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Lake Huron Shoreline Management Plan Update - 2011

St. Clair Region Conservation Authority

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Board of Directors approval - Motion #BD-15-089




Lake Huron Shoreline Management Plan Update - 2011

Prepared for

St. Clair Region Conservation Authority

Prepared by

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TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Background and Purpose of Study

The 1996 St. Clair Region Conservation Authority (SCRCA) *Lake Huron Shoreline Management Plan (SMP)* included Point Edward, Sarnia and Plympton Wyoming. The SMP included the delineation of hazard areas based on the Provincial Policy Statement at the time (May 22, 1996).

In 2006, the former "No-Mans Land"/Southwest Bosanquet portion of Lambton Shores became part of the St. Clair Region Conservation Authority's jurisdiction. Since then, the SCRCA has provided generalized lake erosion, flooding and dynamic beach setbacks for Lambton Shores.

Since the 1996 *Shoreline Management Plan (SMP)* was released, a number of changes have taken place in the legislation, policies and guidelines regarding shoreline hazards. Key changes include the following:

- In 1996, MNR released the Technical Guide for the Great Lakes – St. Lawrence River System and Large Inland Lakes (MNR, 2001a). These guidelines provide the technical basis and procedures for establishing the hazard limits for flooding, erosion and dynamic beaches as well as acceptable scientific and engineering practices for addressing the hazards.

- In 1997, MNR released the Natural Hazards Training Manual to assist planning authorities with explanation of the Natural Hazard Policies (3.1) of the Provincial Policy Statement of the Planning Act.

- MNR prepared "Understanding Natural Hazards" (MNR, 2001b) to assist the public and planning authorities with explanation of the Natural Hazard Policies (3.1) of the Provincial Policy Statement of the Planning Act. This publication updates and replaces the 1997 Natural Hazards Training Manual (MNR).

- Ontario Regulation 97/04 "Content of Conservation Authority Regulations under Subsection 28(1) of the Act: Development, Interference with Wetlands and Alterations to Shorelines and Watercourses" (i.e., Generic Regulation) was approved in May 2004. This Regulation established the content requirements to be met by a Conservation Authority under Subsection 28(1) of the Conservation Authorities Act.

- The Provincial Policy Statement (PPS) (MMAH, March 1, 2005) was issued under the Planning Act. It replaces the PPS issued May 22, 1996 and amended February 1, 1997. The PPS states that Section 3 of the Planning Act "requires that decisions affecting planning matters 'shall be consistent' with policy statements issued under the Act". Responsibility

for providing input with respect to provincial interests under the PPS Section 3.1 – Natural Hazards is delegated to individual Conservation Authorities.

- The PPS (2005) Section 3.1.1 states: "*Development shall 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 hazards, erosion hazards and/or dynamic beach hazards"*. Under the PPS Definition section, Development means "*the creation of a new lot, a change in land use, or the construction of buildings and structure, requiring approval under the Planning Act…"* Section 3.1.2 states "*Development and site alteration shall not be permitted within a) the dynamic beach hazard".*

- To assist CA's during the preparation of new/revised Regulation Schedules the Ministry of Natural Resources and Conservation Ontario (MNR/CO, 2005) released "Guidelines for Developing Schedules of Regulated Areas". The guidelines were generally derived from the MNR publications "Understanding Natural Hazards (2001b) and "Technical Guide for Great Lakes – St. Lawrence River System (2001a).

- Ontario Regulation 171/06 Development, Interference with Wetlands and Alterations to Shorelines and Watercourses, approved in May 2006, specifically enables SCRCA to regulate the Great Lakes shoreline up to the furthest landward extent of the aggregate of the flooding, erosion and dynamic beach hazards.

- In 1998, the Conservation Authorities Act was amended as part of the Red Tape Reduction Act (Bill 25), to ensure that Regulations under the Act were consistent across the province and complementary to provincial policies. Significant changes were made to Section 28, which led to the replacement of the "Fill, Construction and Alteration to Waterways" Regulations with the current "Development, Interference with Wetlands and Alterations to Shorelines and Watercourses" Regulation (MNR/CO, 2008).

- To support administration of CA regulatory programs, the Ministry of Natural Resources and Conservation Ontario (MNR/CO, 2008) released the "Draft Guidelines to Support Conservation Authority Administration of the "Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation". This document is based on numerous existing provincial Technical and Implementation Guidelines developed and approved by the Ministry of Natural Resources.

The purpose of this study was to develop a *Shoreline Management Plan* for the coastal zone of Lake Huron within Lambton Shores for the SCRCA. The *Shoreline Management Plan* has been incorporated into an updated *Shoreline Management Plan (SMP)* to form a consolidated document for the Lake Huron shoreline within SCRCA. The hazard limits for flooding, erosion and dynamic beaches in the existing *Shoreline Management Plan* (1996) have been updated to the current mapping

and technical standards identified in the above noted documents, particularly the MNR *Technical Guide for the Great Lakes – St. Lawrence River System and Large Inland Lakes* (MNR, 2001a).

1.2 Study Limits and Scope

The study area for the 1996 SMP included the Lake Huron shoreline within SCRCA's jurisdiction; approximately 32 km from Point Edward, Sarnia to Townsend Line in Plympton-Wyoming. For the present study, the majority of the work focused on the area in Lambton Shores, extending from Townsend Line north to Army Camp Rd., (see Figure 1.1). The Chippewas of Kettle and Stony Point First Nations land is not included in the study, except in the coastal processes assessment.

The following components of the study were prepared by SCRCA:

- Reach descriptions for all reaches located in Point Edward, Sarnia and Plympton-Wyoming (Reaches 1 to 28).
- Average annual recession rates (AARRs) for all reaches in Point Edward, Sarnia and Plympton-Wyoming (Reaches 1 to 28).
- Hazard Mapping for all reaches located in Point Edward, Sarnia and Plympton-Wyoming (Reaches 1 to 28).
- Hazard Mapping production for reaches in Lambton County (Reaches 29 to 38) using data sets provided by Baird.
- Shoreline Management Guidelines presented in Section 6.4 and delineation of Shoreline Management Areas as shown on Hazard Mapping and described in Appendix B for all reaches.

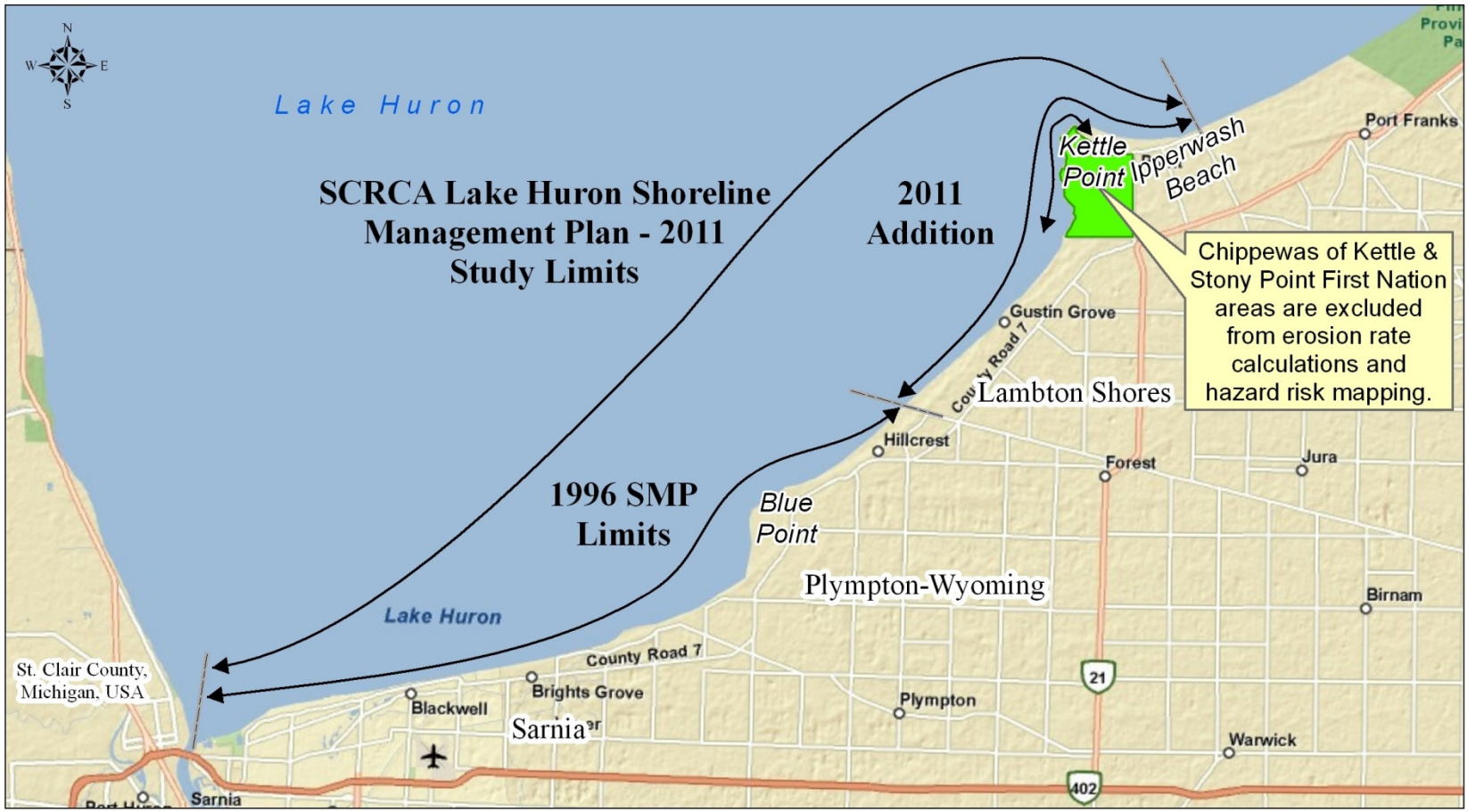
1.3 Previous Studies

A number of studies have been undertaken by and for St. Clair Region Conservation Authority in support of shoreline management planning. Some of these provided significant input to the *1996 Shoreline Management Plan* and were used as a resource for the *Lake Huron Shoreline Management Plan Update 2011*. Key studies are summarized below.

1.3.1 Lake Huron Shoreline Processes Study (1989)

The *Lake Huron Shoreline Processes Study* (F.J. Reinders, 1989) is an unpublished report prepared for the four Conservation Authorities with jurisdiction along the shoreline of Lake Huron including the Saugeen Valley, Maitland Valley, Ausable Bayfield and St. Clair Region. In order to take into account the regional nature of shoreline processes in the development of shoreline management

plans, the four Conservation Authorities determined that a detailed description of the natural shoreline processes was required before comprehensive shoreline planning could proceed. The firm of F.J. Reinders and Associates Canada Limited was retained to conduct a detailed examination of the shoreline processes and to provide a report that would support the development of effective shoreline management plans and which would assist Conservation Authority staff in managing the shoreline.



0 4 8 Kilometres

Study Area

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Figure 1.1 Study Limits

The report addresses a 180 kilometre length of the shoreline of Lake Huron, extending from McRae Point to Sarnia. The report provides information on the study shoreline, including: the definition of littoral cells and reaches within those littoral cells; the description of these reaches with regards to composition, erosion, and sand transport; quantification of the amount of sand moving alongshore; and, recommendations concerning the future management and development of the shoreline. A description of the shoreline processes acting along the shoreline is provided, along with the implication of these processes for shoreline management. Such processes include sand supply, sand transport, bluff recession and erosion. A discussion of existing shore protection and its effects on the shoreline processes is also presented. A discussion of the glacial and post-glacial history of the area is presented along with a summary of those characteristics of the shoreline that exert a control on the present day geomorphic processes.

1.3.2 Lake Huron Shoreline Erosion Hazard Delineation Study (1991)

The *Lake Huron Shoreline Erosion Hazard Delineation Study* was prepared by F.J. Reinders and Associates Canada Limited and Geomatics International Incorporated in 1991 for the St. Clair Region Conservation Authority. In order to develop and evaluate management alternatives for the study area shoreline, there was a need to understand how the shoreline had responded historically to the natural shoreline processes and human influences such as protection works. Shoreline response is often reflected in changes in the erosion and recession rates. As erosion is an ongoing natural process along the shorelines of the Great Lakes, effective erosion hazard management requires continued monitoring of the shoreline and the ability to predict long term erosion rates.

The report documents the use of an Ontario Land Survey completed between 1934 and 1935, and shoreline mapping completed in 1990 under the Canada/Ontario Flood Damage Reduction Program to compare the positions of shoreline features over a 54 year period. This comparison was refined using information collected under the Canada/Ontario Great Lakes Shore Damage Survey (Environment Canada, 1976) and the Great Lakes Erosion Monitoring Program (Boyd, 1981). Using the comparison, the consultant was able to determine historical bluff recession and accretion rates which could then be used to predict future shoreline change. The resultant erosion rates were used to delineate shoreline development setbacks based on shoreline policies of the Ontario Ministry of Natural Resources.

The report was revised and updated in 1992 based on recommendations from Baird & Associates in their memorandum dated October 31, 1991 and subsequent re-interpretation of top of bluff locations from the FDRP Shoreline Mapping.

1.3.3 Design Considerations for Shore Protection Structures (1992)

Design Considerations for Shore Protection Structures is a report prepared by Baird & Associates in 1992 for the St. Clair Region Conservation Authority. The purpose of the document was to present an overview of design considerations for shoreline protection works in the study area, recognizing the presence and performance of existing structures, as well as impacts of existing and new protection works on the shoreline processes. The report recognizes that information on shoreline

erosion and protection works alternatives for the Great Lakes shorelines was widely available from several sources including the Ontario Ministry of Natural Resources, Environment Canada and the United States Army Corp of Engineers. The discussion refers to this information where it has direct application along the shoreline within the study area. The report emphasizes that the information provided is general in nature and intended for guidance purposes only. It is recommended that a qualified professional engineer with experience in Great Lakes shoreline processes, be retained to design protection works on a site specific basis.

1.3.4 Blue Point Recession Study (2004)

St. Clair Region Conservation Authority undertook the *Blue Point Recession Study 2004*, with the support of Plympton-Wyoming, to update recession rate data for Blue Point; this stretch of shoreline that has the highest erosion rates along the SCRCA shoreline. The study compared erosion rates between 1993 and 2004 with the long term erosion rate computed for 1935 to 2004. It was concluded that the erosion hazard limit would not change substantially based on the revised recession rates and that re-mapping the hazard limits was not warranted.

2.0 SHORELINE RECONNAISSANCE

A shoreline reconnaissance was undertaken and 39 sites were visited. Sites 1 through 23 were visited on June 1, 2010, Sites 24 through 31 on June 2, 2010 and Sites 32 through 39 on July 7, 2010. The site visit locations are shown in Figure 2.1. The sites were chosen as representative of the various shoreline conditions encountered within the study area, including eroding bluffs, low shores, beaches and various erosion protection structures (see Figure 2.2).

A standardized form was used for note taking at each site. The forms and photographic records for each site visit are provided in Appendix A.

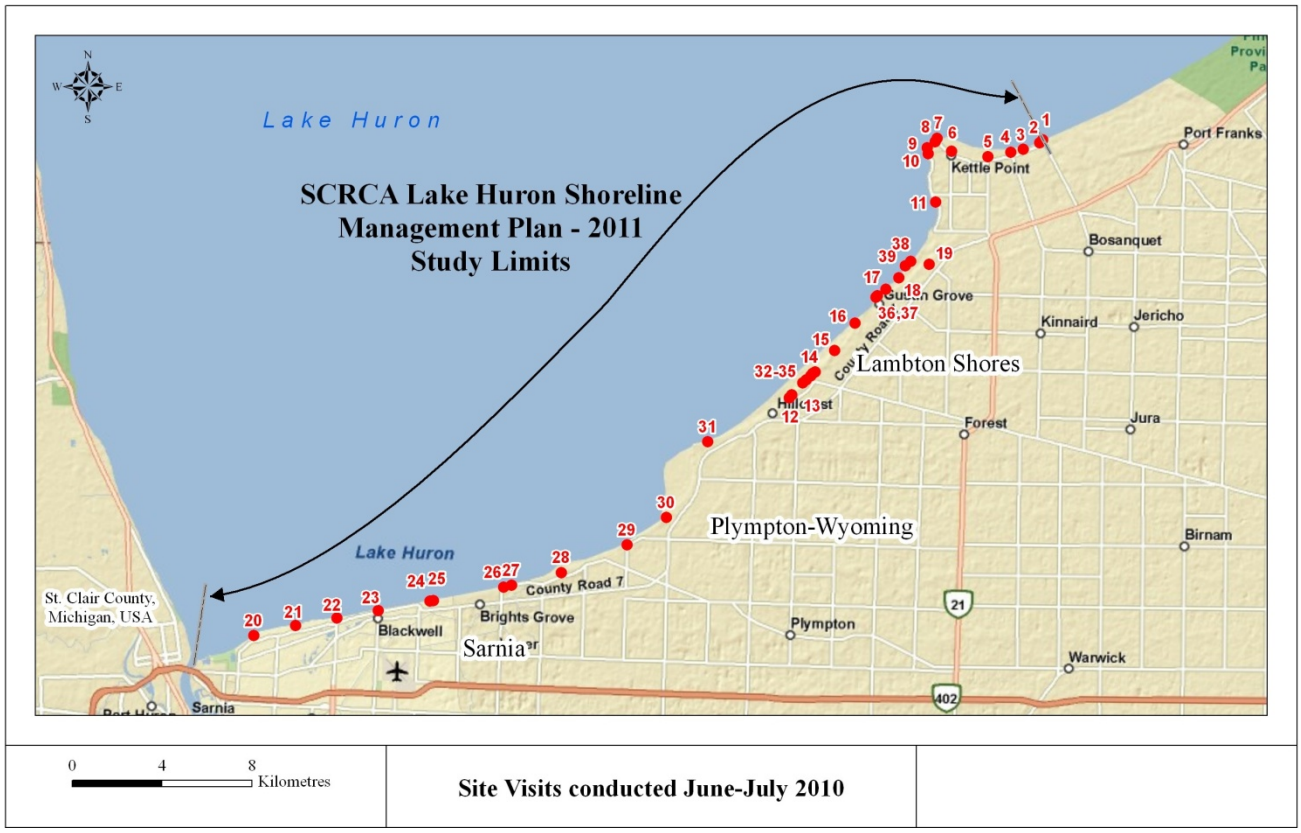

Figure 2.1 Locations of Site Visits (June and July, 2010)

Dynamic Beach – Site 1 Reach 38

Ad Hoc Protection - Site 9 First Nations

Marina at Base of Bluff - Site 16 Reach 31

Beach at Base of Bluff - Site 15 Reach 30

Timber Groynes Retaining Beach - Site 21 Reach 4

Armourstone Revetment, SSP Groynes - Site 26 Reach 11

Figure 2.2 Examples of Shoreline Conditions from Site Visits (June and July, 2010)

3.0 COASTAL PROCESSES AND SHORELINE REACHES

3.1 Coastal Processes Overview

As shown in Figure 1.1, the SCRCA shoreline extends along the southeast shore of Lake Huron from the St. Clair River in the southwest to Ipperwash Beach in the northeast. It excludes the lands of the Chippewas of Kettle and Stony Point First Nations, however Kettle Point and its significance in terms of coastal processes are included in this discussion.

The SCRCA shoreline can be classified into four general reaches in terms of coastal processes. The northern reach extends from Ipperwash Beach to Kettle Point. The beach is well developed with an extensive backshore dune system. The beach orientation is approximately perpendicular to the net wave energy direction. Some loss of sand from the backshore dunes was predicted in F.J. Reinders (1989). It was further noted that the stability of the beach is dependent on the supply of sand transported from the north, which was estimated to be in the range of 68,000 m^3/year. F.J. Reinders (1989) notes that no trend of erosion or accretion has been demonstrated in recent time.

The second reach extends from Kettle Point to Gustin Grove. Kettle Point represents a barrier to alongshore transport. The bedrock shelf extends some distance offshore. There has been a history of erosion at Kettle Point during high water levels and sections of the shoreline are protected with armourstone revetments and ad hoc shore protection. The bedrock shelf extends to Gustin Grove. South of Kettle Point, the shoreline transitions from wetland to sand and cobble beach backed by a low bank. North of Gustin Grove, there is an inland bluff feature from a period when the level of Lake Huron was higher than the present stage, following the retreat of the last glacial ice in southern Ontario. Wave attack eroded the bluff and then the lake levels fell to the present stage, stranding the feature inland. This feature meets the present day shoreline of Lake Huron at Gustin Grove, where the shoreline transitions from low bank to an eroding till bluff.

From Gustin Grove to Brights Grove, the shoreline typically consists of till bluffs, ranging in height from approximately 20 m to approximately 5 m. The bluffs are fronted by narrow beaches. The beaches provide limited protection to the bluffs and erosion is caused by wave action, particularly during high water levels. Much of the shoreline is protected with groynes and seawalls.

Along these cohesive shorelines, erosion of the bluffs is controlled by erosion of the nearshore lakebed. In areas with higher erosion rates, the nearshore lakebed profile is composed of a more erodible till (St. Joseph till) and in areas where the bluff is more stable, it is composed of the stronger Rannoch till (Baird, 1992). This stretch includes Blue Point, which has the highest erosion rates along the SCRCA shoreline (SCRCA, 2004).

Erosion of the bluffs, as well as erosion of the nearshore lakebed at locations throughout the study area, supplies sediment (clay, silt, sand and gravel) to the shore zone. These materials are transported by wave action and currents. The finer sediments (clay and silt) are carried in

suspension and tend to deposit offshore in deep water, while the coarser sediments (sand and gravel) are transported along the shoreline and form beaches and nearshore bars. The coarser sediments comprise a relatively small fraction of the total eroded volume.

To the southwest of Brights Grove, the shoreline typically consists of vegetated dunes fronted by beaches of varying widths. The entire shoreline within this latter reach is protected by an extensive series of groynes, seawalls and revetments. Erosion rates along the shoreline are variable, and dependent on a number of factors, including the nearshore wave climate, the composition of the shoreline and nearshore lake bottom, and the extent and quality of existing shoreline protection works.

Baird (1992) suggests that the nearshore lakebed is composed of Rannoch till along much of the Sarnia shoreline. At Wees Beach (Colborne Road), the lake bottom is covered by a "lag deposit" of gravel and cobbles. This material is the by-product of erosion (over many years) of the stoney Rannoch till. Wave action erodes the clay matrix, leaving the gravel and cobble as a protective layer. This layer effectively stabilizes the lake bottom, and limits erosion of the shoreline in these areas. In the area of Brights Grove, it is suggested that the nearshore lakebed consists of relatively erodible St. Joseph till. The difference in lakebed erodibility has a significant impact on the shoreline stability.

Due to the wave climate and shoreline orientation in the study area, the net potential transport of sand is from northeast to southwest. In addition, the actual rate of sand transport along the shoreline is limited by the supply of sand from updrift erosion. The beaches represent an equilibrium condition between the nearshore wave climate and this limited supply of sand. In addition, the beaches are dynamic in nature, and respond to varying water levels and wave conditions through cross-shore transport and beach profile adjustment. The dynamic nature of the beaches is an important consideration in determining hazard setbacks and in the design of shoreline erosion protection works.

3.2 Reach Descriptions

In the 1996 SMP, the shoreline was divided into 28 reaches. A reach is a length of shoreline having common physiographic characteristics, shore dynamics, environmental elements and land use. In delineating the reaches, the following factors were considered:

- Shoreline geology/stratigraphy (i.e., shale, sand till, silt till, silt);
- Nearshore composition (bedrock, boulders, cobbles, glacial till, sand);
- Wave exposure;
- Shoreline orientation;
- Nearshore bathymetry;
- Littoral transport characteristics (including littoral subcell);

- Bluff height;
- Recession rate;
- Flood susceptibility;
- Environmental sensitivity; and
- Land use.

The 1996 SMP reaches were reviewed for this study and it was concluded that the reach delineation was appropriate in most locations and suitable for the SMP update. In some cases, the geographic boundaries (based on the streets located at the reach limits) were adjusted to more accurately reflect the locations shown in the mapping. A reach was added at the western study limit at Canatara Park. The easterly limits of the reach boundaries of Reaches 4 and 5 were adjusted to match the boundaries of the newly defined dynamic beach at Reach 5 (Hillcrest Dr. to Nesbitt Dr.). In the 1996 SMP, the reaches were not numbered. The reaches have now been numbered and extended to include Lambton Shores.

The reaches extend from Reach 1, at the western limit of the study area to Reach 38 at the eastern limit as shown in Figure 3.1. The geographic boundaries of the reaches are listed in Table 3.1 and descriptions of each of the reaches are provided in Appendix B.

