Ontario

Understanding Natural Hazards

Great Lakes – St. Lawrence River System and large inland lakes, river and stream systems and hazardous sites.

An introductory guide for public health and safety policies 3.1, provincial policy statement

Printed in Ontario, Canada

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Understanding Natural Hazards
Table of Contents

PAGE


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1.0

Purpose of this Publication

This publication has been prepared by the Ontario Ministry of Natural Resources to assist the public and planning authorities such as municipalities and conservation authorities with the explanation of the Natural Hazards Policies (3.1) of the Provincial Policy Statement of the *Planning Act*. Detailed, technical information concerning the implementation of the Natural Hazards Policies, will be available on Compact Discs (CD's) addressing the Great Lakes – St. Lawrence River System and Large Inland Lakes Flooding, Erosion and Dynamic Beach Hazards, River and Stream Systems Flooding and Erosion Hazards and Hazardous Sites. This publication updates and replaces the 1997 Natural Hazards Training Manual (OMNR).

These CD's are available through:

The Watershed Science Centre
Symon's Campus, Trent University
1600 Westbank Drive
Peterborough ON K9J 7B8

Phone: (705) 748-1566
Fax: (705) 755-2276

Or through the following web site:
www.trentu.ca/wsc

This publication is for general information purposes only, and does not provide sufficient detail for planning authorities to undertake technical studies to identify and manage natural hazards.

The term "valid study" appears throughout this publication. Valid study, means a study that is based on current engineering, geotechnical and scientific practices and principles that have been developed, tested and accepted within Ontario and internationally.

Atmospheric conditions can trigger natural hazards...

such as flooding

2.0

What are Natural Hazards?

Natural, physical environmental processes that occur near or at the surface of the earth can produce unexpected events of unusual magnitude or severity. Such occurances are generally regarded as natural hazards. The outcome can be catastrophic, frequently resulting in damage to property, injury to humans and other organisms, and tragically even loss of life. In these cases, natural hazards are considered natural disasters.

All regions of Ontario have experienced natural hazards such as flooding, erosion and slope failures. During a flood, river water levels rise resulting in the inundation of areas not ordinarily covered by water. Such areas are known as floodplains. High water levels are often the result of extreme watercourse flows, which are produced by extreme rainfall and snowmelt. In many areas floods will occur because of a reduction in the natural channel capacity due to ice and debris jams. Ice and debris "block" the ability of water to move and as a result the water floods the land outside the watercourse. How extensive flooding will be in any area in Ontario is determined generally, by the drainage basin or watershed, as well as the land use.

Flooding also occurs on the Great Lakes and large inland lakes and is often the result of high lake water levels, combined with wind and rain.

Wind driven waves and rain combine to create flood risks on the Great Lakes

Erosion is a natural process in all rivers, streams and coastal shorelines of the Great Lakes. The rate of erosion is sometimes accelerated as a result of flooding and increased runoff associated with changing land uses in the watershed. Erosion, or slope failures also occurs in valley slopes outside of the river or stream. Such erosion is influenced by development activities, which results in interference with the drainage systems of slopes weakening the stability of the slope. Slopes (or valley lands) are then more susceptible to dramatic slope failures, such as slumping of the entire face wall.

On the Great Lakes shoreline, in addition to flooding and erosion, dynamic beaches are also considered as ***hazards***. As the name implies, these shoreline beaches are constantly experiencing change and are dynamic in nature. Dynamic beaches are shaped and re-shaped on a range of timescales that extend from either hours or days to years and decades in response to changing wave, wind, and water level conditions and to changes in the rate of sediment supply to a particular stretch of shoreline.

Too close for comfort

Structures and property within the floodplains and slopes and valleys and shorelines may be susceptible to damage from natural processes such as flooding, erosion, slope failures and dynamic beaches. These processes become natural hazards when people and property locate in areas where they normally occur.

These occurrences put large populations at risk, cause untold damages to property and infrastructure and result in social and economic disruption to communities. In addition, more information is becoming available concerning psychological impacts on families and individuals who have been forced to leave their homes during natural hazard emergencies, only to return to find their homes, belongings and personal effects completely destroyed.

Past tragedies resulting from natural hazard events may be easily forgotten, especially if there have not been any events in recent times or memory. In many instances, floodplains and shorelines have been considered as attractive building sites. As a result, many people, either through lack of awareness or disregard, build structures that are vulnerable to flood and erosion damage, or increase risks of property damage and health to their neighbours.

