



NIAGARA PENINSULA  
**CONSERVATION**  
AUTHORITY

**50**  
years

CELEBRATING  
50 YEARS OF  
CONSERVATION

# **LAKE ERIE NORTH SHORE WATERSHED PLAN**

***NOVEMBER 2010***

NIAGARA PENINSULA CONSERVATION AUTHORITY  
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## Executive Summary

The Lake Erie North Shore study area is a unique and diverse watershed. The study area contains nearly 70 kilometres of Lake Erie shoreline consisting of a series of bays, sandy beaches and dune complexes. The area is home to 29 federally listed Species at Risk by the *Committee on the Status of Endangered Wildlife in Canada*; including the threatened Fowlers toad in which Lake Erie is its only known habitat in Canada. The Onondaga Escarpment runs parallel to the shoreline and is the youngest geological feature in Niagara. The study area is also home to 6 Areas of Natural and Scientific Interest, 4 old growth forests and numerous wooded areas and wetlands.



The Lake Erie North Shore watershed falls within the City of Port Colborne, Township of Wainfleet and small portions of the Town of Fort Erie and Haldimand County. Numerous subwatersheds form the Lake Erie North Shore watershed; these include Bay Beach Area Drain, Point Abino Drain, Bearss Drain, Beaver Dam Creek (P.C.), Oil Mill Creek, Wignell Drain, Welland Canal South, Eagle Marsh Drain, Wainfleet Marsh, Casey Drain, Hoover Drain, Low Banks Drain, and

Lake Erie 2, 3, 4, 5, 6, 7, and 8. Individual restoration strategies have been prepared for each of the main subwatersheds to protect the unique characteristics of each system.

Landuse in the Lake Erie North Shore watershed is characterized primarily by agriculture with a focus on poultry and egg production and grain and oilseed. One major concentration of urban land uses (residential, commercial, industrial) is within the City of Port Colborne; smaller concentrations of residential land uses are present in Crystal Beach of Fort Erie and in strips and nodes along the lakeshore for the extent of the study area. Numerous recreational opportunities are abound throughout the watershed, including 5 Conservation Areas, golf courses, hiking and biking trails, and numerous beach-related activities can be enjoyed such as swimming, fishing and boating.

Upland forest habitat covers 20 percent of the watershed, wetland habitat another 16 percent and approximately 64 percent of the watercourses have some riparian habitat. Guidelines set by Environment Canada (2004) suggest minimum upland forest cover in a watershed should be 30 percent, wetlands 10 percent or to historic value, and at least 75 percent of the watercourses in the watershed should have riparian habitat with a 10 meter buffer on both sides being ideal. Therefore, measures to create new upland areas and establish riparian habitat, as well as protect existing upland and wetland areas are recommended to ensure adequate upland, wetland and riparian habitat to sustain minimum viable wildlife populations and maintain ecosystem functions and attributes.

As mentioned, 29 *Species at Risk* as designated by the Committee on the Status of Endangered Wildlife in Canada fall within the study area boundaries. Twelve of these



species are *endangered*, meaning that they are facing imminent extinction or extirpation in Canada; 10 of these species are *threatened* species, which means they are at risk of becoming endangered in Ontario; and 7 of the species are of *special concern* which simply means that they have characteristics that make them sensitive to human activities or natural events. In addition, there are 27 provincially rare flora and fauna found within the Lake Erie North Shore study area.

The unique environmental character of the subwatersheds has resulted in an assortment of issues related to water resources, fish and aquatic habitat, natural heritage resources, urban development, and communication. The watershed issues, which were derived from extensive public input and past studies, were used to form a set of watershed objectives that guided the development of subwatershed restoration strategies and an implementation plan.

The recommended management actions outlined include riparian, wetland and upland restoration and creation to enhance water quality, fish habitat, and wildlife habitat enhancement. The sites were derived from detailed restoration suitability mapping in conjunction with Regional Niagara's Core Natural Heritage Mapping and Carolinian Cores 'Big Picture' mapping. In addition, project opportunities were identified on private and public lands, such as erosion control, and shading to reduce water temperatures in the headwaters through the NPCA Geomorphic Assessment.

The recommended management actions also propose specific policy tools including municipal and regional official plan amendments; outreach and communication for various aspects of water resources management; and research and monitoring programs to obtain additional data from which the Lake Erie North Shore Watershed study area.

The implementation plan identifies responsible stakeholders for each recommended management action as well as a detailed breakdown of each watershed plan objective, recommended action and associated funding (existing and required) and time frame of implementation (e.g. long term, short term) has also been provided.

## Acknowledgments

The Niagara Peninsula Conservation Authority would like to extend our sincere gratification to everyone that had an active role in the creation of the Lake Erie North Shore Watershed Plan.

To the members of the public that attended the public open houses and workshops; your participation in these events and your input to the Watershed Plan has assisted the Conservation Authority in gaining a more intimate understanding of the study area and helped us to identify issues that we may not have been previously aware of.

A special thank-you also goes to the members of the Lake Erie North Shore Steering Committee for your commitment and dedication to the creation of the Lake Erie North Shore Watershed Plan. Your hard work and dedication to the project has resulted in the creation of a valuable and useful document to be used as a resource for watershed managers and stakeholders that will aid in future planning decisions.

The Conservation Authority believes that stakeholder involvement in projects such as these are extremely important and we want you to know that the time you committed to the project is greatly appreciated.

Sincerely,



Tara Metzger  
Watershed Planning Specialist

### Lake Erie North Shore Steering Committee

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**Appendix B:** Best Management Practices

**Appendix C:** Examples of key Ontario ecological, infrastructure, and social values likely to be affected by climate change

**Appendix D:** Summary of Legislation Governing Management in Ontario

**Appendix E:** NPCA Lake Erie North Shore Watershed Geomorphic Summary

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**Appendix H:** Restoration Suitability Criteria and Weighting Scheme

**Appendix I:** Mitigation Measures for Drain Maintenance

## Introduction

The Regional Municipality of Niagara (RMN), Niagara Peninsula Conservation Authority (NPCA) and the Ministry of the Environment (MOE) formed a partnership to develop the foundation of a comprehensive water protection strategy for Niagara's watersheds. The result of this partnership was the *Niagara Water Quality Protection Strategy* (RMN 2003), now known as the *Niagara Water Strategy (NWS)* (2006a). The NWS is a multi-jurisdictional strategy based on 32 Local Management Areas (LMAs) with the intent of guiding respective stakeholders on best management and protection strategies for Niagara's water-dependant resources. The strategy has identified the need to manage Niagara's watersheds in such a manner as to "*sustain healthy rural and urban communities in harmony with a natural environment, and rich in species diversity*". In 2005, the Regional Council of Niagara adopted new environmental policies for the Niagara planning area. These policies call for an integrated ecosystem approach to planning that includes the involvement of all respective stakeholders. An aspect of the framework for the environmental planning process under these policies is the preparation of watershed studies for Niagara's major watersheds. Likewise, in Haldimand County's Strategic Directions (2004) the County recognizes that "*Environmental considerations require strategic input in terms of land use, management and protection*".

### Watershed Planning and the Lake Erie North Shore Watershed

A watershed, also referred to as a catchment basin, is an area of land from which surface runoff (water, sediments, nutrients and contaminants) drain into a common water body (e.g., Beaver Dam Creek, Oil Mill Creek and Point Abino Drain). Watersheds include all water and water-dependent features such as wetlands, forests, urban areas, and agriculture (Pollution Probe 2004).

A watershed management plan is a proactive document created cooperatively by government agencies and the community to manage the water, land/water interactions, aquatic life and aquatic resources within a particular watershed to protect the health of the ecosystem as land uses change (Ontario Ministry of Environment and Energy and Ontario Ministry of Natural Resources 1993). The Lake Erie North Shore Watershed Plan provides a systematic strategy to guide development, identify and recommend alternative and preferred restoration programs, and strengthen stewardship and partnerships in the watershed. Completed in 2 phases, the Watershed Plan consists of:

- background data collection in the form of a watershed characterization;
- a summary of the key issues in the watershed;
- completion of any additional studies to fill in data gaps in the study area;
- identification and suitability of restoration sites, landowner incentive programs, and land acquisition based on key issues in the watershed; and
- creation of an implementation plan including a monitoring component.

Completed over a 36 month period, the watershed planning process follows several steps including numerous opportunities for public involvement through open houses, workshops, commenting, and an agricultural land use survey (Figure 2). The Phase 1 watershed characterization contains a detailed background report including a description of the watershed's physiography, soils, land use, ecological, cultural and natural heritage, as well as a description of surface and groundwater resources. Phase 2 of the

watershed planning process provides a set of watershed objectives that are linked to a comprehensive list of watershed issues derived from the NWS (RMN 2006a), and public events. Issues specific to agriculture were gathered through the *Land Management Issues and Agricultural Best Management Practices* survey (NPCA 2006a) (Appendix A), which was distributed to Ontario Federation of Agriculture members through a partnership with the Niagara Peninsula Conservation Authority. Any issues derived from these documents and public venues form the foundation of the watershed strategy and subsequent action plan, which are the focus of Phase 2 of the watershed planning process.

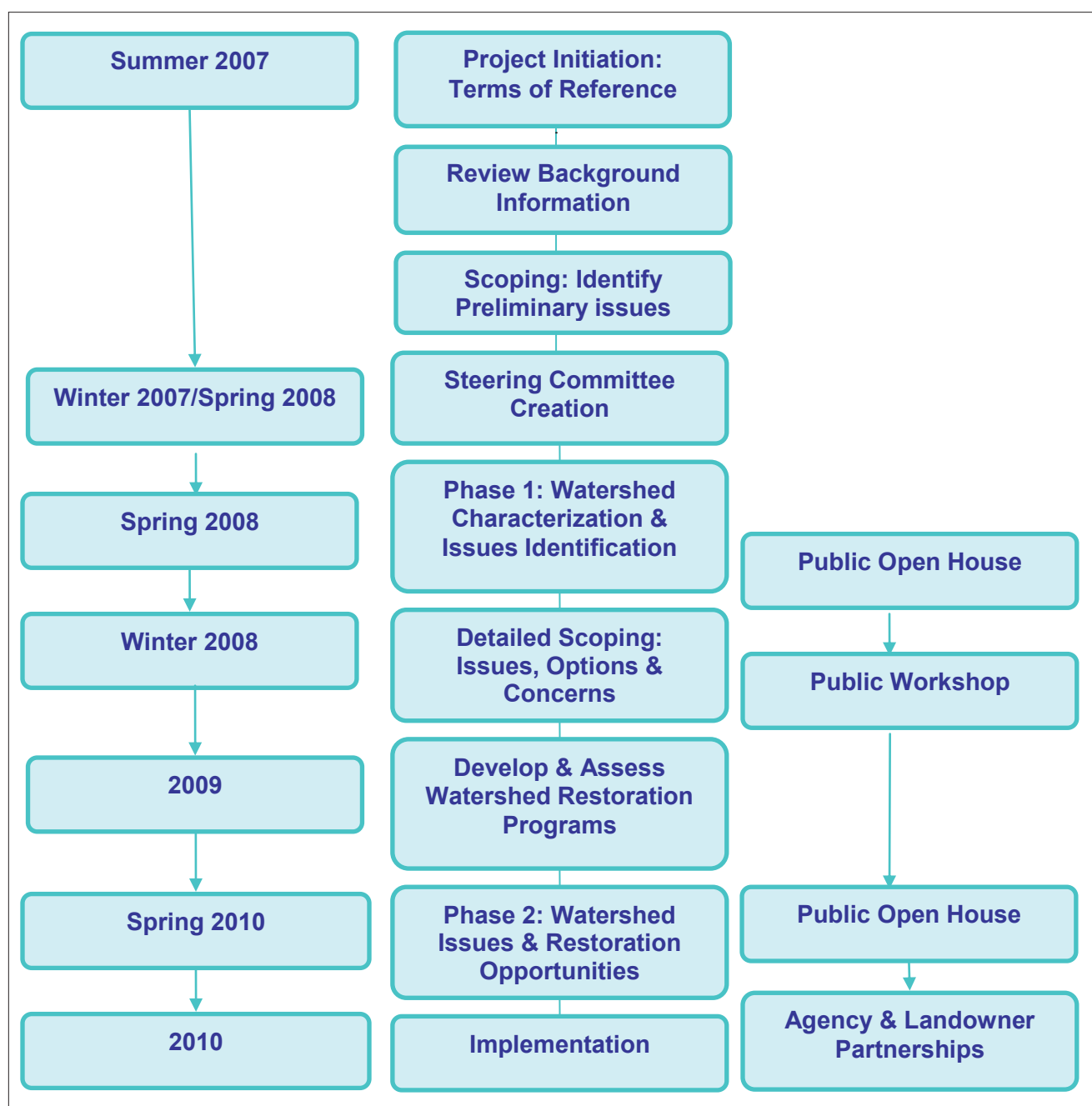
The Lake Erie North Shore study area is a unique and diverse watershed. The study area contains nearly 70 kilometres of Lake Erie shoreline consisting of a series of bays, sandy beaches and dune complexes. The area contains 29 federally listed Species at Risk by the *Committee on the Status of Endangered Wildlife in Canada*; including the threatened Fowler's toad in which Lake Erie is its only known habitat in Canada. The Onondaga Escarpment runs parallel to the shoreline and is the youngest geological feature in Niagara. The study area is also home to 5 Areas of Natural and Scientific Interest, 4 old growth forests and numerous wooded areas and wetlands.

Aside from the industrial area surrounding the Welland Canal, land use in the study area is primarily agriculture focusing on poultry grain and oilseed production. Numerous recreational opportunities are abound throughout the watershed, including 5 Conservation Areas, golf courses, hiking and biking trails, and numerous beach-related activities can be enjoyed such as swimming, fishing and boating.

A watershed management plan for the Lake Erie North Shore watershed will aid in protecting and enhancing these distinctive resources in the watershed.



Figure 1: Geographic Location



**Figure 2: Watershed Planning Framework**

## Watershed Vision

Under the Conservation Authorities Act (R.S.O. 1990, c.C27), the mandate of the Niagara Peninsula Conservation Authority is to establish and undertake programs designed to further the conservation, restoration, development and management of natural resources. In keeping with the mandate of the NPCA, NWS (RMN 2006a), and the watershed challenges and issues, residents of the Lake Erie North Shore watershed envision the following:

*The Lake Erie North Shore watershed will support a balanced ecosystem with healthy watercourses, beaches, agricultural lands and natural areas while sustaining the needs*

*of the community and providing habitat for a diversity of flora and fauna. The Lake Erie North Shore watershed will also support a quality of life and economic vitality that are fostered by a balance of sustainability and compatibility of surrounding land uses and the natural environment.*

## **Watershed Objectives**

Each watershed in the Niagara Peninsula Conservation Authority's jurisdiction is unique, having its own set of watershed planning objectives. The watershed objectives for the Lake Erie North Shore watershed have been categorized based on the watershed's resource components, including the social and built environment. In accordance with the *Provincial Policy Statement* [Ontario Ministry of Municipal Affairs (MMAH) 2005], *Growth Plan for the Greater Golden Horseshoe* [Ontario Ministry of Public Infrastructure Renewal (MPIR) 2006], *Regional Policy Plan* (RMN 2007a), *Haldimand County Strategic Directions* (2004) and public input, natural resources will be managed on a watershed scale in the Lake Erie North Shore watershed to:

### *Water Resources*

- improve, enhance, maintain or protect water quality and/or natural stream processes to support human uses and ecological functions in accordance with Provincial Water Quality Objectives;
- find an ecologically compatible balance between drain maintenance and function;
- ensure storm water management practices minimize storm water volumes and contaminant loads;
- recognize the role of natural features and pervious features in minimizing the impacts of flooding ;
- support healthy beaches for passive recreation;
- manage and mitigate flooding risks to human life and property within acceptable limits; and
- minimize erosion caused by human activity through the establishment and implementation of a comprehensive, priority based erosion control program



### *Fish and Aquatic Habitat*

- protect, enhance and restore populations of native species and their habitats;
- Research and recommend management plans for invasive species (flora and fauna); and
- incorporate management plans for Species at Risk into restoration

### *Natural Heritage and Resources*

- protect, enhance and restore the health, diversity and integrity of the natural heritage systems in the watershed;
- create, maintain, protect and enhance corridors and linkages to natural heritage systems in adjoining watersheds;

- maintain, restore and improve the linkages among surface water features, groundwater features, hydrologic functions, natural heritage features and areas, and their ecological functions;
- recognize the role of natural features in minimizing the impacts of flooding; and
- include management plans for Species at Risk into restoration

### *Communication, Education and Recreation*

- enhance and develop partnerships between and amongst agencies, interest groups and landowners;
- promote the wise use of groundwater and surface water resources in terms of human, agricultural and ecological needs; and
- foster educational programs and awareness pertaining to urban and rural best management practices (e.g. water conservation practices, alternate farming practices, septic maintenance, buffers) Development
- incorporate natural heritage into land use and zoning decisions;
- promote environmentally-sound land use decisions for current and future urban development and rural/agricultural land use;
- encourage stormwater management within municipalities to address future growth capacity projections; and
- encourage intensification of urban areas



## **Watershed Characterization**

### **Location and General Description of the Lake Erie North Shore Watershed**

The Lake Erie North Shore study area encompasses approximately 120 square kilometres of land and includes nearly 70 kilometres of shoreline and 100 kilometres of watercourse of which over 60 percent has been classified as municipal drains. The study area includes Local Management Areas 3.1, 3.2, 3.3 and a small portion of 2.9 as identified in the NWS (RMN 2006a), which falls within the City of Port Colborne, Township of Wainfleet and small portions of the Town of Fort Erie and Haldimand County (Figure 3). Numerous subwatersheds form the Lake Erie North Shore watershed; these include Bay Beach Area Drain, Point Abino Drain, Bearss Drain, Beaver Dam Creek (P.C.), Oil Mill Creek, Wignell Drain, Welland Canal South, Eagle Marsh Drain, Wainfleet Marsh, Casey Drain, Hoover Drain, Low Banks Drain, and Lake Erie 2, 3, 4, 5, 6, 7, and 8 (Figure 1). One major concentration of urban land uses (residential, commercial, industrial) is within the City of Port Colborne; smaller concentrations of residential land uses are present in Crystal Beach of Fort Erie and in strips and nodes along the lakeshore of Lake Erie for the extent of the study area.

### Local Management Area 3.1

Local Management Area 3.1 extends along the shoreline from Low Banks in Haldimand County to Rock Island Point in Wainfleet and includes the subwatersheds Low Banks



Drain, Hoover Drain and Lake Erie 8 (Figure 3). The watercourses in this portion of the study area have not been evaluated in terms of importance for fish habitat. Apart from a couple small tributaries of Hoover Drain all watercourses in this portion of the study area are designated municipal drains.

The topography is very flat behind the bedrock outcrop that marks Mohawk Point on the western edge of the Lake Erie North Shore watershed. The land use in this area is comprised

predominantly of agriculture and rural residential with some strip and small node dwellings of seasonal and permanent residences along the shoreline. Natural heritage features include numerous wetlands and woodlots including Moulton West provincially significant wetland and Bunz Bush, a remnant natural area.

### Local Management Area 2.9

The small portion of Local Management Area 2.9 that is included in the Lake Erie North Shore study area is nestled between LMA 3.1 and LMA 3.2 (Figure 3). It extends along the shoreline from Rock Island to Grabell Point in Wainfleet and includes Lake Erie 6 and Lake Erie 7 subwatersheds. The watercourses in this portion of the study area have not been evaluated in terms of importance for fish habitat.

Aside from the subtle rock headland that marks Grabell Point, the topography is relatively flat in this portion of the study area. Land use is primarily residential along the shoreline made up of seasonal and permanent dwellings, and agriculture northward from Lake Erie. Natural heritage features in this portion of the study area include numerous wetlands and woodlots including Harold Mitchell Nature Reserve, Emerson Road Woodlot and Long Beach Conservation Area.

### Local Management Area 3.2

Local Management Area 3.2 extends from Grabell Point in Wainfleet, eastward to the eastern side of the Welland Canal at Nickel Beach in Port Colborne (Figure 3). Subwatersheds included in this portion of the study area are Casey Drain, Wainfleet Marsh, Eagle Marsh Drain, Welland Canal South and Lake Erie 2, 3, 4, and 5. Casey Drain, Eagle Marsh Drain, Lake Erie 3 and a portion of the Welland Canal (old route) have all been identified as important fish habitat. A portion of Eagle Marsh Drain has been designated as critical fish habitat and the Welland Canal has been designated as marginal fish habitat; the remaining watercourses in this area have not been evaluated in

terms of importance for fish habitat. Municipal drains in this area include Casey Drain, Eagle Marsh Drain, Bessey Branch Drain which is a tributary of Eagle Marsh Drain, and Central Park Drain.

The Onondaga Escarpment and the Welland Canal are the most prominent features in the study area. The Onondaga Escarpment, while being partially buried, makes a few appearances throughout the Lake Erie North Shore watershed. Behind the escarpment the landscape is very flat and poorly drained. The Welland Canal stretches across the Niagara Peninsula from Lake Ontario at Port Weller to Lake Erie at Port Colborne; essentially bisecting the peninsula. Land use in this portion of the study area is comprised of industrial and urban development in Port Colborne around the Welland Canal, and agriculture and rural residential outside of the Port Colborne built-up area.

This portion of the study area includes several quarries; active and abandoned. Two large active quarries include Law Quarry that straddles the border of LMA 3.2 and 2.7 (outside of the study area), and Port Colborne Quarries Ltd which straddles the border of LMA 3.2 and 3.3. Abandoned quarries include Cement Plant Road Quarry and Wainfleet Wetlands Conservation Area. In addition, a proposal for a new quarry has been approved by the Ontario Municipal Board for the undeveloped land between Wainfleet Wetlands and Law Quarry.

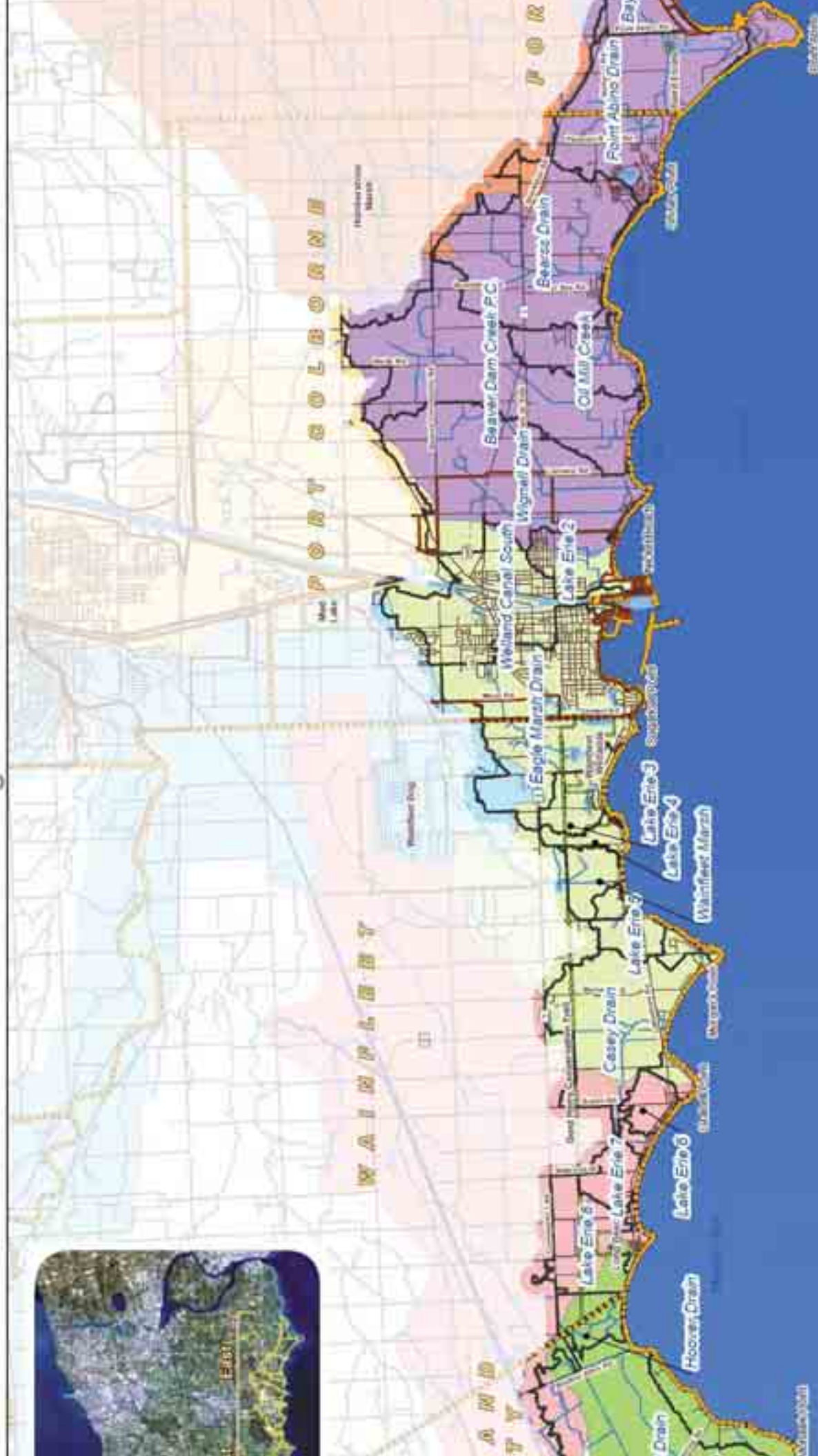
Natural heritage features include provincially significant Life Science Area of Natural and Scientific Interest (ANSI) Port Colborne Quarry and candidate ANSI Onondaga Formation, old growth forests Sugar Loaf Hill and Morgan's Point, and provincially significant wetlands Cement Plant Road Quarry, Wainfleet Wetlands, Nickel Beach Marsh and Woodlot, and Burnaby Wainfleet Airport Wetland. In addition, numerous wooded areas are scattered throughout the study area.

### **Local Management Area 3.3**

Local Management Area 3.3 extends from the eastern side of the Welland Canal at Nickel Beach in Port Colborne to the eastern side of Crystal Beach in Fort Erie; the eastern extent of the Lake Erie North Shore watershed study area (Figure 3). Subwatersheds in this portion of the study area include Wignell Drain, Beaver Dam Creek P.C., Oil Mill Creek, Bearss Drain, Point Abino Drain and Bay Beach Area Drain. Wignell Drain and most of Bearss Drain and Point Abino Drain have been identified as important fish habitat. In addition, a portion of Point Abino Drain and the shoreline area at Nickel Beach, Shisler Point and Crystal Beach have been designated as critical fish spawning habitat; the remaining watercourses in this area have not been evaluated in terms of importance for fish habitat. Aside from a couple of small tributaries, all of the watercourses in this portion of the study area are designated municipal drains.

Apart from the Onondaga Escarpment which hugs the northern boundary of the study area, the topography is relatively flat. Bedrock juts out along the shoreline marking headlands for the bays that are nestled in between the points. The land use in this area is comprised of a small urban area in Crystal Beach and a mix of agriculture and rural residential with some strip and small node dwellings of seasonal and permanent residences along the shoreline. This portion of the study area also includes active and abandoned quarries. The remaining portion of Port Colborne Quarries Ltd, which straddles the border of LMA 3.2 and 3.3, is located in this area as well as Eberly Trucking Ltd; a sand pit located on the western side of Point Abino. In addition,

# Lake Erie North Shore Watershed Local Management Areas



- Legend**
- Roads
  - ~ Watercourses
  - Waterbodies
  - Subwatershed Boundary
  - Conservation Areas
  - Municipal Boundary
  - Urban Area Boundaries



Map prepared by: [Name], [Date], [Organization]

Sherkston Shores Resort, a closed quarry that has been converted to a recreational swimming area, is located in this area.

Natural heritage features include 3 provincially significant Life Science ANSIs: Humberstone Muck Basin Swamp Forest, Empire Beach Backshore Forest Basin and Point Abino Peninsula Sandland Forest; old growth forests Philips Sugar Bush Grove and Marcy's Woods; and provincially significant wetlands Humberstone Marsh and Point Abino Wetland Complex. In addition, numerous wooded areas are scattered throughout the study area.

## Lake Erie

Approximately 70 kilometres of Lake Erie shoreline extends through the Lake Erie North Shore watershed study area; stretching from Low Banks in Haldimand County to Crystal Beach in Fort Erie.

Lake Erie is the shallowest and smallest in volume and has the shortest retention time of all the Great Lakes. It warms quickly during the warmer summer months and typically freezes over during the winter months. The shallowness of the basin and the warmer temperatures make it the most biologically productive of the Great Lakes. Eighty percent of Lake Erie's total inflow of water comes through the Detroit River. Eleven percent is from precipitation (rain and snow) and the remaining nine percent comes from the other tributaries. Lake Erie provides drinking water for approximately 11 million of the approximate 11.6 million people that live in its watershed (Lake Erie LaMP 1999).

According to Dolan (1993), Lake Erie is exposed to greater stress due to urbanization and agricultural practices than any of the other Great Lakes. The lake receives chemically enriched runoff and sediment from agricultural lands within the basin. As well, it surpasses all other Great Lakes in the amount of effluent (discharged waste water) it receives from sewage plants. Therefore proper management of on land activities are important to the health and vitality of Lake Erie.

During the 1960s and 70s water quality conditions in Lake Erie were a major public concern and in response the governments of Canada and the United States (US) signed the Great Lakes Water Quality Agreement in 1972. This led to remedial actions on both sides of the border and eventually the situation improved. In the late 1990s Canada and the US joined forces to create a binational working group and produced the Lake Erie Lakewide Management Plan (LaMP) in 2000. This plan is updated on a regular basis.

Unfortunately Lake Erie water quality has taken a turn for the worse. Despite billions of dollars of public expenditure to reduce phosphorus loadings to the Lake, evidence of nutrient-driven eutrophication is again before us. Algal blooms which threatened the Lake Erie ecosystem in the 1960s and 1970s have returned and the extent and duration of depleted oxygen (hypoxia) in the bottom waters (hypolimnion) of the central basin continues to increase. *Cladophora*



Photo Credit: Lake Erie LaMP

(algae) growth has once again become a problem in shoreline areas with hard bottom substrate; botulism outbreaks are believed to be linked to a combination of interrelationships between *Cladophora*, *dreissenids* and round gobies; and old models developed to predict the lake response to various inputs are no longer accurate.

In 2008 federal, provincial and state agencies in the Lake Erie Basin agreed to renew efforts to address nutrient problems in the Lake through the Binational Lake Erie Nutrient Strategy. The Lake Erie Binational Nutrient Management Strategy is a coordinated and strategic response from Canada and the United States that outlines nutrient management actions to reduce eutrophication of Lake Erie. The strategy provides quantitative targets and identifies nutrient management, restoration, research and monitoring priorities and actions that need to be considered and adopted by everyone (government agencies, non-government organizations and residents) in the watershed (Lake Erie LaMP Nutrient Management Task Group 2009).

The relationship between the lake and its tributaries is a key component of the strategy. Studies are showing that some of the problems along the shoreline may be related to conditions in nearby minor tributaries. As a result Lake Erie managers are looking to watershed partners to assist in addressing conditions in the lake. Healthy watersheds are essential to a healthy Lake Erie.

## **Topography**

The relatively flat topography of the Lake Erie North Shore was shaped largely by glacial activity. Approximately 25,000 to 13,000 years ago continental ice sheet Wisconsin re-advanced over Niagara Peninsula bulldozing any pre-existing surficial deposits resulting in the bedrock being ground and polished by the mass sheet of ice. The tremendous weight of the 4 kilometer thick glacier resulted in the land beneath it to subside (Lewis 1991). As the Wisconsin ice sheet retreated approximately 13,000 years ago, a vast quantity of melt water from the retreating glacier was discharged into the Great Lakes resulting in a rise of Lake Erie water level. As the mass weight from the glacier was released from the landmass, the land rebounded upward and lakes and wetlands in the area expanded and contracted (Lewis 1991).

The low-lying, north-facing Onondaga Escarpment, which rarely reaches heights of more than a few meters, is the most prominent feature in the Lake Erie North Shore watershed. Aside from a few openings, the ridge of the Onondaga prevents drainage south towards Lake Erie, resulting in a wet and swampy landscape north of the Onondaga Escarpment. The shoreline of Lake Erie consists of a series of rocky headlands combined with bayhead beaches that exhibit broad sandy bays or rocky interfaces. The sandy bays and beaches are consistently found west of the headlands, while the rocky, more rugged coastal features are found at the tip or to the east of the headlands (Jackson 1967). The topography of the Lake Erie North Shore watershed is illustrated on Figures 4a and 4b.

# Lake Erie North Shore Watershed - West

## Topography



W A I N F L E E T

Wainfleet Bog

3

M I M A N D  
I N T Y



# Lake Erie North Shore Watershed - East

## Topography



## Geology

The Lake Erie North Shore watershed study area is predominately overlain with bedrock from the Devonian period of roughly 350 million years ago; Onondaga Formation and Bois Blanc Formation. Although a small portion is overlain with bedrock from the end of the Silurian period roughly 410 million years ago; the Bertie Formation from which formed “*the main face of the ,erroneously named’, Onondaga Escarpment*” (Armstrong 2007). The dolostones and shales of the Bertie Formation were deposited in very shallow water as the sea gradually withdrew from the Niagara Peninsula.

When the seas transgressed during the Devonian period due to upwarping of the earth’s crust, the limestones of the Bois Blanc Formation were deposited. Deposition continued further into the Devonian period as the Onondaga Formation was deposited. The cherty, fossiliferous limestone and shale of the Onondaga Formation is the youngest formation in the Niagara Region. The bedrock geology of the Lake Erie North Shore watershed is illustrated on Figures 5a and 5b.

# Lake Erie North Shore Watershed - West

## Bedrock Geology



# Lake Erie North Shore Watershed - East

## Bedrock Geology



## Physiography

The physiographic region of the Lake Erie North Shore watershed is the Haldimand Clay Plain which extends from the Niagara Escarpment to Lake Erie. The Haldimand Clay Plain was submerged by post-glacial Lake Warren and much of it is covered by lacustrine clay deposits; although not all till was covered such as the till moraine in Lowbanks.

Underlying rocks consist of a succession of Palaeozoic beds dipping slightly southward under Lake Erie (Chapman & Putnam 1984). Soft shales have been worn down in front of the hard limestone Onondaga Escarpment, forming a large depression. The overburden of soil materials increases southward from the Niagara Escarpment to a thickness depth nearing 45 meters over the wide buried bedrock valley called the Eriean Valley north of the Onondaga Escarpment. The Eriean Valley extends in a southwestwardly orientation from Fonthill towards Lake Erie cutting through the Onondaga Escarpment in the Moulton Bay area (Armstrong 2007). Southward of the Onondaga Escarpment, overburden remains relatively thin, ranging in thickness from 3 meters up to 15 meters near the shoreline.

North of the shoreline, just west of Shisler Point and extending east to Crystal Beach, a long lacustrine beach of Lake Warren in the form of a gravel elongated mound is visible. Several other smaller remnants have been identified throughout Welland and Wainfleet. According to Chapman and Putnam (1984), these gravel bars are seldom over six or eight feet deep.

The physiography of the Lake Erie North Shore is illustrated on Figures 6a and 6b.

### *Onondaga Escarpment*

The partially-buried Onondaga Escarpment runs in an east-west orientation along the southern edge of the Niagara Peninsula. In Ontario, the Onondaga Escarpment extends from Hagersville to Fort Erie, and then continues into New York. The relatively low feature is capped by the Bois Blanc formation of the Devonian System, a very hard fossiliferous limestone. There are small outcrops of bedrock along the crest of the Onondaga Escarpment (Brady 1980). As previously mentioned, except for a few small watercourses, this ridge prevents drainage south to Lake Erie; north of the Onondaga Escarpment water is forced to drain north and east with the low lying areas remaining flooded. South of the Onondaga Escarpment, water drains directly to Lake Erie.

### *Lake Erie Shoreline*

The *Lake Erie Shoreline Management Plan* (Philpott Assoc.1992) reports that the entire Lake Erie shoreline from Port Ryerse, just west of Port Dover, to the Niagara River lies within one littoral cell with a net direction of littoral drift from west to east under prevailed westerlies. Possible sources of littoral material include bluff erosion, stream discharge, and nearshore lake bottom erosion. The western portion of the shoreline can be characterized by high glacial till bluffs while east of Moulton Bay and the remainder of the shoreline consists of low glacial till bluffs with bedrock outcrops anchoring pockets of sand and shingle beaches. The backshore consists of either a low drift or a dune

# Lake Erie North Shore Watershed - West

## Physiography



WAINFLEET

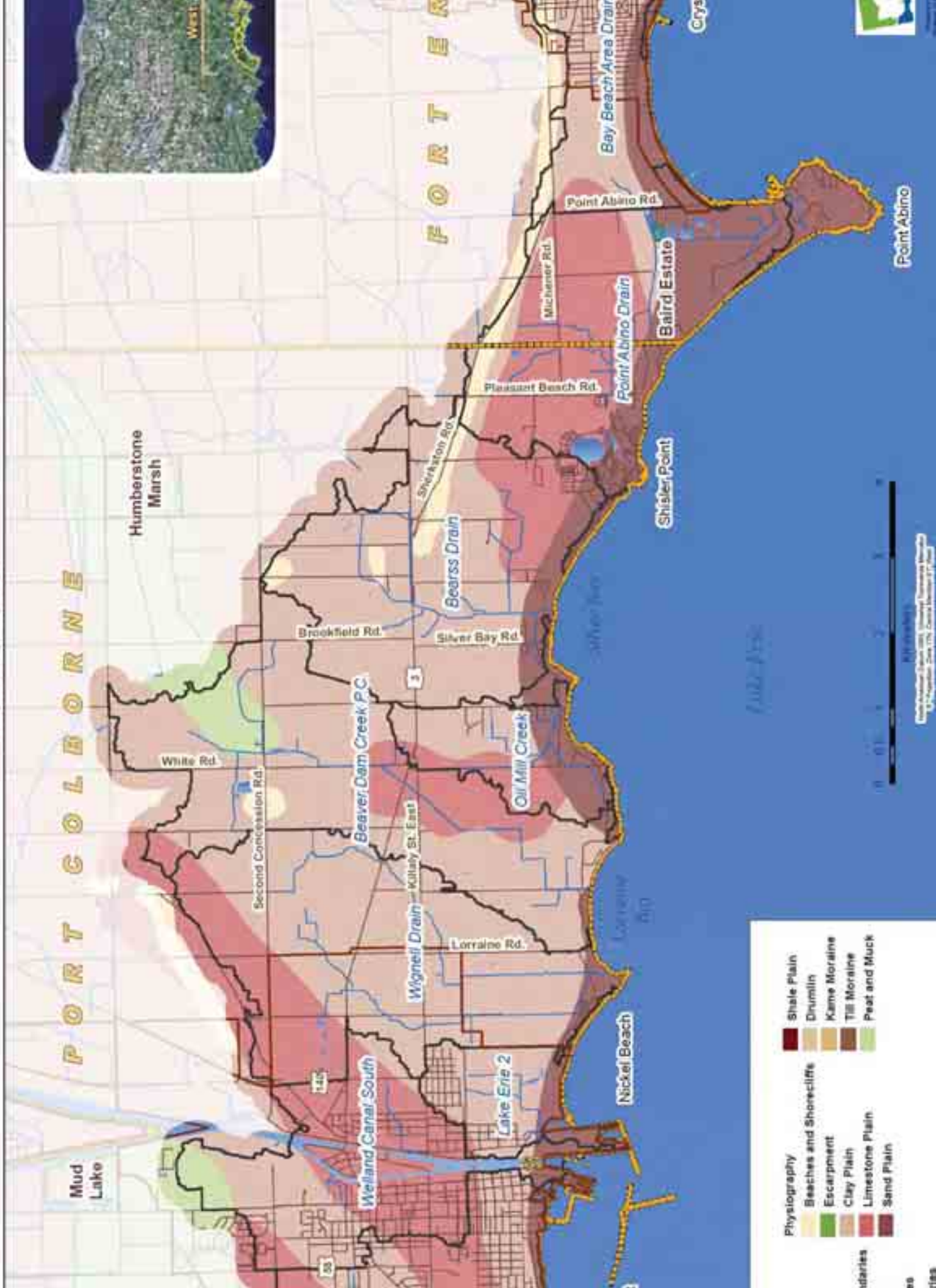
Wainfleet Bog

WAINFLEET



# Lake Erie North Shore Watershed - East

## Physiography



Map prepared by: [illegible]  
 Date: [illegible]  
 Scale: 1:50,000

formation. The Lake Erie North Shore study area can be subdivided into 7 sub-cells within this one littoral cell.

The following descriptions of the shoreline and sub-cells have primarily been derived from the *Lake Erie Shoreline Management Plan* (Philpott Assoc. 1992). A reference map follows entitled *Points and Bays* (Figure 7).

The most western sub-cell (No.2; No.1 does not fall within NPCA jurisdiction) in the study area includes the east side of Mohawk Point and Moulton Bay. The east side of Mohawk Point includes bedrock and low glacial drift shorelines, and the remaining of the sub-cell is comprised of two beach dune complexes and a bedrock outcrop at Rock Island where Long Beach Conservation Area is located. Sand dunes in the backshore rise to elevations of 180m. Shore protection along this stretch protects cottages and Lakeshore Road along the lakefront.



Littoral sub-cell No. 3 extends from Rock Island to Grabbell Point. The bay consists of a beach dune complex in the west that extends 3 kilometres and a short bedrock outcrop that marks the end of this bay at Grabbell Point. The shoreline has been fully developed with cottages located on the dune formation, and a variety of shoreline structures protect the cottages along this stretch; however, a few do rely on natural beach protection.

Littoral sub-cell No. 4 is formed by two bedrock outcrops; Grabbell Point and Morgan's Point. A beach is nestled between the two headlands with a texture that varies from sand in some areas and pebbles and cobbles in other areas. No dune development has occurred in this sub-cell. Development covers a majority of the shoreline and an armourstone revetment protects a portion of this shoreline stretch.



Littoral sub-cell No. 5 is one of the largest littoral cells in the study area. It extends eastward from Morgan's Point to the Welland Canal. Three small headlands interspersed with intermediate bays characterize this stretch of shoreline. The first intermediate bay (Sunset Bay) consists of sand and gravel and is positioned between the gentle

bedrock outcrop that marks the base of Morgan's Point and Rathfon Point to the east. A variety of shoreline protection structures protect this highly developed stretch of shoreline; at times residences are 3 rows deep from the lakefront.

Reeb's Bay is east from Rathfon Point to the next rock outcrop is (unnamed). The beach widens and consistency is mainly sand with some gravel. Aside from a small portion, the entire shoreline is protected by a number of structures; primarily a seawall. A major dune system occupies the backshore area in this reach. The dune system is lower at the west end, rising to elevations about 180m and to 190m at the east end. The dunes in this area are generally vegetated. Beach access can be obtained by steps that run down the face of the dune.

East into the next small bay, the dune system reaches an elevation of approximately 215 metres above sea level (masl), and then drops quickly before reaching the headland of Gravelly Bay. East of the headland, dunes continue to reach significant heights in the western portion of Gravelly Bay, with an elevation of approximately 185 masl. Bedrock is visible along the shore throughout most of the bay. Gravelly Bay marks the western edge of Port Colborne's built-up area. Land use in this area consists primarily of residential, commercial and industrial. Due to the presence of the Welland Canal on the eastern end of the bay, this portion of the shoreline is entirely man-made and natural coastal processes have been altered. Numerous shore protection structures are in place to protect the shoreline.



Littoral sub-cell 6 is formed by a single bay bordered by the Welland Canal to the west and Cassaday Point to the east; nestled between is Nickel Beach, a well used public beach with widths of over 40m backed by a sandy dune. The wide sandy beach holds dunes reaching elevations of 189 masl. Further east, permanent residences have established on the dunes. Dune formation continues east to the bedrock outcrop known as Cassady Point but drops off rapidly towards the east side of the point. Cassady Point supports the provincially significant wetland and

woodlot Nickel Beach Marsh and Woodlot.

Extending from Cassaday Point to Point Abino is littoral sub-cell 7. The most western bay in this sub-cell is Lorraine Bay, a gently curved beach bay anchored by Cassaday Point on the west and Pine Crest Point on the east. Widths of this sand and gravel beach vary from 20 to 40 meters and dune heights reach almost 190 masl. The entire shoreline has been developed with residential and seasonal dwellings and protection structures are in place at the top of the beach and the base of the dune.



East of Pine Crest Point, a small bedrock outcrop separates the shoreline into 2 small bays; Cedar Bay and Silver Bay. The sandy beaches are separated from the sand dunes that back the beach by a protection structure. Development along the bays is continuous with most of it occurring on top of the dunes.

The next eastern stretch of shoreline contains dunes with elevations up to 186 masl. Further towards Shisler Point is one of the few undeveloped extents of shoreline along

the Lake Erie North Shore Study area. The backshore area of this reach supports Empire Beach Backshore Forest Basin Life Science ANSI and provincially significant coastal wetland.

The western edge of Point Abino peninsula forms the down drift headland of this sub-cell and is comprised of sand beaches, a beach resort with seasonal campers and Pleasant Beach settlement area. A sand dune reaching an elevation of up to 200 masl rises above the beach. Not all the sand dunes and sand hills in this area are oriented parallel to the shoreline; therefore they may not be a part of the coastal dune system. This area also supports Point Abino Peninsula Sandland Forest ANSI. Developed areas are protected with a revetment structure; however where there is no development, no protection structure has been put in place.



The stretch from Point Abino eastward to Crystal Beach marks littoral sub-cell No. 8. The dunes of this popular sandy beach rise to approximately 180 masl and are generally protected by a beach wall or revetment. In addition, a pier and a seawall that once protected an amusement park in the area are situated in the eastern part of the bay.

The Lake Erie North Shore watershed contains approximately 68 kilometres of Lake Erie shoreline. Strips of residential homes and seasonal cottages hug the shoreline and numerous beaches offering public access dot the lakefront.

### *Sand Dunes*

The coastal sand dunes that line the shoreline of Lake Erie are significant natural features that not only provide shore protection, but play an important ecological role in providing shelter and habitat for wildlife and rare and endangered species. The dunes previously described do not represent a typical shoreline feature that has formed through the actions of varying lake levels, storm activities and wind action of recent times, but these dunes are old dunes deposited before the current lake level cycle (Philpott Assoc. 1992). The dunes and their associated habitats are vulnerable to activities such as destruction through development, All Terrain Vehicles (ATV), invasive species, shoreline protection structures and extraction. Measures to protect the dune systems and natural dune processes should be implemented; including for example, phasing out any extraction activities, restricting ATV use on the beach, strict development guidelines as well as designing and constructing shoreline protection structures as to minimize effects on dunes and dune processes.



# Points & Bays



POINT COLONNE

WAINFLEET

Humberstone Marsh

Humberstone Mud Basin Swamp Forest

Wainfleet Bog

Gold Harry Conservation Trail

Wainfleet Wetlands

Gravelly Bay

Nickel Beach

Lorraine Bay

Cedar Bay

Silver Bay

Baird Estate

Point Abino Peninsula

Mohawk Point

Moulton Bay

Rock Island

Grabell Point

Morgan's Point

Sunset Bay

Reep's Bay

Rathfon Point

Sugar Loaf Point

Cassaday Point

Pine Crest Point

Shisler Point

Sherkston Beach

Lake Erie

Legend

Roads

Watercourses

Waterbodies

Subwatersheds

Conservation

Municipal Boundary

Urban Area

Areas of Natural Interest



Map of Wainfleet, Ontario, Canada, showing the location of Wainfleet Wetlands and surrounding areas.

## Soils

The soils in the Niagara Region were resurveyed and documented in a report entitled *The Soils of Regional Niagara* (Kingston and Present 1989) by the Ontario Ministry of Agriculture and Food and Agriculture Canada. This study included geological and physiological features; soil groups and types; soil moisture characteristics; drainage and variability; common properties of soil groups; as well as information related to agricultural soil use and classification. The following soil descriptions and associated chart and maps (Figures 8a and 8b) are derived primarily from this document.

Numerous soil groups characterize the Lake Erie North Shore watershed; however, it is generally dominated by the poorly drained Welland and Brooke soil groups. Both soil groups have a high capacity to hold water and a slow to moderate rate of permeability, however, surface cracking increases the permeability of Welland soils during the summer months. Except for the drier period during the summer months, the groundwater level remains close to the surface in Welland soils, and although they have a high capacity to hold water, moisture availability for plants is limited at this time due to the soils high clay content. The combined problems associated with high clay contents and high water tables limit the use of this soil group for most agricultural crops. Welland soils are typically associated with Malton soils and Lincoln soils which like Welland soils, both groups have a high clayey texture, high water-holding capability and a perched water table. These soil groups are also generally limited to field crops if tile drained.

Brooke soils are shallow with clayey textures and a thickness typically reaching only one meter over dolostone bedrock, with surface soils having a high organic content. Due to groundwater ponding on the relatively impermeable bedrock, the shallow Brooke soils with their high water-holding capacity tend to stay saturated for long periods each year. Due to the poor drainage and the shallowness to bedrock, Brooke soils are not suitable for agriculture. They are typically limited to pasture use or growing scrub.

South of the Onondaga Escarpment on the eastern side of the Welland Canal, Chinguacousy soils, Jeddo soils and Farmington soils dominate. Chinguacousy and Jeddo soils are mainly clay loam till. Chinguacousy are imperfectly drained with a moderate to slow permeability and a relatively high capacity for holding water. Regional groundwater fluctuates in the lower horizons with temporary occupancy in the surface horizons for time periods each year. Chinguacousy soils have a moderate to rapid surface runoff and are also quite erodible; therefore as slope increases erosion control measures should be considered. These soils are used for growing common field crops, however tile drainage is necessary.

Jeddo soils are poorly drained, slowly permeable with a moderate to rapid rate of surface runoff, depending on the slope. These soils are saturated by groundwater most of the year and are susceptible to a high degree of compaction. Chinguacousy soils are the most common soils found as soil inclusions with Jeddo soils. Jeddo soils are used to grow a wide range of field crops; however, these soils require tile drainage and continued maintenance, in part, due to high degrees of compaction.

Farmington soils on the other hand, are well drained and typically have good permeability but its water holding capacity varies with texture. Textures vary from sandy loam to silty clay, although loamy textures are most common. Like Brooke soils, Farmington soils are also very shallow with depths reaching only 20 centimetres over the

dolostone and limestone bedrock, making these soils problematic during summer droughts and having little agricultural value.

The rapidly drained Plainfield soils can be found along Point Abino westward to Silver Bay. Plainfield soils are mainly aeolian sands with a very rapid permeability and low capacity to hold water. The Plainfield Soils in this extent are associated with the dune system that lines the shoreline of Lake Erie.

Organic soils groups such as Quarry soils, Lorraine soils, Holly soils, Sherkston soils and Portsmouth soils can also be found throughout the Lake Erie North Shore watershed. These organic soils are very poorly drained. They are rapidly permeable, but are usually saturated with groundwater. They also have a high capacity to hold water and a very slow surface runoff. Typically, before these organic soils can be used for agriculture, extensive clearing and drainage is necessary as well as continued maintenance to control the subsurface water level and prevent the loss of the organic surface horizon through wind erosion. When drained these soils are suitable for common field crops and vegetable crops such as broccoli, potatoes, celery and onions.

The nature of the organic material in Quarry soils is dominantly woody forest peat with occasional sedge fen peat layers and a texture variation from silty clay loam to silty clay. These soils are associated with swamps and forested wetlands and have been mapped east of Port Colborne along Lake Erie.

In Lorraine soils, the nature of the organic materials range from woody fen peat to sedge fen peat. The textures vary from silty clay loam, to silty clay and clay. These soils are associated with fens and forested wetlands and can be found in association with Portsmouth organic soils.

The nature of the organic material in Portsmouth soils range from woody forest peat to woody sedge fen peat with occasional sedge fen peat horizons. These soils are typically associated with forested wetlands and swamps and a texture varying from silty clay and clay to heavy clay.

Sedge fen peat is primarily the nature of the organic material in Sherkston soils. The texture of this soil group is usually silty clay and is typically associated with wetlands and fens. The extent of this soil group in the Lake Erie North Shore watershed is limited to the area between Port Colborne and Fort Erie near Lake Erie.

In Holly soils, the nature of the organic materials range from woody forest peat to sedge fen peat, and a texture that typically varies from silt loam to silt clay loam. These soils are generally associated with forested wetlands. In the Lake Erie North Shore watershed the extent of Holly soils is limited to south of the Onondaga Escarpment.