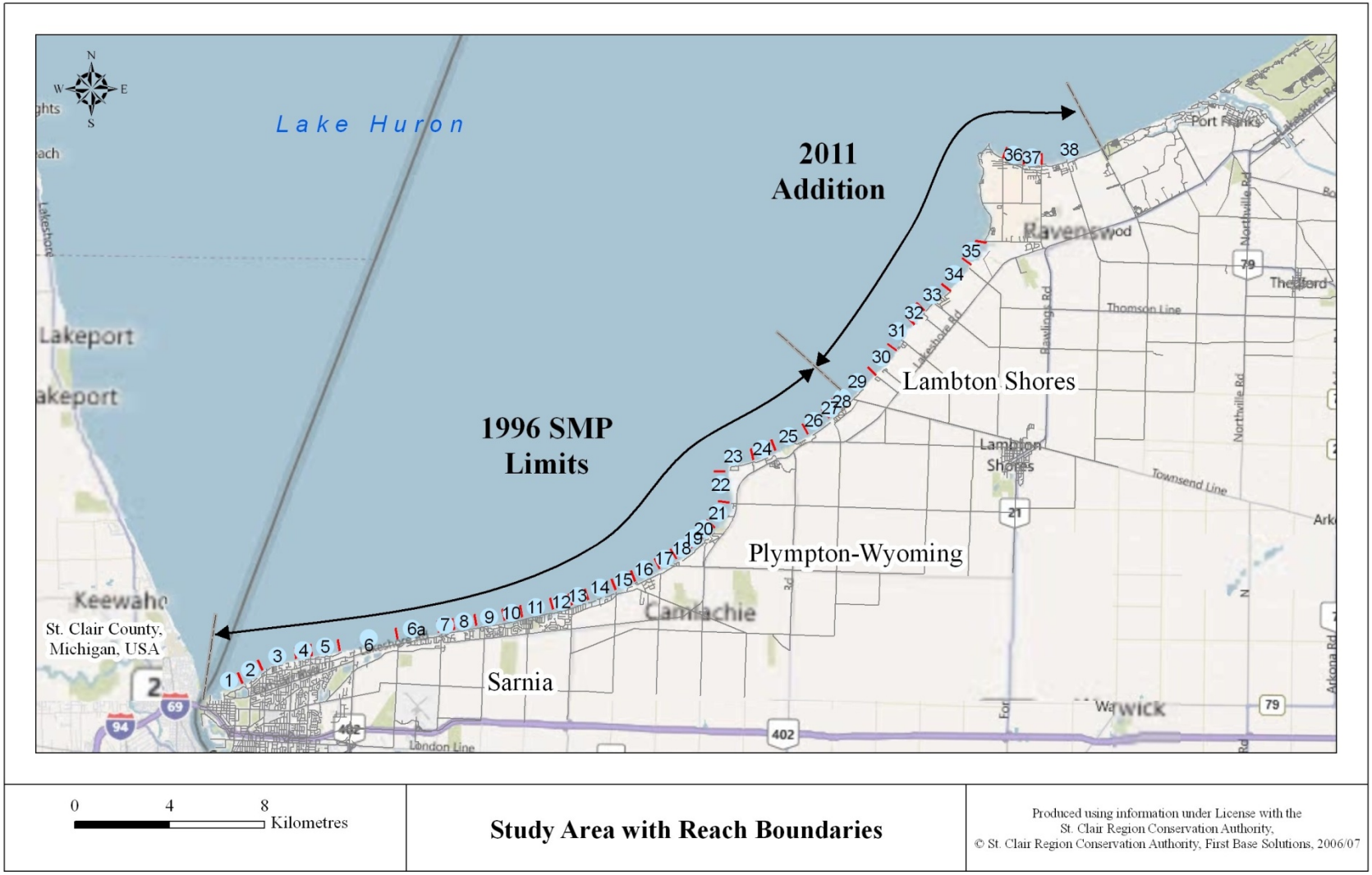

Figure 3.1 Shoreline Reach Boundaries

Table 3.1 Geographic Boundaries of Reaches

Reach	Description	Municipality
1	Canatara Park (Lake Chipican Dr.)	
2	Woodrow Ave. to Beach Lane	
3	Beach Lane to Tudor Close to Winton Road to Edgewater Court	
4	Braemar Lane to Haight Lane	
5	L. Huron Parkway to Hillcrest Drive to Nesbit Drive	
6	Lakeshore Road to Modeland Road to Blackwell Sideroad	
6a	Lakeshore Road past Blackwell Sideroad to Telfer Sideroad	
7	Huron Shores Drive to west of Perch Creek (Cull Drain)	
8	Perch Creek (west of Lambert Lane) to Passingham Drive (Mike Weir Park)	
9	Elprado St. (Mike Weir Park) to Kenwick St.	
10	Kenwick Street to Westgate Crescent	
11	Old Lakeshore Road (Helen Avenue to Cow Creek)	
12	Cow Creek (Huronview Trail) to Lakeview Trail	
13	Sandpiper Trail to Lake View Ave.	
14	Douglas St. to Devonshire Road	
15	O'Brien Rd. to Schram Drive	
16	Errol Beach and Subdivision (Maitland St. to Fleming Rd.)	
17	Fleming to Beverly Glen	
18	Beverly Glen to Ferne Avenue	
19	Bonnie Doon Subdivision (Ferne Av. Developed to Bonnie Doon Creek)	
20	Bonnie Doon Creek to Baldwin Av. (Point View Subdivision)	
21	Blue Point Bay (30 Creek Drain area, south of Douglas Line)	
22	Blue Point Bay north of Douglas Line	
23	Blue Point Subdivision (Blue Point north shore)	
24	Sunset Acres	
25	William St. Gallimere Beach (Kernohan O'Donnell Drain)	
26	Hillcrest Heights (Lakeside St.)	
27	Invercairn Beach (Mack Ave. to Pond Trail	
28	Hillsboro Beach (North and South) around Hickory Creek	
29	Townsend Line to Lake View Haven Dr.	
30	Lake View Haven Dr. to Woods Creek Drain	
31	Woods Creek Drain to James Creek Drain	
32	James Creek Drain to Freeman St. (Gustin Grove)	
33	Freeman St. to Beach St. (northern limit)	
34	Beach St. (northern limit) to Beith Creek (north of Fuller Rd.)	
35	Beith Creek (north of Fuller Rd.) to Indian Lane	
	Kettle and Stony Point First Nations	
36	Centre Sideroad to Juniper Lane	
37	Juniper Lane to West Ipperwash Rd.	
38	West Ipperwash Rd. to Army Camp Rd.	

4.0 SHORELINE HAZARDS

4.1 Overview of Shoreline Hazards

Hazardous lands are defined in the *PPS* (MMAH, 2005) as "property or lands that could be unsafe for development due to naturally occurring processes". Along 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 technical basis and methodologies for defining and applying the hazard limits for flooding, erosion and dynamic beaches are provided by the *Technical Guide for Flooding, Erosion and Dynamic Beaches, Great Lakes – St. Lawrence River System and Large Inland Lakes* (MNR, 2001a). The basic procedures outlined in the *Technical Guide* (MNR, 2001a) with some modifications have been included in subsequent documents, such as *Ontario Regulation 97/04* ("Generic Regulation"), *Guidelines for Developing Schedules of Regulated Areas* (MNR/CO, 2005) and *Draft 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 in the following subsections.

It is important to note, as outlined in the *Technical Guide* (MNR, 2001a), that the regulated hazard limits are generally to be mapped based on the assumption of no shoreline protection works in place. The clearly stated intent is that the mapped flooding, erosion and dynamic hazard limits are to represent the underlying, ambient nature of the hazard and should not be modified by the presence of existing or proposed shoreline protection or filling. The *Technical Guide* (MNR, 2001a), provides guidance in this matter. The limit of hazards is utilized in determining the regulated area of interest and shoreline protection is only then considered in determining if the hazards can be appropriately addressed under *Ontario Regulation 171/06 "Permission to develop*

> *3. (1) The Authority may grant permission for development in or on the areas described in subsection 2(1) if, in its opinion, the control of flooding, erosion, dynamic beaches, pollution or the conservation of land will not be affected by the development."*

This approach is consistent with the *Provincial Policy Statement* (Section 3.1.6), which states that development and site alteration may be permitted in those portions of the hazardous lands "*where the effects and risk to public safety are minor so as to be managed or mitigated in accordance with provincial standards, as determined by the demonstration and achievement of all of the following:*

> *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;*

c) *new hazards are not created and existing hazards are not aggravated; and*

d) *no adverse environmental impacts will result."*

The *PPS* (2005) states that development and site alteration shall not be permitted within the dynamic beach hazard (3.1.2a) and areas rendered inaccessible during times of flooding, erosion and /or dynamic beach hazards (3.1.2c). Development is hazardous areas shall not be permitted where the use is institutional, essential emergency services or hazardous substances (3.1.4).

4.2 Flooding Hazard

4.2.1 Definition of Flooding Hazard

The flooding hazard is defined by the combination of "flood level" and the "flood allowance for wave uprush and other water related hazards" (see Figure 4.1). The *Technical Guide* (MNR, 2001a) requires a flooding allowance of 15 m, measured horizontally from the location of the flood level, if a study using accepted engineering and scientific principles is not undertaken.

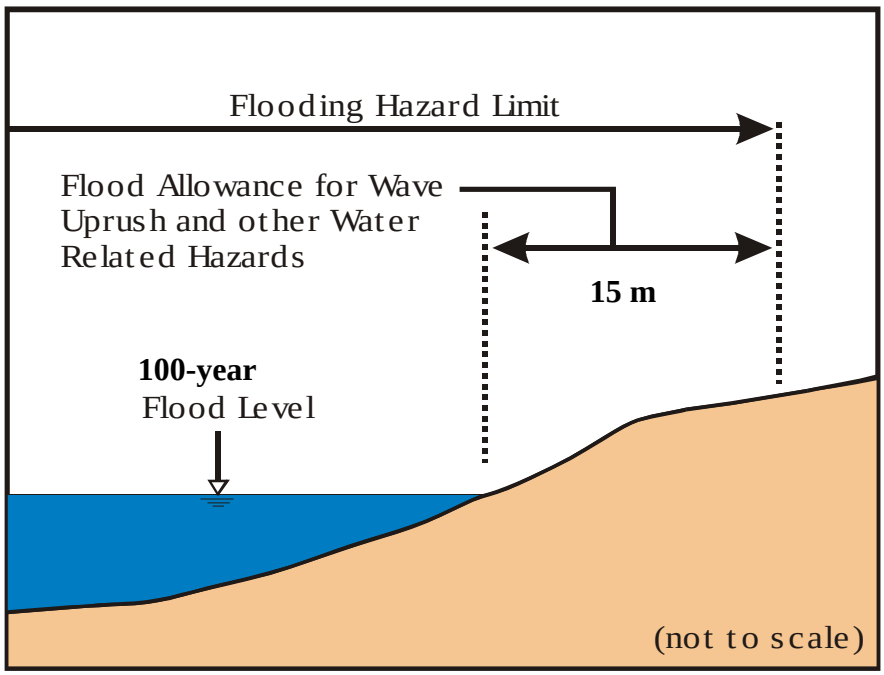

Figure 4.1 Flooding Hazard Limit with Wave Uprush

Where the shoreline is overtopped by waves or ponding occurs, the limit of the flooding hazard is to be determined by a study using accepted engineering and scientific principles (see Figure 4.2).

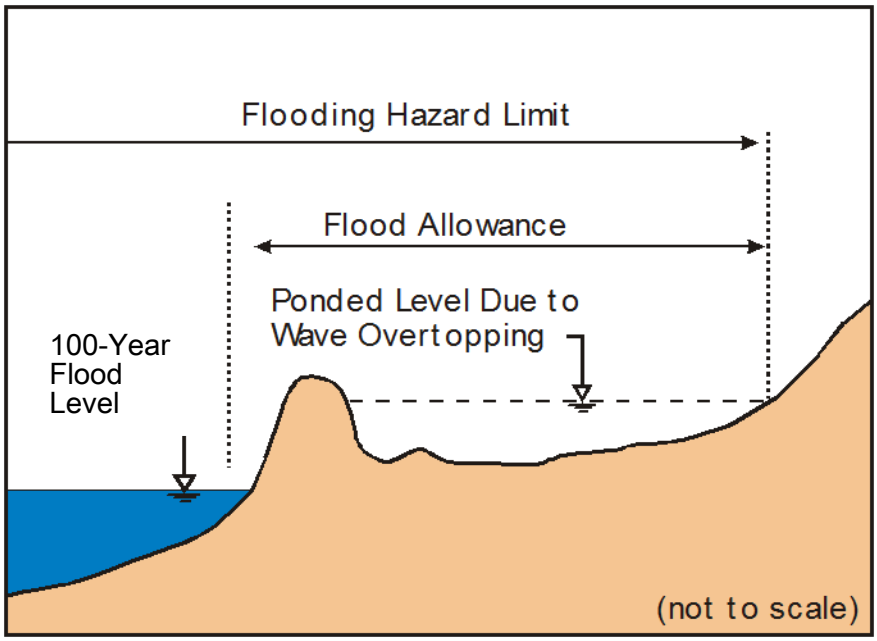

Figure 4.2 Flooding Hazard Limit With Wave Overtopping

The *Technical Guide* (MNR, 2001a) states that mechanisms should be incorporated into the planning process to provide the flexibility to undertake a study, using accepted scientific and engineering principles to determine the landward limit of the flood allowance for wave uprush and other water related hazards. Empirical methodologies for estimating shoreline flooding and wave uprush outlined in the *Technical Guide* (MNR, 2001a) are based on accepted engineering and scientific principles. Wave uprush is further discussed in Section 4.2.3.

4.2.2 100-Year Flood Level

The flood level is the sum of the mean lake level and storm surge with a combined probability of a 100-year return period (i.e., on average, has a 1 percent probability of occurring in any given year). The 100-year flood level used in this study is based on the *Great Lakes System Flood Levels and Water Related Hazards* report (MNR, 1989). Table 4.1 lists the 100-year flood levels for the applicable reaches.

Table 4.1 100-Year Flood Level (m CGD)

Reaches	Location Description	100-year Flood Level (m CGD)
1 to 23	Point Edward to Blue Pt.	178.0
24 to 38	Blue Pt. to Ipperwash	177.9

The 100-year flood levels determined by MNR (1989) were calculated using water levels for the period 1900 to 1987 adjusted to "Basis of Comparison" (BOC) conditions. BOC conditions include the effects of past regulation of Lake Superior outflows, which have some impact on the level of Lake Huron. General climatic trends (i.e. dry versus wet years) have a greater influence on Lake Huron water levels. The following subsections discuss the ongoing International Joint Commission (IJC) International Upper Great Lakes Study, which is reviewing the regulation plan for Lake Superior outflows in the Lakes Michigan-Huron and the potential impacts of climate change on Lake Huron water levels.

4.2.2.1 Influence of Lake Superior Outflows Regulation

The potential influence of regulation structures on lake levels was reviewed for this study. Figure 4.3 presents monthly mean water levels for Lakes Michigan-Huron from 1865 to 2009 in metres International Great Lakes Datum (IGLD 1985). The conversion from IGLD to CGD at Point Edward is (IGLD 1985 – CGD = 0.04 m).

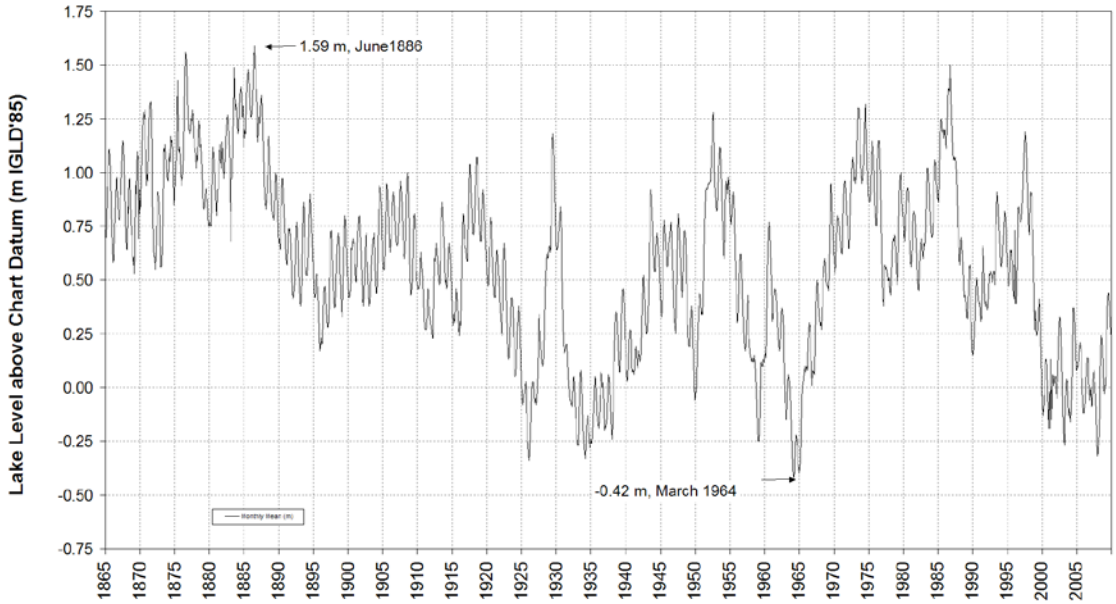

Figure 4.3 Historical Monthly Mean Water Levels on Lakes Michigan-Huron from 1865 to 2009

The Lake Michigan-Huron system is downstream of the regulation structures at Sault Ste. Marie. Therefore, decisions on the volume of water that passes thru the control structures based on Regulation Plan 1977A have some influence on Lakes Michigan-Huron levels. However, the overall hydrologic balance for the Lakes Michigan-Huron basin, which is controlled by the supply of water from rainfall and runoff into the lakes, minus outflows and losses due to evaporation, exert a far greater impact on the long term trends in lake levels.

Since the ongoing IJC study will not generate recommendations for a new regulation plan for Lake Superior until well beyond the completion of this study, it is premature to speculate on potential implications for future Lake Huron water levels. It was concluded that the historical 100-year flood level determined by MNR (1989) is still the most reliable data for use in this study.

4.2.2.2 Impacts of Climate Change on Lake Levels

There have been numerous studies to investigate the potential impacts of climate change on water supplies and levels in the Great Lakes Basin (e.g. USACE, 2000, Croley, 2003; Fan and Fay, 2003; Mortsch, 2009). These studies rely on statistical downscaling techniques which transfer the results from the Global Climate Models (GCMs) to local meteorological stations within the Great Lakes Basin. Since the GCMs generally predict hotter and dryer conditions in the future, the studies that rely on these models for the statistical downscaling predict lower lake levels in the future.

It is important to note, however, that annual and decadal cycles will continue for lake levels, even in a future influenced by climate change. Therefore, the severe swings in high and low lake levels observed in the historical record, as noted in Figure 4.3, will continue in the future. There are other potential climate change impacts that may actually increase flood and erosion risks in the future, such as decreased ice cover which exposes the shoreline to more winter storms, more intense storms and higher storm surges. There has yet to be a comprehensive study on the impacts of climate change on physical processes for Great Lakes shorelines (Baird, 2009) and thus the magnitude of these other impacts are unknown. Based on these findings, a panel of experts assembled in 2009 at the Great Lakes Climate Change & Policy Workshop (Baird, 2009), recommended shoreline managers continue to rely on historical extremes for implementing coastal zone management policies. It was concluded that the historical 100-year flood level determined by MNR (1989) is still the most reliable data for use in this study.

4.2.3 Wave Uprush

The 1996 SMP mapping applied the standard 15 m allowance for wave uprush (also referred to as wave runup) as described in Section 4.2.1, and the 15 m allowance has also been used in this update.

Wave heights during a storm are irregular (i.e., they are not of uniform height). Therefore, the resulting wave uprush during a storm is also irregular. Similar to wave heights, wave uprush elevations are typically reported as either mean, significant or the 2% uprush. The significant wave

uprush is the average of the highest one-third of all the uprush values, while the 2% wave uprush value is the uprush level only exceeded by 2% of all the values. The 2% uprush height can be approximated as 1.4 times the significant uprush height.

Many engineers have typically only reported the significant value of wave uprush. The *Technical Guide* (MNR, 2001a) suggests the 2% uprush height should be used as the estimate for the upper limit of wave uprush. EurOtop (2007), the FEMA *Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update* (FEMA, 2007), and the FEMA Great Lakes Region Update (Collier pers. comm., 2008) also specify the use of the 2% uprush height for hazard mapping. EurOtop (2007) also recommends the addition of one standard deviation to the predicted uprush for deterministic design and safety assessments. This approach ensures the wave uprush prediction incorporates a factor of safety to account for the scatter in the test results on which the runup equations are based. It is recommended that if site specific studies are undertaken to reduce or increase the 15 m wave uprush allowance, then the 2% uprush height with one standard deviation should be used as the estimate for the upper limit of wave uprush.

Note that wave conditions used in estimating the wave uprush height are not necessarily the 100-year return period waves as this would result in a conservative return period for the combined probability of the 100-year flood level and waves. As outlined in the *Technical Guide* (2001a), a return period of 10 to 20 years for the waves is generally sufficient. However, in most instances close to the shore, where water depths are relatively shallow, wave conditions will be depth limited. The depths used in determining the depth-limited wave height should include an allowance for future downcutting of the nearshore profile.

Localized damage can occur as a result of ice effects on shore by wind and wave action (e.g., pile up, ride up, bulldozing). Wave spray can be driven inshore by winds; in freezing temperatures this can result in icing of roads, buildings and utilities close to the shore. No specific data is available for applying a separate allowance for other water related hazards (including wind driven wave spray and ice) and these hazards are included in the generic 15 m flood hazard allowance and should be taken into consideration if the standard 15 m allowance is to be reduced.

4.3 Erosion Hazard

4.3.1 Definition of Erosion Hazard

Calculation of the erosion hazard is a two-step process. In the first step, the erosion hazard is calculated as the sum of the stable slope allowance plus the erosion allowance of 100 times the average annual recession rate, or a minimum erosion allowance of 30 m if sufficient recession data is not available. Figure 4.4 shows the erosion hazard limit as defined in the *Technical Guide* (MNR, 2001a) and *Understanding Natural Hazards* (MNR, 2001b). The approach used in the Generic Regulation is similar but the recession allowance is applied first, then the stable slope allowance is applied; for example:

> *"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."*

Both approaches will result in a similar erosion hazard limit if the table land is relatively flat.

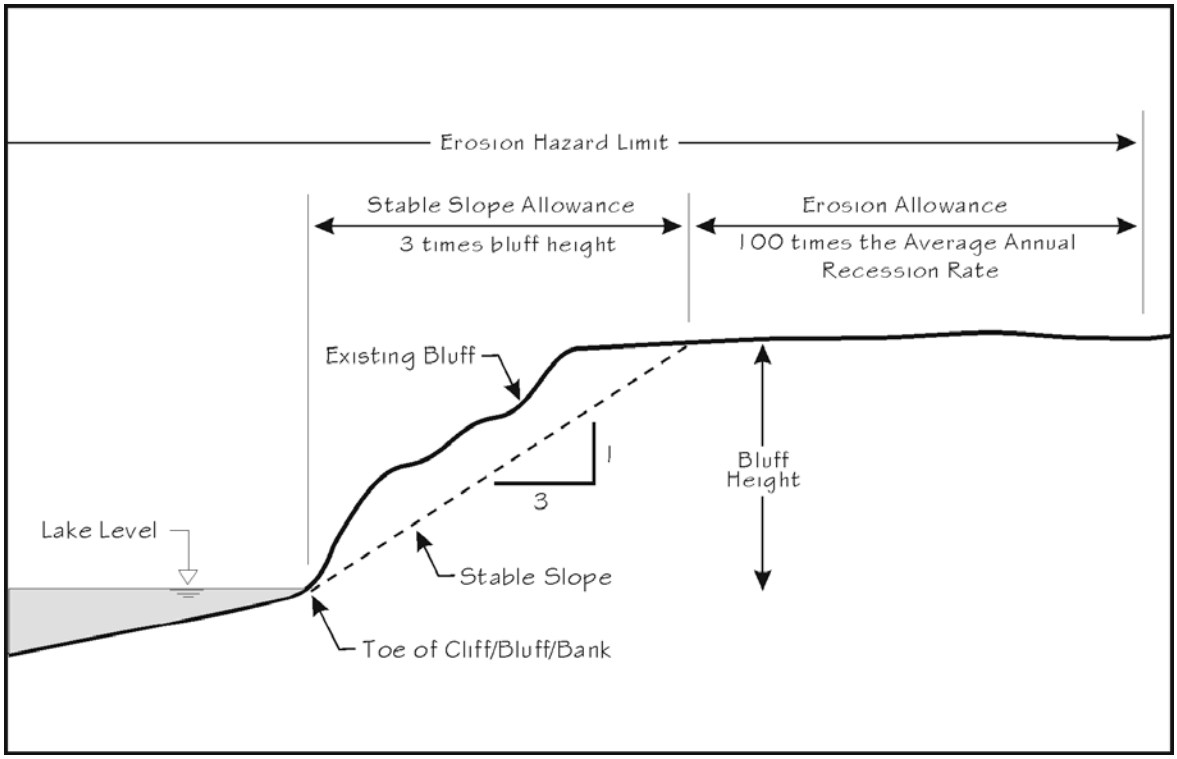

Figure 4.4 Erosion Hazard Limit Defined by *Technical Guide* (MNR 2001a)

For this study, the stable slope allowance was delineated first because slope stability is an immediate risk while erosion is an ongoing future risk. Development should not be permitted within the stable slope allowance, while measures can be proposed to address the erosion hazard (See Section G.2). Further details on mapping the hazard are provided in Section 5.

The average annual recession rate is used to determine the erosion allowance over 100 years where there is at least 35 years of reliable recession information. Where there is insufficient reliable recession information, the *Technical Guide* (MNR, 2001a) suggests a minimum 30 m setback distance to allow for erosion along the Great Lakes-St. Lawrence River system. For this study, the recession rates used in determining the 100-year erosion allowances are discussed in Section 4.3.3.

In the second step, the landward limit of the erosion hazard is calculated as a 30 m erosion allowance measured landward from the top of the shoreline cliff, bluff or bank, or the first lakeward break in slope, as shown in Figure 4.5. It is the greater of the landward measurements from Steps 1 and 2, which ultimately determines the landward limit of the erosion hazard. The second method of calculation would generally govern in situations where the existing slope is a flatter inclination than the stable slope allowance, MNR (2001a, 2001b).

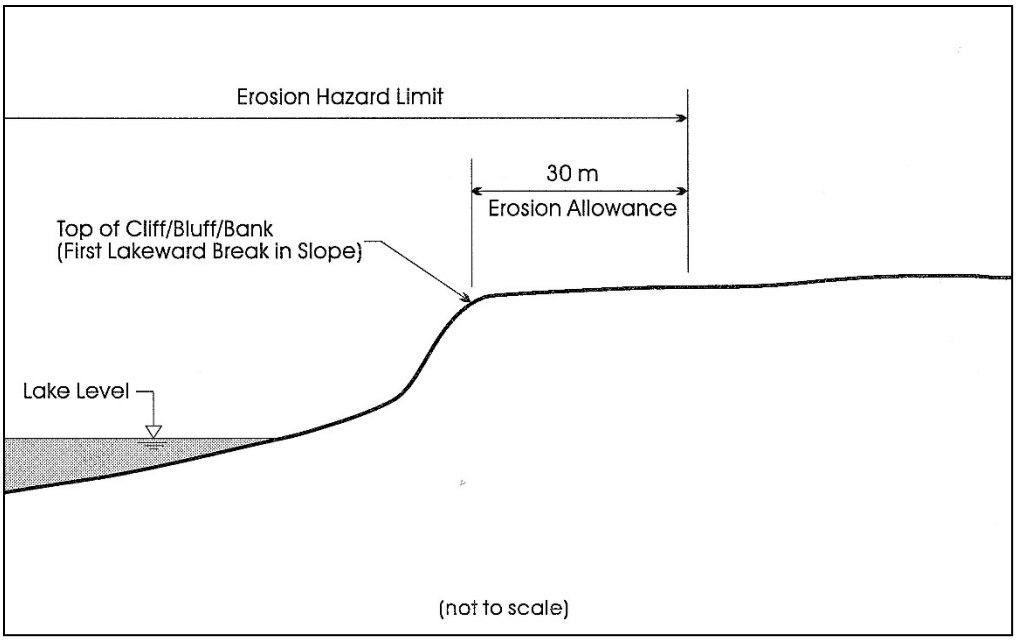

Figure 4.5 Erosion Allowance Measured from First Lakeward Break in Slope

4.3.2 Slope Stability

The *Technical Guide* (MNR, 2001a) recommends using a stable slope allowance of 3:1 (i.e., three times the bluff height, measured from the toe of slope) unless a geotechnical engineer provides a detailed site study (See Figure 4.4). A slope stability allowance of 3:1 (horizontal:vertical) was used in this study. The 1996 SMP also used 3:1 stable slope allowance.

4.3.3 Recession Rates

Average annual shoreline recession rates were calculated along the Point Edward, Sarnia, Plympton-Wyoming and Lambton Shores shorelines, for all reaches for which the Erosion Hazard applies. The calculated average annual recession rates (AARRs) were then used to define the erosion allowance for each reach. The erosion allowances for Lambton Shores were determined by Baird as described in Section 4.3.3.1. The erosion allowances for all other reaches were determined by SCRCA as described in Section 4.3.3.2.

Recession rates can be calculated by comparing shoreline feature positions from different time periods. Longer time periods are preferred for analysis because they reduce the variability of localized erosion and provide more accurate annualized recession rates. The *Technical Guide* (MNR, 2001a) recommends that at least 35 years of sound recession information for the unprotected shoreline should be used to determine an AARR for a site. The standard approach, as outlined in the *Technical Guide* (MNR, 2001a), is to use the top of bluff edge, not the water/shoreline because of the variability of water levels, to determine the recession rate.

4.3.3.1 AARRs for Lambton Shores

The oldest shoreline survey available is the *1935 Plan of Shore Survey* series conducted by the Ontario Land Surveyors, commonly referred to as the 1935 OLS surveys. This survey was carried out to map the Crown's water right of way, but the survey also captures top of bank locations at 80 m intervals along the shoreline traverse. The top of bank measurements were excluded when the location was under the erosion influence of other physical processes (gullies/ravines).