Eroding river bank

Massive slope failure

Dynamic beaches

Finding a way out

3.0

Natural Hazards in Ontario

Floods have a long history in Ontario

Flooding and other natural hazard occurrences have a long history in Ontario. Early settlers in Upper Canada were keen observers of daily weather and natural conditions. Most settlers kept diaries recording weather entries, and made a point of communicating local conditions through letters. One record, a letter from Mr. Joseph Brant, dated December 15, 1797, states that the rise of the waters between Burlington Bay and York prevents him from proceeding to York by land.

Ontario's waterways have been the prime areas for settlements for hundreds of years. Early settlers relied on select locations along Lake Ontario and St. Lawrence River shorelines for strategic reasons as well as economic and commercial reasons. Gradually developments began to migrate upstream from many of the rivers that outlet into the Great Lakes. These areas were attractive, as they provided a means of transportation, a source of abundant drinking water, and a location for the construction of mills, and other economic activities.

Shorelines adjacent to rivers, streams, lakes as well as the Great Lakes have experienced much development over the last 100 years. Because many communities have been located in areas subjected to flooding, erosion and other physical processes, the Province of Ontario and many of its citizens have experienced social and economic losses as well as human tragedies.

Encroachment of the floodplain

In the 1930's and 1940's, massive deforestation and draining of wetlands due largely to increased agricultural activity, combined with an extended dry weather period, led to regional overland soil erosion problems, unreliable water supply, increased flooding and erosion, crop and livestock losses, creating major social and economic hardships across Ontario. Following this period of hardship, federal, provincial and local governments responded in an unique way and the concept of the watershed emerged in Ontario as a suitable management framework to address water and water-related resources.

The Guelph Conference in 1941 provided a major impetus in Ontario for the establishment of the conservation authorities Movement and the enactment of the *Conservation Authorities Act* in 1946. When the Hurricane Hazel Storm crossed into Ontario in October 1954, killing 81 people and causing hundreds of millions of dollars in damages, a framework, through the watershed based conservation authorities and provincial partnership was in place to deal with future floods and natural hazards.

Hurricane Hazel destruction in 1954

There have been thousands of flood events in Ontario, some have been worse than others have. Certainly, the most catastrophic was Hurricane hazel, due to the tragic human losses and social and economic burdens associated with replacing communities and infrastructure.

Other significant flood events include the Grand River Flood in 1974 which prompted a Royal Commission Inquiry into the Grand River Flood (1974) asserted provincial and conservation authority responsibilities for floodplain management and flood forecasting and warning.

On the Great Lakes, 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 ecosystem. Interference with these processes can result in increased flooding and erosion risks. Between 1985-86, property owners on the on the Great Lakes coasts experienced record high lake levels in the century. 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.

Property damage on the Great Lakes

Many rivers and streams flood regularly in March and April as a result of the spring freshet. Ice jams and debris jams are common on some rivers such as the Credit River, the Thames and the Moira River. Rivers can become jammed with broken, thawing ice which flows faster than the channel can carry it away. Ice jams restrict the capability of the river to carry water, and as a result the water spills out of the banks and floods the adjacent land areas.

Flooding due to ice jams is common in the spring

These adjacent areas, or floodplains, are really a part of the rivers natural living space. When this space is infringed upon through human activities, this causes problems for society and limits the capability of the river to perform what is really, a natural function.

A floodplain is really part of the rivers natural living space.

Infrastructure damage

Erosion damage to rail line

Flooding, wind and wave action damage to property on Lake Erie

4.0

Provincial Perspective

Why is the Province interested in natural hazards and why are natural hazards considered *"areas of provincial interest"* the Provincial Policy Statement of the *Planning Act*?