**Table 1: Soils of the Lake Erie North Shore Watershed Plan Study Area**

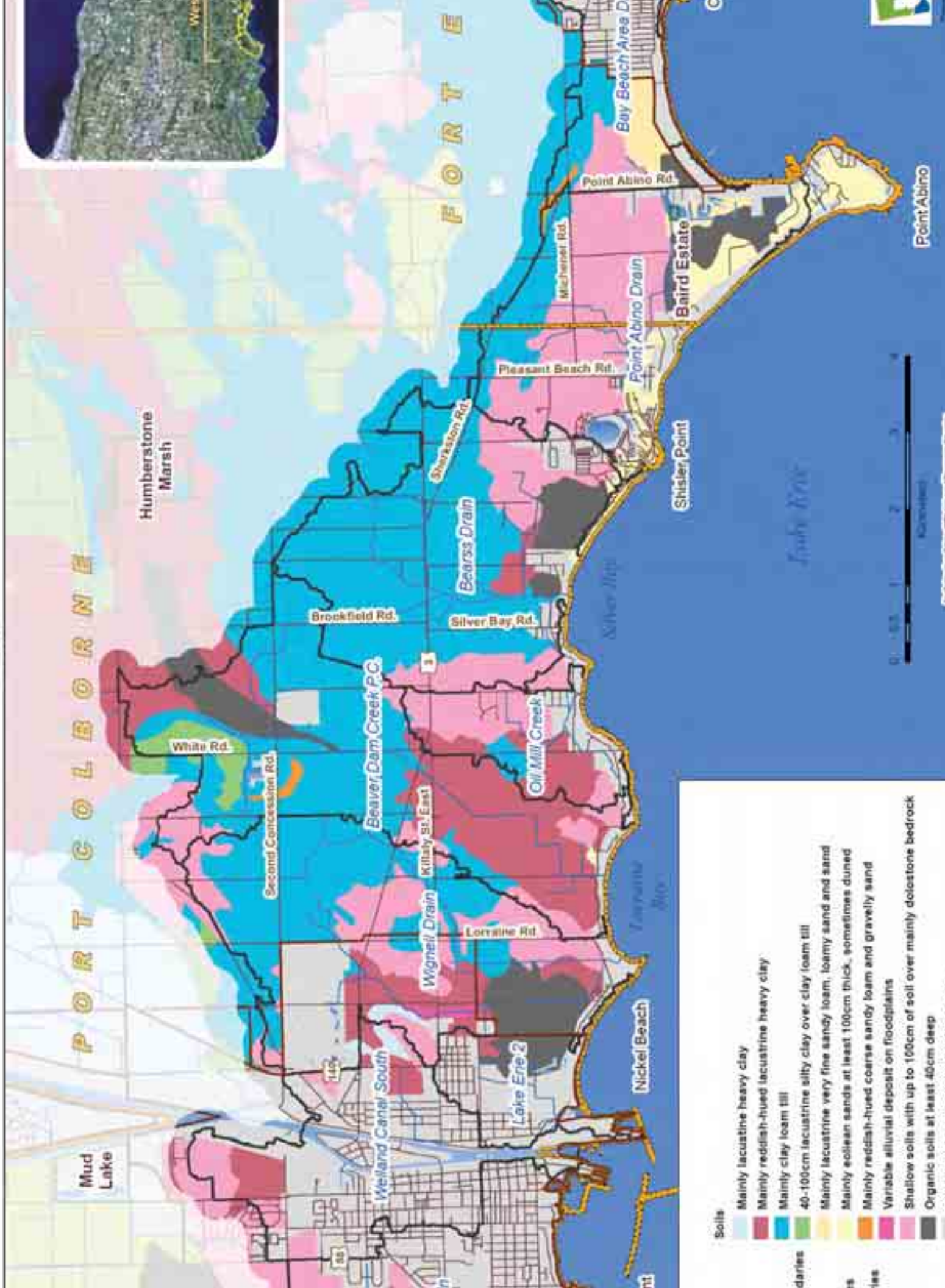
| Soil Series              | Geologic Deposits                                                     | Natural Drainage | Water Holding Capacity | Permeability     | Surface Runoff    | Class       | Land use Comments                                                                   |
|--------------------------|-----------------------------------------------------------------------|------------------|------------------------|------------------|-------------------|-------------|-------------------------------------------------------------------------------------|
| <b>Mineral Soils</b>     |                                                                       |                  |                        |                  |                   |             |                                                                                     |
| Welland Soils (WLL)      | Mainly reddish-hued deep water lacustrine heavy clay                  | Poor             | Relatively High        | Slow             | Slow to Moderate  | 3WD, 4W, 5W | Range from unsuitable to poorly suitable for most fruit & vegetable crops           |
| Malton Soils (MAT)       | 40-100cm clayey sediments over clay loam till                         | Poor             | Relatively High        | Slow             | Slow              | 3W          | Limited use for agriculture; artificial drainage recommended                        |
| Lincoln Soils (LIC)      | Deep water lacustrine heavy clay                                      | Poor             | High                   | Slow             | Slow to Rapid     | 3WD         | Unsuitable for most horticultural crops                                             |
| Brooke Soils (BOK)       | Variable sediments 10-100cm over mainly limestone & dolostone bedrock | Poor             | Fairly High            | Moderate to Slow | Moderate          | 4W, 5W      | Not suited for most agricultural uses due to shallowness to bedrock & poor drainage |
| Chinguacousy Soils (CGU) | Clay loam till                                                        | Imperfect        | Relatively High        | Moderate to Slow | Moderate to Rapid | 2D          | Widely used for growing common field crops                                          |
| Jeddo Soils (JDD)        | Clay loam till                                                        | Poor             | Relatively High        | Slow             | Moderate to Rapid | 3W          | Over compaction is a serious management concern                                     |
| Farmington Soils (FRM)   | Variable sediments 10-100cm over mainly limestone & dolostone bedrock | Well             | Variable               | Good             | Variable          | 3R, 4R      | Little agricultural value due to shallow bedrock & droughtiness conditions          |
| Plainfield Soils (PFD)   | Eolian dunes, sand dunes                                              | Rapid            | Low                    | Rapid            | Slow              | 3F          | Limitations due to seasonal droughtiness, low fertility & pH problems               |
| <b>Organic Soils</b>     |                                                                       |                  |                        |                  |                   |             |                                                                                     |
| Quarry Soils (QRY)       | Organic swamp sediments 40-160cm over loamy sediments                 | Very Poor        | High                   | Rapid            | Very Slow         | 2HL-3H      | Extensive clearing & drainage necessary before suitable for agriculture             |
| Lorraine Soils (LRR)     | Organic fen sediments 40-160cm over clayey sediments                  | Very Poor        | High                   | Rapid            | Very Slow         | 2FHL-3FH    | Extensive clearing & drainage necessary before suitable for agriculture             |
| Portsmouth Soils (PUH)   | Organic swamp sediments >160cm                                        | Very Poor        | High                   | Rapid            | Very Slow         | 2FL-3F      | Extensive clearing & drainage necessary before suitable for agriculture             |
| Sherkston Soils (SRK)    | Organic fen sediments >160cm                                          | Very Poor        | High                   | Rapid            | Very Slow         | 4K          | Extensive clearing & drainage necessary before suitable for agriculture             |
| Holly Soils (HOY)        | Organic swamp sediments 40-160cm over loamy sediments                 | Very Poor        | High                   | Rapid            | Very Slow         | 3H-4H       | Extensive clearing & drainage necessary before suitable for agriculture             |

## Soils



# Lake Erie North Shore Watershed - East

## Soils



## Land Use

### Current Land Use

The Lake Erie North Shore watershed study area spans the Town of Fort Erie (10%), City of Port Colborne (51%), Township of Wainfleet (24%), and Haldimand County (15%). Land use in the study area is characterized mainly by agriculture, recreation, and natural areas interspersed with strips and nodes of residential areas with one small concentration of urban land uses in Crystal Beach and one major concentration of urban land uses (residential, commercial, industrial) in the City of Port Colborne (Figures 9a and 9b). Numerous active and abandoned quarries are within the Lake Erie North Shore study area. In addition, closed quarries that have been converted to recreational activities are also present in the watershed such as Sherkston Shores Resort and Wainfleet Wetlands Conservation Area.

### *Agriculture*

The location of the Niagara Peninsula between the moderating influences of the Great Lakes and the Niagara Escarpment creates a unique microclimate that supports a viable agricultural community. In fact, the combination of geography and climate make parts of Niagara a thriving tender fruit district (Planscape 2003). In 2001, the Region of Niagara commissioned a study to assess the nature of agriculture in Niagara; *Regional Agricultural Economic Impact Study 2003*. The study confirmed that “agriculture is of tremendous importance to the Niagara economy both directly and indirectly” (Planscape 2003). According to the study, in 2001 the agricultural industry generated over \$511 million in gross farm receipts in Niagara.

Agriculture is the most predominant land use in the Lake Erie North Shore study area and although the study area does not fall within prime agricultural lands, the Good General agricultural lands in this area support numerous prosperous commodity sectors. As described earlier, the mineral soils in the area are rated as Class 3 and Class 4 according to the Canada Land Inventory (CLI) Classification System for Agricultural. These soil classes have moderately severe to severe limitations that restrict the range of crops and/ or require special conservation practices. The limitations affect one or more of the following practices: timing and ease of tillage; planting and harvesting; choice of crops; and methods of conservation (Kingston and Presant 1989). The organic



soils in the study area range from Class 2 to Class 4. According to the CLI Capability Classification for Organic Soils Class 2 soils have one minor limitation; this limitation may be woodiness, reaction, flooding, topography, depth or climate. Class 3 and Class 4 soils have moderately severe to severe limitations that restrict the range of crops and/or require special management practices (Kingston and Presant 1989).

According to Statistics Canada 2006 Agricultural Profile, the main agricultural commodity groups based on the North American Industry Classification System farm-typing categories for each district in the Lake Erie North Shore watershed are:

- Town of Fort Erie: animal production, other crop farming, and grain and oilseed;
- City of Port Colborne: grain and oilseed, animal production, miscellaneous speciality;
- Township of Wainfleet: grain and oilseed, animal production, miscellaneous speciality; and
- Haldimand County: grain and oilseed, cattle ranching and farming, and other crop farming

### *Recreation*

The Lake Erie North Shore offers numerous recreational opportunities throughout the watershed. Beaches all along the shoreline provide ample opportunity for swimming, fishing and relaxing, in addition to numerous other beach related activities. Hiking and biking trails can be enjoyed throughout the area, including a portion of the Welland Canal Trail, Gord Harry Conservation Trail, Regional Bicycle Network, Scenic Bike Loops, Greater Niagara Circle Route and the Waterfront Trail along portions of Lake Erie. There are four golf courses in the watershed: Long Beach Country Club and Port Colborne Country Club in Wainfleet, and Coyote Golf Club and Whiskey Run Golf Course are located in Port Colborne. Camping is available at Highland Trailer Park and RV Resort and Pinegrove Park in Lowbanks in Haldimand County, Pleasant Beach Tent and Trailer Park and Sherkston Shores Resort in Port Colborne as well as at Long Beach Conservation Area in Wainfleet. Additional conservation areas in the study area include Morgan's Point Conservation Area, Wainfleet Wetlands Conservation Area, Gord Harry Conservation Trail and Baird Estate Wilderness Reserve.

### **Future Land Use**

In Ontario planning decisions are influenced by all levels of government: federal, provincial, regional and local (e.g. municipal). Although each tier has an appropriate role in planning decisions, co-ordination between tiers is necessary for effective planning and management of respective jurisdictions. For example, in Niagara the federal government would be responsible for regulating railroads, the Welland Canal, and the defense of our international boundary; whereas the provincial government's major responsibilities are primarily concerned with matters of provincial interest, for example, provincial transport routes, utilities, property assessment, land use planning, and protection of the environment, as well as numerous aspects of municipal development. Regional governments are responsible for planning, waste management, regional roads, treatment and distribution of water, and community services (e.g. police, health and welfare). Municipalities are primarily responsible for their respective jurisdictions in areas of physical, economic and social development while adhering to provincial and regional policies. However, some of the aforementioned responsibilities are shared with respective municipalities with some direction from the provincial government; areas such as treatment and distribution of water, waste management, planning and land use regulation.

Therefore, implementation of the Lake Erie North Shore Watershed Plan should be integrated into planning initiatives and roles of regulation by all levels of government.

Land use changes in the Lake Erie North Shore watershed should also consider recommendations put forth by the Watershed Plan and supporting studies and documents where appropriate.

### *Provincial Tier*

In Ontario, the *Growth Plan for the Greater Golden Horseshoe* (GGH) (Ministry of Public Infrastructure Renewal 2006) has been prepared under the *Places to Grow Act* (Ministry MPIR 2005), to help guide land-use planning decisions in the Greater Golden Horseshoe area. The Plan provides a framework for managing the projected future growth in the region by guiding decisions on a wide range of important planning aspects such as future transportation needs and infrastructure, natural heritage and resource protection, land use planning and housing requirements. The GGH promotes intensification of existing built-up areas and revitalization of urban growth centres while recognizing the vital economic and cultural importance of our rural communities. The GGH works with other government initiatives such as the *Provincial Policy Statement* (PPS) (Ontario Ministry of Municipal Affairs and Housing 2005a), which provides overall direction on matters related to land use and development in Ontario, and municipal official plans by providing growth management policy direction.

The PPS recognizes that sustainability of Ontario's natural and cultural heritage resources over the long term is of key provincial interest given that they provide significant social, economic and environmental benefits; "*Strong communities, a clean and healthy environment and a strong economy are inextricably linked*" (PPS 2005). Accordingly, while providing direction on appropriate development, the policies of the PPS provide protection for; resources of provincial interest, quality of the natural environment, and public health and safety by focusing growth within existing settled areas and away from sensitive or significant natural resources or areas that may pose as a threat to public health and safety.

The PPS calls for the wise use and management of resources by imposing stringent limitations on development and site alteration for numerous natural settings, including, but not limited to; significant and /or sensitive natural areas (terrestrial and aquatic), lands adjacent to significant and /or sensitive natural features, and areas of fish habitat. The PPS also calls upon planning authorities to "*protect, improve or restore the quality and quantity of water*" (Section: 2.2.1) by means of for example, using the watershed as the ecological scale for planning activities; ensuring stormwater management practices have minimal negative impacts; and linkages and related functions between terrestrial/aquatic features are maintained.

In terms of agricultural areas, the PPS calls for the protection of prime agricultural areas for long-term agriculture and related usage, and for respective planning authorities to designate specialty crop areas in accordance with provincial evaluations. In regards to extraction of mineral aggregate resources, the PPS requires extraction to be "*undertaken in a manner which minimizes social and environmental impacts*" (Section: 2.5.2.2), and rehabilitation of the extraction area is required to "*accommodate subsequent land uses, promote land use compatibility, and to recognize the interim nature of extraction*" (Section 2.5.3.1).

In addition to requiring the wise use and management of resources, the PPS calls for promotion of healthy, active communities by for example, providing public accessibility to natural settings for recreation, including "*parklands, open space areas, trails and , where practical, water-based resources*" (Section: 1.5.1) including shorelines.

The *PPS* policies may be complemented by other provincial (e.g. *GGH*), regional (e.g. *Regional Policy Plan, Haldimand Strategic Directions*), and municipal policies (Official Plans) regarding matters of regional and municipal interest. Together, provincial plans, and regional and municipal official plans provide a “*framework for comprehensive, integrated and long-term planning that supports and integrates the principles of strong communities, a clean and healthy environment and economic growth, for the long term*” (PPS 2005).

### *Region of Niagara: Upper Tier*

The *Planning Act* (MMAH 1990) designates the *Policy Plan: Regional Strategy for Development and Conservation* (RMN 2007a) as the paramount planning document for Niagara Region as stated in *Section 27.1* of the *Planning Act*: “*The council of a lower-tier municipality shall amend every official plan and every by-law passed under section 34 [addresses zoning by-laws], or a predecessor of it, to conform with a plan that comes into effect as the official plan of the upper-tier municipality*”. In accordance with the *GGH*, *PPS* and other provincial policies, the *Policy Plan* outlines numerous regional policies and strategies addressing local interests. For instance; land use and development, agriculture, cultural and natural heritage and aquatic resources, and tourism and recreation are a few of the areas of interest addressed in the *Policy Plan*.

In 2009, Region of Niagara updated the Urban Areas policies in the *Policy Plan* (Amendment 2-2009) to implement strategic directions of an extensive 5-phase growth management strategy. It is the intent of the Region of Niagara to “*promote an integrated land use planning framework for decision making*” that involves all respective stakeholders, and it is the position of the amended policies to “*represent an opportunity for Niagara to affirm its commitment to building sustainable, complete communities*” (RMN 2009 Section 2). Accordingly, objectives of the Urban Policies include strategies that are intended to guide decisions related to “*land use planning, infrastructure development, natural and cultural resource management and fiscal planning*” (Section 2.2). Strategies in the *Policy Plan* for implementing this balance include policies related to for example, urban structure, intensification, Greenfield areas and transportation corridors.

The *Policy Plan* also outlines a number of objectives and strategies to maintain and foster a viable agricultural industry by preserving Niagara’s agricultural lands and production through a multi-tier government coordinated effort by supporting the following policies; tariff/quota protection from imports (federal); adequate marketing and protection of unjustified taxes (provincial and local); and financial assistance and protection of unique and good agricultural lands are some of the local policies that the *Policy Plan* outlines.

The environmental policies apply an ecosystem approach to the environmental policy framework by employing proactive sustainable principles. Some of these principles include: stewardship plus regulation; environmental protection plus enhancement; and ecosystem health and sustainability. These principles are also applied to the mineral extraction sector to ensure that these resources are not only available for future use, but the extraction and “*management is compatible with the natural and human environment*” (Section 7.E).

Extensive trail systems such as the Trans Canada Trail, Welland Canals Trail and The Greater Niagara Circle Route not only provide an abundance of recreational opportunities for residents and tourists, but these trail systems link Niagara Region’s

history and cultural heritage with its natural heritage. It is the intent of the *Policy Plan* to promote and coordinate further development of recreational trails in Niagara to promote recreational opportunities and encourage healthy lifestyles while fostering the expansion of the tourism industry.

The *Policy Plan* also recognizes that successful planning and environmental conservation requires coordination and cooperation involving all levels of government and respective stakeholders (e.g. municipalities, landowners, environmental agencies and interest groups). Accordingly, the *Policy Plan*, which adheres to provincial policies, provides an overall framework for development and planning in Niagara Region that the respective municipalities are to adhere to with further detail at a municipal level.

### *Region of Niagara: Lower Tier*

Due to Niagara's importance in cross border trade with the United States, the *GGH* identifies a Gateway Economic Zone and Centre in Niagara. Accordingly, the RMN in partnership with the province and local municipalities commissioned a study to develop an action plan for the implementation of the *Gateway Economic Zone and Centre* (GKH 2008) in Niagara Region. The Gateway Economic Centre in the Lake Erie North Shore watershed includes all the settlement areas and port infrastructure in Port Colborne, the Welland Canal and the linkage between Port Colborne and Welland. The Gateway Economic Zone does not fall within the Watershed Plan study area.

In the Lake Erie North Shore watershed, the *GGH* also identifies the area surrounding the built-up areas adjacent to the Welland Canal in Port Colborne as a designated greenfield area, making this the focus area of future intensification with an overall minimum density target of 50 jobs and residents per hectare (MPIR 2006). The remainder of the Lake Erie North Shore watershed is considered a Good General Agricultural Area.

### *City of Port Colborne*

The Council approved *Draft New Official Plan for the City of Port Colborne* (Dillon 2006) identifies strategic directions for the future of land use planning in Port Colborne. Intensification will be promoted within the urban area boundary, which will extend north and westward for the first 15 years, then eastwards there after (II-Section B1a). Likewise, designated industrial lands will extend in a northern direction along both sides of the Welland Canal and port facilities and marine transportation industries will be encouraged to thrive (II-Section B2a). The expansion or establishment of quarry operations will be subject to a series of provisions including a rehabilitation plan and potentially contaminated sites will require written verification stating that the parcel is suitable for the proposed land use in accordance with provincial legislation and regulations (Section II-C12a).

The lakeshore along Lake Erie has been designated as rural land use. Numerous policies outline the criteria necessary for future development of these lands including but not limited to; the planting of mature vegetation; do not and will not require municipal water supply services or piped sewage treatment; and incorporation of architectural treatment and landscaping that is compatible with the natural setting of the Lake Erie shoreline (III-Section E3c). In addition, it is the intent of the City's *Official Plan* to protect and support the rural and farm related operations by, for example, protecting the

cultivated lands north of Highway #3, and supporting farm-related activities that contribute to the viability of the farm operations (II-Section B5).

The municipality recognizes the importance of Port Colborne's natural, cultural and heritage resources to the community; accordingly it is the intent of the *Draft Official Plan* to strengthen these resources by for example, enhanced protection of natural features; incentive programs; and the "*establishment of a [cultural] Heritage Character Area*" (II-Section B3b).

### *Township of Wainfleet*

The predominant land use within the Township of Wainfleet is agriculture. *The Official Plan of the Wainfleet Planning Area* (Township of Wainfleet 1996) recognizes the need to preserve their prime agricultural land and therefore development is encouraged only in areas that a balance of quality and sustainability can be maintained. Accordingly, the majority of the lands north of Highway #3 are zoned agriculture and consist of prime agricultural land. It is the intent of the *Official Plan* to "*maintain the integrity of the agricultural area*"; therefore "*all uses shall be compatible with agriculture and farm parcel sizes shall be maintained to foster the viability of the agricultural area*" (Section 4b). The lands south of Highway #3 are primarily zoned rural with a strip of lakeshore residential and pockets of estate residential along the shoreline of Lake Erie. Land use activities permitted in the rural zone include agriculture and agricultural related activities with non-farm related uses encouraged to locate in the industrial, commercial, lakeshore and estate residential zones (Section 4Bi). In areas zoned for extractive industrial, all new applications for a new pit/quarry or the expansion of an existing pit/quarry shall have regard for numerous potential impacts (e.g. impact on water table, transportation systems, adjacent land uses) to ensure that the extraction is carried out with minimal environmental and social costs (Section 12biv).

Population is not projected to dramatically increase in the near future in the Township of Wainfleet due to the "*unserved nature of the Township, the capability of nearby urban centres to absorb significant increase in population, and the relatively slow population growth rate of the Township in the past*" (Township of Wainfleet 1996). In addition, due to the accessibility of the larger urban centres of Welland, Port Colborne and Dunnville, commercial development remains oriented towards cottagers. New development along the lakeshore is limited to single dwelling homes or cottages, and conversions from cottages to permanent dwellings will only be permitted if several stipulations are met [e.g. lot size, access, suitability, sewage treatment (Section 8b)]. Currently the Township of Wainfleet is working with Regional Niagara to generate a secondary plan for the lakeshore area; therefore once complete this section will be updated.

Objectives of the *Official Plan* not only include protection and promotion of the farm related lands and operations, but also provides a framework to protect and enhance Wainfleet's natural and cultural heritage resources by adopting policies that will preserve and protect these significant assets. The environmental policies of the *Official Plan* are designed "*to identify and protect the critical components of this valuable natural resource, including hazard lands, wetlands, environmentally sensitive areas, fish habitat and natural resources areas*" (Section 14a). The *Official Plan* calls for the designated land use activities to "*maintain the significant environmental attributes and functions*" (Section 14a). As previously indicated, it is also the intent of the *Official Plan* to "*preserve and enhance structures, buildings and properties of historical, cultural,*

*archaeological and architectural significance*” (Section 4B1) by implementing policies that promote the preservation and maintenance of these unique features.

Currently, the Township of Wainfleet is in the process of updating their Official Plan.

#### *Town of Fort Erie*

Approximately 10 percent of the Lake Erie North Shore watershed study area falls within the municipality of the Town of Fort Erie. The land use in this portion of the municipality is predominately agriculture and protected environmental area. The Council approved *Draft Official Plan for the Town of Fort Erie* (Town of Fort Erie 2009) outlines a number of goals and objectives in terms of future land use planning for Fort Erie. For the area of interest for this watershed plan, it is the intent of the Town of Fort Erie to preserve and protect its agricultural land from activities and land uses which could limit productivity, and prevent further fragmentation of agricultural lands by non-agricultural purposes and conservation of the rural landscape (Section 2.3.4).

The Point Abino area has been designated as an Environmental Protection Area in the *Draft Official Plan* which will protect this unique area from further development due to restrictions on development and site alterations in such designated areas as outlined in the *Official Plan* (Section 8.2.1). The same restrictions apply to the Dune Protection Area which has been outlined in the *Draft Official Plan*; this will protect Point Abino’s unique dune system from any new development (Section 8.2.4V).

North of the Point Abino Environmental Protection area, the area is zoned rural. Numerous criteria must be met for a non-agricultural or related land use to be permitted in rural zoned areas. Some of the criteria include, but are not limited to; a minimum lot size of 0.4 hectares is required; natural drainage systems of surrounding agricultural lands shall not be interfered; and the development must be at a scale and density that is suitable for the physical characteristics of the site (Section 4.6.2). The majority of the lands within the Crystal Beach urban area that form part of this study are designated Urban Residential. This zone is intended to facilitate a number of housing forms and associated urban land uses and services [e.g. schools, public utilities, cemeteries (Section 4.7.4)].

#### *Haldimand County: Single Tier*

The remaining 15 percent of the Lake Erie North Shore watershed study area falls within Haldimand County. The land use consists primarily of agriculture, recreation and seasonal residential, with some permanent dwellings. In consultation with the community, Haldimand County has also developed a series of strategic directions regarding the future of their municipality; *Haldimand County Strategic Directions 2004*. The strategic directions process is based on 6 core themes (e.g. environment, economy, growth management) that are used to outline the main components of the Official Plan. These core themes will assist in preparing policy direction for achieving various components of the Vision Statement that was developed through community involvement (Haldimand County 2004).

Similar to other official plans, the *Haldimand County Official Plan* (Haldimand County Planning 2006) outlines various strategies for future development under the core themes developed through the Strategic Directions process as previously indicated. The *Official*

*Plan* also identifies the need to preserve and manage the County's natural environment features and that these principles should form the basis for future development and land use decisions. The *Official Plan* states that a *"high quality environment will be achieved and retained as human health is linked to environmental health. The County will strive to preserve essential **ecological functions** and protect natural biological diversity and **ecological integrity**"* (Section 2A.4). In order to accomplish this, the *Official Plan* outlines numerous policies with regard to for example, provincially significant wetlands, habitats of „species at risk‘, development, and other natural environments such as water resources. The *Official Plan* also recognizes that cooperation and communication with other agencies is necessary to accomplish these objectives.

The *Official Plan* recognizes the importance of Haldimand's productive agricultural lands as the *"prime economic basis for the rural community"* and it is in the *"County's interest to preserve that lifestyle and foster the agricultural industry"* (Section A1). The *Official Plan* outlines various policies that are intended to preserve and protect the agricultural land base for agricultural purposes by for example, limiting land use activities to agricultural and related activities and for land uses that are compatible with agriculture. In addition, the policies *"encourage the development of agricultural support services within urban areas and designated hamlets"* (Section 3A.3).

A study was conducted in 2004 titled *North Shore Strategies: The Lakeshore Area Study* (Haldimand County) with the purpose of providing the County with background information on the lakeshore area so informed decisions regarding policies for land use along the lakeshore could be formulated. A major concern identified in the study was the increase of housing conversions from seasonal to permanent that have been occurring over the past few years along the lakeshore, therefore a challenge of Haldimand County includes finding a balance between a sustainable and viable shoreline community while protecting the natural environment and preserving the lakeshore as an asset for residents and tourism. Accordingly, the *Official Plan* outlines numerous policies in regards to shoreline development as the County recognizes this area as an invaluable resource and the County *"supports the preservation of the open nature of the lakeshore by limiting development to designated areas or nodes. Scenic roads, public vistas, and landscapes along the lakeshore will be identified and protected"* (Section F6).

### *Conservation Authorities*

It is the intent of the Province of Ontario in the *PPS* (MMAH 2005) to direct development *"away from areas of natural or human-made hazards where there is an unacceptable risk to public health or safety or of property damage"* (Section 3.0). Accordingly, along the Lake Erie shoreline, development is restricted within the shoreline hazard limit. This limit is defined as the *"furthest landward extent of the aggregate of the flooding hazard limit plus the erosion hazard limit plus the dynamic beach hazard limit"* (NPCA 2007b). These hazards are defined in the *PPS* (MMAH 2005) as follows:

- **Flooding hazard limit** (along Great Lakes shoreline): based on the 100 year flood level plus an allowance for wave uprush and other water-related hazards.
  - **Wave uprush** means the rush of water up onto a shoreline or structure following the breaking of a wave; the limit of wave uprush is the point of furthest landward rush of water onto the shoreline.

- **Other water-related hazards** mean water-associated phenomena other than flooding hazards and wave uprush which act on shorelines. This includes, but is not limited to ship-generated waves, ice piling and ice jamming.
- **Erosion hazard limit:** determined using considerations that include the 100 year erosion rate (the average annually rate of recession extended over a 100 year time span), an allowance for slope stability, and an erosion/erosion access allowance.
- **Dynamic Beach hazard limit:** consists of the flooding hazard limit plus a dynamic beach allowance [30m dynamic beach horizontal setback (MNR 2001)]. The dynamic beach hazard policy is generally *“not applied where beach or dune deposits overlying bedrock are generally less than 0.3 meters in thickness, 10 meters in width or extend for less than 100 meters along the shoreline”* (NPCA 2007b).



Conservation Authorities are the governing body responsible for hazard lands in Ontario. Hazardous land, as defined in the *Conservation Authorities Act* [Section 28 (25)], is *“land that could be unsafe for development because of naturally occurring processes associated with flooding, erosion, dynamic beaches or unstable soil or bedrock.”*

Accordingly, under the *Planning Act* (MMAH 1990), the Niagara

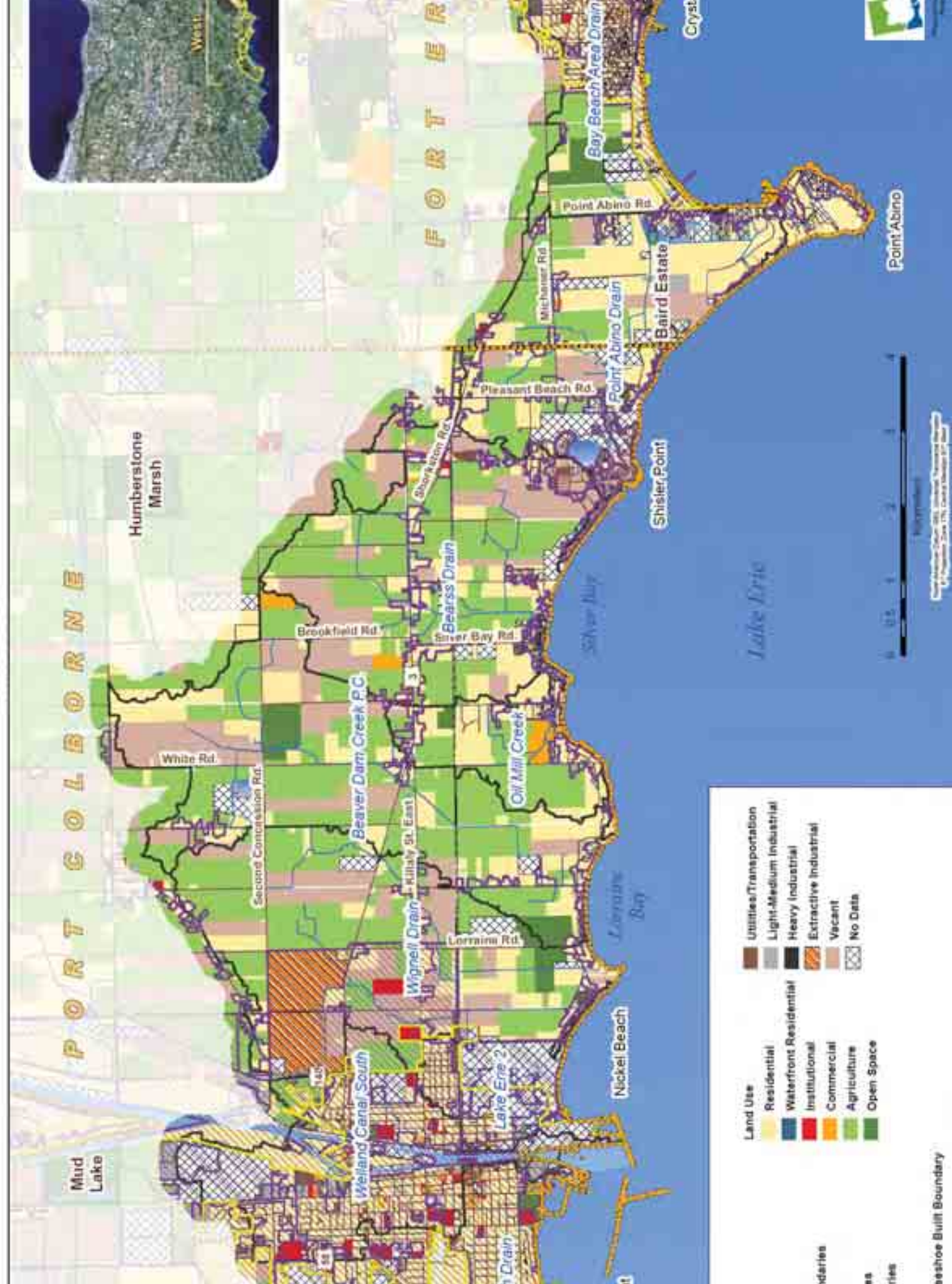
Peninsula Conservation Authority is delegated provincial responsibility for reviewing natural hazard lands for respective municipalities on any proposed development within the NPCA jurisdiction. The NPCA has a Memorandum of Understanding with regional and local municipalities whereby all water-related issues be reviewed by the NPCA. Comments provided by the NPCA outline implications of development proposals from a watershed perspective pertaining to natural hazard planning, natural heritage planning, or groundwater and surface water management [NPCA 2007b (Section 4.0)]. These comments not only reflect the goals and the objectives of the NPCA under the *Conservation Authorities Act* in terms of *“a program designed to further the conservation, restoration, development and management of natural resources other than gas, oil, coal and minerals”* (R.S.O. 1990, c. C.27, s. 20.), but also reflect the requirements of Niagara Region's and Haldimand County's environmental policies.

The policies for NPCA's regulated areas are administered under the Ontario Regulation 155/06: *Development, Interference with Wetlands and Alteration to Watercourse Regulation*. The policies apply to all *“watercourses, floodplains, valleylands, hazardous lands, wetlands, the shoreline of Lake Ontario, Lake Erie and the Niagara River, and*

## Land Use



# Lake Erie North Shore Watershed - East Land Use



*lands adjacent to each of these features/functions, within NPCA's jurisdiction" (NPCA 2007b).*

The Shoreline Management Plan prepared by Philpott Associates in 1992 followed the *Guidelines for Developing Great Lakes Shoreline Management Plans* (MNR 1987). In 2010 the NPCA updated the 1992 Lake Erie Shoreline Management Plan to adhere to changes in the *PPS* and *Planning Act* with regards to Natural Hazards Policies. The NPCA will use the *Lake Erie Shoreline Management Plan Update* (Shoreplan Engineering Limited 2010) when processing applications made pursuant to Ontario Regulation 155/16 as discussed above.

## Natural Heritage Resources

*"One of the most fundamental principles of conservation is that there should be a system of natural corridors across the landscape, interspersed with large core natural areas"* (Federation of Ontario Naturalists No Date). Not only does a natural heritage network provide a web of natural habitats that is crucial to the long-term survival and sustainability of biological diversity but this natural complex is critical in the maintenance of a healthy functioning ecosystem.



In southwestern Ontario, the Carolinian Life Zone is a rich and diverse network of cores and corridors that stretches from Toronto to Grand Bend extending southward to Lake Erie. Also known as the Eastern Deciduous Forest Region, this unique ecosystem boasts roughly one-third of Canada's rare and endangered species. Even though the Carolinian Life Zone makes up less than one percent of Canada's total land area, it contains a greater number of species than any other ecosystem in Canada and many of these species are not found anywhere

else in the country (Johnson 2005). As part of its *Big Picture* project, Carolinian Canada identified considerable lands within the Lake Erie North Shore watershed as a „Carolinian Core Natural Area' (Figures 10a and 10b).

A core natural area is defined as: *"an intact natural area with larger habitat blocks; regions with a high overall percentage of natural vegetation cover; viable occurrences of globally rare species and vegetation community types, and concentrations of rare species and vegetation; should exceed 200 hectares where possible with smaller high-quality sites in areas with lower amounts of natural vegetation cover; as well as having minimum corridor widths of 200 metres plus any adjacent areas of natural cover"* (Riley et al 2003).

Corridors provide an increase in functionality of core areas, even smaller or fragmented areas, by not only facilitating in the movement of larger mammals between natural areas, but *"they are also essential for the movement and maintenance of genetic diversity for virtually all species regardless of size or species-pollen and seeds and other genetic material are passed along corridors"* (Pim No Date).

In Ontario the *PPS* (MMAH 2005) calls for the wise use and management of resources, accordingly Section 2.1.2 of the *PPS* states: “*The diversity and connectivity of natural features in an area, and the long-term ecological function and biodiversity of natural heritage systems, should be maintained, restored or, where possible, improved, recognizing linkages between and among natural heritage features and areas, surface water features and ground water features.*”

As previously indicated, Regional Niagara's *Policy Plan: Regional Strategy for Development and Conservation* (RMN 2007a), includes objectives for a healthy landscape in the environmental policies. For example, Policy 7.A.1b calls upon planning authorities to employ an ecosystem approach that address “*The health and integrity of the broader landscape, including impacts on the natural environment in neighboring jurisdictions*” when making decisions regarding planning and development or conservation.

Likewise, the Natural Environment Policies of the *Haldimand County Official Plan* also outline various policies related to the Natural Environment, including specific policies for Provincially Significant Wetlands and Habitat for Endangered and Threatened Species, as well as general policies for other significant natural environmental features. The County is “*committed to preserving significant Natural Environmental Areas to sustain essential **ecological functions** and protect natural biological diversity*” (Section 2.A.1).

The Lake Erie North Shore Watershed Plan Restoration Strategy (Table 20 to 33) acknowledges and addresses linkages and potential corridors that extend outside of the study area. Large core areas that are present within and outside of the study area (e.g. Humberstone Marsh, Wainfleet Bog) play an integral role in the formation or enhancement of corridors.

## Lake Erie North Shore Watershed Study Area Natural Heritage Resources

The percentages of upland forest cover, wetlands, and riparian habitat in the Lake Erie North Shore watershed are recorded in Table 2. These figures will be assessed based on the guidelines set by Environment Canada (EC) (2004c) as part of the restoration strategies in the watershed plan.

All of the natural heritage areas including wetlands, woodlots, Areas of Natural and Scientific Interest (ANSI), Environmentally Sensitive/Significant areas and old growth forests are illustrated on Figures 11a, 11b, 12a, 12b, 13a, and 13b respectively, and described below. This information was compiled as a joint initiative by the Ministry of Natural Resources (MNR), Regional Municipality of Niagara, and the Niagara Peninsula Conservation Authority.

| Table 2: Natural Heritage Resources |           |                       |
|-------------------------------------|-----------|-----------------------|
| Natural Heritage Resource           | Current % | Guideline (minimum) % |
| Upland Forests                      | 20        | 30                    |
| Wetlands                            | 16        | 10                    |
| Riparian Habitat                    | 64        | 75                    |

## Carolinian Canada Signature Site

As part of the Carolinian Canada Coalition's early workings, inventories of all the remaining natural areas in the Carolinian Life Zone were reviewed by a subcommittee of scientists and stakeholders. As a result, 38 key sites were identified as being critically important; these sites are the best representatives of a particular community and ecosystem type in the Carolinian Life Zone that were at the time of survey (1984) unprotected (Johnson 2005). The **Point Abino Peninsula Sandland Forest**, located in Fort Erie, has been identified as one of the 38 key sites in the Carolinian Life Zone. This unique natural heritage site has portions that remain virtually untouched and is the "*largest expanse of naturally forested sandland hills, wetland basins, and undisturbed shoreline along the north coast of Lake Erie*" (Johnson 2005).

This site is also a Life Science ANSI, a provincially significant wetland and contains old growth forest.

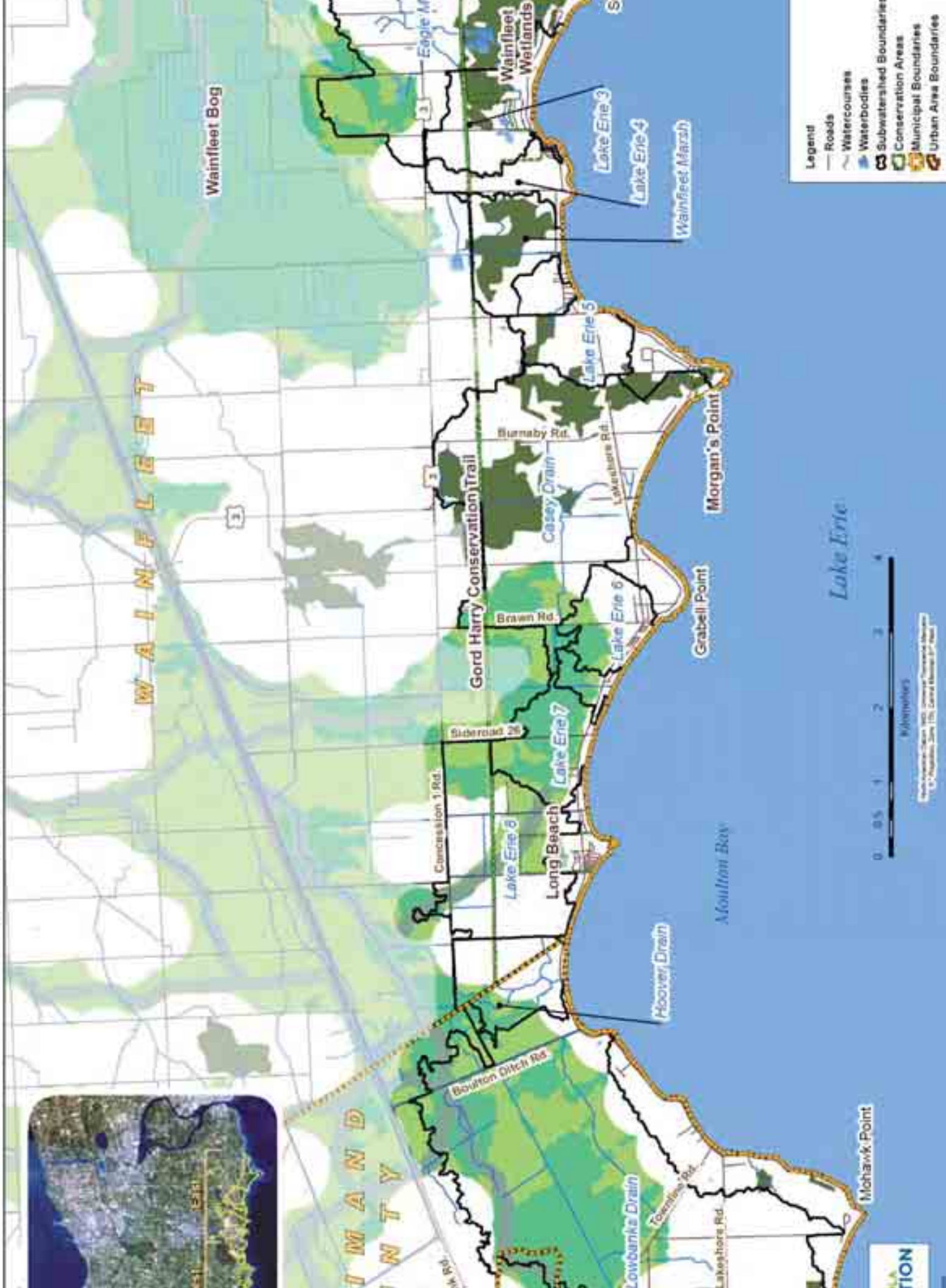
## Life Science and Earth Science Areas of Natural and Scientific Interest

An Area of Natural and Scientific Interest (ANSI) "*is an area of land and water containing natural landscapes or features that have been identified as having life science or earth science values related to protection, scientific study or education*" (MMAH 2005). The following natural areas are designated or candidate ANSIs in the Lake Erie North Shore watershed.

### *Point Abino Peninsula Sandland Forest Life Science ANSI*

The provincially significant Point Abino Peninsula Sandland Forest is remarkably rich in its diversity and representation of the Lake Erie shoreline. The significance of this ANSI has been recognized by the Ontario Ministry of Natural Resources, Carolinian Canada of which it is a signature site, and numerous naturalists and nature clubs including the Bert Miller Nature Club. The 198 hectare privately owned ANSI comprises the most extensive and spectacular expanse of naturally forested sandland hills, wetland basins and undisturbed shorelines along the north coast of Lake Erie in this region (Macdonald 1990a). The peninsula extends 3 kilometres off the north shore of Lake Erie and is a tombolo which has developed as a sand bar between an offshore limestone shelf and the mainland, eventually maturing to become a well-developed peninsula with high sand ridges originating as a dune system, sand and limestone pavement beaches, eroding sandy shorecliffs with ridge crest and backslope features, and an extensive wetland basin (Macdonald 1990a). According to an inventory done in 1980 by Macdonald (Beechey & Eagles 1985), the vegetation communities consist of a mixture of sand ridge forests and backshore wetlands. For example, the southwesterly facing slopes and backshore fringes tend to support a dry forest of white pine, red oak and red maple. On the mesic slopes, communities of sugar maple, american beech and red oak tend to dominate, while the moist intraridge basin communities support conifer groves and deciduous forests of yellow birch and silver maple. The backshore Provincially Significant Wetland communities consist of, for example, swamp scrublands; sub-intermediate deciduous swamp forest; and successional wetland communities in the open areas that were once affected by cutting.

# Lake Erie North Shore Watershed - West Cores and Connections of the Carolinian Zone



# Lake Erie North Shore Watershed - East

## Cores and Connections of the Carolinian Zone



### *Empire Beach Backshore Forest Basin Life Science ANSI*

This provincially significant Area of Natural and Scientific Interest has also been designated as a Provincially Significant coastal Wetland. The shallow basin is a clay covered limestone plain resulting in a poorly drained area which is separated from Lake Erie's shoreline by a small sand dune complex which hampers drainage resulting in a low lying swampy area. According to Macdonald (1990b) the basin itself includes a series of parallel, low sand ridges which barely rise through the organic soils of the wetland. The vegetation represents a number of Lake Erie coastal communities, of particular importance according Macdonald (1990b), is the temperate element of the deciduous and mixed lowland forests of the swamp basin. They present intermediate to sub-mature growths of silver maple, black ash, yellow birch, eastern hemlock and red ash. In the wetland basin, deciduous swamps of silver maple, white elm and red ash dominate; the sand dune vegetation is dominated by upland deciduous forest of silver maple, american beach and northern red oak with a well developed shrub and herb flora understory; and the forested vegetation along northern and eastern peripheral areas are generally disturbed by drainage, clearing and cutting, although in the north-eastern section, the "forest cover appears to have succeeded from past selective cutting, resulting in a very eclectic, but notably rich, complement in all the strata (Macdonald 1990)".

### *Humberstone Muck Basin Swamp Forest Life Science ANSI*

The provincially significant Humberstone Muck Basin Swamp Forest straddles the subwatershed boundaries of Black Creek and Beaver Dam Creek; therefore only a portion of this unique natural heritage feature falls within the Lake Erie North Shore study area. The following description has been provided by Macdonald (1980): "*The landform of this peat and muck filled basin adjacent to the Onondaga Escarpment is one of only three such occurrences in the Haldimand Clay Plain. The extent, degree of development, diversity and species richness of the community patterns, particularly those swamp forests and scrublands in the southern half, are rarely occurrent elsewhere in the region*". Vegetation communities include for example, a lowland deciduous forest which dominates the basin; deciduous swamp forests and scrubland. On the south-eastern fringe, the transition onto the Onondaga Escarpment rockland supports a forest dominated by red maple, bur and pin oak and shagbark hickory while the corresponding slope on the western side consists of deeper clay soils that support a younger successional mixture of forest patterns (Macdonald 1980).



### *Humberstone Quarry (Port Colborne Quarry) Earth Science ANSI*

The Humberstone Quarry has been designated as a provincially significant Area of Natural and Scientific Interest due to its excellent representation of the Bertie Formation. The bedrock in the quarry exhibits the contact between the Devonian (Bois Blanc Formation) and the Silurian (Bertie Formation) Palaeozoic periods. Present in the quarry, is an exposed sequence of Bertie dolostone and the presence of a major unconformity which can be traced throughout the Niagara Peninsula (MNR 1983).

### *Onondaga Formation Earth Science ANSI-regional*

The Onondaga Formation is a regionally significant Area of Natural and Scientific Interest which belongs to the Devonian Period, Paleozoic Era. Two to three metres of bedrock outcrop is exposed in a flooded quarry west of Port Colborne. The outcrop pattern of the Clarence member is controlled by the occurrence of biothermal mounds in the Edgecliff member (Telford and Tarrant 1975).

### *Bertie Formation III Earth Science ANSI-regional*

As previously described, the Bertie Formation belongs to the Silurian Period. This section is located in the Law Quarry west of Port Colborne. The Devonian Bois Blanc limestone overlies 43 feet of Silurian Bertie dolomite (MNR 1983).

## **Wetlands**

The Ontario Wetland Evaluation System (OWES) is a science-based ranking system



used by the Ministry of Natural Resources to assess wetland functions and societal values. Wetlands are evaluated and assigned a status as „provincially significant’ or „locally significant’. With the assistance of the NPCA’s Natural Heritage Areas Inventory program, the Ministry of Natural Resources is currently revising the boundaries of existing wetlands and identifying new wetlands in the Lake Erie North Shore watershed. To date, over 75 percent of the wetlands have been designated as provincially significant, approximately 10 percent are

designated as locally significant and the remaining 15 percent are awaiting evaluations.

The following wetlands have been designated as Provincially Significant Wetlands (PSWs) in the Lake Erie North Shore watershed:

The **Moulton Wetland West** provincially significant wetland complex straddles the subwatershed boundaries of Lowbanks Drain and Mill Race Creek. The wetland is comprised of 96.6 percent swamp and 3.4 percent marsh (Moraal and Smith 1984b). Numerous wetland vegetation communities have been identified by Moraal and Smith (1984b) including for example, robust emergents such as cattails; submerged plants such as coontail and pondweed; free-floating plants such as duckweed; and deciduous trees such as willow, maple and poplar.

The **Emerson Road Woodlot/ Lowbanks Backshore Provincially Significant Wetland Complex** is over 32 hectares of provincially significant wetland made up of 85 individual wetland pockets. These pockets are composed 7.2 percent swamp and 28 percent marsh (Thomas and Knoll 1986). Thomas and Knoll (1986) have noted numerous vegetation communities including for example; robust emergents such as cattails and bulrush; broad-leaved emergents such as water plantain; low shrubs such as swamp rose, dogwood, and winterberry; and deciduous trees such as red maple, swamp white oak and white elm.

Only a small portion of **The Burnaby Wainfleet Airport Wetlands** has been designated as a provincially significant wetland. This area has not undergone a complete evaluation to date, so it is possible that in the future as the evaluation is complete a larger tract of land will be given a designation of provincially significant.

The **Cement Plant Road Quarry** is a provincially significant wetland composed of 8 percent swamp and 92 percent marsh (Kwiczinski and Littleton 1989). Numerous wetland communities have been identified by Kwiczinski and Littleton (1989) including submergents such as water milfoil; low shrubs such as dogwood and poplar; and tall shrubs such as willow.

The **Nickel Beach Marsh and Woodlot** is 47 hectares of provincially significant wetland and woodlot. This area is a continuation of the Lake Erie shoreline dune complex. The area behind the dunes is flat and relatively dry except in the western section. The soils vary from Eastport Sand on the dunes to Muck and Jeddo clay in the areas behind the dunes (Brady 1980). Vegetation has been noted as mature and numerous species identified including for example, trembling and largetooth aspen; black and peachleaf willow; butternut walnut; and Allegheny serviceberry (Brady 1980).

The **Beaver Dam Creek Wetland Complex** is a provincially significant wetland complex composed of 6 individual wetlands totalling 136 hectares. This wetland complex is located behind the Lake Erie Sand Dunes and is in part an organic backshore basin. Several terrestrial linkages are present such as hedgerows, abandoned agricultural fields and meadows. Other important linkages include Lake Erie to the south and Humberstone Marsh to the north (MNR 2009b).

The **Point Abino Wetland Complex** is a provincially significant coastal wetland complex comprised of three individual wetlands consisting of 97 percent swamp and 3 percent marsh (Moraal and Smith 1984a). Numerous wetland vegetation communities have been noted by Moraal and Smith (1984a), including for example, robust emergents such as cattails; free-floating plants such as duckweed; tall shrubs such as dogwood; and deciduous trees such as maple, ash and willow.

The **Humberstone Marsh** is 381 hectares of provincially significant wetland that straddles the borders of the Black Creek and Beaver Dam Creek subwatersheds. A portion of this system has also been designated **Humberstone Muck Basin Swamp Forest ANSI**, as previously described. According to a report done by Brady (1980) the vegetation species composition varies in each of the sections of marsh. Brady noted that the vegetation of the eastern section included for example, pin oak, white and red oak and shagbark hickory; the central section consisted of trembling aspen and black cherry; and the western section was dominated by species such as red and black maple and

yellow birch. Brady also noted that the groundcover varied in thickness throughout the area and included species such as spice-bush, fern spp., and solomon's seal.

The **Wainfleet Wetlands** are 185 hectares of provincially significant wetland. The **Wainfleet Wetlands Conservation Area** consists of 181 hectares of woodlots; abandoned quarries; successional meadow; and provincially significant wetland. The Niagara Peninsula Conservation Authority purchased the land in 1978 for the purpose of providing habitat for fish and wildlife while protecting the wetland, alvar, prairie and meadow communities, and unique open rock features. This wetland is unique as it attracts a large variety of bird species. Over 50 different species of birds have been sighted including, yellow warblers, great blue herons, egrets, gulls, terns, and sandpipers (NPCA No Date). This site is also important habitat for reptiles and amphibians (Frohlich 2010).

In the woodlots that make up the wetland, numerous vegetation species have been noted by Brady (1980). These include for example, red, black and white ash, shagbark hickory, american beech and black cherry. Ground cover varies throughout the area and consists of arrow-wood, day-lilies, river-bank grape and fern spp.,

### Identified Old Growth

The Ministry of Natural Resources characterizes an old growth ecosystem “*by the presence of old trees and their associated plants, animals, and ecological processes. They show little or no evidence of human disturbance*” (MNR 1994). During an old growth forest survey conducted by the Bert Miller Nature Club during 2002 and 2003, the definition of an old growth forest used for purposes of their field work was “*a natural community that has been continuously forested since before European Settlement, and that forest's canopy must be dominated by trees with ages of 150 years or older. Most old-growth forests have 8 or more trees per acre that are 150 years old or greater*” (Bert Miller Nature Club 2004).



In the Lake Erie North Shore Watershed study area, four old growth forests have been identified by the Bert Miller Nature Club. **Marcy's Woods**, located at Point Abino, measures 65 acres of high quality (possibly virgin) old growth and has been identified as Niagara Peninsula's largest ancient forest and confirmed as the world's last known old growth black maple forest. In addition, it has also been designated as one of Carolinian Canada's signature sites. The Bert Miller Nature Club (2004) has also noted that Marcy's Woods is one of only 3 places where old growth hemlock grows on sand dunes and one of the only places known where Canadian yew thrives on sand dunes. The Canadian yew colonies in Marcy's Woods are probably 500 years old, possibly older.

Also located at Point Abino is **Phillips Ancient Sugar Bush Grove** which historically was a sugar bush. The survey conducted by the Bert Miller Nature Club (2004) noted that most of the sugar maples were in the 300 to 320 year range, with a few possibly reaching 400 years old.

**Sugar Loaf Hill**, located along the Lake Erie shoreline just west of Port Colborne's downtown area, is one of three Lake Erie coastal dunes to be covered by old growth trees. The Bert Miller Nature Club noted ancient hemlocks growing on sand dunes, which is an extremely rare scenario. In addition, several tree species with ages ranging from 150 years old to over 200 years old were identified. These include for example, a sugar maple with a diameter ranging from 20 to 26 inches and an age ranging from 165 to 230 years old; a hemlock with a diameter of 14 inches and an age ranges of 170 to over 200 years old; and a pignut hickory with an 18 inch diameter and an age range of 175 to 190 years old (Bert Miller Nature Club 2004).

**Morgan's Point** owned by the Niagara Peninsula Conservation Authority has been noted as Lake Erie's most eastern lakeshore savannah grove with old growth trees up to 73 inches in diameter and ages of 300 years old (Bert Miller Nature Club 2004). Most of the large trees are stately black walnuts with a diameter range around 30 inches and an age range of 150 to 200 years old. Other old growth species include for example, sugar maples with a diameter range of 20 to 34 inches and ages reaching over 300 years old; a record sized red oak with a 73 inch diameter and an age of 350 years; and several hop hornbeam have been identified with diameters ranging from 8 to 15 inches and ages ranging from 230 to 250 years old (Bert Miler Nature Club 2004).

## **Conservation Areas**

### *Long Beach Conservation Area*

Long Beach Conservation Area is located in the Township of Wainfleet along Lake Erie. This 56 hectare park offers camping, swimming and numerous other opportunities for beach related activities along the sandy shores of Lake Erie. Forest and lake habitats present opportunities for bird watching and wildlife photography. Exposed limestone rock along parts of the shoreline at Long Beach offer visitors an opportunity to examine fossilized remains of ancient flora and fauna. Under the lake's surface this unique rock form continues out to a small island visible from shore. The result is a natural magnet to the Great Lakes birds and fish, offering them unique shelter, feeding and spawning habitat (NPCA No Date).

### *Morgan's Point Conservation Area*

Located along the shore of Lake Erie, this significant parcel of land is designated as a regionally environmentally sensitive area due to its significant dune and plant community, including old growth forest as previously described. The lakefront bedrock shoal outcrop, sand dunes, tall grass meadow, woodlot and open areas offer passive recreational uses as well as an excellent opportunity for viewing migratory birds and monarch butterflies.

### *Wainfleet Wetlands Conservation Area*

The Wainfleet Wetlands Conservation Area has in part been designated as provincially significant wetland, as previously described. This area also offers numerous summer and winter recreational activities such as hiking, snowshoeing, cross-country skiing and nature appreciation. The walls of the quarries pose a unique opportunity to view the bedrock formations of the Onondaga Formation. Coral fossils that comprise a part of our natural history are displayed in this unique open rock history and can be observed throughout the Wainfleet Wetlands quarries. In addition, as described earlier, this conservation area is important for the protection of various ecological communities and providing habitat for wildlife (Frohlich 2010).



