Continued)						
Additions to existing stairs and/or boardwalks.	No	No	No	No	No	No
Alterations, repairs and/or maintenance to existing stairs and/or boardwalks.	No	No	Yes	Yes	Yes	Yes
Additions, alterations, repairs and/or maintenance of existing in water structures.	No	No	No	No	No	No
New Development						
New habitable buildings or structures	No	No	No	No	No	No
New accessory building or structure (non-habitable, movable, not connected to main structure) including a decks, shed and/or gazebo	No	No	No	No	No	Yes provided condition <sup>10</sup> is met.
New Unattached Garage	No	No	No	No	No	No
Creation of a new lot (severance, subdivision)	No	No	No	No	No	No
Parks or open space use with no buildings or structures located in the hazard and no alteration of grade	Yes	Yes	Yes	Yes	Yes	Yes
Boat Ramps/Frames (deemed to be seasonal, temporary and removable.)	No	Yes provided condition <sup>11</sup> is met.	No	Yes provided condition <sup>11</sup> is met.	Yes provided condition <sup>11</sup> is met.	N/A
In-Water Docks	Yes	Yes	No	No – N/A	No – N/A	No – N/A
Swimming Pools	No	No	No	No	No	Yes, provided condition <sup>9</sup> is met.
Creation of a technical severance (e.g. a boundary adjustment where no new lot is created).	Yes	Yes	Yes	Yes	Yes	Yes
Lot consolidation	Yes	Yes	Yes	Yes	Yes	Yes



Development Activity Permitted (Yes/No)	Lakeshore Area 1				Lakeshore Area 2	
	Flood		Dynamic Beach	Erosion	Dynamic Beach	Erosion
	100 Year Flood Allowance	15 m (Wave Uprush + OWRH)	100 year flood level + 15 m (Wave Uprush+OWRH)+ 15 m* (ABCA Specific Allowance)	Stable Slope Allowance 3:1	Defined Portion of DBH - 30 m	Erosion Allowance = 100 x AARR+ 15 m** (ABCA Specific Allowance)
New Development (Continued)						
Land use designation/zoning changes	Support changes to planning documents to recognize Hazard, Natural Environment or Open Space designations and zoning. No support for intensification of use. (See footnote condition 6).			Support changes to planning documents to promote inclusion of a Lakeshore Overlay (L) designation and zoning provisions. No support for proposed land use designation, official plan changes or zoning provisions that intensify use. (See footnote condition 6).		
New in water structures and shoreline protection works.	No	No	No	No	No	No
Bluff Works for temporary Stabilization of Slope (Includes drainage works, placement of Fill and/or Re-grading of slope).	No - N/A	No - N/A	No - N/A	Yes as part of geotechnical engineered bluff works.	No - N/A	Yes as part of geotechnical engineered bluff works.
Placement of Artificial Beach Material (e.g. beach nourishment). <sup>i</sup>	Yes	Yes	Yes	No - N/A	Yes	No - N/A
Large scale placement of fill not associated with on-site development or redevelopment (e.g. commercial fill).	No	No	No	No	No	No
Removal of Beach Material	No	No	No	No - N/A	No	No - N/A
Lot re-grading.	No	No	No	No unless associated with bluff or slope stability works.	No	No unless associated with bluff or slope stability works.

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<sup>i</sup> Provided no new hazards are created, existing hazards are not aggravated and no adverse environmental impacts will result. Must be designed by a qualified professional engineer and/or coastal geomorphologist.

OWRH = Other Water Related Hazards

N/A = Not Applicable

NOTE: Footnote # <sup>3</sup> was added as an Option to Consider an Additional Provision for Implementation, this could also apply to the other Footnote <sup>2</sup> items throughout the chart if the ABCA could like to change the suggested Implementation time frame: ABCA to identify sunset clause for additions, alterations, repairs and/or maintenance (e.g. something other than 10 years) after which none permitted in Lakeshore Area 2.