Following natural disasters, various levels of government are sometimes asked to financially assist the community and property owners with damages and recovery. If granted, however, government subsidies do not cover all losses. Assistance for items such as secondary residences, non-essential furniture or appliances and recreational vehicles is not available under disaster relief assistance programs. Private insurance for perils such as flooding, erosion is not available to homeowners. As a result many individuals and communities rely on governments to step in and provide immediate disaster relief to those affected. Many losses caused by natural hazards are impossible to calculate in monetary terms. Commercial and economic activities may be affected by a range of impacts including; employees being unable to work due to personal losses; or closure of roads and highways, preventing transport of goods and services;

Social disruption

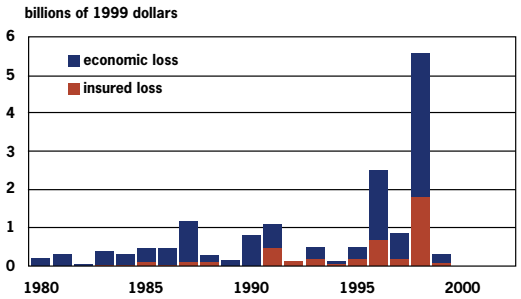
damage to gas lines and other utility systems, disrupting services; closure of public buildings, banks, and institutions such as hospitals. Entire communities can be severely disrupted during these events and for long periods afterwards. Recent data compiled by Emergency Preparedness Canada and the Institute of Catastrophic Loss Reduction indicate that the economic costs incurred as a result of natural disasters such as floods increasing in Canada (See graph 1).

Dyke

Dam

Erosion protection

Canadian natural disaster losses



Graph 1 - Source: Institute of Catastrophic Loss Reduction, based on data from the insurance Bureau of Canada and Emergency Preparedness Canada

Financial assistance requests are made for either direct costs associated with private property damage or for structural improvements, such as flood walls, dams, erosion control works and channelization to prevent future damages. Slopes and shorelines can be engineered to meet safety standards; however, these structures require ongoing maintenance to ensure that they continue to function in the way they were designed to. There is often urgency associated with the need to install structures to protect people and their property, to address the immediacy of the risk. Unfortunately, the protection works were sometimes installed in an ad hoc fashion to provide a quick fix solution, ignoring natural process and environmental impacts. Sometimes structures that are improperly designed, constructed, located or not carefully looked after, can cause problems for downstream or upstream property owners, causing environmental damage, accelerating erosion or increasing flood potential and therefore, increasing risk to property damage elsewhere.

Debris dumped into valley may result in erosion

Protective structures can lull communities into a false sense of security. In some areas, these structures have actually contributed towards increased encroachment into hazard lands, because all too often, it has been assumed that the hazard is controlled. Structures can only mitigate the effects of natural hazards, depending on their design life, their maintenance and upkeep. A protective structure always has the potential to fail, depending on the event. As unlikely as it seems, water control structures such as dams, have been known to periodically fail.

Human activities can increase the risk of slope failure

Many people still locate in areas, which are not entirely free from natural hazards. People enjoy the amenities associated with living near water or on slopes. For example, ravine lots and waterfront lots are often sold at a premium because of their desirability.

Potential risks associated with slope failure and erosion can be addressed through site-specific geotechnical studies, and sometimes through construction of protective erosion control works. These approaches may not prove to be entirely reliable over the long term as they do not take into account broader watershed processes or land use changes which may result in altered drainage patterns. In addition, activities by homeowners located in these areas may actually exacerbate problems. Removal of vegetation on slopes and the construction of new structures such as pools or additions, weaken roots, which bind soil particles and place new load on the slope. In some areas slopes have become susceptible to failure because property

A stream gauge records water flowsand levels

Hazardous lands map

Response and recovery

owners have used the ravine as a place to dump gardening debris, leaves and sometimes even garbage. This material plugs natural drainage outlets on the face of the slope and ground water cannot properly drain. A build up of moisture in the soil can weaken the slope causing slope failure.

All governments, federal, provincial, regional and municipal, have an important role to ensure that all citizens in their care are aware of potential health and safety risks, and that appropriate action is taken to reduce such risks.

The Province of Ontario has recognized the seriousness of flooding and erosion impacts on communities and has actively tried to minimize the threats to public health and safety. The Ministry of Natural Resources (MNR) is the lead administrative Ministry having overall Government responsibility for natural hazard policies and programs.

Reducing impacts of natural hazards to prevent risk to loss of life and minimize property damage is a key goal and is based on three components: prevention, protection and emergency response.