### *Gord Harry Conservation Trail (formerly Wainfleet Rail Trail)*



This multi-use trail follows the pathway of the former Grand Trunk Railroad, stretching 13 kilometers from the Wainfleet Wetlands Conservation Area, west to the border of Wainfleet and Haldimand County. The trail offers horseback riders, cyclists and hikers an opportunity to enjoy the picturesque countryside from the spoils of a manicured trail.

### *Baird Estate Conservation Area and Wildlife Reserve*

This 2 hectare wetland does not have any public access; this natural areas acts as a wildlife refuge.

### *Philips Conservation Area (not indicated on mapping)*

Philips Conservation Area is 38 hectares in size and includes **Philips Ancient Sugar Bush Grove**. This conservation area protects the diversity of ecological communities and wildlife habitat of forest; wetland; meadow; old growth forest of sugar maple, black cherry, and oak; and meta core and wildlife connections (Frohlich 2010). There is no public access to this site.

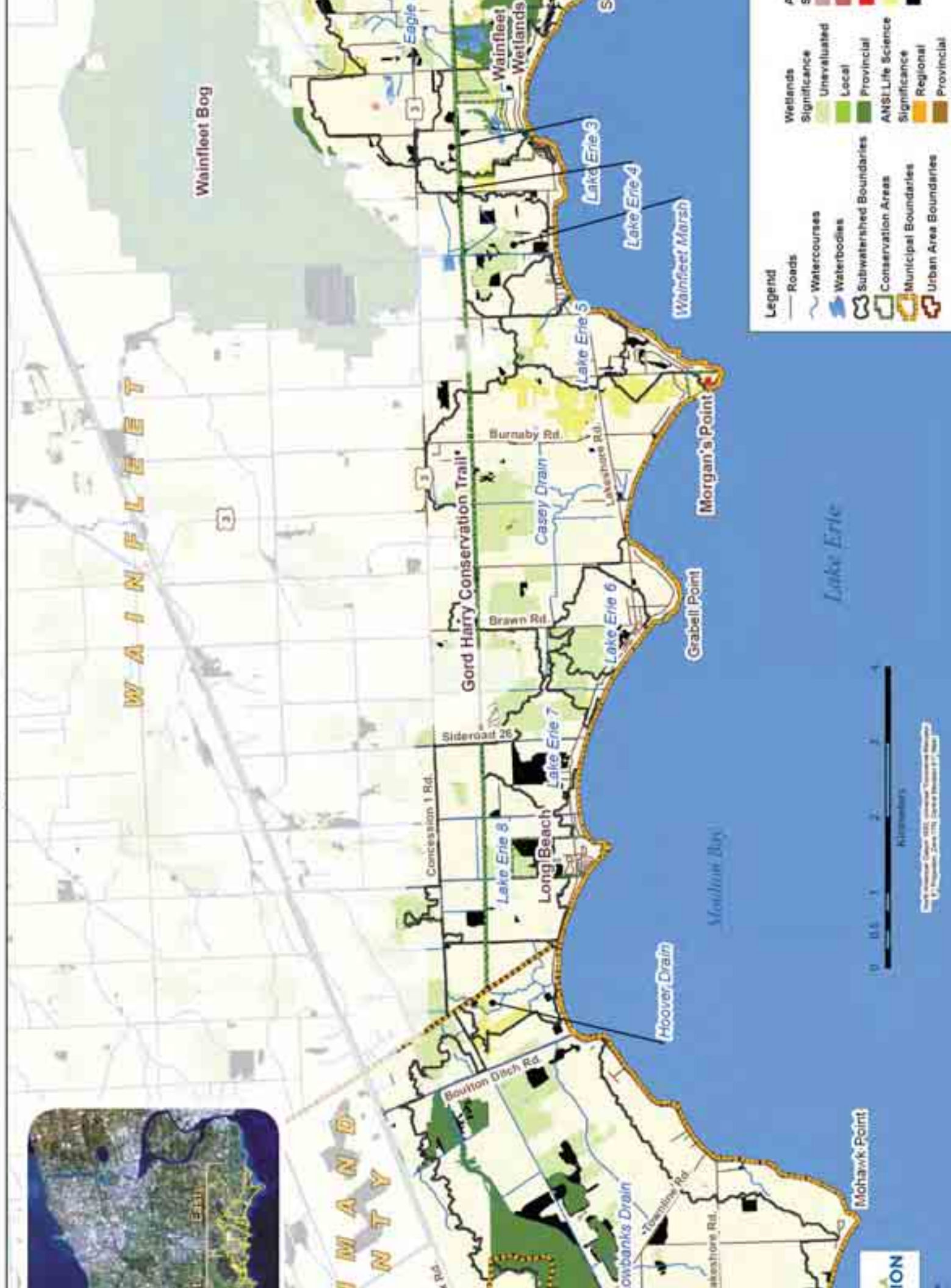
## Important Bird Areas

Important Bird Areas (IBA) are sites critical to the long-term viability of bird populations and are priority areas for “*the conservation of globally threatened, range restricted and congregatory birds*” (Bird Life International No Date). IBA areas are recognized as having an occurrence of key bird species that are vulnerable to global extinction or whose populations are otherwise irreplaceable.

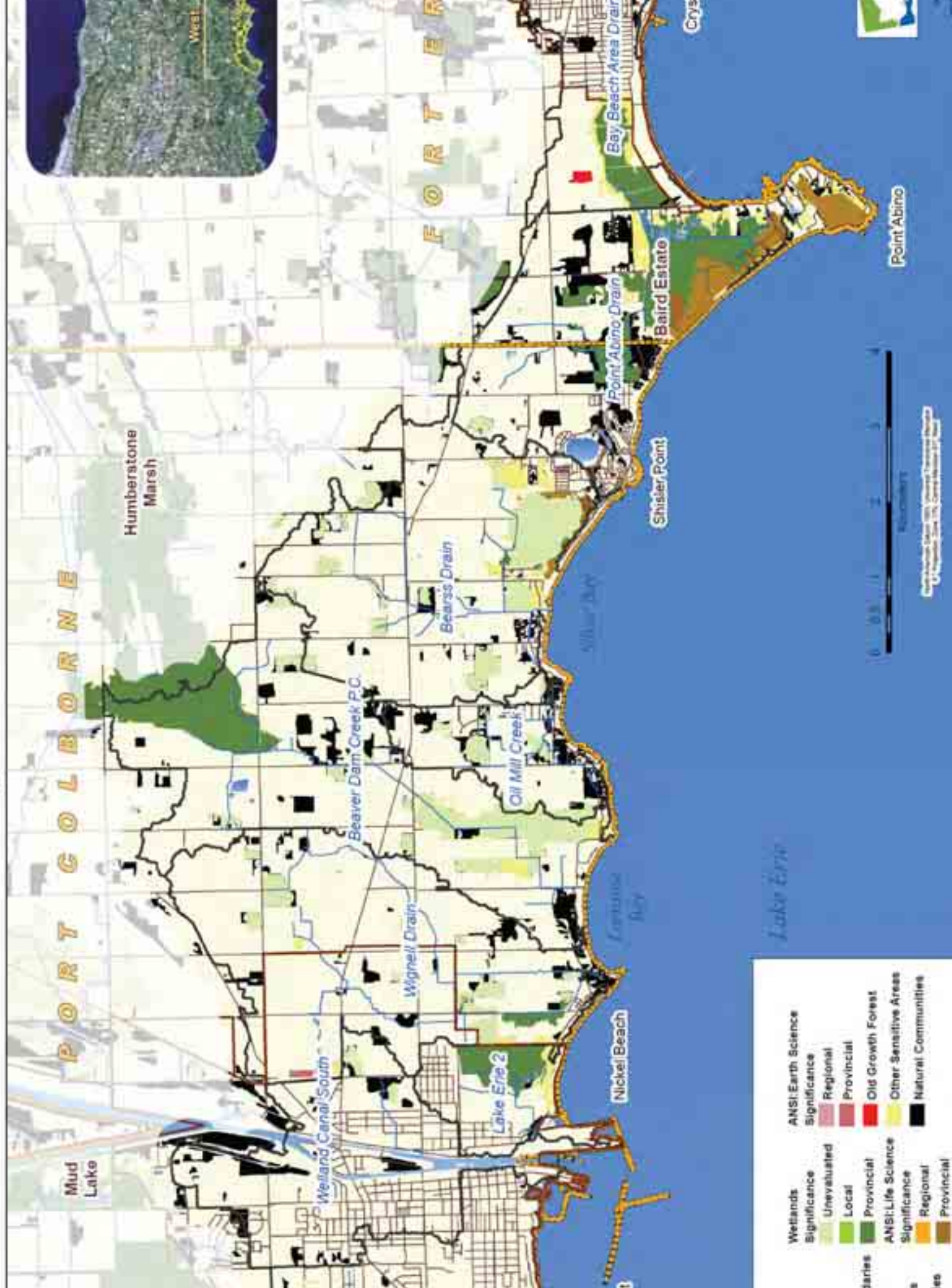
There are two recognized IBA's in the Lake Erie North Shore study area; **Point Abino** and **Port Colborne's breakwater and mainland**. **Point Abino**, also a designated provincially significant ANSI, PSW, old growth forest, significant woodland and a Carolinian Canada signature site, boasts a diverse breeding community. Several rare species of songbirds such as acadian flycatchers, hooded warblers and cerulean warblers have been noted in the area. In addition, in a 1999 survey 73 breeding bird species were observed (Bird Studies Canada No Date). During the spring and fall migration, large concentrations of land birds commonly gather off the tip of the Point Abino peninsula.

The **Port Colborne** IBA consists of colonies at two locations; on a breakwater approximately one kilometer offshore, and a landfill inland on the east side of the Welland Canal terminus. Common terns (breakwall colony) and ring-billed gulls (both colonies) can be found nesting at these colonies. Bird Studies Canada noted that 1,311 pairs of common terns were recorded at the breakwall in 1987 and in 1990; an estimated 43,590 pairs of ring-billed colonies were nesting on the mainland site along with another 2,500 on the breakwater. In addition to the common terns and ring-billed gulls, Bird Canada Studies recorded 175 pairs of nesting herring gulls and in 1997 a pair of great-backed gulls was identified nesting there for the first time.

# Lake Erie North Shore Watershed - West Significant Natural Areas



# Lake Erie North Shore Watershed - East Significant Natural Areas

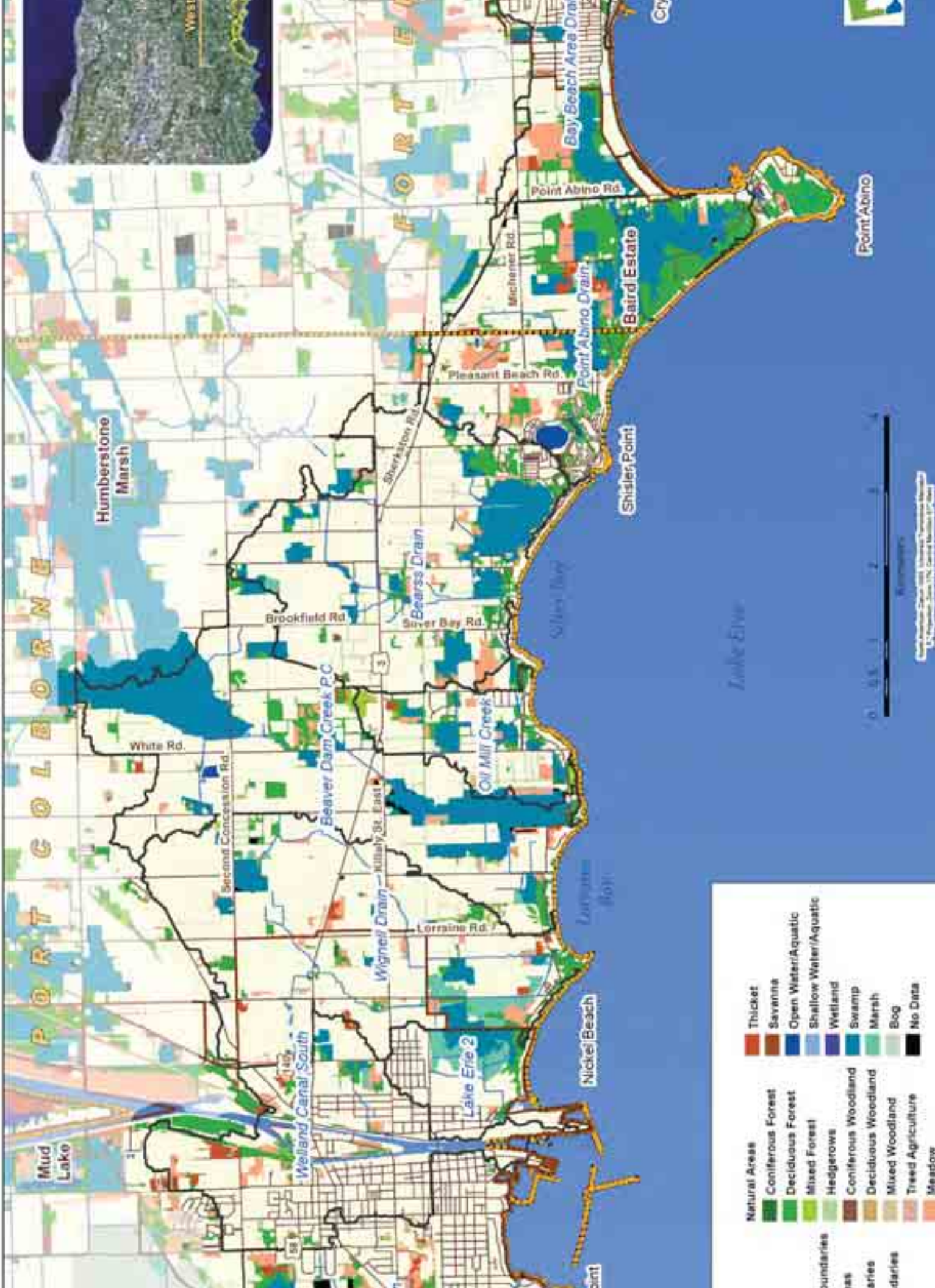


## Natural Heritage System



# Lake Erie North Shore Watershed - East

## Natural Heritage System



- |                      |                       |
|----------------------|-----------------------|
| <b>Natural Areas</b> | <b>Thicket</b>        |
| Coniferous Forest    | Savanna               |
| Deciduous Forest     | Open Water/Aquatic    |
| Mixed Forest         | Shallow Water/Aquatic |
| Hedgerows            | Wetland               |
| Coniferous Woodland  | Swamp                 |
| Deciduous Woodland   | Marsh                 |
| Mixed Woodland       | Bog                   |
| Treed Agriculture    | No Data               |
| Meadow               |                       |

Map prepared by: [illegible]  
 Date: [illegible]  
 Scale: 1:50,000

## NPCA Natural Areas Inventory Sites

In 2006, the Niagara Peninsula Conservation Authority initiated a comprehensive Natural Areas Inventory that was completed in partnership with the Regional Municipality of Niagara, local municipalities, Peninsula Field Naturalists and numerous other partners. The goal of the project was to use industry standard, scientifically-defensible protocols to inventory the natural areas in the NPCA watershed. The updated inventory will provide a solid resource of information to aid in planning decisions, policy development, and the prioritization of restoration opportunities. Four major aspects comprise the Natural Areas Inventory project, these include a Community Series Ecological Land Classification (ELC) Mapping; field verifications of vegetative communities to Vegetation Type (ELC); faunal inventories of for example birds, lepidoptera and odonata, herpetofauna, and lichens; and education. In total, over 500 properties were visited for ELC vegetation type assessments.

The following descriptions of natural areas and associated mapping (Figures 13a and 13b) have been derived directly from the NPCA Natural Areas Inventory Report. For more information regarding the faunal inventories conducted during this study, please refer to the NPCA NAI Report.

**Site ID:** HAL-01-00-00-00-00

**Municipality:** Haldimand County

**Subwatershed:** Lowbanks Drain

**Approx. Size:** 50 hectares

**General Summary:** Study site HAL-01 is located along the Lake Erie shoreline and was primarily made up of swamp and marsh communities. The swamp community was dominated by Green Ash with associates. There are a total of 72 recorded taxa (unique plant records) for this site.



This site is also in part designated as wetland and is awaiting evaluation in terms of significance.

**Name:** Bunz Bush (Brady 1980)

**Site ID:** WF-17-00-00-00-00

**Municipality:** Haldimand /Wainfleet

**Subwatershed:** This study site drains east to Mill Race Creek, south to Hoover Drain and west to Lowbanks Drain.

**Approx. Size:** 727 hectares

**General Summary:** This very large study site is located south of the feeder canal and is bound by Lake Erie on the south, Townline Road in Lowbanks on the west and Sideroad 30 in Wainfleet on the east. The dominant community at this site is Green Ash Swamp. The swamps are underlain by clay loam soils that help them hold water and there are many large vernal pools. The properties visited also contained many high climbing vines. A second noted community is dominated by Poplar Swamp with the Green Ash Swamp in the lower lying areas. Throughout this community, there are drier knolls where the Poplars are the dominant species. The wetter areas of the swamp support

small communities of Green Ash Organic Swamp with organic accumulation up to 55cm deep. There are a total of 130 recorded taxa for this study site.

This site is also in part designated as **Moulton Wetland West PSW** and a portion of the identified wetland on this site is still waiting to be evaluated in terms of significance.

**Name:** Harold Mitchell Nature Reserve

**Site ID:** WF-18-00-00-00-00

**Municipality:** Township of Wainfleet

**Subwatershed:** Mill Race Creek and Hoover Drain

**Approx. Size:** 66 hectares

**General Summary:** Study site WF-18 is located at Long Point along Lake Erie. It is bound by Concession 1 Road to the north, Minor Road to the east, Etling Road to the west, and Lakeshore Road to the south. This area is a nature reserve owned by the Niagara Falls Nature Club. It has a slough-ridge terrain with numerous ponds and open marshes. This site contains



the last remaining stand of Hemlock trees along Lake Erie in the Niagara Region (The Nature Conservancy of Canada 1979). There is also a complex of fresh-moist mixed meadow ecosite (MEMM4) that covers a smaller portion of the polygon or site, generally on the higher knolls. There are a total of 132 recorded taxa for this study site.

This site is also in part designated as **Harold Mitchell Nature Reserve LSW** and partially falls within the boundary of **Long Beach Conservation Area** and the **Gord Harry Conservation Trail**.

**Name:** Emerson Road Woodlot (Brady 1980)

**Site ID:** WF-19-00-00-00-00

**Municipality:** Township of Wainfleet

**Subwatershed:** This study site drains to Lake Erie via a number of drains.

**Approx. Size:** 331 hectares

**General Summary:** This study site is bounded by Concession 1 Road to the north, Lake Erie/ Lakeshore Road to the south, Station Road to the east, and Minor Road to the west. The majority of this study site is a typical slough forest community with complex microtopography. It was noted that the canopy is highly variable and successional. There was some standing water present at the time of the survey. The dominant species recorded include, Green Ash, Freeman's Maple, Red Maple, Red Oak, and White Elm. Other associates noted were Eastern Cottonwood, Swamp White Oak, and Willow. The understory was characterized by Gray Dogwood, Nannyberry, and Choke Cherry with some small Silver Maple or Shagbark Hickory. The herbaceous layer consisted of largely Spotted Touch-me-nots, Sedges, Thicket Creeper, Avens, and Goldenrods. Other noted areas were a complex mix of thicket swamps, marshes, and upland knolls of thicket. These areas were largely Narrow-leaved Meadowsweet, dominated with Gray Dogwood and Southern Arrow-wood as associates. The wet

pockets were characterized by Cattails and Willows. There are a total of 206 recorded taxa for this study site.

This site is also in part designated as **Emerson Road Woodlot /Lowbanks Backshore PSW Complex. The Gord Harry Conservation Trail** also cuts across the top of this site.

**Name:** Morgan's Point (Brady 1980)

**Site ID:** WF-21-00-00-00-00

**Municipality:** Township of Wainfleet

**Subwatershed:** Casey Drain and Mill Race Creek

**Approx. Size:** 194 hectares

**General Summary:** The site is bordered by Lake Erie to the south, Burnaby Rd. to the west, CNR tracks to the north, and Golf Course Rd. to the east. The town of Burnaby lies in the centre of the area. This area comprises 30 hectares of gently rolling terrain (Brady 1980) and for the most part is characterized by very rich upland forest communities. The most common was a Sugar Maple, White Ash community with Staghorn Sumac, and Black Raspberry. Shagbark Hickory was the dominant canopy species in some areas with an herbaceous layer of White Trillium, Herb Robert and some Garlic Mustard. Also noted was a very rocky area of the Onondaga Escarpment with vernal pools associated with changes in microtopography. In this area, the canopy was more fragmented with many dying White Ash. Some regeneration was noted along with a thicker shrub layer. There are a total of 209 recorded taxa for this study site.

This site is also in part designated as **Burnaby Wainfleet Airport PSW and LSW, Morgans Point Old Growth Forest, and Morgan's Point Conservation Area. In addition, Gord Harry Conservation Trail** cuts through a portion of the study site.

**Name:** Fletcher Woodlot (Brady 1980)

**Site ID:** WF-15-00-00-00-00

**Municipality:** Township of Wainfleet

**Subwatershed:** Mill Race Creek

**Approx. Size:** 167 hectares

**General Summary:** The Fletcher Woods study site is located south of the Feeder Canal and the Village of Wainfleet. It stretches south of Concession 1 Road and is nestled between Sideroad 22 and Gilmore Road, west of where Highway 3 turns north towards the Village. Within the Green Ash swamp were drier knolls that supported a community of Red Oak, Sugar Maple and White Ash. Small depressions were found throughout this study site that held water for extended periods of time and therefore had no ground cover. A total of 29 taxa were recorded for this study site.



**Name:** Wainfleet Wetlands – Eagle Marsh Drain (Brady 1980)

**Site ID:** WF-22-00-00-00-00

**Municipality:** Township of Wainfleet

**Subwatershed:** Wainfleet Marsh and Eagle Marsh Drain

**Approx. Size:** 454 hectares

**General Summary:** This site is located south of the Wainfleet Bog/ Highway 3 between Golf Course Road to the west and Steele Street to the east. The southern boundary is Lake Erie. This study site is unique in that it contains all of the expected wetland communities but also has interesting communities associated with exposed rock including alvar and rock barren. The most common community recorded for this study site was the Shallow Marsh community characterized by Common Reed, Rushes, Sedges, Cattails, and Canada Blue-joint. The study site also has a very rich coastal marsh, which is most likely the largest coastal shallow marsh along the Lake Erie Shoreline from Fort Erie to Wainfleet. A dam immediately north of Lakeshore Road disconnects this marsh from fluctuating lake levels. The second most common community denoted was Thicket Swamp. This community was dominated by Silky Dogwood with Gray Dogwood, Southern Arrow-wood, Narrow-leaved Meadowsweet, Nannyberry, Willows, and Manitoba Maple. For more information on this site please refer to the NPCA NAI Inventory. There are a total of 564 recorded taxa for this site. This site is also in part designated as **Cement Plant Road Quarry PSW, Wainfleet/Eagle Marsh Drain PSW, and Wainfleet Wetlands Conservation Area. In addition, Gord Harry Conservation Trail** cuts through a portion of the study site.



**Site ID:** WF-13-00-00-00-00

**Municipality:** Port Colborne / Wainfleet

**Subwatershed:** Primarily part of the Biederman Drain subwatershed with a portion in the west draining to the Mill Race Creek subwatershed.

**Approx. Size:** 2080 hectares

**General Summary:** This study site is bordered by the Welland Canal on the east and Dixie Road on the west. It is located south of the Feeder Canal and stretches south of Highway 3. This large study site can be subdivided into three areas; the Onondaga Escarpment, Mud Lake, and the Wainfleet Bog (Brady 1980).

#### Onondaga Escarpment Sites

The Onondaga Escarpment contains the wooded scarp itself, which is surrounded by agriculture, and is the southern boundary of the Wainfleet Bog. The community occurring in large patches along the drier escarpment rim supports large, spreading Red Oaks that dominate the canopy with Sugar Maple as a close co-dominant. Associates include Bitternut Hickory, American Beech, Black Cherry and occasionally, Red Elm. The subcanopy is dominated by Sugar Maple with Hop Hornbeam, Black Maple, and American Elm occasionally occurring. White Ash and Choke Cherry form a very sparse shrub layer. On the ground layer, Blue Cohosh, Wild Leeks, Herb Robert, Running Strawberry and False Solomon's Seal cover between 25 to 60% of the rocky\stony shallow soil. However, particularly in areas further back from the escarpment rim, Sugar Maple forms the canopy. For additional information on the Onondaga Escarpment site as well as information on the Mud Lake and Wainfleet Bog sites, please refer to the NPCA Natural Areas Inventory. A total of 620 taxa were documented at these sites.

This site is also in part designated as **Wainfleet/Eagle Marsh Drain Wetland Complex PSW, Onondaga Escarpment Wetland Complex LSW, and Bertie Formation (III) Earth Science ANSI.**

**Name:** Sugarloaf Hill (Sand Hills)

**Site ID:** PC-10-00-00-00-00

**Municipality:** City of Port Colborne

**Subwatershed:** Eagle Marsh Drain

**Approx. Size:** 27 hectares

**General Summary:** This site is located on the west side of the Welland Canal and follows the shoreline from Elm Street west to Quarry Road. The northern boundary is Lakeshore Road. This site includes very tall canopied mature forest with scattered old growth individuals. Many Red Oak and Sugar Maple trees are approx. 1m diameter at breast height. The sand dunes are stabilized with Red Oak - Sugar Maple forests and are carpeted with Impatiens or Garlic mustard in the ground layer. Some patches support grassy areas of Nodding Fescue and shrubs of Bladdernut along the top or ridge of dune. The bedrock outcrop east of Sugarloaf Hill has nice Willow species thickets with some shrubby Eastern Cottonwood and very nice Juncus (Rush)/ Great Lake Coastal Meadow marshes following the numerous bedrock fissures. The majority of species for this study site were observed on the Calcareous Rock/ Bedrock Open Shoreline Ecosite or the Willow Gravel Shrub Shoreline Type patch and especially from the marshes which grow in the bedrock fissures closer to the waveline. While the majority of the plants were recorded in the complexes, the open sandy beach covered a greater percentage of the area. In this Open Sandy Beach community, the plant cover is very patchy and barren. Sea Rocket, Clammy Weed, Beach Pea and other upland species were found in this community. For more information on this site please refer to the NPCA Natural Areas Inventory. A total of 112 taxa were collected for this study site.

This site is also in part designated as **Sugar Loaf Hill** old growth forest.

**Name:** Canal Lands

**Site ID:** WE-07-00-00-00-00

**Municipality:** City of Port Colborne

**Subwatershed:** This study site follows the Welland Canal on both sides from the Welland River to Lake Erie and therefore only a portion is in the Watershed Plan study area. This study spans the Welland Canal North, Welland Canal, Welland Canal South and Welland River Between Canals subwatersheds.

**Approx. Size:** 1081 hectares

**General Summary:** This site is characterized by poor soils due to the construction of the canals. The soil horizon in many areas is inverted and thus there are vast areas where no vegetation is present. Field crews did visit some vegetated areas of Deciduous Swamp communities with dominant Green Ash and Swamp Maple. The understory was largely regenerating Green Ash and Swamp Maple with a ground cover of Fowl Manna Grass, Crested Sedge, Spotted Touch-me-not, and False Nettle. There are a total of 92 recorded taxa for this study site.

**Name:** Nickel Beach Woodlot (Brady 1980)

**Site ID:** PC-04-00-00-00-00

**Municipality:** City of Port Colborne

**Subwatershed:** Wignell Drain

**Approx. Size:** 197 hectares

**General Summary:** This study site includes a very rich active dune community. It is the third largest extant of dune ecosystem in the entire NPCA watershed jurisdiction. A rare form of poison-ivy thicket is found here with stems up to 30-60cm tall on active dunes as

an associate with the more dominant Beach Grass. The backdunes are a mix of Red Oak – Hop Hornbeam dune forest in the rich mature areas and naturalized Scotts Pine or Red Pine plantations. Also a very neat and rich Sugar Maple- Hemlock forest covers cool, north facing slopes to the east of the study area. A total of 154 recorded taxa were collected for this study site.

This site is also in part designated as **Nickel Beach Marsh PSW**.

**Name:** Babion Woods (Brady 1980)

**Site I.D.:** PC-01-00-00-00-00

**Municipality:** City of Port Colborne

**Subwatershed:** The majority of this study site flows to the Indian Creek Drain with a small portion draining north/west to the Lyons Creek Drain.

**Approx. Size:** 751 hectares

**General Summary:** The relatively flat terrain of this study site contains intermittent sloughs and numerous drainage ditches. The extensive network of drainage ditches and the construction of the highway have lead to a drier community than would have existed historically. The most common community noted was the Deciduous Swamp dominated by Swamp Maple and Green Ash. Associated species included, Swamp White Oak, Red Maple, Silver Maple, and White Elm. There are a total of 176 recorded taxa recorded for this site.

**Name:** Dann Dunes

**Site ID:** PC-16-00-00-00-00

**Municipality:** City of Port Colborne

**Subwatershed:** Wignell Drain

**Approx. Size:** 38 hectares

**General Summary:** Located south of Highway 3 between Lorraine Road and Weaver



Road. This natural area supports an excellent example of forested sand dunes with numerous old growth trees and old growth forest characteristics. The Deciduous Forests recorded were dominated by Sugar Maple, Red Oak and some Eastern Hemlock. A large forested swamp characterized by Red Maple, Green Ash and Yellow Birch was also noted for this Study Site. The Thicket Swamp and Meadow Marsh communities were situated on mineral or deep organic soils

in a backdune muck basin. The Thicket Swamp was dominated by Bebb's Willow with Silky Dogwood and Narrow-leaved Meadowsweet. The Meadow Marsh was largely Reed Canary Grass. This natural area is noteworthy for its many old growth trees and for being one of the best examples of forested dune communities along the Lake Erie shoreline. There are a total of 160 recorded taxa for this study site.

This site is also in part designated as **Beaver Dam Creek Wetland Complex PSW**.

**Name:** Weaver Road Woods (Brady 1980)

**Site ID:** PC-05-00-00-00-00**Municipality:** City of Port Colborne**Subwatershed:** Beaver Dam Creek and Oil Mill Creek**Approx. Size:** 190 hectares

**General Summary:** It is bounded by Main Street East/Highway 3 on the north, Lake Erie to the south, Weaver Road to the west and Pinecrest Road to the east. The most common community noted was Deciduous Swamp dominated by Green, Swamp Maple, and Red Maple with White Elm. The understory was largely Spicebush, Climbing Poison-ivy, Common Buckthorn, and Gray Dogwood. The herbaceous layer was a mix of Spotted Touch-me-not, Fowl Manna Grass, Radiate Sedge, Stout Woodreed, Awl-fruited Sedge, Goldenrod species, and Western Poison-ivy. There are a total of 167 recorded taxa for this study site.

This site is also in part designated as **Beaver Dam Creek Wetland Complex PSW**.

**Name:** Old Mill Creek Wetlands and Dunes**Site ID:** PC-14-00-00-00-00**Municipality:** City of Port Colborne**Subwatershed:** Old Mill Creek and Bearss Drain.**Approx. Size:** 129 hectares

**General Summary:** This site lies between Highway # 3 to the north, Lake Erie to the south, Pinecrest Road to the west, and Bearss Drain to the east. The first community is dominated by Swamp Maple or Red Maple with numerous large spreading trees, some over 1m diameter. The major associate throughout this community is Green Ash which dominates some patches. White Elm, Shagbark Hickory and occasionally Bitternut Hickory or Yellow Birch are found as associates. There were pockets with deep organics which measured more than 30cm where the wetland and dune meet. A low, stabilized back-dune community dominated by very large diameter, mature Red Oaks with patches of American Beech (some very, very large, almost 1m dia., and healthy trees) was also documented. A few Yellow Birch were recorded near the wetland edge, along with a Black Cherry and one, approx. 50cm dia., Tulip Tree. A total of 38 taxa were documented at this site.

This site is also in part designated as **Oil Mill Creek Wetland Complex LSW** and **Empire Beach Backshore Basin Forest Life Science ANSI and PSW**.

**Site ID:** PC-11-00-00-00-00**Municipality:** City of Port Colborne**Subwatershed:** Bearss Drain and Beaver Dam Creek P.C.**Approx. Size:** 123 hectares

**General Summary:** This site is situated below Humberstone Marsh. There is a very successional swamp forest regenerating around upland patches of plantation (plantation includes open meadow patches\Grey Dogwood thicket or closed plantation). A strip of old field meadow stretches from east to west along the northern margin of the natural area. This also supports an inclusion of Narrow-leaved Cattail Shallow Marsh. To the south of the forested polygons 1 & 2, a dry-moist old field has also succeeded with numerous meadow marsh slough communities. The study site also has many large diameter oaks. A total of 206 taxa were collected for this study site.

This site is also in part designated as **Humberstone Southwest Wetland Complex LSW**.

**Name:** Point Abino (Brady 1980)

**Site I.D.** FE-11-00-00-00-00

**Municipality:** Town of Fort Erie

**Subwatershed:** Point Abino Drain

**Approx. Size:** 639 hectares

**General Summary:** This site is bounded by Pleasant Beach Road to the west, Willowood Avenue to the east, Sherkston Road and Michener Road to the north and Lake Erie to the south. Along the lake there are high dunes with good drainage, while behind these dunes the area is very low and consists primarily of marsh and swamp communities. The sand dunes at Point Abino support a mature virgin forest and are considered a unique geomorphological and biological feature in Ontario. The foredune and beach community adjacent to Lake Erie is also significant since it is one of few examples of a natural, relatively undisturbed beach at the eastern end of Lake Erie. A mature Silver Maple Deciduous Swamp lies north of the deciduous dune forest and is a high quality, mature and undisturbed forest community. The Shallow Marshes or backdune wetlands are characterized by Broad-leaved Sedges and deep organic soils. The Point Abino Drain runs along the north and west of this study site and has lead to a drastic drying of the once dominant wetland communities and swamp forests. In places there are 120 cm of organics but they are mostly dry. The deep open water channel of the drain supports a continuous mat of Lesser Duckweed. There are a total of 448 recorded taxa for this study site.

This site is also in part designated **Point Abino Wetland Complex PSW**, **Point Abino Peninsula Sandland Forest Life Science ANSI** and Old growth forest **Marcy's Woods** and **Philips Sugar Bush Grove**. This site also encompasses **Baird Estate Conservation Area**.

**Name:** Humberstone Marsh (Brady 1980)

**Site ID:** PC-03-00-00-00-00

**Municipality:** City of Port Colborne

**Subwatershed:** Black Creek, Indian Creek Drain and Beaver Dam Creek Drain

**Approx. Size:** 895 hectares

**General Summary:** A small area of this large site was visited by NAI Field Crews. The following is a summary of the notations taken in the field. The dominant community noted is Deciduous Swamp with Red Maple, Green Ash, and Swamp Maple as the dominant species. The higher ground between wet depressions in the swamps was categorized as Deciduous Forest dominated by Red Oak, White Oak, and Shagbark



Hickory. The marshes for which this area is named were categorized as Sedge Marshes or Cattail Marshes. The Broad-leaved Sedge Marshes were dominated by a variety of sedges including Fox Sedge, Porcupine Sedge, and Bladder Sedge with Three-lobed Beggar-ticks, Spotted Touch-me-not and Sensitive Fern. The Shallow Marsh community dominated by Broad-leaved Cattails and Rice Cut Grass included Narrow-leaved

Meadowsweet, Three-lobed Beggar-ticks and Porcupine Sedge. There are a total of 286 recorded taxa for this study site.

This site is also in part designated as **Humberstone Marsh PSW** and **Humberstone Muck Basin Swamp Forest Life Science ANSI**. As previously indicated, only a portion of this site falls in the Lake Erie North Shore Watershed Plan study area.

In 1979 and 1980, Brock University undertook a field study that involved inventorying and evaluating remnant natural areas in the Niagara Region. A remnant natural area is best defined as “*areas which maintain a forest ecosystem that appears unaltered by urban or agricultural activities at this time*” [time of study] (Brady 1980). Through the study, numerous significant natural areas were documented throughout the Niagara Region. „*Significant*” in regards to natural heritage features and areas, is defined in the RMN Environmental Policies as “*ecologically important in terms of features, functions, representation or amount, and contributing to the quality, diversity, ecological health and integrity of the Core Natural Heritage System*” (Section 7.36.c). For this inventory, significance was based on numerous criteria borrowed from previous studies done by Eagles and Adindu (1978). Examples of the criteria used include: the ecological function is vital to the healthy maintenance of a natural system beyond its boundaries (e.g., water storage/recharge area); the area is an unusual habitat with limited representation, or a small remnant of a particular habitat which have virtually disappeared within the Region; area provides habitat for rare or endangered species; and the area has an unusually high diversity of biological communities and associated plants and animals.

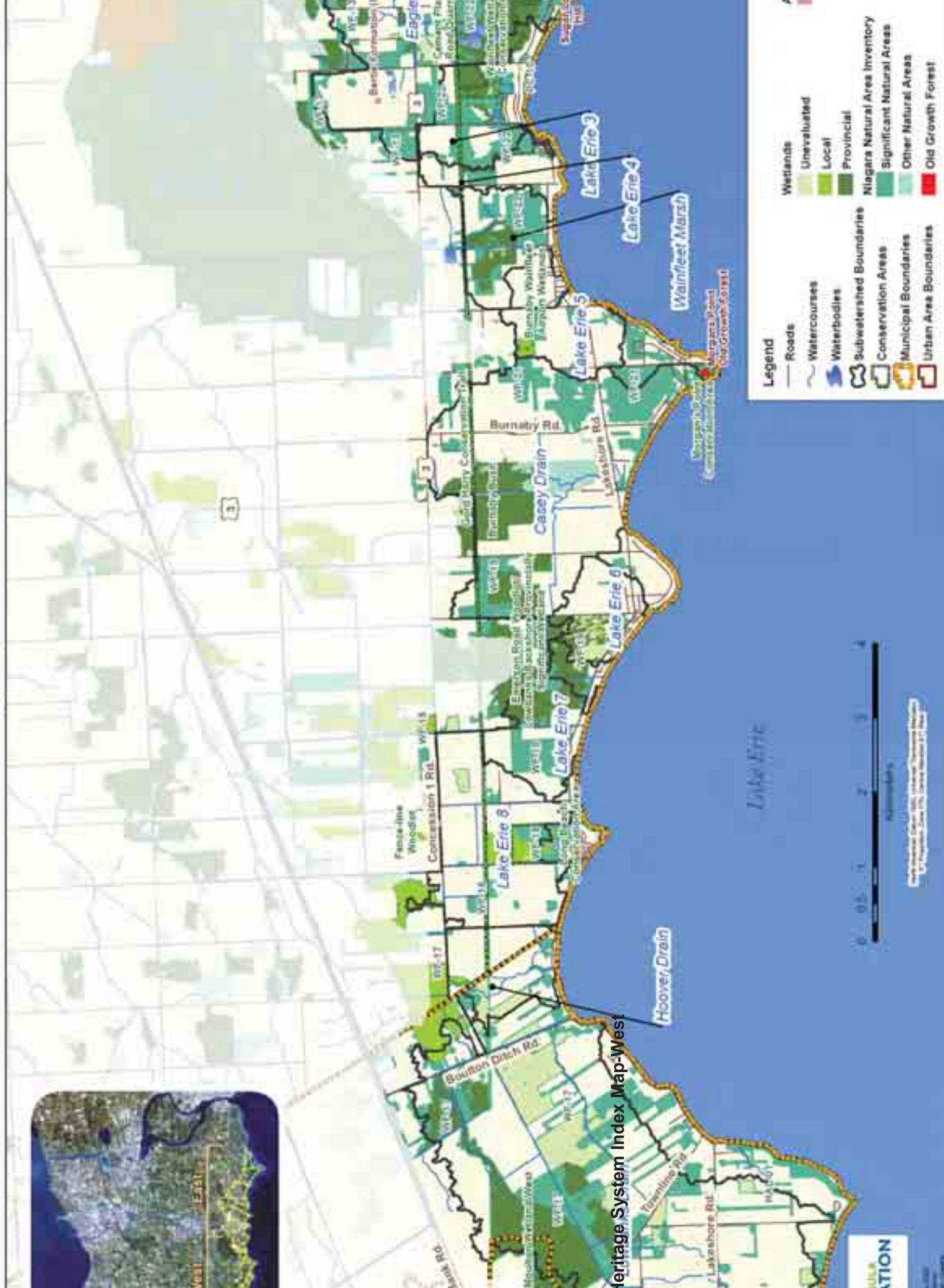
The following descriptions of the following remnants natural areas have been provided by this report; *Regional Municipality of Niagara Environmentally Sensitive Areas* (Brady 1980). It is important to note that some of the identified remnant natural areas have also been designated as Areas of Natural and Scientific Interest or provincially significant wetlands and therefore have already been described above, or may have been described through the Natural Areas Inventory.

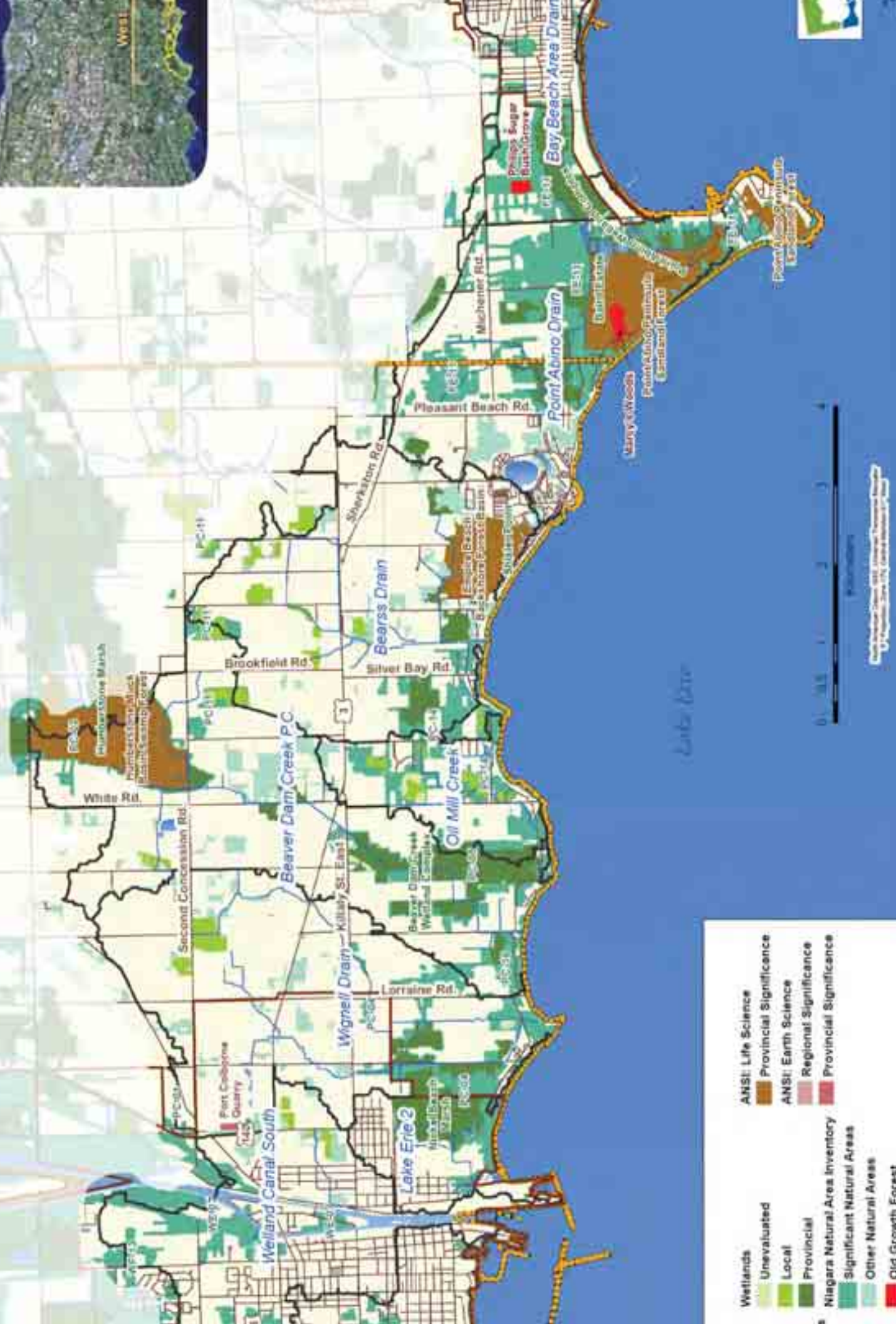
**Shisler Point Woods** is a 77 hectare woodlot located in Port Colborne. This site borders the Lake Erie shoreline and contains forested dunes and low lying swampy areas which are a result of the woodlot being at a lower elevation than the lake. This area, in part, is also designated **Empire Beach Backshore Forest Basin ANSI and PSW**.

The **Burnaby Bush** is a 59 hectare woodlot that is bisected by the Canadian National Railroad. The poor drainage of the Welland Clay soils contributes to the wet condition of the site. The vegetation association of the woodlot consists of maple/american beech and maple spp./red ash/oak spp. Game birds and deer have also been noted in the woodlot.

The **Fence-Line Woodlot** is a 30 hectare woodlot overlain by dark grey loam soil. Drainage varies from good in the southern section with intermittent sloughs and very little standing water, while the north section has poor drainage and contains an intermittent stream. The vegetation association of the woodlot consists of red ash/willow spp in the south and eastern cottonwood/trembling aspen/willow spp in the north.

# Lake Erie North Shore Watershed - West Natural Heritage System - Index Map





## Species at Risk

A Species at Risk is “any plant or animal threatened by, or vulnerable to extinction” (MNR No Date). In Ontario, species at risk are governed by two bodies; *Committee on the Status of Endangered Wildlife in Canada* (COSEWIC) and the *Committee on the Status of Species at Risk in Ontario* (COSSARO).

COSEWIC is an independent body responsible for identifying species that are considered to be at risk in Canada. COSEWIC reports their findings to the federal government. The federal government then determines which at-risk species qualify for protection under the *Species At Risk Act* (EC 2003). COSSARO is an independent review body made up of up to 11 members from the public and private sectors; at least 5 of the members must be non-OMNR members. A species status designation may differ from COSEWIC and COSSARO because their vulnerability changes depending on the geographic scale. All species status designations given by COSEWIC will also be given an equal or greater status designation by COSSARO; a higher status indicates that there is a greater concern for a species province-wide than nation-wide. In addition, a species may have been given a status designation by COSSARO and not from COSEWIC because there may only be a province-wide vulnerability.



In Ontario, over 185 native species have been given official status designations by the OMNR (OMNR No Date). Currently, several legislative and policy tools protect species at risk in Ontario. For instance, the *Provincial Policy Statement* (MMAH 2005) under Ontario's *Planning Act* affords habitat protection by stating “Development and site alteration shall not be permitted in: significant habitat of endangered species and threatened species” (Section 2.1.3).

In May 2007, *Bill 184*, Ontario's new *Endangered Species Act*, (MNR 2007a) made it to Royal Assent in Ontario. It replaced Ontario's previous *Endangered Species Act* (1971) in June 2008. *Bill 184* states:

*“If a species is listed on the Species at Risk in Ontario List as an endangered or threatened species, the Bill prohibits damaging or destroying the habitat of the species. This prohibition also applies to an extirpated species if the species is prescribed by regulations. The regulations may specifically prescribe an area as the habitat of a species but, if no habitat regulation is in force with respect to a species, “habitat” is defined to mean an area on which the species depends, directly or indirectly, to carry on its life processes”.*

The OMNR status definitions for species designations range from extinct (no longer exists anywhere) to data deficient (insufficient information for status recommendation). In the Lake Erie North Shore Watershed Plan study area, endangered, threatened and species of special concern have been documented by the OMNR and the NPCA (Table 3).

The definitions for these status designations by the OMNR are as follows:

- **Extirpated:** A native species that no longer exists in the wild in Ontario, but still exists elsewhere
- **Endangered ( Regulated):** A species facing imminent extinction or extirpation in Ontario which has been regulated under Ontario's Endangered Species Act
- **Endangered (Not Regulated):** A species facing imminent extinction or extirpation in Ontario which is a candidate for regulation under Ontario's Endangered Species Act
- **Threatened:** A species that is at risk of becoming endangered in Ontario if limiting factors are not reversed
- **Special Concern:** A species with characteristics that make it sensitive to human activities or natural events

| Table 3: Listed Species at Risk in Lake Erie North Shore Watershed |                             |                            |                                         |
|--------------------------------------------------------------------|-----------------------------|----------------------------|-----------------------------------------|
| COSEWIC Status (Federal)                                           | COSSARO Status (Provincial) | Common Name                | Scientific Name                         |
| Endangered                                                         | Endangered-R                | King Rail                  | <i>Rallus elegans</i>                   |
| Endangered                                                         | Endangered-R                | Prothonotary Warbler       | <i>Protonotaria citrea</i>              |
| Endangered                                                         | Endangered-R                | Small White Lady's-slipper | <i>Cypripedium candidum</i>             |
| Endangered                                                         | Endangered-R                | Piping Plover              | <i>Charadrius melodus circumcinctus</i> |
| Endangered                                                         | Endangered                  | Kidneyshell                | <i>Ptychobranhus fasciolaris</i>        |
| Endangered                                                         | Endangered                  | Round Pigtoe               | <i>Pleurobema sintoxia</i>              |
| Endangered                                                         | Endangered                  | Snuffbox                   | <i>Epioblasma triquetra</i>             |
| Endangered                                                         | Endangered                  | Acadian Flycatcher         | <i>Empidonax virescens</i>              |
| Endangered                                                         | Endangered                  | American Ginseng           | <i>Panax quinquefolius</i>              |
| Endangered                                                         | Endangered                  | Butternut                  | <i>Juglans cinerea</i>                  |
| Endangered                                                         | Endangered                  | Eastern Flowering Dogwood  | <i>Cornus florida</i>                   |
| Threatened                                                         | Threatened                  | Blanding's Turtle          | <i>Emydoidea blandingii</i>             |
| Endangered                                                         | Special Concern             | Spotted Turtle             | <i>Clemmys guttata</i>                  |
| Threatened                                                         | Threatened                  | Fowler's Toad              | <i>Bufo fowleri</i>                     |
| Threatened                                                         | Threatened                  | Common Hop Tree            | <i>Ptelea trifoliata</i>                |
| Threatened                                                         | Threatened                  | Eastern Hognose Snake      | <i>Heterodon platirhinos</i>            |
| Threatened                                                         | Threatened                  | Massasauga Rattlesnake     | <i>Sistrurus catenatus</i>              |
| Threatened                                                         | Threatened                  | Least Bittern              | <i>Ixobrychus exilis</i>                |
| Threatened                                                         | Threatened                  | Hooded Warbler             | <i>Wilsonia citrina</i>                 |
| Threatened                                                         | Threatened                  | White Wood Aster           | <i>Eurybia divaricata</i>               |
| Threatened                                                         | Threatened                  | Grey Fox                   | <i>Urocyon cinereoargenteus</i>         |
| Threatened                                                         |                             | Western Chorus Frog        | <i>Pseudacris triseriata</i>            |
| Special Concern                                                    | Endangered                  | Peregrine Falcon -shore    | <i>Falco peregrinus anatum</i>          |
| Special Concern                                                    | Special Concern             | Northern Map Turtle -shore | <i>Graptemys geographica</i>            |
| Special Concern                                                    | Special Concern             | Eastern Milksnake          | <i>Lampropeltis triangulum</i>          |
| Special Concern                                                    | Special Concern             | Grass Pickerel             | <i>Esox americanus vermiculatus</i>     |
| Special Concern                                                    | Special Concern             | Woodland Vole              | <i>Microtus pinetorum</i>               |
| Special Concern                                                    | Special Concern             | Cerulean Warbler           | <i>Dendroica cerulea</i>                |
| Special Concern                                                    | Under Review                | Snapping Turtle            | <i>Chelydra serpentina serpentina</i>   |

## Fowler's Toad

The Fowler's toad was designated as a *threatened* Species at Risk in 1999 by COSEWIC. With only 3 known habitats left in Canada, all which are along the north shore of Lake Erie, this species is at risk of becoming endangered in Canada. The Lake Erie North Shore watershed is one of the locations that the Fowler's toad can be found.



The sandy beaches and dunes along Lake Erie are important habitats for this species, along with nearby shoreline feeding areas and breeding sites of shallow open rocky pools, ponds, wetlands and stream mouths (Fowler's Toad Recovery Team No Date). The Fowler's toad utilizes different habitat types during different times of the year. During winter hibernation and daily shelter during spring, summer and fall the Fowler's toad seeks sandy beaches that are in close proximity to sand dunes. During spring and early summer breeding and tadpole development, shallow, open rocky pools, ponds, streams, river mouths and backshore wetlands are used; and shoreline areas are used for nightly hydration and feeding during the spring, summer and fall (Yagi et al.

2007). Therefore protection of all these habitat types is integral to the survival of the Fowler's toad.

The Fowler's toad habitat is threatened by construction of shoreline break walls, piers and other structures that threaten the natural processes of dune formation. In addition, destruction of backshore wetlands, development, intensive beach grooming and the use of vehicles on the beach is also devastating the habitat of the *threatened* Fowler's toad. Stewardship projects are being conducted by the MNR, NPCA and numerous volunteers along the shoreline from Long Beach to the Niagara River. Projects include population surveys and a dune enhancement and pond creation at Morgan's Point Conservation Area and the former East Seal Camp Lakewood property.



In addition to the listed endangered, threatened and species of special concern, numerous provincially rare species have also been documented by the OMNR and NPCA within the Lake Erie North Shore Watershed Plan study area (Table 4).

**Table 4: Provincially Rare Species in Lake Erie North Shore Watershed**

| Common Name                  | Scientific Name                     |
|------------------------------|-------------------------------------|
| American Beachgrass          | <i>Ammophila breviligulata</i>      |
| Beach Dune Tiger Beetle      | <i>Cicindela hirticollis</i>        |
| Bugseed                      | <i>Corispermum hookeri</i>          |
| Citrine Forktail             | <i>Ischnura hastata</i>             |
| Dwarf Umbrella-sedge         | <i>Fuirena pumila</i>               |
| Few-flowered Sedge           | <i>Carex oligocarpa</i>             |
| Fogg's Goosefoot             | <i>Chenopodium foggii</i>           |
| Goose-foot Corn-salad        | <i>Valerianella chenopodiifolia</i> |
| Grass-leaved Water-plantain  | <i>Alisma gramineum</i>             |
| Many-fruit False-loosestrife | <i>Ludwigia polycarpa</i>           |
| Pin Oak                      | <i>Quercus palustris</i>            |
| Pumpkin Ash                  | <i>Fraxinus profunda</i>            |
| Purple Cudweed               | <i>Gnaphalium purpureum</i>         |
| Red-root Flatsedge           | <i>Cyperus erythrorhizos</i>        |
| Schweinitz's Flatsedge       | <i>Cyperus schweinitzii</i>         |
| Sedge                        | <i>Carex seorsa</i>                 |
| Sharp-fruit Rush             | <i>Juncus acuminatus</i>            |
| Small-flower Groovebur       | <i>Agrimonia parviflora</i>         |
| Smith's Club-rush            | <i>Schoenoplectus smithii</i>       |
| Spring Avens                 | <i>Geum vernum</i>                  |
| Southern Tickseed            | <i>Bidens coronata</i>              |
| Tufted Titmouse              | <i>Baeolophus bicolor</i>           |
| Torrey's Manna Grass         | <i>Torreyochloa pallida</i>         |
| Toadflax                     | <i>Linaria canadensis</i>           |
| Weak Stellate Sedge          | <i>Carex seorsa</i>                 |
| Wild Bean                    | <i>Strophostyles helvula</i>        |
| Yellow Corydalis             | <i>Corydalis flavula</i>            |

## Aquatic Habitat

In Canada, the *Fisheries Act* (Department of Fisheries and Oceans R.S. 1985, c. F-14) was established to protect and manage Canada's fisheries resources. The Act applies to all fishing zones; territorial and inland waters. As federal legislation, should a conflict arise between the *Fisheries Act* and provincial legislation, the *Fisheries Act* takes precedence. Although management of fish habitat falls under the authority of the federal government, the federal government has “essentially no control over the use of inland waters, beds of watercourses or shorelines which fall under provincial jurisdiction. Alternatively, the provinces cannot make regulatory decisions concerning fish habitat” (DFO No Date).