\*NOTE: The additional ABCA 15m allowance\*, consists of a Specific ABCA Dynamic Beach Allowance.

\*\*NOTE: The additional ABCA 15m allowance\*\*, is a Specific ABCA Allowance consisting of an Access Allowance of 6m plus provision for any recent erosion changes.

## 7.9 Managing the Impacts on the Environment

A summary of the Environmental Features within the ABCA jurisdiction can be found in Section 2.3.3 & Figure 6 of the ABCA SMP 2<sup>nd</sup> Edition (2000). The assessment of the impacts on both the natural process and the environment is key in carrying out the requirements of Section 3.1.7 of the PPS. The following highlights the relevant units from Section 3.1.7 of the PPS.

- 3.1.7 Further to policy 3.1.6, and except as prohibited in policies 3.1.2 and 3.1.5, *development* and *site alteration* may be permitted in those portions of *hazardous lands* and *hazardous sites* where the effects and risk to public safety are minor, could be mitigated in accordance with provincial standards, and where all of the following are demonstrated and achieved:
- d) no adverse environmental impacts will result.”**

Potential impacts can be categorized, based on the importance of the ecosystem affected, the spatial extent of the impact, the recovery rate of the ecosystem, the potential for mitigation and the consideration of cumulative effects.

The location of protection works in the coastal zone (e.g., onshore, backshore, or nearshore) dictates to a large degree the biological community or habitat which may be potentially affected. See Figure 4.5 for the coastal zone descriptions. Structures which occupy or impact the nearshore can have a direct negative impact on the fish and aquatic habitat as the sedimentation process are disturbed and can directly cover the bottom substrate. This can result in the direct loss of fish habitat. The significance of impacts on the productive capacity of fish is related to the nearshore habitat type. For example, exposed bedrock and exposed cohesive substrates have low productivity compared to other substrates such as cobble/boulder and wetland areas. In some instances, the covering of substrates such as cobbles and boulders by cohesive sand materials will destroy habitat and productivity of the habitat.

An alteration of erosion and deposition patterns may result in changes to existing habitat areas. The reduction in a new supply of surficial sediments (e.g., sand, gravel, cobble, boulders) may reduce the amount and distribution of this substrate in the nearshore area. The amount to which the supply of this material is altered relates to the type and erodibility of the backshore material. For example, the protection of a bedrock cliff will have little effect on the supply of new sand/gravel, or cobble/boulder deposits. A cohesive bluff, however, with a high content of glacial materials may contribute substantially to the supply of coarse materials in the nearshore. Protection works should not be constructed in critical source areas as these will negatively impact the supplies of these substrates for the aquatic communities.

Onshore structures can directly affect the terrestrial habitat and often indirectly the fish and aquatic habitat in the area. The indirect impacts of protection works located on the onshore on aquatic habitat must also be considered. Fish and aquatic habitats and wetland areas may be affected by the disruption of surface and groundwater drainage, or an increase in erosion and sedimentation resulting from onshore works. The physical impacts associated with shoreline management approaches located in onshore, backshore and nearshore areas, and the potential habitats affected (e.g., terrestrial, aquatic and wetland) are summarized on Table 8.2. of the MNRF Technical Guide and provide some assistance in outlining these impacts which must be considered in any coastal or bluff works.

Some of the highlight for the nearshore environmental considerations have been outlined below and additional information is provided in Appendix L for the backshore areas. Further details for all coastal zone areas can be found in MNRF Technical Guide - Part 8 (2001).

#### 7.10 River Mouth Dredging

Three locations have been identified within the ABCA jurisdiction where river mouth dredging is of concern. These include:

1. Port Franks
2. Grand Bend
3. Bayfield

The recommended management approach is the same for all of the mouths of the rivers/creeks, as follows:



If any dredging takes place then the materials should remain in the system and be placed close to the beach on the downdrift/ shadow side of the mouth of the river that has been dredged. This is a general recommendation for all dredging where the sediment is predominantly sand and gravel derived from longshore sediment transport that has infilled the entrance to the harbour/marina.