- **Prevention measures** provide the greatest, and most cost effective means of protecting public health and safety, and as such, are of highest priority. Prevention includes activities aimed at increasing public awareness of potential risks, good land use planning, development and management, and the regulation of hazardous lands and unsafe developments.
- **Protection measures** aim to mitigate against known natural hazard risks and involve investments in structural, protective works such as dams, dykes and erosion control works. These approaches require long term, and often expensive maintenance and capital investment commitments. In some instances, cost-benefit analysis may indicate that acquisition and removal of buildings from the floodplain is more appropriate than the construction of protective works. Protection measures also include acquisition of hazardous lands.
- **Emergency response and recovery measures;** the Ministry of Natural Resources, in cooperation with the conservation authorities of Ontario, maintains a stream flow forecast centre which is linked to a network of weather stations, stream gauges, and rain gauges throughout the Province. Advance warning of an impending flood enables municipalities and other government agencies to put into operation their emergency action plans for evacuation of people and moveable property from flood susceptible areas. Although this approach assists in reducing the threat of life and some property losses, it does not prevent flooding and the bulk of related damages from recurring.

A good balance between development, environmental protection and public health and safety

In 1997 the Province of Ontario released the Provincial Policy Statement of the *Planning Act*, including the Natural Hazards Policies, (section 3.1) formally recognizing the unacceptable public health and safety risks associated with these areas, and requiring municipalities "to have regard to" hazard lands in their planning documents. The Provincial Policy statement replaces the previous 1988 Flood Plain Planning Policy Statement made under the *Planning Act*. One fundamental premise of the government's adoption of the PPS was the empowerment of municipalities to implement provincial interests at the local level. Municipalities need to consider areas subjected to natural hazards in planning documents.

The Principles of the PPS state that Ontario's long term economic prosperity, environmental health and social well being depend on:

1. *Managing change and promoting efficient, cost effective development and land use patterns which stimulate economic growth and protect the environment and public health*

2. *Protecting resources for their economic use and/or environmental benefits; and*

3. *Reducing the potential for public cost or risk to Ontario's residents by directing development away from areas where there is risk to public health or safety or of property damage.*

Municipalities are delegated with the responsibility to identify areas subjected to natural hazards and develop management plans to limit exposure to public health and safety risks. Development in these areas should not result in an unacceptable level of risk to the residents, the community or to other governments. The Natural Hazards Policies as they appear in the PPS are summarized in section 5.0.

It is important to note that there are other hazards that pose risks to society, which are not addressed in the PPS, such as tornados, ice storms and other severe weather hazards, as well as droughts. Recently, MNR has been delegated with Special Area Responsibility for Droughts under the *Emergency Plans Act* and together with other provincial ministries and conservation authorities is developing a strategy to better address low water situations as they occur in Ontario.

5.0

Natural Hazards Policies, Section 3.1 of the Provincial Policy Statements

3.1 Natural Hazards

3.1.1 Development will generally be directed to areas outside of:

a. *hazardous lands* adjacent to the shorelines of the *Great Lakes - St. Lawrence River System* and *large inland lakes* which are impacted by *flooding*, *erosion*, and/or *dynamic beach hazards;*

b. *hazardous lands* adjacent to *river and stream systems* which are impacted by *flooding* and/or *erosion hazards;* and

c. *hazardous sites*.

3.1.2 *Development* and *site alteration* will not be permitted within:

a. *defined portions of the dynamic beach*;

b. *defined portions of the one hundred year flood level along connecting channels* (the St. Mary's, St. Clair, Detroit, Niagara and St. Lawrence Rivers); and

c. *a floodway* (except in those exceptional situations where a Special Policy Area has been approved).

3.1.3 Except as provided in policy 3.1.2, *development* and *site alteration* may be permitted in *hazardous lands* and *hazardous sites*, provided that all of the following can be achieved:

a. the hazards can be safely addressed, and the *development* and *site alteration* is carried out in accordance with *established standards* and *procedures*;

b. new hazards are not created and existing hazards are not aggravated;

c. no adverse environmental impacts will result;

d. vehicles and people have a way of safely entering and exiting the area during times of flooding, erosion and other emergencies; and

e. the *development* does not include *institutional uses* or *essential emergency services* or the disposal, manufacture, treatment or storage of *hazardous substances*.