The 1935 top of bank locations were mapped and compared with the 2007 top of bank locations (established from the half-metre contour intervals derived from the 2007 10 cm stereo orthophotography). The measured difference between the two top of bank locations represents erosion over the 72 year period. The Lambton Shores shoreline is largely unprotected. The individual erosion measurements (spaced at 80 m intervals) were then grouped based on the reaches listed in Table 3.1, and for each reach an AARR was calculated as (72 year mean recession plus 1 standard deviation)/72 years. The standard deviation is included to address the issue of variability in erosion rates along the shoreline (Zuzek et al, 2003). For reaches where the calculated rate was less than 0.1 m/yr, a minimum AARR rate of 0.1 m/year was applied. This accounts for uncertainty in the analysis. For a number of reaches, it was not possible to determine an AARR, due to difficulties in defining a top of bluff. At these locations, the minimum AARR of 0.1 m/year was also applied. The average annual recession rates used to determine the erosion allowance for calculation of the Erosion Hazard Limit are summarized in Table 4.2.

4.3.3.2 AARRs for Point Edward, Sarnia and Plympton-Wyoming

AARRs developed for the 1996 SMP and associated mapping, for Point Edward, Sarnia and Plympton-Wyoming were updated by SCRCA. The reaches defined in the 1996 SMP had been subdivided into blocks based on recession rate, bluff height, human activity, and locations of streams or gullies, as described in Reinders and Geomatics (1991). The AARRs have been updated in this study, by comparing top of bank locations for 2007 and 1935 as described in Section 4.3.3.1. For consistency, the AARRs have been calculated using the blocks developed for the 1996 SMP. It is noted that the SCRCA used recession data based on a 72 year period of comparison and did not necessarily identify periods of time when shore protection was in place.

4.3.4 Recommendations for Future Determination of Recession Rates

As outlined in the Technical Guide (MNR, 2001a), Zuzek et al (2003), and as described in Section 4.1, recession rates should be based on the natural, ambient recession of the shoreline (i.e., unaffected by shoreline protection). This is based on the premise that the erosion allowance is intended to provide an indication of the underlying nature of the hazard, that shore protection works have a limited design life, and there is no assurance that they will be maintained or exist in the future (see for example the deteriorating groynes along the Sarnia shoreline). It is difficult to determine ambient recession rates in Plympton-Wyoming, Sarnia and Point Edward because there are a limited number of sites that have been left unprotected. AARRs listed in Table 4.2 are based on recession data for a 72 year period of comparison, however SCRCA did not necessarily identify periods of time when shore protection was in place. Further studies of areas that are unprotected are recommended in the future.

Table 4.2 Average Annual Recession Rates Used to Determine Erosion Allowance SCRCA Board Approved November 2011

Reach	Measurement Numbers[1]	AARR (m/year) 1935-2007[2]	Governing Hazard	
1	1-34	n/a	Dynamic Beach	Sarnia
2	35-47	n/a	Erosion	
3	48-88	n/a	Erosion	
4	89-95	0.37	Erosion	
5	96-118	n/a	Dynamic Beach	
6-1	119-138	0.17	Erosion	
6-2	139-145	0.60	Erosion	
6-3	146-150	0.42	Erosion	
6-4	151-164	0.26	Erosion	
6a-1	165-185	0.11	Erosion	
6a-2	186-195	0.19	Erosion	
6a-3	196-207	0.21	Erosion	
7	208-218	0.12	Erosion	
8a	221-290	0.33	Erosion	
8b	291-295	0.23	Erosion	
8c	296-299	0.35	Erosion	
9	300-321	0.14	Erosion	
10	322-327	0.14	Erosion	
11	328-369	0.21	Erosion	
12	370-381	n/a	Dynamic Beach	
13	383-394	0.18	Erosion	
14a	395-404	0.29	Erosion	
14b	405-416	.10	Erosion	
15	417-436	0.33	Erosion	
16a[3]	439-447	0.46	Erosion	
16b[3]	448-462	0.42	Erosion	
17a	463-472	0.34	Erosion	
17b[3]	475-483	0.30	Erosion	
18[3]	484-502	0.37	Erosion	
19	503-509	0.29	Erosion	
20	517-527	0.32	Erosion	
21	532-553	0.16	Erosion	
22a	554-559	0.06	Erosion	
22b	560-569	0.39	Erosion	
22c	570-576	0.25	Erosion	
22d	577-586	0.1	Erosion	
23a	587-590	0.41	Erosion	
23b	591-608	0.56	Erosion	
24	609-626	0.54	Erosion	
25	647-656	0.10	Erosion	
26a	657-661	0.06	Erosion	
26b	662-681	0.07	Erosion	
27a	684-688	0.06	Erosion	
27b	690-693	0.04	Erosion	
28	694-707	0.08	Erosion	

29	1-8	0.23	Erosion	Lambton Shores
30	9-14	0.15	Erosion	
31	15-17	0.08	Erosion	
32	18-23	0.36	Erosion	
33	n/a	n/a	Erosion	
34	n/a	n/a	Erosion	
35	n/a	n/a	Erosion	
36	n/a	n/a	Dynamic Beach	
37	n/a	n/a	Dynamic Beach	
38	n/a	n/a	Dynamic Beach	

Notes:

[1]Measurement numbers for Reaches 1-28 are from 1996 SMP. Measurement numbers for Reaches 29-38 are from current study.

[2]Where calculated AARR was less than 0.1 m/year a minimum AARR of 0.1 m/year was applied to account for uncertainties in the analysis.

[3] Due to limited data for these reaches they were investigate and updated in 2015.

"n/a" indicates that it was not possible to determine AARR due to difficulties in defining top of bluff and a minimum AARR of 0.1 m/year was applied.

4.4 Dynamic Beach Hazard

4.4.1 Definition of Dynamic Beach Hazard

The dynamic beach hazard involves the calculation of the cumulative impact of the flooding hazard, the erosion allowance and a dynamic beach allowance. In addressing these factors, the dynamic beach hazard is defined as:

- The landward limit of the flooding hazard (100-year flood level plus a flood allowance for wave uprush and other water related hazards) plus a 30 metre dynamic beach allowance, plus 100-year erosion allowance (see Figure 4.6);

or

- The landward limit of the flooding hazard (100-year flood level plus a flood allowance for wave uprush and other water related hazards) plus a dynamic beach allowance based on a study using accepted scientific and engineering principles, plus 100-year erosion allowance.

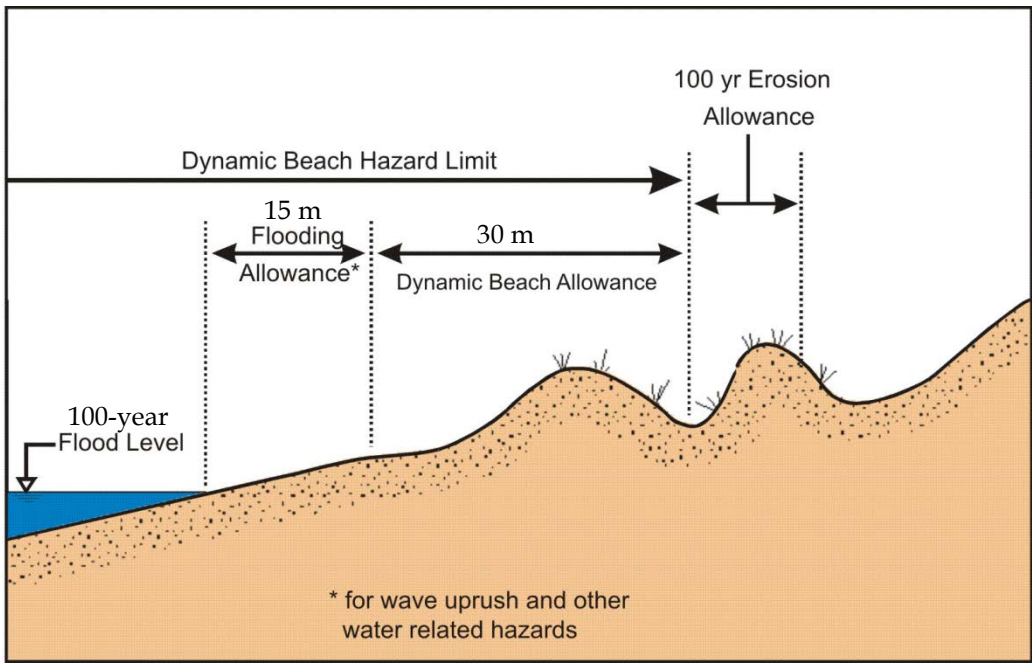

Figure 4.6 Dynamic Beach Hazard Limit

The "flood level" and the "flood allowance" represent the flooding hazard, as described in Section 4.2. The flood allowance accommodates waves, which rush up the shoreline beyond the water level. The *Technical Guide* (MNR, 2001a) requires a flood allowance of 15 m, measured horizontally from location of the flood level, if a study using accepted engineering and scientific principles is not undertaken.

The dynamic beach allowance is intended to permit the natural erosion and accretion of the beach/dune system in response to variable lake levels and storm events. The *Technical Guide* (MNR, 2001a) requires a dynamic beach allowance of 30 m if no study using accepted engineering and scientific principles is undertaken. The sum of the combined flooding and dynamic beach hazard allowances is 45 m measured horizontally from the position of the 100-year flood level.

The standard "default" values for the flooding and dynamic beach hazards reasonably encompass most sites on the Great Lakes. In the development of the dynamic beach hazard limit, the landward side of the first main foredune was deemed to be a reasonable limit in most situations. The *Technical Guide* (MNR, 2001a) states:

> *"…where developments and site alterations have been directed to locations inland of the beach or dune features (i.e., landward of the first main foredune), these features often naturally prevent flood waters from reaching inland areas and absorb the erosive impacts and forces of wave action."*

As sand accumulates on a beach, an embryo dune will begin to form. Eventually the embryo dune grows high enough to be termed the foredune. The first main foredune is the first fully formed sand dune nearest the lake. A detailed description of beach and dunes processes is provided in the *Technical Guide* (MNR, 2001a).

In addition to the flooding and dynamic beach hazard allowances, an erosion allowance must also be considered where appropriate. The erosion allowance is intended to accommodate long-term recession of the shoreline. Due to the dynamic nature of beaches and the changes in beach width that occur in response to variations in water level, quantification of erosion for dynamic beach shorelines is complex and requires a significant amount of data and analysis. An erosion allowance has not been calculated for the beaches in the study area. A more detailed analysis could be undertaken in the future to determine if an erosion allowance is warranted. Such an analysis would survey beach response to variations in water levels and storm events over many years.

The *Technical Guide* (MNR, 2001a) outlines several circumstances under which natural factors may require redefining the landward limit of the dynamic beach hazard based on field investigations. The following situation (shown in Figure 4.7 and described in the *Technical Guide* (MNR, 2001a) is applicable to sections of the SCRCA shoreline:

> *"…where a cliff or bluff, consisting of cohesive sediments or bedrock, exists landward of the beach, the toe of the bluff/cliff acts to limit the landward extent of dynamic beach profile adjustment. In these areas the dynamic beach hazard limit should be defined as the toe of the cliff or bluff".*

On dynamic beaches backed by a cliff or bluff, the calculation and definition of the erosion hazard is applied to the cliff or bluff feature and as such, recession of the beach is accounted for in the determination of the landward limit of the erosion hazard for the cliff or bluff feature.

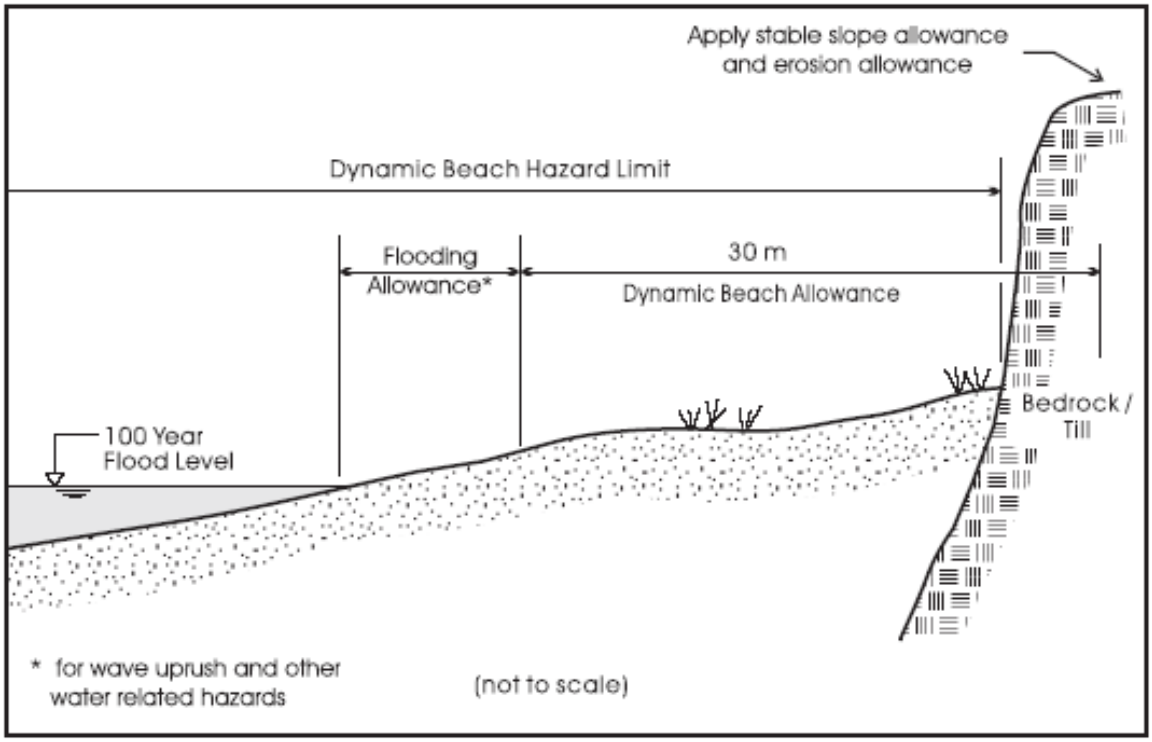

Figure 4.7 Dynamic Beach Hazard Limit Backed for Bluff

The *Technical Guide* (MNR, 2001a) provides for the flexibility to undertake a study, using accepted scientific and engineering principles, to determine the landward limit of the dynamic beach hazard to replace the default 45 m value, as measured from the 100-year flood level. A proper study to further evaluate the dynamic beach limit typically involves a two-step process. The first step is an initial site reconnaissance to determine if further, more detailed analysis would be warranted. The initial reconnaissance would be accompanied by a review of existing data on the coastal processes and geomorphology of the area. The second step involves site specific field surveys of the nearshore and beach/dune profiles, compiling offshore bathymetric data, collecting sand samples and testing for grain size, determining design flood levels and wave conditions and numerical modeling of the likely limit of the dynamic beach hazard under storm and high water conditions using appropriate cross-shore beach profile models.

4.4.2 Identifying Dynamic Beaches

The term dynamic beach is used in the *Technical Guide* (MNR, 2001a) to describe beach profiles which undergo changes on a broad range of time scales in response to changing wave, wind and water level conditions and to change in the rate of sediment supply. The dynamic beach hazard is only applied where: a beach or dune deposit exists landward of the water line; AND beach or dune deposits overlying bedrock or cohesive material are equal to or greater than 0.3 metres in thickness, 10 metres in width and 100 metres in length along shoreline, AND where the maximum fetch distance measured over an arc extending 60 degrees on either side of a line perpendicular t the

shoreline is greater than 5 km (this excludes embayments, connecting channels and other areas of restricted wave action where wave processes are too slight to alter the beach profile landward of the waterline).

The locations of the dynamic beaches in the study area (shown in Figure 4.8) are as follows:

- Reach 1, Canatara Park (Lake Chipican Dr.): The beach east of the Point Edward marina is a fillet beach which was formed by accretion of longshore sediment that was trapped following construction of the marina. A fillet beach is typically updrift of a breakwater or shore perpendicular jetty and is roughly triangular in planform. The dynamic beach hazard limit was mapped at the standard 30 m from the flood hazard. No analysis was undertaken to determine if the beach is eroding or accreting and an erosion allowance was not applied. It should be noted that the stability of the beach is dependent on the continued presence of the marina structures.

- Reach 5, Lake Huron Parkway to Hillcrest Drive to Nesbit Drive: The beach deposit in this area is wider and more significant than adjacent shorelines. The air photo suggests an offshore feature which has resulted in salients forming along the beach. The dynamic beach hazard limit was mapped at the transition from the unconsolidated beach materials to the low plain. The beach does not appear to be recessional but due to the overall recessional nature of the shoreline via historic photos and mapping, an erosion hazard was also mapped.

- Reach 12, Cow Creek (Huronview Trail to Lakeview Trail): The beach on the east side of the jetty at the mouth of Cow Creek is a fillet beach which was formed by accretion of alongshore sediment that was trapped following construction of the jetties at the mouth of the creek. The dynamic beach hazard limit was mapped at the transition from the unconsolidated beach materials to the low plain. The beach does not appear to be recessional based on a simple review of historic photographs and mapping but due to the overall recessional nature of the shoreline, an erosion hazard was also mapped. It should be noted that the stability of the beach is dependant on the continued presence of the jetties.

- Reaches 36 to 38, Ipperwash Beach (Centre Side Road to Army Camp Road): The beach is a fully developed dynamic beach with an established dune system. The dune system decreases in a southerly direction, approaching Kettle Point. The dynamic beach hazard limit was mapped at the standard 30 m from the flood hazard, extending to the landward side of the first main foredune. The adjustment of the beach profile to the lower water levels was taken into consideration by adjusting the beach profile as described in Section 4.4.3. The shoreline does not appear to be recessional and no erosion allowance was therefore applied.

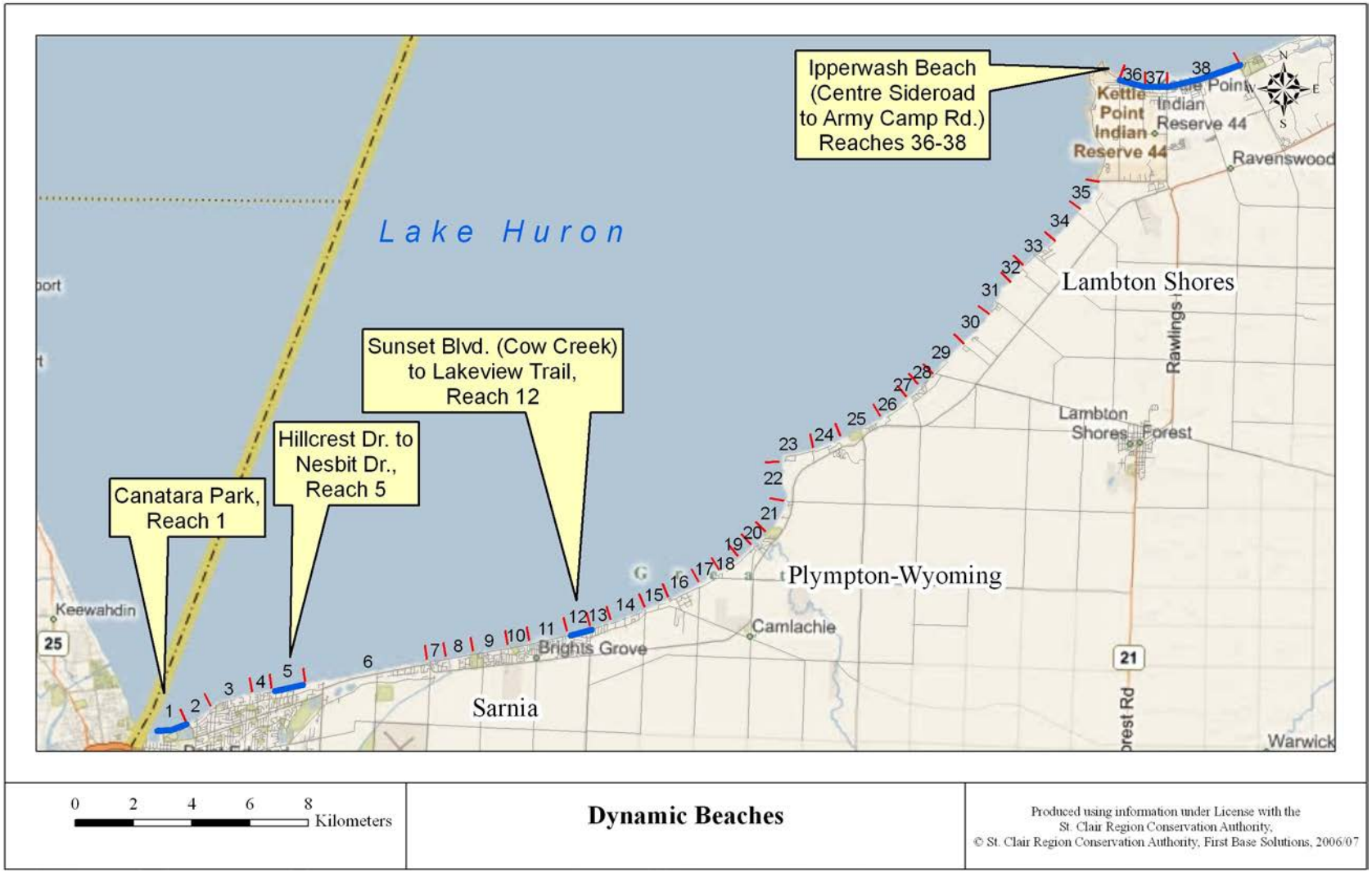

Figure 4.8 Dynamic Beach Locations

4.4.3 Beach Profile Adjustment for Low Water Level

On Great Lakes shorelines, changes in beach profile elevation occur in response to lake level variations. During periods of higher lake levels, the beach profile erodes, and during periods of lower lake levels, the beach profile accretes. This can have an impact on the horizontal position of the 100-year flood elevation and in turn, on the location of the flood and dynamic beach hazard limits. Lake Huron water levels have been below average since 1998 and this has resulted in significant accretion at Ipperwash Beach.

Profile data from six different years at beach monitoring station H-10-18 at Ipperwash Beach are shown in Figure 4.9. In each case, the beach profile and corresponding monthly mean water level are shown. The data from April 2007 was plotted from the 2007 topographic contours and orthoimagery used to delineate the hazard limits for this study. The 2007 profile is the furthest lakeward of the measurements and also corresponds to the lowest lake level (176.04 m CGD).

Hazard mapping is based on extreme conditions. The 100-year monthly mean high water level is 177.40 CGD at Ipperwash. This approximates the water levels that occurred during August 1973 (177.3 m CGD) and this profile was therefore used to quantify the profile adjustment made to the 2007 topographic contours and orthoimagery. From Figure 4.9, the profile adjustment at the 100-year flood level (177.88 m CGD) is 15 m. The 100-year flood level was therefore adjusted 15 m landward on the 2007 topographic contours at Ipperwash Beach (Reaches 36 to 38). This adjustment is reflected in the flood hazard limit and the dynamic beach hazard limit at these locations.

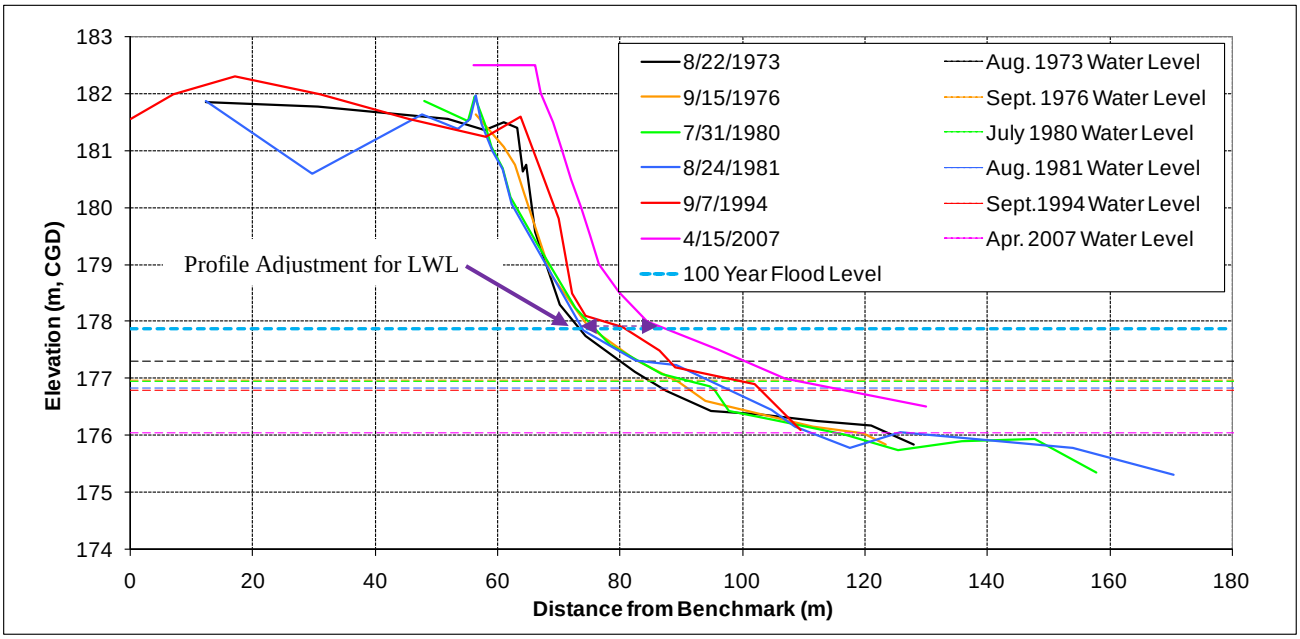

Figure 4.9 Monitoring Data from Profile H-10-18 Ipperwash Beach showing Profile Adjustment at Ipperwash Beach for Low Water Level

5.0 MAPPING THE HAZARDS

In accordance with the project scope, this study focused on updating the flooding, erosion and dynamic beach hazards in Lambton Shores (Reaches 29 to 38 excluding the First Nations land); the remainder of the study area, Point Edward, Sarnia and Plympton-Wyoming (Reaches 1 to 28) has been updated concurrently by SCRCA.

The flood, erosion and dynamic beach hazard lines have been located on the mapping with half-metre contour intervals derived from the 2007 10 cm stereo orthophotography and do not consider the effect of local irregularities and physical shoreline conditions that may affect site specific hazards. Where development is proposed, the location of the hazard limits should be reviewed with regard to the most recent and detailed site information available, with due consideration to the effect of adjacent shoreline conditions and associated hazards. A site specific study, using accepted scientific and engineering principles may be undertaken by the proponent to evaluate the hazard limits.

The steps undertaken to map the hazard limits are consistent with the *Technical Guide* (MNR, 2001a), as described in Section 4.0, and are summarized as follows:

- 100-Year Flood Level: The position of the 100-year flood level was derived from the 2007 topographic contours. The topographic contours were provided at 0.5 metre intervals. The Lake Huron 100-year flood level for the study area is 177.9 to 178.0 m CGD (see Table 4.1), but with the topographic data limited to 0.5 metre intervals, the value of 178 m was used for the entire study area. At Ipperwash Beach, the profile was adjusted to compensate for the low water levels which have resulted in a lakeward shift of the beach profile in the 2007 topographic contours and orthoimagery. This resulted in a shift of 15 m landward as discussed in Section 4.4.3.

- Flood Hazard Limit: The flood hazard limit for each reach segment was delineated using the 100-year flood level as a baseline and then generating a spatial buffer of 15 m measured horizontally to add a wave uprush allowance.