Section 35 of the Fisheries Act is the prime focus of the Fisheries Act. This section is a “general prohibition of harmful alteration, disruption or destruction (HADD) of fish habitat”. Therefore, any project, work or undertaking that results in a HADD situation would result in a breach of this section of the Act and could result in a fine up to one million dollars, imprisonment or both.

## Fish Community Studies

The fish species found in Lake Erie are representative of a warm water fish community. Cold water species are present but are few and generally restricted to the deeper portions of the lake. The warm water fishery of Lake Erie supports commercial and sport fisheries. Over 70 public access points can be found along the shoreline providing ample of opportunity for recreational fishing.

The Ministry of Natural Resources considers the warm water fishery along Lake Erie as important fish habitat. On the north-east shore of Lake Erie an important smallmouth bass population is present. The Ministry of Natural Resources conducted a number of studies to assess the spawning habitat of the smallmouth bass in this area. As a result of these studies, a number of important spawning sites were identified including Gravelly Bay, Nickel Beach, Lorraine Bay and just east of Windmill Point; the latter falls outside the Lake Erie North Shore Watershed study area. In Gravelly Bay and Cassaday Point, fish sanctuaries have been established for the duration of June 1 to July 15, to protect the smallmouth bass during the spawning period. In addition, a significant smallmouth bass spawning, nursery, and feeding area has also been identified near Rock Island, off Long Beach (Philpott Assoc. 1992).

The Ministry of Natural Resources conducted fish sampling surveys from 1999 to 2002 at 4 sites that fall within the Lake Erie North Shore study area. In 1999 and 2001 the shore along Point Abino was sampled at 3 separate stations. In total 29 species were identified. During 2001 and 2002, 5 separate stations in Point Abino Drain were sampled, and 16 species were identified, including grass pickerel. During 1999 and 2001, 3 separate stations off shore in Port Colborne were sampled identifying 22 different species. The fourth site, Wyldewood Beach in Port Colborne, was sampled at one station during 2001; 3 species were identified. A list of species identified during these surveys can be found in Table 5.

In October 2008, the NPCA conducted additional sampling at 4 sites in the study area; Eagle Marsh, Lowbanks Drain, Beaver Dam Creek, and Casey Drain. A total of 13 species were identified at these sites (Table 5).

## Significant Fish Species

One of the fish species identified along the Lake Erie shoreline is considered “at risk”; grass pickerel. Grass pickerel has been designated as a species of *special concern* by the *Committee on the Status of Endangered Species in Canada* and *Committee on the Status of Species at Risk in Ontario*.



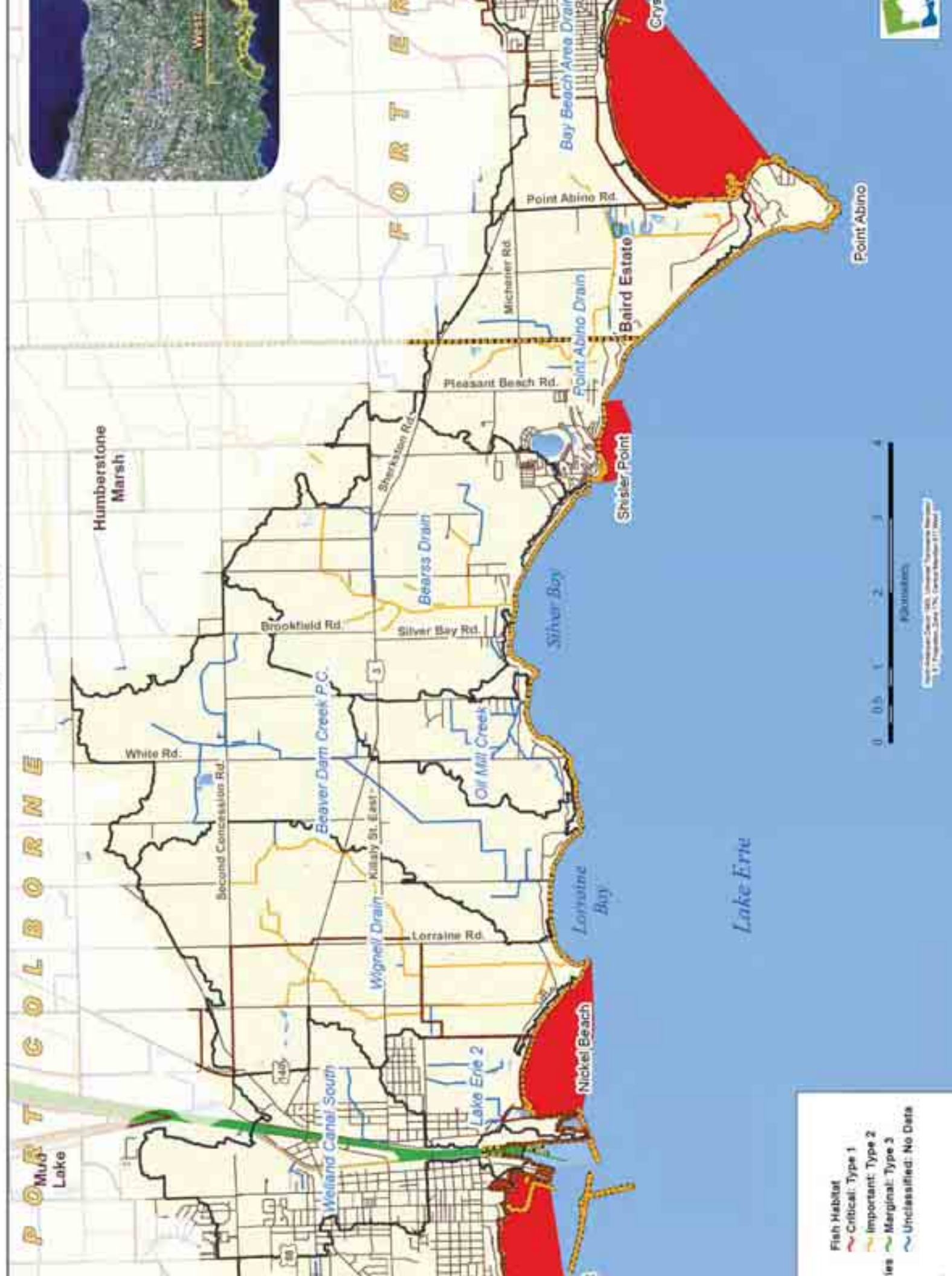
|              |    |    |    |   |   |   |   |
|--------------|----|----|----|---|---|---|---|
| n Bullhead   | I  | I  | I  |   |   | I |   |
| al Mudminnow | I  |    |    |   | I | I |   |
| nel Catfish  |    |    |    |   |   |   |   |
| mon Carp     | I  | I  | I  |   |   |   |   |
| pie          |    | I  |    |   |   |   |   |
| ald Shiner   |    | I  | I  | I | I | I |   |
| ead Minnow   |    |    |    |   |   | I |   |
| nwater Drum  | I  | I  | I  |   |   |   |   |
| ard Shad     |    | I  | I  |   |   |   |   |
| en Shiner    | I  | I  |    |   |   | I | I |
| fish         |    | I  | I  |   |   | I |   |
| s Pickerel   | I  |    |    |   |   |   |   |
| n Sunfish    | I  |    |    |   |   |   |   |
| ny Darter    |    | I  |    |   |   |   |   |
| emouth Bass  | I  | I  | I  | I |   | I |   |
| mis sp.      | I  |    | I  |   |   |   |   |
| Perch        |    | I  |    |   |   |   |   |
| nose Gar     |    | I  |    |   |   |   |   |
| nose Dace    |    |    | I  |   |   |   |   |
| ow family    | I  |    |    |   |   |   |   |
| ern Pike     |    |    | I  | I |   |   |   |
| okinseed     | I  | I  | I  |   | I | I |   |
| oack         |    | I  | I  |   |   |   |   |
| orse         |    | I  |    |   |   |   |   |
| Bass         | I  | I  | I  |   |   |   |   |
| d Goby       |    |    |    | I |   |   |   |
| Shiner       |    | I  | I  |   |   |   |   |
| lmouth Bass  | I  | I  | I  |   |   |   |   |
| tail Shiner  |    | I  | I  |   |   |   |   |
| own Catfish  |    | I  |    |   |   |   |   |
| own Minnow   |    | I  |    |   |   |   |   |
| eye          |    | I  |    |   |   |   |   |
| e Sucker     |    | I  |    |   | I |   |   |
| w Perch      | I  | I  | I  | I | I |   |   |
| Species      | 16 | 29 | 22 | 6 | 7 | 9 | 3 |

# Lake Erie North Shore Watershed - West Fish Habitat



# Lake Erie Wetland Critical Fish Habitat

## Fish Habitat



## Fish Habitat

Fish habitat falls into 1 of 3 categories in Niagara: Type 1, Type 2 or Type 3 (OMNR 2000). Habitat type is based on the sensitivity and significance of current or potential habitats in a water body. Type 1 habitat is the most sensitive habitat of the 3 types. As a result, it requires the highest level of protection. Examples of Type 1 habitat include critical spawning and rearing areas, migration routes, over-wintering areas, productive feeding areas and habitats occupied by sensitive species. Type 2 habitat is less sensitive and requires a moderate level of protection. These areas are considered “ideal for enhancement or restoration projects” and include feeding areas for adult fish and unspecialized spawning habitat. The third habitat type is considered marginal or highly degraded and does not contribute directly to fish productivity. Examples of Type 3 habitat include channelized streams and artificially created watercourses (OMNR 2000).

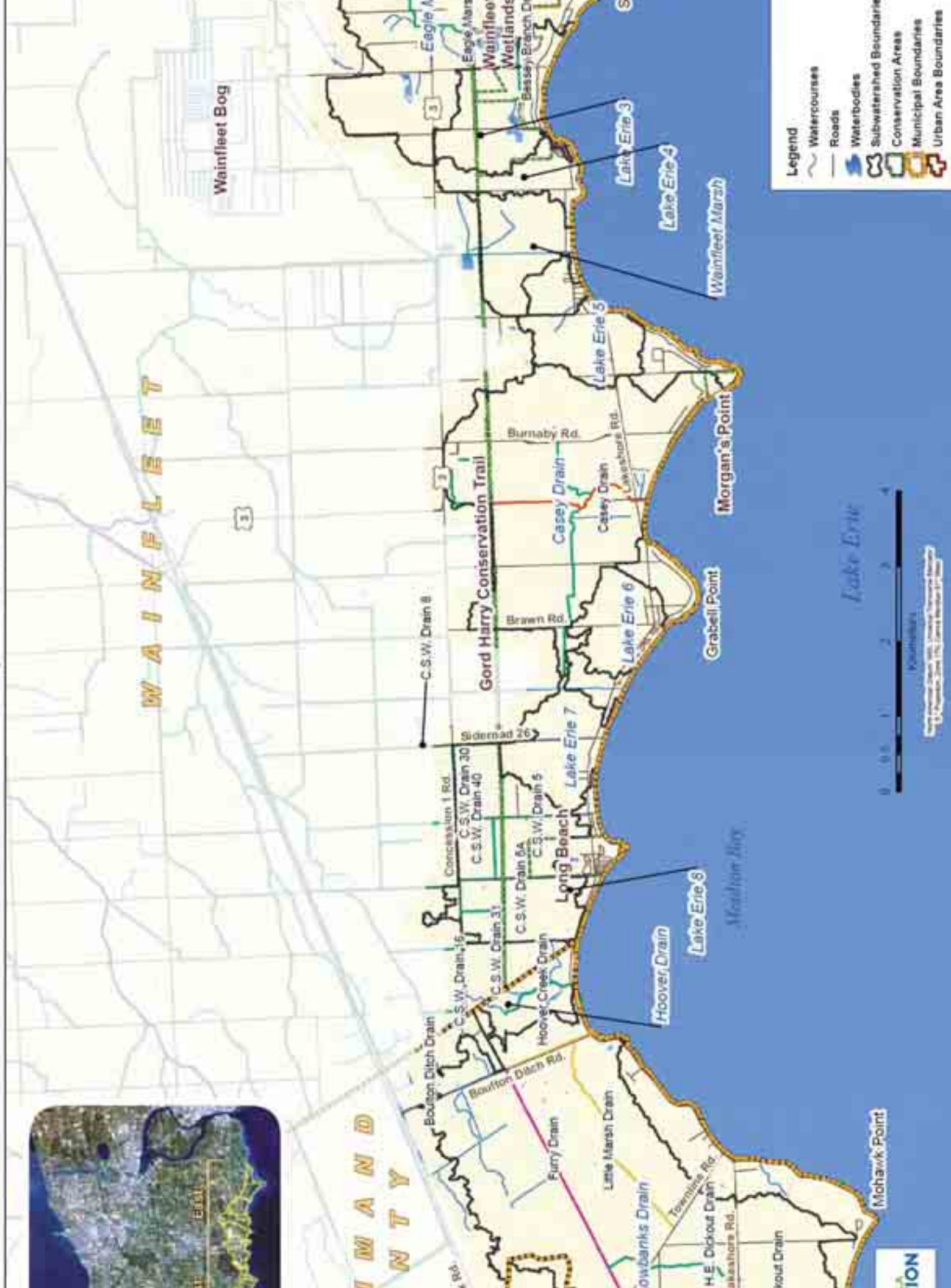
Fish habitat type in the Lake Erie North Shore watershed has been delineated according to the Ministry of Natural Resources stream classification data. These areas are depicted on Figures 14a and 14b as critical habitat (Type 1), important habitat (Type 2) and marginal habitat (Type 3). As illustrated and previously described, numerous areas along Lake Erie have been identified as critical spawning areas, therefore these areas have been designated as critical (Type 1) habitat. Casey Drain, Eagle Marsh Drain, Wignell Drain, Bearss Drain and Point Abino Drain have been classified as important (Type 2) fish habitat and the Welland Canal has been classified as marginal (Type 3) fish habitat. The remaining watercourses in the Lake Erie North Shore watershed have not been evaluated to date in terms of importance for fish habitat.

## Municipal Drains

Under the *Ontario Drainage Act* (R.S.O. 1990, Chapter D.17) drainage works “*include a drain constructed by any means, including the improving of a natural watercourse, and includes works necessary to regulate the water table or water level within or on any lands or to regulate the level of the waters of a drain, reservoir, lake or pond, and includes a dam, embankment, wall, protective works or any combination thereof.*”

A large quantity of municipal drains are present in the Lake Erie North Shore watershed (Figures 15a and 15b). Even though their purpose is to remove excess water from the land, municipal and agricultural drains do contain fish habitat. To better manage these drains, Fisheries and Oceans Canada has developed a classification system that identifies municipal drains as Types A through F using variables such as flow conditions, temperature, fish species present, and the length of time since the last clean out (Fisheries and Oceans Canada No Date). For example, a Class A drain has permanent flow with cold or cool water temperature and no presence of trout or salmon present. A Type E drain also has a permanent flow with warm water temperatures and top predators (e.g., largemouth bass, northern pike, muskellunge and crappie) present in the drain. Type F drains are characterized by intermittent flow (Fisheries and Oceans Canada No Date). This classification system has been created for use by municipal drainage superintendents for the purpose of drain maintenance.

# Lake Erie North Shore Watershed - West Municipal Drains



- Legend**
- Watercourses
  - Roads
  - Waterbodies
  - Subwatershed Boundaries
  - Conservation Areas
  - Municipal Boundaries
  - Urban Area Boundaries



### Municipal Drains



In the Lake Erie North Shore watershed, over 61 percent of the watercourses have been classified as municipal drains. The drainage classifications range from Class B to Class F; the majority have a Class F designation (Table 6).

| <b>Table 6: Municipal Drains</b> |                                            |                      |
|----------------------------------|--------------------------------------------|----------------------|
| <b>Class</b>                     | <b>Drain Name</b>                          | <b>Subwatershed</b>  |
| B                                | Point Abino Drain-main channel             | Point Abino Drain    |
| B                                | Wignell Drain                              | Wignell Drain        |
| C                                | Bearss Drain                               | Bearss Drain         |
| C                                | Casey Drain-main branch                    | Casey Drain          |
| C                                | Beaverdam Drain-south portion              | Beaverdam Drain P.C  |
| C                                | Silver Bay Drain                           | Bearss Drain         |
| D                                | Furry Drain                                | Lowbanks Drain       |
| E                                | Bay Beach Area Drain                       | Bay Beach Area Drain |
| E                                | Little Marsh Drain                         | Lowbanks Drain       |
| E                                | Boulton Ditch Drain                        | Lowbanks Drain       |
| E                                | Eagle Marsh Drain-main branch              | Eagle Marsh Drain    |
| F                                | Point Abino Drain-northern branch          | Point Abino Drain    |
| F                                | William-Michael Drain                      | Bearss Drain         |
| F                                | Neff Drain                                 | Bearss Drain         |
| F                                | Oil Mill Creek Drain                       | Oil Mill Creek Drain |
| F                                | Beaverdam Drain-northern portion           | Beaverdam Drain P.C  |
| F                                | Michener Drain                             | Wignell Marsh Drain  |
| F                                | Central Park Drain                         | Welland Canal South  |
| F                                | Bessey Branch Drain                        | Eagle Marsh Drain    |
| F                                | Casey Drain: East, West and North Branches | Casey Drain          |
| F                                | Hoover Creek Drain                         | Hoover Drain         |
| F                                | H.E. Dickout Drain                         | Lowbanks Drain       |
| F                                | Chalmers Dickout Drain                     | Lowbanks Drain       |

In general, Municipal Drains are designed to facilitate in land drainage, prevent flooding and move water quickly through the watercourse (they are dredged and straightened, and there is no connection between the floodplain and the channel), therefore it would imply that the watercourses would be classified as flashy (VanRiezen 2010). Some factors that influence the shape of the hydrograph for the watercourses in the Lake Erie North Shore watershed suggest that the majority of the watercourses actually are not flashy. Physical characteristics found during the NPCA Lake Erie North Shore Geomorphology Study (2009b) would suggest that most of the watercourses have some degree of being sluggish.

1. Eight of the eleven designated Municipal Drain subwatersheds have wetlands within their boundaries which results in the storage of water.
2. The surrounding topography is flat which will affect the time it takes for the water to get to the watercourse by direct runoff.
3. Vegetation type, impervious area, as well as soil type within the subwatershed will influence the shape of the hydrograph. If the water cannot infiltrate into the ground then it will increase the direct runoff and produce a flashy hydrograph. The major land uses within the subwatersheds include monoculture, rural landuse, wooded areas, mixed agriculture, and built-up areas (impervious). The majority of field sites visited had some degree of vegetation in the riparian corridor.
4. Municipal Drain maintenance will control the longitudinal profile of the watercourse (the way in which the stream's elevation changes over distance). If

the longitudinal profile is steep then there will be a more rapid response on the hydrograph. Overtime, sediment deposited on the bed may change this profile and drain maintenance would be required to remove the sediment in order to have the proper longitudinal profile. Relatively deep, unconsolidated sediment was identified at various field sites.

5. Vegetation in and along the channel bed will influence how quickly the water moves through the channel. Some instream vegetation growth and debris jams were noted at field sites, but this variable will depend on drain maintenance schedules.

The majority of the field sites visited during the summer 2008 had some water present in the channel but they were classified as having low to no flow. Algae and turbid water were identified at numerous sites during that time period as well (Van Riezen 2010).



## Water Quality

### NPCA Water Quality Monitoring Program

The Ontario Ministry of Environment (MOE) has established a set of *Provincial Water Quality Objectives* (PWQO) that are intended to be used to guide respective agencies when making water quality management decisions. The surface water quality management goal is “*To ensure that the surface waters of the province are of a quality which is satisfactory for aquatic life and recreation*” [MOE 1994 (Section 3.1)]. Table 7 summarizes indicator parameters that are the most useful in assessing relative stream water quality. They include: total phosphorus, nitrate, copper, lead, zinc, *Escherichia coli*, chloride, suspended solids and benthic invertebrates (NPCA 2010). These parameters are useful indicators but other non-chemical factors such as for example, loss of habitat, sedimentation, and indigenous species must also be considered when assessing ecosystem health.

In the Lake Erie North Shore study area, the NPCA monitors surface water quality at seven stations along the north shore of Lake Erie through the collection of monthly grab samples (Figures 16a and 16b). All stations are located at the watershed outlets to capture the cumulative water quality impacts for their respective drainage areas, except for the station located at the Wainfleet Wetlands Conservation Area; this is a large abandoned quarry owned by the NPCA. Sampling was initiated in April of 2007 and samples are collected on a monthly basis during the ice-free season and analyzed for several parameters including nutrients, metals, bacteria, suspended solids, and general chemistry.

The Water Quality Index (WQI) is used by the NPCA to summarize water quality data collected from NPCA surface water quality monitoring stations for reporting and communication purposes. The WQI was developed by a sub-committee established under the Canadian Council for Ministers of the Environment (CCME) Water Quality Guidelines Task Group to provide a convenient means of summarizing complex water

quality information and communicating it to the public (CCME 2001). The index produces a number between 0 and 100 which represents the worst and best water quality, respectively. These numbers are divided into five descriptive categories that range from *poor* to *excellent*.

Based on the results of the Water Quality Index (WQI), two of seven Lake Erie tributary stations in the study area are rated as having *poor* water quality, 3 stations are rated as *marginal*, station PA001 is rated as *fair*, and station WW001 is rated as *good* (Table 8). Water quality is negatively impacted by high concentrations of total phosphorus. Mean total phosphorus concentrations exceed the provincial objective of 0.03mg/L at all stations, particularly at Wignell Drain station WD001 and Casey Drain station CD001.



Sources of phosphorus at these stations include runoff from urban and agricultural land use, sewage discharges, and soil erosion. Wainfleet Wetlands Conservation Area station WW001 has the lowest mean total phosphorus concentration of all stations monitored in 2009 (NPCA 2010).

Elevated concentrations of *E. coli* are frequently observed at most stations. Sources of *E. coli* at these stations include sewage discharges, animal waste, and runoff from urban

and agricultural land use (NPCA 2010).

Water quality at Eagle Marsh Drain station EM001 and Wignell Drain station WD001 is influenced by discharge from bedrock quarries located upstream. Chloride concentrations frequently exceed the guideline for irrigation quality at station EM001; however, this is largely attributed to groundwater input. Other potential sources of chloride include road salt applied for de-icing and sewage discharges (NPCA 2010).

Wainfleet Wetlands Conservation Area station WW001 has achieved the highest water quality index rating for the second year in a row. Water quality at this station is improved by inflow from groundwater and Lake Erie (NPCA 2010).

**Table 7: Water Quality Parameters (as modified from NPCA 2010)**

| Category        | Indicator Parameter     | Objective        | Reference               |
|-----------------|-------------------------|------------------|-------------------------|
| Nutrients       | Total Phosphorus        | 0.03 mg/L        | PWQO (MOE 1994)         |
| Nutrients       | Nitrate                 | 13 mg/L          | CWQG (CCME 2007)        |
| Metals          | Copper                  | 0.005 mg/L       | PWQO (MOE 1994)         |
| Metals          | Lead                    | 0.005 mg/L       | PWQO (MOE 1994)         |
| Metals          | Zinc                    | 0.02 mg/L        | PWQO (MOE 1994)         |
| Microbiological | <i>Escherichia coli</i> | 100 counts/100mL | PWQO (MOE 1994)         |
| Other           | Chloride                | 100 mg/L         | CWQG (CCME 2005)        |
| Other           | Suspended Solids        | 25 mg/L          | BC MOE (2001)           |
| Biological      | Benthic Invertebrates   | Unimpaired       | BioMAP (Griffiths 1999) |

Generally, the WQI ratings obtained at Lake Erie tributary stations are higher than other parts of the NPCA watershed; however, it is important to note that these stations were recently added to the network in 2007. As such, the datasets for these stations are limited and these index ratings may change as additional data is collected (NPCA 2010).

## Biological Monitoring and Assessment Program

Benthic macroinvertebrate sampling has been completed at surface water quality monitoring stations using the BioMAP (Biological Monitoring and Assessment Program) protocol (Griffiths 1999). Benthic macroinvertebrates are defined as the larger organisms inhabiting the substrate of waterways for at least part of their life cycle. Benthic macroinvertebrate species that are commonly found in the Niagara Peninsula include clams, snails, leeches, worms, and the larval stages of dragonflies, stoneflies, caddisflies, mayflies and beetles.

For the analysis, the number and assortment of animals found at each site are used to calculate the biological metrics and indices for the biological assessment. These indices and metrics are used to convert biological data into a measure of water quality. This allows for the determination of water quality at a sample site and for cross comparison against other equivalent watercourses. Water quality results can then be classified as *impaired* or *unimpaired*. *Unimpaired* sites consist of animals that are susceptible to environmental pressures; in turn finding these animals in a water system implies the system has limited environmental stresses. *Impaired* sites consist mainly of organisms that are more tolerant to environmental stressors and typically do not include animals that are historically found. A *grey-zone* designation is for those sites which cannot be clearly defined as *impaired* or *unimpaired*.

BioMAP results indicate that water quality is *impaired* at most Lake Erie tributary stations (Table 8). Sediment loading, reduced baseflow, lack of in-stream habitat, and nutrient enrichment are primary causes of impairment at these stations. BioMAP samples have not been collected from station WW001 due to high water depth and access restrictions (NPCA 2010).

## Beach Postings Study

Bacterial contamination at public beaches is a major health concern which results in beach closures. Therefore, in addition to weekly water quality sampling that is conducted at 22 public beaches along Lake Erie from June to the end of August, the Regional Municipality of Niagara is also undertaking a Beach Posting Study (RMN 2007c) at six public beaches along Lake Erie within the Lake Erie North Shore Watershed Plan study area. The beaches included in the study are Crystal Beach in Fort Erie, Lorraine Road and Nickel Beach in Port Colborne and Long Beach as well as the east and west beaches of the Long Beach Conservation Area in Wainfleet. The objectives of the study are to identify beaches that are frequently affected by poor water quality which results in beach closures; recommend mitigation measures to remediate the poor water quality; and recommend a long-term annual program that



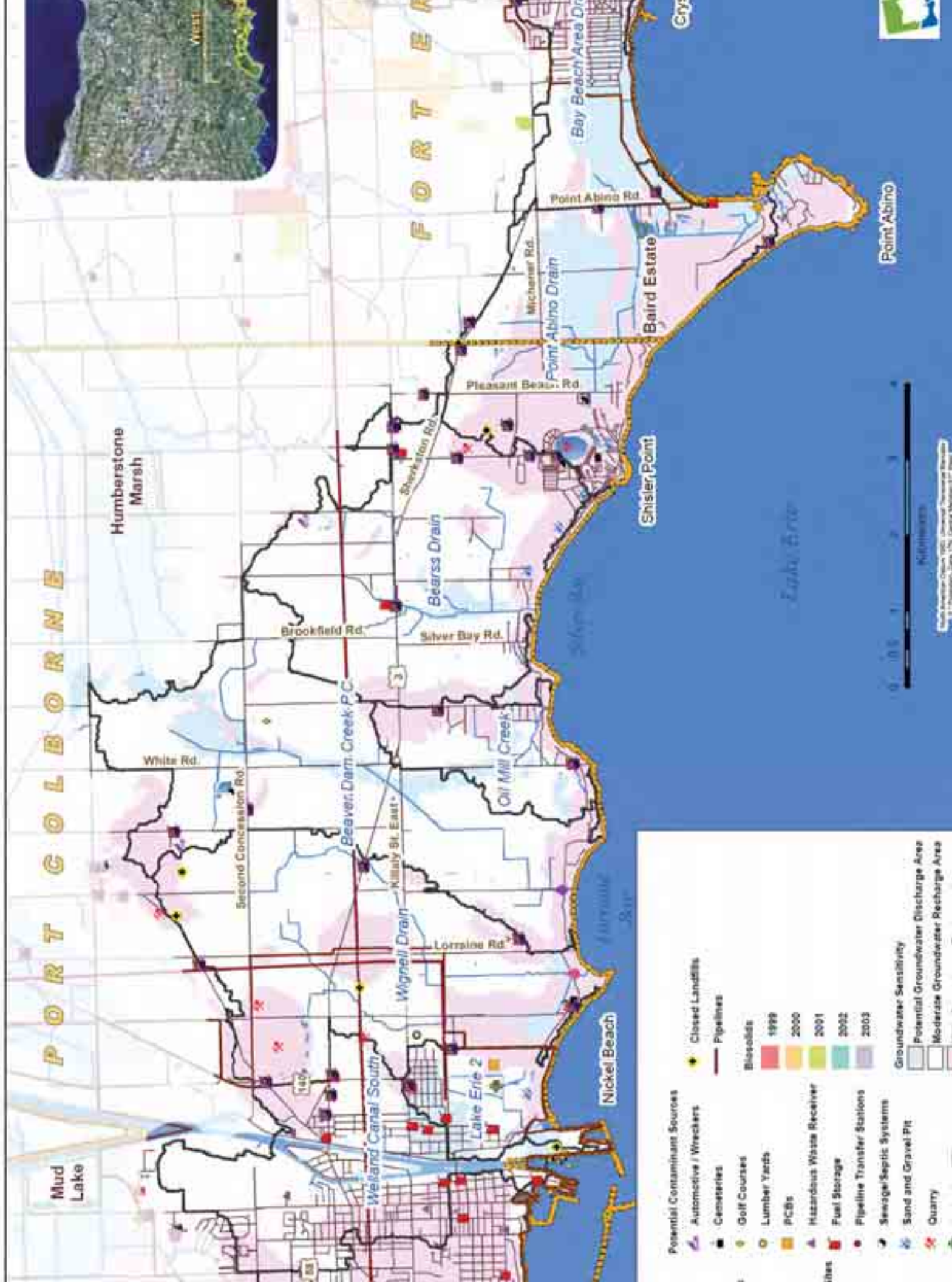
examines priority beaches in further detail (RMN 2007c). Several sources are known contributors to poor near-shore water quality, including for example, stormwater runoff; combined sewer overflows; faulty septic systems; and fecal matter from large populations of waterfowl. Therefore it is necessary to examine and evaluate the issues and challenges that are associated with the near-shore water pollution in order to determine appropriate mitigation measures to improve the water quality, thus reducing the number of beach closures.

**Table 8: Summary of NPCA Water Quality Data for Lake Erie tributaries (2007-2009)**

| Station | Watershed                            | WQI Rating | BioMAP Rating | Factors Affecting Water Quality                                                                                                                                                                                                                                                                                                                         |
|---------|--------------------------------------|------------|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| BD001   | Beaver Dam Drain                     | Poor       | Impaired      | <ul style="list-style-type: none"> <li>· Exceedances of copper, total phosphorus and <i>E. coli</i></li> <li>· Frequent nickel exceedances</li> <li>· Nutrient enrichment from upstream urban and agricultural areas</li> <li>· Lack of riparian buffer</li> </ul>                                                                                      |
| CD001   | Casey Drain                          | Marginal   | Impaired      | <ul style="list-style-type: none"> <li>· Exceedances of <i>E. coli</i>, total phosphorus and suspended solids</li> <li>· Nutrient enrichment from upstream urban and agricultural areas</li> <li>· Site is vulnerable to low baseflow and water stagnation</li> <li>· Algae observed during summer months</li> <li>· Lack of riparian buffer</li> </ul> |
| EM001   | Eagle Marsh Drain                    | Poor       | Impaired      | <ul style="list-style-type: none"> <li>· Exceedances of chloride, <i>E. coli</i>, total phosphorus and suspended solids</li> <li>· Nutrient enrichment from upstream urban and agricultural areas</li> <li>· Site is influenced by groundwater discharge from upstream bedrock quarry</li> </ul>                                                        |
| LB001   | Low Banks Drain                      | Marginal   | Impaired      | <ul style="list-style-type: none"> <li>· Exceedances of <i>E. coli</i> and total phosphorus</li> <li>· Nutrient enrichment from upstream urban and agricultural areas</li> <li>· Site is vulnerable to low baseflow and water stagnation</li> <li>· Severe algae growth observed during summer months</li> <li>· Lack of riparian buffer</li> </ul>     |
| PA001   | Point Abino Drain                    | Fair       | Impaired      | <ul style="list-style-type: none"> <li>· Exceedances of total phosphorus</li> <li>· Nutrient enrichment from upstream urban and agricultural areas</li> <li>· Site is influenced by backflow from Lake Erie</li> </ul>                                                                                                                                  |
| WD001   | Wignell Drain                        | Marginal   | Grey Zone     | <ul style="list-style-type: none"> <li>· Exceedances of copper, <i>E. coli</i> and total phosphorus</li> <li>· Frequent nickel exceedances</li> <li>· Nutrient enrichment from upstream urban and agricultural areas</li> <li>· Site is influenced by groundwater discharge from upstream bedrock quarry</li> </ul>                                     |
| WW001   | Wainfleet Wetlands Conservation Area | Good       | n/a           | <ul style="list-style-type: none"> <li>· Exceedances of total phosphorus</li> <li>· Nutrient enrichment from upstream urban and agricultural areas</li> </ul>                                                                                                                                                                                           |



# Water Quality Monitoring and Potential Contaminants



## Groundwater Resources

All Ontarians have the right to clean water, not only for recreational purposes but also for bathing, drinking and cooking. In Ontario, the provincial government launched a *Source Water Protection* program to address the need for better protection of water resources from contamination or overuse. In 2005, a *Groundwater Study* [Waterloo Hydrogeologic Inc.(WHI) 2005] was completed for the land area within the jurisdiction of the NPCA. This study was a key component for planning and implementing measures to protect the sources of water for the use by the residents of the Niagara Peninsula.

The *Groundwater Study* provides baseline data that outlines threats, potential threats and impacts to the areas groundwater resources. The study includes a series of maps illustrating recharge/discharge areas, well locations, overburden thickness, bedrock types, groundwater use, contaminant sources, and groundwater susceptibility to contamination.

Potential groundwater recharge and discharge areas are identified on Figures 16a and 16b. Discharge areas are locations where groundwater leaves the aquifer and flows to the surface. Groundwater discharge occurs where the water table (or potentiometric surface) intersects the land surface. Potential discharge areas have been identified in areas north of the Onondaga Escarpment and in the Wainfleet Wetlands and surrounding lowlands. The potential height of the water table ranges between 0 and 30 metres below the ground surface at these sites.

Groundwater recharge areas are locations where water is transmitted downward to an aquifer. The amount of water that infiltrates to the water table depends on, for example, vegetation cover, slope, soil composition, surficial geology, and depth to the water table. In the Lake Erie North Shore watershed, potential recharge areas are located along the Onondaga Escarpment and several bedrock outcrops that are scattered between the shoreline and the Onondaga Escarpment. Water that infiltrates to the water table may carry contaminants with it. Therefore, these areas are considered groundwater sensitive.

Figures 16a and 16b illustrate areas with high, medium and low shallow intrinsic susceptibility. The Lake Erie North Shore study area has been delineated as having a predominately high intrinsic susceptibility. Areas along the Onondaga Escarpment and areas where there are bedrock outcrops have been delineated as having a high shallow intrinsic susceptibility because the openings in fractured bedrock allow for the direct passage of surface water and contaminants to groundwater resources. In addition, most of the area south of the Onondaga Escarpment to the lakeshore also has a high intrinsic susceptibility due to the thin overburden and the porous limestone of the Onondaga Formation. Areas of medium intrinsic susceptibility are found north and west of the Onondaga Escarpment where the Onondaga Formation is overlain with less permeable clay and the overburden reaches a thickness value of up to 25 meters above the bedrock.

The yellow and green areas illustrated on Figures 17a and 17b are considered vulnerable to groundwater contamination due to the presence of permeable soils and/or the shallow depth of the groundwater table. Under the *Clean Water Act* (MOE 2006b), vulnerable groundwater areas that fall within an Intake Protection Zone will be protected under the *Source Protection Plan*.

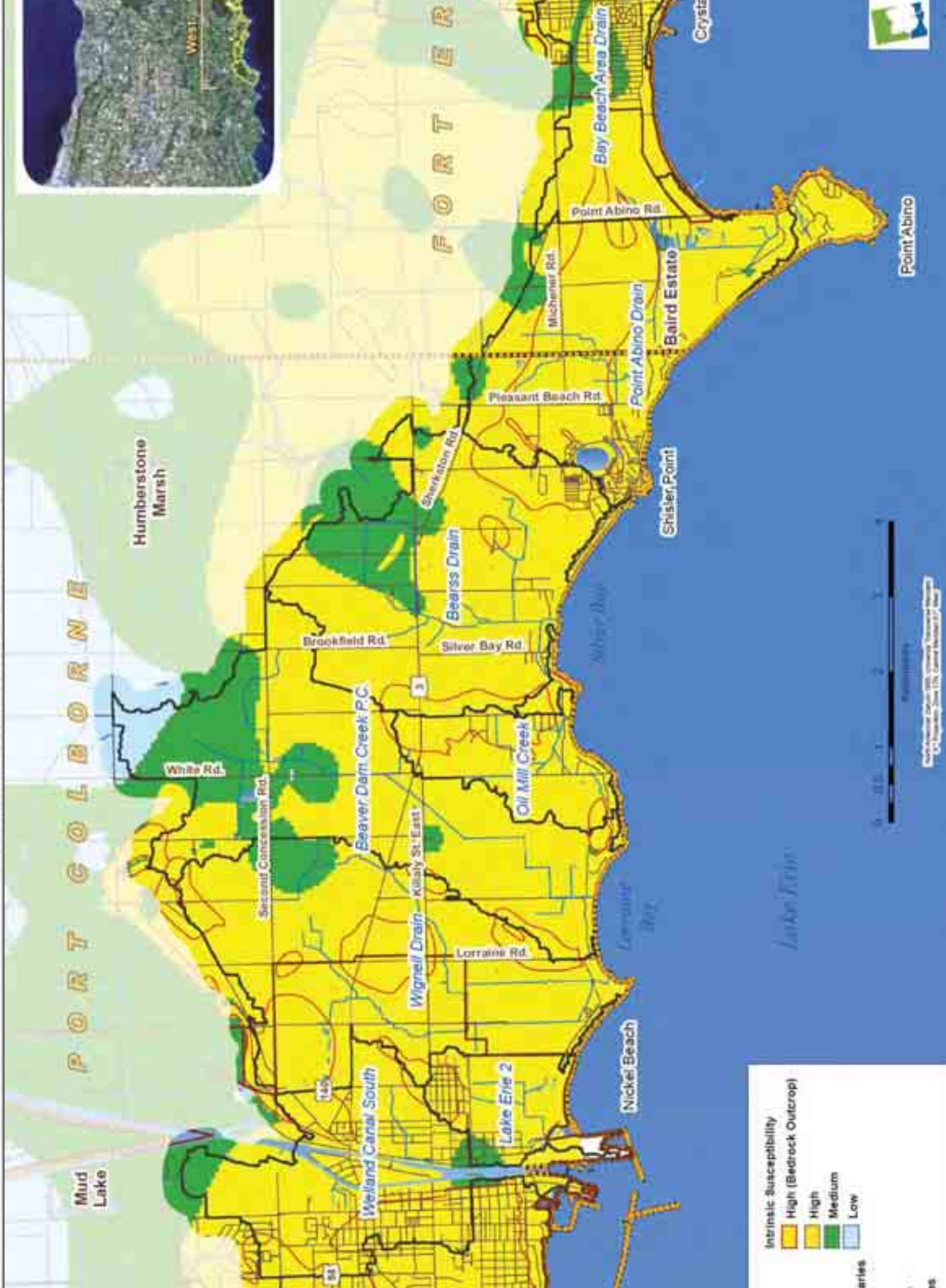
# Lake Erie North Shore Watershed - West

## Shallow Intrinsic Suseptibility



# Lake Erie North Shore Watershed - East

## Shallow Intrinsic Susceptibility



## Intake Protection Zone Study

In Ontario over 80 percent of the population receives their drinking water from municipal sources (O'Connor 2002). Therefore, another facet of source water protection was the passage of the *Clean Water Act* in 2006 by the provincial government. The purpose of the *Clean Water Act* (MOE 2006b) is to protect existing and future sources of drinking water supplies.

Accordingly, the Regional Municipality of Niagara has completed a *Surface Water Vulnerability Study* for each of its 6 municipal Water Treatment Plant (WTP) intakes; the Port Colborne intake falls within the Lake Erie North Shore Watershed Plan study area. The main focus of the *Surface Water Vulnerability Study* was to characterize the aquatic and upland features of the area surrounding the WTP intake, delineate the Intake Protection Zone (IPZ) around the intake, and assess the vulnerability of this intake to drinking water threats that are located within the IPZ.



The *Clean Water Act* (2006) required the Conservation Authorities across Ontario to establish source protection committees under the guidance of the provincial government with the Chairman of the committee being appointed directly by the province. There are 19 Source Protection Regions/Areas established in Ontario, each with a respective Source Protection Committee. The work of the committee includes mapping vulnerable areas around municipal drinking water sources,

identifying and assessing risks to municipal drinking water, and ultimately developing and implementing plans for safeguarding rivers, creeks and other sources of surface and ground water for municipal drinking water supplies within their geographic jurisdictions. Therefore, all 6 *Surface Water Vulnerability Study[s]* are being used by the Niagara Peninsula Source Protection Committee (NPSPC) to prepare an *Assessment Report* and a *Source Protection Plan* which are required under the *Clean Water Act* (MOE 2006b).

The purpose of the *Assessment Report* (NPCA 2010b) is to assess the quality and quantity of municipal drinking water supplies across the source protection area. The *Assessment Report* identifies significant threats including potential future threats that could impact our drinking water sources (NPCA 2010b). Based on the analysis for the Port Colborne IPZ areas, there are no significant threats in the IPZ zone immediate surrounding the intake, and there are 3 significant threats found within the outer IPZ zone; this outer zone was delineated based on a 2-hour time of travel to the intake. All 3 significant threats “relate to the establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage” (NPCA 2010b).

Upon approval of the *Proposed Assessment Report* by the MOE, the report will be used to prepare a Source Protection Plan (SPP). The purpose of the *Source Protection Plan* is to eliminate or reduce significant threats to municipal drinking water sources that are identified in the Assessment Report (NPCA 2010b). The *Source Protection Plan*, which should be completed by 2012, may require municipalities to restrict future land use activities within the area of the Intake Protection Zone, in order to protect the municipal drinking water source (Wright 2007). The SPP “*could use various types of policies ranging from outreach and education to incentive plans to risk management plans or even prohibition of certain activities*” (NPCA 2010).

The *Clean Water Act* (MOE 2006b) also requires that decisions made under the *Planning Act* or the *Condominium Act* (MMAH 1990,1998) shall conform to the significant threat policies and designated Great Lakes policies set out in the Source Protection Plans; the *Source Protection Plan* ‘prevails’ in the case of a conflict with official plans and zoning by-laws, although subject to “*the provision that provides the greatest protection to the quality and quantity of any water that is or may be used as a source of drinking water prevails*” (MOE 2006b, CWA Section 39). Therefore, while no policies are in place yet, once the *Source Protection Plan* is approved, it could restrict future land use activities within the areas of the Intake Protection Zones.

## Water Quantity

### Water Budget

Under the *Clean Water Act* (MOE 2006b), one of the requirements of the Assessment Report Technical Rules is that each Source Protection Region/Area must complete a Tier 1 Water Budget. The purpose of the Tier 1 Water Budget in Niagara Peninsula is to:

- Estimate the hydrologic stress of each watershed planning area in order to screen out areas that are unstressed with respect to water quantity
- Highlight areas where the reliability of water supplies is questionable
- Delineate significant groundwater recharge areas

*The Niagara Peninsula Tier 1 Water Budget and Water Quantity Stress Assessment* (NPCA 2009c) contains an analysis of the water inflows and outflows within each watershed planning area, for example, the Lake Erie North Shore Watershed Plan study area. The inflows include precipitation, lateral groundwater inflows, surface water inflows from upstream catchments, and water diversions (such as those from Welland Canal). Outflows include evapotranspiration, surface water discharges (e.g. Wignell Drain into Lake Erie), water takings by industry, residences and agriculture, and lateral groundwater outflow.

A *Water Availability Study* (WAS) (AquaResource Inc 2009) was completed for each watershed planning area by analyzing the inflows and outflows using computer models. The purpose of the WAS was to determine the water available for surface water flow, groundwater recharge and evapotranspiration on a monthly basis for the time period 1991 to 2005. This time period was chosen to best suit available datasets and meet the minimum World Meteorological Organization climate normal criterion of fifteen years.

Once the *Water Availability Studies* were completed, the Tier 1 Water Budget focused on anthropogenic water takings and water consumption, to determine if the watershed planning area is stressed hydrologically. The *Tier Water Budget and Water Quantity Stress Assessment* (NPCA 2009c) ties in the *Water Availability Study* and a Stress Assessment. The report includes a watershed characterization (climate, topography, geology, physiology, land cover, soils, streamflow), watershed modelling (model set-up, calibration, verification, sensitivity, results, and uncertainty), water taking analysis and stress assessment, as well as conclusions and recommendations. The Stress Assessment was completed for both surface water systems and groundwater systems; these assessments were conducted separately. A system is considered moderately or significantly stressed if the demand exceeds a provincial benchmark threshold value Table 9 (NPCA 2009c).

The *Niagara Peninsula Tier 1 Water Budget and Water Quantity Stress Assessment* (NPCA 2009c) identified the Lake Erie North Shore watershed as having a moderate surface water stress level based on provincial benchmark threshold values (Table 9). A moderate stress level is assigned to surface water systems where the maximum monthly water demand consists of 20% to 50% of the surface water supply. The Lake Erie North Shore was also identified as having a significant groundwater stress level. A significant stress level is assigned to groundwater systems where the demand for monthly maximum exceeds 50% or the average annual exceeds 25% of the groundwater supply.

| Table 9: Provincial Benchmark Threshold Values |                |                                |
|------------------------------------------------|----------------|--------------------------------|
| Potential for Surface Water Stress Thresholds  |                |                                |
| Stress Level Assignment                        |                | Maximum Monthly % Water Demand |
| Significant                                    |                | > 50%                          |
| Moderate                                       |                | 20% to 50%                     |
| Low                                            |                | < 20%                          |
| Potential for Groundwater Stress Thresholds    |                |                                |
| Stress Level Assignment                        | Average Annual | Monthly Maximum                |
| Significant                                    | > 25%          | > 50%                          |
| Moderate                                       | > 10%          | > 25%                          |
| Low                                            | 0 to 10%       | 0 to 25%                       |

Additional benefits that will result from the completion of the *Tier 1 Water Budget* include; this project will satisfy one of the Niagara Water Strategy objectives which is to prepare water budgets for watersheds within Niagara Region; and the project will aid the NPCA when commenting on Permit-To-Take-Water (PTTW) applications (Wright 2009).

In Ontario, water takings (both surface and ground) are governed under the Ontario Water Resources Act (MOE 1990) and the Water Taking and Transfer Regulation. Under the Ontario Water Resources Act “a person shall not take more than 50,000 litres of water on any day by any means except in accordance with a permit issued by the Director” (section 34.3). Currently in the Lake Erie North Shore Watershed Plan study area there are 21 PTTW.

## Identification of Challenges in the Lake Erie North Shore Watershed

The NWS (RMN 2006a) summarized a list of key water protection issues in the Lake Erie North Shore watershed. Additional issues have been identified by residents living in the watershed via public open houses and workshops in the spring and fall of 2008. A *Land Management and Agricultural Best Management Practice* survey (NPCA 2006a) (Appendix A) helped to identify land and water management issues in rural areas of the watershed. A description of the challenges facing the Lake Erie North Shore watershed are reported here.

### Landfill Sites

Seven known closed dump/fill sites in the Lake Erie North Shore watershed were identified in the *Groundwater Study* (WHI 2005); all of which fall within the Port Colborne municipal boundary. In addition, the last active landfill in the study area which was located in Wainfleet closed December 2008. Landfill sites labelled as 'old dump/fill sites' are areas that were once used as a dump or landfill. The subwatersheds where these sites are located are as follows; 3 in Wignell Drain; 1 in Welland Canal South; 1 in Lake Erie 4; and 2 in Point Abino Drain. The NWS (RMN 2006a) has identified concern that potential leachate could be discharging from these old dump/fill sites.

### Quarry Operations

The NWS (RMN 2006a) has identified concern that the local quarries may be disrupting the natural flows of water and the *Groundwater Study* (WHI 2005) has identified concerns in terms of posing a potential threat to groundwater quality since extraction removes any overlying protection of soil and overburden, exposing the bedrock or shallow overburden deposits. In addition, water sampling conducted by the NPCA commencing in 2007 indicates that water quality at the sampling stations in Eagle Marsh Drain and Wignell Drain are influenced by groundwater discharge from upstream bedrock quarries (Michaud Personal Communication).

In 2005, M.A.Q. Aggregates, Inc. submitted an application to the MNR in support of the Aggregate Resources Act to license a 70 hectare property in Wainfleet for partial aggregate extraction (Azimuth Environmental Consulting, Inc. 2008). The subject property, known as Reeb Quarry, is located south of Highway 3 and located on the adjacent lands to the north of Wainfleet Wetlands Conservation Area.

The license was approved in 2009 subject to prescribed conditions as outlined in the Aggregate Resources of Ontario Provincial Standards. Some of the conditions include, but are not limited to, a Spills Contingency program will be developed prior to site preparation; if required a Certificate of Approval will be obtained for the discharge system, should water be discharged off site; and if required, a Permit to Take Water will be obtained for utilizing ground and/or surface water (MNR 2009a).

### Water Quantity

Currently in the Lake Erie North Shore Watershed Plan study area there are 21 PTTW. Six of these permits are in the Township of Wainfleet and the remaining 15 are in the

City of Port Colborne. Four of the PTTW are for surface water takings and the remaining 17 are for groundwater takings. The purposes of these permits are as follows; two are for commercial uses, 3 industrial, 3 de-watering, 1 recreational, 7 for groundwater remediation, and the remaining 6 are for water supply (MOE 2009).

Due to the moderate and significant stress assignments determined by the *Water Budget and Water Quantity Stress Assessment* (NPCA 2009c) study and an ongoing fluctuation of water demand it is recommended that this study be improved further by undergoing development of subwatershed scale hydrogeologic characterizations and the inclusion of precise actual takings in the demand calculations for large permitted takers (NPCA 2009c). Increased precision in the water budgets and modelling would provide better information to make informed decisions in regard to PTTW applications and for use in planning decisions and policy development.

### Groundwater Sensitivity

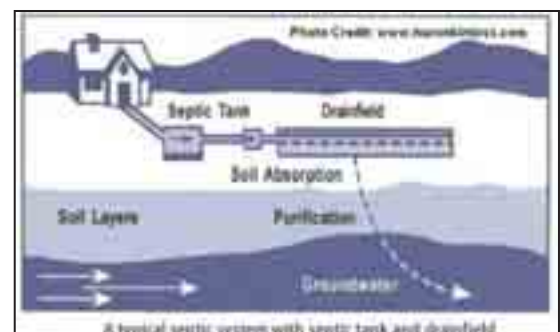
The *NWS* (RMN 2006a) and the *Groundwater Study* (WHI 2005) have identified the majority of the Lake Erie North Shore study area as highly susceptible to groundwater contamination due to the thin overburden and bedrock outcrops. The thin overburden is unable to effectively provide the groundwater with sufficient protection from bacteria, sediment and other insoluble forms of contaminants that in a thick overburden would become trapped and filtered within the soil pores. In addition, the openings in the fractured bedrock as well as the porous limestone allow for the direct passage of surface water and contaminants to groundwater resources.

The *PPS* in section 2.2.1(MMAH 2005) requires planning authorities to protect, improve or restore vulnerable and sensitive surface and ground water features, and their hydrologic functions. Likewise, it is the intent of the *Regional Niagara Policy Plan* (RMN 2007a) to protect, improve or restore the quantity and quality of ground and surface water resources [Section 7(A.2.2)]. Haldimand County is also committed to ensuring a sufficient supply of high quality is available. As stated in Haldimand County's *Official Plan*, the County understands that "*The protection, conservation and careful management of water resources is necessary in order to meet both present and future needs. As contamination is extremely difficult, costly and sometimes impossible to rectify, prevention of contamination is the best strategy*" [Section (B.1.10)].

Under the *Clean Water Act*, vulnerable groundwater areas that fall within an Intake Protection Zone will be protected under the *Source Protection Plan* and decisions made under the *Planning Act* must conform to the *Source Protection Plan*.

### Septic Systems

A well designed septic system can function properly for years. The basic design of a septic system includes a septic tank and a drainage field. Wastewater from toilets, bathtubs, sinks and other drains flow into the tank where bacteria that is naturally found in the wastewater breaks down any solid material. The liquid effluent travels through the perforated distribution pipes to the leaching bed. The water is then absorbed and filtered by the



ground in the drainage field. Problems with septic tanks often stem from improper use and maintenance. Faulty septic systems can create serious local contamination problems with the potential to contaminate groundwater wells (Pollution Probe 2004).

Faulty or improperly maintained septic systems have been reported as a concern by participants of a public workshop in November 2008. In addition, the *Groundwater Study* (WHI 2005) in consultation with the Region of Niagara Health Department identified areas where septic systems have been reported to cause problems with the quality of groundwater (Figure 14). In the Lake Erie North Shore Watershed, septic system ‘hot spots’ include the Onondaga Hydrogeologically Sensitive Area, where the overburden overlying the bedrock is too thin to sufficiently treat the septic tank effluent (WHI 2005). It is evident that aging and faulty septic systems contribute to poor water quality by discharging partly or untreated sewage effluent into subsurface and surface drainage pathways (NPCA 2010).

### *Wainfleet*

Like much of the area along the Lake Erie shoreline, municipal water and wastewater infrastructure does not exist in the Township of Wainfleet. Currently, most of Wainfleet is serviced by on-site water wells, aside from the Long Beach area which utilizes a communal water supply, and sewage disposal for the Town of Wainfleet is serviced by individual on-site septic systems (MacViro Consultants 2002).

Since April 10 2006, the area of Wainfleet south of the former rail line to Lake Erie has been under a Boil Water Advisory after studies conducted by Niagara Region's Public Health and Public Works departments and Ministry of the Environment identified a significant health concern as a result of the groundwater contamination: *“Environmental and potential health problems associated with the failure and malfunctioning of the existing private septic tank systems in the Lakeshore Communities in some cases include raw sewage in roadside ditches, odours associated with these sewage discharges and on-site ponding from tile field breakouts”* (Earth Tech 2005a).

In an effort to address the issue, a Class Environmental Assessment (EA) was initiated by the Township of Wainfleet and Region of Niagara. The Class EA planning process includes public and review agency consultation, an evaluation of alternatives, assessment of the impacts of proposed improvements, and mitigation measures identified.