It is important to understand the natural hazard policies, as provided for in the PPS, and associated methods for delineating *hazardous lands*. The approaches used to identify flooding and erosion hazard limits on the Great Lakes are different from the approaches, which apply to river and stream systems. Sections 6.0, 7.0 and 8.0 briefly summarize the tools that have been developed by Ontario to assist planning authorities with the identification of

hazardous lands. The information presented here is for explanation purposes and will not provide enough direction or detail to manage *hazardous lands*. Detailed engineering, geotechnical and scientific principles, practices and procedures for *hazardous lands* identification, planning and management are contained in the following technical guides:

- Technical Guide for Great Lakes – St. Lawrence River Shorelines, Flooding, Erosion and Dynamic Beaches
- Technical Guide for Large Inland Lakes Shorelines
- Technical Guide: River and Stream Systems Flooding Hazard Limit
- Technical Guide: River and Stream Systems Erosion Hazard Limit
- Technical Guide for Hazardous Sites

The natural hazards technical guides will be available on 2 sets of Compact Discs (CD's), one for the Great Lakes – St. Lawrence River System and Large Inland Lakes, and one for River and Stream Systems. The Hazardous Sites Technical Guide is contained on both CD sets.

Stormy waters on the Great Lakes

6.0

Great Lakes – St Lawrence River System and Large Inland Lakes

Hazardous Lands adjacent to the Shorelines of the Great Lakes – St. Lawrence River System and Large Inland Lakes

The policy applies to the shorelines of the Great Lakes – St. Lawrence River System, including Lake Superior, Lake Huron, Georgian Bay, Lake Erie and Lake Ontario, as well as the St. Lawrence River. The policy also applies to the connecting channels, which include the St. Mary's River, the St. Clair River, the Detroit River, and the Niagara River.

Slumping of slope on Lake Huron shoreline

Large Inland Lakes are defined as those waterbodies that have a surface area of equal to or greater than 100 square kilometres where there is no measurable or predictable response to a single runoff event.

The key to selecting the most appropriate planning or management approaches lies in understanding local conditions and the natural processes affecting them. A shoreline classification system has been developed and provides a consistent, technically sound and viable approach for identifying unique or similar segments of shoreline, based on shore type. Application of a classification scheme makes it easier to determine the factors and processes that influence the severity of *flooding*, *erosion and dynamic beach hazards*, and then to select the management approach best suited to addressing that hazard.

Hazardous lands on the Great Lakes – St. Lawrence River system and large inland lakes are defined by delineating the farthest combined landward extent of the three key shoreline natural hazards: *flooding hazards*, *erosion hazards and dynamic beach hazards*.

Shoreline flooding

6.1 Flooding Hazards

How far will the water go during a flood in a particular area? What will make it worse? When drawing the limits of flood hazard lands along Great Lakes-St. Lawrence River system shores and large inland lakes, water experts consider three things:

- 100-year flood level
- Flood allowance for wave uprush
- Flood allowance for other water related hazards

Other water related hazards – ice build up, combined with freezing wave spray on Lake Erie

The 100-Year Flood Level

It's the "worst scenario" flood—almost. The 100-year flood is the minimum design flood criteria standard in Ontario. It is the peak or flood flow with one chance in one hundred of occurring in any given year. Ontario uses the 100-year design flood or regional storm events, such as Hurricane Hazel (whose level exceeded the 100-year design flood).

In many areas with a century of wind and water level records, the 100 year level is based on the highest known level and the strongest wind "setup"—the combination of wind forces at a given time.

Wave uprush

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

Along irregular shorelines, or where there are docks, protection structures or other structures, planners also have to take into account the effect of waves hitting vertical surfaces and sending spray inland. They also have to calculate the area affected when particularly strong waves overtop breakwalls, bluffs or other shoreline structures that act as barriers.

Other water related hazards

Planning authorities also have to take into account other water related factors that can magnify flood destruction. They include these and other influences:

- Ship-generated waves—especially from wheat and ore carriers in St. Lawrence and Great Lakes shipping lanes.
- Ice piling. Ice pushed up onto the shore can tear out banks and other natural protection, destroy buildings. In some cases, 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.

Wave uprush

Effects of ice piling

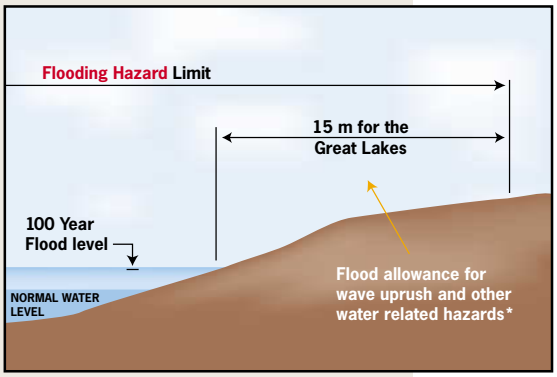
Wave uprush

Wave uprush and other hazards

Where planning authorities lack technical information from studies, the province suggests using the following allowances for wave uprush and other water related hazards—measured horizontally from the 100-year flood level:

Great Lakes-St. Lawrence River system (lakes Superior, Huron, St. Clair and Ontario):	15 metres
Connecting channels	5 metres
Large inland lakes	5 metres

Figure 1



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

Where a planning authority finds that the 15- and five-metre allowances are either too great or too small, the authority may determine allowances through a valid study. The flooding hazard limit would then be 1) the 100-year flood level, plus 2) the engineered flood allowance for wave uprush and other water related hazards. (Figure 1).