Mitigation of any temporary disruption of the sediment should be addressed specifically for the individual sites, and this may require a specific dredging study.

Any dredging work should be carried out in consultation with a qualified coastal engineer or geomorphologist who will determine the level of study required, varying from a letter to a full study, again depending on specific needs and local requirements.



## 1. Port Franks

At Port Franks the area of concern is currently being propeller washed two or three times every week.



Updrift Side (Left Hand Side) of River Mouth



Downdrift Side (Right Hand Side) of River Mouth

This is not a deep dredging activity. A review of the site has indicated that it would be best to direct the material to the south side of the mouth of the river, in this way the sediment would assist in providing material for the properties along this section whose owners feel they are experiencing reduced materials on their beach.

## 2. Grand Bend



The recommendation for Grand Bend is that any dredged materials should be returned to the system on the downdrift/ shadow side of the creek or river mouth. In the figure above, the downdrift/shadow side is on the right hand side of the photograph.



Updrift side of River Mouth



Downdrift Side of River Mouth

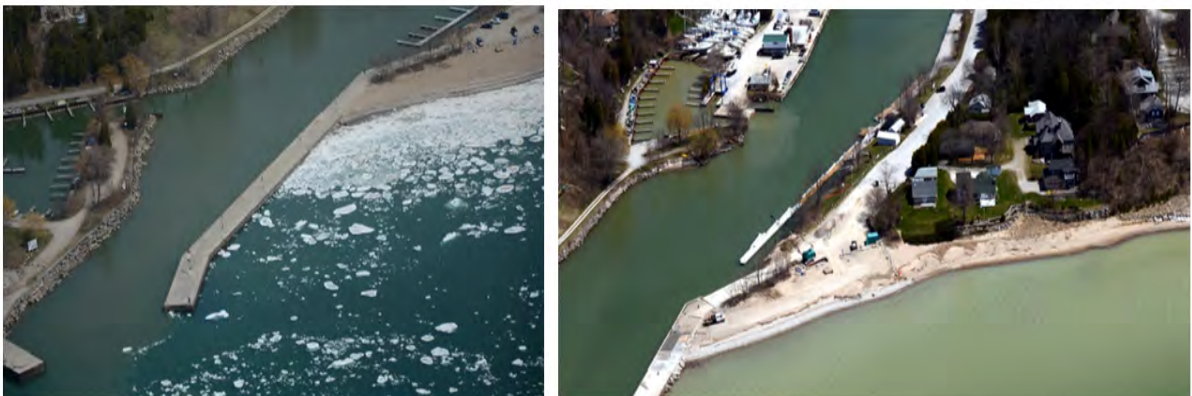
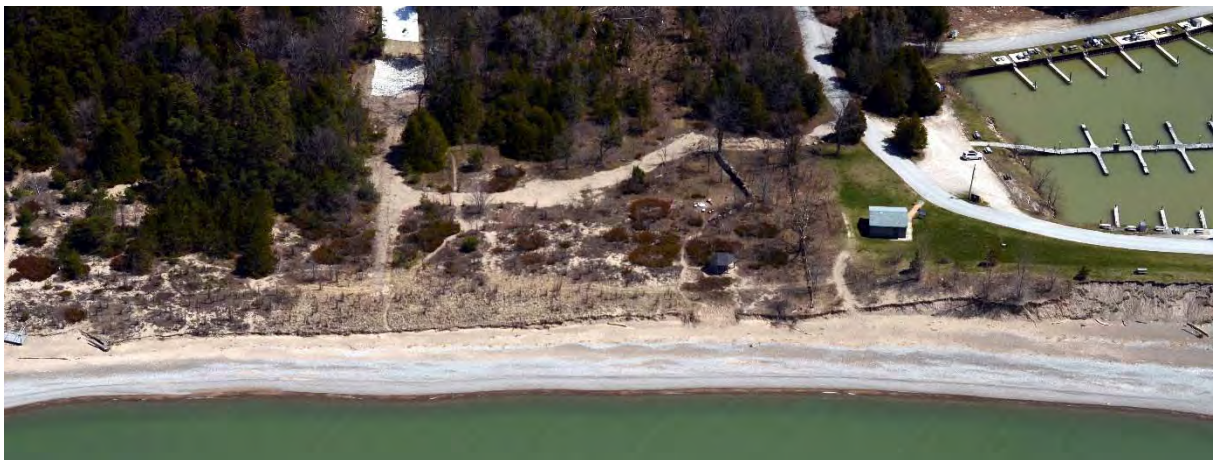