As a result of the Environmental Assessment, the preferred alternative for providing the Wainfleet area with a potable water source is to establish a network of piping and use the Water Treatment Plant in Port Colborne as a water source. The preferred option in terms of wastewater servicing is the establishment of gravity sewer systems with pumping stations. The collected sewage flows would be discharged to the trunk sewer system in Port Colborne and treatment would occur at the Seaway Waste Water Treatment Plant (Earth Tech 2005b)

The Minister of the Environment endorsed the preferred alternative to build municipal water and wastewater central systems, and cited a number of conditions that must be met prior to construction (MOE 2006c). At the request of the Township of Wainfleet, Region of Niagara is acting on behalf of the municipality as project manager for the Lakeshore Water and Wastewater servicing project. Numerous studies are currently

being carried out as required by the MOE and are available for public commenting as distributed by Region of Niagara. The studies are as follows: Archaeological Impact Assessment, Natural Resources Impact Assessment, Socio-Economic Impact Assessment Study, preliminary Engineering Design, and a Financial Analysis (RMN No Date).

## Road Salt

Originating from salt storage and snow disposal sites as well as from runoff, road salts are an environmental concern because they are known to have an adverse effect on freshwater ecosystems, soil, vegetation and wildlife (EC 2004a). In April 2004, Environment Canada produced a *Code of Practice for the Environmental Management of Road Salts*. The *Code of Practice* recommends that all road authorities prepare and implement salt management plans that incorporate the implementation of best management practices (BMP) for salt application, salt storage and handling, and snow disposal. The benefits of improved salt management include:

- a reduction in corrosive damage to salt application equipment, vehicles, and infrastructure such as concrete sidewalks and steps;
- a reduction in salt damage to vegetation and surrounding roads and walkways;
- reduced salt releases to surrounding waterways; and
- an overall, more efficient and effective service resulting in safer roads and sidewalks for users (EC 2004b).

In 2005, the Regional Municipality of Niagara undertook a *Salt Vulnerability Study* (Ecoplans Ltd), which identified vulnerable areas from road salt for land use, surface water groundwater, and natural areas.

The relatively flat topography of Lake Erie North Shore watershed results in a high to moderate vulnerability to surface run off, therefore the entire study area has been ranked as moderately high for surface water, wetland and fish habitat vulnerability from road salt. Land use vulnerability outside of the wetland areas has been ranked with a predominantly moderate to moderately low vulnerability. Groundwater vulnerability along the shoreline is high, with inland vulnerability ranging from moderately high to moderately low.



It is important to note that the Regional Niagara Salt Vulnerability Study only assessed risk for Regional roads. Municipal roads should also be assessed to better identify salt vulnerable areas in the watershed.

In Haldimand County, where a road salt study has not yet been prepared, a Salt Management Plan is being prepared for the assessment of environmentally sensitive areas and procedures to assist and control the environmental effects of road salts (N. Mahmood Personal Communication).

## Nutrient Management

Concern over proper nutrient management in the Lake Erie North Shore watershed was expressed by participants at a public open house and 2 public workshops in the spring and fall of 2008. Concerns over nutrient management were also identified in the *NWS* (RMN 2006a) and in the *Land Management and Agricultural Best Management Practices* survey (NPCA 2006a) distributed to agricultural land owners. Nutrients derived from manure and chemical fertilizers are necessary for farm production. However, the improper use of nutrients can result in soil-nutrient imbalances and it can impair water quality locally and downstream of a farm. In order to maintain soil and water quality, in 2002 the Ontario government introduced the *Nutrient Management Act* (OMAFRA and OMOE). As of September 2003, new livestock farms that are over 5 Nutrient Units (NU) and existing livestock farms expanding to 300 NU or more are required to complete a nutrient management strategy (NMS) that includes information on its operation, how much nutrient is produced, how it will be stored, an analysis of its nutrient content, and where it will be used. A Nutrient Management Plan (NMP) must be completed for agricultural operations that apply nutrients to the land. The NMP includes information about the farm and its fields, an analysis of the nutrients to be applied, how much will be applied and at what rate, and how the nutrients will be stored (OMAFRA and OMOE 2003). The purpose of proper nutrient management is to protect surface and ground water from contamination.

## Beach Postings

Concern over the number of beach postings was expressed by participants at a public open house and 2 public workshops during the spring and fall of 2008. Beach postings due to microbial and visible contamination were also identified as an issue in the *NWS*.



Bacterial contamination at public beaches is a major health concern which results in beach closures. Therefore, as previously described, the RMN is undertaking a Beach Posting Study in addition to weekly water quality sampling that is conducted at 22 public beaches along Lake Erie from June to the end of August. The objectives of the study are to identify beaches that are frequently affected by poor water quality which results in beach postings; recommend mitigation

measures to remediate the poor water quality; and recommend a long-term annual program that examines priority beaches in further detail (RMN 2007c).

Several sources are known contributors to poor near-shore water quality, including for example, faulty septic systems and stormwater runoff and combined sewer overflows; there are 9 CSO's in Port Colborne and a total of 12 storm outfalls in the Lake Erie North Shore Watershed.

Therefore it is necessary to examine and evaluate the issues and challenges that are associated with the near-shore water pollution in order to determine appropriate

mitigation measures to improve the water quality, thus reducing the number of beach closures.

## **Urban Development**

Future expansion of Port Colborne has been identified as a concern in the *NWS* (RMN 2006a), in terms of affecting natural areas. In addition, this issue was also identified as a serious concern by the members of the agricultural community that participated in the *Land Management and Agricultural Best Management Practices* survey (NPCA 2006a). Survey participants were very concerned about the loss of agricultural land and the loss of natural areas to urban development.

As previously noted, the portion of Port Colborne that falls within the Lake Erie North Shore Watershed Plan study area falls within the Onondaga Hydrogeologically Sensitive Area. As indicated, this area is susceptible to groundwater contamination due to the thin overburden and shallow bedrock of the area. Therefore, further development in this area could potentially have an adverse impact on groundwater quality. However, a portion of this area falls within an Intake Protection Zone, and under the *Clean Water Act*, vulnerable groundwater areas that fall within an Intake Protection Zone will be protected under the *Source Protection Plan*.

Background studies conducted for the Region's *Growth Management Strategy* indicate that the City of Port Colborne has "*an ample supply of serviced (or serviceable) designated residential and non-residential land to accommodate growth to 2031 and beyond*" (Dillon 2008). Accordingly, it is the intent of the City of Port Colborne to promote intensification of future development within the urban area boundary and protect and support the rural and farm related operations, as indicated in the *Draft New Official Plan for the City of Port Colborne* (City of Port Colborne 2006).

In addition, the Region of Niagara also outlines numerous strategies in the *Policy Plan* that provide for the wise use of Niagara's agricultural resources. Such policies include for example, the protection of unique and good general agriculture; financial support to local agricultural groups; and not permitting non-agricultural uses in agricultural areas (Section 6).

## **Urban Storm Water Management**

A lack of stormwater management facilities to treat urban runoff in Port Colborne has been identified as a key issue in the *NWS* (RMN 2006a). Twelve storm outfalls have been identified in the Lake Erie North Shore watershed; 2 in LMA 3.2 and 10 in LMA 3.3. During a rain event in an urban or developed area, stormwater remains on the surface collecting contaminants instead of seeping into the ground as it would in a natural system. As a result, stormwater accumulates and runs off in great amounts, creating the potential for flooding and erosion (Pollution Probe 2004). Several strategies can be implemented to achieve stormwater management that aims to reduce stormwater runoff such as for example, storing excess water on or near the site, and releasing it slowly over a long period of time. It is the intent of the City of Port Colborne in the *Draft New Official Plan for the City of Port Colborne* (City of Port Colborne 2006) to manage stormwater on-site to reduce impacts on surrounding properties.

The NPCA and RMN have developed policies that provide for a long-term plan for the safe and effective management of runoff in urban and urbanizing areas, while sustaining the health of local rivers and stream (AECOM 2010). The report entitled „*Stormwater Management Policies and Guidelines*’ provides a consist approach to stormwater management for all municipalities in Niagara Region. Examples of stormwater best management practices are listed in Appendix B.

## **Combined Sewer Overflows**

Combined Sewer Overflows (CSO) have also been identified as a key issue in the Lake Erie North Shore watershed through the NWS (RMN 2006a). Nine CSO’s and a pumping station have been identified in the study area. A combined sewer is designed to collect stormwater runoff and wastewater (sewage and used water) and transport it to the treatment plant. However, during heavy rain events or snow melts the wastewater in the sewer may reach capacity of the sewer system or possibly the treatment plant. When this occurs, the sewer system overflows and discharges the excess wastewater in to the nearby watercourse or waterbody. The overflows which contain sewage and stormwater are called Combined Sewer Overflows, and have been identified as a key issue in the Lake Erie North Shore watershed.

The Region of Niagara recognizes the significant environmental impact of CSO’s and sewage treatment bypasses and accordingly has made the elimination of these a Regional priority [Policy 7.A.2.5 (RMN 2007a)]. In addition, it is the intent of the City of Port Colborne to address this issue through the *Draft New Official Plan* (City of Port Colborne 2006), which states “*Combined storm and sanitary sewers are not permitted and the City will endeavor to separate combined storm and sanitary sewers*” (Section II-C4b2).

In 2009, the City of Port Colborne in conjunction with the Regional Municipality of Niagara initiated an Extraneous Flow Reduction Pilot Program for a portion of Port Colborne. The program involves the “*inspection of private sanitary sewer services to assess their condition and the presence of any improper connections, followed by recommendations and City funded improvements to remove sources of rainwater from the sanitary sewer system*” (City of Port Colborne 2009). Participation is mandatory for private landowners and should the inspection indicate that repairs are necessary, financial assistance is available through the new Sewer Use By-Law.

According to Town of Fort Erie’s Council approved *Draft Official Plan* (2009), improvements to existing sanitary sewer system and the reduction of extraneous flows are a priority of Council (Section 12.3).

## **Ballast Water Regulations**

Ballast water is carried in the ballast of the ship or cargo tank to assist in the stability, list, stress or draught of the ship. However, when ballast water is discharged in the lake water, harmful pathogens and invasive aquatic species may be introduced, potentially threatening the health of the aquatic ecosystem. Non-native species do not have natural competitors outside of their native habitats; therefore they pose a threat by out-competing native species for food and habitat.

In 2006, the Minister of Transport, Infrastructure and Communities announced *Ballast Water Control and Management Regulations*. The previous voluntary, now mandatory

measures, include best management practices that must be followed when a ship does not travel beyond 200 miles from shore or cannot exchange ballast water in mid-ocean due to safety issues such as weather. Best management practices include either treating the ballast water, not discharging the water, or exchanging the ballast water in an alternate zone specified under the regulations which have been identified based on scientific advice provided by the Department of Fisheries and Oceans (Transport Canada 2006).

However, more stringent measures are necessary to completely void the threat of invasive aquatic species. Filtering or heating ballast water or using an ultraviolet light could be options that may help alleviate the threat of non-native aquatic species from entering the Great Lakes.

### **Municipal Drain Maintenance**

In addition to having an impact on aquatic and riparian habitat, drain maintenance has the potential to become quite costly through repeated maintenance activities. Naturalizing drains, especially through natural areas, is a recommendation that was made in the *NWS* (RMN 2006a). Naturalizing drains can potentially lengthen the time between maintenance events by reducing the amount of sediment entering the watercourse. Vegetating bare banks and maintaining a buffer strip; restricting cattle access; and allowing a slight meander to reduce bank erosion and flooding are a few measures that could potentially reduce the amount of sediment loading in the watercourse. In addition, when maintenance does occur several measures can be taken such as leaving the banks alone, working from one side of the drain and remove the vegetation at intervals. If a complete cleanout is necessary then ensure that the banks are not cut too steep as this will just make the banks more vulnerable to erosion. However, for a ditch or pipe to become a municipal drain there must be a by-law adopting an engineer's report.



Once the municipal drain has been constructed under the by-law, it becomes part of the infrastructure of the respective municipality. The local municipality is therefore responsible for repairing and maintaining the drain. Therefore, in order to implement alternative maintenance practices, the engineers report for the respective drain will need to be re-visited.

Over 60 percent of the watercourses in the Lake Erie North Shore watershed are classified as municipal drains. Haldimand County began a 10 year drain maintenance cycle program; a full cleanout is not necessarily conducted every. The drains included in this cycle and their last year of maintenance is as follows; Little Marsh Drain (1998), and Furry Drain, Boulton Ditch, HE Dickout, and Chalmers Dickout (2007).

In Niagara Region, drain maintenance has occurred on the following municipal drains since 2001: Casey Drain (main branch), Point Abino, Michener Drain, Beaverdam Drain. Drain maintenance has been scheduled in the near future for Bearss Drain and Bay Beach Area Drain, and reports for Wignell Drain and Little Marsh Drain are currently in progress.

## **Natural Heritage and Resources**

Concern over the loss and lack of protection of natural areas was expressed by participants of a public open house and 2 public workshops in the spring and fall of 2008. Although regional and municipal official plans include the protection of environmentally significant areas, the loss of natural features still occurs with development. Natural features include, for example, wetlands, forests, meadows, and riparian stream cover, and they provide many ecological functions in the Lake Erie North Shore watershed in terms of protecting water quality, moderating water quantity and providing habitat. In natural areas stormwater is more or less infiltrated where it falls, allowing most of the pollutants to be filtered through soils. When these areas are lost, and their functions not replaced with infiltration, detention or restoration measures, receiving watercourses are negatively affected with increased flows and pollutant loads. A lack of tributary buffers has been identified as a major issue in the watershed (RMN 2006a) as well as the fragmentation of natural areas in the study area. Ecological linkages between natural areas facilitates in the movement of flora and fauna between natural areas as well as providing habitat and enhancing ecological diversity.

The challenge for the Lake Erie North Shore watershed is to protect and preserve existing forest and wetland areas. The establishment and expansion of riparian buffers is needed to protect water quality in the watershed.

The following is a brief summary of some of the benefits of each feature and its contribution to maintaining a healthy watershed.

### ***Wetland Habitat***

Wetlands provide very important water quality and ecological functions in a watershed. Currently, the percent of wetland cover in the Lake Erie North Shore watershed is high and should be maintained. Therefore, means to maintain the numbers and/or size of wetlands will be included in the watershed strategy because wetlands:

- naturally filter water resources thereby improving water quality,
- act like sponges, slowing the flow of water which reduces the impact of flooding and allows for groundwater recharge,
- help to prevent soil erosion, and
- augments low-flow by raising local water tables, which helps to maintain base flows.

### ***Riparian Cover***

Riparian cover in the watershed is moderate with 64 percent of the watercourses have some vegetation along the watercourse. Therefore a means to improve the riparian habitat will be addressed in the restoration plan of the Lake Erie North Shore Watershed Plan. Like wetlands, riparian buffers also improve water quality. For example, riparian buffers:

- remove sediment and pollution such as chemicals, fertilizers, pesticides, bacteria and road salt before they reach surface water,
- reduce the impacts of flooding,
- prevent erosion,
- improve water clarity, and
- provide shade and cooler water temperatures for fish and other aquatic organisms (NPCA 2003).

#### *Upland Habitat: Woodland and Grasslands (Prairies and Meadows)*

The amount of forest cover in a watershed determines its ability to support species diversity. The Lake Erie North Shore watershed is below adequate levels to protect water quality and provide habitat with 20 percent of the watershed in forest cover. Forest cover is beneficial because it:

- reduces flooding and high flow events by intercepting runoff thereby encouraging infiltration,
- improves water quality by slowing the rate of runoff to watercourses, and trapping, using or breaking down some of the pollutants and nutrients found in runoff water,
- improves water quality by lowering water temperatures and shading water courses,
- improves groundwater quality by increasing the amount of rainfall that percolates to the groundwater table,
- reduces soil erosion, and
- preserves and increases flora and fauna diversity.

In addition, prairies and meadows also play an important role in creating habitat diversity and foraging areas for wildlife. Therefore, they should be given consideration in habitat creation and restoration actions in the Lake Erie North Shore watershed.

### **Fish and Aquatic Habitat**

As previously mentioned the fish community in the Lake Erie North Shore watershed is representative of a tolerant warm water fishery. Different species of fish have varying tolerances to environmental change; therefore, they are considered valuable indicators of environmental and ecosystem health (Nottawasaga Valley Conservation Authority 1995). The protection and improvement of critical and important fish habitat has been identified as an issue in this watershed, in addition to the completion of fish habitat classification of all watercourses in the study area (RMN 2006a).

Fish habitat consists of areas that fish need, whether directly or indirectly in order to carry out their life processes including spawning grounds, nursery, rearing, food supply, and migration areas. Broadly defined, wetlands, groundwater recharge areas, aquifers, and the quantity and quality of groundwater and surface water are all important factors for maintaining the quality and quantity of fish habitat. Development activities, structures, changes in land use, and alteration to hydrology can all impact fish



and fish habitat. Fish habitat can be damaged in numerous ways including:

- dredging and filling near spawning and nursery habitat,
- loss of riparian vegetation,
- stream alterations including fish barriers,
- poorly managed stormwater runoff,
- impaired water quality (e.g., sediment and nutrient loadings, increased temperature), and
- loss of groundwater recharge capability (*Fisheries Act, Section 34*).

The watershed strategy will focus on preserving Type 1 fish habitat in the watershed, and it will suggest restoration alternatives to maintain and improve Type 2 fish habitat.

## Climate Change

Most climatologists agree that climate change and warming of the Earth's atmosphere is occurring. In addition, there is also broad agreement that human activities are primarily responsible for the changes to global climate that have been observed during the last half of the twentieth century (de Loë and Berg 2006). In 2007, the Ministry of Natural Resources released a report on climate projections for Ontario and how Ontario's climate could change during the 21<sup>st</sup> century. Climate models predict the effect of higher greenhouse gases based on increasing amounts of heat trapped in the atmosphere. Each modelled scenario has a different set of assumptions about future social and economic conditions *"since the amount of greenhouse gas in the future depends on highly variable factors such as global population, human behaviour, technological development and the carbon sink/source behaviour of land and water ecosystems"* (MNR 2007b).

For the Niagara region and westward to Windsor and Sarnia, the modeled projections calculate an increase in summer (April to September) average temperatures of 5 to 6 degrees Celsius and a 10 % decrease in precipitation by 2071 (MNR 2007b). The winter climate for most of southern Ontario is projected to increase 1 to 2 degrees Celsius between 2011 and 2040, and could increase by 3 to 4 degrees by mid-century. In addition, most of southern Ontario could receive 10% less precipitation during the cold season (MNR 2007b). Although the projections for Ontario's future climate are not certain, it is reported by the MNR in this study that the projections are likely *"closer to future reality than assuming that the future climate will be similar to that of the past 30, 60, or 100 years"* (2007b).

The report also outlines possible impacts that climate change could have on Ontario's ecosystems, societal values and infrastructure. For example, impacts to the agricultural sector could include a possible change in crops grown, longer growing season and a reduced productivity where an increase of temperature without a compensatory increase in precipitation occurs (MNR 2007b). Examples of potential impacts to the environment include changes in biodiversity of species and ecosystems, and new species becoming *'at risk'* because of disequilibrium with climate (MNR 2007b). For the complete list of examples of key possible impacts that climate change could have on Ontario's ecosystems, societal values and infrastructure taken from this report refer to Appendix C.

In *Mainstreaming Climate Change in Drinking Water Source Protection Planning In Ontario*, de Loë and Berg (2006) report some of the predicted impacts climate change could have on the hydrologic cycle and water resources in the Great Lakes Basin. The hydrologic cycle is sensitive to changes in temperature, precipitation and evaporation which accordingly could result in significant changes to streamflows, lake levels, water quality, groundwater infiltration, and patterns of groundwater recharge and discharge (de Loë and Berg 2006). The following are examples of potential impacts that the predicted changes to the hydrologic cycle could have on water resources in the Great Lakes Basin as reported by de Loë and Berg (2006):

- Winter runoff is expected to increase, but total runoff is expected to decrease, thus summer and fall low flows are expected to be lower and longer lasting;
- Groundwater recharge is expected to decrease due to a greater frequency of droughts and extreme precipitation events. As a result, shallow aquifers will be more sensitive to these changes than deeper wells; and
- Water temperature in rivers and streams is expected to rise as air temperatures rise, and as summer baseflow is reduced.

These modeled or predicted impacts to water resources will affect society as well as ecosystems. Societal water use issues may arise because decreased runoff may lead to reduced water quality, resulting in increased water treatment costs and greater competition and conflict for water resources during low water or drought conditions. Ecologically, changes to wetland form and function may also experience change due to the impacts of climate change. For example, a reduction in groundwater discharge and an increase in surface water temperature will stress fish and fish habitat (de Loë and Berg 2006).

For the summary table of identified hydrological changes expected in the Great Lakes Basin identified in this report, refer to Appendix C.

## **Ecological Restoration and Environmental Planning Tools**

### **Communication and Education**

Watersheds often span numerous political boundaries. Therefore, agency, non-governmental partnerships, and citizen involvement is essential to the successful implementation of the Lake Erie North Shore watershed strategy. To facilitate communication between citizens and agencies in the watershed, a list of the major water resources legislation and agencies governing water management in Ontario is provided in Appendix D. In addition to partnering on public and private lands, policy tools can be employed to foster environmentally responsible land and water management in the watershed.

#### *Policy Tools and Incentive Programs*

Policy tools addressing land use planning, significant natural heritage features and water quality and quantity protection can be implemented at the local or regional levels of government in the watershed. Designed to allow for continued development and/or

revitalization and intensification of developed areas, these tools ensure that issues pertaining to the protection, improvement, and enhancement of our natural resources are taken into consideration throughout the development process. Policy tools might include municipal policies, incentive-based tools as well as other water conservation related tools. Specific examples of these policy tools and incentives are presented here.

- **Stormwater Management Policies** require the control and treatment of stormwater discharges to prevent flooding, minimize downstream channel erosion, and protect water quality.
- **Riparian Buffer Policies** protect watercourses and maintain aquatic habitat. Riparian buffer guidelines should take into account the amount of natural vegetation adjacent to a stream, the width of the vegetated buffer, total suspended solid concentrations, percent imperviousness in urbanizing watersheds, and fish communities (EC 2004c).
- **Shoreline Protection Works** should take into consideration natural coastal processes and incorporate natural elements in the design and the materials. Shoreline protection should also be designed and constructed as to not impeded natural dune processes or create a barrier preventing amphibians during reproductive migrations between water and land(e.g. Fowler's Toad)
- **Sustainable Subdivision Design** encourage the development of subdivisions whereby houses are clustered and open space is protected. Conventional subdivisions spread development evenly throughout a parcel of land. However, conservation subdivisions are considered "density neutral", which means that the same number of lots can fit on a parcel of land, but the arrangement of the houses are clustered.
- **Incentive-based Tools** such as **Water Conservation Programs** aid in the protection of water quality, quantity and aquatic habitat by reducing the demand on water resources and maintaining instream flows. Thus, the natural hydrology of streams is protected during peak water demand.
- **Alternative Land Use Services** is a program whereby agricultural producers offer Canadians an environmental partnership opportunity by contributing the use of a portion of their land, plus labour, equipment, fuel, and money to produce environmental benefits, while encouraging investments from the rest of society to manage these benefits.
- **Land Securement Programs:** securing land into public or private ownership can help to protect water quality and natural heritage features. For example, maintaining the natural condition of land around watercourses is an ideal approach to enhance water quality protection. Land securement programs help protect greenspace, conserve biodiversity and promote stewardship and community involvement, e.g. **NPCA, Niagara Land Trust**
- **Conservation Easements:** are agreements made between a landowner and a conservation groups whereby the landowner still owns the property but has agreed to restrict or prevent certain land uses in order to protect the natural features on the property.
- **Brownfield Redevelopment Incentives** encourage the rehabilitation, remediation and redevelopment of abandoned, underused or idle industrial and commercial properties. There are several programs that can be implemented through the RMN and municipalities such as the **Brownfield Tax Grant Program, Brownfield Tax Assistance Program, Brownfield Tax Arrears Credit Program, Brownfield Development Charge Incentive Program, and Municipal Brownfield Leadership Program** (RMN 2007b)

- **Brownfield Financial Tax Incentive Program:** is a provincial funding initiative to encourage the remediation and redevelopment of brownfield properties. The program matches provincial education property tax assistance to municipal property tax assistance for eligible brownfield property owners for the cleanup of the brownfield property.
- **Environmental Assessment Grant Program:** This program will assist developers of brownfield sites in acquiring the environmental information needed to determine the financial viability of developing these sites (RMN 2007b).
- **Downtown/Commercial Area Redevelopment Incentive Programs:** these programs are designed to provide financial incentives to encourage the redevelopment and rehabilitation of downtown properties and commercial areas in the Region of Niagara. These programs include the **Downtown Redevelopment Grant Program, Building and Façade Improvement Loan/Grant Program, and Downtown Development Charge Incentive Program** (RMN 2007b).
- **Heritage Properties Tax Reduction Program:** this program is designed to help property owners defer the higher maintenance and repair costs of heritage properties (RMN 2007b).
- **Heritage Restoration and Improvement Incentive Programs:** these programs are designed to provide financial incentives to encourage restoration and improvement of heritage properties in the Region of Niagara. These programs include the **Heritage Grant/Loan Program, Professional Design Study Grant Program, and Heritage Development Charge Incentive Program** (RMN 2007b).
- **Special Multi-Residential Tax Rate:** encourages the construction of new medium and high density rental housing by providing a special property tax rate (RMN 2007b).
- **Residential Conversion and Intensification Incentive Programs:** these programs are designed to provide financial incentives to encourage residential conversion and intensification. These programs include the **Residential Grant/Loan Program, Convert-to-Rent Grant Program, and Residential Development Charge Incentive Program** (RMN 2007b).

## Funding Sources for Environmental Projects

Several funding sources and land management tax incentive programs are available for landowners and non-profit organizations for creating, enhancing and preserving natural heritage. Examples of some of these programs follows:

### *Water Quality Improvement Program*

The Niagara Peninsula Conservation Authority provides landowners with up to 75 percent cost-share funding (depending on the eligible project) through its Water Quality Improvement Program. Participating landowners are responsible for any remaining costs through cash and in-kind contributions. To qualify for funding the following criteria must be met:

- projects must be within the NPCA's jurisdiction;
- projects must demonstrate an improvement to local surface and/or groundwater quality;
- the landowner must demonstrate good land stewardship practices;
- the landowner must contribute financially to the project in some capacity; and
- the landowner must complete a water quality improvement application and sign a project agreement form (NPCA 2003).

Eligible projects are related to woodland, wetland and riparian habitat restoration; manure and nutrient management; milkhouse washwater treatment and disposal; livestock restriction, alternate watering systems and crossings; and conservation farm practices.

### *Conservation Land Tax Incentive Program*

The Conservation Land Tax Incentive Program (CLTIP), offered by the Ministry of Natural Resources, was established by the province in 1998 to recognize, encourage and support the long-term private stewardship of Ontario's provincially significant conservation lands. This program provides property tax relief (100 percent for the eligible portion of the property) to landowners and non-profit organizations who agree to protect the natural heritage values of their property. Eligible lands consist of provincially significant areas identified by the Ministry of Natural Resources, and include: provincially significant wetlands; provincially significant Areas of Natural and Scientific Interest; endangered species habitats; lands designated as escarpment natural areas in the Niagara Escarpment Plan; and community conservation lands, which are natural areas of significance owned by non-profit charitable conservation organizations and conservation authorities. Landowners whose land is eligible and who are enrolled in this program are automatically notified by the MNR during the summer before each new tax year (MNR 2004).

### *The Managed Forest Tax Incentive Program*

The Managed Forest Tax Incentive Program (MFTIP), offered by the Ministry of Natural Resources, was established in 1998 to recognize the social and ecological benefits of forest lands. Privately owned forest land is eligible to be taxed at 25 percent of the municipal tax rate set for residential properties provided the property has at least 4 hectares of forest, is owned by a Canadian citizen, and has a Managed Forest Plan approved by a consultant designated by the MNR (Ontario Woodlot Association 2005).

### *Farm Property Class Tax Rate*

Under the Farm Property Class tax rate, farm properties that satisfy the eligibility requirements will be taxed at 25 percent of the municipal residential rate. However, the farm residence and 1 acre of land surrounding the residence will be taxed as part of the residential class. In order to be eligible for the Farm Property Class tax rate all of the following criteria must be satisfied:

- the property must be assessed as farmland;
- the property must be used as part of a farming operation generating Gross Farm Income of at least \$7,000 as reported to the Canada Revenue Agency for income tax purposes;
- a valid Farm Business Registration number is required for the business operating on the land; and
- the property must be owned by a Canadian citizen or a permanent resident of Canada (OMAFRA 2004).

### *Species at Risk Farm Incentive Program*

The Species at Risk Farm Incentive Program (SARFIP) was launched in 2008 by the Ministry of Natural Resources to encourage greater protection and conservation of species at risk and their habitats on privately owned agricultural lands across Ontario. The program provides “*enhanced cost share opportunities for farmers who take action on selected environmental Beneficial Management Practices that play a key role in contributing to a healthy and diverse environment as well as helping sustain production and profitability on the farm*” (MNR No Date-b). Ontario farmers may be eligible for up to 100 percent of the cost to establish a BMP project from the list of approved projects. Projects include, but are not limited to:

- riparian area management
- erosion control structures in riparian area
- improved pest management
- shelterbelt establishment, and
- enhancement of wildlife habitat and biodiversity.

### *Water Well Decommissioning Program*

The NPCA has launched a water well decommissioning granting program for qualifying landowners with lands located within the NPCA jurisdiction. To qualify for funding the following criteria must be met:

- grants are available for the decommissioning of unused water wells only. Oil wells, gas wells and cisterns are not eligible under this program;
- the proposed work must be completed by a water well contractor licensed by the Ministry of the Environment (MOE) as set out in Ontario Regulation 903;
- the proposed work must comply with MOE procedures for plugging or abandoning unused water wells according to Ontario Regulation 903. Details of the procedure must be documented on the water well record and submitted to the MOE by the hired water well contractor upon completion;
- a copy of the water well record must also be submitted to the NPCA by the landowner or the hired water well contractor upon completion;
- priority will be given to:
  - o hydrogeologically sensitive areas (based on NPCA Groundwater Study or other studies as endorsed by NPCA),
  - o projects located in areas with a high density of domestic water wells, and
  - o areas where watershed plans have been completed or are on-going; and
- all proposals are subject to review and approval by NPCA staff.

Under this grant program, applicants must apply and be approved prior to initiating their project. Projects already underway or completed without NPCA approval are not eligible. Eligible costs include those incurred by a licensed contractor and/or licensed technician fees for water well decommissioning (as approved by the NPCA). The Grant will cover 90 percent of well decommissioning costs to a maximum of \$2,000 per well (limit of two wells per property). This is a reimbursement program; the landowner will pay the full cost to the contractor, and will be reimbursed for 90 percent of the total project cost after all receipts, invoices, and water well decommissioning records are submitted to the NPCA.

### *EcoAction Community Funding Program*

Environment Canada's EcoAction Community Funding Program provides financial support to community groups for projects that have measureable, positive impacts on the environment. Funded projects promote the participation of local communities to address clean air, climate change, clean water, and nature to protect, rehabilitate or enhance the natural environment (Environment Canada No Data). A maximum of \$100,000 is available per project and the project duration may be up to 3 years. The following is a list of those that can apply for funding through the EcoAction Community Funding Program:

- Non-profit non-government groups and organizations and community groups
- Environmental groups
- Aboriginal groups and First Nation Councils
- Service Clubs
- Associations, and
- Youth and Senior Organizations

### **Watershed Best Management Practices**

A best management practice (BMP) is a land management practice implemented to control sources or causes of pollution. The 3 types of BMPs that treat, prevent, or reduce water pollution include:

- Structural BMPs are practices that require construction activities such as stormwater basins, grade stabilization structures, and crib walls.
- Vegetative BMPs use plants, including grasses, trees and shrubs to stabilize erosion sites.
- Managerial BMPs involve policy changes or operating procedures at a site (Brown, *et al.* 2000).

It is important to note that BMPs are available for both urban and rural areas. A brief description of urban and rural BMPs follow and a more complete list of structural, vegetative and managerial BMPs are provided in Appendix B.

### *Urban Best Management Practices*

Urban BMPs are designed to redirect water from impervious surfaces to infiltration areas such as lawns, gardens, or forested areas. Residential landowners can minimize outdoor water consumption; plant drought-tolerant vegetation; capture rainwater for outdoor watering; avoid clearing vegetation around streams, riparian zones or floodplains; avoid channelizing streams or channels that connect to streams; avoid filling in floodplain or riparian zone areas; and discontinue the use of chemical fertilizers on their lawns and gardens. In addition to landowner BMPs in urban areas, BMPs can also be employed by local and regional governments to reduce the impacts to water quality and quantity from stormwater. Examples of Urban BMP's can be reviewed in Appendix B.

## *Stormwater Best Management Practices*

Stormwater BMPs are techniques, measures, or structural controls that are used to manage the quantity and improve the quality of stormwater runoff in a cost effective manner. Measures for controlling storm water include at source and lot-level controls, conveyance controls and end-of-pipe controls. Examples of Stormwater BMP's can be reviewed in Appendix B.

### *At Source and Lot-Level Quantity Controls:*

Typically *At Source and Lot-Level* controls are the most effective in providing water quality protection because they prevent pollutants from entering the drainage system and provide for flow retention at source. Most practices can assist in addressing the four criteria; quantity, quality, stream erosion, and hydrologic cycle, but they are more often associated with quality and quantity control (National Guide to Sustainable Municipal Infrastructure 2003; AECOM 2010). At Source and Lot-Level controls consist of non-structural source controls, housekeeping practices, control of construction activities, and structural at-source controls (AECOM 2010).

### *Conveyance Controls*

Conveyance controls provide quality and/or quantity control within the conveyance system between the source and outlet, to help mitigate the impacts of urbanization. They transport runoff from developed areas through storm sewers, roadside ditches, or vegetated swales (AECOM 2010).

### *End-of-Pipe Controls*

End-of-pipe controls allow for flow attenuation, major flow conveyance, and water quality enhancement of storm water before outletting to receiving body of water. Examples include wetlands, dry ponds and wet ponds. End-of-pipe controls allow for storm water quality and quantity mitigation at or near the downstream end of the conveyance control (AECOM 2010).

## *Managerial Best Management Practices*

Managerial BMPs can also be achieved through municipalities. Municipalities can encourage and/or regulate land use planning and management by developing ordinances to manage stormwater impacts by limiting pavement, preserving open space, and delineating areas in the watershed for more on-site stormwater management facilities. Examples of Managerial BMP's can be reviewed in Appendix B.

## *Agricultural Best Management Practices*

BMPs can improve rural non-point source pollution problems. For example, a lack of tributary buffers, and nutrient management have been identified in the watershed (RMN 2006). Sediment control BMPs, water quality BMPs and nutrient management BMPs can be employed to mitigate the impacts of these activities on watercourses and wetlands. Examples of agricultural BMPs are provided below and a more thorough list of agricultural BMPs can be found in Appendix B.

### *Sediment Control Best Management Practices*

Conservation tillage results in minimum soil disturbance by leaving at least 30 percent of the soil surface covered with crop residue immediately after planting. It is estimated that conservation tillage reduces soil loss by 50-95 percent and is effective in improving water quality. Windbreaks also control sediment and simply consist of rows of trees planted around the edge of fields to reduce soil erosion by wind.

### *Water Quality Best Management Practices*

Tailwater recovery ponds are located at the base of a drainage area. They are designed to intercept runoff before it enters a stream to treat and remove sediment and nutrients from the water. These ponds can also be used as a source of irrigation water. Contour farming involves ploughing furrows perpendicular to the contour of the land, which allows water to be captured between the furrows to prevent the formation of erosion rills down the slope. This method also helps minimize the volume of water that is applied to the field thereby reducing sediment washoff. Buffer strips represent a third example of agricultural BMPs to protect water quality. Vegetation planted along a watercourse ensures bank stability and provides shade to the stream. Buffer strips also act to trap sediment and filter nutrients out of runoff from agricultural fields.

### *Nutrient Management Practices*

The objective of nutrient management in Ontario is to use nutrients wisely for optimum economic benefit, while minimizing the impact on the environment (OMAF 1996). A nutrient management plan provides direction on how nutrients are to be applied to a given land base to optimize the use of nutrients by crops in order to minimize environmental impacts. In addition to nutrient management plans, fertilizer storage BMPs can also be implemented on a farm to ensure storage facilities are placed in appropriate areas (e.g., impermeable areas, away from wells).

## **Watershed Habitat Restoration**

Environment Canada (2004c) in its *How Much Habitat is Enough?* document puts forth restoration guidelines for wetland, riparian, and forest habitat. This framework provides “science-based information and general guidelines to assist government and non-government restoration practitioners, planners and others involved in natural heritage conservation and preservation by ensuring there is adequate riparian, wetland and forest habitat to sustain minimum viable wildlife populations and help maintain selected ecosystem functions and attributes”. Given the breadth of science used to generate this framework, its guidelines will serve as the basis for the Lake Erie North Shore watershed strategy. A summary of the riparian, wetland and forest habitat restoration guidelines have been reproduced in Appendix G.

### **Watershed Restoration Guidelines**

Environment Canada's (2004c) guidelines for wetland, riparian and forest habitat restoration identify targets for each habitat type in a watershed (Appendix G). The guidelines recommend the following:

- Wetlands: Greater than 10 percent of each major watershed in wetland habitat; greater than 6 percent of each subwatershed in wetland habitat; or restore to original percentage of wetlands in the watershed.
- Forest: At least 30 percent of the watershed should be in forest cover.
- Riparian: 75 percent of stream length should be naturally vegetated.

As previously indicated, the guidelines are intended as minimum ecological requirements and are meant to provide guidance in setting local habitat restoration and protection targets.

The Lake Erie North Shore watershed currently contains approximately 16 percent wetland cover and approximately 20 percent forest cover (NPCA 2007). Based on the above guidelines, an additional 10 percent of forest cover is required to create minimum desirable habitat proportions in the Lake Erie North Shore watershed. Therefore, measures to create new upland areas, as well as protect and enhance existing forest cover should be implemented to



ensure no net loss of forest cover. Riparian cover in the watershed is approximately 64 percent in the watershed. Based on this percentage approximately 11 percent of the watershed requires a vegetative buffer. The guidelines represent minimum desirable habitat proportions for riparian, wetland and upland forest habitat. Additional restoration above the minimum target is encouraged once these targets have been met. Existing natural heritage features and areas in the watershed should be preserved and enhanced whenever possible to improve water quality, ecological uses and human uses of the natural features. In addition, whenever possible projects should benefit species which are designated federally under the *Species At Risk Act* or provincially under the *Endangered Species Act* (EC 2004c).

## Watershed Strategy

For convenience, and to make restoration recommendations more manageable and easier to implement, the watershed planning strategy has been divided into separate restoration plans for the following subwatersheds: Lowbanks Drain, Hoover Drain, Lake Erie 8, Casey Drain, Lake Erie 5, Wainfleet Marsh, Lake Erie 3, Eagle Marsh Drain, Wignell Drain, Beaver Dam Creek, Oil Mill Creek, Bearss Drain, Point Abino Drain, and Bay Beach Area Drain.

Restoration areas have been identified using riparian, wetland and upland restoration suitability mapping produced by the NPCA (Figures 17 to 19); Carolinian Canada's 'Big Picture' corridors; Regional Niagara's Core Natural Heritage System mapping, in conjunction with all natural heritage mapping layers including MNR's wetland mapping, wooded areas, NPCA ELC data, ANSI's, and old growth forests.

Carolinian Canada's 'Big Picture' identifies existing natural cores, corridors and potential linkages in Canada's Carolinian life zone while Regional Niagara's Core Natural Heritage System consists of core natural areas to Niagara Region and potential linkages to areas identified as core areas. These layers and all subsequent layers were used in the analysis and identification of potential restoration areas in the Lake Erie North Shore Watershed.

The criteria for each restoration category (riparian, wetland and upland) were derived from several sources including Environment Canada's (2004c) framework for guiding habitat rehabilitation (Appendix G).

Each type of habitat restoration (riparian, wetland, upland) has been prioritized as most suitable, moderately suitable or least suitable. Areas suitable for riparian, wetland and upland habitat restoration may overlap on the following watershed restoration strategy maps due to the methodology from which they were derived. When this occurs, the most suitable restoration project should be implemented based on field verification, available project funding, landowner partnerships as well as the opportunity to enhance ecological linkages.

## **Restoration Suitability Mapping**

The criteria used to create the restoration suitability mapping were derived from several sources (Appendix H). The criteria for each restoration category (riparian, wetland and upland) vary and have been weighted differently based on the suitability of the land for habitat creation. A complete list, including the rationale, methodology and reference for each criterion used in the suitability analysis are presented in Appendix H, and the top three criteria for each restoration category are presented below.

### ***Riparian Habitat Restoration Suitability***

The criteria used to identify riparian habitat restoration suitability include, for example, stream bank erosion rates. This criterion is used because riparian areas identified as having high erosion rates resulting from an upslope contributing area and slope gradient analysis are most suitable to restoration with bioengineering. The proximity to a watercourse or waterbody identified riparian suitability because these areas contribute to both riparian buffers and floodplains, and restoration in these areas will improve the hydrological, habitat and water quality functions in the watershed. Land use type is ranked third in terms of identifying suitable areas for riparian restoration. Areas classified as scrub, low intensity agriculture, or natural areas are much more suitable to restoration than areas classified as industrial or urban.

### ***Wetland Habitat Restoration Suitability***

The criteria used to identify wetland habitat restoration suitability include, for example, soil drainage because the drainage class of an underlying soil determines the amount of water the soil can receive and store before runoff. The more poorly drained the underlying soil, the more suitable the area is for wetland restoration. The wetness index predicts zones of water saturation where steady-state conditions and uniform soil properties are assumed. Similar to riparian restoration, land use type plays a role in determining areas suitable for wetland restoration.

### *Upland Habitat Restoration Suitability*

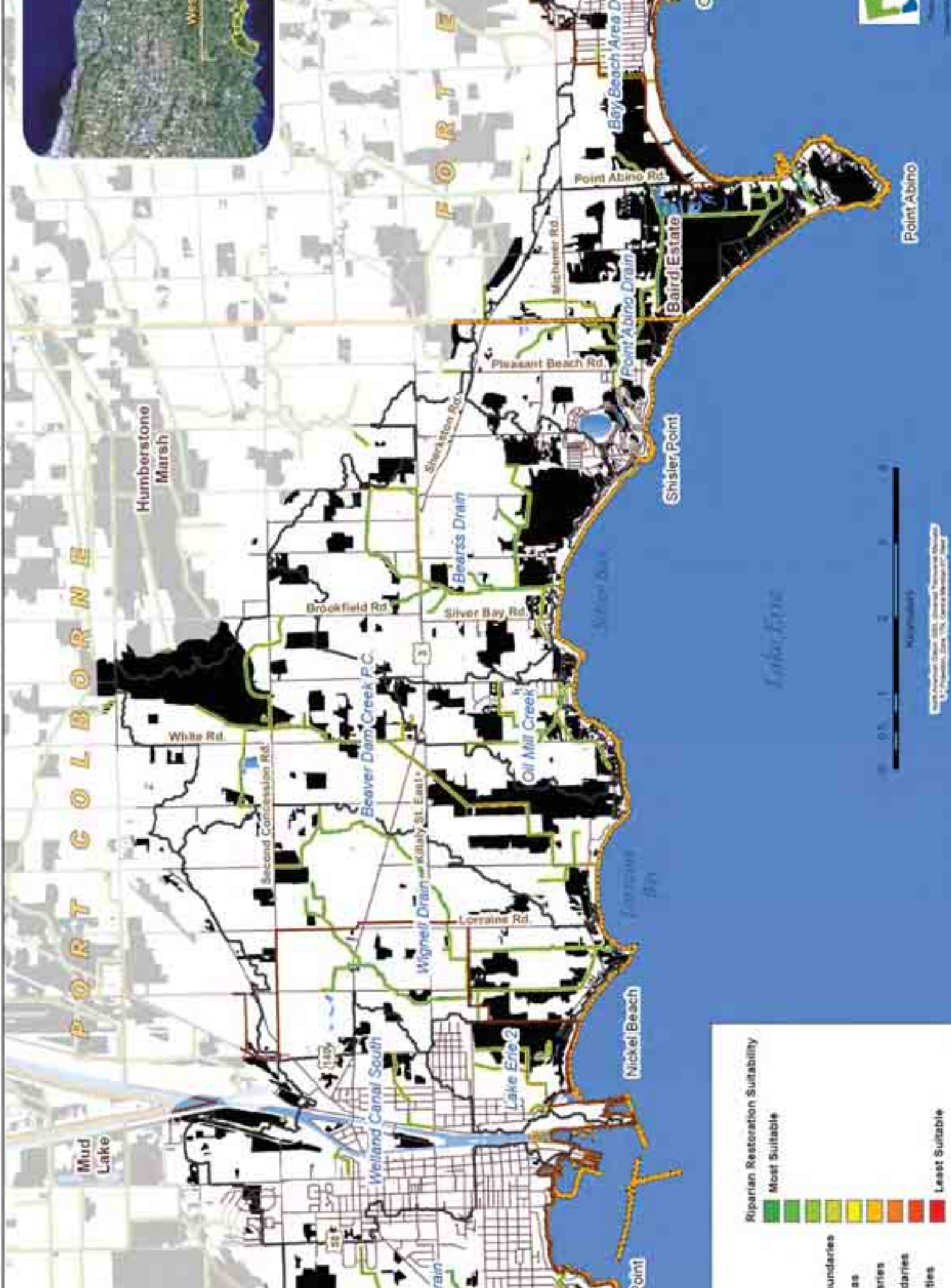
Upland habitat restoration suitability is also evaluated based on land use type. Wetland buffer habitat thresholds (0-240m) are also used, which include areas within the 0-240 metre span of a wetland because they contribute to a range of habitat functions when vegetated. Vegetation within the closest proximity to a wetland provides the greatest benefit to that wetland; this area is known as the Critical Function Zone. The third criterion for determining upland suitability is the proximity of an area to a significant patch. Areas within the closest proximity to existing forest patches with the highest Natural Heritage Score, or core size, are considered the most suitable for upland restoration because these sites will increase interior habitat. Additional criteria and the weighting scheme are presented in Appendix H. A series of habitat restoration suitability maps are provided (Figures 18 - 20).

### Riparian Restoration Suitability

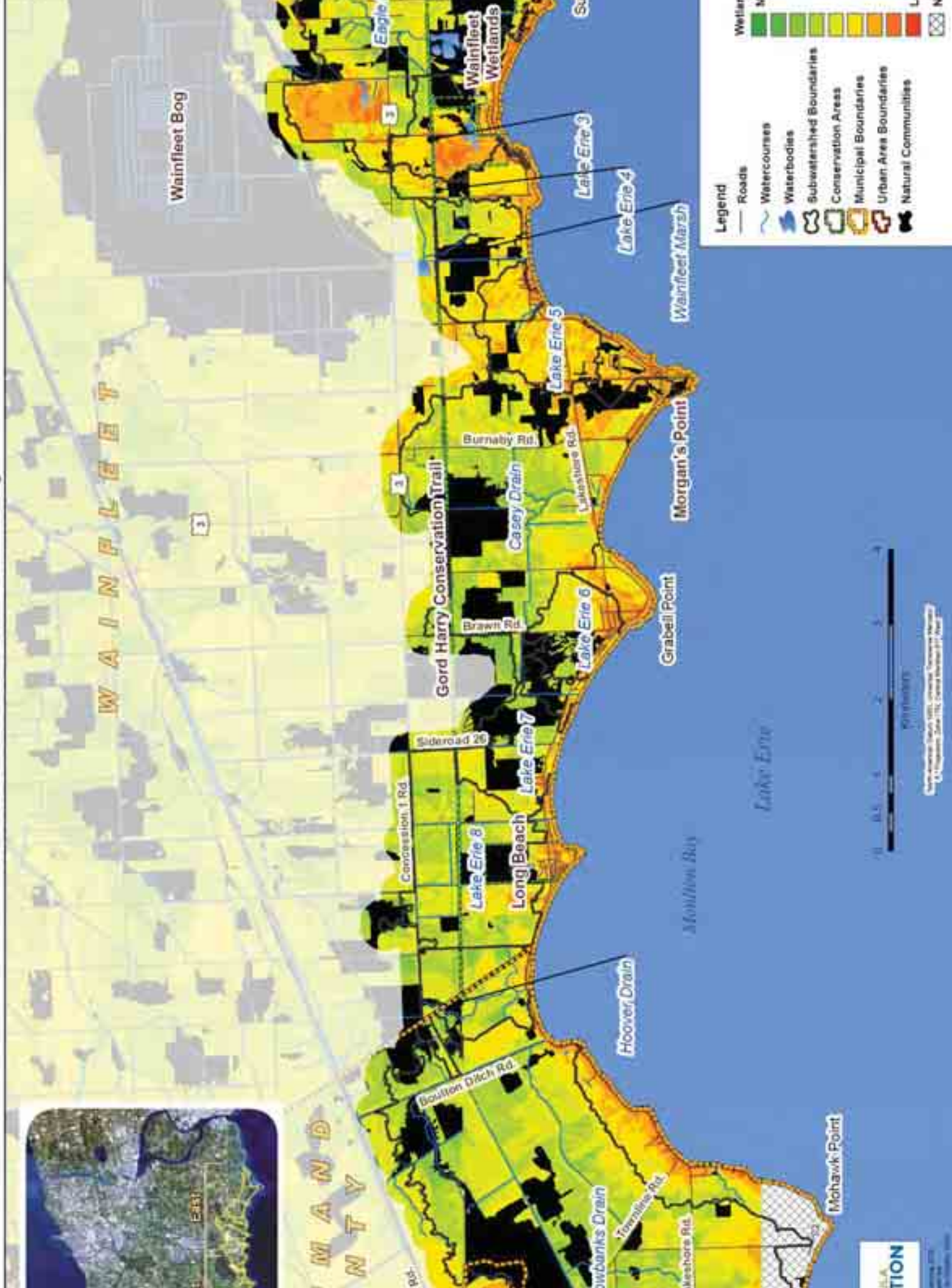


# Lake Erie North Shore Watershed - East

## Riparian Restoration Suitability

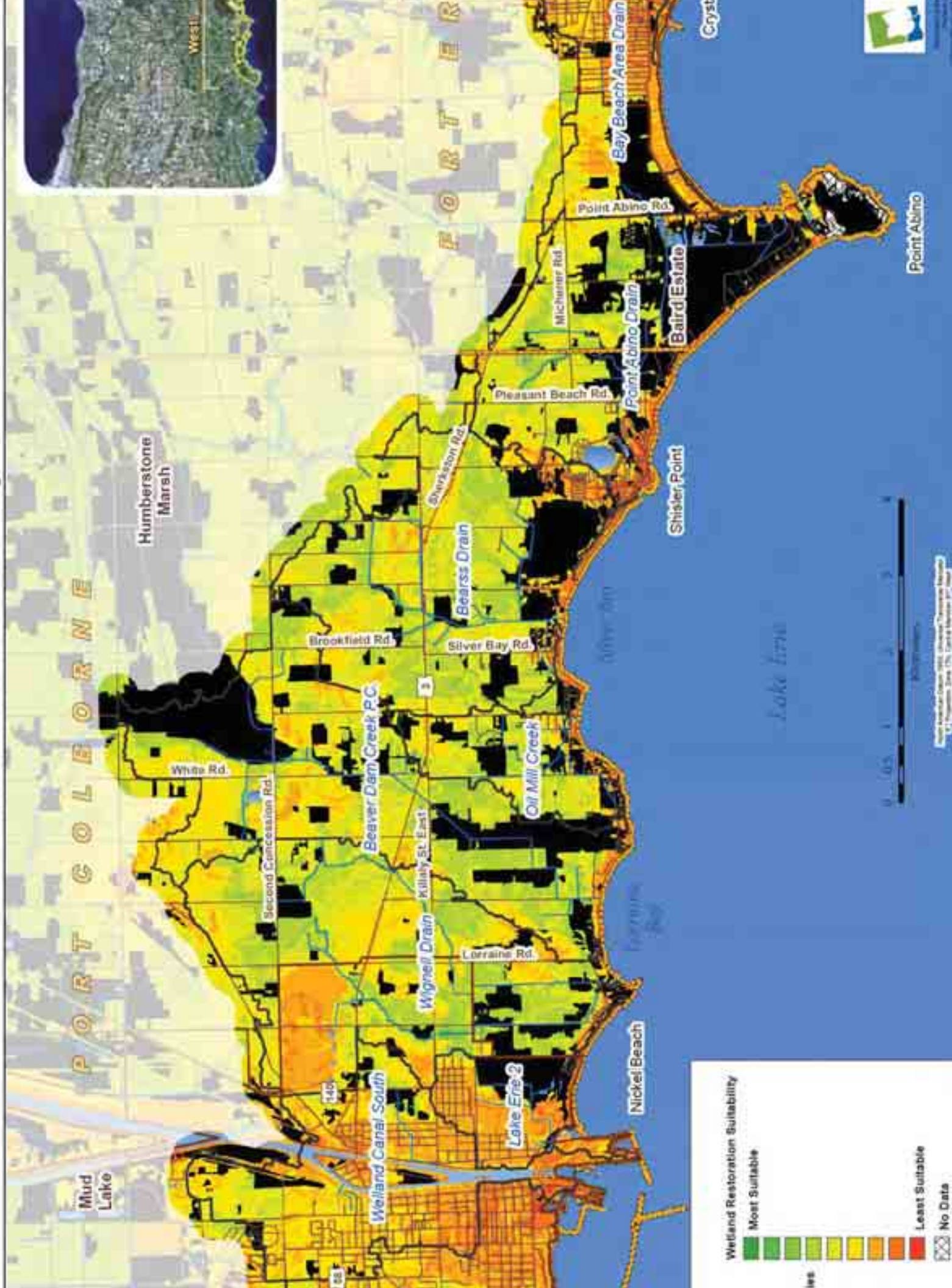


## Wetland Restoration Suitability



# Lake Erie North Shore Watershed - East

## Wetland Restoration Suitability

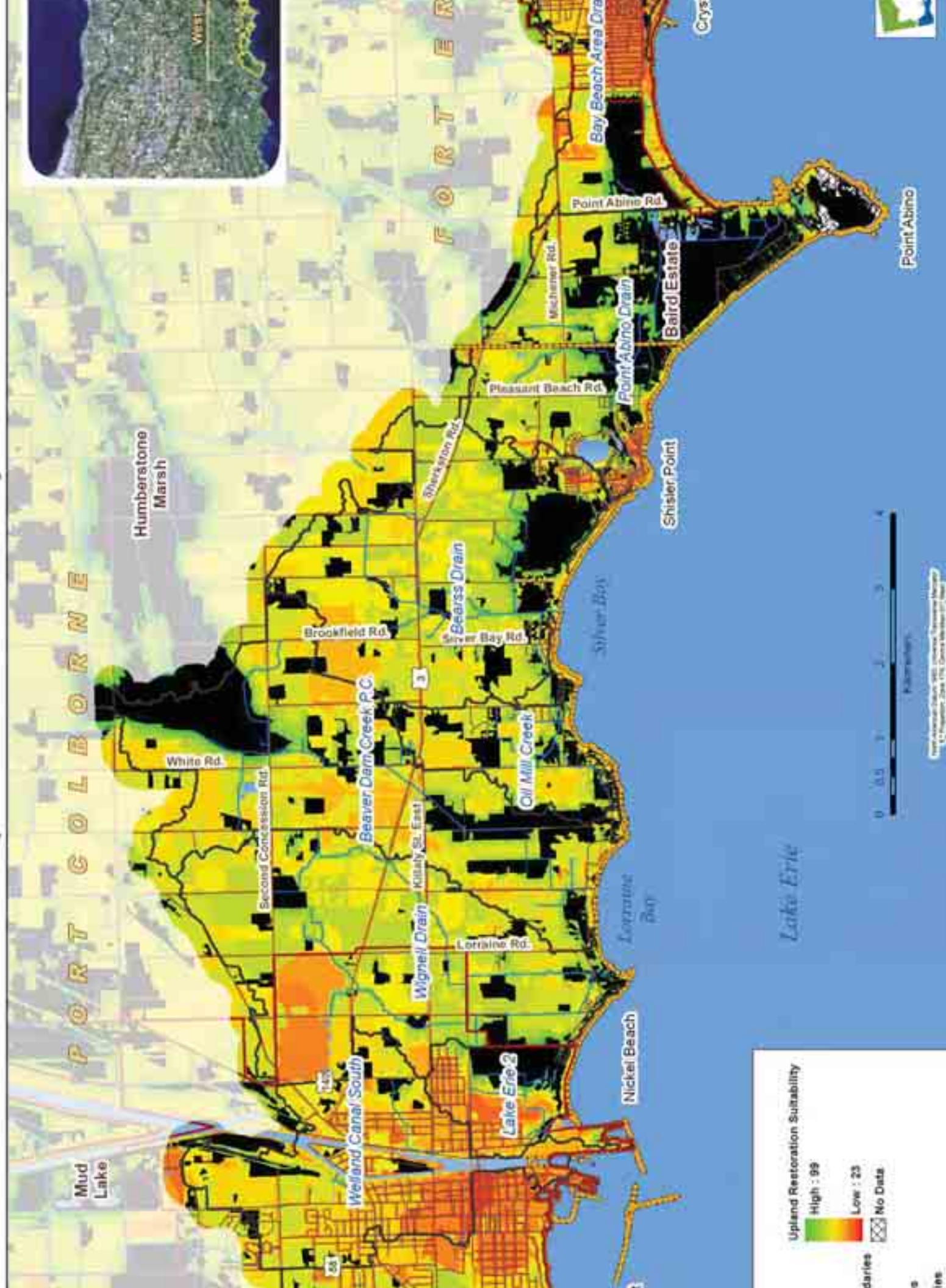


# Lake Erie North Shore Watershed - West Upland Restoration Suitability



# Lake Erie North Shore Watershed - East

## Upland Restoration Suitability



## Lowbanks Drain Restoration Strategy

Lowbanks Drain subwatershed is primarily drained by municipal drains. Chalmers Dickout Drain and H.E. Dickout Drain are designated as Class F Drains, Furry Drain is designated as a Class D Drain, and both Little Marsh Drain and Boulton Ditch Drain are designated Class E Drains. None of the watercourses in this subwatershed have been evaluated in terms of importance for fish habitat. Eight sites were assessed in this subwatershed as part of the NPCA Geomorphic Assessment. Seven of these sites were within municipal drains. Bank instability and relatively deep unconsolidated sediment deposited along the channel bed was noted at a number of field sites.