- Toe of Bluff: According to the Technical Guide (2001a) "toe and top of the cliff, bluff, or bank positions usually correspond with contour lines on topographic maps, with visible changes, often in slope, on aerial photographs…" For this study, the toe of bluff feature was traced by visually interpreting from the 2007 orthophoto, using "heads-up digitizing" onscreen within a GIS environment at a map resolution of about 1:1,000-scale; where clarification was needed, other supplemental datasets were used, primarily the topographic contours and the colour 2007 airphotos. The toe of bluff line is segmented to match each Reach segment.

- Stable Slope Allowance: The stable slope allowance (SSA) was calculated uniquely for each Reach. The SSA was generated using a spatial buffer tool with the toe of bluff lines as the base and 3 times the average bluff height as the horizontal distance. The average bluff height was determined on a per reach basis by reviewing the 2007 topographic contours at 1 metre intervals and by averaging a number of bluff height measurements within the reach.

- Erosion Hazard Limit: The landward limit of the erosion hazard is the more landward of either:

  (1) sum of the stable slope allowance plus 100 times the average annual recession rate (i.e., 100 year recession; recession rates in Table 4.2) plus 1 standard deviation of the erosion variability within the reach, measured landward from the toe of the shoreline cliff, bluff, or bank, and mathematically generated for each reach segment, using a spatial buffer based on the toe of bluff line; or

  (2) the 2007 Top of Bank plus a 30 metre allowance.

- Dynamic Beach Hazard: The dynamic beach hazard limit was mapped as the flood hazard limit plus 30 m. As discussed above, the beach profile was adjusted to compensate for the low water levels which have resulted in a lakeward shift of the beach profile in the 2007 topographic contours and orthoimagery.

- At larger rivers, the erosion and flood hazards were extended up the river, following the banks, until they intersected with the river flood hazard lines.

5.1 Shoreline Development and the *PPS* and Ontario Regulation 171/06

Prevention is the preferred approach for management of the Great Lakes shoreline hazards as it reduces or minimizes losses by modifying the loss potential by controlling, restricting and/or prohibiting development activities within the hazardous lands. The *Provincial Policy Statement* (2005) states that development shall generally be directed to areas outside of hazardous lands adjacent to the shorelines of the Great Lakes which are impacted by flooding hazards, erosion hazards and/or dynamic beach hazards.

As discussed in Section 4.1 of this report, the *PPS* (2005) prohibits development within the dynamic beach hazard.

The *PPS* (Section 3.1.6) does allow that development and site alteration may be permitted in those portions of the flood and erosion hazard lands *"where the effects and risk to public safety are minor so as to be managed or mitigated in accordance with Provincial Standards, as determined by the demonstration and achievement of all of the following:*

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;

c) new hazards are not created and existing hazards are not aggravated; and

d) no adverse environmental impacts will result."

The inclusion of these requirements under Section 3.1.6 is intended to provide flexibility to recognize local conditions (*Technical Guide*, MNR 2001a). Areas of existing development are one specific local condition that is explicitly recognized in the *Technical Guide* as appropriate for consideration of flexibility in applying the requirements of the protection works standards (i.e., see Appendix A7.2, Existing Development Within the Hazardous Lands, MNR 2001a).

5.2 Addressing Flood and Erosion Hazards

As outlined in Section 6.1, development and site alteration may be permitted in those portions of the flood and erosion hazard lands where the effects and risk to public safety are minor so as to be managed or mitigated in accordance with floodproofing standards, protection works standards and access standards.

5.2.1 Floodproofing Standard

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. Floodproofing and flood protection works can only reduce the risk and/or lessen the damage to properties. No measure will prevent all damages due to flooding. Where it has been determined that development and site alteration could possibly be located within the less hazardous portion of the flooding hazard, the floodproofing standard should be applied. The minimum floodproofing standard is as follows: development and site alteration is to be protected from flooding, as a minimum, to an elevation equal to the sum of the 100-year monthly mean lake level plus the 100-year wind setup plus a vertical flood allowance for wave uprush and other water related hazards determined on a site specific basis.

5.2.2 Protection Works Standards

By definition (*PPS*, Section 6.0 Definitions), protection works standards *"means the combination of non-structural or structural works and allowances for slope stability and flooding/erosion to reduce the damages caused by flooding hazards, erosion hazards and other water-related hazards, and to allow access for their maintenance and repair"* (PPS, 2005). The *Technical Guide* (MNR, 2001a), developed in support of the *PPS*, outlines specific guidelines for the protection works standard including protection works, the stable slope allowance and the erosion hazard allowance.

The three key elements of the protection works standard are described in the *Technical Guide* (MNR, 2001a) as follows:

- Protection works should be of sound, durable construction and be designed by a qualified coastal engineer according to accepted practice;
- Protection works should be used in conjunction with appropriate stable slope and hazard allowances; and
- There must be access to the protection works for suitable equipment for future rehabilitation, replacement or repairs.

5.2.2.1 Planning Horizon for Development

The erosion hazard allowance is dependent on the recession rate and the planning horizon for the development. For new development, the *PPS* supports a planning horizon of 100 years.

5.2.2.2 Shoreline Protection Structure Design Life

Structure design life differs from the planning horizon of the project. Structure design life is the length of time that a structure, with routine maintenance, is able to safely and adequately perform its function. Structures requiring replacement or significant rehabilitation have reached the end of their useful design life. The design life of a structure can be extended beyond its original design life by rehabilitation or restoration provided sufficient funds and suitable construction access are available. Guidelines for the typical expected design life of shoreline structures are outlined in the *Technical Guide* (MNR, 2001a):

- "In areas with low recession rates (i.e., ≤0.3 m/yr), it may be appropriate to consider that a sound, well designed, properly constructed and well maintained structure will have a life span in the order of 25 to 40 years. This assumes that proper measures have been taken to address flanking of the protection. Evidence supporting a design life longer than 40 years should be clear and convincing and should include continuous and unobstructed access to the shoreline for future maintenance and repairs." "A design life greater than 50 years generally should not be considered without compelling evidence of the long-term stability of underlying material and the likelihood that the proponent, or subsequent owners, will undertake any necessary future repairs and/or rehabilitation."

- "In areas of moderate recession rates (i.e., 0.3 m/yr to 0.7 m/yr), it may be appropriate to consider a structure design life in the order of 15 to 25 years for sound, well designed, properly constructed and well maintained structures. Due to the ongoing nearshore erosion and the potential for undermining, shoreline managers should be cautious about accepting a claim for a design life greater than 25 years. For example, along cohesive shores there are practical construction limitations to the amount of excavation that can be done to sufficiently embed the toe of the structure to provide downcutting protection."

- "In areas of high (i.e., 0.7 m/yr to 1.2 m/yr) to severe recession rates (i.e., >1.2 m/yr), undermining may become a significant concern within as little as 10 to 15 years.

In all instances a qualified coastal engineer should evaluate the life span of the structure (existing or planned), including specific discussion of the approach to address nearshore downcutting.

5.2.2.3 Stable Slope Allowance

The stable slope allowance is defined by consideration of the geotechnical conditions at the site and the appropriate factors of safety. It should be noted that the stable slope allowance is determined from the toe of the natural bank behind the protection work, not from the top of the protection works.

The stable slope allowance should be applied in all situations. Development should not be permitted within the stable slope allowance, with the exception of minor structures such as staircases and walkways.

5.2.2.4 Erosion Hazard Allowance

As outlined in the *Technical Guide* (MNR, 2001a), the erosion hazard allowance is determined by subtracting the design life of the protection structure from the planning horizon with the remaining number of years then multiplied by the average annual recession rate. The resultant erosion hazard allowance is then measured horizontally from the limit of the stable slope allowance. For example, considering an average annual recession rate of 0.3 m/yr, a planning horizon of 100 years and installation of protection works with a structure design life of 20 years, the erosion allowance required should be 24 m measured from the stable slope allowance ([100 years – 20 years] x 0.3 m/yr = 24 m).

5.2.2.5 Access

The design and installation of protection works must allow for access to the protection works for appropriate equipment and machinery for regular maintenance and/or repair purpose. Typically the width for access should be in the order of 5 m and should extend both to the shore and along the shore. Access is particularly important in situations where the erosion hazard allowance has been relaxed due to specific site constraints.

5.2.3 General Considerations for Protection Works

The 1996 SMP provided a discussion on shore protection works. The following recommendations are summarized from the 1996 SMP:

1. Along the shoreline of the study area it will become increasing necessary to balance the desire to maintain (and enhance if possible) the existing sand beaches along the shoreline with the increasing pressure for erosion protection works. In order to maintain the beaches, the natural shoreline processes must continue, including the erosion of the bluffs which supply sand to the shoreline, the longshore transport of sand to the southwest, and the deposition of sand in the area of Canatara Park. Wherever possible, the use of development setbacks, the relocation of existing buildings, and the consolidation of adjacent properties should be utilized rather than the construction of shore protection structures. Eliminating shore protection structures allows the bluffs to continue to erode and provides sand to the shoreline.

2. The process of recession in the bluff areas is continual and the loss of land is permanent. Bluff areas experiencing recession typically have little vegetative cover on the slope face, are fronted by narrow beach deposits and have an eroding nearshore lake bottom.

3. Water level fluctuations have a considerable influence on shore erosion, primarily by exposing different parts of the shore to wave action. When lake levels are high, the beach is inundated and the area of attack of breaking waves moves inland. The effectiveness of the beach as a defence is reduced and erosion increases rapidly. At low water levels, a wider beach is exposed and waves break further away from the shore.

The 1996 SMP included a discussion of alternative protection measures based on recommendations provided in Baird (1992). Three types of shore protection are discussed in this section. A site specific investigation by a qualified coastal engineer with experience on the Great Lakes is required to determine the preferred shore protection measures for specific sites.

5.2.4 Armourstone Revetments

Well-designed and constructed armour stone revetments, using good quality, durable stone generally provide effective protection where it is necessary. An example of an armourstone revetment at Brights Grove is shown in Figure 6.1.

Figure 6.2 presents design considerations for an armour stone revetment. The primary advantages and disadvantages of the revetment are outlined in Baird (1992) along with general design and construction guidelines. A key advantage of an armour stone revetment is that it is a relatively flexible structure that can accommodate some settlement and movement.

Providing a proper allowance for nearshore profile downcutting (see Section 6.2.8) and coordination with adjacent properties to minimize outflanking (see Section 6.2.9) remain two key factors that will affect the expected design life and hence the erosion setback that must be provided. A stable slope allowance must also be included in the setback consideration.

Other key design features for the armour stone revetment include: sound, good quality, durable armour stone with sufficient size to resist wave action and ice; sufficient crest elevation to protect against wave overtopping; riprap underlayer; and geotextile filter to prevent loss of backfill. The armour stone size is dependent on the wave height, the inclination of the revetment slope, number of stone layers and placement (i.e., degree of “interlocking”). Typically, the individual armour stones in an armour stone revetment have a mass of 3 to 5 tonnes for a single layer of armour; slightly smaller stones could be used with flatter slopes or double layers. A double layer of armour provides more “reserve capacity” (i.e., damage to a double layer armour revetment is more progressive than damage to a single layer). A qualified coastal engineer should design the revetment.

The implementation of the structure must consider the impacts to the environment. Section 6.2.10 provides further discussion of environmental considerations.

Figure 6.1 Armour Stone Revetment (Brights Grove; Site 26, Reach 11)

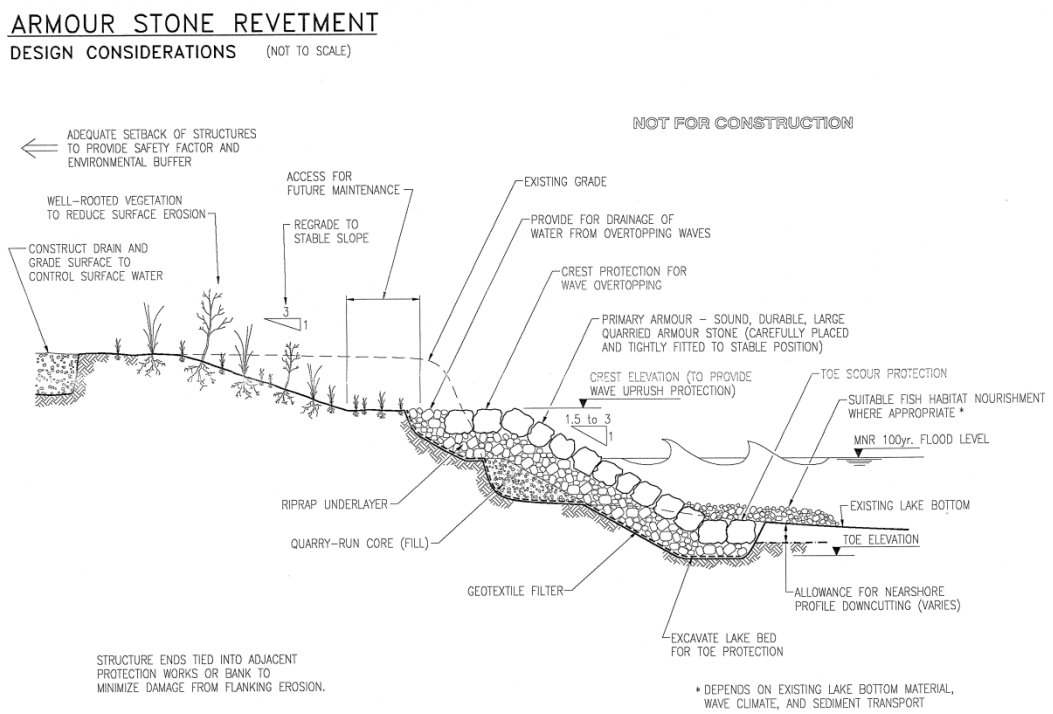

Figure 6.2 Armour Stone Revetment Design Considerations

5.2.5 Seawalls

Seawalls are frequently used as shore protection and they may be constructed of cast-in-place concrete, stacked concrete, armourstone blocks or steel sheet piling. Figures 6.3, 6.4 and 6.5 show examples of stacked armour stone, steel sheet pile and concrete block walls respectively. Stacked stone and block walls must carefully consider the foundation conditions, as they are less flexible than revetments and more prone to collapse due to settlement and undermining. Vertical, impermeable walls (e.g., concrete and steel sheet pile) are generally not recommended due to concerns with wave reflection and scour. Vertical walls are rigid and have much less reserve strength (i.e., ability to withstand wave conditions exceeding the design wave) than armour revetments. Gabion baskets often have a limited life span when used on exposed shorelines and are generally not recommended for use on the open lake.

Figure 6.3 Example of a Stacked Armourstone Wall Outside of Study Area

Figure 6.4 Steel Sheet Pile Wall (Blackwell Sideroad; Site 23, Reach 6)

Figure 6.5 Concrete Block Wall (Modeland Rd.; Site 22, Reach 6)

5.2.6 Groynes and Headlands

As described in the 1996 SMP and Baird (1992), there is a long history of groyne use for shore protection along the Sarnia shoreline. An extensive system of timber groynes was constructed in the 1950's in response to high lake levels. An example of timber groynes with a steel sheetpile wall protecting the backshore is shown in Figure 6.6. These structures deteriorated through the 1960's during a period of relatively low lake levels. In the early 1970's, a number of steel sheetpile groynes were constructed when water levels rose again (see Figure 6.7). These are also now in a state of disrepair and in many cases are no longer fully functional.

Although groynes have historically been a popular form of shore protection that may increase beach stability and width at low water levels, in general, groynes cannot on their own provide adequate protection to the backshore during high water levels. In many cases, backshore protection consisting of seawalls, revetments or ad hoc protection has also been constructed as shown in Figures 6.8 and 6.9. Headlands are more substantive beach anchors than groynes.

Groyne/headland anchored beaches are generally complex approaches that require analysis and design by qualified coastal engineers. Due to potential downdrift impacts, there can be difficulties in obtaining permits from the regulatory agencies. Potential impacts are discussed in Baird (1992) and Section 6.2.10.

Figure 6.6 Timber Groynes with Steel Sheetpile Along Backshore (Murphy Rd., Site 21, Reach 4)

Figure 6.7 Steel Sheetpile Groynes (Blackwell Sideroad, Site 23, Reach 6)

Figure 6.8 Steel Sheetpile Groynes with Rubble Bank Protection (Old Lakeshore Rd., Site 24, Reach 7)

Figure 6.9 Steel Sheetpile Groynes with Armourstone Revetment (Brights Grove, Site 26, Reach 11)

5.2.7 Ad Hoc Protection

Within the study area, there are extensive examples of ad hoc protection consisting of dumped stone and concrete rubble, inverted concrete pipes and miscellaneous other materials. Figures 6.10 and 6.11 respectively, provide examples of ad hoc structures consisting of a groyne made from scrap concrete and rip rap dumped along the shoreline. Ad hoc structures are often ineffective in the longer term due to limited or no toe embedment (i.e., lack of consideration of nearshore downcutting), lack of geotextile filters, insufficient crest height to protect against wave overtopping, and poor quality materials.

Figure 6.10 Ad Hoc Protection (Concrete Rubble Groyne at Hilltop Rd.; Site 35 , Reach 29)

Figure 6.11 Ad Hoc Protection (Riprap Protecting Road at Kettle Point)

5.2.8 Allowance for Nearshore Profile Downcutting

As described in the 1996 SMP and Reinders (1989), sections of the study shoreline feature cohesive or consolidated glacial sediment. As such, the controlling process for erosion of the shore is the permanent downcutting of the lakebed, which has significant implications for the design and lifespan of the shoreline protection. Specifically, downcutting of the nearshore lake bottom in front of a shoreline protection structure will eventually result in undermining of the structure leading to damage and perhaps failure of the structure as shown in Figure 6.12. In addition, this process will result in deeper water in front of the structure, thus allowing larger waves to attack the structure. For shore protection to be effective over the medium to long term, the design must consider the future downcutting of the lake bottom, and the larger waves, which will ultimately attack the structure.

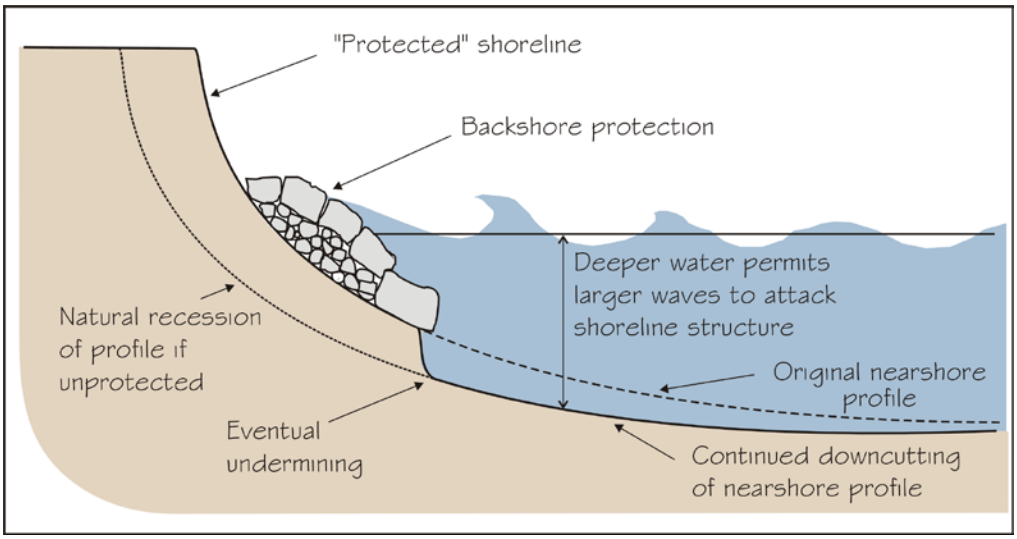

Figure 6.12 Future Undermining of Structure Due to Downcutting

5.2.9 Coordinated Protection

The importance of coordinated, cooperative protection (see Figure 6. 13) was described in Baird (1991); individual efforts are often outflanked, reducing the effectiveness and design life of the protection. This is particularly important in areas of high erosion such as Blue Point.

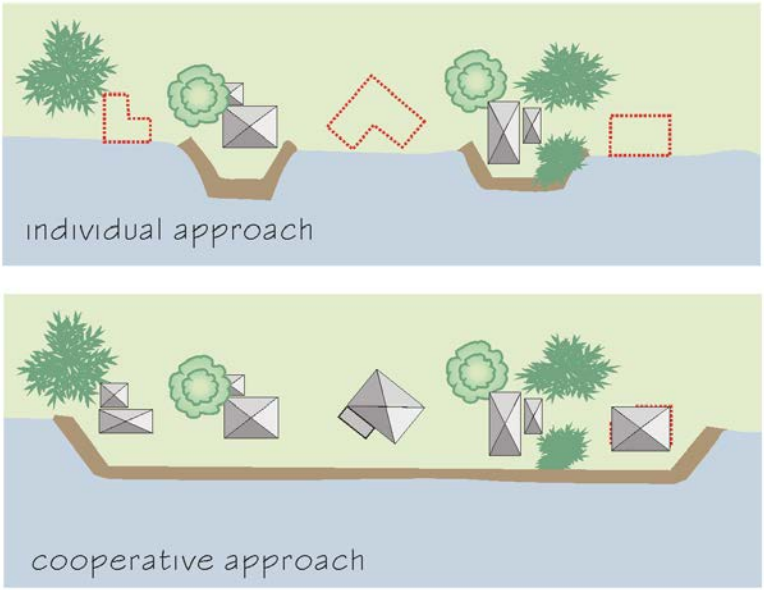

Figure 6.13 Cooperative Protection

5.2.10 Increased Consideration of Environmental Impacts

Recognition of the potential environmental impacts of shoreline protection has increased since the 1996 SMP. The environmental impacts were discussed briefly in the 1996 SMP but three particular aspects now require greater consideration:

1. Loss of fish habitat;

2. Cumulative impact of reducing sediment supply; and

3. Diverting and/or blocking longshore transport.

Fisheries and Oceans Canada Technical Fact Sheet T-6 states that the high water mark (HWM) is the guideline elevation that is used by DFO in the review of development projects in or near water to determine the minimum elevation that will be considered as the boundary for fish habitat. The HWM corresponds to the 80th percentile elevation for the month in which the highest annual water level occurs. For Lake Huron, the HWM elevation is 176.96 m IGLD 1985. The strict application of this requirement may mean moving a proposed structure further towards the shoreline, thus requiring more excavation of the existing bluff.

Successful shoreline protection, by definition, will reduce erosion of the shore. As described in Reinders (1989) and Baird (1992), erosion of the bluffs and nearshore generate the sediment that forms the beaches at the shoreline. Reduction of the bluff supply by placing shoreline protection will impact, cumulatively over time, the downdrift beaches by reducing the supply of new sediment to the beaches while the existing sediment at the beach is lost through natural degradation and abrasion.

Structures that extend into the nearshore have the potential to trap sediment on the updrift side as well as divert or deflect sediment offshore, resulting in possible downdrift erosion (see Figure 6.14).

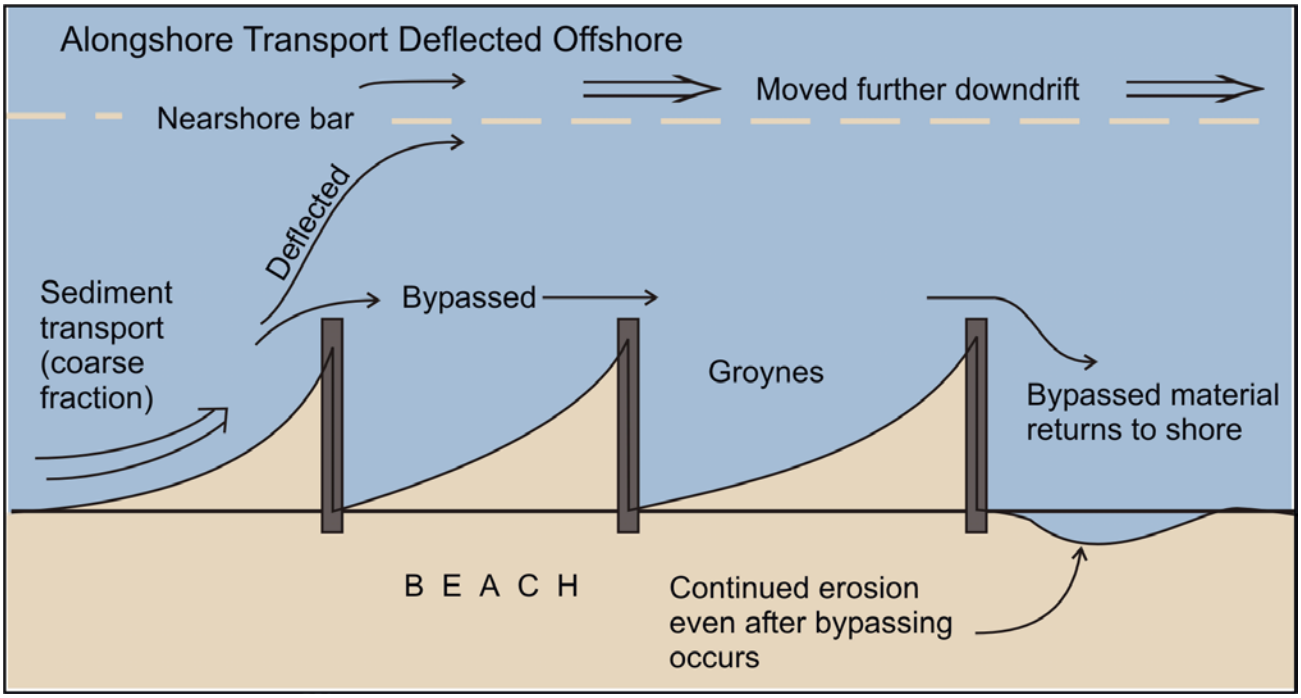

Figure 6.14 Potential Impacts of Groynes

5.3 Addressing Dynamic Beach Hazards

Along dynamic beach shorelines, the simplest, most effective and most desirable approach to addressing the hazard is to setback all permanent construction such as buildings, roads, and parking lots, landward of the dynamic beach hazard limit (i.e., landward of the area that will be affected by wave action and other natural beach processes). As such, the *PPS* (2005) prohibits development within the dynamic beach hazard.

For areas where development has already taken place within the dynamic beach hazard, the *Technical Guide* (MNR 2001a) provides guidance on addressing the hazard on non-erosional and erosional dynamic beaches. As presented in the *Technical Guide*, a "non-erosional" dynamic beach is defined as one where there is no measurable recession rate and no evidence of long-term shoreline recession. A "non-erosional" dynamic beach shoreline will exhibit movement in the beach profile, in response to water level variations and wave action, but the overall, long-term position of the shoreline will remain constant.

The *Technical Guide* provides a preferred order to implementing the potential range of responses to addressing the hazard where development already exists within the dynamic beach hazard limit on a non-erosional beach:

1. Relocate buildings, roads, and other facilities to a position landward of the dynamic beach hazard limit. This in turn will permit removal of retaining walls and shore protection structures such as revetments, walls and groynes from the dynamic beach hazard limit.

2. Where existing buildings, roads and other facilities are located near landward margin of the dynamic beach hazard limit and are subject to wave action only infrequently (i.e., less than once every 10 years) they may be protected by changes to the structure itself to minimize the impact of wave action and to reduce interference with the natural processes. Such changes could include raising the structure on stilts or removing porches and windows at low levels.