### 3. Bayfield

At Bayfield, any dredged materials should be returned to the system on the downdrift/ shadow side of the river mouth.



Left Hand Side is the Updrift side of River Mouth

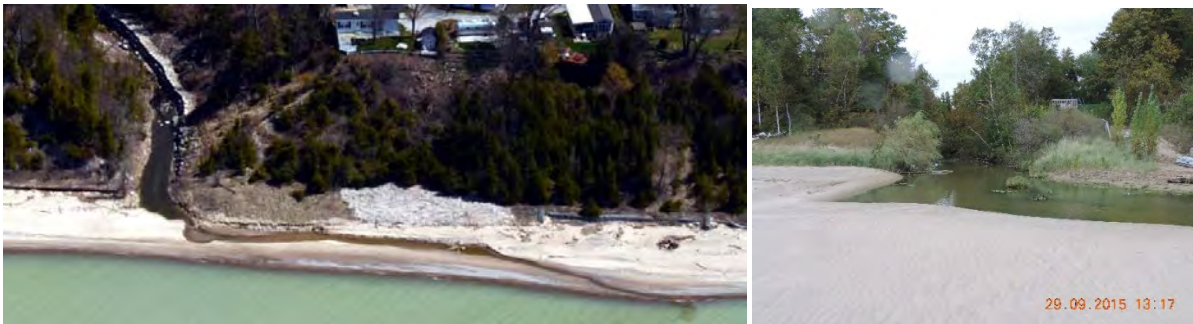


Right Hand Side of the River Mouth – Downdrift Side

ABCA staff have identified the fact that there are small temporary issues due to blockage or diversion of the mouths of small creeks as in the photographs below where they reach the lake. These sites will need to be examined and assessed individually.



Varying issues occur along the mouths of the outlets of individual creeks and gullies.



Ponding at the toe of the slope along the beach is occurring in the above location.



Each individual site should be examined by a qualified coastal engineer or geomorphologist to determine appropriate site specific recommendations. In general however, any dredged materials should be returned to the system on the downdrift/ shadow side of the creek or river mouth.



## 8.0 Recommendations for Further Action

There are a number of issues that emerged during the development of this Shoreline Management Plan update that fell outside of the parameters of this plan but were important to document as recommendations for further and potentially future action. These include the following:

1. That ABCA consider the development of an Applicant's Guide to explain the permitting process and the regulatory responsibilities assigned to ABCA for natural hazards along the Lake Huron shoreline.
2. That a roster of pre-approved Geotechnical Engineers be developed by ABCA and made available on the ABCA website for those who may be interested in securing the services of a professionally qualified Geotechnical Engineer.
3. That ABCA enter into an agreement with professional qualified Geotechnical Engineers who could respond immediately in the event of an emergency situation. It is further recommended that ABCA consider the approach that has been adopted by Maitland Valley Conservation Authority that provides MVCA with ready access to qualified Geotechnical Engineers on a needs-be emergency basis.
4. That ABCA develop a roster of specialized contractors and qualified professional consulting firms who offer a range of highly specialized services including coastal engineering, geotechnical engineering and coastal geomorphology.
5. That ABCA ensure that any Municipal Emergency Preparedness Plans include notification to riparian landowners of the hazards and risks associated with existing buildings and activities that may be negatively impacted as a result of natural shoreline hazards including flooding, erosion and dynamic beach hazards.
6. That ABCA explore the opportunities to work with other conservation authorities, Conservation Ontario, municipal and provincial partners to explore the options associated with voluntary resettlement including fiscal support through comprehensive provincial funding support and/or tax rebates as well as non-fiscal service-related incentives including expedited planning and permitting approvals and the public acquisition of hazardous shoreline areas for open space park and passive recreational use, as appropriate.