BioMAP samples in this subwatershed indicate water quality is impaired. Primary causes of impairment at the Lake Erie BioMAP stations include sediment loading, reduced baseflow, lack of in-stream habitat and nutrient enrichment (NPCA 2010). Water quality sampling indicates marginal water quality with exceedances of total phosphorus, *E. coli* and suspended solids. This site is vulnerable to low base flow and water stagnation with severe algae growth identified during the summer months (NPCA 2010). Soil erosion, the use of fertilizers and pesticides coupled with the lack of sufficient riparian buffers are likely sources of total phosphorus in this watershed. Potential sources of *E. coli* include runoff from urban and agricultural land use, animal waste, and sewage discharge. Promotion of the NPCA's education programs pertaining to agricultural best management practices and water quality would be beneficial for the landowners. These programs also include information on sources of funding for environmental projects on private land to encourage adoption and implementation of best management practices

Land use in the subwatershed is primarily agriculture with some strip and node residential throughout the subwatershed and along the lakeshore. Before draining into Lake Erie, Lowbanks Drain and its tributaries flow through several agricultural fields and natural areas including, Moulton Wetland West PSW, and Bunz Bush. Several Species at Risk have been identified in the Lowbanks Drain subwatershed, including the endangered kidneyshell, round pigtoe, and snuffbox mussels, and the threatened blanding's turtle. In addition, numerous provincially rare species have been identified by the NPCA and the MNR.

The challenge of the Lowbanks Drain subwatershed is the establishment of a sufficient vegetative riparian buffer which is imperative in assisting with the protection and enhancement of water quality, as well as providing a corridor and shelter that will facilitate in wildlife movement along the watercourse between natural areas. The fragmented pattern of the natural areas in this subwatershed offers ample opportunity for the establishment of corridor connections and enhancement of existing natural areas including Moulton Wetland West, a large core area. In areas where natural areas are narrow and irregular it is important to enhance these areas reducing the amount of forest edge and increasing the interior resulting in an increased ability to support a larger diversity of flora and fauna.

The Lowbanks Drain Subwatershed Restoration Strategy identifies three zones with specific stewardship and restoration recommendations (Table 10 and Figure 21).

**Table 10: Lowbanks Drain Subwatershed Restoration Strategy**

| <b>Recommended Restoration Strategies</b>                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Restoration Opportunities</b>                                  | <b>Riparian</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Wetland</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Upland and Ecological Linkages</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 1. Headwaters region: H.E. Dickout Drain & Chalmers Dickout Drain | <ul style="list-style-type: none"> <li>priority should be placed on establishing riparian habitat; the headwaters run through agricultural lands with little to no buffer.</li> <li>riparian buffers will help to reduce sediment and cool the water to enhance water quality and fish habitat as well create corridors that will connect fragmented natural areas providing cover for wildlife</li> <li>watercourses are managed as municipal drains therefore establishment of riparian corridors (e.g. deep rooted grasses &amp; shrubs) should consider future maintenance activities (refer to engineers report and drainage BMP practice recommendations)</li> </ul> | <ul style="list-style-type: none"> <li>very high riparian-wetland restoration suitability along watercourse between fragmented natural areas</li> <li>protect existing wetlands (e.g., create a buffer of trees and shrubs between the wetlands and the agricultural activities)</li> <li>create/enhance wetlands in areas where the wetness index and soil drainage permit; priority should be given to areas adjacent to existing wetlands (e.g., very high restoration suitability exists between Moulton Wetland West PSW complexes)</li> </ul> | <ul style="list-style-type: none"> <li>very high suitability exists for creating a Critical Function Zone (CFZ) between Moulton Wetland West PSW complexes by means of filling in gaps increasing interior habitat while providing a variety of critical functions for wetland-associated fauna (e.g. nesting habitat)</li> <li>A Critical Function Zone is a functional extension of the wetland into the upland area. CFZ's provide a number of functions for wetland-associated fauna that extend beyond the wetland boundary (e.g. nesting habitats, foraging areas).</li> </ul> |
| 2. Furry Drain, northern tributary and Little Marsh Drain         | <ul style="list-style-type: none"> <li>watercourse partially receives cover from adjacent natural areas therefore focus should be on establishment of areas with little to no existing riparian (e.g. north branch off Furry Drain and Little Marsh Drain)</li> <li>ample of opportunity exists for establishment of riparian habitat providing connectivity between adjacent natural areas (e.g., between complexes of Moulton Wetland West PSW and adjacent natural areas)</li> <li>existing riparian should be maintained</li> <li>watercourses are managed as</li> </ul>                                                                                               | <ul style="list-style-type: none"> <li>very high riparian-wetland restoration suitability along watercourse between fragmented natural areas</li> <li>high suitability for infilling and enhancement of Moulton Wetland West PSW complexes and between unevaluated wetlands south of Furry Drain</li> </ul>                                                                                                                                                                                                                                         | <ul style="list-style-type: none"> <li>very high suitability for infilling in and around Moulton Wetland West PSW providing a Critical Function Zone and increasing interior size which would support a larger diversity of flora and fauna</li> <li>opportunity for linkage creation between fragmented natural areas</li> </ul>                                                                                                                                                                                                                                                    |

|                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                                | municipal drains therefore establishment of riparian corridors should consider future maintenance activities. (refer to engineers report and drainage BMP recommendations)<br>■ Little Marsh Drain currently undergoing section 78 engineers report; good time to implement BMP recommendations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                          |
| 3. Boulton Ditch Drain                                                                                                                                                                                                         | <ul style="list-style-type: none"> <li>measures to establish and enhance buffer should be considered to reduce sediment and contaminant loads from adjacent land use (road on west, agriculture on east) before outletting to Lake Erie.</li> <li>watercourses are managed as municipal drains therefore establishment of riparian corridors should consider future maintenance activities (refer to engineers report and drainage BMP recommendations)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <ul style="list-style-type: none"> <li>very high riparian-wetland restoration suitability along watercourse between fragmented natural areas</li> <li>high suitability for infilling and enhancement of unevaluated wetland east and west of Boulton Ditch Drain</li> </ul> | <ul style="list-style-type: none"> <li>restoration suitability mapping indicates high enhancement suitability of existing uplands, primarily in the northeast corner of subwatershed. This would connect existing natural areas to adjacent areas in adjoining subwatersheds creating larger contiguous natural areas that would support a wider diversity of flora and fauna</li> </ul> |
| <ul style="list-style-type: none"> <li>All restoration measures should where possible, benefit Species at Risk and provincially rare species</li> <li>Carolinian and native species should be used for all projects</li> </ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Project Opportunities</b>                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                          |
| NPCA Lake Erie North Shore Geomorphic Assessment Study (NPCA 2009b)                                                                                                                                                            | <b>Recommended Action for Public and Private Lands</b><br><br><b>1. Regional Road 3 (LBMB):</b> This section of watercourse is managed as a municipal drain; Furry Drain. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. Bank instability is present in the form of bare soil extending up the steep bank, and possibly slumping. Relatively deep unconsolidated sediment is deposited along the channel bed. Few to no pools exist along the bed but there is stagnant water present throughout the field site. The plant arrowhead, as well as aquatic vegetation in the form of a vine was identified along the bed of the channel throughout the field site. The presence of algae was also noted during a site visit in 2008. The riparian buffer along this reach is poor along the left bank and therefore will influence bank stability. A number of small tributaries and possibly rills/gullies exist along the watercourse. Measurements taken at channel cross sections would indicate that the watercourse at this field site has moderate to minor entrenchment which results in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil. The presence of bank slumping usually indicates that vegetative roots are too shallow to stabilize the bank. Water quality should |                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                          |

continue to be monitored within this watershed. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. Projects to prevent and limit further development of rills adjacent to the watercourse should be implemented. Some examples include grassed waterways, chute spillways, tile drainage outlets, and proper tillage and cropping practices (OMAFRA, 1997a, and OMAFRA, 1997b). Alternatives to traditional drainage design, such as wetland creation, floodplain development, and increasing channel curvature should also be considered. All recommendations should be discussed with the Drainage Superintendent.

**2. Rymer Road (LBMb/LBMc):** This section of watercourse is managed as a municipal drain; Chalmers Dickout Drain. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. Relatively deep unconsolidated sediment is deposited along the channel bed. Few to no pools exist along the bed but there is stagnant water present throughout the field site. A number of small tributaries and possibly rills/gullies exist along the watercourse. The riparian buffer along this reach is small, especially adjacent to the manicured lawn and therefore habitat and shading over the stream will be impacted. Dense vegetation within the channel was noted during a site visit in 2008. Measurements taken at channel cross sections would indicate that the watercourse at this field site is moderately entrenched which results in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil. Projects to prevent and limit further development of rills adjacent to the watercourse should be implemented. Some examples include grassed waterways, chute spillways, tile drainage outlets, and proper tillage and cropping practices (OMAFRA, 1997a, and OMAFRA, 1997b). Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. Alternatives to traditional drainage design, such as wetland creation, floodplain development, and increasing channel curvature should also be considered. All recommendations should be discussed with the Drainage Superintendent.

**3. Regional Road 3 (LBMb-2):** This section of watercourse is managed as a municipal drain; Furry Drain. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. Bank instability is present in the form of bare soil extending up the bank. Relatively deep unconsolidated sediment is deposited along the channel bed. Few to no pools exist along the bed but there is stagnant water present throughout the field site. Dense vegetation along the channel bed was noted during a site visit in 2008. A number of small tributaries and possibly rills/gullies exist along the watercourse. The riparian buffer along the left bank is small and therefore habitat and shading over the stream will be impacted. Measurements taken at channel cross sections would indicate that the watercourse at this field site is moderately entrenched which results in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil. Projects to prevent and limit further development of rills adjacent to the watercourse should be implemented. Some examples include grassed waterways, chute spillways, tile drainage outlets, and proper tillage and cropping practices (OMAFRA 1997a, and OMAFRA, 1997b). Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the

watercourse. Alternatives to traditional drainage design, such as wetland creation, floodplain development, and increasing channel curvature should also be considered. All recommendations should be discussed with the Drainage Superintendent.

**4. Townline Road (LBMb-3):** This section of watercourse is managed as a municipal drain; Furry Drain. It lacks any depositional features along the stream bed which indicate little flow diversity within the channel. Bank instability is present in the form of bare soil extending up the bank. Relatively deep unconsolidated sediment is deposited along the channel bed. Shallow pools and stagnant water is present throughout the field site. Some algae and an oily sheen on the water surface were noted during a site visit in 2008. There was also dense vegetation growing along the channel bed. A number of small tributaries and possibly rills/gullies exist along the watercourse. Measurements taken at channel cross sections would indicate that the watercourse at this field site is moderately entrenched which results in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil. Projects to prevent and limit further development of rills adjacent to the watercourse should be implemented. Some examples include grassed waterways, chute spillways, tile drainage outlets, and proper tillage and cropping practises (OMAFRA, 1997a, and OMAFRA 1997b). Water quality testing should continue to be monitored in this watershed. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. Alternatives to traditional drainage design, such as wetland creation, floodplain development, and increasing channel curvature should also be considered. All recommendations should be discussed with the Drainage Superintendent.

**5. Regional Road 3 (LBTa):** This section of watercourse is managed as a municipal drain; Little Marsh Drain. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. Relatively deep unconsolidated sediment is deposited along the channel bed. Few to no pools exist along the bed but there is stagnant water present throughout the field site. An oily sheen on the water surface was noted during a site visit in 2008. There was also dense vegetation growing along the channel bed. The lack of large trees adjacent to the channel results in little canopy cover over the channel and also impacts habitat. A number of small tributaries and possibly rills/gullies exist along the watercourse. A crossing through the channel that has no culvert is present at this field site. This can leave the bed and banks more susceptible to erosion and therefore add sediment into the watercourse. Concrete pieces were identified along the right bank indicating that some erosion protection measures have been implemented by the landowner. Recommendations for this site include increasing the amount of large woody vegetation adjacent to the channel to provide cover and habitat for fish, insects, and invertebrates along the watercourse. Projects to prevent and limit further development of rills adjacent to the watercourse should be implemented. Some examples include grassed waterways, chute spillways, tile drainage outlets, and proper tillage and cropping practises (OMAFRA, 1997a, and OMAFRA 1997b). Water quality testing should continue to be monitored in this watershed. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. A proper crossing with a culvert should be installed to limit bed and bank erosion. Proper bank protection measures should be installed along the right bank to ensure adequate stabilization. All recommendations should be discussed with the Drainage Superintendent.

**6. Regional Road 3 (LBTa-2):** This section of watercourse is managed as a municipal drain; Little Marsh Drain. It has been channelized and lacks any depositional features along the bed which indicate little flow diversity within the channel. Relatively deep unconsolidated sediment is deposited along the channel bed. An odour was emitted from the sediment when it was disturbed which could be caused by decaying vegetation. Few to no pools exist along the bed but there is stagnant water present throughout the field site. A number of small tributaries and possibly rills/gullies exist along the watercourse. A full reforestation project has been completed on this property in partnership with the Niagara Peninsula Conservation Authority (completed in 2008). Projects to prevent and limit further development of rills adjacent to the watercourse should be implemented. Some examples include grassed waterways, chute spillways, tile drainage outlets, and proper tillage and cropping practices (OMAFRA, 1997a, and OMAFRA, 1997b). Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. All recommendations should be discussed with the Drainage Superintendent.

**7. Townline Road (LBTa-3):** This section of watercourse is managed as a municipal drain; Little Marsh Drain. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. There are few to no pools along the streambed. A number of small tributaries and possibly rills/gullies exist along the watercourse. Measurements taken at channel cross sections would indicate that the watercourse at this field site has moderate and minor entrenchment which results in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil. Projects to prevent and limit further development of rills adjacent to the watercourse should be implemented. Some examples include grassed waterways, chute spillways, tile drainage outlets, and proper tillage and cropping practices (OMAFRA, 1997a, and OMAFRA, 1997b). Alternatives to traditional drainage design, such as wetland creation, floodplain development, and increasing channel curvature should also be considered. All recommendations should be discussed with the Drainage Superintendent.

**8. Hutchinson Road (LBTb):** This section of the watercourse has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. The watercourse along this field site is not managed as a municipal drain. The small buffer zone along the right bank, as well as the lack of large trees impact cover and habitat along this channel. Some bank instability is present adjacent to the garage in the form of bare soil extending up the bank. There may also be some slumping occurring as well. Measurements taken at channel cross sections would indicate that the watercourse at this field site is moderately entrenched which results in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil. The presence of bank slumping usually indicates that vegetative roots are too shallow to stabilize the bank. Proper bank protection measures should be implemented along the right bank to ensure adequate stabilization of the bank adjacent to the garage. Increasing the variety and diversity of native plant species within the buffer zone will provide cover and habitat for fish, insects, and invertebrate along the watercourse.

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|                                                         | <p>Seven of the eight field sites are within a designated municipal drain (three in Furry Drain, one in Chalmers Dickout Drain, and three in Little Marsh Drain). Bank instability and relatively deep unconsolidated sediment deposited along the channel bed was noted at a number of field sites. The possibility of rills/gullies present at almost all of the field sites indicates the potential for additional sediment entering the watercourse. Rill prevention measures such as slope re-grading, erosion control blankets, and seeding should be implemented along the adjacent property. Excessive sediment deposition can cause problems in the watercourse, such as lateral channel adjustments, increased turbidity, filling in of pools, and impacting fish habitat. Long term monitoring of sediment accumulation should be completed to avoid any potential problems and this can be done by the use of sediment traps. Six of the eight field sites are moderately entrenched, which means that flood waters will have little to no access to the floodplain. Confining the flood waters to the channel results in the loss of the adjacent floodplain, which impacts the hydraulic function of the watercourse (floodplains are storage areas for flood waters) and the physical habitat (loss of floodplain vegetation and the organisms that live there). It will also change the channel geometry overtime due to increased velocity, stream power, and channel slope. Increasing the variety and diversity of native plant species within small buffer zones will provide cover and habitat for fish, insects, and invertebrate along the watercourse. All recommendations should be discussed with the Drainage Superintendent.</p> |
| Naturalizing Drains and Drain Best Management Practices | <p>In addition to having an impact on aquatic and riparian habitat, drain maintenance has the potential to become quite costly through repeated maintenance activities. Naturalizing drains can potentially lengthen the time between maintenance events by reducing the amount of sediment entering and remaining in the drain. Best Management Practices for drain maintenance should be developed in consultation with, but not limited to, the following agencies; OMAFRA, DFO, MNR, Conservation Ontario, OFA, DSAO, CFFO, and the agricultural community to reduce ecological impacts to aquatic systems and to prevent sediment from returning to the drain. Any future maintenance of this watercourse should be done in accordance with Best Management Practices for drains. To review examples of current BMP mitigation measures, refer to Appendix I.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Promote Good Shoreline Stewardship                      | <p>Work with partnering stakeholders to promote shoreline areas that have been maintained naturally or restored to find a balance between natural processes and shoreline protection measures.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Blue Flag Beach Program                                 | <p>Work with partnering agencies to mitigate water quality issues and work towards Blue Flag Beach status. Blue Flag status meets high standards with respect to water quality, environmental management, environmental education and safety and services (Blueflag.ca) and is known globally. Blue Flag beaches have the potential to increase tourism in the area.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Ecological Linkages between Natural Areas               | <p>Opportunity potential is present for creating ecological linkages between natural areas creating larger contiguous natural features. Such areas have the potential to enhance movement of flora and fauna between natural areas as well as provide habitat and ecological diversity for a wide range of species.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Riparian Buffer Education and Grant Program             | <p>Many landowners keep their properties manicured or plant crops to the edge of the creek. The NPCA's program aimed at educating landowners about the benefits of buffer zones along watercourses should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the NPCA's Water Quality Improvement Program. This program provides grants to a maximum of 75% of the cost of a project with caps between \$2,000 and \$10,000.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Wetlands are Worth It Program                           | <p>Wetlands provide important water quality and ecological functions in a watershed by augmenting low flow, acting as natural filtration systems and helping to reduce flooding by acting like giant sponges and absorbing excess</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

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|                                                          | <p>water. The Wetlands are Worth It Program through NPCA's Water Quality Improvement Program aims to assist landowners that are interested in restoring, protecting, rehabilitating and creating wetland habitat on their property by providing grants to a maximum of 75% of the cost of a project with a grant ceiling of \$10,000.</p> <p>The NPCA's program aimed at educating landowners about the benefits of rural and agricultural best management practices should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum 75% of the cost of a project with caps between \$5,000 and \$12,000 depending on the project.</p>                                                                                                                                |
| Agricultural Best Management Practices Program           | Abandoned wells that are not properly decommissioned (capped and sealed) pose a threat to groundwater resources by providing a direct route to groundwater. The NPCA has a well decommissioning program in place for its jurisdiction. Grants are available for the decommissioning of unused water wells only. Priority is given to hydrogeologically sensitive areas, projects located in areas with a high density of domestic water wells, and areas where watershed plans have been completed or are ongoing (NPCA 2007). Approved grants will cover 90% of well decommissioning costs to a maximum of \$2,000 per well (limit of 2 wells per property). This is a reimbursement program, which means that the landowner will pay the full cost to the contractor, and will be reimbursed for 90% of the total project cost after all receipts, invoices, and water well decommissioning records are submitted to the NPCA. |
| Abandoned Well Decommissioning Program                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Special Studies</b>                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Riparian Buffer Tax Incentive Program                    | <b>Recommendations for Further Study</b><br>Partial exemption on property taxes for the establishment and maintenance of effective riparian and conservation buffers on property. Buffers provide a wide range of functions and benefits depending on their location (e.g. adjacent to watercourse or separating land uses).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Septic System Education and Funding Program              | Improperly functioning septic systems and abandoned septic systems are a known threat to water quality. A septic system education and funding program should be developed and implemented to ensure that private septic systems are functioning properly, and to ensure that abandoned systems are decommissioned.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Septic System Re-Inspection Program                      | Faulty or improperly maintained septic systems have been identified as a concern by participants at public events for the study area. Therefore, areas along the lakeshore that have a high intrinsic susceptibility should be considered priority for such a program. Municipal councils could approve and endorse the allocation of funds from property taxes or general revenue to fund the program. This approach may be facilitated with council knowledge that a percentage of inspected septic systems will also require remedial action on the part of some property owners, including the installation of new septic systems. Owners may also pro-actively undertake action if they are aware that a program is underway. Both will affect the number of permits issued in a municipality, and may generate revenue as a result (MMAH 2001).                                                                            |
| Road Salt Impact Study                                   | The Lowbanks subwatershed has been identified as having a medium and high shallow intrinsic susceptibility to groundwater contamination due to the presence of permeable soils and shallow depth of the groundwater table. A Road Salt Management Plan would be beneficial to Haldimand to determine the impacts from road salt applications on sensitive areas, surface water features, natural heritage areas, and agricultural crops.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Integrated Roadside Vegetation Management (IRVM) Program | Implement an IRVM program for Haldimand County. IRVM integrates the use of native vegetation with appropriate management techniques to produce a cost-effective, environmentally sound management alternative for roadside weed and erosion control while providing numerous ecological benefits (e.g. buffer strips).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Subwatershed Hydrogeologic                               | Development of subwatershed scale hydrogeologic characterizations would provide optimal information to make informed decisions in regard to applications and for use in planning decisions and policy development.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

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| Characterization                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Fish Habitat Classification                             | The watercourses in this subwatershed have not been evaluated in terms of importance for fish habitat. It is recommended that this assessment be completed so this information can be used for proper resource management and land use planning decisions.                                                                                                                                                                                                                                                                                                                         |
| Groundwater Intrinsic Susceptibility Studies            | The <i>Groundwater Study</i> (2005) has identified several areas with a high shallow intrinsic susceptibility (Figure 16a & 16b). The intrinsic susceptibility of groundwater considers only the physical factors affecting the flow of water to, and through, the groundwater resource. Additional studies should be conducted in this watershed to ensure that current and future land uses do not conflict with the protection of groundwater resources in susceptible areas as part of the NPCA's <i>Groundwater Study</i> (2005) and proposed <i>Source Protection Plan</i> . |
| Potential Contaminant Sources of Point Source Pollution | An inventory of potential contaminant sources and threats to water quality was identified as part of the objectives for the NPCA's <i>Groundwater Study</i> (2005). An updated inventory to confirm potential contaminant sources and locations is recommended as well as further investigation into the possible effects these potential contaminants may have on surface water quality and aquatic habitat and whether or not a contaminant management plan is needed.                                                                                                           |
| Site Specific Water Quality Sampling                    | Enhanced sampling methods upstream and downstream of potential points of contamination should be considered to help identify priority areas for remediation and/or restoration.                                                                                                                                                                                                                                                                                                                                                                                                    |



## Hoover Drain Restoration Strategy

Over 50 percent of the main channel of Hoover Drain is designated as municipal drain; Hoover Creek Drain is a Class F Drain. The watercourses have not been evaluated in terms of importance for fish habitat and the NPCA does not conduct water quality or BioMAP sampling in this subwatershed. A geomorphic assessment was conducted at one site along the municipal drain in this subwatershed. A lack of any depositional features along the stream bed was noted which indicates little flow diversity within the channel (NPCA 2009b).

Land use is primarily agriculture with a strip of residential along the lakeshore. The headwaters commence in Moulton Wetland East PSW and flow south through Bunz Bush and a wetland that is still awaiting evaluation by the MNR. The remaining watercourses in this subwatershed flow through agricultural fields with little to no riparian habitat. The challenge in this subwatershed is the establishment of a sufficient riparian buffer which is imperative in maintaining, protecting and enhancing water quality and fish habitat.

Opportunity is present for infilling gaps of natural areas thus reducing the amount of forest edge while increasing interior size resulting in an increased ability to support a larger diversity of flora and fauna. In addition, opportunity exists for the establishment and enhancement of linkages to adjacent natural areas including a core area Moulton West Wetland Complex. These connections would facilitate in the movement of flora and fauna between natural areas.

The Hoover Drain Subwatershed Restoration Strategy identifies one zone with specific stewardship and restoration recommendations (Table 11 and Figure 22).

**Table 11: Hoover Drain Subwatershed Restoration Strategy**

| <b>Restoration Opportunities</b>                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
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| <b>Recommended Restoration Strategies</b>                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                                                                                                                                                                                                                                 | <b>Riparian</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Wetland</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Upland and Ecological Linkages</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 1.                                                                                                                                                                                                                              | <ul style="list-style-type: none"> <li>headwaters receive cover from wetland therefore priority should be placed on establishing and enhancing riparian habitat south of the Gord Harry Conservation Trail.</li> <li>riparian buffers will help to reduce sediment and cool the water to enhance water quality and fish habitat as well create corridors that will connect fragmented natural areas providing cover for wildlife</li> <li>the main branch south of the Gord Harry Conservation Trail is managed as a municipal drain therefore establishment of riparian corridors(e.g. deep rooted grasses &amp; shrubs) should consider future maintenance activities (refer to engineers report and drainage BMP practice recommendations )</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <ul style="list-style-type: none"> <li>protect existing wetlands (e.g., create a buffer of trees and shrubs between the wetlands and the agricultural activities)</li> <li>enhance wetlands in areas where the wetness index and soil drainage permit; priority should be given to areas adjacent to existing wetlands(e.g. very high restoration suitability exists between Moulton Wetland West PSW complexes and north section of unevaluated wetland west of watercourse)</li> </ul> | <ul style="list-style-type: none"> <li>restoration suitability mapping indicates very high suitability exists for creating a Critical Function Zone (CFZ) between Moulton Wetland West PSW complexes and the northern edge of the unevaluated wetland by means of infilling. This will provide for a variety of critical functions for wetland-associated fauna (e.g. nesting habitat) as well as increase interior size which would support a larger diversity of flora and fauna</li> </ul> |
| <ul style="list-style-type: none"> <li>All restoration measures should, where possible, benefit Species at Risk and provincially rare species</li> <li>Carolinian and native species should be used for all projects</li> </ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Recommended Action for Public and Private Lands</b>                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Project Opportunities</b><br>NPCA Lake Erie North Shore Geomorphic Assessment Study (NPCA 2009b)                                                                                                                             | <p><b>1. Lakeshore Road (HvDMA):</b> This section of watercourse is managed as a municipal drain; Hoover Creek Drain. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. Bank instability is present in the form of bare soil extending up the steep bank, and possibly slumping. Relatively deep unconsolidated sediment is deposited along the channel bed. Few to no pools exist along the bed but there is stagnant water present throughout the field site. The plant arrowhead, as well as aquatic vegetation in the form of a vine was identified along the bed of the channel throughout the field site. The presence of algae was also noted during a site visit in 2008. The riparian buffer along this reach is poor along the left bank and therefore will influence bank stability. A number of small tributaries and possibly rills/gullies exist along the watercourse. Measurements taken at channel cross sections would indicate that the watercourse at this field site has moderate to minor entrenchment which results in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Recommendations for this site include not grading the channel banks too steep during the dredging process so</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

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|                                                         | that deep rooted vegetation can become established along the banks and stabilize the soil. The presence of bank slumping usually indicates that vegetative roots are too shallow to stabilize the bank. Water quality should continue to be monitored within this watershed. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. Projects to prevent and limit further development of rills adjacent to the watercourse should be implemented. Some examples include grassed waterways, chute spillways, tile drainage outlets, and proper tillage and cropping practices (OMAFRA, 1997a, and OMAFRA, 1997b). Alternatives to traditional drainage design, such as wetland creation, floodplain development, and increasing channel curvature should also be considered. All recommendations should be discussed with the Drainage Superintendent. |
| Naturalizing Drains and Drain Best Management Practices | In addition to having an impact on aquatic and riparian habitat, drain maintenance has the potential to become quite costly through repeated maintenance activities. Naturalizing drains can potentially lengthen the time between maintenance events by reducing the amount of sediment entering and remaining in the drain. Best Management Practices for drain maintenance should be developed in consultation with, but not limited to, the following agencies: OMAFRA, DFO, MNR, Conservation Ontario, OFA, DSAO, CFFO, and the agricultural community to reduce ecological impacts to aquatic systems and to prevent sediment from returning to the drain. Any future maintenance of this watercourse should be done in accordance with Best Management Practices for drains. To review examples of current BMP mitigation measures, refer to Appendix I.                                                                   |
| Promote Good Shoreline Stewardship                      | Work with partnering stakeholders to promote shoreline that have been maintained naturally or restored to find a balance between natural processes and shoreline protection measures.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Ecological Linkages between Natural Areas               | Opportunity potential is present for creating ecological linkages between natural areas creating larger contiguous natural features. Such areas have the potential to enhance movement of flora and fauna between natural areas as well as provide habitat and ecological diversity for a wide range of species.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Riparian Buffer Education and Grant Program             | Many landowners keep their properties manicured or plant crops to the edge of the creek. The NPCA's program aimed at educating landowners about the benefits of buffer zones along watercourses should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the NPCA's Water Quality Improvement Program. This program provides grants to a maximum of 75% of the cost of a project with caps between \$2,000 and \$10,000.                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Wetlands are Worth It Program                           | Wetlands provide important water quality and ecological functions in a watershed by augmenting low flow, acting as natural filtration systems and helping to reduce flooding by acting like giant sponges and absorbing excess water. The Wetlands are Worth It Program through NPCA's Water Quality Improvement Program aims to assist landowners that are interested in restoring, protecting, rehabilitating and creating wetland habitat on their property by providing grants to a maximum of 75% of the cost of a project with a grant ceiling of \$10,000.                                                                                                                                                                                                                                                                                                                                                                 |
| Agricultural Best Management Practices Program          | The NPCA's program aimed at educating landowners about the benefits of rural and agricultural best management practices should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum 75% of the cost of a project with caps between \$5,000 and \$12,000 depending on the project.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Abandoned Well Decommissioning Program                  | Abandoned wells that are not properly decommissioned (capped and sealed) pose a threat to groundwater resources by providing a direct route to groundwater. The NPCA has a well decommissioning program in place for its jurisdiction. Grants are available for the decommissioning of unused water wells only. Priority is given to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

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|                                                          | hydrogeologically sensitive areas, projects located in areas with a high density of domestic water wells, and areas where watershed plans have been completed or are ongoing (NPCA 2007). Approved grants will cover 90% of well decommissioning costs to a maximum of \$2,000 per well (limit of 2 wells per property). This is a reimbursement program, which means that the landowner will pay the full cost to the contractor, and will be reimbursed for 90% of the total project cost after all receipts, invoices, and water well decommissioning records are submitted to the NPCA.                                                                                                                                                                                                                                                           |
| <b>Special Studies</b>                                   | <b>Recommendations for Further Study</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Riparian Buffer Tax Incentive Program                    | Partial exemption on property taxes for the establishment and maintenance of effective riparian and conservation buffers on property. Buffers provide a wide range of functions and benefits depending on their location (e.g. adjacent to watercourse or separating land uses).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Septic System Education and Funding Program              | Improperly functioning septic systems and abandoned septic systems are a known threat to water quality. A septic system education and funding program should be developed and implemented to ensure that private septic systems are functioning properly, and to ensure that abandoned systems are decommissioned.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Septic System Re-Inspection Program                      | Faulty or improperly maintained septic systems have been identified as a concern by participants at public events for the study area. Therefore, areas along the lakeshore that have a high intrinsic susceptibility should be considered priority for such a program. Municipal councils could approve and endorse the allocation of funds from property taxes or general revenue to fund the program. This approach may be facilitated with council knowledge that a percentage of inspected septic systems will also require remedial action on the part of some property owners, including the installation of new septic systems. Owners may also pro-actively undertake action if they are aware that a program is underway. Both will affect the number of permits issued in a municipality, and may generate revenue as a result (MMAH 2001). |
| Road Salt Impact Study                                   | The Hoover Drain subwatershed has been identified as having a medium shallow intrinsic susceptibility to groundwater contamination. A Road Salt Management Plan would be beneficial to Haldimand County to determine the impacts from road salt applications on sensitive areas, surface water features, natural heritage areas, and agricultural crops. Through RMN's <i>Salt Vulnerability Study</i> (2005) the entire LENS study area has been ranked as having a moderately high vulnerability to road salt for regional roads, however this study was not conducted on local municipal roads; therefore it is recommended that a similar study be completed by the respective local municipalities in Niagara Region to determine the impact of road salt applications on local municipal roads to the surrounding natural features.             |
| Integrated Roadside Vegetation Management (IRVM) Program | Implement an IRVM program for Haldimand County. IRVM integrates the use of native vegetation with appropriate management techniques to produce a cost-effective, environmentally sound management alternative for roadside weed and erosion control while providing numerous ecological benefits (e.g. buffer strips). Niagara Region and municipalities should work together to expand Niagara Region's IRVM Program; focus of program expansion should be directed to main roads and roads in areas with a high shallow intrinsic susceptibility.                                                                                                                                                                                                                                                                                                   |
| Subwatershed Hydrogeologic Characterization              | Development of subwatershed scale hydrogeologic characterizations would provide optimal information to make informed decisions in regard to applications and for use in planning decisions and policy development.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Fish Habitat Classification                              | The watercourses in this subwatershed have not been evaluated in terms of importance for fish habitat. It is recommended that this assessment be completed so this information can be used for proper resource management and land use planning decisions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

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|---------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Groundwater Intrinsic Susceptibility Studies            | <p>The <i>Groundwater Study</i> (2005) has identified areas with a high shallow intrinsic susceptibility (Figure 16a &amp; 16b). The intrinsic susceptibility of groundwater considers only the physical factors affecting the flow of water to, and through, the groundwater resource. Additional studies should be conducted in this watershed to ensure that current and future land uses do not conflict with the protection of groundwater resources in susceptible areas as part of the NPCA's <i>Groundwater Study</i> (2005) and proposed <i>Source Protection Plan</i>.</p> |
| Potential Contaminant Sources of Point Source Pollution | <p>An inventory of potential contaminant sources and threats to water quality was identified as part of the objectives for the NPCA's <i>Groundwater Study</i> (2005). An updated inventory to confirm potential contaminant sources and locations is recommended as well as further investigation into the possible effects these potential contaminants may have on surface water quality and aquatic habitat and whether or not a contaminant management plan is needed.</p>                                                                                                      |
| Site Specific Water Quality Sampling                    | <p>Enhanced sampling methods upstream and downstream of potential points of contamination should be considered to help identify priority areas for remediation and/or restoration.</p>                                                                                                                                                                                                                                                                                                                                                                                               |



Figure 22: Hoover Drain Subwatershed Restoration Strategy Study Area

## Lake Erie 8 Restoration Strategy

Aside from the final stretches of watercourse before draining into Lake Erie, the watercourses in Lake Erie 8 subwatershed are managed as municipal drains; all are Class F Drains. The watercourses in this subwatershed have not been evaluated in terms of importance for fish habitat. Geomorphic assessments or water quality sampling was not conducted on the watercourses in this subwatershed.

Land use in this subwatershed is also primarily agriculture with a strip of residential along the lakeshore. There is one golf course in this subwatershed; Long Beach Country Club. Long Beach Conservation Area is also located in this subwatershed. This public recreational area offers camping, and an array of beach related activities.

There is little to no riparian buffers or corridor connections between natural areas in this subwatershed, or linkages to natural areas in adjacent subwatersheds. The challenge of the Lake Erie 8 subwatershed is the establishment and preservation of riparian habitat when maintenance activities are necessary on the municipal drains to facilitate in proper drainage of the agricultural fields. In addition, many of these drains run along the roadway, therefore the establishment and maintenance of riparian buffers is important in this subwatershed to protect, maintain, and enhance water quality before outletting to Lake Erie. Therefore, incorporation of best management drain maintenance practices are recommended, if not already being undertaken, such as minimizing bank disturbance or leaving one side of the drain covered in vegetation. This would not only provide a corridor for wildlife but would also provide benefits to water quality, provide the drain stability and filter sediment coming from adjacent fields and roads resulting in less sediment entering the drain and possibly lengthening the time between clean-outs. Refer to Appendix I for examples of typical mitigation measures for drain maintenance.

The sparse and fragmented pattern of natural areas in this subwatershed does not offer many opportunities of linkage creation aside from riparian establishment, fortifying the importance of riparian habitat in this subwatershed. However, by integrating golf course management practices with wildlife management, such as incorporating enhanced natural areas into the landscaping, golf courses have the potential to offer a wide range of habitat for wildlife. In addition, encouragement of environmentally responsible maintenance practices, if not already adopted, will be beneficial to water quality and the aquatic habitat.

The Lake Erie 8 Subwatershed Restoration Strategy identifies two zones with specific stewardship and restoration recommendations (Table 12 and Figure 23).

**Table 12: Lake Erie 8 Subwatershed Restoration Strategy**

| <b>Recommended Restoration Strategies</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Restoration Opportunities</b>          | <b>Riparian</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Wetland</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Upland and Ecological Linkages</b>                                                                                                                                                                                                                                                                                                                                                                     |
| 1. North of Gord Harry Conservation Trail | <ul style="list-style-type: none"> <li>priority should be placed on establishing riparian habitat; the headwaters flow between agricultural lands and along roadsides with little to no buffer.</li> <li>riparian buffers will help to reduce sediment and cool the water to enhance water quality and fish habitat before outletting to Lake Erie, as well as create corridors that will connect the fragmented natural areas providing cover for wildlife</li> <li>watercourses are managed as municipal drains therefore establishment of riparian corridors (e.g. deep rooted grasses &amp; shrubs) should consider future maintenance activities (refer to engineers report and drainage BMP practice recommendations)</li> </ul> | <ul style="list-style-type: none"> <li>create/enhance wetlands in areas where the wetness index and soil drainage permit; priority should be given to areas adjacent to existing wetlands (e.g., very high restoration suitability exists for enhancement Moulton Wetland LSW)</li> <li>wetland restoration suitability mapping identifies numerous areas suitable for wetland creation: see map</li> </ul>                                                                                                                                         | <ul style="list-style-type: none"> <li>very high suitability exists for creating a Critical Function Zone surrounding Moulton Wetland East LSW. This will provide for a variety of critical functions for wetland-associated fauna (e.g. nesting habitat)</li> </ul>                                                                                                                                      |
| 2. South of Gord Harry Conservation Trail | <ul style="list-style-type: none"> <li>west watercourse receives cover partial cover from adjacent natural area therefore focus should be on maintenance of existing riparian</li> <li>focus should be establishment of riparian in areas with little to no existing riparian; e.g., east watercourse has little to no riparian and therefore measures to establish and enhance buffer should be considered to reduce sediment and contaminant loads from adjacent land use (roads and agricultural fields) before outletting to Lake Erie.</li> </ul>                                                                                                                                                                                 | <ul style="list-style-type: none"> <li>protect existing wetland (e.g., create a buffer of trees and shrubs between the wetland agricultural activities)</li> <li>create/enhance wetlands in areas where the wetness index and soil drainage permit; priority should be given to areas adjacent to existing wetlands (e.g., very high restoration suitability exists for enhancement of Harold Mitchell Nature Reserve)</li> <li>wetland restoration suitability mapping identifies numerous areas suitable for wetland creation: see map</li> </ul> | <ul style="list-style-type: none"> <li>very high suitability exists for creating a Critical Function Zone surrounding Harold Mitchell Nature Reserve LSW. This will provide for a variety of critical functions for wetland-associated fauna (e.g. nesting habitat) as well as increase interior size resulting in the natural areas ability to support a larger diversity of flora and fauna.</li> </ul> |

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|                                                                                                                                                                                                                                | <ul style="list-style-type: none"> <li>watercourses are in part managed as municipal drains therefore establishment of riparian corridors should consider future maintenance activities (refer to engineers report and drainage BMP recommendations)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  |  |
| <ul style="list-style-type: none"> <li>All restoration measures should where possible, benefit Species at Risk and provincially rare species</li> <li>Carolinian and native species should be used for all projects</li> </ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  |  |
| <b>Project Opportunities</b>                                                                                                                                                                                                   | <b>Recommended Action for Public and Private Lands</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |  |  |
| Naturalizing Drains and Drain Best Management Practices                                                                                                                                                                        | <p>In addition to having an impact on aquatic and riparian habitat, drain maintenance has the potential to become quite costly through repeated maintenance activities. Naturalizing drains can potentially lengthen the time between maintenance events by reducing the amount of sediment entering and remaining in the drain. Best Management Practices for drain maintenance should be developed in consultation with, but not limited to, the following agencies; OMAFRA, DFO, MNR, Conservation Ontario, OFA, DSAO, CFFO, and the agricultural community to reduce ecological impacts to aquatic systems and to prevent sediment from returning to the drain. Any future maintenance of this watercourse should be done in accordance with Best Management Practices for drains. To review examples of current BMP mitigation measures, refer to Appendix I.</p> <p>Work with partnering stakeholders to promote shoreline areas that have been maintained naturally or restored to find a balance between natural processes and shoreline protection measures.</p> <p>Work with partnering agencies to mitigate water quality issues and work towards Blue Flag Beach status. Blue Flag status meets high standards with respect to water quality, environmental management, environmental education and safety and services (Blueflag.ca) and is known globally. Blue Flag beaches have the potential to increase tourism in the area.</p> |  |  |
| Promote Good Shoreline Stewardship                                                                                                                                                                                             | <p>Niagara Region and municipalities should work together to expand Niagara Region's IRVM Program. IRVM integrates the use of native vegetation with appropriate management techniques to produce a cost-effective, environmentally sound management alternative for roadside weed and erosion control while providing numerous ecological benefits (e.g. buffer strips). Focus of program expansion should be directed to main roads and roads in areas with a high shallow intrinsic susceptibility.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |  |  |
| Integrated Roadside Vegetation Management (IRVM) Program                                                                                                                                                                       | <p>Opportunity potential is present for creating ecological linkages between natural areas creating larger contiguous natural features. Such areas have the potential to enhance movement of flora and fauna between natural areas as well as provide habitat and ecological diversity for a wide range of species.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  |  |
| Ecological Linkages between Natural Areas                                                                                                                                                                                      | <p>Many landowners keep their properties manicured or plant crops to the edge of the creek. The NPCA's program aimed at educating landowners about the benefits of buffer zones along watercourses should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum of 75% of the cost of a project with caps between \$2,000 and \$10,000.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |  |  |
| Riparian Buffer Education Program                                                                                                                                                                                              | <p>Wetlands provide important water quality and ecological functions in a watershed by augmenting low flow, acting as natural filtration systems and helping to reduce flooding by acting like giant sponges and absorbing excess water. The Wetlands are Worth It Program through NPCA's Water Quality Improvement Program aims to assist landowners that are interested in restoring, protecting, rehabilitating and creating wetland habitat on their property by providing grants to a maximum of 75% of the cost of a project with a grant ceiling of \$10,000.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |  |
| Wetlands are Worth It Program                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  |  |

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| Environmentally Responsible Maintenance Practices for Golf Courses | By integrating golf course management practices with wildlife management, such as incorporating enhanced natural areas into the landscaping, golf courses have the potential to offer a wide range of habitat for wildlife. In addition, encouragement of environmentally responsible maintenance practices, if not already adopted, will be beneficial to water quality and the aquatic habitat. Investigation into the Audubon Cooperative Sanctuary Program for Golf Courses should be explored for golf courses if such a program has not already been adopted. In addition, environmentally friendly practices should be encouraged (e.g. chemical free practices).                                                                                                                                                                                                                                                         |
| Agricultural Best Management Practices Program                     | The NPCA's program aimed at educating landowners about the benefits of rural and agricultural best management practices should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum 75% of the cost of a project with caps between \$5,000 and \$12,000 depending on the project.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Abandoned Well Decommissioning Program                             | Abandoned wells that are not properly decommissioned (capped and sealed) pose a threat to groundwater resources by providing a direct route to groundwater. The NPCA has a well decommissioning program in place for its jurisdiction. Grants are available for the decommissioning of unused water wells only. Priority is given to hydrogeologically sensitive areas, projects located in areas with a high density of domestic water wells, and areas where watershed plans have been completed or are ongoing (NPCA 2007). Approved grants will cover 90% of well decommissioning costs to a maximum of \$2,000 per well (limit of 2 wells per property). This is a reimbursement program, which means that the landowner will pay the full cost to the contractor, and will be reimbursed for 90% of the total project cost after all receipts, invoices, and water well decommissioning records are submitted to the NPCA. |
| <b>Special Studies</b>                                             | <b>Recommendations for Further Study</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Riparian Buffer Tax Incentive Program                              | Partial exemption on property taxes for the establishment and maintenance of effective riparian and conservation buffers on property. Buffers provide a wide range of functions and benefits depending on their location (e.g. adjacent to watercourse or separating land uses).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Septic System Education and Funding Program                        | Improperly functioning septic systems and abandoned septic systems are a known threat to water quality. A septic system education and funding program should be developed and implemented to ensure that private septic systems are functioning properly, and to ensure that abandoned systems are decommissioned.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Septic System Re-Inspection Program                                | Areas that have been identified as „septic hotspots“ through the <i>NPCA Groundwater Study</i> and areas that have a high intrinsic susceptibility should be considered priority for such a program. Municipal councils could approve and endorse the allocation of funds from property taxes or general revenue to fund the program. This approach may be facilitated with council knowledge that a percentage of inspected septic systems will also require remedial action on the part of some property owners, including the installation of new septic systems. Owners may also pro-actively undertake action if they are aware that a program is underway. Both will affect the number of permits issued in a municipality, and may generate revenue as a result (MMAH 2001).                                                                                                                                              |
| Road Salt Impact Study                                             | Through RMN's <i>Salt Vulnerability Study</i> (2005) the entire LENS study area has been ranked as having a moderately high vulnerability to road salt from regional roads, however this study was not conducted on local municipal roads; therefore it is recommended that a similar study be completed by the respective local municipalities to determine the impact of road salt applications on local municipal roads to the surrounding natural features.                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Subwatershed Hydrogeologic Characterization                        | Development of subwatershed scale hydrogeologic characterizations would provide optimal information to make informed decisions in regard to applications and for use in planning decisions and policy development.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

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| Fish Habitat Classification                             | The watercourses in this subwatershed have not been evaluated in terms of importance for fish habitat. It is recommended that this assessment be completed so this information can be used for proper resource management and land use planning decisions.                                                                                                                                                                                                                                                                                                               |
| Groundwater Intrinsic Susceptibility Studies            | The <i>Groundwater Study (2005)</i> has identified areas with high shallow intrinsic susceptibility (Figure 16a & 16b). The intrinsic susceptibility of groundwater considers only the physical factors affecting the flow of water to, and through, the groundwater resource. Additional studies should be conducted in this watershed to ensure that current and future land uses do not conflict with the protection of groundwater resources in susceptible areas as part of the NPCA's <i>Groundwater Study (2005)</i> and proposed <i>Source Protection Plan</i> . |
| Potential Contaminant Sources of Point Source Pollution | An inventory of potential contaminant sources and threats to water quality was identified as part of the objectives for the NPCA's <i>Groundwater Study (2005)</i> . An updated inventory to confirm potential contaminant sources and locations is recommended as well as further investigation into the possible effects these potential contaminants may have on surface water quality and aquatic habitat and whether or not a contaminant management plan is needed.                                                                                                |
| Site Specific Water Quality Sampling                    | Enhanced sampling methods upstream and downstream of potential points of contamination should be considered to help identify priority areas for remediation and/or restoration.                                                                                                                                                                                                                                                                                                                                                                                          |



## Casey Drain Restoration Strategy

The main watercourse branches of the Casey Drain subwatershed are designated as municipal drains. The main branch of Casey Drain is a Class C municipal drain and the West, East and North Branches are all designated as Class F Drains. The West, East and the southern portion of the main branch of Casey Drain are classified as important (Type 2) fish habitat. The Lake Erie shoreline in this area has been identified as Fowler Toad habitat of which Niagara is one of only three areas in Canada where this SAR is found. Six sites were assessed in this subwatershed as part of the NPCA Geomorphic Assessment; all sites were within designated municipal drains. Bank instability and relatively deep unconsolidated sediment deposited along the channel bed was noted at a number of field sites (NPCA 2009b).

BioMAP samples in this subwatershed indicate water quality is impaired. Primary causes of impairment at the Lake Erie BioMAP stations include sediment loading, reduced baseflow, lack of in-stream habitat and nutrient enrichment (NPCA 2010). Water quality sampling indicates poor water quality with exceedances of chloride, total phosphorus, *E. coli*, and suspended solids. This site is vulnerable to low base flow and water stagnation with severe algae growth identified during the summer months (NPCA 2010). Soil erosion, the use of fertilizers and pesticides coupled with the lack of sufficient riparian buffers are likely sources of total phosphorus in this watershed. Potential sources of *E. coli* include runoff from urban and agricultural land use, animal waste, and sewage discharge. Promotion of the NPCA's education programs pertaining to agricultural best management practices and water quality would be beneficial for the landowners. These programs also include information on sources of funding for environmental projects on private land to encourage adoption and implementation of best management practices.

Land use in the subwatershed is primarily agriculture with some strip and node residential throughout the subwatershed and along the lakeshore. The north branch of Casey Drain flows through Lowbanks Backshore Wetland Complex before joining the main drain. The remainder of the watercourses flow through several agricultural fields with little to no buffer before reaching the slight residential node along the lakeshore and draining into Lake Erie.

The clustered fragments of natural areas in this subwatershed offers plenty of opportunity for creating ecological linkages between natural areas creating larger contiguous areas and infilling by enhancement of existing natural areas thus increasing core size. The challenge of the Casey Drain subwatershed is the establishment and maintenance of a sufficient vegetative riparian buffer when maintenance activities are necessary on the municipal drains to facilitate in proper drainage of the agricultural fields. However, a riparian buffer is imperative in assisting with the protection and enhancement of water quality and fish habitat while providing a linkage that will facilitate in wildlife movement along the watercourse between natural areas. Incorporation of best management drain maintenance practices are recommended for this subwatershed, if not already being undertaken, such as minimizing bank disturbance or leaving one side of the drain covered in vegetation. Refer to Appendix I for examples of typical mitigation measures for drain maintenance.

The Casey Drain Subwatershed Restoration Strategy identifies two zones with specific stewardship and restoration recommendations (Table 13 and Figure 24).