3. Protection in the form of a wall or revetment may be used to prevent wave action from reaching a building. However, this should be placed next to the primary building itself and as far away from the beach as possible in order to minimize impact on normal beach processes. Seawalls, revetments and other protection works positioned for the protection of non-essential structures and features, including but not limited to ancillary structures (e.g., gazebos, sheds, etc.), lawns and/or other landscaping features, and which extend into the dynamic beach hazard, should not be permitted.

4. Where existing buildings, road and other facilities are located so close to the beach that they are subject to wave action more than once every ten years, then a greater degree of protection than set out in 3 above will be required. This should be permitted only in exceptional cases where it is essential for the operation of the facility that it remains located in this area, otherwise the preferred solution is relocation. In this case it is likely that the hazard will be overcome by constructing some form of seawall or revetment close to the building. The protective structure should be designed to minimize impact on the beach in front of the property and on adjacent beaches. However, it should be recognized that it is impossible to build a structure within this zone without having a significant impact on the beach environment. Alternative approaches that involve either increasing of the beach width, through trapping of sand in groynes, or behind detached breakwaters, are likely to have an even greater impact on downdrift areas and are therefore even less desirable.

Where one of the first three approaches is taken, the protection afforded by the beach and associated dunes on a sandy beach can be enhanced by promotion of dune development through protection of the natural dune vegetation and through measures designed to minimize the impact of activities on the vegetation and the dune form. These will promote deposition of sand within this zone as well as preventing losses of sediment inland. Boardwalks, boat houses and other similar facilities should be made removable so that they are placed during summer months and removed during the period of maximum storm activity in the spring and fall, and so that their location can be adjusted to long-term lake level fluctuations.

At erosional dynamic beaches, where there is existing development, relocation landward of the dynamic beach hazard limit is also the preferred alternative, particularly if existing development is

close enough to the water to interfere with normal beach processes. Where it is not possible to do this, protection against waves and other water related hazards could be accomplished using the four alternatives described for non-erosional dynamic beaches. However, it should be recognized that the frequency and magnitude of the hazard would increase through time as the shoreline position recedes, and the structure becomes closer and closer to the nearshore zone; thus the effectiveness of the approach chosen will decrease. Ultimately, as the shoreline recedes, the shoreline will reach the building or other facility. Therefore, measures 2, 3, and 4 outlined for non-erosional beaches, do not provide a permanent solution on an eroding beach and their longevity will need to be assessed carefully, along with the possible environmental impacts.

5.4 Shoreline Management Guidelines

5.4.1 Management Area Delineation for Existing Development

Prohibiting or restricting development within the hazard lands will protect new development from shoreline hazards. Implementation of PPS is straightforward when dealing with new development related to subdivision development and multi-lot severances. However, applying the full scope of the PPS to existing developments or existing undeveloped lots is more complex. For this reason, the standards used to define the hazard limits, have also been used to classify the hazard lands into Management Areas, to assist in the implementation of guidelines for existing development. Management Areas recognize local natural conditions of bluff and bank height, slope angle, erosion and beach development.

Generally, Shoreline Area 1 represents the more vulnerable area, whereas Shoreline Area 2 represents those areas of the lakeshore that are a concern over the longer term.

5.4.1.1 Flood and Erosion Hazards

Area 1 is the area of the shoreline landward (or inland) from the water's edge to the greater of the following limits:

i. Stable slope allowance (SSA);
ii. 100-year return period flood level plus wave uprush allowance; or
iii. First lakeward break in slope on SCRCA 2007 mapping (10cm resolution imagery and contours).

Area 2 is the area of the shoreline landward (or inland) from Shoreline Area 1 to the greater of the following limits:

i. Stable slope allowance plus 100 year erosion allowance; or
ii. 30 metres from top of unaltered bluff/bank.

5.4.1.2 Dynamic Beach Hazards

Area 1 is the area measured landward (or inland) from the water's edge including the flood hazard (100-year return period water level plus wave uprush allowance) plus a distance of 15 metres measured horizontally. This 15 metres is considered the active beach zone and can include a portion of the dune complex which would be affected by wave action during the 100-year flood plus wave uprush event.

Area 2 is the area measured landward (or inland) from Area 1 to the dynamic beach limit. This distance is a minimum of 15 metres landward from Area 1.

Community prescription maps located in Appendix B of the SMP show the delineation of both Shoreline Area 1 and Shoreline Area 2 on each shoreline property.

5.4.2 Shoreline Development Guidelines

A summary of development guidelines applicable to shoreline properties is provided in Table 6.1. This table was developed by SCRCA and is based on the 1996 SMP Development Guidelines and extensive consultation that occurred. Table 6.1 is also based on the principles provided in MNR Technical Guide for Great Lakes – St. Lawrence River Shorelines Appendix A7.2 "Existing Development within the Hazardous Lands". Table 6.1 lists the various development activities which are commonly undertaken on shoreline properties within the study area and provides direction on which activities will be permitted within each of the delineated management areas. It is important to note that any development on shoreline properties must adhere to other municipal planning policies that are in effect (i.e. zoning by-law requirements) and any other regulatory requirements. The guidelines reflect principles associated with SCRCA comment on *Planning Act* applications as well as SCRCA Regulation application review.

Table 6.1 SCRCA Board Approved April 2006

SCRCA Lake Huron Shoreline Development Guidelines

Development Activity	Lakeshore Area 1			Lakeshore Area 2	
	Flood	**Dynamic Beach**	**Erosion**	**Dynamic Beach**	**Erosion**
Existing Developed Lots					
Repairs/Maintenance (No intensification of use)	Yes	Yes	Yes	Yes	Yes
Interior Alterations (No intensification of use)	Yes	Yes	Yes	Yes	Yes
Minor Additions (less than 30% of area of existing dwelling)	No	No	Conditional[1]	Yes - landward of foredune and design must minimize dune impact**	Dependent upon Erosion Rate **
Major Additions (equal to or greater than 30% of area of existing dwelling)	No	No	No	Yes - landward of foredune and existing dwelling and design must minimize dune impact**	Dependent upon Erosion Rate & landward of existing dwelling**
Rebuilding of dwelling destroyed by forces other than flooding and erosion	yes - if same size and utilizes maximum lot depth (most landward location)			Yes - most landward location and design must minimize dune impact	yes - most landward location
Rebuilding of dwelling destroyed by flooding and/or erosion	No	No	No	No	No
Relocation of dwelling away from shoreline	Optional on the part of the landowner; encouraged by CA			Owner should consider this as a future option, depending on severity of hazard	
Existing Vacant Lots (Infilling)					
New Dwellings*	No	No	No	Conditional[3]	Conditional[4]
Septic Systems	No	No	No	Yes-most landward location	Yes - most landward location
New Development					
Creation of New Lot(s) (ie. Severance, subdivisions)	No	No	No	No	No
Technical Severance***	Yes	Yes	Yes	Yes	Yes
Lot Consolidation	Yes	Yes	Yes	Yes	Yes
Land Use designation/zone changes	Support Changes to planning documents to Hazard, Natural Environment or Open Space designations			Support Changes to planning documents to a lakeshore overlay (subscript "L") designation	
	Do not support proposed zoning, land use designation or official plan changes which further intensify land use: ie. Seasonal residential to multi-unit dwelling				
Accessory Structures					
Unattached Garages	No	No	No	No	Dependent upon Erosion Rate & landward of existing dwelling
Major Structures (structure greater than 14m^2)	No	No	No	No	Dependent upon Erosion Rate & landward of existing dwelling
Minor Structures (10 m2 - 14m2)	No	No	Conditional[2]	Yes - impact to dune minimized	Dependent upon Erosion Rate & landward of existing dwelling
Swimming Pools	No	No	No	No	Dependent upon Erosion Rate & landward of existing dwelling
New Septic Systems	No	No	No	Yes - landward of existing dwelling	Yes - landward of existing dwelling
Decks (Existing)					
Repair and Maintenance	Yes	Yes	Yes	Yes	Yes
Decks (New)	No	No	No closer than 3m to top of bank and not connected to dwelling - size restriction may apply	If landward of the foredune - size restriction may apply & design must minimize impact to dune	Yes
Boardwalks and/or stairs (existing)					
Repair and Maintenance	Yes	Yes	Yes	Yes	Yes
Boardwalks and/or stairs (new)	No	Yes - may require design by coastal engineer	Yes - may require design by coastal engineer	Yes - may require design by coastal engineer	Yes - may require design by coastal engineer
Site Alteration					
Fill Placement	Conditional[5]	Conditional[6]	Conditional[6]	Conditional[5]	Conditional[6]
Fill Removal	Conditional[5]	Conditional[6]	Conditional[6]	Conditional[5]	Conditional[6]
Re-grading	Conditional[5]	Conditional[6]	Conditional[6]	Conditional[5]	Conditional[6]
In Water Structures					
Groynes					
New	No				
Partial Replacement	Yes				
Complete Replacement	Yes - design by coastal engineer indicating no impact on littoral transport and coastal processes, with approval of adjacent landowners				
Repair and Maintenance	Yes				
Shoreline Protection					
Repair and Maintenance	Yes				
Partial Replacement	Yes				
New (includes complete replacement)	yes - design by coastal engineer indicating no impact on littoral transport and coastal processes, with approval of adjacent landowners				

Notes: Proposed development partially located within two zones automatically defaults to more restrictive zone requirements

Definition	
Development:	- the construction, reconstruction, erection or placing of a building or structure of any kind - any change to a building or structure that would have the effect of altering the use or potential use of the building or structure, increasing the size of the building or structure or increasing the number of dwelling units in the building or structure, - site grading - the temporary or permanent placing, dumping or removal of any material, originating on the site or elsewhere

Legend

Yes - Permissible

No - not allowed

Conditional[1] - yes, provided calculated erosion rate is less than 0.3 m/yr and slope stability is addressed

Conditional[2] - yes, provided structure is inland from primary dwelling if calculated erosion rates are greater than 0.3m/yr

Conditional[3] - yes, one dwelling, most landward location, building is movable by design, impacts to dunes is minimized and outside critical main dune feature, and provided that more than 50% of existing lots/parcels in the residential/cottage area are developed**

Conditional[4] - yes, dependent upon erosion rate - one dwelling, most landward location and outside 60 year recession (50year Measurement # 587-626), building is movable by design, and provided that more than 50% of existing lots/parcels in the residential/cottage area are developed**.

Conditional[5] - yes, provided BMPs followed

Conditional[6] -yes, as part of engineered shoreline stabilization or flood proofing

*Includes redevelopment

** Coastal assessment and/or protection must meet established coastal professional engineering standards and procedures

***A technical severance is a boundary adjustment where no new lot is created.

Works clearly falling within the following criteria will not require written permission of the St. Clair Region Conservation Authority:

a. Seasonal removal of sand around existing dwellings in dune or dynamic beach areas and as necessary to permit entrance into existing structures
b. Seasonal removal of sand from roads/laneways
c. Erection, Construction or placement of structure less than $9m^2$ with no utilities

6.0 PUBLIC INVOLVEMENT

On July 21 and 22, 2010, the Conservation Authority held public meetings in an open house format at the Camlachie Community Centre (July 21) and at Indian Hills Golf Club (July 22) for the residents of Lambton Shores. In each case a presentation was made and there was opportunity for landowners to discuss individual properties and issues on a one-on-one basis.

The meetings were held to inform the shoreline community about the Lake Huron Shoreline Management Plan Update and to provide an opportunity for feedback. Notices were posted on community notice boards and an advertisement was placed in The Forest Standard and the Sarnia Observer newspapers. The meetings at Camlachie Community Centre and at Indian Hills Golf Club were attended by approximately 55 and 50 people respectively.

To all stakeholders that expressed an interest during the initial consultation process, contact was made to provide updates on mapping and the plan via the Authority website. In 2011 and 2012, further comments were received from municipal staff and stakeholders including one on one consultation meetings with community association representatives. Municipal staff input was presented to the Board of Directors on April 10, 2012. Comments and feedback are noted and incorporated into the Plan where applicable. A summary of comments received by the Conservation Authority and responses are found in Appendix C.

Dynamic Beaches
It was determined that a separate consultation process and study was necessary for the Sarnia Haight Hillcrest Nisbet Drive area.
It was also recommended that further detailed development guidelines and policies were necessary for the West Ipperwash area.

Subject to funding and approvals, the above actions may be undertaken, reviewed and incorporated into the plan as deemed necessary.

7.0 STEERING COMMITTEE

Several steering committee meetings were held at St. Clair Region Conservation Authority or by teleconference. The steering committee consisted of SCRCA Planning/Regulation and GIS staff, the Ausable Bayfield Conservation Authority Planning/Regulation Manager as well as municipal planners. Invitations to participate were sent to SCRCA Board members representing the shoreline municipalities as well as the First Nations chief (Stony/Kettle Point). The issue of municipal representation on the Committee was discussed at the SCRCA Board level. It was determined that as the Plan was an update for Point Edward, Sarnia and Plympton –Wyoming and needed to be consistent with the ABCA Shoreline Management Plan and Provincial guidelines, municipal staff representation was sufficient. No response was received from First Nations. The SCRCA does not have jurisdiction on First Nation lands.

Several Steering committee meetings were held in 2010. The final draft management plan and mapping was circulated to the steering committee for comment in 2011 with revisions to be considered and incorporated.

Steering Committee members:

Nancy Bourgeois (City of Sarnia)
Carlie Burns (Plympton-Wyoming)
Will Nywening (County of Lambton; Plympton-Wyoming)
Patti Richardson (County of Lambton; Lambton Shores)
Geoff Cade (ABCA)
Chris Durand/ Alison Seidler (SCRCA)
Patty Hayman (SCRCA)

8.0 GLOSSARY

Accepted Engineering Principles - those principles, methods and procedures which are used and applied in current engineering practice.

Accepted Geotechnical Principles - those principles, methods and procedures involving slope stability analysis which are used and applied in current geotechnical practice.

Accretion - the slow and imperceptible addition of shoreline by natural deposition.

Average Annual High Water Level - the average of the highest monthly mean level of each year over a period of time.

Average Annual Low Water Level - the average of the lowest monthly mean level of each year over a period of time.

Average Annual Water Level - the average of monthly mean water levels over the year.

Backfill - the material used to refill a ditch or other excavation, or the process of doing so.

Backrush - the lakeward return of water following the uprush of waves.

Backshore - the part of the shore or beach that is usually dry extending from the limit of wave uprush at the average annual high water level to either the place where there is marked change in material or physiographic form; or the line of permanent vegetation (usually the effective limit of storm waves); or the high water mark.

Bar - submerged or emerged embankment of sand, gravel, or other unconsolidated material built in the nearshore zone by waves and currents.

Bathymetry - the topography of the lake bottom.

Beach - the zone of unconsolidated material that extends landward from the average annual low water level to either the place where there is marked change in material or physiographic form; the line of permanent vegetation (usually the effective limit of storm waves); or the high water mark. A beach includes foreshore and backshore.

Beach Nourishment - supplementing the naturally occurring supply of sand to the shoreline by importing suitable material from other sources.

Beach Starvation - the loss of beach building materials due to updrift changes in littoral transport conditions.

Bluff Toe - the intersection of the bluff with the beach (or the nearshore bottom, if underwater).

Borehole Logs - a stratigraphic record, or "log" of the material which forms the subsurface obtained through drilling or boring a hole.

Breaking Point - the point at which a wave begins to break or deform.

Breakwater - a structure protecting a shore area, harbour anchorage, or basin from wave action.

By-passing of Sand - physically removing sand from one side of a structure (i.e., harbour structure) and placing it on the other side.

Celerity - velocity of a moving wave.

CGD – Canadian Geodetic Datum; datum for the referencing of elevation.

Closed Littoral Cell - a cell which does not receive or deposit littoral material from outside the cell limits.

Comprehensive Zoning By-law - a document adopted by a municipal council pursuant to the provisions of the Planning Act or the Municipal Act to control and direct the use and development of property within the boundaries of the municipality.

Control Points - related to land surveys; points of known or fixed locations regarding either horizontal and/or vertical distances.

Contour - a line drawn connecting points of the same elevation and used to represent topography on land surface or depths below a datum.

Crown Land - all land (including land under water) held by the Province, both land which has never been sold and land which has been reacquired.

Current, Longshore - the current in the breaker zone moving essentially parallel to the shore generated by waves breaking at an angle to the shoreline.

D50 - a measurement of sand grain size distribution representing 50th percentile of sample.

Development - means the construction, erection or placing of a building or structure.

Dissipate - expend or scatter, as of energy of moving waves.

Downdrift - the direction of the predominant movement of littoral materials.

Dune - ridges or mounds of loose, wind-blown material, usually sand.

Duration - in wave forecasting, the length of time the wind blows in the same or nearly the same direction over the fetch.

Environmentally Significant Areas - areas identified for their environmental value related to their hydrologic, biologic, or geomorphologic characteristics, as in wetlands, woodlots, or sites which possess rare and endangered species of flora and/or fauna.

Erosion - a volumetric reduction of shoreline by natural or human influenced processes.

Erosion Rate - the net loss of shoreline over a specific period of time.

Failure Plane (slip surface) - the plane or surface along which an unstable soil mass moves at failure; in bluff areas a curved line extending from the horizontal top of bluff a distance away from the crest and extending through the vertical face of the bluff usually in the vicinity of the toe of the bluff

Flora and Fauna - refers to the plant and animal species.

Fetch - the distance over water which waves are generated by a wind having a generally constant direction and speed.

Fillet Beach - an accretional beach which exists due to the occurrence of an artificial structure (i.e., harbour structure) which interrupts the littoral drift.

Filter - a layer of well graded rock or a synthetic material between protection works and backfill soil to prevent escape of the soil through the voids in the protection works materials.

French Drain - a subsurface drainage inlet which is constructed by placing stone over a buried perforated drain pipe.

Gabion - wire baskets filled with rock.

Geodetic Referencing - describing a feature using known geographical coordinates (commonly using latitude/longitude or UTM grid coordinates).

Geomorphic - based on the physical shape or landform which exists.

Groundwater - subsurface water occupying the zone of saturation. In a strict sense, the term is applied only to water below the water table.

Gully Erosion - the erosion process whereby water accumulates in narrow channels and, over short periods, removes the soil from this narrow area to considerable depth.

Groyne - a shore protection structure built at an angle from the shore to trap sediment drift and to protect the shoreline from erosion by currents and waves through the development of a beach.

Groyne Field - a series of groynes acting together to protect a section of shoreline.

Habitable Space - means rooms or spaces required and intended for overnight occupancy, and includes facilities for storage, heating, air conditioning, electrical, hot water supplies, plumbing, waste connections, etc. which are necessary to maintain the habitable condition.

Hazard Land - land which, because of its physical characteristics in combination with its location, presents a risk for its occupants including loss of life, property damage and social disruption.

High Water Mark - the upper most extent that water levels range, also associated with a break in slope or vegetation.

Historical Storm Event - a storm which due to its extreme magnitude of flooding and erosion hazard, is an event which is referred to for historical reference.

Hydrographic Survey - a survey of the lake bottom.

Ice Damage - damage related to the build-up and movement of ice along the shoreline during the winter and spring months.

Infilling - with regard to construction; development on previously undeveloped lots, generally bounded by existing development on both sides.

Infilling Severances - the division of land to create three (3) or less new building lots in existing developed areas generally bounded on both sides by existing dwellings.

I.G.L.D. - International Great Lakes Datum (1985), referenced to mean water level at Father Point in the St. Lawrence River. Elevations referenced to the datum are dynamic elevations which take into account not only the measured linear height above the reference zero, but also the force of gravity at that particular locality. The resulting elevation differs by varying amounts depending on location from the standard orthometric elevation published by the Geodetic Survey of Canada.

Inundation - the temporary submergence of shoreline normally located above lake level.

Jetty - an elongated artificial obstruction projecting into the lake from the shore to control shoaling and scour by deflection and dissipation of currents and waves.

Lag Deposits - residual accumulations of coarser soil particles (i.e., cobbles and boulders) from which the finer material has been carried away.

Lake Bank Overloading - creating a potentially unstable bank by adding additional weight to the upper area.

Lakeside Effects - the processes originating on the lake which act upon the shoreline and cause change (i.e., storm wave action, high lake levels).

Lakeward - the direction toward the lake.

Landside Effects - the processes originating on the land which act upon the shoreline and cause change (commonly related to human actions of drainage, construction and earth moving).

Landward - the direction toward the land.

Leeward - the direction toward which the wind is blowing, and the direction toward which waves are travelling.

Linear Development - development which exists in a linear alignment parallel to the shoreline, typically with each lot having shoreline frontage.

Littoral - pertaining to or along the shore, particularly to describe currents, deposits and drift.

Littoral Cell - areas under the continuous influence of specific longshore currents.

Littoral Drift – the sedimentary material moved in the littoral zone under the influence of waves and currents.

Littoral Sink - areas where the littoral materials are ultimately deposited and sand accumulates.

Littoral Transport - the movement of littoral material in the littoral zone by currents, including movement parallel to the shoreline (longshore transport) and perpendicular to the shoreline (onshore/offshore transport); movement is due to the prevailing current and oblique wave direction.

Longshore - parallel to and near the shoreline, usually within the littoral zone.

Monthly Mean Lake Level - the average water level occurring during the month computed from the hourly readings in each month.

Moveable Dwelling - refers to design and site considerations which will allow a structure to be moved away from a hazardous area, and includes such factors as size of building in relation to the

adjacent road systems, type of foundation, and available space for adjacent building relocation and space for moving equipment access.

Nearshore - an indefinite zone extending lakeward from the average annual water level to beyond the breaker zone defining the area of nearshore currents formed primarily by wave action.

Net Loss of Sand - the situation which results when inputs to the sediment budget are less than the losses to the budget resulting in a net loss.

New Dwelling - a building containing habitable space constructed on a previously undeveloped lot or replacing a dwelling on a previously developed lot.

Official Plan - a document adopted by a municipal council pursuant to the provisions of the Planning Act which identifies the existing use of land, guides and directs potential land uses, and establishes implementation policies within the boundaries of the municipality.

Offshore - the area extending lakeward of the breaker zone.

Offshore Breakwater - a structure located in the offshore area which is designed to protect a shoreline area, harbour, or basin through the dissipation of wave energy.

Onshore - the area extending landward of the normal high water mark.

Onshore Wind - a wind blowing toward the shoreline.

Outfall - a structure extending into a body of water for the purpose of discharging sewage or stormwater runoff.

Overtopping - passage of water over the top of a structure as a result of wave uprush and/or wind setup.

Pile - a long, heavy timber, or concrete or metal casing driven into the ground or lake bed to provide support or protection.

Post-glacial Lake - lakes formed as a result of the melting and retreat of the glaciers which formerly covered the Great Lakes basin.

Protection Works - refers to structural and/or non-structural works which are intended to address damages caused by flooding, erosion and other water related hazards.

Public Land - any land owned or administered by a public body or agency, including lands owned by Federal, Provincial and municipal governments and lands held by agencies such as parks commissions and conservation authorities.

Reach - portions of the shoreline containing similar physiographic or biological characteristics and shoreline dynamics, such as erosion rates, flood elevation; includes such characteristics as shoreline alignment and orientation, offshore bathymetry, fetch length, sediment transport rates, flood susceptibility, land use suitability and environmental features.

Recession - a landward retreat of the shoreline by shore processes.

Redevelopment - means the reconstruction or replacement of existing buildings or structures and can include major additions to existing buildings.

Remedial Works - structural measures intended to provide a remedy specifically aimed at problems of erosion and inundation for the purposes of shoreline protection.

Remnant Dune - a dune feature which has been stabilized by development practices such as protection works, vegetation and/or building construction.

Retaining Wall - wall designed to provide support to an adjacent feature or structure.

Revetment - a sloping facing of quarried stone, concrete or similar material constructed to protect an embankment or adjacent development against erosion and failure by wave action or currents.

Riparian Owner - the owner of land containing or directly abutting a natural lake or watercourse.

Riparian Rights - the rights of a person owning land containing or bordering on a watercourse or other body of water in or to its banks, bed or waters edge.

Riprap - quarried stone or clean broken concrete (generally 10-60 centimetres in diameter) used as backfill, filter material or facing layer in revetment, splash pad and scour pad construction.

Rubblemound Revetment - a sloping pile of randomly shaped and randomly placed stone material covered with a facing layer of selected stones or engineered concrete units arranged and fitted together.

Sand - granular soil or detritus coarser than silt and finer than gravel, and ranging in diameter from 0.06 to 3.0 millimetres.

Scour - removal of material by waves and currents, especially at the toe of shoreline protection works or bluff features.

Scour Pad - a facing of quarried stone or broken concrete constructed at the base of protection works to dissipate wave energy and prevent the erosion of supporting materials.

Seawall - a vertical structure separating land and water areas primarily designed to prevent erosion and other damage due to wave action.

Sediment Budget - gives an estimate of material entering the littoral zone from each source, the amount leaving the zone and the amount of sediment deposited at each sink or barrier along the shore. The sediment budget must balance; that is, the total amount of supply must equal the total amount deposited plus the amount still in transport.

Sediment Source Area - that area of the sediment budget which contributes a large quantity of material to the overall budget.

Seepage - water escaping through or emerging along an extensive line or surface; the slow movement of water through soil by gravity or pressure.

Seiche - an oscillatory motion resulting in alternate high and low water levels at each end of a lake that continues after the originating force has ceased.

Setback Requirement - a distance measured inland from an edge of a feature such as a bluff, where construction is prohibited.

Severances and Subdivisions - refers to the assemblance and division of land in previously undeveloped areas or to create more than three (3) building lots.

Sheet Pile - a pile with a generally slender, flat cross section to be driven into the ground or lakebed and linked or interlocked with like members to form a vertical wall or bulkhead.

Shoals - offshore areas which have lesser depths of water than surrounding depths.

Shoreline - the area of interface between land and water extending from the lakeward limit of the littoral zone landward to the first major change in terrain.

Silt - inorganic particles carried in suspension or deposited by currents, ranging in diameter from 0.05 to 0.005 millimetres.

Slump - a failure of a bluff slope with a mass movement of soil along a failure plain.

Spit - a point of land or a narrow shoal projecting into a body of water from the shore.

Splash Pad - a facing of quarried stone, broken concrete or other stable material constructed above the crest of protection works to absorb and dissipate the energy of overtopping water following wave impact or uprush.

Stable Slope - refers to the angle a slope would achieve in the long term when toe erosion is absent.

Stillwater Level - the elevation a water surface would assume if all wave action were absent.

Stratigraphy - is the description of the rock layers or units of a physical feature (also known as lithographic units) commonly determined by borehole analysis.

Tableland - that area above the bluff or bank slope which is relatively flat.

Threshold Slope Inclination - the slope angle which, if exceeded, will result in an unstable condition. It is determined by the inherent strength of the material which comprises the slope, the load on the slope and groundwater conditions.

Till - unsorted, unlayered consolidated glacial debris which commonly forms the bluffs along the southern Great Lakes.

Toe Erosion - the erosion which occurs at the bottom of bluffs largely as a result of the continuous removal of earthen material by waves and currents.

Topography - the configuration of a surface including its relief, the position of its streams, roads, buildings and other physical features.

Undercut - undermining, erosion of the lower part of a steep bank so as to reduce the stability of the upper part.

Updrift - the direction opposite that of the predominant movement of littoral materials.

Wave - a ridge, deformation, or undulation of the surface of the water.

Wave Crest - the highest part of the wave.

Wave Diffraction - the restructuring and redirecting of waves by underwater structures or features.

Wave Direction - the direction from which a wave approaches.

Wave Height - the vertical distance between a wave crest and the preceding wave trough.

Wave Hindcasting - the use of historic wind data to calculate wave characteristics that probably occurred in the past.