In some areas, 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. Given the variety in protection works and naturally occurring shoreline banks that could contribute to ponding, no one suggested approach is useful. In this situation, planning authorities should undertake studies to determine the flood allowance for wave uprush and other water related hazards.

6.2 Erosion hazards

All shorelines are erosion-prone – even bedrock formations, if they are soft. How far will shorelines erode? What will increase erosion? Erosion Hazards 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 100 year erosion rate (the average annual rate of recession extended over a hundred year time span), an allowance for slope stability, and an erosion allowance. When drawing the limits of erosion hazards Great Lakes-St. Lawrence River system shores and large inland lakes, engineers consider three components:

1) Stable slope allowance: The suggested angle of a slope for stability is about three-to-one (horizontal:vertical), or approximately 18 degrees. The stable slope allowance is a horizontal allowance measured landward from the toe of the shoreline cliff, bluff or bank that is three

times the height of the cliff, bluff or bank. The height is the difference in elevation between the toe of the shoreline cliff, bluff or bank, which may be above the surface of the water, or below it, and the top or first lakeward break in slope.

2) Average annual recession: The recession rate average for a site where there is at least 35 years of reliable recession information.

3) Erosion allowance: Where there is no reliable recession information, the province suggests a setback distance to allow for erosion along the Great Lakes-St. Lawrence River system and along the shoreline of large inland lakes.

Determining what is threatened by erosion

The province suggests a two-step method of calculating the area potentially threatened by erosion.

Step One: Select one of the following two options.

a) Measure the stable slope allowance and add to it the average annual rate of recession (where there's a minimum of 35 years of reliable recession information available) times 100. Measure inland from the toe of the shoreline cliff, bluff, or bank., (figure 2) OR;

b) Measure the stable slope allowance and add to it an erosion allowance of 30 metres (on the Great Lakes-St. Lawrence River system) or 15 metres on large inland lakes where there is insufficient recession rate information (figure 3).

Step Two: Measure a 30-metre erosion allowance for the Great Lakes-St. Lawrence River system or a 15-metre erosion allowance for large inland lakes, measured toward the land from the top of the shoreline cliff, bluff or bank or the first landward break in slope (figure 4).

Compare the measurement that resulted from your choice in Step One with this measurement. Which measurement is the greatest? The greatest measurement is the one that should be used as the limit of the erosion hazard.