**Table 13: Casey Drain Subwatershed Restoration Strategy**

| <b>Recommended Restoration Strategies</b>                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
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| <b>Restoration Opportunities</b>                                             | <b>Riparian</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Wetland</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Upland and Ecological Linkages</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 1. Casey Drain North Branch and West Branch and northern half of main branch | <ul style="list-style-type: none"> <li>the watercourses in this portion partially receive cover from adjacent natural areas therefore focus should be on establishment of a buffer in areas with little to no existing riparian (east of Brawn Road along West Branch and north of Gord Harry Conservation Trail)</li> <li>priority should be placed on establishing riparian habitat; the headwaters run through agricultural lands with little to no buffer.</li> <li>riparian buffers will help to reduce sediment and cool the water to enhance water quality and fish habitat as well create corridors that will connect fragmented natural areas providing cover for wildlife</li> <li>watercourses are managed as municipal drains therefore establishment of riparian corridors (e.g. deep rooted grasses &amp; shrubs) should consider future maintenance activities (refer to engineers report and drainage BMP practice recommendations)</li> </ul> | <ul style="list-style-type: none"> <li>very high riparian-wetland restoration suitability along watercourses between fragmented natural areas</li> <li>very high suitability exists for enhancement of wetlands north of Casey Branch West Branch</li> <li>in areas where the wetness index and soil drainage permit; priority should be given to areas adjacent to existing wetlands (e.g., very high restoration suitability exists between Lowbanks Backshore Wetland Complexes)</li> <li>wetland restoration suitability mapping identifies numerous areas suitable for wetland creation: see map</li> <li>protect existing wetlands (e.g., create a buffer of trees and shrubs between the wetlands and the agricultural activities)</li> </ul> | <ul style="list-style-type: none"> <li>very high suitability exists upland restoration between natural areas in western portion of study area, extending into adjacent subwatershed creating ecological linkages or infilling increasing interior size of feature</li> <li>very high suitability for creating a Critical Function Zone surrounding Emerson Road Woodlot. This will provide for a variety of critical functions for wetland-associated fauna (e.g. nesting habitat)</li> </ul> |
| 2. Casey Drain East Branch and southern half of main branch                  | <ul style="list-style-type: none"> <li>the watercourses in this portion of the study area have little to no riparian habitat therefore priority should be placed on the establishment of a riparian buffer</li> <li>riparian buffers will help to reduce sediment and cool the water to enhance water quality</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <ul style="list-style-type: none"> <li>enhance existing or establish new wetlands as natural flood storage reservoirs and groundwater recharge areas</li> <li>create new wetlands in areas where the wetness index and soil drainage permit; wetland restoration suitability mapping</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <ul style="list-style-type: none"> <li>very high suitability for infilling and enhancing in and around wooded areas in eastern portion of study area and extending into adjacent subwatershed therefore increasing interior size and/or creating larger contiguous which would enhance the natural areas ability to support a larger diversity of flora and fauna</li> </ul>                                                                                                                  |

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|                                                                                                                                                                                                                                | <p>and fish habitat before outletting to Lake Erie</p> <ul style="list-style-type: none"> <li>existing riparian should be maintained</li> <li>watercourses are in part managed as municipal drains therefore establishment of riparian corridors should consider future maintenance activities (refer to engineers report and drainage BMP recommendations)</li> </ul> | identifies numerous areas suitable for wetland creation: see map                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <ul style="list-style-type: none"> <li>opportunity for creation of ecological linkages between fragmented natural areas facilitating in the movement of flora and fauna between natural areas</li> </ul> |
| <ul style="list-style-type: none"> <li>All restoration measures should where possible, benefit Species at Risk and provincially rare species</li> <li>Carolinian and native species should be used for all projects</li> </ul> | <b>Project Opportunities</b>                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                          |
|                                                                                                                                                                                                                                | <b>Recommended Action for Public and Private Lands</b>                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                          |
|                                                                                                                                                                                                                                | <p>NPCA Lake Erie North Shore Geomorphic Assessment Study (NPCA 2009b)</p>                                                                                                                                                                                                                                                                                             | <p>1. <b>Burnaby Road (CDHeadwaters):</b> This section of watercourse is managed as a municipal drain; Casey Drain North Branch. It has been channelized and lacks any depositional features along the bed which indicate little flow diversity within the channel. At least 3 debris jams were present upstream of the culvert, which could be due to an undersized culvert or bank instability. There is some bank instability present in the form of bare soil extending up the bank, as well as slumping. Small tributaries or possibly gullies/rills exist along the watercourse. No pools exist along the bed but there are areas of stagnant water throughout the field site. Dense vegetation within the channel was noted in certain locations during a site visit in 2008. Measurements taken at channel cross sections would indicate that the watercourse at this field site has moderate to minor entrenchment which results in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil. The presence of bank slumping usually indicates that vegetative roots are too shallow to stabilize the bank. It should be confirmed that the culvert is not constricting the channel and if it is then it should be rebuilt and adequately sized. Projects to prevent and limit further development of rills adjacent to the watercourse should be implemented. Some examples include grassed waterways, chute spillways, tile drainage outlets, and proper tillage and cropping practices (OMAFRA, 1997a, and OMAFRA, 1997b). All recommendations should be discussed with the Drainage Superintendent.</p> <p>2. <b>Lakeshore Road (CDMa):</b> This section of watercourse is managed as a municipal drain; Casey Drain. It has been channelized and contains few depositional features along the stream bed which indicate little flow diversity within the channel. The width of the buffer zone is small due to residential properties and Sideroad 18 being adjacent to the watercourse. The stream banks are steep but there was little instability found during a site visit in 2008. Wire mesh and small stones were identified along the right bank indicating that some erosion protection measures have been implemented by landowners. Upstream of Lakeshore Road relatively deep unconsolidated sediment is deposited along the channel bed. There are a couple areas where vegetative debris is being thrown onto the bank. This debris will eventually end up in stream which can cause debris jams and impact water quality. Two culverts entering the channel from the roadside ditches are approximately 30cm from the streambed indicating that degradation may be occurring at this field site. The culvert at Lakeshore Road is</p> |                                                                                                                                                                                                          |

potentially constricting the channel. Measurements taken at channel cross sections would indicate that the watercourse at this field site is entrenched which results in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil. It should be confirmed that the culvert is not constricting the channel and if it is then it needs to be rebuilt and adequately sized. Due to the impact on water quality it is advised that landowners stop throwing vegetated debris over the bank. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. Proper bank protection measures should be installed along the right bank to ensure adequate stabilization. All recommendations should be discussed with the Drainage Superintendent.

**3. Sideroad 18 (CDMa-2):** This section of watercourse is managed as a municipal drain; Casey Drain. It has been channelized and there are a few point bars and side bars present within the channel. The near bank and riparian vegetation consists predominantly of herbaceous vegetation and therefore habitat and shading over the stream will be negatively impacted. No pools exist but there is stagnant water present throughout the field site. Algae and an oily sheen on the water surface were identified throughout the watercourse during a site visit in 2008, as well as dense vegetation within the channel. Small tributaries or possibly gullies/rills exist along the watercourse. Relatively deep unconsolidated sediment is deposited along the channel bed. Bank instability is present in the form of bare soil extending up the bank, undercut banks, and possible slumping. This instability is occurring on both banks which can indicate that widening may be occurring at this field site. Measurements taken at channel cross sections would indicate that the watercourse at this field site is moderately entrenched which results in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil. The presence of bank slumping usually indicates that vegetative roots are too shallow to stabilize the bank. Water quality should continue to be monitored in this watershed. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. Projects to prevent and limit further development of rills adjacent to the watercourse should be implemented. Some examples include grassed waterways, chute spillways, tile drainage outlets, and proper tillage and cropping practices (OMAFRA, 1997a, and OMAFRA, 1997b). All recommendations should be discussed with the Drainage Superintendent.

**4. Sideroad 18 (CDMb):** This section of watercourse is managed as a municipal drain; Casey Drain. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. The buffer zone is predominantly shrubs and herbaceous vegetation therefore habitat and shading over the watercourse will be impacted. No pools exist along the bed but there is stagnant water present throughout the field site. Relatively deep unconsolidated sediment is deposited along the channel bed. Algae and turbid water were noted during a site visit in 2008. Small tributaries or possibly gullies/rills exist along the watercourse. A failed culvert exists at the road allowance and a debris jam exists upstream of it. Bank erosion is evident along the steep banks of the channel. Bare soil extends up the bank, slumping is occurring, and fracture lines are present at the top of the banks. Measurements taken at channel cross sections would indicate that the watercourse at this field site is moderately entrenched which results in flood waters having limited to no

access to the floodplain. Therefore, the energy within the flow is contained in the channel. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil. The presence of bank slumping usually indicates that vegetative roots are too shallow to stabilize the bank. Water quality should continue to be monitored in this watershed. Projects to prevent and limit further development of rills adjacent to the watercourse should be implemented. Some examples include grassed waterways, chute spillways, tile drainage outlets, and proper tillage and cropping practices (OMAFRA, 1997a, and OMAFRA, 1997b). The failed culvert should be replaced with a properly sized culvert. All recommendations should be discussed with the Drainage Superintendent.

**5. Sideroad 18 (CDTa):** This section of watercourse is managed as a municipal drain; Casey Drain East Branch. It has been channelized and there are a few point bars and mid channel bars present within the channel. The presence of algae was noted throughout the field site during a site visit in 2008. Relatively deep unconsolidated sediment is deposited along the channel bed. Few to no pools are present along the bed but there is stagnant water throughout the field site. The buffer zone is predominantly shrubs and herbaceous vegetation therefore habitat and shading over the watercourse will be impacted. Small tributaries or possibly gullies/rills exist along the watercourse. Bank instability is present on both sides of the channel in the form of bare soil extending up the bank, and slumping. Measurements taken at channel cross sections would indicate that the watercourse at this field site is moderately entrenched which results in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil. The presence of bank slumping usually indicates that vegetative roots are too shallow to stabilize the bank. Water quality should continue to be monitored in this watershed. Projects to prevent and limit further development of rills adjacent to the watercourse should be implemented. Some examples include grassed waterways, chute spillways, tile drainage outlets, and proper tillage and cropping practices (OMAFRA, 1997a, and OMAFRA 1997b). Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. All recommendations should be discussed with the Drainage Superintendent.

**6. Burnaby Road (CDTa-2):** This section of watercourse is managed as a municipal drain; Casey Drain East Branch. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. Large stones and concrete pieces are laid along a section of the left bank indicating that some erosion protection measures have been implemented by the landowner. The presence of algae was noted throughout the field site during a site visit in 2008. Relatively deep unconsolidated sediment is deposited along the channel bed. Few to no pools are present along the bed but there is stagnant water throughout the field site. Small tributaries or possibly gullies/rills exist along the watercourse. The small buffer and the lack of large woody vegetation adjacent to the channel results in little canopy cover and habitat. Bank instability is present on both sides of the channel in the form of slumping. Measurements taken at channel cross sections would indicate that the watercourse at this field site is moderately entrenched which results in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil. The

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|                                                         | <p>presence of bank slumping usually indicates that vegetative roots are too shallow to stabilize the bank. A vegetative buffer will also provide a filter for sediment and chemicals that may enter the channel from runoff of fields and roads. Water quality should continue to be monitored in this watershed. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. Projects to prevent and limit further development of rills adjacent to the watercourse should be implemented. Some examples include grassed waterways, chute spillways, tile drainage outlets, and proper tillage and cropping practices (OMAFRA, 1997a, and OMAFRA 1997b). Proper bank protection measures should be installed along the bank to ensure adequate stabilization. All recommendations should be discussed with the Drainage Superintendent.</p> <p>All of the field sites are within designated municipal drains (Casey Drain North Branch, Casey Drain, and Casey Drain East Branch). Bank instability and relatively deep unconsolidated sediment was identified at the majority of the field sites. The majority of the sites also have small tributaries or possibly gullies/rills along the watercourse. Rill prevention measures such as slope re-grading, erosion control blankets, and seeding should be implemented along the adjacent properties. Excessive sediment deposition can cause problems in the watercourse, such as lateral channel adjustments, increased turbidity, filling in of pools, and impacting fish habitat. Long term monitoring of sediment accumulation should be completed to avoid any potential problems and can be done by the use of sediment traps. Water quality should continue to be monitored in this watershed. The degree of entrenchment varies at all of the field sites from minor to complete entrenchment. This means that flood waters will have little to no access to the floodplain. Confining the flood waters to the channel results in the loss of the adjacent floodplain, which impacts the hydraulic function of the watercourse (floodplains are storage areas for flood waters) and the physical habitat (loss of floodplain vegetation and the organisms that live there). It will also change the channel geometry overtime due to increased velocity, stream power, and channel slope. Alternatives to traditional drainage design, such as wetland creation, floodplain development, and increasing channel curvature should also be considered. Increasing the variety and diversity of native plant species within the buffer zone will provide cover and habitat for fish, insects, and invertebrate along the watercourse. Three of the field sites along this watercourse potentially contain culverts that may constrict the channel. This can cause problems in the watercourse and therefore the culverts should be measured and replaced if necessary. All recommendations should be discussed with the Drainage Superintendent.</p> |
| Naturalizing Drains and Drain Best Management Practices | <p>In addition to having an impact on aquatic and riparian habitat, drain maintenance has the potential to become quite costly through repeated maintenance activities. Naturalizing drains can potentially lengthen the time between maintenance events by reducing the amount of sediment entering and remaining in the drain. Best Management Practices for drain maintenance should be developed in consultation with, but not limited to, the following agencies; OMAFRA, DFO, MNR, Conservation Ontario, OFA, DSAO, CFFO, and the agricultural community to reduce ecological impacts to aquatic systems and to prevent sediment from returning to the drain. Any future maintenance of this watercourse should be done in accordance with Best Management Practices for drains. To review examples of current BMP mitigation measures, refer to Appendix I.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Promote Good Shoreline Stewardship                      | <p>Work with partnering stakeholders to promote shoreline that have been maintained naturally or restored to find a balance between natural processes and shoreline protection measures.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Integrated Roadside Vegetation Management               | <p>Niagara Region and municipalities should work together to expand Niagara Region's IRVM Program. IRVM integrates the use of native vegetation with appropriate management techniques to produce a cost-effective,</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

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| (IRV/M) Program                                | environmentally sound management alternative for roadside weed and erosion control while providing numerous ecological benefits (e.g. buffer strips). Focus of program expansion should be directed to main roads and roads in areas with a high shallow intrinsic susceptibility.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Ecological Linkages between Natural Areas      | Opportunity potential is present for creating ecological linkages between natural areas creating larger contiguous natural features. Such areas have the potential to enhance movement of flora and fauna between natural areas as well as provide habitat and ecological diversity for a wide range of species.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Riparian Buffer Education Program              | Many landowners keep their properties manicured or plant crops to the edge of the creek. The NPCA's program aimed at educating landowners about the benefits of buffer zones along watercourses should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum of 75% of the cost of a project with caps between \$2,000 and \$10,000.                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Wetlands are Worth It Program                  | Wetlands provide important water quality and ecological functions in a watershed by augmenting low flow, acting as natural filtration systems and helping to reduce flooding by acting like giant sponges and absorbing excess water. The Wetlands are Worth It Program through NPCA's Water Quality Improvement Program aims to assist landowners that are interested in restoring, protecting, rehabilitating and creating wetland habitat on their property by providing grants to a maximum of 75% of the cost of a project with a grant ceiling of \$10,000.                                                                                                                                                                                                                                                                                                                                                                |
| Agricultural Best Management Practices Program | The NPCA's program aimed at educating landowners about the benefits of rural and agricultural best management practices should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum 75% of the cost of a project with caps between \$5,000 and \$12,000 depending on the project.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Abandoned Well Decommissioning Program         | Abandoned wells that are not properly decommissioned (capped and sealed) pose a threat to groundwater resources by providing a direct route to groundwater. The NPCA has a well decommissioning program in place for its jurisdiction. Grants are available for the decommissioning of unused water wells only. Priority is given to hydrogeologically sensitive areas, projects located in areas with a high density of domestic water wells, and areas where watershed plans have been completed or are ongoing (NPCA 2007). Approved grants will cover 90% of well decommissioning costs to a maximum of \$2,000 per well (limit of 2 wells per property). This is a reimbursement program, which means that the landowner will pay the full cost to the contractor, and will be reimbursed for 90% of the total project cost after all receipts, invoices, and water well decommissioning records are submitted to the NPCA. |
| <b>Recommendations for Further Study</b>       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Special Studies                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Riparian Buffer Tax Incentive Program          | Partial exemption on property taxes for the establishment and maintenance of effective riparian and conservation buffers on property. Buffers provide a wide range of functions and benefits depending on their location (e.g. adjacent to watercourse or separating land uses).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Septic System Education and Funding Program    | Improperly functioning septic systems and abandoned septic systems are a known threat to water quality. A septic system education and funding program should be developed and implemented to ensure that private septic systems are functioning properly, and to ensure that abandoned systems are decommissioned.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Septic System Re-Inspection Program            | Areas that have been identified as „septic hotspots“ through the <i>NPCA Groundwater Study</i> and areas that have a high intrinsic susceptibility should be considered priority for such a program. Municipal councils could approve and endorse the allocation of funds from property taxes or general revenue to fund the program. This approach may be facilitated with council knowledge that a percentage of inspected septic systems will also require remedial action on the part of some property owners, including the installation of new septic systems. Owners may also                                                                                                                                                                                                                                                                                                                                             |

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|                                                         | pro-actively undertake action if they are aware that a program is underway. Both will affect the number of permits issued in a municipality, and may generate revenue as a result (MMAH 2001).                                                                                                                                                                                                                                                                                                                                                                                  |
| Road Salt Impact Study                                  | Through RMN's <i>Salt Vulnerability Study</i> (2005) the entire LENS study area has been ranked as having a moderately high vulnerability to road salt from regional roads, however this study was not conducted on local municipal roads; therefore it is recommended that a similar study be completed by the respective local municipalities to determine the impact of road salt applications on local municipal roads. to the surrounding natural features.                                                                                                                |
| Subwatershed Hydrogeologic Characterization             | Development of subwatershed scale hydrogeologic characterizations would provide optimal information to make informed decisions in regard to applications and for use in planning decisions and policy development.                                                                                                                                                                                                                                                                                                                                                              |
| Fish Habitat Classification                             | Not all the watercourses in this subwatershed have been evaluated in terms of importance for fish habitat. It is recommended that this assessment be completed so this information can be used for proper resource management and land use planning decisions.                                                                                                                                                                                                                                                                                                                  |
| Groundwater Intrinsic Susceptibility Studies            | The <i>Groundwater Study</i> (2005) has identified several areas with high shallow intrinsic susceptibility (Figure 16a & 16b) The intrinsic susceptibility of groundwater considers only the physical factors affecting the flow of water to, and through, the groundwater resource. Additional studies should be conducted in this watershed to ensure that current and future land uses do not conflict with the protection of groundwater resources in susceptible areas as part of the NPCA's <i>Groundwater Study</i> (2005) and proposed <i>Source Protection Plan</i> . |
| Potential Contaminant Sources of Point Source Pollution | An inventory of potential contaminant sources and threats to water quality was identified as part of the objectives for the NPCA's <i>Groundwater Study</i> (2005). An updated inventory to confirm potential contaminant sources and locations is recommended as well as further investigation into the possible effects these potential contaminants may have on surface water quality and aquatic habitat and whether or not a contaminant management plan is needed.                                                                                                        |
| Site Specific Water Quality Sampling                    | Enhanced sampling methods upstream and downstream of potential points of contamination should be considered to help identify priority areas for remediation and/or restoration.                                                                                                                                                                                                                                                                                                                                                                                                 |

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## **Lake Erie 5 Restoration Strategy**

The watercourses in the Lake Erie 5 subwatershed consist of two main branches. The northern branch commences on the north side of Burnaby Wainfleet Airport PSW and flows between the wetland and a woodlot and the Port Colborne Country Club golf course before joining a roadside ditch that leads to Lake Erie. This roadside ditch outlets with a second roadside ditch that comes from a strip of residential properties on the southern edge of the subwatershed. The second branch flows from an agricultural field with little to no riparian buffer before also joining the roadside ditch.

The watercourses in this subwatershed have not been evaluated in terms of importance for fish habitat, however the MNR has identified important spawning areas near the outlet in Lake Erie and the Lake Erie shoreline in this area has been identified as Fowler Toad habitat of which Niagara is one of only three areas in Canada where this SAR is found. No geomorphic assessments or water quality sampling was conducted in Lake Erie 5.

Land use in this subwatershed is primarily agricultural with some strip and node residential areas.

The challenge of the Lake Erie 5 subwatershed is the establishment of a sufficient vegetative riparian buffer which is imperative in assisting with the protection and enhancement of water quality and fish habitat as well as providing a corridor that will facilitate in wildlife movement along the watercourse between fragmented natural areas. By integrating golf course management practices with wildlife management, such as incorporating enhanced natural areas into the landscaping, golf courses have the potential to offer a wide range of habitat for wildlife. In addition, encouragement of environmentally responsible maintenance practices, if not already adopted, will be beneficial to water quality and the aquatic habitat.

The Lake Erie 5 Subwatershed Restoration Strategy identifies one zone with specific stewardship and restoration recommendations (Table 14 and Figure 25).

**Table 14: Lake Erie 5 Subwatershed Restoration Strategy**

| Restoration Opportunities                               | Recommended Restoration Strategies                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                      |
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|                                                         | Riparian                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Wetland                                                                                                                                                                                                                                                                                                                                                                     | Upland and Ecological Linkages                                                                                                                                                                                                                                                                                                                                                                                       |
| 1. Lake Erie 5                                          | <ul style="list-style-type: none"> <li>The north branch partially receives cover from adjacent natural areas along south side of watercourse; therefore focus should be on establishment of a sufficient buffer separating watercourse from adjacent land use (golf course)</li> <li>The southern branch of the headwaters flow through agricultural fields with little to no buffer; priority should be placed on establishing riparian habitat</li> <li>riparian buffers will help to reduce sediment and cool the water to enhance water quality and fish habitat as well as create corridors that will connect fragmented natural areas providing cover for wildlife</li> <li>there are a series of roadside ditches in this portion of the study area that drain into Lake Erie; measures to establish and enhance buffer should be considered to reduce sediment and contaminant loads from adjacent land use (roads and agricultural fields) before outletting to Lake Erie.</li> </ul> | <ul style="list-style-type: none"> <li>protect existing wetland (e.g., create a buffer of trees and shrubs between the wetlands and the agricultural activities)</li> <li>wetland suitability mapping indicates a high suitability exists for enhancement Burnaby Wainfleet Airport wetland creating an ecological linkage to woodlots in adjacent subwatershed.</li> </ul> | <ul style="list-style-type: none"> <li>very high suitability exists for upland restoration between natural areas in north-western portion of study area, extending into adjacent subwatershed creating ecological linkages or infilling increasing interior size of feature</li> <li>high to medium suitability for enhancement of fragmented wooded areas in the south-western portion of the study area</li> </ul> |
|                                                         | <ul style="list-style-type: none"> <li>All restoration measures should where possible, benefit Species at Risk and provincially rare species</li> <li>Carolinian and native species should be used for all projects</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Project Opportunities</b>                            | <b>Recommended Action for Public and Private Lands</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Naturalizing Drains and Drain Best Management Practices | <p>In addition to having an impact on aquatic and riparian habitat, drain maintenance has the potential to become quite costly through repeated maintenance activities. Naturalizing drains can potentially lengthen the time between maintenance events by reducing the amount of sediment entering and remaining in the drain. Best Management Practices for drain maintenance should be developed in consultation with, but not limited to, the following agencies: OMAFRA, DFO, MNR, Conservation Ontario, OFA, DSAO, CFFO, and the agricultural</p>                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                      |

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|                                                                    | community to reduce ecological impacts to aquatic systems and to prevent sediment from returning to the drain. Any future maintenance of this watercourse should be done in accordance with Best Management Practices for drains. To review examples of current BMP mitigation measures, refer to Appendix I.                                                                                                                                                                                                                                                                                                                                                            |
| Promote Good Shoreline Stewardship                                 | Work with partnering stakeholders to promote shoreline that have been maintained naturally or restored to find a balance between natural processes and shoreline protection measures.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Blue Flag Beaches                                                  | Work with partnering agencies to mitigate water quality issues and work towards Blue Flag Beach status. Blue Flag status meets high standards with respect to water quality, environmental management, environmental education and safety and services (Blueflag.ca) and is known globally. Blue Flag beaches have the potential to increase tourism in the area.                                                                                                                                                                                                                                                                                                        |
| Integrated Roadside Vegetation Management (IRVM) Program           | Niagara Region and municipalities should work together to expand Niagara Region's IRVM Program. IRVM integrates the use of native vegetation with appropriate management techniques to produce a cost-effective, environmentally sound management alternative for roadside weed and erosion control while providing numerous ecological benefits (e.g. buffer strips). Focus of program expansion should be directed to main roads and roads in areas with a high shallow intrinsic susceptibility.                                                                                                                                                                      |
| Ecological Linkages between Natural Areas                          | Opportunity potential is present for creating ecological linkages between natural areas creating larger contiguous natural features. Such areas have the potential to enhance movement of flora and fauna between natural areas as well as provide habitat and ecological diversity for a wide range of species.                                                                                                                                                                                                                                                                                                                                                         |
| Riparian Buffer Education Program                                  | Many landowners keep their properties manicured or plant crops to the edge of the creek. The NPCA's program aimed at educating landowners about the benefits of buffer zones along watercourses should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum of 75% of the cost of a project with caps between \$2,000 and \$10,000.                                                                                                                                                                       |
| Wetlands are Worth It Program                                      | Wetlands provide important water quality and ecological functions in a watershed by augmenting low flow, acting as natural filtration systems and helping to reduce flooding by acting like giant sponges and absorbing excess water. The Wetlands are Worth It Program through NPCA's Water Quality Improvement Program aims to assist landowners that are interested in restoring, protecting, rehabilitating and creating wetland habitat on their property by providing grants to a maximum of 75% of the cost of a project with a grant ceiling of \$10,000.                                                                                                        |
| Environmentally Responsible Maintenance Practices for Golf Courses | By integrating golf course management practices with wildlife management, such as incorporating enhanced natural areas into the landscaping, golf courses have the potential to offer a wide range of habitat for wildlife. In addition, encouragement of environmentally responsible maintenance practices, if not already adopted, will be beneficial to water quality and the aquatic habitat. Investigation into the Audubon Cooperative Sanctuary Program for Golf Courses should be explored for golf courses if such a program has not already been adopted. In addition, environmentally friendly practices should be encouraged (e.g. chemical free practices). |
| Agricultural Best Management Practices Program                     | The NPCA's program aimed at educating landowners about the benefits of rural and agricultural best management practices should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum 75% of the cost of a project with caps between \$5,000 and \$12,000 depending on the project.                                                                                                                                                                                                                         |
| Abandoned Well Decommissioning Program                             | Abandoned wells that are not properly decommissioned (capped and sealed) pose a threat to groundwater resources by providing a direct route to groundwater. The NPCA has a well decommissioning program in place for its jurisdiction. Grants are available for the decommissioning of unused water wells only. Priority is given to hydrogeologically sensitive areas, projects located in areas with a high density of domestic water wells, and areas                                                                                                                                                                                                                 |

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|                                                         | where watershed plans have been completed or are ongoing (NPCA 2007). Approved grants will cover 90% of well decommissioning costs to a maximum of \$2,000 per well (limit of 2 wells per property). This is a reimbursement program, which means that the landowner will pay the full cost to the contractor, and will be reimbursed for 90% of the total project cost after all receipts, invoices, and water well decommissioning records are submitted to the NPCA.                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Special Studies</b>                                  | <b>Recommendations for Further Study</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Riparian Buffer Tax Incentive Program                   | Partial exemption on property taxes for the establishment and maintenance of effective riparian and conservation buffers on property. Buffers provide a wide range of functions and benefits depending on their location (e.g. adjacent to watercourse or separating land uses).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Septic System Education and Funding Program             | Improperly functioning septic systems and abandoned septic systems are a known threat to water quality. A septic system education and funding program should be developed and implemented to ensure that private septic systems are functioning properly, and to ensure that abandoned systems are decommissioned.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Septic System Re-Inspection Program                     | Faulty or improperly maintained septic systems have been identified as a concern by participants at public events for the study area. Therefore, areas along the lakeshore that have a high intrinsic susceptibility should be considered priority for such a program. Municipal councils could approve and endorse the allocation of funds from property taxes or general revenue to fund the program. This approach may be facilitated with council knowledge that a percentage of inspected septic systems will also require remedial action on the part of some property owners, including the installation of new septic systems. Owners may also pro-actively undertake action if they are aware that a program is underway. Both will affect the number of permits issued in a municipality, and may generate revenue as a result (MMAH 2001). |
| Road Salt Impact Study                                  | Through RMN's <i>Salt Vulnerability Study</i> (2005) the entire LENS study area has been ranked as having a moderately high vulnerability to road salt from regional roads, however this study was not conducted on local municipal roads; therefore it is recommended that a similar study be completed by the respective local municipalities to determine the impact of road salt applications on local municipal roads to the surrounding natural features.                                                                                                                                                                                                                                                                                                                                                                                       |
| Subwatershed Hydrogeologic Characterization             | Development of subwatershed scale hydrogeologic characterizations would provide optimal information to make informed decisions in regard to applications and for use in planning decisions and policy development.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Fish Habitat Classification                             | The watercourses in this subwatershed have not been evaluated in terms of importance for fish habitat. It is recommended that this assessment be completed so this information can be used for proper resource management and land use planning decisions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Groundwater Intrinsic Susceptibility Studies            | The <i>Groundwater Study</i> (2005) has identified several areas with high shallow intrinsic susceptibility (Figure 16a & 16b) The intrinsic susceptibility of groundwater considers only the physical factors affecting the flow of water to, and through, the groundwater resource. Additional studies should be conducted in this watershed to ensure that current and future land uses do not conflict with the protection of groundwater resources in susceptible areas as part of the NPCA's <i>Groundwater Study</i> (2005) and proposed <i>Source Protection Plan</i> .                                                                                                                                                                                                                                                                       |
| Potential Contaminant Sources of Point Source Pollution | An inventory of potential contaminant sources and threats to water quality was identified as part of the objectives for the NPCA's <i>Groundwater Study</i> (2005). An updated inventory to confirm potential contaminant sources and locations is recommended as well as further investigation into the possible effects these potential contaminants may have on surface water quality and aquatic habitat and whether or not a contaminant management plan is needed.                                                                                                                                                                                                                                                                                                                                                                              |
| Site Specific Water Quality                             | Enhanced sampling methods upstream and downstream of potential points of contamination should be                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

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| Sampling | considered to help identify priority areas for remediation and/or restoration. |
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# **Lake Erie 5 Subwatershed** Restoration Strategy



Figure 25: Lake Erie 5 Subwatershed Restoration Strategy Study Area

## **Wainfleet Marsh Restoration Strategy**

The main watercourses in the Wainfleet Marsh subwatershed flow through woodlots and wetlands almost in their entirety before outletting to Lake Erie. The watercourses in this subwatershed have not been evaluated in terms of importance for fish habitat however the MNR has identified an important spawning area at the outlet in Lake Erie. In addition, the Lake Erie shoreline in this area has been identified as Fowler Toad habitat of which Niagara is one of only three areas in Canada where this SAR is found. The spotted turtle, a species of special concern, has also been identified in this subwatershed.

No water quality sampling was conducted in this subwatershed. A geomorphic assessment was conducted at one site in this subwatershed. Bank instability was noted in the form of fallen vegetation and exposed roots along the watercourse. Channel widening seems to be the dominant process occurring due to the presence of leaning trees on either side of the channel, as well as trees and shrubs within the watercourse. Debris jams were also identified along this field site (NPCA 2009b).

Opportunity in this subwatershed exists for infilling of natural areas and creation of corridor connections to adjacent natural areas creating a larger contiguous natural heritage block that would support a larger diversity of flora and fauna. The challenge in this subwatershed would be establishment of a sufficient riparian buffer along the final trunk of the watercourse before it outlets into Lake Erie.

The Wainfleet Marsh Subwatershed Restoration Strategy identifies one zone with specific stewardship and restoration recommendations (Table 15 and Figure 26).

**Table 15: Wainfleet Marsh Subwatershed Restoration Strategy**

| <b>Recommended Restoration Strategies</b>                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
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| <b>Restoration Opportunities</b>                                                                                                                                                                                               | <b>Riparian</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Wetland</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Upland and Ecological Linkages</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 1                                                                                                                                                                                                                              | <ul style="list-style-type: none"> <li>most of the watercourses flow through wetland and wooded areas therefore receiving cover from these natural areas; however portions of the headwaters commence in agricultural areas with little to no buffer therefore priority should be placed on establishing riparian habitat in these areas</li> <li>in the southern portion of the study area there are roadside ditches and portions of watercourse that have little to no riparian cover before outletting into Lake Erie, therefore measures to establish and enhance buffers should be considered to reduce sediment and contaminant loads from adjacent land use (roads and agricultural fields) before outletting to Lake Erie</li> <li>riparian buffers will help to reduce sediment and to maintain and enhance the integrity of water quality and fish habitat before outletting to Lake Erie, as well as create corridors that will connect the fragmented natural areas providing cover for wildlife</li> </ul> | <ul style="list-style-type: none"> <li>create/enhance wetlands in areas where the wetness index and soil drainage permit; priority should be given to areas adjacent to existing wetlands(e.g., very high suitability for wetland creation/enhancement in north-eastern portion of subwatershed); see map</li> <li>very high suitability to create an ecological corridor linking to wooded area in adjacent subwatershed</li> <li>protect existing wetlands (e.g., create a buffer of trees and shrubs between the wetland agricultural activities)</li> </ul> | <ul style="list-style-type: none"> <li>high suitability exists for creating a Critical Function Zone surrounding Wainfleet Bog PSW Complex. This will provide for a variety of critical functions for wetland-associated fauna (e.g. nesting habitat) as well as increase interior size resulting in the natural areas' ability to support a larger diversity of flora and fauna.</li> <li>potential is present for creating ecological linkages between natural areas facilitating in the movement of flora and fauna between natural areas and adjacent subwatershed</li> </ul> |
| <ul style="list-style-type: none"> <li>All restoration measures should where possible, benefit Species at Risk and provincially rare species</li> <li>Carolinian and native species should be used for all projects</li> </ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

| Project Opportunities                                               | Recommended Action for Public and Private Lands                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
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| NPCA Lake Erie North Shore Geomorphic Assessment Study (NPCA 2009b) | <p>1. <b>Neff Road (WMHeadwaters):</b> This section of the watercourse has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. Dense instream vegetation was noted in some areas during a site visit in 2008. Bank instability is present in the form of fallen vegetation and exposed roots along the watercourse. Channel widening seems to be the dominant process occurring due to the presence of leaning trees on either side of the channel, as well as trees and shrubs within the watercourse. Debris jams were also identified along this field site. Small tributaries and/or possibly gullies/rills exist along the watercourse. Measurements taken at channel cross sections would indicate that the watercourse at this field site has moderate entrenchment which results in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Long term monitoring of the debris jams should be completed to ensure they do not get larger and divert the flow. Projects to prevent and limit further development of rills adjacent to the watercourse should be implemented. Some examples include grassed waterways, chute spillways, tile drainage outlets, and proper tillage and cropping practices (OMAFRA, 1997a, and OMAFRA, 1997b).</p> |
| Naturalizing Drains and Drain Best Management Practices             | <p>In addition to having an impact on aquatic and riparian habitat, drain maintenance has the potential to become quite costly through repeated maintenance activities. Naturalizing drains can potentially lengthen the time between maintenance events by reducing the amount of sediment entering and remaining in the drain. Best Management Practices for drain maintenance should be developed in consultation with, but not limited to, the following agencies: OMAFRA, DFO, MNR, Conservation Ontario, OFA, DSAO, CFFO, and the agricultural community to reduce ecological impacts to aquatic systems and to prevent sediment from returning to the drain. Any future maintenance of this watercourse should be done in accordance with Best Management Practices for drains. To review examples of current BMP mitigation measures, refer to Appendix I.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Promote Good Shoreline Stewardship                                  | <p>Work with partnering stakeholders to promote shoreline that have been maintained naturally or restored to find a balance between natural processes and shoreline protection measures.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Integrated Roadside Vegetation Management (IRVM) Program            | <p>Niagara Region and municipalities should work together to expand Niagara Region's IRVM Program. IRVM integrates the use of native vegetation with appropriate management techniques to produce a cost-effective, environmentally sound management alternative for roadside weed and erosion control while providing numerous ecological benefits (e.g. buffer strips). Focus of program expansion should be directed to main roads and roads in areas with a high shallow intrinsic susceptibility.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Ecological Linkages between Natural Areas                           | <p>Opportunity potential is present for creating ecological linkages between natural areas creating larger contiguous natural features. Such areas have the potential to enhance movement of flora and fauna between natural areas as well as provide habitat and ecological diversity for a wide range of species.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Riparian Buffer Education Program                                   | <p>Many landowners keep their properties manicured or plant crops to the edge of the creek. The NPCA's program aimed at educating landowners about the benefits of buffer zones along watercourses should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum of 75% of the cost of a project with caps between \$2,000 and \$10,000.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Wetlands are Worth It Program                                       | <p>Wetlands provide important water quality and ecological functions in a watershed by augmenting low flow, acting as natural filtration systems and helping to reduce flooding by acting like giant sponges and absorbing excess water. The Wetlands are Worth It Program through NPCA's Water Quality Improvement Program aims to assist landowners that are interested in restoring, protecting, rehabilitating and creating wetland habitat on their property.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

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|                                                                    | by providing grants to a maximum of 75% of the cost of a project with a grant ceiling of \$10,000.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Environmentally Responsible Maintenance Practices for Golf Courses | By integrating golf course management practices with wildlife management, such as incorporating enhanced natural areas into the landscaping, golf courses have the potential to offer a wide range of habitat for wildlife. In addition, encouragement of environmentally responsible maintenance practices, if not already adopted, will be beneficial to water quality and the aquatic habitat. Investigation into the Audubon Cooperative Sanctuary Program for Golf Courses should be explored for golf courses if such a program has not already been adopted. In addition, environmentally friendly practices should be encouraged (e.g. chemical free practices).                                                                                                                                                                                                                                                         |
| Agricultural Best Management Practices Program                     | The NPCA's program aimed at educating landowners about the benefits of rural and agricultural best management practices should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum 75% of the cost of a project with caps between \$5,000 and \$12,000 depending on the project.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Abandoned Well Decommissioning Program                             | Abandoned wells that are not properly decommissioned (capped and sealed) pose a threat to groundwater resources by providing a direct route to groundwater. The NPCA has a well decommissioning program in place for its jurisdiction. Grants are available for the decommissioning of unused water wells only. Priority is given to hydrogeologically sensitive areas, projects located in areas with a high density of domestic water wells, and areas where watershed plans have been completed or are ongoing (NPCA 2007). Approved grants will cover 90% of well decommissioning costs to a maximum of \$2,000 per well (limit of 2 wells per property). This is a reimbursement program, which means that the landowner will pay the full cost to the contractor, and will be reimbursed for 90% of the total project cost after all receipts, invoices, and water well decommissioning records are submitted to the NPCA. |
| <b>Special Studies</b>                                             | <b>Recommendations for Further Study</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Riparian Buffer Tax Incentive Program                              | Partial exemption on property taxes for the establishment and maintenance of effective riparian and conservation buffers on property. Buffers provide a wide range of functions and benefits depending on their location (e.g. adjacent to watercourse or separating land uses).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Septic System Education and Funding Program                        | Improperly functioning septic systems and abandoned septic systems are a known threat to water quality. A septic system education and funding program should be developed and implemented to ensure that private septic systems are functioning properly, and to ensure that abandoned systems are decommissioned.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Septic System Re-Inspection Program                                | Faulty or improperly maintained septic systems have been identified as a concern by participants at public events for the study area. Therefore, areas along the lakeshore that have a high intrinsic susceptibility should be considered priority for such a program. Municipal councils could approve and endorse the allocation of funds from property taxes or general revenue to fund the program. This approach may be facilitated with council knowledge that a percentage of inspected septic systems will also require remedial action on the part of some property owners, including the installation of new septic systems. Owners may also pro-actively undertake action if they are aware that a program is underway. Both will affect the number of permits issued in a municipality, and may generate revenue as a result (MMAH 2001).                                                                            |
| Road Salt Impact Study                                             | Through RMN's <i>Salt Vulnerability Study</i> (2005) the entire LENS study area has been ranked as having a moderately high vulnerability to road salt from regional roads, however this study was not conducted on local municipal roads; therefore it is recommended that a similar study be completed by the respective local municipalities to determine the impact of road salt applications on local municipal roads to the surrounding natural features.                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Subwatershed                                                       | Development of subwatershed scale hydrogeologic characterizations would provide optimal information to make                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

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| Hydrogeologic Characterization                          | informed decisions in regard to applications and for use in planning decisions and policy development.                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Fish Habitat Classification                             | The watercourses in this subwatershed have not been evaluated in terms of importance for fish habitat. It is recommended that this assessment be completed so this information can be used for proper resource management and land use planning decisions.                                                                                                                                                                                                                                                                                                                 |
| Groundwater Intrinsic Susceptibility Studies            | The <i>Groundwater Study</i> (2005) has identified areas with a high shallow intrinsic susceptibility (Figure 16a & 16b). The intrinsic susceptibility of groundwater considers only the physical factors affecting the flow of water to, and through, the groundwater resource. Additional studies should be conducted in this watershed to ensure that current and future land uses do not conflict with the protection of groundwater resources in susceptible areas as part of the NPCA's <i>Groundwater Study</i> (2005) and proposed <i>Source Protection Plan</i> . |
| Potential Contaminant Sources of Point Source Pollution | An inventory of potential contaminant sources and threats to water quality was identified as part of the objectives for the NPCA's <i>Groundwater Study</i> (2005). An updated inventory to confirm potential contaminant sources and locations is recommended as well as further investigation into the possible effects these potential contaminants may have on surface water quality and aquatic habitat and whether or not a contaminant management plan is needed.                                                                                                   |
| Site Specific Water Quality Sampling                    | Enhanced sampling methods upstream and downstream of potential points of contamination should be considered to help identify priority areas for remediation and/or restoration.                                                                                                                                                                                                                                                                                                                                                                                            |

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### Lake Erie 3 Restoration Strategy

Two main watercourses drain the Lake Erie 3 subwatershed. One branch flows east to west from Wainfleet/Eagle Marsh Drain Wetland Complex which straddles the subwatershed boundaries of Lake Erie 3 and Eagle Marsh Drain. This branch has been classified as important fish habitat by the MNR fish classification system. The upper segment of this branch is also designated as Class F municipal drain; Bessey Branch Drain. The final segment of this watercourse flows from the abandoned quarry to Lake Erie. The MNR has identified an important spawning area at the outlet in Lake Erie. In addition, the Lake Erie shoreline in this area has been identified as Fowler's Toad habitat of which Niagara is one of only three areas in Canada where this SAR is found.

As indicated earlier, a new license has been approved in this subwatershed under the Aggregate Resources Act. In 2008, the Ontario Municipal Board (OMB) outlined a list of conditions for the Reeb Quarry which includes for example, an Adaptive Management Plan, ongoing water level monitoring of the Wainfleet Wetlands, Cement Plant Road Quarries and the Quarry Lakes, and monitoring plans for quantity and quality of water (C.C.Tatham & Associates Ltd. 2008). It is recommended that once these monitoring plans are complete, they be reviewed by the Implementation Committee and incorporated into any restoration measures in the subwatershed.

A geomorphic assessment was conducted at one site in this subwatershed. It was noted that the section of the watercourse had been channelized and lacked any depositional features along the stream bed which indicates little flow diversity within the channel. In addition, bank instability was present in the form of bare soil extending up the bank and bank slumping was present.

Water quality sampling is conducted at one site in this subwatershed; in the Wainfleet Wetlands Conservation Area. This site received a water quality index rating of Good which is the highest rating received in the study area. Water quality is improved at this station by an inflow of groundwater and Lake Erie (NPCA 2010).

Land use in the study area is a mix of residential and natural areas. The Wainfleet Wetlands Conservation Area makes up a large portion of this subwatershed. This conservation area primarily consists of abandoned quarries and provincially significant wetlands. Numerous Species at Risk have been noted in this subwatershed including for example the endangered king rail, threatened fowler's toad, common hop tree and eastern hog-nosed snake, as well as the eastern milksnake; a species of special concern. In addition, several provincially rare species have been identified in this subwatershed by the MNR and NPCA.

The challenge of the Lake Erie 3 subwatershed is the establishment and maintenance of a sufficient riparian buffer along the watercourses downstream of the wetland complexes, primarily along important fish habitat. The establishment and maintenance of riparian buffers is important to protect and enhance the integrity of the water quality and fish habitat before outletting to Lake Erie. Therefore, incorporation of best management drain maintenance practices are recommended, if not already being undertaken, in areas managed as municipal drain such as minimizing bank disturbance or leaving one side of the drain covered in vegetation. Refer to Appendix I for examples of typical mitigation measures for drain maintenance.

The Lake Erie 3 Subwatershed Restoration Strategy identifies one zone with specific stewardship and restoration recommendations (Table 16 and Figure 27).

**Table 16: Lake Erie 3 Subwatershed Restoration Strategy**

| <b>Recommended Restoration Strategies</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
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| <b>Restoration Opportunities</b>          | <b>Riparian</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Wetland</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Upland and Ecological Linkages</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 1.                                        | <ul style="list-style-type: none"> <li>the eastern branch in this subwatershed commences in Wainfleet/Eagle Marsh Drain Wetland complex, and then flows through scrubland with little to no buffer before outletting into the abandoned quarries. Priority for this branch should be the maintenance of existing riparian and the enhancement and/or establishment of riparian buffers in areas with little to no buffers to protect and enhance the integrity of the water quality from upstream area before outletting into the quarries which have been designated as critical fish habitat</li> <li>riparian buffers will help to reduce sediment and protect and enhance water quality and fish habitat as well create corridors that will connect fragmented natural areas providing cover for wildlife</li> <li>the eastern branch is in part managed as municipal drain, therefore establishment of riparian corridors should consider future maintenance activities (refer to engineers report and drainage BMP practice recommendations)</li> <li>the branch that connects the abandoned quarries to Lake Erie flows along the road with little to no buffer, therefore priority should be placed on establishment of buffer to reduce</li> </ul> | <ul style="list-style-type: none"> <li>wetland suitability mapping indicates high suitability for Wainfleet/Eagle Marsh Drain PSW Wetland Complex</li> <li>protect existing wetlands (e.g., create a buffer of trees and shrubs between the wetlands and the agricultural activities)</li> <li>create wetlands in areas where the wetness index and soil drainage permit(e.g., high restoration suitability exists north of Gord Harry Conservation Trail)</li> </ul> | <ul style="list-style-type: none"> <li>very high suitability exists for enhancement of Wainfleet/Eagle Marsh Drain PSW Wetland Complex creating a Critical Function Zone (CFZ). This will provide for a variety of critical functions for wetland-associated fauna (e.g. nesting habitat)</li> <li>opportunity exists for infilling some of the gaps creating a larger interior and creating linkages between natural areas resulting in a larger contiguous natural area which would increase the areas' ability to support a larger diversity of flora and fauna</li> </ul> |

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|                                                                                                                                                                                                                                    | sediment and contaminant loads from adjacent road before outletting to Lake Erie                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |  |
| <ul style="list-style-type: none"> <li>■ All restoration measures should where possible, benefit Species at Risk and provincially rare species</li> <li>■ Carolinian and native species should be used for all projects</li> </ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  |
| <b>Project Opportunities</b>                                                                                                                                                                                                       | <b>Recommended Action for Public and Private Lands</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |
| NPCA Lake Erie North Shore Geomorphic Assessment Study (NPCA 2009b)                                                                                                                                                                | <p>1. <b>Quarrie Road (LE3Ma):</b> This section of the watercourse has been channelized and lacks any depositional features along the stream bed which indicates little flow diversity within the channel Bank instability is present in the form of bare soil extending up the bank, as well as slumping. The buffer zone along the left bank is small due to the proximity of the road and therefore results in little canopy cover and habitat. There are some small coniferous trees in the buffer that will provide cover in the future when they get bigger. A failed culvert exists at Lakeshore Road. There is an area where vegetative debris is being thrown onto the bank. This debris will eventually end up in stream which can cause debris jams and impact water quality. The water that flows through this channel is pumped out from the old quarry. Dense aquatic vegetation, duckweed, and algae were noted during a site visit in 2008. Recommendations for this field site include planting deep rooted vegetation along the banks and stabilize the soil. The presence of bank slumping usually indicates that vegetative roots are too shallow to stabilize the bank. Increasing the variety and diversity of native plant species within the buffer zone will provide cover and habitat for fish, insects, and invertebrates along the watercourse. Water quality should continue to be monitored in this watershed. Due to the impact on water quality it is advised that landowners stop throwing vegetated debris over the bank. The failed culvert should be replaced with a properly sized culvert.</p> |  |
| Naturalizing Drains and Drain Best Management Practices                                                                                                                                                                            | <p>In addition to having an impact on aquatic and riparian habitat, drain maintenance has the potential to become quite costly through repeated maintenance activities. Naturalizing drains can potentially lengthen the time between maintenance events by reducing the amount of sediment entering and remaining in the drain. Best Management Practices for drain maintenance should be developed in consultation with, but not limited to, the following agencies: OMAFRA, DFO, MNR, Conservation Ontario, OFA, DSAO, CFFO, and the agricultural community to reduce ecological impacts to aquatic systems and to prevent sediment from returning to the drain. Any future maintenance of this watercourse should be done in accordance with Best Management Practices for drains. To review examples of current BMP mitigation measures, refer to Appendix I.</p> <p>Work with partnering stakeholders to promote shoreline that have been maintained naturally or restored to find a balance between natural processes and shoreline protection measures.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |
| Promote Good Shoreline Stewardship                                                                                                                                                                                                 | <p>Niagara Region and municipalities should work together to expand Niagara Region's IRVM Program. IRVM integrates the use of native vegetation with appropriate management techniques to produce a cost-effective, environmentally sound management alternative for roadside weed and erosion control while providing numerous ecological benefits (e.g. buffer strips). Focus of program expansion should be directed to main roads and roads in areas with a high shallow intrinsic susceptibility.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |
| Integrated Roadside Vegetation Management (IRVM) Program                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  |
| Ecological Linkages between Natural Areas                                                                                                                                                                                          | <p>Opportunity potential is present for creating ecological linkages between natural areas creating larger contiguous natural features. Such areas have the potential to enhance movement of flora and fauna between natural areas as well as provide habitat and ecological diversity for a wide range of species.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |  |

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| Riparian Buffer Education Program              | Many landowners keep their properties manicured or plant crops to the edge of the creek. The NPCA's program aimed at educating landowners about the benefits of buffer zones along watercourses should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum of 75% of the cost of a project with caps between \$2,000 and \$10,000.                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Wetlands are Worth It Program                  | Wetlands provide important water quality and ecological functions in a watershed by augmenting low flow, acting as natural filtration systems and helping to reduce flooding by acting like giant sponges and absorbing excess water. The Wetlands are Worth It Program through NPCA's Water Quality Improvement Program aims to assist landowners that are interested in restoring, protecting, rehabilitating and creating wetland habitat on their property by providing grants to a maximum of 75% of the cost of a project with a grant ceiling of \$10,000.                                                                                                                                                                                                                                                                                                                                                                |
| Agricultural Best Management Practices Program | The NPCA's program aimed at educating landowners about the benefits of rural and agricultural best management practices should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum of 75% of the cost of a project with caps between \$5,000 and \$12,000 depending on the project.                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Abandoned Well Decommissioning Program         | Abandoned wells that are not properly decommissioned (capped and sealed) pose a threat to groundwater resources by providing a direct route to groundwater. The NPCA has a well decommissioning program in place for its jurisdiction. Grants are available for the decommissioning of unused water wells only. Priority is given to hydrogeologically sensitive areas, projects located in areas with a high density of domestic water wells, and areas where watershed plans have been completed or are ongoing (NPCA 2007). Approved grants will cover 90% of well decommissioning costs to a maximum of \$2,000 per well (limit of 2 wells per property). This is a reimbursement program, which means that the landowner will pay the full cost to the contractor, and will be reimbursed for 90% of the total project cost after all receipts, invoices, and water well decommissioning records are submitted to the NPCA. |
| <b>Special Studies</b>                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Riparian Buffer Tax Incentive Program          | <b>Recommendations for Further Study</b><br>Partial exemption on property taxes for the establishment and maintenance of effective riparian and conservation buffers on property. Buffers provide a wide range of functions and benefits depending on their location (e.g. adjacent to watercourse or separating land uses).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Septic System Education and Funding Program    | Improperly functioning septic systems and abandoned septic systems are a known threat to water quality. A septic system education and funding program should be developed and implemented to ensure that private septic systems are functioning properly, and to ensure that abandoned systems are decommissioned.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Septic System Re-Inspection Program            | Areas that have been identified as „septic hotspots' through the <i>NPCA Groundwater Study</i> and areas that have a high intrinsic susceptibility should be considered priority for such a program. Municipal councils could approve and endorse the allocation of funds from property taxes or general revenue to fund the program. This approach may be facilitated with council knowledge that a percentage of inspected septic systems will also require remedial action on the part of some property owners, including the installation of new septic systems. Owners may also pro-actively undertake action if they are aware that a program is underway. Both will affect the number of permits issued in a municipality, and may generate revenue as a result (MMAH 2001).                                                                                                                                              |
| Road Salt Impact Study                         | Through RMN's <i>Salt Vulnerability Study</i> (2005) the entire LENS study area has been ranked as having a moderately high vulnerability to road salt from regional roads, however this study was not conducted on local municipal roads; therefore it is recommended that a similar study be completed by the respective local municipalities to determine the impact of road salt applications on local municipal roads to the surrounding natural                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

|                                                         | features.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
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| Subwatershed Hydrogeologic Characterization             | Development of subwatershed scale hydrogeologic characterizations would provide optimal information to make informed decisions in regard to applications and for use in planning decisions and policy development.                                                                                                                                                                                                                                                                                                                                                                                            |
| Fish Habitat Classification                             | Not all the watercourses in this subwatershed have been evaluated in terms of importance for fish habitat. It is recommended that this assessment be completed so this information can be used for proper resource management and land use planning decisions.                                                                                                                                                                                                                                                                                                                                                |
| Groundwater Intrinsic Susceptibility Studies            | The <i>Groundwater Study</i> (2005) has identified the entire Lake Erie 3 subwatershed as having a high shallow intrinsic susceptibility (Figure 16a & 16b). The intrinsic susceptibility of groundwater considers only the physical factors affecting the flow of water to, and through, the groundwater resource. Additional studies should be conducted in this watershed to ensure that current and future land uses do not conflict with the protection of groundwater resources in susceptible areas as part of the NPCA's <i>Groundwater Study</i> (2005) and proposed <i>Source Protection Plan</i> . |
| Potential Contaminant Sources of Point Source Pollution | An inventory of potential contaminant sources and threats to water quality was identified as part of the objectives for the NPCA's <i>Groundwater Study</i> (2005). An updated inventory to confirm potential contaminant sources and locations is recommended as well as further investigation into the possible effects these potential contaminants may have on surface water quality and aquatic habitat and whether or not a contaminant management plan is needed.                                                                                                                                      |
| Site Specific Water Quality Sampling                    | Enhanced sampling methods upstream and downstream of potential points of contamination should be considered to help identify priority areas for remediation and/or restoration.                                                                                                                                                                                                                                                                                                                                                                                                                               |

## Lake Erie 3 Subwatershed Restoration Strategy



**Figure 27: Lake Erie 3 Subwatershed Restoration Strategy Study Area**

## Eagle Marsh Drain Restoration Strategy

The watercourses in this subwatershed are in part managed as municipal drains; Eagle Marsh Drain and Bessey Branch Drain. The northern portion of Eagle Marsh Drain is designated as Class F Drain, while the southern portion is Class E. Bessey Branch Drain is a Class F Drain. A control structure is located at the outlet of Eagle Marsh and is an integral component of the municipal drain as it serves as flood protection for inland properties. A concrete armour wall is located at this site as the energy upstream, at and downstream of the structure are significant. The engineering design for the replacement of this wall will be undertaken sometime during 2010 (Bennemeer 2010).

The main branch of Eagle Marsh Drain and Bessey Branch Drain are both classified as important fish habitat and the eastern tributary within the Wainfleet Marsh Conservation Area is classified as critical fish habitat. In addition, the MNR has identified Gravelly Bay as an important spawning area. The remainder of the watercourses in this subwatershed have not been evaluated in terms of importance for fish habitat.

Geomorphic assessments were conducted at 5 sites in this subwatershed; 4 of the sites are within Eagle Marsh municipal drain and one along Bessey Branch Drain. Some bank instability was noted and relatively deep unconsolidated sediment deposited along the stream bed was identified. Excessive sediment deposition can cause problems in the watercourse, such as lateral channel adjustments, increased turbidity, filling in of pools, and impacting fish habitat (NPCA 2009b).

Water quality sampling indicates a water quality index rating of Marginal for Eagle Marsh Drain and a BioMAP rating of Impaired. Factors affecting these ratings include exceedances of chloride, *E. coli*, total phosphorus, and suspended solids. This site is influenced by groundwater discharge from the upstream bedrock quarry (NPCA 2010). As indicated earlier, a new license has been approved in this subwatershed under the Aggregate Resources Act. In 2008, the Ontario Municipal Board (OMB) outlined a list of conditions for the Reeb Quarry which includes for example, an Adaptive Management Plan, ongoing water level monitoring of the Wainfleet Wetlands, Cement Plant Road Quarries and the Quarry Lakes, and monitoring plans for quantity and quality of water (C.C.Tatham & Associates Ltd. 2008). It is recommended that once these monitoring plans are complete, they be reviewed by the Implementation Committee and incorporated into any restoration measures in the subwatershed.

In terms of land use in the subwatershed, the eastern half is primarily residential (City of Port Colborne) and the western portion is a mix of natural areas and agriculture. Several significant features are present in this subwatershed, including Bertie Formation (III) and Onondaga Formation Regional Earth Science ANSI's, Sugar Loaf Hill Old Growth Forest, Cement Plant Road Quarry PSW, and the remainder of Wainfleet/Eagle Marsh Drain Wetland Complex PSW. Several Species at Risk have been identified in this subwatershed by the MNR, including the federally endangered spotted turtle, least bittern, and the northern map turtle, which is a species of special concern. In addition, the Lake Erie shoreline in this area has been identified as Fowler's toad habitat, a federally and provincially threatened species, of which Niagara is one of only three areas in Canada where this SAR is found.