Wavelength - the horizontal distance between similar points on two successive waves measured perpendicular to the wave crest.

Wave Period - the time for two successive wave crests to pass a fixed point.

Wave Reflection - the return of a portion of a wave lakeward following uprush or breaking on a steep beach, barrier or other reflecting surface.

Wave Trough - the lowest part of a wave between successive wave crests.

Wave Uprush - or wave runup; the rush of water up onto the beach or shore following the breaking of a wave; for any given water level the limit of uprush is the point of farthest uprush.

Wind Setup - the vertical rise above normal water level on the leeward side of a body of water caused by wind stresses on the surface of the water.

Windward - the direction from which the wind is blowing.

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APPENDIX A

SHORELINE SITE VISITS, JUNE AND JULY 2010

APPENDIX B

SHORELINE REACH DESCRIPTIONS

This appendix provides shoreline reach descriptions. The descriptions for the reaches in Sarnia (Reaches 1-12) and Plympton Wyoming (Reaches 13-28) were taken from the 1996 Shoreline Management Plan. The reach descriptions were derived from F.J. Reinders Lake Huron Shoreline Processes Study (1989) and supplemented by SCRCA. The descriptions for Lambton Shores (Reaches 29-38) were prepared by Baird & Associates. Definition of Management Areas for all reaches was completed by SCRCA. Management Area delineation is utilized for the purpose of implementation.

REACH 1
CANATARA PARK (LAKE CHIPICAN DR.)
City of Sarnia (Lots 69, 68, Front Concession)
MEASUREMENT NUMBERS 1-34
Sarnia Maps 1 and 2

Shoreline Characteristics

beach - 30-60 metre wide (based on 2007 air photos) sand beach,

bluff -low bluff; natural bluff composed of sand materials which are part of a massive natural sand deposit which formed a recurved spit from the St. Clair River to approximately Telfer Sideroad

development -few permanent residential dwellings
-primarily parkland (Canatara Park)

protection works -steel sheet-pile groynes;

Erosion Issues

-recession rates were not calculated for beaches; calculation of recession rates for dynamic beaches is complex and was beyond the scope of this study
-historical damages to protection works and property during high magnitude storm events
-turbulence created by wave reflection off vertical seawalls and groynes may contribute to removal of beach materials

Objective of Protection Works

-limit storm wave uprush and damage
-provide recreational beach

Recommendations

-maintain existing groynes

-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992)

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the 100 year flood line plus a 15 m wave uprush allowance (Flood Hazard Limit) plus a 15 metre allowance	Dynamic Beach
Shoreline Area 2	-between Shoreline Area 1 and a line defined by the Flood Hazard Limit plus a 30 metre Dynamic Beach Setback	Dynamic Beach

REACH 2
WOODROW AVENUE – BEACH LANE
City of Sarnia (Lots 68 to 65, Front Concession)
MEASUREMENT NUMBERS 35-47
Sarnia Maps 3 and 4

Shoreline Characteristics

beach -sand beach typically ±15 metres wide at normal summer water levels, becoming narrower during periods of high lake levels

bluff -low bluff; natural bluff composed of sand materials which are part of a massive natural sand deposit which formed a recurved spit from the St. Clair River to approximately Telfer Sideroad

development -permanent residential development located at and along the top of bluff

protection works -steel sheet-pile groynes; some groynes supplemented with vertical sheet-pile seawalls

Erosion Issues

-long term top of bank recession rate is generally low at < 0.3 metres/year
-beach erosion and wave uprush damage
-historical damages to protection works and property during high magnitude storm events
-turbulence created by wave reflection off vertical seawalls and groynes may contribute to removal of beach materials
-during storm events, wave action can temporarily overrun the beach and directly attack the shoreline bluff and protection works

Objective of Protection Works

-limit storm wave uprush and damage
-provide recreational beach

Recommendations

-maintain existing groynes
-damaged seawalls should be replaced with sloping rubblemound revetments
-where additional protection from wave uprush is necessary, recommended approach is rubblemound revetment
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992)

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the 100 year flood line plus a 15 metre wave uprush allowance(Flood Hazard)	Flood
Shoreline Area 2	-between Shoreline Area 1 and a line defined by the Stable Slope Allowance plus 30 m erosion allowance	Erosion

REACH 3

BEACH LANE- TUDOR CLOSE- WINTON ROAD - EDGEWATER COURT
City of Sarnia (Lots 64 to 56, Front Concession)
MEASUREMENT NUMBERS 48-88
Sarnia Maps 4, 5, 6, 7, 8

Shoreline Characteristics

beach -sand beach typically ±10 metres wide at normal summer water levels, becoming narrower during periods of high lake levels

bluff -low bluff; natural bluff composed of sand materials which are part of a massive natural sand deposit which formed a recurved spit from the St. Clair River to approximately Telfer Sideroad

development -permanent residential development located at and along the top of bluff

protection works -steel sheet-pile groynes; many groynes supplemented with vertical sheet-pile seawalls and sheet-pile and concrete retaining walls
-broken concrete and other construction materials used in sloping rubblemound revetment at some locations

Erosion Issues

-long term top of bank recession rate is generally low at < 0.3 metres/year
-beach erosion and wave uprush damage
-historical damages to protection works and property during high magnitude storm events
-turbulence created by wave reflection off vertical seawalls and groynes may contribute to removal of beach materials
-during storm events, wave action can temporarily overrun the beach and directly attack the shoreline bluff and protection works

Objective of Protection Works

-limit storm wave uprush and damage
-provide recreational beach

Recommendations

-vertical seawalls and retaining walls are not recommended
-maintain existing groynes
-damaged seawalls should be replaced with sloping rubblemound revetments
-where additional protection form wave uprush is necessary, recommended approach is rubblemound revetment
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird, 1992)

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
	48-85 -between the water's edge and a line defined by the 100 year flood line plus a 15 meter wave uprush allowance	Flood
	86-88 – between the water's edge and a line defined by the first lakeward break in slope	Erosion
Shoreline Area 2	-between Shoreline Area 1 and a line defined by the Stable Slope Allowance plus a 30 m erosion allowance	Erosion

REACH 4
BRAEMAR LANE - HAIGHT LANE
City of Sarnia (Lots 55 to 53, Front Concession)
MEASUREMENT NUMBERS 89-95
Sarnia Map 9

Shoreline Characteristics

beach -sand beach typically ±10 metres wide at normal summer water levels, becoming narrower during periods of high lake levels

bluff -low bluff; natural bluff composed of sand materials which are part of a massive natural sand deposit which formed a recurved spit from the St. Clair River to approximately Telfer Sideroad
- in many areas the natural slope has been replaced with bluff stabilization measures (grading, filling, etc.) due to past erosion events

development -permanent residential development located at the top of bluff and on the bluff face

protection works -steel sheet-pile groynes supplemented with vertical sheet-pile seawalls

Erosion Issues

-long term top of bank recession rate is generally low to moderate ±0.3 metres/year
-beach erosion and wave uprush damage
-historical damages to protection works and property during high magnitude storm events
-turbulence created by wave reflection off vertical seawalls and groynes may contribute to removal of beach materials
-during storm events, wave action can temporarily overrun the beach and directly attack the shoreline bluff and protection works

Objective of Protection Works

-limit storm wave uprush and damage
-provide recreational beach

Recommendations

-vertical seawalls and retaining walls are not recommended
-maintain existing groynes
-supplement or replace existing seawalls with sloping rubblemount revetments
-as part of overall shoreline protection scheme, property owners should consider relocation of existing dwellings currently located on the bluff face
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird, 1992)

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
	89-91 -between the water's edge and a line defined by the slope stability allowance measured landward from the toe of the bluff	Erosion
	92-95 –between the water's edge and a line defined by the 100 year flood line plus a 15 m wave uprush allowance	Flood
Shoreline Area 2	-between Shoreline Area 1 and a line defined by the Stable Slope Allowance plus 100 times the average annual recession rate	Erosion

REACH 5

LAKE HURON PARKWAY- HILLCREST DRIVE - NESBIT DRIVE
City of Sarnia (Lots 52 to 46, Front Concession)
MEASUREMENT NUMBERS 96-118
Sarnia Maps 9,10, 11

Shoreline Characteristics

beach -sand beach typically ±10 metres wide at normal summer water levels, becoming narrower during periods of high lake levels

bluff -low bluff; natural bluff composed of sand materials which are part of a massive natural sand deposit which formed a recurved spit from the St. Clair River to approximately Telfer Sideroad

development -permanent residential development located at and along the top of bluff

protection works -steel sheet-pile groynes; many groynes supplemented with vertical sheet-pile seawalls and sheet-pile and concrete retaining walls
-broken concrete and other construction materials used in sloping rubblemound revetment at some locations

Erosion Issues

-beach erosion and wave uprush damage
-historical damages to protection works and property during high magnitude storm events
-turbulence created by wave reflection off vertical seawalls and groynes may contribute to removal of beach materials
-during storm events, wave action can temporarily overrun the beach and directly attack the shoreline bluff and protection works

Objective of Protection Works

-limit storm wave uprush and damage
-provide recreational beach

Recommendations

-vertical seawalls and retaining walls are not recommended
-maintain existing groynes
-damaged seawalls should be replaced with sloping rubblemound revetments
-where additional protection form wave uprush is necessary, recommended approach is rubblemound revetment
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992)

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the 100 year flood line plus a 15 m wave uprush allowance (Flood Hazard Limit) plus a 15 metre allowance	Dynamic Beach
Shoreline Area 2	**96-108** - between Shoreline Area 1 and the building encroachment limit, which is the limit at which beach processes are impacted **109-118** - between Shoreline Area 1 and a line defined by the Flood Hazard Limit plus a 30 metre Dynamic Beach Setback	Dynamic Beach

REACH 6
LAKESHORE ROAD -MODELAND ROAD - BLACKWELL SIDEROAD
City of Sarnia (Lots 45 to 37, Front Concession)
MEASUREMENT NUMBERS 119-164
Sarnia Map 12,13,14,15,16

Shoreline Characteristics

beach -sand and gravel beach typically ±10 metres wide at normal summer water levels, becoming narrower during periods of high lake levels

bluff -low bluff; natural bluff composed of sand materials which are part of a massive natural sand deposit which formed a recurved spit from the St. Clair River to approximately Telfer Sideroad
-in many areas the natural slope has been replaced with bluff stabilization measures (grading, filling, etc.) due to past erosion events

development -permanent residential development located at and along the top of bluff

protection works -steel sheet-pile groynes supplemented with vertical sheet-pile seawalls and sheet-pile and concrete retaining walls
-broken concrete and other construction materials used in sloping rubblemound revetments at some locations

Erosion Issues

-long term top of bank recession rate is moderate at >0.3 metres/year
-beach erosion and wave uprush damage
-recurring damages to protection works and property during high magnitude storm events
-turbulence created by wave reflection off vertical seawalls and groynes may contribute to removal of beach materials
-during storm events, wave action can temporarily overrun the beach and directly attack the shoreline bluff and protection works

Objective of Protection Works

-limit storm wave uprush and damage
-provide recreational beach

Recommendations

-vertical seawalls and retaining walls are not recommended
-maintain existing groynes;
-sloping rubblemound revetment is the recommended approach to protect shoreline from erosion; supplement or replace existing seawalls with sloping rubblemount revetments
-as part of overall shoreline protection scheme, property owners should consider relocation of existing dwellings currently located close to the top of the bluff
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992)

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area		**Description**	**Applicable column in Shoreline Development Guidelines**
Shoreline Area 1		-between the water's edge and a line defined by the first lakeward break in slope	Erosion
Shoreline		-between Shoreline Area 1 and a line	Erosion

Area 2		defined by a 30 m erosion allowance measured from the top of the bluff/bank	
Shoreline Area 1		-between the water's edge and a line defined by the 100 year flood line plus a 15 metre wave uprush allowance (Flood Hazard Limit)	Flood
Shoreline Area 2		-between Shoreline Area 1 and a line defined by a 30 m erosion allowance measured from the top of the bluff/bank	Erosion
Shoreline Area 1		-between the water's edge and a line defined by the 100 year flood line plus a 15 metre wave uprush allowance (Flood Hazard Limit)	Flood
Shoreline Area 2		-between Shoreline Area 1 and a line defined by the slope stability allowance plus 100 times the average annual recession rate(Erosion Hazard Limit)	Erosion
Shoreline Area 1		-between the water's edge and a line defined by the 100 year flood line plus a 15 metre wave uprush allowance (Flood Hazard Limit)	Flood
Shoreline Area 2		-between Shoreline Area 1 and a line defined by the slope stability allowance plus 100 times the average annual recession rate(Erosion Hazard Limit)	Erosion
Shoreline Area 1		-between the water's edge and a line defined by the slope stability allowance measured landward from the toe of the bluff	Erosion
Shoreline Area 2		-between Shoreline Area 1 and a line defined by the slope stability allowance plus 100 times the average annual recession rate (Erosion Hazard Limit)	Erosion

REACH 6a
LAKESHORE ROAD- BLACKWELL SIDEROAD - TELFER SIDEROAD
City of Sarnia (Lots 36 to 28, Front Concession)
MEASUREMENT NUMBERS 165-207
Sarnia Map 17,18,19,20,21

Shoreline Characteristics

beach -sand and gravel beach typically ±5 metres wide at normal summer water levels, becoming narrower during periods of high lake levels

-virtually no beach sand present in some areas; till material making up the lakebed is regularly exposed at the water's edge

bluff -natural bluff composed of sand materials which are part of a massive natural sand deposit which formed a recurved spit from the St. Clair River to approximately Telfer Sideroad
-in many areas the natural slope has been replaced with bluff stabilization measures (grading, filling, etc.) due to past erosion events

development -permanent residential development located at and along the top of bluff

protection works -steel sheet-pile groynes supplemented with vertical sheet-pile seawalls and sheet-pile and concrete retaining walls

Erosion Issues

-long term top of bank recession rate is generally low at < 0.3 metres/year
-beach erosion and wave uprush damage
-recurring damages to protection works and property during high magnitude storm events
-turbulence created by wave reflection off vertical seawalls and groynes may contribute to removal of beach materials or prevent deposition of beach materials
-with the absence of beach materials, the nearshore lakebottom is exposed to erosion (downcutting); as the nearshore becomes progressively deeper, the shoreline is exposed to increasingly severe wave attack and potential storm damages

Objective of Protection Works

-stabilize shoreline from future erosion
-limit storm wave uprush and damage
-provide recreational beach

Recommendations

-vertical seawalls and retaining walls are not recommended
-engineered rubblemound revetment is the recommended approach to protect shoreline from erosion; supplement or replace existing seawalls with sloping rubblemount revetments; revetment design must consider beach stability and erosion (downcutting) of the nearshore lakebottom
-maintain existing groynes;
-as part of overall shoreline protection scheme, property owners should consider relocation of existing dwellings currently located close to the top of the bluff
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992)

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area		Description	Applicable column in Shoreline Development Guidelines
Shoreline Area 1		-between the water's edge and a line defined by the first lakeward break in slope	Erosion
Shoreline Area 2		-between Shoreline Area 1 and a line defined by a 30 m erosion allowance measured from the top of the bluff/bank	Erosion
Shoreline Area 1		-between the water's edge and a line defined by the slope stability allowance measured landward from the toe of the bluff	Erosion
Shoreline Area 2		-between Shoreline Area 1 and a line defined by a 30 m erosion allowance measured from the top of the bluff/bank	Erosion
Shoreline Area 1		-between the water's edge and a line defined by the slope stability allowance measured landward from the toe of the bluff	Erosion
Shoreline Area 2		-between Shoreline Area 1 and a line defined by a 30 m erosion allowance measured from the top of the bluff/bank	Erosion
Shoreline Area 1		-between the water's edge and a line defined by the slope stability allowance measured landward from the toe of the bluff	Erosion
Shoreline Area 2		-between Shoreline Area 1 and a line defined by a 30 m erosion allowance measured from the top of the bluff/bank	Erosion
Shoreline Area 1		-between the water's edge and a line defined by the 100 year flood line plus a 15 metre wave uprush allowance (Flood Hazard Limit)	Flood
Shoreline Area 2		-between Shoreline Area 1 and a line defined by a 30 m erosion allowance measured from the top of the bluff/bank	Erosion

REACH 7
HURON SHORES DRIVE TO WEST OF PERCH CREEK (CULL DRAIN)
City of Sarnia
MEASUREMENT NUMBERS 208-219
Sarnia Maps 21 and 22

Shoreline Characteristics

beach -sand and gravel beach typically very narrow at normal summer water levels
-no beach present during periods of higher lake levels

bluff -grass covered bank; slope materials made up of poorly draining clay fill; broken concrete and fill dumped over bank to replace eroded slope

development -shoreline bank with paved walkway and paved roadway above are contained within municipal road allowance
-permanent residential development located south of road allowance on Huron Shores Drive and Old Lakeshore Road

protection works -vertical steel sheet-pile seawall and groynes; approximately 150 metre length of seawall along paved roadway replaced with sloping rubblemound revetment
-groynes badly damaged by abrasion and ice loading
-remaining seawall has collapsed in several areas

Erosion Issues

-long term top of bank recession rate is generally low at < 0.3 metres/year
-beach erosion and wave uprush damage
-historical damages to protection works, municipal infrastructure and property during high magnitude storm events
-with the absence of beach materials, the nearshore lakebottom is exposed to erosion (downcutting); as the nearshore becomes progressively deeper, the shoreline is exposed to increasingly severe wave attack and potential storm damages

Objective of Protection Works

-stabilize shoreline from future erosion
-limit storm wave uprush and damage
-provide recreational beach

Recommendations

-vertical seawalls and retaining walls are not recommended
-engineered rubblemound revetment is the recommended approach to protect shoreline from erosion; supplement or replace existing seawalls with sloping rubblemount revetments
-revetment design must consider beach stability and erosion (downcutting) of the nearshore lakebottom
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992)

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area	Descriptions	Applicable Column in Shoreline Development Guidelines
Shoreline Area 1	-between the water's edge and a line defined by the 100 year flood line plus a 15 metre wave uprush allowance	Flood
Shoreline Area 2	-between Shoreline Area 1 and a line defined by a 30 metre erosion allowance measured from the top of the bluff/bank	Erosion

REACH 8

PERCH CREEK (WEST OF LAMBERT LANE) TO PASSINGHAM DRIVE (MIKE WEIR PARK)
City of Sarnia
MEASUREMENT NUMBERS 221-299
Sarnia Maps 22, 23, 24

Shoreline Characteristics

Beach -sand and gravel beach typically very narrow at normal summer water levels
-no beach present during periods of higher lake levels

bluff -grass covered bank; slope materials made up of poorly draining clay fill; broken concrete and fill dumped over bank to replace eroded slope

development -municipal road allowance contains shoreline bank and public trail
permanent residential development located south of road allowance

protection works -vertical steel sheet-pile seawall and groynes located within municipal road allowance
groynes badly damaged by abrasion and ice loading
seawall has collapsed in several areas

Erosion Issues

-long term top of bank recession rate is generally low to moderate ± 0.3 metres/year
-beach erosion and wave uprush damage
-historical damages to protection works, municipal infrastructure and property during high magnitude storm events
-with the absence of beach materials, the nearshore lakebottom is exposed to erosion (downcutting); as the nearshore becomes progressively deeper, the shoreline is exposed to increasingly severe wave attack and potential storm damages

Objective of Protection Works

-stabilize shoreline from future erosion
-limit storm wave uprush and damage
-provide recreational beach

Recommendations

-vertical seawalls and retaining walls are not recommended
-engineered rubblemound revetment is the recommended approach to protect shoreline from erosion; supplement or replace existing seawalls with sloping rubblemount revetments
-revetment design must consider beach stability and erosion (downcutting) of the nearshore lakebottom
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992)

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area		**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1		-between the water's edge and a line defined by the slope stability allowance measured landward from the toe of the bluff	Erosion
Shoreline		-between Shoreline Area 1 and a line defined by the slope	Erosion

Area 2		stability allowance plus 100 times the average annual recession rate	
Shoreline Area 1		-between the water's edge and a line defined by the first lakeward break in slope	Erosion
Shoreline Area 2		-between Shoreline Area 1 and a line defined by a 30 m erosion allowance measured from the top of the bluff/bank	Erosion
Shoreline Area 1		-between the water's edge and a line defined by the 100 year flood line plus a 15 metre wave uprush allowance (Flood Hazard Limit)	Flood
Shoreline Area 2		-between Shoreline Area 1 and a line defined by a 30 m erosion allowance measured from the top of the bluff/bank	Erosion
Shoreline Area 1		-between the water's edge and a line defined by the slope stability allowance measured landward from the toe of the bluff	Erosion
Shoreline Area 2		-between Shoreline Area 1 and a line defined by the slope stability allowance plus 100 times the average annual recession rate(Erosion Hazard Limit)	Erosion

REACH 9
OLD LAKESHORE ROAD -ELPRADO STREET (MIKE WEIR PARK) TO KENWICK STREET
City of Sarnia
MEASUREMENT NUMBERS 300-321
Sarnia Map 24, 25, 26

Shoreline Characteristics

beach -sand and gravel beach typically very narrow at normal summer water levels
-no beach present during periods of higher lake levels

bluff -grass covered bank; slope materials made up of poorly draining clay fill

development -municipal road allowance contains shoreline bank and paved roadway
-permanent residential development located south of road allowance

protection works -vertical steel sheet-pile seawall and groynes replaced with engineered sloping rubblemound revetment between 1989 and 1992
-groynes badly damaged by abrasion and ice loading

Erosion Issues

-long term top of bank recession rate is generally low at < 0.3 metres/year
-beach erosion and wave uprush damage
-historical damages to protection works, municipal infrastructure and property during high magnitude storm events
-with the absence of beach materials, the nearshore lakebottom is exposed to erosion (downcutting); as the nearshore becomes progressively deeper, the shoreline is exposed to increasingly severe wave attack and potential storm damages

Objective of Protection Works

-stabilize shoreline from future erosion
-limit storm wave uprush and damage
-provide recreational beach

Recommendations

- vertical seawalls and retaining walls are not recommended
- engineered rubblemound revetment is the recommended approach to protect shoreline from erosion; revetment design must consider beach stability and erosion (downcutting) of the nearshore lakebottom
- monitor condition of protection works, maintain structures and reconstruct where necessary
- alternative approach to protect shoreline (and incorporate a recreational beach) would require offshore breakwaters to contain beach fill; primary design issue would be maintaining longshore transport of sand past the project

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the 100 year flood line plus a 15 metre wave uprush allowance (Flood Hazard Limit)	Flood
Shoreline Area 2	-between Shoreline Area 1 and a line defined by a 30 metre erosion allowance measured from the top of the bluff/bank	Erosion

REACH 10

KENWICK STREET TO WESTGATE CRESCENT
City of Sarnia
MEASUREMENT NUMBERS 322-327
Sarnia Maps 26 and 27

Shoreline Characteristics

beach -sand and gravel beach typically very narrow at normal summer water levels
-no beach present during periods of higher lake levels

bluff -grass covered bank; slope materials made up of poorly draining clay fill; broken concrete and fill dumped over bank to replace eroded slope

development -municipal road allowance contains shoreline bank and paved walkway
-permanent residential development located south of walkway on Westgate Crescent; Wildwood Park under municipal ownership

protection works -vertical steel sheet-pile seawall and groynes; seawall along park replaced with sloping rubblemound revetment
-groynes badly damaged by abrasion and ice loading
-remaining seawall has collapsed in several areas

Erosion Issues

- long term top of bank recession rate is generally low at < 0.3 metres/year
- beach erosion and wave uprush damage
- historical damages to protection works, municipal infrastructure and property during high magnitude storm events
- with the absence of beach materials, the nearshore lakebottom is exposed to erosion (downcutting); as the nearshore becomes progressively deeper, the shoreline is exposed to increasingly severe wave attack and potential storm damages

Objective of Protection Works

- stabilize shoreline from future erosion
- limit storm wave uprush and damage
- provide recreational beach

Recommendations

- vertical seawalls and retaining walls are not recommended
- engineered rubblemound revetment is the recommended approach to protect shoreline from erosion; revetment design must consider beach stability and erosion (downcutting) of the nearshore lakebottom
- monitor condition of protection works, maintain structures and reconstruct where necessary
- alternative approach to protect shoreline (and incorporate a recreational beach) would require offshore breakwaters to contain beach fill; primary design issue would be maintaining longshore transport of sand past the project

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the 100 year flood line plus a 15 metre wave uprush allowance	Flood
Shoreline Area 2	-between Shoreline Area 1 and a line defined by a 30 metre erosion allowance measured from the top of the bluff/bank	Erosion

REACH 11
OLD LAKESHORE ROAD (HELEN AVENUE TO COW CREEK)
City of Sarnia
MEASUREMENT NUMBERS 328-369
Sarnia Maps 27, 28, 29, 31, 31

Shoreline Characteristics

beach -sand and gravel beach ±5 metres wide at normal summer water levels
-no beach present during periods of higher lake levels

bluff -grass covered bank; slope materials made up of poorly draining clay fill

development -municipal road allowance contains shoreline bank and paved roadway
-permanent residential development located south of road allowance

protection works -vertical steel sheet-pile seawall and groynes being replaced with engineered sloping rubblemound revetment (approximately 600 metres completed to 1995)
-groynes badly damaged by abrasion and ice loading

Erosion Issues

-long term top of bank recession rate is generally low at < 0.3 metres/year
-beach erosion and wave uprush damage
-historical damages to protection works, municipal infrastructure and property during high magnitude storm events
-with the absence of beach materials, the nearshore lakebottom is exposed to erosion (downcutting); as the nearshore becomes progressively deeper, the shoreline is exposed to increasingly severe wave attack and potential storm damages

Objective of Protection Works

- stabilize shoreline from future erosion
- limit storm wave uprush and damage
- provide recreational beach

Recommendations

- vertical seawalls and retaining walls are not recommended
- engineered rubblemound revetment is the recommended approach to protect shoreline from erosion; revetment design must consider beach stability and erosion (downcutting) of the nearshore lakebottom
- monitor condition of protection works, maintain structures and reconstruct where necessary
- alternative approach to protect shoreline (and incorporate a recreational beach) would require offshore breakwaters to contain beach fill; primary design issue would be maintaining longshore transport of sand past the project

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the 100 year flood line plus a 15 metre wave uprush allowance	Flood
Shoreline Area 2	-between Shoreline Area 1 and a line defined by a 30 metre erosion allowance measured from the top of the bluff/bank	Erosion

REACH 12

COW CREEK (HURONVIEW TRAIL) TO LAKEVIEW TRAIL
City of Sarnia
MEASUREMENT NUMBERS 370 -381
Sarnia Maps 31 and 32

Shoreline Characteristics

beach -sand beach typically ±10-15 metres wide at normal summer water levels, becoming narrower during periods of high lake levels

bluff -low bluff; well vegetated with matural trees

development -permanent residential development interspersed with some cottage residences
-dwellings located along the top of bluff

protection works -steel sheet-pile groynes; some groynes supplemented with vertical sheet-pile seawalls and retaining walls
-training walls (jetties) at mouth of Cow Creek function as long groynes and act to stabilize the recreational beach to the east for approximately 600 metres
-Cow Creek training walls administered by Small Craft Harbours, Fisheries and Oceans Canada

Erosion Issues

-beach erosion and wave uprush damage
-historical damages to protection works and property during high magnitude storm events
-turbulence created by wave reflection off vertical seawalls and groynes may contribute to removal of beach materials
-during storm events, wave action can temporarily overrun the beach and directly attack the shoreline bluff and protection works