While these issues are beyond the scope of the updated Shoreline Management Plan they offer an important focus for future action.

## 9.0 Additional References & Resources

Ausable Bayfield Conservation Authority. (June 2016). Landowner Fact Sheet – Shoreline Slope Stability Risks & Hazard (Lake Huron Shoreline Stability Considerations), prepared by Terraprobe Ltd.,

Ausable Bayfield Conservation Authority. (February 1994). Shoreline Management Plan, Considerations for Shore Protection Structures. Prepared by Baird and Associates.

Davidson-Arnott, R. (2010). Introduction to Coastal Processes and Geomorphology. Cambridge University Press. © R. Davidson-Arnott.

Kamphuis, J. William. (2000). Introduction to Coastal Engineering and Management. Advanced Series on Ocean Engineering – Volume 16. Copyright © 2000 World Scientific Publishing Co. Pte, Ltd.

Ontario Ministry of Municipal Affairs and Housing. (2014). Provincial Policy Statement. (replaces the Provincial Policy Statement issued May 22, 1996, and amended February 1, 1997). ©Queen’s Printer for Ontario.

Ontario Ministry of Natural Resources/ Conservation Ontario (OMNR/CO), 2005. Guidelines for Developing Schedules for Regulated Areas. October.

Ontario Ministry of Natural Resources. (2001). Great Lakes — St. Lawrence River System and Large Inland Lakes Technical Guides for flooding, erosion and dynamic beaches in support of Natural Hazards Policies 3.1 of the Provincial Policy Statement (1997) of the Planning Act. Published by Watershed Science Centre, Trent University Peterborough, Ontario, Canada Copyright © 2001 The Queen's Printer for Ontario.

Ontario Ministry of Natural Resources. (2001). Understanding Natural Hazards. Great Lakes – St. Lawrence River System and Large Inland Lakes, River and Stream Systems and Hazardous Site. An Introductory Guide for Public Health and Safety Policies 3.1 - Provincial Policy Statement. Published by Queen’s Printer for Ontario. Printed in Ontario, Canada. Copyright © 2001, The Queen's Printer for Ontario.

Ontario Ministry of Natural Resources. (January 1997). OMNR Natural Hazards Training Manual Version 1.0, Provincial Policy Statement, Public Health and Safety Policies 3.1, (Table 1, page 5).

Ontario Ministry of Natural Resources. (1998) Geotechnical Principles for Stable Slopes. Prepared by Terraprobe Ltd., & Aqua Solutions.

Ontario Ministry of Natural Resources (OMNR), 1989. Great Lakes System Flood Levels and Water Related Hazards, February.

Peach, G.H. (2008). The Port Franks Beach and Dune Stewardship Guide by the Lake Huron Centre for Coastal Conservation. (<http://lakehuron.ca/uploads/pdf/Beach.Stewardship.Guide.for.Port.Franks-2008.pdf>)

F.J. Reinders & Associates, 1989. Lake Huron Shoreline Processes Study. A report prepared for ABCA, MVCA, SCRCA and SVCA, December 1989.

B. Singh, M.A.Sc., P. Eng. (2016). Geotechnical Principles for Stable Slopes Fact Sheet- Terraprobe Limited. Slope Stability & Erosion Risks - A Regulatory Perspective. June.

Zuzek, P.J., Nairn, R.B., and Thieme, S.J., 2003. Spatial and Temporal Considerations for Calculating Shoreline Change Rates in the Great Lakes Basin. *Journal of Coastal Research*, Special Edition 38, p.125-146.