Figure 2

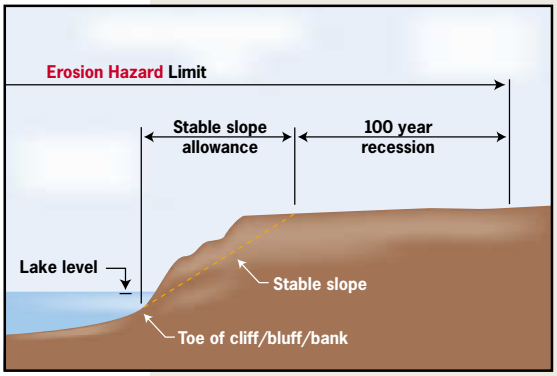

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Figure 3

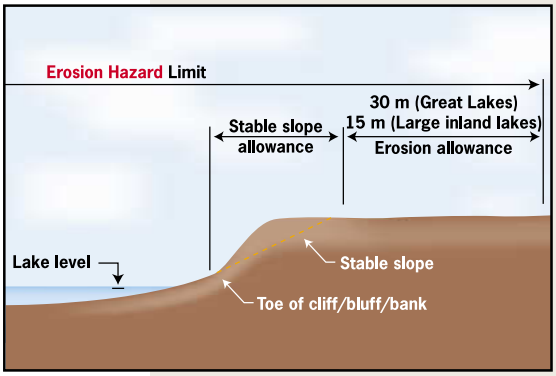

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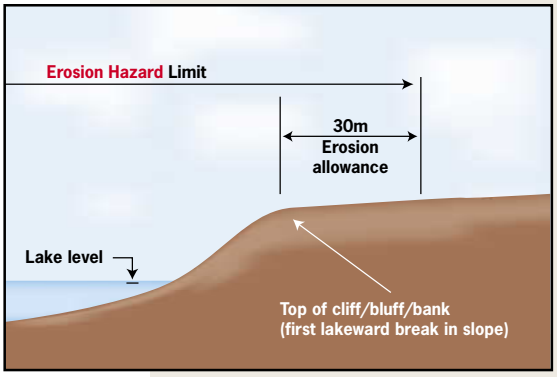
Figure 4



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Dynamic beach - Cobble

Dynamic Beach Scalloped Bluff, Long Point, Lake Erie

Dynamic Beach Blow-out

6.3 Dynamic beach hazards

A dynamic beach moves and because the elevation of any point on the beach changes, it's not possible to define the hazard limit of a dynamic beach in terms of a single elevation, as we would a stable shoreline.

A narrow strip of sand at the bottom of a bluff overlooking a lake or strips of sand along a riverbank may be called beaches, but they are not "dynamic" beaches in terms of Provincial Policy Statement 3.1.

To define a dynamic beach, the first step is to know where the flooding hazard limit is. The flooding hazard limit combines the 100 year flood elevation plus wave uprush. In dynamic beach areas, elevations can change quite dramatically from season to season and year to year due to build up and erosion of sand, cobbles and other beach deposits. When elevations change, so does the location of the flooding hazard limit. This is an especially important consideration, because in times of low lake levels, (as has recently been the case on the Great Lakes), the near shore areas that have been submerged under normal or high lake levels are now exposed, subjected to accretion and erosion processes. It may seem that the landward extent of the dynamic beach has changed, thereby introducing potential for development or expansion of existing development. Historic information about the farthest landward extent of flooding, will be an important consideration for good long-term management of dynamic beach hazards. In fact, areas on the Great Lakes, that experience chronic flood and erosion damages, were typically constructed during times of low lake levels.

The dynamic beach hazard limit is the combined flooding hazard limit, (the 100-year flood level plus an allowance for wave uprush and other water related hazards), **plus the dynamic beach allowance of 30 metres** on the Great Lakes-St. Lawrence River system (or **15 metres** on large inland lakes). (Figure 5).

If the dynamic beach is subject to erosion or is receding, the **flooding hazard** limit is added to the horizontal distance representing 100 times the average annual recession rate, plus **dynamic beach allowance of 30 metres** on the Great Lakes-St. Lawrence River system or **15 metres** on large inland lakes.

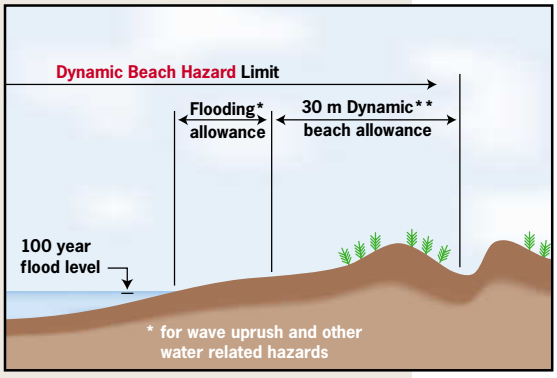
A planning authority may undertake a study to determine the dynamic beach limit which would be based on **the flooding hazard limit** (the 100-year flood level plus an allowance for wave uprush and other water related hazards) plus **Scientific and engineered dynamic beach allowance** as determined by a valid study.

How to recognize a dynamic beach hazard

Dynamic beach hazards exist when there are,

- Beach or dune deposits along a shoreline.
- Deposits are 0.3 metres or more thick, 10 metres in width and 100 metres in length along the shoreline.
- The fetch (distance the wind blows over the water onto the shore) is more than five kilometres. (Measuring the fetch on a map: Draw a line perpendicular to the point where water meets beach (the tip). From the tip measure out five kilometres in an arc 60 degrees on either side of the perpendicular line, creating a wide pie-shape whose tip is pointing inland. The area within the pie-shape should be open water).

Figure 5



(NOT TO SCALE)
**15 m Dynamic beach allowance for large inland lakes