Objective of Protection Works

- limit storm wave uprush and damage
- provide recreational beach

Recommendations

- vertical seawalls and retaining walls are not recommended
- supplement or replace existing vertical seawalls with sloping rubblemound revetments to reduce wave impact and beach erosion
- maintain existing groynes;
- for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992)

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the 100 year flood line plus a 15 m wave uprush allowance (Flood Hazard Limit) plus a 15 metre allowance	Dynamic Beach
Shoreline Area 2	-between Shoreline Area 1 and a line defined by the Flood Hazard Limit plus a 30 metre Dynamic Beach Setback	Dynamic Beach

REACH 13
SANDPIPER TRAIL - LAKE VIEW AVE.
Plympton Township (Registered Plan 12, 14)
MEASUREMENT NUMBERS 383-394
Plympton Maps 1 and 2

Shoreline Characteristics

beach -sand beach typically ±5 metres wide at normal summer water levels, becoming narrow or non-existent during periods of high lake levels

bluff -high bluff; stabilization measures (grading, drainage) undertaken in some areas; steep and eroding with sparse vegetation in other areas

development -permanent residential development with some cottage residences
-dwellings located at top of bluff

protection works -steel sheet pile groynes; most groynes supplemented with vertical sheet pile seawalls and retaining walls; at two locations groynes have been constructed with "T" and "L" shaped heads

Erosion Issues

-long term bluff recession rate is generally low at < 0.3 metres/year
-beach erosion and wave uprush damage during storm events and high lake level periods
-turbulence created by wave reflection off vertical seawalls and groynes may remove beach materials exposing the protection works to more severe wave attack
-historical damage to protection works and property during high magnitude storm events

Objective of Protection Works

-limit storm wave uprush and damage
-provide recreational beach

Recommendations

-vertical seawalls and retaining walls are not recommended
-supplement or replace existing vertical seawalls with sloping rubblemound revetments to reduce wave impact and beach erosion
-revetment design must consider beach stability and erosion (downcutting) of the nearshore lake bottom
-maintain existing groynes; where groyne cells are not full "nourish" with suitable beach sand (clean sand and gravel, D_{50} > 0.3mm)
-the T shaped groynes are meant to reduce turbluence and scour within the groyne cell; constructed in deeper water, they tend to be more exposed to damages caused by wave impact and ice
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992)

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the slope stability allowance measured landward from the toe of the bluff	Erosion
Shoreline Area 2	-between Shoreline Area 1 and a line defined by a 30 metre erosion allowance measured from the top of the bluff/bank	Erosion

REACH 14

DOUGLAS STREET TO DEVONSHIRE ROAD
Plympton Township (Registered Plan 16, 13, 15 20, 695, and 19)
MEASUREMENT NUMBERS 395-416
Plympton Maps 2, 3, 4

Shoreline Characteristics

beach -sand beach typically ±5 metres wide at normal summer water levels, becoming narrow or non-existent during periods of high lake levels

bluff -high bluff; stabilization measures (grading, drainage) undertaken in some areas; steep and eroding with sparse vegetation in other areas

development -permanent residential development with some cottage residences
-dwellings located at top of bluff

protection works -steel sheet pile groynes; most groynes supplemented with vertical sheet pile seawalls and retaining walls; at two locations groynes have been constructed with "T" and "L" shaped heads

Erosion Issues

-long term bluff recession rate is generally low at < 0.3 metres/year
-beach erosion and wave uprush damage during storm events and high lake level periods
-turbulence created by wave reflection off vertical seawalls and groynes may remove beach materials exposing the protection works to more severe wave attack
-historical damage to protection works and property during high magnitude storm events

Objective of Protection Works

-limit storm wave uprush and damage
-provide recreational beach

Recommendations

-vertical seawalls and retaining walls are not recommended
-supplement or replace existing vertical seawalls with sloping rubblemound revetments to reduce wave impact and beach erosion
-revetment design must consider beach stability and erosion (downcutting) of the nearshore lake bottom
-maintain existing groynes; where groyne cells are not full "nourish" with suitable beach sand (clean sand and gravel, D_{50} > 0.3mm)
-the T shaped groynes are meant to reduce turbluence and scour within the groyne cell; constructed in deeper water, they tend to be more exposed to damages caused by wave impact and ice
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area	Descriptions	Applicable Column in Shoreline Development Guidelines
Shoreline Area 1	-between the water's edge and a line defined by the slope stability allowance measured landward from the toe of the bluff	Erosion
Shoreline Area 2	**395-404**- between Shoreline Area 1 and a line defined by the Stable Slope Allowance plus 100 times the average annual recession rate **405-416** between Shoreline Area 1 and a line defined by a 30 metre erosion allowance measured from the top of the bluff/bank	Erosion

REACH 15
O'BRIEN ROAD TO SCHRAM DRIVE
Plympton Township LOTS 10 to 13, Front Concession
MEASUREMENT NUMBERS 417-436
Plympton Maps 4, 5, 6

Shoreline Characteristics

beach -sand beach typically ±5 metres wide at normal summer water levels, becoming narrow or non-existent during periods of high lake levels

bluff -high bluff; stabilization measures (grading, drainage) undertaken in some areas; steep and eroding with sparse vegetation in other areas

development -permanent residential development
-dwellings located at top of bluff

protection works -steel sheet pile groynes; most groynes supplemented with vertical sheet pile seawalls

Erosion Issues

-long term recession rate is generally low to moderate ± 0.3 metres/year
-beach erosion and wave uprush damage during storm events and high lake level periods
-turbulence created by wave reflection off vertical seawalls and groynes may remove beach materials exposing the protection works to more severe wave attack
-historical damage to protection works and property during high magnitude storm events

Objective of Protection Works

-limit storm wave uprush and damage
-provide recreational beach

Recommendations

-vertical seawalls and retaining walls are not recommended
-supplement or replace existing vertical seawalls with sloping rubblemound revetments to reduce wave impact and beach erosion
-revetment design must consider beach stability and erosion (downcutting) of the nearshore lake bottom
-maintain existing groynes; where groyne cells are not full "nourish" with suitable beach sand (clean sand and gravel, D_{50} > 0.3mm)
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992)

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the slope stability allowance measured landward from the toe of the bluff	Erosion
Shoreline Area 2	-between Shoreline Area 1 and a line defined by the slope stability allowance plus 100 times the average annual recession rate	Erosion

REACH 16
ERROL BEACH AND SUBDIVISION (MAITLAND ST. TO FLEMING RD.)
Plympton Township (Registered Plans 2 and 421)
MEASUREMENT NUMBERS 439-462
Plympton Maps 6, 7, 8

Shoreline Characteristics

beach -sand beach typically ±10 metres wide at normal summer water levels, becoming narrower during periods of high lake levels

bluff -high bluff; stabilization measures (grading, drainage) undertaken in some areas; steep and eroding with sparse vegetation in other areas

development -permanent residential development
-dwellings located at top of bluff

protection works -steel sheet pile groynes; some groynes supplemented with vertical sheet pile seawalls

Erosion Issues

-long term recession rate is generally moderate at > 0.5 metres/year
-beach erosion and wave uprush damage
-during storm events, wave action can temporarily overrun the beach and directly attack the bluff materials and protection works
-turbulence created by wave reflection off vertical seawalls and groynes may remove beach materials exposing the protection works to more severe wave attack
-historical damage to protection works and property during high magnitude storm events

Objective of Protection Works

-stabilize shoreline from future recession
-limit storm wave uprush and damage
-provide recreational beach

Recommendations

-community approach to construction and maintenance of protection works is recommended
-vertical seawalls and retaining walls are not recommended
-supplement or replace existing vertical seawalls with sloping rubblemound revetments to reduce wave impact and beach erosion
-revetment design must consider beach stability and erosion (downcutting) of the nearshore lake bottom
-maintain existing groynes; where groyne cells are not full "nourish" with suitable beach sand (clean sand and gravel, D_{50} > 0.3mm)
-for more detailed information, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992)

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area	Descriptions	Applicable Column in Shoreline Development Guidelines
	439-460 -between the water's edge and a line defined by the slope stability allowance measured landward from the toe of the bluff	Erosion
	461-462- between the water's edge and a line defined by the first lakeward break in slope	Erosion
Shoreline Area 2	-between Shoreline Area 1 and a line defined by the slope stability allowance plus 100 times the average annual recession rate	Erosion

REACH 17
FLEMING ROAD TO BEVERLY GLEN
Plympton Township (Registered Plan 30)
MEASRUEMENT NUMBERS 463-483
Plympton Maps 8, 9, 10

Shoreline Characteristics

beach -sand beach typically ±10 metres wide at normal summer water levels, becoming narrow during periods of high lake levels

bluff -high bluff; areas sparsely vegetated with seasonal grasses, small trees and shrubs; other areas well vegetated with mature trees

development -permanent residential development
-dwellings located along the top of bluff

protection works -steel sheet pile groynes; supplemented at one location with gabion basket seawall

Erosion Issues

-long term recession rate is generally moderate at > 0.3 metres/year
-undercutting at the toe of the bluff by wave action has caused instability and successive shallow slips on the bluff face
-during storm events, wave action can temporarily overrun the beach and directly attack the bluff materials
-wave uprush during storm events is intensified during periods of high lake levels
-instability aggravated by landside influences (drainage, groundwater seepage, etc.)

Objective of Protection Works

-stabilize shoreline from future recession
-limit storm wave uprush damages
-provide recreational beach

Recommendations

-community approach to construction and maintenance of protection works is recommended
-vertical seawalls and retaining walls are not recommended
-maintain existing groynes; where groyne cells are not full, "nourish" existing groyne cells with suitable beach sand (clean sand and gravel, D_{50} > 0.3mm)
-intercept surface runoff and convey down bluff to beach in closed drainage system
-where additional protection of toe of bluff is required, sloping rubblemound revetment constructed along toe of bluff is recommended approach to protect shoreline from erosion
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992)

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area	Descriptions	Applicable Column in Shoreline Development Guidelines
	463-466 -between the water's edge and a line defined by the first lakeward break in slope	Erosion
	467-483- between the water's edge and a line defined by the slope stability allowance measured landward from the toe of the bluff	Erosion
Shoreline Area 2	-between Shoreline Area 1 and a line defined by the slope stability allowance plus 100 times the average annual recession rate	Erosion

REACH 18

BEVERLY GLEN TO FERNE AVENUE
Plympton Township (Registered Plan 496)
Measurement Numbers 484-502
Plympton Maps 10, 11, 12

Shoreline Characteristics

beach -sand beach typically ±5 metres wide at normal summer water levels, becoming narrow or non-existent during periods of high lake levels

bluff -high bluff; steep and eroding; sparsely vegetated with seasonal grasses and some small shrubs

development -22 vacant lots in registered plan dated 1960

protection works -shoreline bluff unprotected

Erosion Issues

-long term recession rate is generally moderate at > 0.5 metres/year
-undercutting at the toe of the bluff by wave action has caused instability and successive shallow slips on the bluff face but also deeper internal rotational slumps
-wave uprush during storm events is intensified during periods of high lake levels
-instability aggravated by landside influences (drainage, groundwater seepage, loading, etc.)

Objective of Protection Works

-stabilize shoreline from future recession

Recommendations

-engineered sloping rubblemound revetment constructed along toe of bluff is recommended approach to protect shoreline from erosion; bluff stabilization measures (grading, drainage, vegetation) also necessary above protection works
-CONSTRUCT PRIOR TO DEVELOPMENT TO ENSURE ACCESS and suitable setbacks
-revetment design must consider beach stability and erosion (downcutting) of the nearshore lake bottom
-any new groyne construction should include prefilling of groyne cells with suitable beach sand (clean sand and gravel, D_{50} > 0.3mm)
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992), and, MNR (1986) and USACOE (1977, 1981)
-as an alternative to protection works, recommend that the property owner(s) consider acquisition of additional land from adjacent owner to facilitate construction of dwellings landward of Shoreline Area 2 (Erosion Hazard Limit)

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the slope stability allowance measured landward from the toe of the bluff	Erosion
Shoreline Area 2	-between Shoreline Area 1 and a line defined by the slope stability allowance plus 100 times the average annual recession rate	Erosion

REACH 19

BONNIE DOON SUBDIVISION (FERNE AVENUE DEVELOPED TO BONNIE DOON CREEK)
Plympton Township (Registered Plan 29)
Measurement Numbers 503-509
Plympton Map 12 and 13

Shoreline Characteristics

beach -sand beach typically ±10 metres wide at normal summer water levels, becoming narrower during periods of high lake levels

bluff -high bluff; sparsely vegetated with seasonal grasses and some small tree and shrubs

development -permanent residential development with some cottage residences
-dwellings located at top of bluff

protection works -much of shoreline bluff unprotected
-several steel sheet pile groynes irregularly spaced; one groyne supplemented with vertical sheet pile seawall/retaining wall

Erosion Issues

-long term recession rate is generally low at < 0.3 metres/year
-undercutting at the toe of the bluff by wave action has caused instability and successive shallow slips on the bluff face but also deeper internal rotational slumps
-during storm events, wave action can temporarily overrun the beach and directly attack the bluff materials
-wave uprush during storm events is intensified during periods of high lake levels
-instability aggravated by landside influences (drainage, groundwater seepage, loading, etc.)

Objective of Protection Works

-stabilize shoreline from future recession
-limit storm wave uprush and damage
-provide recreational beach

Recommendations

-community approach to construction and maintenance of protection works is recommended
-vertical seawalls and retaining walls are not recommended
-engineered sloping rubblemound revetment constructed along toe of bluff is recommended approach to protect shoreline from erosion; bluff stabilization measures (grading, drainage, vegetation) also necessary above protection works; **revetment design must consider beach stability and erosion (downcutting) of the nearshore lake bottom**
-maintain existing groynes; where groyne cells are not full "nourish" with suitable beach sand (clean sand and gravel, D_{50} > 0.3mm)
-for more detailed information, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992)

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the slope stability allowance measured landward from the toe of the bluff	Erosion
Shoreline Area 2	-between Shoreline Area 1 and a line defined by the slope stability allowance plus 100 times the average annual recession rate	Erosion

REACH 20
BONNIE DOON CREEK TO BALDWIN AVENUE (POINT VIEW SUBDIVISIONS)
Plympton Township (Registered Plans 587 and 33)
Measurement Numbers 517-527
Plympton Maps 14 and 15

Shoreline Characteristics

beach -sand beach typically ±10 metres wide at normal summer water levels, becoming narrower during periods of high lake levels

bluff -high bluff; well vegetated with mature trees
-some localized instability (creep, slumping) due to previous toe erosion by wave action, and landside influences (drainage, groundwater seepage, etc.)

development -seasonal and permanent residential development
-dwellings located at top of bluff

protection works -steel sheet pile groynes

Erosion Issues

-long term recession rate is generally low to moderate ± 0.3 metres/year
-during storm events, wave action can temporarily overrun the beach and directly attack the bluff materials; erosion of the beach and toe of bluff result

Objective of Protection Works

-limit storm wave uprush damages and toe of bluff erosion
-provide recreational beach

Recommendations

-community approach to construction and maintenance of protection works is recommended
-vertical seawalls and retaining walls are not recommended
-maintain existing groynes
-intercept surface runoff and convey down bluff to beach in closed drainage system
-if additional protection from wave uprush is required during periods of high lake levels, "nourish" existing groyne cells with suitable beach sand (clean sand and gravel, D_{50} > 0.3mm)
-where additional protection of toe of bluff is required and/or beach nourishment not feasible, construct sloping rubblemound revetment along toe of bluff to reduce wave impact and beach erosion
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992)

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the slope stability allowance measured landward from the toe of the bluff	Erosion
Shoreline Area 2	-between Shoreline Area 1 and a line defined by the slope stability allowance plus 100 times the average annual recession rate	Erosion

REACH 21
BLUE POINT BAY (30 CREEK DRAIN AREA, SOUTH OF DOUGLAS LINE)
Plympton Township (Lot 29, Front Concession)
Measurement Numbers 532-553
Plympton Maps 15, 16, 17

Shoreline Characteristics

beach -sand and gravel beach typically ±10 metres wide at normal summer water levels, becoming narrow during periods of high lake levels

bluff -high bluff; well vegetated with mature trees
-some localized instability (creep, slumping) due to previous toe erosion by wave action, and landside influences (drainage, groundwater seepage, etc.)
-gully development prevalent

development -seasonal residential development
-dwellings located along the top of bluff

protection works -shoreline bluff unprotected

Erosion Issues

-long term recession rate is generally low at low at < 0.3 metres/year
-beach erosion and toe of bluff erosion caused by wave uprush during storms and high lake level periods

Objective of Protection Works

-limit storm wave uprush damages and toe of bluff erosion

Recommendations

-community approach to construction and maintenance of protection works is recommended
-vertical seawalls and retaining walls are not recommended
-intercept surface runoff and convey down bluff to beach in closed drainage system
-any new groyne construction should include prefilling of groyne cells with suitable beach sand (clean sand and gravel, D_{50} > 0.3mm)
-where additional protection is required during periods of high lake levels, sloping rubblemound revetment along toe of bluff is recommended approach
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992)

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the slope stability allowance measured landward from the toe of the bluff	Erosion
Shoreline Area 2	-between Shoreline Area 1 and a line defined by a 30 metre erosion allowance measured from the top of the bluff	Erosion

REACH 22
BLUE POINT BAY NORTH OF DOUGLAS LINE
Plympton Township (Registered Plan 25 and 28)
Measurement Numbers 554-586
Plympton Maps 17, 18, 19, 20, 21

Shoreline Characteristics

beach -sand, gravel and cobble beach typically ±5 metres wide at normal summer water levels, becoming narrow during periods of high lake levels

bluff -high bluff; well vegetated with mature trees
-some localized instability (creep, slumping) due to previous toe erosion by wave action, and landside influences (drainage, groundwater seepage, etc.)
-gully development prevalent

development -seasonal and permanent residential development
-dwellings located along the top of bluff

protection works -gabion basket groynes; supplemented at two locations with gabion basket seawalls

Erosion Issues

-long term recession rate is generally moderate at > 0.3 metres/year
-beach erosion and toe of bluff erosion caused by wave uprush during storms and high lake level periods

Objective of Protection Works

-limit storm wave uprush damages and toe of bluff erosion

Recommendations

-community approach to construction and maintenance of protection works is recommended
- vertical seawalls and retaining walls are not recommended
-intercept surface runoff and convey down bluff to beach in closed drainage system
-where additional protection is required during periods of high lake levels, sloping rubblemound revetment along toe of bluff is recommended approach
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992)

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	**-**between the water's edge and a line defined by the slope stability allowance measured landward from the toe of the bluff	Erosion
Shoreline Area 2	**554-559**- between Shoreline Area 1 and a line defined by a 30 metre erosion allowance measured from the top of the bluff **560-586**-between Shoreline Area 1 and a line defined by the slope stability allowance plus 100 times the average annual recession rate	Erosion

REACH 23

BLUE POINT SUBDIVISION (BLUE POINT NORTH SHORE)
Plympton Township (Registered Plan 28)
MEASUREMENT NUMBERS 587-608
Plympton Map 21, 22 23

Shoreline Characteristics

beach -sand beach typically ± 5 metres wide at normal summer water levels, becoming narrow or non-existent during periods of high lake levels

bluff -high bluff; steep and eroding; sparsely vegetated with seasonal grasses/small shrubs

development -permanent residential development with several vacant lots of record
-dwellings located at top of bluff

protection works -majority of shoreline bluff unprotected
-several steel sheet pile groynes; some groynes supplemented with vertical sheet pile seawalls

Erosion Issues

-long term recession rate is generally moderate at > 0.4metres/year
-undercutting at the toe of the bluff by wave action causes instability and success shallow slips on the bluff face but also deeper internal rotational slumps
-wave uprush during storm events is intensified during periods of high lake levels
-instability aggravated by landside influences (drainage, loading, groundwater seepage, etc.)

Objective of Protection Works

-stabilize shoreline from future recession by preventing erosion by wave action at toe of bluff

Recommendations

-community approach to construction and maintenance of protection works is recommended
-vertical seawalls and retaining walls are not recommended
-CONSIDER RELOCATION AND MOVEABLE DWELLING DESIGNS instead of protection works
-engineered sloping rubblemound revetment constructed along toe of bluff is recommended approach to protect shoreline from continual erosion; bluff stabilization measures (grading, drainage, vegetation) necessary in conjunction with protection works; **revetment design must consider beach stability and erosion (downcutting) of the nearshore lake bottom**
-maintain existing groynes; where groyne cells are not full "nourish" with suitable beach sand (clean sand and gravel, D_{50} > 0.3mm)
-intercept surface runoff and convey landward to storm drainage system or over bluff face and down to beach in closed drainage system
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992)

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the slope stability allowance measured landward from the toe of the bluff	Erosion
Shoreline Area 2	-between Shoreline Area 1 and a line defined by the slope stability allowance plus 100 times the average annual recession rate	Erosion

REACH 24
SUNSET ACRES
Plympton Township (Registered Plan 448)
MEASURMENT NUMBERS 609-626
Plympton Maps 24 and 25

Shoreline Characteristics

beach -sand beach typically ±5 metres wide at normal summer water levels, becoming narrow or non-existent during periods of high lake levels

bluff -high bluff; steep and eroding; sparsely vegetated with seasonal grasses/small shrubs

development -permanent residential development with numerous vacant lots of record
-dwellings located along the top of bluff

protection works -majority of shoreline bluff unprotected
-two steel sheet pile groynes

Erosion Issues

-long term recession rate is generally moderate at > 0.5 metres/year
-undercutting at the toe of the bluff by wave action causes instability and success shallow slips on the bluff face but also deeper internal rotational slumps
-wave uprush during storm events is intensified during periods of high lake levels
-instability aggravated by landside influences (drainage, loading, groundwater seepage, etc.)

Objective of Protection Works

-stabilize shoreline from future recession by preventing erosion by wave action at the toe of bluff

Recommendations

-community approach to construction and maintenance of protection works is recommended
-vertical seawalls and retaining walls are not recommended
-engineered sloping rubblemound revetment constructed along toe of bluff is recommended approach to protect shoreline from continual erosion; bluff stabilization measures (grading, drainage, vegetation) necessary in conjunction with protection works
-revetment design must consider beach stability and erosion (downcutting) of the nearshore lake bottom
-maintain existing groynes; where groyne cells are not full "nourish" with suitable beach sand (clean sand and gravel, D_{50} > 0.3mm)
-intercept surface runoff and convey landward to storm drainage system or over bluff face and down to beach in closed drainage system
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992)

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the slope stability allowance measured landward from the toe of the bluff	Erosion
Shoreline Area 2	-between Shoreline Area 1 and a line defined by the slope stability allowance plus 100 times the average annual recession rate	Erosion

REACH 25
WILLIAM ST. GALLIMERE BEACH (KERNOHAN O'DONNELL DRAIN)
Plympton Township (Registered Plans 17 and 23)
MEASURMENT NUMBERS 647-656
Plympton Maps 26 and 27

Shoreline Characteristics

beach -sand beach typically ±10 metres wide at normal summer water levels, becoming narrow during periods of high lake levels

bluff -high bluff; well vegetated with mature trees
-several areas of localized instability (creep, slumping) due to previous toe erosion by wave action, and landside influences (drainage, loading, groundwater seepage, etc.)

development -seasonal residential development; some conversion to permanent residences
-cottages located along the top of bluff

protection works -steel sheet pile groynes

Erosion Issues

-long term recession rate is generally low at < 0.3 metres/year
-beach erosion and toe of bluff erosion caused by wave uprush during storms and high lake level periods

Objective of Protection Works

-limit storm wave uprush damages and toe of bluff erosion
-provide recreational beach

Recommendations

-community approach to construction and maintenance of protection works is recommended
-vertical seawalls and retaining walls are not recommended
-maintain existing groynes
-intercept surface runoff and convey down bluff to beach in closed drainage system
-if additional protection from wave uprush is required during periods of high lake levels, "nourish" existing groyne cells with suitable beach sand (clean sand and gravel, D_{50} > 0.3mm)
-where additional protection of toe of bluff is required and/or beach nourishment not feasible, construct sloping rubblemound revetment along toe of bluff to reduce wave impact and beach erosion
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird, 1992)

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the slope stability allowance measured landward from the toe of the bluff	Erosion
Shoreline Area 2	-between Shoreline Area 1 and a line defined by a 30 metre erosion allowance measured from the top of the bluff	Erosion

REACH 26

HILLCREST HEIGHTS (LAKESIDE STREET)
Plympton Township (Registered Plans 31, 34 and 440)
Measurement Numbers 657-681
Plympton Maps 27, 28, 29

Shoreline Characteristics

beach -sand beach typically ±10 metres wide at normal summer water levels, becoming narrow during periods of high lake levels

bluff -high bluff; well vegetated with mature trees
-several areas of localized instability (creep, slumping) due to previous toe erosion by wave action, and landside influences (drainage, groundwater seepage, etc.)

development -permanent residential development interspersed with some cottage residences
-dwellings located along the top of bluff

protection works -varies from no protection to irregularly spaced steel sheet pile groynes and, gabion basket and concrete seawalls

Erosion Issues

-long term recession rate is generally low at < 0.3 metres/year
-beach erosion and toe of bluff erosion caused by wave uprush during storms and high lake level periods

Objective of Protection Works

-limit storm wave uprush damages and toe of bluff erosion
-provide recreational beach

Recommendations

-community approach to construction and maintenance of protection works is recommended
-vertical seawalls and retaining walls are not recommended
-maintain existing groynes
-intercept surface runoff and convey down bluff to beach in closed drainage system
-if additional protection from wave uprush is required during periods of high lake levels, "nourish" existing groyne cells with suitable beach sand (clean sand and gravel, D_{50} > 0.3mm)
-where additional protection of toe of bluff is required and/or beach nourishment not feasible, construct sloping rubblemound revetment along toe of bluff to reduce wave impact and beach erosion
-any new groyne construction should include prefilling of groyne cells with suitable beach sand
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992)

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the slope stability allowance measured landward from the toe of the bluff	Erosion
Shoreline Area 2	-between Shoreline Area 1 and a line defined by a 30 metre erosion allowance measured from the top of the bluff	Erosion

REACH 27
INVERCAIRN BEACH (MACK AVENUE TO POND TRAIL)
Plympton Township (Registered Plan 27)
MEASUREMENT NUMBERS 684-693
Plympton Map 30

Shoreline Characteristics

beach -sand beach typically ±15 metres wide at normal summer water levels, becoming narrower during periods of high lake levels

bluff -high bluff; well vegetated with mature trees
-some localized instability (creep, slumping) due to previous toe erosion by wave action, and landside influences (drainage, groundwater seepage, etc.)

development -seasonal residential development; some conversion to permanent residences
-cottages located along the top of bluff
-cottages located on bluff face in Fisher Beach
-cottages in Moorings located along the top of bluff

protection works -steel sheet pile groynes and groynes supplemented by vertical sheet pile seawalls; constructed by subdivision community during mid-1970's

Erosion Issues

-long term recession rate is generally low at <0.3 metres/year
-beach erosion and minor toe of bluff erosion caused by wave uprush during storms and high lake level periods

Objective of Protection Works

-limit storm wave uprush damages
-provide recreational beach

Recommendations

-community approach to construction and maintenance of protection works is recommended
-vertical seawalls and retaining walls are not recommended
-maintain existing groynes
-intercept surface runoff and convey down bluff to beach in closed drainage system
-if additional protection from wave uprush is required during periods of high lake levels, "nourish" existing groyne cells with suitable beach sand (clean sand and gravel, D_{50} > 0.3mm)
-where additional protection of toe of bluff is required and/or beach nourishment not feasible, construct sloping rubblemound revetment along toe of bluff to reduce wave impact and beach erosion
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992)

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the slope stability allowance measured landward from the toe of the bluff	Erosion
Shoreline Area 2	-between Shoreline Area 1 and a line defined by a 30 metre erosion allowance measured from the top of the bluff	Erosion

REACH 28

HILLSBORO BEACH (NORTH AND SOUTH) AROUND HICKORY CREEK
Plympton Township (includes Registered Plan 26)
MEASUREMENT NUMBERS 694-706
Plympton Maps 31 and 32

Shoreline Characteristics

beach -sand beach typically ±10 metres wide at normal summer water levels, becoming narrow during periods of high lake levels
-Hillsboro South on remnant dune feature located between beach and backshore bluff

bluff -high bluff in Hillsboro North; well vegetated with mature trees
-some localized instability due to landside influences (drainage, loading, etc.)

development -seasonal residential development
-cottages located on bluff face and along top of bluff in Hillsboro North
-cottages in Hillsboro South located on remnant dune feature at the beach

protection works -steel sheet pile groynes supplemented by vertical sheet pile, concrete and rock seawalls and retaining walls, and rubble mounds

Erosion Issues

-long term recession rate is generally low at < 0.3 metres/year
-beach erosion and wave uprush damage during storms and high lake level periods
-historical damage to protection works, property and structures located on the bluff face/beach

Objective of Protection Works

-limit storm wave uprush damages
-provide recreational beach

Recommendations

-community approach to construction and maintenance of protection works is recommended
-maintain existing groynes; where groyne cells are not full, "nourish" with suitable beach sand (clean sand and gravel, D_{50} > 0.3mm)
-vertical seawalls and retaining walls are not recommended
-supplement or replace existing vertical walls with sloping rubblemound revetments to reduce wave impact and beach erosion
-any new groyne construction should include prefilling of groyne cells with suitable beach sand
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird, 1992)

*Shoreline Reach Characteristics, F.J. Reinders Lake Huron Shoreline Processes Study, 1989 and MNR Technical Guidelines

Management Area Delineation (by SCRCA)

Shoreline Area	Descriptions	Applicable Column in Shoreline Development Guidelines
	694-701–between the water's edge and a line defined by the 100 year flood line plus a 15 m wave uprush allowance	Flood
	704-707-between the water's edge and a line defined by the slope stability allowance measured landward from the toe of the bluff	Erosion
Shoreline Area 2	-between Shoreline Area 1 and a line defined by a 30 metre erosion allowance measured from the top of the bluff	Erosion

REACH 29
TOWNSEND LINE TO LAKE VIEW HAVEN DR.
Lambton Shores (includes Registered Plan 42 and Plan 500)
MEASUREMENT NUMBERS 1-8
Lambton Shores Maps 1, 2, 3

Shoreline Characteristics

beach - narrow sand and cobble beach at time of 2007 air photos

bluff -approx. 16 m bluff; well vegetated with mature trees

development -traditionally agricultural, with some areas of housing development along top of bluff

protection works -minimal consisting of occasional groynes made of boulders cleared from nearshore lakebed

Erosion Issues

-long term recession rate is generally low at < 0.3 metres/year; clearing of boulders from nearshore increases erosion

Objective of Protection Works

- there is minimal shore protection in this reach, likely due to a combination of relatively low erosion rates and the cost of shore protection compared with the value of the land
- clearing of boulders and construction of groynes is likely intended to create a swimming area and boat access, as opposed to shore protection

Recommendations

-locate development outside hazard limits
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992), and MNR (2001a,b).

Management Area Delineation (by SCRCA)

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the stable slope allowance measured landward from the toe of the bluff	Erosion
Shoreline Area 2	-between Shoreline Area 1 and a line defined by the slope stability allowance plus 100 times the average annual recession rate (this is the predominant hazard for this reach, however SCRCA should examine mapping for site specific hazard descriptions).	Erosion

REACH 30
LAKE VIEW HAVEN DR. TO WOODS CREEK DRAIN
Lambton Shores (includes Registered Plan 28)
MEASUREMENT NUMBERS 9-14
Lambton Shores Maps 4, 5, and 6

Shoreline Characteristics

beach - 25 m to 50 m wide sand beach at time of 2007 air photos

bluff - approx. 16 m bluff; well vegetated with mature trees

development - traditionally agricultural, with some areas of housing development along top of bluff

protection works - minimal consisting of occasional groynes made of boulders cleared from nearshore lakebed

Erosion Issues

-long term recession rate is generally low at <0.3 metres/year

Objective of Protection Works

- there is minimal shore protection in this reach, likely due to a combination of relatively low erosion rates and the cost of shore protection compared with the value of the land
- clearing of boulders and construction of groynes is likely intended to create a swimming area and boat access, as opposed to shore protection

Recommendations

-locate development outside hazard limits
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992), and MNR (2001a,b).

Management Area Delineation (by SCRCA)

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the slope stability allowance measured landward from the toe of the bluff	Erosion
Shoreline Area 2	-between Shoreline Area 1 and a line defined by a 30 metre erosion allowance measured from the top of the bluff/bank (this is the predominant hazard for this reach, however SCRCA should examine mapping for site specific hazard descriptions).	Erosion

REACH 31
WOODS CREEK DRAIN TO JAMES CREEK DRAIN
Lambton Shores (includes Registered Plan 30)
MEASUREMENT NUMBERS 15-17
Lambton Shores Maps 7, 8, and 9

Shoreline Characteristics

beach - narrow sand and cobble beach and exposed bedrock at time of 2007 air photos

bluff - approx. 16 m bluff; well vegetated with mature trees

development
- traditionally agricultural, with some residential development along top of bluff
- a couple of small marinas

protection works - boulder groynes and breakwaters protecting marina developments, steel sheet pile wall in marina

Erosion Issues

-long term recession rate is generally low at <0.3 metres/year

Objective of Protection Works

- there is minimal shore protection in this reach, likely due to a combination of relatively low erosion rates and the cost of shore protection compared with the value of the land

Recommendations

-locate development outside hazard limits
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992), and MNR (2001a,b).

Management Area Delineation (by SCRCA)

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the slope stability allowance measured landward from the toe of the bluff	Erosion
Shoreline Area 2	-between Shoreline Area 1 and a line defined by a 30 metre erosion allowance measured from the top of the bluff/bank (this is the predominant hazard for this reach, however SCRCA should examine mapping for site specific hazard descriptions).	Erosion

REACH 32
JAMES CREEK DRAIN TO FREEMAN St. (GUSTIN GROVE)
Lambton Shores (includes Registered Plan 24)
MEASUREMENT NUMBERS 18-23
Lambton Shores Maps 10, 11

Shoreline Characteristics

beach - narrow sand and cobble beach and exposed bedrock at time of 2007 air photos

bluff - approx. 16 m bluff; well vegetated with mature trees

development - traditionally agricultural, with some residential development along top of bluff

protection works - minimal consisting of occasional groynes made of boulders cleared from nearshore lakebed

Erosion Issues

-long term recession rate is moderate at (0.36 metres/year)

Objective of Protection Works

- there is minimal shore protection in this reach, likely due to a combination of relatively low erosion rates and the cost of shore protection compared with the value of the land

Recommendations

-locate development outside hazard limits
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992), and MNR (2001a,b).

Management Area Delineation (by SCRCA)

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the slope stability allowance measured landward from the toe of the bluff	Erosion
Shoreline Area 2	-between Shoreline Area 1 and a line defined by the slope stability allowance plus 100 times the average annual recession rate (this is the predominant hazard for this reach, however SCRCA should examine mapping for site specific hazard descriptions).	Erosion

REACH 33
FREEMAN ST. TO BEACH ST. (NORTHERN LIMIT)
Lambton Shores (includes Registered Plan 24,38 and 479)
MEASUREMENT NUMBERS n/a
Lambton Shores Maps 11, 12, and 13

Shoreline Characteristics

beach - narrow sand, cobble and boulder beach at time of 2007 air photos, exposed bedrock, marsh in some areas

bluff - approx. 2 m bank; gradual slope north of Proof Line

development - residential

protection works - nearshore has been cleared of boulders for boat and swimming access
- intermittent concrete, steel sheet pile and timber retaining walls/seawalls along back of beach

Erosion Issues

-long term recession rate was indeterminate and the minimum value of 0.1 m/year was therefore used to determine setbacks

Objective of Protection Works

- there is minimal shore protection in this reach, likely due to low erosion rates

Recommendations

-locate development outside hazard limits
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992), and MNR (2001a,b).

Management Area Delineation (by SCRCA)

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the 100 year flood line plus a 15 metre wave uprush allowance (Flood Hazard)	Flood
Shoreline Area 2	-between Shoreline Area 1 and a line defined by a 30 metre erosion allowance measured from the top of the bluff/bank	Erosion

REACH 34
BEACH ST. (NORTHERN LIMIT) TO BEITH CREEK (NORTH OF FULLER RD.)
Lambton Shores (Con West of Lake Road Pt. Lot 68-69)
MEASUREMENT NUMBERS n/a
Lambton Shores Maps 14, 15 and 16
Shoreline Characteristics

beach - exposed bedrock, marsh

bluff - gradual slope

development - minimal including trailer park, agricultural

protection works - none observed

Erosion Issues

-long term recession rate was indeterminate and the minimum value of 0.1 m/year was therefore used to determine setbacks

Objective of Protection Works

- no protection observed

Recommendations

-locate development outside hazard limits
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992), and MNR (2001a,b).

Management Area Delineation (by SCRCA)

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the 100 year flood line plus a 15 metre wave uprush allowance (Flood Hazard) OR between the water's edge and a line defined by the first lakeward break in slope	Flood
Shoreline Area 2	-between Shoreline Area 1 and a line defined by a 30 metre erosion allowance measured from the top of the bluff/bank	Erosion

REACH 35
BEITH CREEK (NORTH OF FULLER RD.) TO INDIAN LANE
Lambton Shores (Con West of Lake Road Pt. Lots 63-68)
MEASUREMENT NUMBERS n/a
Lambton Shores Maps 17-20

Shoreline Characteristics

beach - exposed bedrock, marsh

bluff - gradual slope

development - minimal including marina, some residential, agricultural

protection works - none observed

Erosion Issues

-long term recession rate was indeterminate and the minimum value of 0.1 m/year was therefore used to determine setbacks

Objective of Protection Works

- no protection observed

Recommendations

-locate development outside hazard limits
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992), and MNR (2001a,b).

Management Area Delineation (by SCRCA)

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the 100 year flood line plus a 15 metre wave uprush allowance (Flood Hazard)	Flood
Shoreline Area 2	-between Shoreline Area 1 and a line defined by a 30 metre erosion allowance measured from the top of the bluff/bank	Erosion

REACH 36
CENTRE SIDEROAD TO JUNIPER LANE
Lambton Shores (includes Registered Plan 417 and 457)
MEASUREMENT NUMBERS n/a
Lambton Shores Maps 21 and 22

Shoreline Characteristics

beach - 50 to 60 m wide (based on 2007 air photos) sand beach

bluff - gradual slope, some dune development

development - residential

protection works - intermittent seawalls

Erosion Issues

-recession rates were not calculated for beaches; calculation of recession rates for dynamic beaches is complex and was beyond the scope of this study

Objective of Protection Works

- define property limit, erosion protection during high water levels

Recommendations

-locate development outside hazard limits
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992), and MNR (2001a,b).

Management Area Delineation (by SCRCA)

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the 100 year flood line plus a 15 metre wave uprush allowance(Flood Hazard), plus a distance measured 15 m horizontally	Dynamic Beach
Shoreline Area 2	-between Shoreline Area 1 and a line defined by the Flood Hazard Limit plus a 30 metre Dynamic Beach Setback	Dynamic Beach

REACH 37
JUNIPER LANE TO WEST IPPERWASH RD.
Lambton Shores (includes Registered Plan 417, 472 and 512)
MEASUREMENT NUMBERS n/a
Lambton Shores Maps 23 and 24

Shoreline Characteristics

beach - 40 to 60 m wide (based on 2007 air photos) sand beach

bluff - dune development

development - residential

protection works - none observed

Erosion Issues

-recession rates were not calculated for beaches; calculation of recession rates for dynamic beaches is complex and was beyond the scope of this study

Objective of Protection Works

- no protection observed

Recommendations

-locate development outside hazard limits
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992), and MNR (2001a,b).

Management Area Delineation (by SCRCA)

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the 100 year flood line plus a 15 metre wave uprush allowance(Flood Hazard), plus a distance measured 15 m horizontally	Dynamic Beach
Shoreline Area 2	-between Shoreline Area 1 and a line defined by the Flood Hazard Limit plus a 30 metre Dynamic Beach Setback	Dynamic Beach

REACH 38
WEST IPPERWASH RD. TO ARMY CAMP RD.
Lambton Shores (includes Registered Plan 530, 433 and 402)
MEASUREMENT NUMBERS n/a
Lambton Shores Maps 24-30

Shoreline Characteristics

beach - 60 m wide (based on 2007 air photos) sand beach

bluff - well developed dune

development - residential development on dune

protection works - none observed

Erosion Issues

-recession rates were not calculated for beaches; calculation of recession rates for dynamic beaches is complex and was beyond the scope of this study

Objective of Protection Works

- no protection observed

Recommendations

-locate development outside hazard limits
-for more detailed information and guidance, refer to the supporting document entitled Design Considerations for Shore Protection Structures (Baird,1992), and MNR (2001a,b).

Management Area Delineation (by SCRCA)

Shoreline Area	**Descriptions**	**Applicable Column in Shoreline Development Guidelines**
Shoreline Area 1	-between the water's edge and a line defined by the 100 year flood line plus a 15 metre wave uprush allowance(Flood Hazard), plus a distance measured 15 m horizontally	Dynamic Beach
Shoreline Area 2	-between Shoreline Area 1 and a line defined by the Flood Hazard Limit plus a 30 metre Dynamic Beach Setback	Dynamic Beach

APPENDIX C

PUBLIC OPEN HOUSE AND STAKEHOLDER COMMENTS

Comments and Responses from the Public Open Houses held on July 21 and 22, 2010
St. Clair Region Conservation Authority
Lake Huron Shoreline Management Plan Update 2010

Comment	Response
Shore Protection	
Are the groynes between Kettle Point and Blue Point decreasing sand supply at Blue Point?	The groynes updrift of Blue Point were not constructed recently and would therefore be filled and bypassing by now. A wide stable beach is not a natural feature of the Blue Point shoreline.
Groynes – please explain. "Downdrift erosion can be a problem" – does this mean only one side of groyne collects?	Generally sand accumulates on the updrift side of groynes (based on the net direction of sediment transport).
Do you recommend a certain height for trees at top of bluff to reduce weight on the top?	This should be looked at on a site specific basis as it is dependent on the type o tree and its root system. In general, trees are a positive feature in stabilizing the shoreline.
What would be the optimum number of properties to go together in a community effort of erosion control?	Although shore protection may be used to protect properties where setbacks are not an option, hardening of the shoreline reduces the natural supply of sediment to downdrift shorelines. Where shore protection is considered, cooperation between property owners can be advantageous as it may reduce the risk of flanking. This must be looked at on a site specific basis.
Can the property owners at the ends of the community effort block the erosion control efforts of the community?	The permitting process requires consideration of downdrift impacts and there is opportunity for adjacent property owners to voice concerns.
Site Specific	
Question regarding property at Cedar Point Line. Drawing provided. Early spring the subdivision has water flooding conditions. • Residents have cut off the drainage culverts under their driveway • Surface water is recurring problem. Cottages – mostly seasonal sit on the top of a high bluff on Lake Huron. Small lots are a concern may be re: the drainage beds of the septic systems.	Surface water drainage is outside project scope.
Cedar Point Subdivision – map provided • Concern with ravine erosion • Concern with flooding in early spring	Ravine erosion is natural process. SCRCA has established setbacks to direct development outside of high risk areas.

Comment	Response
	Flooding in spring is likely due to drainage, freshets. This is outside the project scope.
Sunset Acres – concern that movable housing may be permitted on lakeside lots in Bluepoint.	After due consideration, Plympton Wyoming council did not approve moveable housing as proposed.
Will SCRCA make construction of groynes and seawalls a condition of granting building permits on lakeside lots in Sunset Acres. This would go a long way toward protecting the shoreline and make natural hazard management less onerous.	The Shoreline Management Plan encourages development to be limited to areas outside the natural hazard limits. The PPS (2005) allows for development within the hazard lands where risks to safety are minor and can be managed as outlined in Section 6 of the Shoreline Management Plan.
Blue Point – Request updated calculation of the erosion rates at Blue Point. I have a vested interest in this matter as I own property and live in Blue Point. Therefore I would appreciate the appropriate authorities practicing due diligence and revising the designation for this area to better reflect the facts.	The erosion rates at Blue Point were most recently re-calculated in 2011 via this SMP update. Methodologies consistent with the Technical Guide have been used to establish hazard limits.
Blue Point Lots 5-41 • Recession rates not accurate. Some years very low. Erosion is over exaggerated. • Opinion that nearshore is eroding and exposing gravel and cobble which protects Blue Pt. • Opinion that drainage and other various works have been carried out which are lowering erosion and stabilizing bank. • Concern with how the shoreline is divided into reaches and the AARR is calculated for entire reaches. Need to look at specific locations. • Field stone vs. armourstone for shore protection?	• The methodologies used to calculate the AARR are consistent with the Technical Guide, which requires a minimum 35 year time span to establish long term recession rates. • See above comment. We are required to use AARRs established over a minimum 35 year time span. If there is a gravel lag deposit protecting shorelines, this will be reflected in the AARRs over time. • The AARR is to be established in the absence of protection works as per the Technical Guide. • The shoreline has been divided into reaches for the purposes of calculating AARRs, based on shoreline characteristics. If the individual property owner wishes to undertake a detailed coastal engineering assessment of their specific site using accepted engineering methods, they may do so. • The design of shore protection must be undertaken by a qualified coastal engineer as stated in the Technical Guide and the Shoreline Management Plan. The coastal engineer will determine the stone size required to withstand wave and ice forces at specific sites.

Comment	Response
Environment	
Main concern is pollution from farms – concern with more hog farms to come in area.	Water quality and environmental issues are outside the scope of this project.
Loss of lake creatures – crayfish, minnows and increase of gobi and zebra mussels.	Outside project scope.
Windfarms won't add to beauty of the area.	Outside project scope.
Water quality concern with respect to septic and agriculture.	Outside project scope.
Dumping of black mud in water. Is it a health hazard to people? Do you know when a lab report can be obtained re: consistency of this material?	Outside project scope.
Wondering about the black mud on Ipperwash Beach. I want to know the source and would like to be involved in remedial actions to solve problem.	Outside project scope. Direct contact will be made with the commenter, provided contact information was provided.
Who is the correct contact for environmental concerns? What is the interface between SCRCA and the Ministry of the Environment?	The Ministry of the Environment (MOE) is responsible for water quality. The SCRCA , from time to time, has been involved in partnership with MOE on water quality studies.
Driving of motor vehicles in lake to launch boats. What effect does this have on water?	Vehicular access to the lake is outside the project scope.
Is there any plan in place to address cladophora and who could we contact regarding this?	The SCRCA is not aware of a plan. Direct contact will be made with the commenter, provided contact information was provided.
Concern phragmites running rampant along the shoreline, and how are property owners to deal with this.	This is outside the scope of this project. Direct contact will be made with the commenter, provided contact information was provided.
Other	
Lake levels – no issue – prefer current low levels.	Lake levels are largely controlled by precipitation and evaporation. Variations in water level are natural.
Control of buildings on the shoreline – not on property	Hazard lands are defined in the Provincial Policy and are addressed in this study.
Reduction of lot sizes is rumoured for our area – need to maintain current standard of 100 ft.	Outside project scope. Speak to municipality.
Information Request	
Require plans and maps as it affects this property.	To be provided online and in SMP.
Could you please provide us with a draft map of our area. Could we also get information on boundary of our property versus Ministry if you have this info.	To be provided online and in SMP. Not sure about mapping with property boundary.

Comment	Response
Didn't expect much – didn't get much.	
Who is the correct contact to report obvious abuse to shoreline? When an obvious infraction of the regulations occurs, how does the SCRCA respond? Is it only to a formal complaint or would the Authority demand correction of an infraction seen by an SCRCA officer?	SCRCA Regulations Officer. SCRCA carries out a site inspection and investigates. Violation may be issued and if not remedied, charge may be laid. SCRCA Officer will respond to all complaints but an investigation and follow up will determine actions. Legal action must be approved by the SCRCA Board of Directors.

A number of enquiries were made regarding specific properties and SCRCA has responded to them individually.

Comments and Responses from municipal staff April 2012

Comment	Response
Provincial Policy adherence	
prefer the SMP clearly state up front, as per Provincial Policy Statement (PPS), that development will generally be directed to areas outside Great Lakes hazards	Agree. Will reword. Done – bullet added.
PPS states no development/site alteration in a dynamic beach hazard, however, CA is (without engineering) recommending beach processes end at building line for a section in Sarnia (Reach 5). Should this be special policy area needing special approval from MMAH and MNR	CA staff have followed engineers direction but there has not been a specific engineering analysis. Will look into similar approach elsewhere ie. NVCA and report back. SPA approach typically utilized in riverine floodplain; will investigate. Update: Engineering analysis undertaken. SPA not needed as analysis determined beach not dynamic past the minimum 34 m from the 100 year flood level for Reach 5. Based on consultation and approval, incorporate findings into next SMP update.

Specific technical question re engineering and standards	
questions the distribution of Rannoch vs St Joseph till in Lambton. What is it based on?	relying on coastal engineering expertise in respect to professionally accepted geological information. Checked with CA source protection geologist (P. Geo.) and did not dispute current knowledge and info in report.
Wave uprush – questions the recommendation for 2% uprush ht with one standard deviation under a site specific study	SCRCA utilizes a 15 m wave uprush allowance which is reasonable considering the protection and angle of exposure to direct wave attack on L. Huron. The coastal engineer's recommendation re: 2% , is professional engineering standard. Baird quotes reputable resources.
Minimum erosion rate of 0.1 m/yr utilized in Table 4.2, however, values are lower in Table	Agree, needs clarification. Default minimum erosion rate of 0.1 m/yr utilized only where historic information not available (ie Lambton Shores) Will clarify at the bottom of the chart. Done.
Many average annual recession rate's (aarr's) increased substantially, although still in the low category. Is this due to erosion since 1993 (question this?) or standards in delineating top of bank	No, it is not due to delineating top of bank. Due to coastal engineer interpretation of Technical guide; stating that aarr's are not to be dependent on protection and that is why standard deviation is incorporated. Background Incorporating one standard deviation accepted coastal aarr calculation practice for reaches (Reference: Scientific published paper: "Spatial and Temporal Considerations for Calculating Shoreline Change.Rates in the Great Lakes Basin, Zuzek et al. W.F Baird & Assoc. and US Army Corps of Engineers, 2003, Journal of Coastal Research) Published paper was Appendix A of SCRCA Board of Directors accepted 2010 SMP proposal by Baird & Associates. An average recession rate with out standard deviation for a reach means half of the rates are more than calculated. This is non-conservative and does not account for uncertainty in the analysis. Ambient recession rates difficult to measure due to protection that is in place. Protection has a design life. 40 years max. according to Technical guide. Standard deviation accounts for uncertainty.

Section 5.2.2.4 discusses relief from the hazard if shoreline property not owned; seems to present an inconsistency because other reasons ie. Can't get community to co-operate, costs too expensive, etc.	Believe that this pertains to inland lots where road has been protected to max engineered limit; incl infrastructure. Will clarify with Baird and clarify in text. Action: Sentence omitted.

Specific questions re text/content	
Diagrams include 100 year erosion allowance; is this applicable? Can it be removed?	Diagrams are copies from the PPS Technical guide. Update: Although SCRCA is not adding an erosion allowance (has not been calculated) due to the use of the default 45 m value; see SMP explanation Section 4.4.1 on retaining this requirement. Basically, needed should more intensive dynamic beach study undertaken. Erosion needs to be addressed.
Can diagrams be included for every scenario in municipalities?	No, diagrams for specific municipalities should be included in their Official Plans.
Management Areas are not included in PPS Technical guide, but can diagrams in SMP text include Areas.	Management Areas are Included in Reach descriptions (Appendix B) . Not included in diagrams as Management Areas are not included in PPS Technical Guide. Due to existing development along the shoreline, the SCRCA (along with ABCA etc.) utilize Mgt Areas for implementation purposes.
Mapping of ravines; wants more explanation of how they were mapped	Shoreline hazard mapped first and then MNR Tech guide for inland erosion/flood hazard on ravines mapped. Limit determined where lines meet. SMP is based on Lake Huron hazards .
More background needed on Table 6.1 as this Table is much more detailed.	Agree. Will include more info in text Section 5.4.2 on purpose of Table, based on other CA's guides and MNR Appendix A7.2 "Existing Development within Hazardous Lands" Done. See Section 5.4.2.

2011 and 2012 Stakeholder Consultation

Comment	Response
Jurisdiction	
Can the SCRCA Regulate the grading and removal of sand (grooming) on the beach in West Ipperwash (Centre Sideroad to West Ipperwash Road)?	The Conservation Authority's Regulation objective is to protect the dynamic beach system in order to provent risk to flooding and erosion to properties during high lake level periods. Cleaning debris and organic material from the beach does not impact coastal process, however, the large scale removal of sand can negatively impact coastal processes. The accumulation of sand material provide a first line of protection to beach properties during higher lake levels and storm events. The Authority investigated the jurisdictional question and determined via a Supreme Court decision, First Nations have "rights of use" on the beach in this area. As there was significant interest in this issue, the Board of Directors passed the following motion on Sept 20, 2012. Motion BD-12-125 *"That the Board of Directors acknowledges the discussion paper on SCRCA jurisdiction on West Ipperwash Beach area dated Sept 7, 2012 and further concurs that their understanding, at this time, is that the St. Clair Region Conservation Authority does not have regulatory jurisdiction over First nations activity described under Section 28 of the Conservation Authorities Act*." The SCRCA has expressed interest in participation on future FN/municipal liaison committees to discuss Best Management Practices. Written interest as directed by the Board of Directors was provided in March 2013.

Site specific	
For the dwellings in the high hazard (Shoreline Area 1/flood), if there was a fire, could the dwelling be replaced?	Yes, rebuild on the existing footprint with same density and purpose; result of a non-flooding and/or non erosion disaster. Protect to greatest extent possible.
In the high hazard (Shoreline Area 1/flood) is a second storey considered a major addition?	Yes. In many cases, the foundation/footings also need repair/rebuild to be structurally sound.
If SCRCA staff do not recommend an addition in Shoreline Area 1, can this decision be appealed?	Yes, this can be appealed to the Board of Directors (hearing) and if denied by BoD, BoD decision can be appealed to Mining and Lands Commissioner of Ontario.
Does SCRCA Regulation 171/06 contain Water Quality objectives via legislation which would assist with beach water quality?	No.
Concern with development restrictions in Shoreline Area 1 in West Ipperwash, as many cottages/dwellings situated within Area 1. A reasonable approach needed.	Agree, that site specific analysis required here. Encroachment into the floodzone and beach area historically occurred. Within floodzone; development is prohibited; unless coastal engineering proves otherwise. In respect to the dynamic beach limit, the extent of beach processes impacted site by site needs to be reviewed. Current guidelines are reflective of this management approach. SCRCA will pursue further study and detailed guidelines as opportunities arise.