The challenge of the Eagle Marsh Drain subwatershed is the establishment and preservation of riparian habitat when maintenance activities are necessary on the municipal drains to facilitate in proper drainage of the agricultural fields. However, a sufficient vegetative riparian buffer is imperative in assisting with the protection and enhancement of water quality while providing a corridor and shelter that will facilitate in wildlife movement along the watercourse between natural areas. Therefore, incorporation of best management drain maintenance practices are recommended, if not already being undertaken, such as minimizing bank disturbance or leaving one side of the drain

covered in vegetation. This would not only provide a corridor for wildlife but would also provide benefits to water quality, provide the drain stability and filter sediment coming from adjacent fields and roads resulting in less sediment entering the drain and possibly lengthening the time between clean-outs. The fragmented pattern of the natural areas in the upper portion of the subwatershed offers ample of opportunity for creation of ecological linkages. In the southern portion of the subwatershed opportunity exists for infilling and connection of adjacent natural areas to create one large contiguous natural area that would support a larger diversity of flora and fauna. The Eagle Marsh Drain Subwatershed Restoration Strategy identifies two zones with specific stewardship and restoration recommendations (Table 17 and Figure 28).

**Table 17: Eagle Marsh Drain Subwatershed Restoration Strategy**

| <b>Recommended Restoration Strategies</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                             |
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| <b>Restoration Opportunities</b>          | <b>Riparian</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Wetland</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Upland and Ecological Linkages</b>                                                                                                                                                                                                                                                                                                                                                                                                       |
| 1. North of Highway 3: headwaters region  | <ul style="list-style-type: none"> <li>■ priority should be placed on establishing riparian habitat; the headwaters run through agricultural lands with little to no buffer.</li> <li>■ measures to establish and enhance buffer should be implemented to reduce sediment and contaminant loads from adjacent land use (road and agriculture)</li> <li>■ riparian buffers will help to reduce sediment and cool the water to enhance water quality and fish habitat as well create corridors that will connect fragmented natural areas providing cover for wildlife</li> <li>■ watercourses are managed as municipal drains therefore establishment of riparian corridors (e.g. deep rooted grasses &amp; shrubs) should consider future maintenance activities (refer to engineers report and drainage BMP practice recommendations)</li> </ul> | <ul style="list-style-type: none"> <li>■ wetland restoration suitability mapping indicates ample of suitability for riparian-wetland creation/enhancement along the watercourse north of Highway 3: see map</li> <li>■ create/enhance wetlands in areas where the wetness index and soil drainage permit; priority should be given to areas adjacent to existing wetlands(e.g., very high restoration suitability exists surrounding Wainfleet/Eagle Marsh Drain Wetland complexes for enhancement increasing size of interior, or creation of ecological linkages facilitating in the movement of flora and fauna between natural areas)</li> <li>■ protect existing wetlands (e.g., create a buffer of trees and shrubs between the wetlands and the agricultural activities)</li> </ul> | <ul style="list-style-type: none"> <li>■ moderate suitability for upland restoration adjacent to existing natural heritage areas; focus should be on increasing core natural areas, filling in gaps between adjacent areas and creating ecological linkages between fragmented areas and adjacent subwatersheds</li> </ul>                                                                                                                  |
| 2. South of Highway 3                     | <ul style="list-style-type: none"> <li>■ watercourse receives cover from natural areas south of Gord Harry Conservation Trail therefore focus should be on establishment of areas with little to no existing riparian (e.g. watercourses between Highway 3 and Gord Harry Conservation Trail and east of subdivision)</li> <li>■ headwaters of critical fish habitat have little to no buffer;</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                         | <ul style="list-style-type: none"> <li>■ high suitability for filling in gaps in existing wetlands (e.g., Wainfleet/Eagle Marsh Drain Wetland Complex)</li> <li>■ create/enhance wetlands in areas where the wetness index and soil drainage permit (e.g., south of Highway 3)</li> <li>■ protect existing wetlands (e.g., create a buffer of trees and shrubs between the wetlands and the</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                     | <ul style="list-style-type: none"> <li>■ very high suitability for infilling and enhancement around Cement Plant Road Quarry PSW and Wainfleet/Eagle Marsh Drain Wetland Complex providing a Critical Function Zone, increasing interior size and creating a larger contiguous natural area which would increase the area's ability to support a larger diversity of flora and fauna</li> <li>■ opportunity for linkage creation</li> </ul> |

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|                                                                                                                                                                                                                                 | therefore priority should be placed on establishing riparian habitat along this branch <ul style="list-style-type: none"><li>■ existing riparian should be maintained</li><li>■ watercourses are in part managed as municipal drains therefore establishment of riparian corridors should consider future maintenance activities (refer to engineers report and drainage BMP recommendations)</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | agricultural activities and subdivision) | between fragmented natural areas (e.g., south watershed along Lakeshore Road and east of Cement Plant Road PSW) |
| <ul style="list-style-type: none"><li>■ All restoration measures should where possible, benefit Species at Risk and provincially rare species</li><li>■ Carolinian and native species should be used for all projects</li></ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                          |                                                                                                                 |
| <b>Project Opportunities</b>                                                                                                                                                                                                    | <b>Recommended Action for Public and Private Lands</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                          |                                                                                                                 |
| NPCA Lake Erie North Shore Geomorphic Assessment Study (NPCA 2009b)                                                                                                                                                             | <p>1. <b>Bessey Road (EMHeadwaters)</b>: This section of watercourse is managed as a municipal drain; Bessey Branch Drain. It has been channelized and lacks any depositional features along the stream bed which indicates little flow diversity within the channel. No pools exist along the bed but there is stagnant water present throughout the field site. Algae, duckweed, and turbid water were noted during a site visit in 2008. Relatively deep unconsolidated sediment and organics are deposited along the channel bed. An odour was emitted from disturbed sediment which could be decomposing vegetation. Water quality testing should continue to be monitored in this watershed. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. All recommendations should be discussed with the Drainage Superintendent.</p> <p>2. <b>Lakeshore Road West (EMMa)</b>: This section of watercourse is managed as a municipal drain; Eagle Marsh Drain. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. Bank protection structures exist along both of the banks. These structures consist of a concrete block wall, a concrete wall, and a steel wall. The concrete block wall that exists along the outside bend of the channel is failing. This can be due to undercutting, high flows within the channel, or surface runoff that will remove the sediment from in behind the structure. Fish cover and invertebrate habitat are impacted due to the presence of revetments along the banks, as well as the lack of a riparian buffer. Turbid water and the lack of instream vegetation were noted during a site visit in 2008. There is a floodgate present at this location which would constrict the channel. Water quality should continue to be monitored in this watershed. Increasing the variety and diversity of native plant species within the buffer zone would help to stabilize the bank and limit the amount of sediment entering the channel but this may be difficult due to space constraints from urbanization. If possible, the steel and concrete revetments should be replaced with a soil bio-engineering bank protection structure. This would allow some habitat for fish, insects, and invertebrate along the watercourse, as well as shading adjacent to the channel. All recommendations should be discussed with the Drainage Superintendent.</p> <p>3. <b>Eagle Drive (EMMa-2)</b>: This section of watercourse is managed as a municipal drain; Eagle Marsh</p> |                                          |                                                                                                                 |

Drain. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. Slow moving water was present within the channel but there were no distinct pools identified. Relatively deep unconsolidated sediment is deposited along the channel bed. Turbid water was noted during a site visit in 2008. The lack of large trees adjacent to the channel impacts cover over the stream. The riparian buffer along the right bank was smaller, most likely due to the residential property and the road. There is bank instability present along the right bank but the herbaceous vegetation covers it. Chunks of concrete were identified along the right bank indicating that some erosion protection measures have been implemented by the landowner. There is an area along the right bank where vegetative debris is being thrown onto the bank. This debris will eventually end up in stream which can cause debris jams and impact water quality. Recommendations for this site include increasing the variety and diversity of native plant species within the buffer zone to provide cover and habitat for fish, insects, and invertebrates. Deep rooted vegetation will help to stabilize the bank which will limit the amount of sediment entering the stream. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. Due to the impact on water quality it is advised that landowners stop throwing vegetated debris over the bank. Water quality should continue to be monitored in this watershed. Proper bank protection measures should be installed along the right bank to ensure adequate stabilization. All recommendations should be discussed with the Drainage Superintendent.

4. **Cement Road (EMMa-3):** This section of watercourse is managed as a municipal drain; Eagle Marsh Drain. It has been channelized and lacks any depositional features along the stream bed which indicates little flow diversity within the channel. Bank instability is present in the form of slumping and undercutting. The width of the riparian buffer is small along the right bank and also lacks large woody vegetation that would provide shading over the channel. Some trees have recently been planted along the right bank. There is a small area along the left bank near Cement Road where no buffer exists either. Erosion pins were inserted along the left bank near Cement Road and erosion has been identified. Overhanging vegetation along the left bank makes it difficult to determine any other bank instability problems. Turbid and clear water along this study site were noted during various site visits in 2008. A number of carp were seen in the upstream section of this field site. Near Cement Road the bed of the channel is composed of bedrock but upstream there is relatively deep unconsolidated sediment deposited along the channel bed. Recommendations for this site include increasing the variety and diversity of native plant species within the buffer zone to provide cover and habitat for fish, insects, and invertebrates along the watercourse. Deep rooted vegetation will help to stabilize the bank which will limit the amount of sediment entering the stream. Water quality should continue to be monitored in this watershed. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. All recommendations should be discussed with the Drainage Superintendent.

5. **Youngs Road (EMMc):** This section of watercourse is managed as a municipal drain; Eagle Marsh Drain. It has been channelized and there are a few point bars present within the channel. Relatively deep unconsolidated sediment is deposited along the channel bed. Bank instability is present in the form of bare soil extending up the bank, and fallen vegetation. For most of the field site there is no aquatic vegetation present within the channel. No pools exist along the bed but there is stagnant water present throughout the field site. An oily sheen on the water surface was noted during a site visit in 2008. Riprap was identified along the right bank at a bend in the channel, which indicates that some erosion protection measures have been implemented

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|                                                          | <p>by the landowner. Measurements taken at channel cross sections would indicate that the watercourse at this field site is moderately entrenched which results in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil. Water quality testing should continue to be monitored in this watershed to determine any water quality issues. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. Proper bank protection measures should be installed along the right bank to ensure adequate stabilization. All recommendations should be discussed with the Drainage Superintendent.</p> <p>Four of the five sites are within the designated municipal drain Eagle Marsh Drain and the fifth site is within the Bessey Branch Drain. Some bank instability is present and relatively deep unconsolidated sediment deposited along the stream bed has been identified. Excessive sediment deposition can cause problems in the watercourse, such as lateral channel adjustments, increased turbidity, filling in of pools, and impacting fish habitat. Water quality should continue to be monitored in this watershed. Increasing the size of small buffer zones would help to prevent bank erosion, provide habitat and cover, control the amount of sediment entering the channel, and also filter any pollutant that may enter the stream by runoff. If it is possible to replace the steel and concrete revetments at the outlet with soil bio-engineering structures then this would provide more habitat and shading along the watercourse. Alternatives to traditional drainage design, such as wetland creation, floodplain development, and increasing channel curvature should also be considered. All recommendations should be discussed with the Drainage Superintendent.</p> |
| Naturalizing Drains and Drain Best Management Practices  | <p>In addition to having an impact on aquatic and riparian habitat, drain maintenance has the potential to become quite costly through repeated maintenance activities. Naturalizing drains can potentially lengthen the time between maintenance events by reducing the amount of sediment entering and remaining in the drain. Best Management Practices for drain maintenance should be developed in consultation with, but not limited to, the following agencies; OMAFRA, DFO, MNR, Conservation Ontario, OFA, DSAO, CFFO, and the agricultural community to reduce ecological impacts to aquatic systems and to prevent sediment from returning to the drain. Any future maintenance of this watercourse should be done in accordance with Best Management Practices for drains. To review examples of current BMP mitigation measures, refer to Appendix I.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Promote Good Shoreline Stewardship                       | <p>Work with partnering stakeholders to promote shoreline that have been maintained naturally or restored to find a balance between natural processes and shoreline protection measures.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Integrated Roadside Vegetation Management (IRVM) Program | <p>Niagara Region and municipalities should work together to expand Niagara Region's IRVM Program. IRVM integrates the use of native vegetation with appropriate management techniques to produce a cost-effective, environmentally sound management alternative for roadside weed and erosion control while providing numerous ecological benefits (e.g. buffer strips). Focus of program expansion should be directed to main roads and roads in areas with a high shallow intrinsic susceptibility.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Ecological Linkages between Natural Areas                | <p>Opportunity potential is present for creating ecological linkages between natural areas creating larger contiguous natural features. Such areas have the potential to enhance movement of flora and fauna between natural areas as well as provide habitat and ecological diversity for a wide range of species.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Riparian Buffer Education Program                        | <p>Many landowners keep their properties manicured or plant crops to the edge of the creek. The NPCA's program aimed at educating landowners about the benefits of buffer zones along watercourses should be extensively</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

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|                                                | promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum of 75% of the cost of a project with caps between \$2,000 and \$10,000.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Wetlands are Worth It Program                  | Wetlands provide important water quality and ecological functions in a watershed by augmenting low flow, acting as natural filtration systems and helping to reduce flooding by acting like giant sponges and absorbing excess water. The Wetlands are Worth It Program through NPCA's Water Quality Improvement Program aims to assist landowners that are interested in restoring, protecting, rehabilitating and creating wetland habitat on their property by providing grants to a maximum of 75% of the cost of a project with a grant ceiling of \$10,000.                                                                                                                                                                                                                                                                                                                                                                |
| Agricultural Best Management Practices Program | The NPCA's program aimed at educating landowners about the benefits of rural and agricultural best management practices should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum of 75% of the cost of a project with caps between \$5,000 and \$12,000 depending on the project.                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Abandoned Well Decommissioning Program         | Abandoned wells that are not properly decommissioned (capped and sealed) pose a threat to groundwater resources by providing a direct route to groundwater. The NPCA has a well decommissioning program in place for its jurisdiction. Grants are available for the decommissioning of unused water wells only. Priority is given to hydrogeologically sensitive areas, projects located in areas with a high density of domestic water wells, and areas where watershed plans have been completed or are ongoing (NPCA 2007). Approved grants will cover 90% of well decommissioning costs to a maximum of \$2,000 per well (limit of 2 wells per property). This is a reimbursement program, which means that the landowner will pay the full cost to the contractor, and will be reimbursed for 90% of the total project cost after all receipts, invoices, and water well decommissioning records are submitted to the NPCA. |
| <b>Special Studies</b>                         | <b>Recommendations for Further Study</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Riparian Buffer Tax Incentive Program          | Partial exemption on property taxes for the establishment and maintenance of effective riparian and conservation buffers on property. Buffers provide a wide range of functions and benefits depending on their location (e.g. adjacent to watercourse or separating land uses).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Septic System Education and Funding Program    | Improperly functioning septic systems and abandoned septic systems are a known threat to water quality. A septic system education and funding program should be developed and implemented to ensure that private septic systems are functioning properly, and to ensure that abandoned systems are decommissioned.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Septic System Re-Inspection Program            | Areas that have been identified as 'septic hotspots' through the <i>NPCA Groundwater Study</i> and areas that have a high intrinsic susceptibility should be considered priority for such a program. Municipal councils could approve and endorse the allocation of funds from property taxes or general revenue to fund the program. This approach may be facilitated with council knowledge that a percentage of inspected septic systems will also require remedial action on the part of some property owners, including the installation of new septic systems. Owners may also pro-actively undertake action if they are aware that a program is underway. Both will affect the number of permits issued in a municipality, and may generate revenue as a result (MMAH 2001).                                                                                                                                              |
| CSO Management Plan                            | The City of Port Colborne has initiated an Extraneous Flow Reduction Pilot Program for a portion of the City of Port Colborne. Expanding this program to the entire urban area of Port Colborne would greatly benefit water quality by eliminating any unnecessary infiltration of storm water to the sanitary sewers potentially creating Combined Sewers Overflows which results in the discharge of sanitary waste into nearby watercourses and waterbodies.                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Road Salt Impact Study                         | Through RMN's <i>Salt Vulnerability Study</i> (2005) the entire LENS study area has been ranked as having a                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

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|                                                         | moderately high vulnerability to road salt from regional roads, however this study was not conducted on local municipal roads; therefore it is recommended that a similar study be completed by the respective local municipalities to determine the impact of road salt applications on local municipal roads to the surrounding natural features.                                                                                                                                                                                                                                                                 |
| Subwatershed Hydrogeologic Characterization             | Development of subwatershed scale hydrogeologic characterizations would provide optimal information to make informed decisions in regard to applications and for use in planning decisions and policy development.                                                                                                                                                                                                                                                                                                                                                                                                  |
| Fish Habitat Classification                             | Not all the watercourses in this subwatershed have been evaluated in terms of importance for fish habitat. It is recommended that this assessment be completed so this information can be used for proper resource management and land use planning decisions.                                                                                                                                                                                                                                                                                                                                                      |
| Groundwater Intrinsic Susceptibility Studies            | The <i>Groundwater Study</i> (2005) has identified the entire Eagle Marsh Drain subwatershed as having a high shallow intrinsic susceptibility (Figure 16a & 16b). The intrinsic susceptibility of groundwater considers only the physical factors affecting the flow of water to, and through, the groundwater resource. Additional studies should be conducted in this watershed to ensure that current and future land uses do not conflict with the protection of groundwater resources in susceptible areas as part of the NPCA's <i>Groundwater Study</i> (2005) and proposed <i>Source Protection Plan</i> . |
| Potential Contaminant Sources of Point Source Pollution | An inventory of potential contaminant sources and threats to water quality was identified as part of the objectives for the NPCA's <i>Groundwater Study</i> (2005). An updated inventory to confirm potential contaminant sources and locations is recommended as well as further investigation into the possible effects these potential contaminants may have on surface water quality and aquatic habitat and whether or not a contaminant management plan is needed.                                                                                                                                            |
| Site Specific Water Quality Sampling                    | Enhanced sampling methods upstream and downstream of potential points of contamination should be considered to help identify priority areas for remediation and/or restoration.                                                                                                                                                                                                                                                                                                                                                                                                                                     |

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## Wignell Drain Restoration Strategy

The watercourses in the Wignell Drain subwatershed are primarily managed as municipal drains; Wignell Drain and Michener Drain. Michener Drain and the upper branches of Wignell Drain are Class F Drains and Wignell Drain is a Class B Drain and all are designated as important fish habitat. The MNR has also identified the Nickel Beach area as critical fish habitat. Water quality sampling results indicate a water quality index rating of Poor with exceedances of chloride, *E.coli.*, total phosphorus, and suspended solids (NPCA 2010). Promotion of the NPCA's education programs pertaining to agricultural best management practices and water quality would be beneficial for the landowners. These programs also include information on sources of funding for environmental projects on private land to encourage adoption and implementation of best management practices.

Thirteen geomorphic assessments were conducted along Wignell Drain and Michener Drain. Bank instability and relatively deep unconsolidated sediment deposition was noted along the channel bed throughout the watercourse. The possibility of rills/gullies present at approximately half of the field sites visited indicates the potential for additional sediment entering the watercourse. Excessive sediment deposition can cause problems in the watercourse, such as lateral channel adjustments, increased turbidity, filling in of pools, and impacting fish habitat (NPCA 2009b).

Land use in the subwatershed is primarily agriculture with rural residential throughout the study area. Nickel Beach, a public beach is located along the shoreline in this area. There is one golf course in this portion of the study area; Whiskey Run Golf Club. By integrating golf course management practices with wildlife management, such as incorporating enhanced natural areas into the landscaping, golf courses have the potential to offer a wide range of habitat for wildlife. In addition, encouragement of environmentally responsible maintenance practices, if not already adopted, will be beneficial to water quality and the aquatic habitat.

In terms of natural heritage features, Port Colborne Quarry provincial earth science ANSI, a portion of Nickel Beach Marsh PSW, and numerous small woodlots areas scattered throughout the watershed. Several Species at Risk have been identified in the study area including the endangered butternut tree and the threatened common hop tree and fowler's toad. The Lake Erie shoreline in this area has been identified as fowler's toad habitat, a federally and provincially threatened species, of which Niagara is one of only three areas in Canada where this SAR is found.

The challenge of the Wignell Drain subwatershed is the establishment and preservation of riparian habitat when maintenance activities are necessary on the municipal drains to facilitate in proper drainage of the agricultural fields. Incorporation of best management drain maintenance practices are recommended, if not already being undertaken, such as minimizing bank disturbance or leaving one side of the drain covered in vegetation. This would not only provide a corridor for wildlife but would also provide stability to the drain and filter sediment coming from adjacent fields resulting in less sediment entering the drain and possibly lengthening the time between clean-outs. A *"new Engineer's Report is scheduled to be completed to address a number of issues such as water quality and the potential constriction at the control structure"* (Bennemeer 2010). This would be an ideal time to work with the Drainage Superintendant to help address the aforementioned issues while finding an ecological balance between form and function of the municipal drain.

The fragmented pattern of the natural areas in this subwatershed provide for an abundance of opportunity for creating ecological linkages between existing natural areas throughout the subwatershed and extending into adjacent subwatersheds. As previously mentioned, the establishment of riparian habitat would also provide important links for wildlife to move between these scattered natural areas. In addition, ample of opportunity exists for filling in gaps in and between natural heritage features increasing the natural areas interior and creating larger contiguous

natural heritage blocks with adjacent natural areas. Larger areas have an increased ability to support a larger diversity of flora and fauna.

High restoration suitability is present surrounding Nickel Beach Marsh PSW and Wignell Drain Wetland Complex LSW. Enhancement around these significant features will provide for a variety of habitat for wetland-associated fauna that may extend beyond the wetland boundary, such as nesting sites for turtles and birds.

The Wignell Drain Subwatershed Restoration Strategy identifies two zones with specific stewardship and restoration recommendations (Table 18 and Figure 29).

**Table 18: Wignell Drain Subwatershed Restoration Strategy**

| <b>Recommended Restoration Strategies</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
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| <b>Restoration Opportunities</b>             | <b>Riparian</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Wetland</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Upland and Ecological Linkages</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 1. North of Durham Street: headwaters region | <ul style="list-style-type: none"> <li>■ priority should be placed on establishing riparian buffer habitat; the headwaters run through agricultural lands with little to no buffer.</li> <li>■ riparian buffers will help to reduce sediment and contaminant loads from adjacent land uses, and cool the water to enhance water quality and fish habitat.</li> <li>■ the establishment of riparian habitat is ideal in this portion of the subwatershed for creating important linkages that will connect fragmented natural areas providing cover for wildlife</li> <li>■ watercourses are managed as municipal drains therefore establishment of riparian corridors (e.g. deep rooted grasses &amp; shrubs) should consider future maintenance activities (refer to engineers report and drainage BMP practice recommendations)</li> </ul> | <ul style="list-style-type: none"> <li>■ wetland restoration suitability mapping indicates very high wetland restoration suitability for riparian-wetland along watercourses providing important linkages between fragmented natural areas</li> <li>■ suitability also high for wetland enhancement and creation surrounding Wignell Drain Wetland Complex potentially linking complexes by filling in gaps creating a larger contiguous wetland and providing a corridor to West Humberstone in adjacent subwatershed</li> <li>■ protect and enhance existing wetlands (e.g., create a buffer of trees and shrubs between the wetlands and the agricultural activities)</li> </ul> | <ul style="list-style-type: none"> <li>■ very high suitability for upland restoration adjacent to existing natural heritage areas; focus should be on increasing core natural heritage areas, filling in gaps between adjacent areas and creating ecological linkages between fragmented areas and adjacent subwatersheds</li> <li>■ high suitability for enhancement around Wignell Drain Wetland Complex providing a Critical Function Zone, increasing interior size and creating a larger contiguous natural area which would increase the area's ability to support a larger diversity of flora and fauna</li> </ul> |
| 2. South of Durham Street                    | <ul style="list-style-type: none"> <li>■ watercourses receive partial cover from adjacent natural areas; however there are large sections of watercourses with little to no riparian habitat; therefore focus should be on establishment of riparian buffers in areas with little to no existing riparian</li> <li>■ west branch flows along the roadway therefore measures to establish and enhance buffer</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                       | <ul style="list-style-type: none"> <li>■ high suitability for filling in gaps in and around Nickel Beach Marsh PSW creating a larger natural block which will increase the natural heritage areas' ability to support a larger diversity of flora and fauna</li> <li>■ protect existing wetlands (e.g., create a buffer of trees and shrubs between the wetlands and the agricultural activities and subdivision)</li> </ul>                                                                                                                                                                                                                                                        | <ul style="list-style-type: none"> <li>■ moderate to high upland suitability in this portion of the study area therefore focus should be on enhancement of existing wooded areas and enhancement of Nickel Beach Marsh providing a Critical Function Zone, increasing interior size and creating a larger contiguous natural area which would increase the area's ability to support a larger diversity of flora and fauna</li> <li>■ opportunity for linkage creation</li> </ul>                                                                                                                                         |

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|                                                                                                                                                                                                                                    | <p>should be implemented to reduce sediment and contaminant loads from adjacent land use (road and agriculture)</p> <ul style="list-style-type: none"> <li>■ east branch flows through agricultural fields and golf course with little to no buffer strip therefore measures to establish and enhance buffer should be implemented to reduce sediment and contaminant loads from adjacent land use (golf course and agriculture)</li> <li>■ existing riparian should be maintained</li> <li>■ watercourses are managed as municipal drains therefore establishment of riparian corridors should consider future maintenance activities (refer to engineers report and drainage BMP recommendations)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  | between fragmented natural areas (e.g., south subwatershed along Lakeshore Road extending into adjacent subwatershed) |
| <ul style="list-style-type: none"> <li>■ All restoration measures should where possible, benefit Species at Risk and provincially rare species</li> <li>■ Carolinian and native species should be used for all projects</li> </ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |  |                                                                                                                       |
| <b>Project Opportunities</b>                                                                                                                                                                                                       | <b>Recommended Action for Public and Private Lands</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |                                                                                                                       |
| <p>NPCA Lake Erie North Shore Geomorphic Assessment Study (NPCA 2009b)</p>                                                                                                                                                         | <p>1. <b>Lakeshore Road East (WDMa):</b> This section of watercourse is managed as a municipal drain; Wignell Drain. It has been channelized and there are sediment bars present within the watercourse. Bank instability is present in the form of bare soil extending up the bank, as well as undercut banks. The bare soil may be due to the tree canopy over the channel preventing vegetation from growing. Concrete slabs were identified along the left bank indicating that some erosion protection measures have been implemented by landowners. Duckweed and an oily sheen on the water surface were identified during a site visit in 2008. There is a floodgate present at this location which would constrict the channel. Some sediment deposition is present upstream near the floodgate. Measurements taken at channel cross sections would indicate that the watercourse at this field site has moderate entrenchment which results in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil. Water quality testing should continue to be completed in this watershed to determine any water quality issues. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. Proper bank protection measures should be installed along the left bank to ensure adequate stabilization. All recommendations should be discussed with the Drainage Superintendent.</p> |  |                                                                                                                       |

2. **Lakeshore Road East (WDMa-2):** This section of watercourse is managed as a municipal drain; Wignell Drain. It has been channelized and lacks any depositional features along the stream bed which indicates little flow diversity within the channel. Bank instability is present in the form of fallen vegetation on the left bank. There are also areas where the lawn is mowed right to the edge of the channel. The lack of large woody vegetation limits the canopy cover. Duckweed was noted during a site visit in 2008. Relatively deep unconsolidated sediment is deposited along the channel bed. Few to no pools were present along the streambed but there is stagnant water present in some areas. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil. Water quality should continue to be monitored in this watershed. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. Alternatives to traditional drainage design, such as wetland creation, floodplain development, and increasing channel curvature should also be considered. All recommendations should be discussed with the Drainage Superintendent.

3. **Snider Road near Lakeshore Road (WDMa-3):** This section of watercourse is managed as a municipal drain; Wignell Drain. It has been channelized and lacks any depositional features along the stream bed which indicates little flow diversity within the channel. Bank instability is present in the form of bare soil extending up the bank. A bank protection structure exists along the right bank of the channel. This structure consists of concrete blocks laid on top of each other forming a wall. The lack of large woody vegetation in the buffer zone impacts habitat and canopy cover over the channel. Few to no pools were present along the streambed but there is stagnant water present in some areas. Relatively large amounts of duckweed and algae were noted during a site visit in 2008. An oily sheen on the water surface was also identified. Possibly a gully/rill exist along the watercourse. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil. Water quality should continue to be monitored in this watershed. Projects to prevent and limit further development of rills adjacent to the watercourse should be implemented. Some examples include grassed waterways, chute spillways, tile drainage outlets, and proper tillage and cropping practices (OMAFRA, 1997a, and OMAFRA, 1997b). Alternatives to traditional drainage design, such as wetland creation, floodplain development, and increasing channel curvature should also be considered. An assessment should be completed on whether or not the concrete block wall can be replaced with a soil bio-engineered structure to increase habitat. All recommendations should be discussed with the Drainage Superintendent.

4. **Snider Road (WDMb):** This section of watercourse is managed as a municipal drain; Wignell Drain. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. Algae, duckweed, and areas of dense in-channel vegetation were noted during a site visit in 2008. Turbid water was also noted in the upstream section of this reach. Width of the channel and the lack of large woody vegetation in some areas impact the amount of canopy cover over the channel. Few to no pools were present along the streambed but stagnant water is present throughout. Small tributaries and/or possibly gullies/rills exist along the watercourse. Old bridge abutments are present and the abutments make the channel narrower than the other parts of the channel. Erosion is present around woody vegetation, as well as the bridge abutments. Relatively deep unconsolidated sediment is deposited along the stream bed at this study site. Recommendations for this site include not grading the channel banks too steep during the dredging process so

that deep rooted vegetation can become established along the banks and stabilize the soil. Increasing the amount of large woody vegetation adjacent to the channel would provide more canopy cover over the watercourse. Water quality should continue to be monitored in this watershed. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. Alternatives to traditional drainage design, such as wetland creation, floodplain development, and increasing channel curvature should also be considered. Projects to prevent and limit further development of rills adjacent to the watercourse should be implemented. Some examples include grassed waterways, chute spillways, tile drainage outlets, and proper tillage and cropping practices (OMAFRA, 1997a, and OMAFRA, 1997b). All recommendations should be discussed with the Drainage Superintendent.

**5. Snider Trail (WDMc):** This section of watercourse is managed as a municipal drain; Michener Drain M-2. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. Bank instability is present in the form of undercut banks and slumping. In the upstream section of this field site there appears to be a terrace within the channel. Due to the vegetation within and adjacent to the channel, it is difficult to confirm whether or not this is a terrace or an area of slump sediment. Algae, duckweed, and areas of dense in-channel vegetation were noted during a site visit in 2008. Relatively deep unconsolidated sediment is deposited along the channel bed. Few to no pools were present along the streambed but there is stagnant water present in some areas. A small buffer width with a lack of large woody vegetation exists on either side of the channel due to an agricultural field and the Friendship Trail. This impacts the canopy cover over the channel. Measurements taken at channel cross sections would indicate that the watercourse at this field site has moderate entrenchment which results in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil. The presence of bank slumping usually indicates that vegetative roots are too shallow to stabilize the bank. Increasing the amount of large native woody vegetation adjacent to the channel would provide more canopy cover over the watercourse. Water quality should continue to be monitored in this watershed. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. Alternatives to traditional drainage design, such as wetland creation, floodplain development, and increasing channel curvature should also be considered. All recommendations should be discussed with the Drainage Superintendent.

**6. Lorraine Road (WDMC-2):** This section of watercourse is managed as a municipal drain; Michener Drain M-2. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. In some areas there is relatively deep unconsolidated sediment deposited along the channel bed. Few to no pools were present along the streambed but there is stagnant water present throughout the study site. The vegetated buffer width is small in various locations along the watercourse. Recommendations for this site include increasing the size and diversity of native plant vegetation within the buffer zone if possible. This will provide cover and habitat for fish, insects, and invertebrates along the watercourse. It will also provide a filter for sediment and chemicals that may enter the channel from runoff of fields and roads. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. All recommendations should be discussed with the Drainage Superintendent.

**7. Killaly Street East (WDMc-3(DS)):** This section of watercourse is managed as a municipal drain; Michener Drain M-2. It has been channelized and there are a few bars present within the channel. Bank instability is present in the form of bare soil extending up the bank, as well as undercut banks. The vegetated buffer width is small in various locations along the watercourse. In-channel vegetation and algae were noted during a site visit in 2008. In some areas there is relatively deep unconsolidated sediment deposited along the channel bed. Small tributaries and/or possibly gullies/rills exist along the watercourse. Measurements taken at channel cross sections would indicate that the watercourse at this field site has moderate entrenchment which results in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil. Water quality should continue to be monitored in this watershed. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. Projects to prevent and limit further development of rills adjacent to the watercourse should be implemented. Some examples include grassed waterways, chute spillways, tile drainage outlets, and proper tillage and cropping practices (OMAFRA, 1997a, and OMAFRA, 1997b). All recommendations should be discussed with the Drainage Superintendent.

**8. Killaly Street East (WDMc-4(US)):** This section of watercourse is managed as a municipal drain; Michener Drain M-2. It has been channelized and there are a few bars present within the channel. Bank instability is present in the form of bare soil extending up the bank. The vegetated buffer width is small along the residential property. In-channel vegetation and algae were noted during a site visit in 2008. Few to no pools were present along the streambed but there is stagnant water present throughout the study site. Measurements taken at channel cross sections would indicate that the watercourse at this field site has moderate to minor entrenchment which results in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil. Water quality should continue to be monitored in this watershed. All recommendations should be discussed with the Drainage Superintendent.

**9. Weaver Road (WDMc-5):** This section of watercourse is managed as a municipal drain; Michener Drain M-2. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. Bank instability is present in the form of bare soil extending up the bank. The vegetated buffer width is small adjacent to the fields. Few to no pools were present along the streambed but there is stagnant water present throughout the study site. Small tributaries and/or possibly gullies/rills exist along the watercourse. Increasing the size and diversity of native plant vegetation within the buffer zone will provide cover and habitat for fish, insects, and invertebrates along the watercourse. It will also provide a filter for sediment and chemicals that may enter the channel from runoff of fields and roads. Projects to prevent and limit further development of rills adjacent to the watercourse should be implemented. Some examples include grassed waterways, chute spillways, tile drainage outlets, and proper tillage and cropping practices (OMAFRA, 1997a, and OMAFRA, 1997b). All recommendations should be discussed with the Drainage Superintendent.

**10. Main Street East (WDMd):** This section of watercourse is managed as a municipal drain; Michener Drain M-2. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. The vegetated buffer width is small in various locations along the watercourse which will impact habitat and cover over the stream. Few to no pools were present along the streambed but there are areas of stagnant water present. Measurements taken at channel cross sections would indicate that the watercourse at this field site is entrenched to moderately entrenched which results in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Increasing the size and diversity of native plant vegetation within the buffer zone will provide cover and habitat for fish, insects, and invertebrates along the watercourse. It will also provide a filter for sediment and chemicals that may enter the channel from runoff of fields and roads. All recommendations should be discussed with the Drainage Superintendent.

**11. Miller Road (WDMd-2):** This section of watercourse is managed as a municipal drain; Michener Drain M-2. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. Bank vegetation made it difficult to identify instability but both banks were very steep. The vegetated buffer width is small in various locations along the watercourse which will impact habitat and cover over the stream. Few to no pools were present along the streambed but there is stagnant water throughout the field site. There is a watercourse that flows in between the agricultural fields which could be a gully or a rill. Increasing the size and diversity of native plant vegetation within the buffer zone will provide cover and habitat for fish, insects, and invertebrates along the watercourse. It will also provide a filter for sediment and chemicals that may enter the channel from runoff of fields and roads. The watercourse that flows in between the vegetated fields should be monitored for bank instability to prevent additional sediment from entering the main watercourse. All recommendations should be discussed with the Drainage Superintendent.

**12. Friendship Trail (WDTa):** This section of watercourse is managed as a municipal drain; Wignell Drain. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. Bank instability is present in the form of undercutting, as well as bare soil exposed along an outer bend. The lack of large woody vegetation in the buffer zone impacts habitat and cover over the stream. Few to no pools were present along the streambed but there is stagnant water present throughout. The presence of algae was noted along the watercourse during a site visit in 2008. Tributaries and/or gullies/rills enter the watercourse at this field site. Measurements taken at channel cross sections would indicate that the watercourse at this field site has moderate to minor entrenchment which results in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil. Water quality should continue to be monitored in this watercourse. Alternatives to traditional drainage design, such as wetland creation, floodplain development, and increasing channel curvature should also be considered. All recommendations should be discussed with the Drainage Superintendent.

**13. Snider Road at Main Street East (WDTa-2):** This section of watercourse is managed as a municipal

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|                                                         | <p>drain; Wignell Drain. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. The lack of large woody vegetation in the buffer zone impacts habitat and cover over the stream. The buffer width is small which results in agricultural land being close to the stream. In-channel vegetation and algae were noted during a site visit in 2008. In some areas there is relatively deep unconsolidated sediment deposited along the channel bed. Small tributaries and/or possibly gullies/rills exist along the watercourse. Increasing the size and diversity of native plant vegetation within the buffer zone will provide cover and habitat for fish, insects, and invertebrates along the watercourse. It will also provide a filter for sediment and chemicals that may enter the channel from runoff of fields and roads. Water quality should continue to be monitored in this watercourse. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. Projects to prevent and limit further development of rills adjacent to the watercourse should be implemented. Some examples include grassed waterways, chute spillways, tile drainage outlets, and proper tillage and cropping practices (OMAFRA, 1997a, and OMAFRA, 1997b). All recommendations should be discussed with the Drainage Superintendent.</p> <p>All field sites are within a designated municipal drain, Wignell Drain and Michener Drain M-2. Both bank instability and relatively deep unconsolidated sediment deposited along the channel bed was identified throughout the watercourse. The possibility of rills/gullies present at approximately half of the field sites visited indicates the potential for additional sediment entering the watercourse. Rill prevention measures such as slope re-grading, erosion control blankets, and seeding should be implemented along the adjacent property. Excessive sediment deposition can cause problems in the watercourse, such as lateral channel adjustments, increased turbidity, filling in of pools, and impacting fish habitat. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. Some of the field sites have moderate entrenchment, which means that flood waters will have little to no access to the floodplain. Confining the flood waters to the channel results in the loss of the adjacent floodplain, which impacts the hydraulic function of the watercourse (floodplains are storage areas for flood waters) and the physical habitat (loss of floodplain vegetation and the organisms that live there). It will also change the channel geometry overtime due to increased velocity, stream power, and channel slope. Increasing the variety and diversity of native plant species within small buffer zones will provide cover and habitat for fish, insects, and invertebrate along the watercourse. All recommendations should be discussed with the Drainage Superintendent.</p> |
| Naturalizing Drains and Drain Best Management Practices | <p>In addition to having an impact on aquatic and riparian habitat, drain maintenance has the potential to become quite costly through repeated maintenance activities. Naturalizing drains can potentially lengthen the time between maintenance events by reducing the amount of sediment entering and remaining in the drain. Best Management Practices for drain maintenance should be developed in consultation with, but not limited to, the following agencies; OMAFRA, DFO, MNR, Conservation Ontario, OFA, DSAO, CFFO, and the agricultural community to reduce ecological impacts to aquatic systems and to prevent sediment from returning to the drain. Any future maintenance of this watercourse should be done in accordance with Best Management Practices for drains. To review examples of current BMP mitigation measures, refer to Appendix I.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Promote Good Shoreline Stewardship                      | <p>Work with partnering stakeholders to promote shoreline that have been maintained naturally or restored to find a balance between natural processes and shoreline protection measures.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Blue Flag Beaches                                       | <p>Work with partnering agencies to mitigate water quality issues and work towards Blue Flag Beach status. Blue</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

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|                                                                    | Flag status meets high standards with respect to water quality, environmental management, environmental education and safety and services (Blueflag.ca) and is known globally. Blue Flag beaches have the potential to increase tourism in the area.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Integrated Roadside Vegetation Management (IRVM) Program           | Niagara Region and municipalities should work together to expand Niagara Region's IRVM Program. IRVM integrates the use of native vegetation with appropriate management techniques to produce a cost-effective, environmentally sound management alternative for roadside weed and erosion control while providing numerous ecological benefits (e.g. buffer strips). Focus of program expansion should be directed to main roads and roads in areas with a high shallow intrinsic susceptibility.                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Ecological Linkages between Natural Areas                          | Opportunity potential is present for creating ecological linkages between natural areas creating larger contiguous natural features. Such areas have the potential to enhance movement of flora and fauna between natural areas as well as provide habitat and ecological diversity for a wide range of species.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Riparian Buffer Education Program                                  | Many landowners keep their properties manicured or plant crops to the edge of the creek. The NPCA's program aimed at educating landowners about the benefits of buffer zones along watercourses should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum of 75% of the cost of a project with caps between \$2,000 and \$10,000.                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Wetlands are Worth It Program                                      | Wetlands provide important water quality and ecological functions in a watershed by augmenting low flow, acting as natural filtration systems and helping to reduce flooding by acting like giant sponges and absorbing excess water. The Wetlands are Worth It Program through NPCA's Water Quality Improvement Program aims to assist landowners that are interested in restoring, protecting, rehabilitating and creating wetland habitat on their property by providing grants to a maximum of 75% of the cost of a project with a grant ceiling of \$10,000.                                                                                                                                                                                                                                                                                                                                                                |
| Environmentally Responsible Maintenance Practices for Golf Courses | By integrating golf course management practices with wildlife management, such as incorporating enhanced natural areas into the landscaping, golf courses have the potential to offer a wide range of habitat for wildlife. In addition, encouragement of environmentally responsible maintenance practices, if not already adopted, will be beneficial to water quality and the aquatic habitat. Investigation into the Audubon Cooperative Sanctuary Program for Golf Courses should be explored for golf courses if such a program has not already been adopted. In addition, environmentally friendly practices should be encouraged (e.g. chemical free practices).                                                                                                                                                                                                                                                         |
| Agricultural Best Management Practices Program                     | The NPCA's program aimed at educating landowners about the benefits of rural and agricultural best management practices should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum 75% of the cost of a project with caps between \$5,000 and \$12,000 depending on the project.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Abandoned Well Decommissioning Program                             | Abandoned wells that are not properly decommissioned (capped and sealed) pose a threat to groundwater resources by providing a direct route to groundwater. The NPCA has a well decommissioning program in place for its jurisdiction. Grants are available for the decommissioning of unused water wells only. Priority is given to hydrogeologically sensitive areas, projects located in areas with a high density of domestic water wells, and areas where watershed plans have been completed or are ongoing (NPCA 2007). Approved grants will cover 90% of well decommissioning costs to a maximum of \$2,000 per well (limit of 2 wells per property). This is a reimbursement program, which means that the landowner will pay the full cost to the contractor, and will be reimbursed for 90% of the total project cost after all receipts, invoices, and water well decommissioning records are submitted to the NPCA. |
| <b>Special Studies</b>                                             | <b>Recommendations for Further Study</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

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| Riparian Buffer Tax Incentive Program                   | Partial exemption on property taxes for the establishment and maintenance of effective riparian and conservation buffers on property. Buffers provide a wide range of functions and benefits depending on their location (e.g. adjacent to watercourse or separating land uses).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Septic System Education and Funding Program             | Improperly functioning septic systems and abandoned septic systems are a known threat to water quality. A septic system education and funding program should be developed and implemented to ensure that private septic systems are functioning properly, and to ensure that abandoned systems are decommissioned.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Septic System Re-Inspection Program                     | Faulty or improperly maintained septic systems have been identified as a concern by participants at public events for the study area. Therefore, areas along the lakeshore that have a high intrinsic susceptibility should be considered priority for such a program. Municipal councils could approve and endorse the allocation of funds from property taxes or general revenue to fund the program. This approach may be facilitated with council knowledge that a percentage of inspected septic systems will also require remedial action on the part of some property owners, including the installation of new septic systems. Owners may also pro-actively undertake action if they are aware that a program is underway. Both will affect the number of permits issued in a municipality, and may generate revenue as a result (MMAH 2001). |
| Road Salt Impact Study                                  | Through RMN's <i>Salt Vulnerability Study</i> (2005) the entire LENS study area has been ranked as having a moderately high vulnerability to road salt from regional roads, however this study was not conducted on local municipal roads; therefore it is recommended that a similar study be completed by the respective local municipalities to determine the impact of road salt applications on local municipal roads to the surrounding natural features.                                                                                                                                                                                                                                                                                                                                                                                       |
| Subwatershed Hydrogeologic Characterization             | Development of subwatershed scale hydrogeologic characterizations would provide optimal information to make informed decisions in regard to applications and for use in planning decisions and policy development.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Fish Habitat Classification                             | Not all the watercourses in this subwatershed have been evaluated in terms of importance for fish habitat. It is recommended that this assessment be completed so this information can be used for proper resource management and land use planning decisions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Groundwater Intrinsic Susceptibility Studies            | The <i>Groundwater Study</i> (2005) has identified nearly the entire Wignell Drain subwatershed as having a high shallow intrinsic susceptibility (Figure 16a & 16b). The intrinsic susceptibility of groundwater considers only the physical factors affecting the flow of water to, and through, the groundwater resource. Additional studies should be conducted in this watershed to ensure that current and future land uses do not conflict with the protection of groundwater resources in susceptible areas as part of the NPCA's <i>Groundwater Study</i> (2005) and proposed <i>Source Protection Plan</i> .                                                                                                                                                                                                                                |
| Potential Contaminant Sources of Point Source Pollution | An inventory of potential contaminant sources and threats to water quality was identified as part of the objectives for the NPCA's <i>Groundwater Study</i> (2005). An updated inventory to confirm potential contaminant sources and locations is recommended as well as further investigation into the possible effects these potential contaminants may have on surface water quality and aquatic habitat and whether or not a contaminant management plan is needed.                                                                                                                                                                                                                                                                                                                                                                              |
| Site Specific Water Quality Sampling                    | Enhanced sampling methods upstream and downstream of potential points of contamination should be considered to help identify priority areas for remediation and/or restoration. For instance, partner with the Lorraine Bay Water Quality Group to help identify potential sites and to help initiate sampling.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |



## Beaver Dam Creek Restoration Strategy

The Beaver Dam Creek subwatershed is primarily drained by municipal drains; Beaverdam Drain. The final extent of the Beaverdam Drain before it outlets to Lake Erie is a Class C Drain, the remainder is classed as Class F. The watercourses in this subwatershed have not been evaluated in terms of importance for fish habitat.

Water quality sampling conducted at the outlet of the subwatershed indicates a water quality index of Poor and a BioMAP rating of Impaired. Factors affecting water quality include nutrient enrichment from upstream urban and agricultural areas and a lack of riparian buffer (NPCA 2010). Promotion of the NPCA's education programs pertaining to agricultural best management practices and water quality would be beneficial for the landowners. These programs also include information on sources of funding for environmental projects on private land to encourage adoption and implementation of best management practices.

Geomorphic assessments were conducted at four sites within Beaverdam municipal drain. Bank instability was identified at all four locations and some of the field sites had relatively deep unconsolidated sediment deposited along the bed. Excessive sediment deposition can cause problems in the watercourse, such as lateral channel adjustments, increased turbidity, filling in of pools, and impacting fish habitat (NPCA 2009b).

Land use in this study area is primarily agriculture with a strip of residential along the lakeshore and rural residential scattered throughout the study area. There is one golf course in this portion of the study area; Emerald Pines Golf Club. By integrating golf course management practices with wildlife management, such as incorporating enhanced natural areas into the landscaping, golf courses have the potential to offer a wide range of habitat for wildlife. In addition, encouragement of environmentally responsible maintenance practices, if not already adopted, will be beneficial to water quality and the aquatic habitat.

The MNR has identified the Lake Erie shoreline in this area as fowler's toad habitat, a federally and provincially threatened species, of which Niagara is one of only three areas in Canada where this SAR is found.

In terms of natural heritage features, Humberstone Marsh provincially significant life science ANSI straddles the northern boundary of the study area and the southern portion of the subwatershed is home to Beaver Dam Creek Wetland Complex PSW. The fragmented pattern of numerous wooded areas scattered throughout the subwatershed offer ample of opportunity to create ecological corridors linking fragmented natural areas with the larger core areas. The establishment of riparian buffer corridors will play an important role in linking fragmented natural areas throughout the subwatershed. In addition, ample of opportunity is present for filling in gaps of existing natural areas creating a larger contiguous natural area that would support a wide diversity of flora and fauna.

Like Wignell Drain subwatershed, the challenge of the Beaver Dam subwatershed is the establishment and preservation of riparian habitat when maintenance activities are necessary on the municipal drains to facilitate in proper drainage of the agricultural fields. Incorporation of best management drain maintenance practices are also recommended for this subwatershed, if not already being undertaken, such as minimizing bank disturbance or leaving one side of the drain covered in vegetation.

The Beaver Dam Creek P.C. Subwatershed Restoration Strategy identifies three zones with specific stewardship and restoration recommendations (Table 19 and Figure 30).

**Table 19: Beaver Dam Creek P.C. Subwatershed Restoration Strategy**

| <b>Recommended Restoration Strategies</b>                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
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| <b>Restoration Opportunities</b>                          | <b>Riparian</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Wetland</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Upland and Ecological Linkages</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 1. North of Second Concession Road: headwaters region     | <ul style="list-style-type: none"> <li>priority should be placed on establishing riparian buffer habitat; portions of the headwaters flow through agricultural lands with little to no buffer.</li> <li>riparian buffers will help to reduce sediment and contaminant loads from adjacent land uses, and cool the water to enhance water quality and fish habitat.</li> <li>main channel and portion of east branch flows through Humberstone Marsh; existing riparian should be maintained to protect and enhance integrity of water quality</li> <li>watercourses are managed as municipal drains therefore establishment of riparian corridors (e.g. deep rooted grasses &amp; shrubs) should consider future maintenance activities (refer to engineers report and drainage BMP practice recommendations)</li> </ul> | <ul style="list-style-type: none"> <li>wetland restoration suitability mapping indicates very high wetland restoration suitability for Humberstone Marsh</li> <li>mapping also indicates very high suitability for riparian-wetland restoration along watercourse between Humberstone Marsh and West Humberstone Wetland linking complexes providing a corridor between natural areas</li> <li>protect and enhance existing wetlands (e.g., create a buffer of trees and shrubs between the wetlands and the agricultural activities)</li> </ul> | <ul style="list-style-type: none"> <li>very high suitability for upland restoration adjacent to Humberstone Marsh; focus should be on increasing core natural heritage block would increase the area's ability to support a larger diversity of flora and fauna</li> <li>upland enhancement of Humberstone Marsh would also provide a Critical Function Zone and would provide a variety of habitat functions for wetland-associated fauna that extend beyond the wetland limit</li> </ul>                                                                               |
| 2. North of Killaly Street and south of Second Concession | <ul style="list-style-type: none"> <li>watercourses receive partial cover from adjacent natural areas, however there are large sections of watercourses with little to no riparian habitat; therefore focus should be on establishment of riparian buffers in areas with little to no existing riparian</li> <li>main branch largely flows along the roadside therefore measures to establish and enhance buffer should be implemented to reduce sediment and contaminant loads from adjacent land use (road and agriculture)</li> </ul>                                                                                                                                                                                                                                                                                 | <ul style="list-style-type: none"> <li>high suitability for filling in gaps in and around fragmented wooded areas creating a larger contiguous natural block which will increase the natural heritage areas' ability to support a larger diversity of flora and fauna</li> <li>high suitability for riparian-wetland restoration along watercourse from Humberstone Marsh to Beaver Dam Creek Pt. Col Wetland Complex</li> <li>protect existing wetlands (e.g., create a buffer of trees and shrubs between the wetlands and the</li> </ul>      | <ul style="list-style-type: none"> <li>upland restoration suitability mapping indicates very high suitability surrounding Humberstone Marsh providing a Critical Function Zone that would provide for wetland-associated species that extend beyond the wetland boundary</li> <li>moderate to high upland suitability surrounding existing natural areas, therefore focus should be on enhancement of existing wooded areas and filling in gaps of natural areas reducing forest edge –interior ratio and creating a larger contiguous natural area extending</li> </ul> |

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|                                                                                                                                                                                                                                | <ul style="list-style-type: none"> <li>the establishment of riparian habitat is ideal in this portion of the subwatershed for creating important linkages that will connect fragmented natural areas providing cover for wildlife</li> <li>upper east branches flow from golf course with little to no buffer strip therefore measures to establish and enhance buffer should be implemented to reduce sediment and contaminant loads from adjacent land use</li> <li>existing riparian should be maintained</li> <li>the main channel managed as municipal drain therefore establishment of riparian corridors should consider future maintenance activities (refer to engineers report and drainage BMP recommendations)</li> </ul> | agricultural activities and subdivision)                                                                                                                                                                                                                                                                                                                                                                                                                     | into adjacent subwatershed. A larger natural block could support a larger diversity of flora and fauna                                                                                                                                                                                                                                                                                    |
| 3. South of Killaly Street to Lake Erie                                                                                                                                                                                        | <ul style="list-style-type: none"> <li>a large portion of watercourse flows through wetland therefore focus should be on establishing riparian buffers south of wetland where there is little to none</li> <li>existing riparian should be maintained</li> <li>the main channel managed as municipal drain therefore establishment of riparian corridors should consider future maintenance activities (refer to engineers report and drainage BMP recommendations)</li> </ul>                                                                                                                                                                                                                                                        | <ul style="list-style-type: none"> <li>wetland restoration suitability indicates very high suitability surrounding Beaver Dam Creek Pt. Colborne PSW and very high riparian-wetland suitability between wetland complexes</li> <li>focus should be on enhancement of existing PSW and filling in gaps and creating ecological linkages between fragmented wetland complexes facilitating in the movement of flora and fauna between natural areas</li> </ul> | <ul style="list-style-type: none"> <li>high suitability surrounding Beaver Dam Creek Pt. Colborne PSW, therefore focus should be on enhancement and filling in gaps creating a larger contiguous natural block</li> <li>opportunity for linkage creation between fragmented natural areas (e.g., golf course and adjacent natural areas) extending into adjacent subwatersheds</li> </ul> |
| <ul style="list-style-type: none"> <li>All restoration measures should where possible, benefit Species at Risk and provincially rare species</li> <li>Carolinian and native species should be used for all projects</li> </ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Recommended Action for Public and Private Lands</b>                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Project Opportunities</b>                                                                                                                                                                                                   | <b>1. Weaver Road (BDCMa):</b> This section of watercourse is managed as a municipal drain; Beaver Dam Drain. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                           |
| NPCA Lake Erie North Shore Geomorphic                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                           |

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| Assessment Study (NPCA 2009b) | <p>within the channel. A bank protection structure, consisting of a concrete block wall, exists along the left bank of the channel adjacent to Weaver Road. . The riparian buffer along this reach is small and consists predominantly of herbaceous vegetation except in the wooded area. No pools exist but there is stagnant water present throughout the field site. A foot bridge that crosses the channel on private property is narrower than the channel width and may be considered a channel constriction. Algae, duckweed, and a brown film on the water surface were noted during a site visit in 2008. Slumping is occurring on private property on Weaver Road and fracture lines are present at the top of the bank. The asphalt driveway adjacent to the channel is cracking which further suggests bank instability. Bank failure is also present in the failing bank revetment adjacent to Weaver Road. Possible causes of instability include undercutting or pressure from in behind the wall. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil. Further assessment of the concrete block revetment should be done to determine the stability of the wall. If the foot bridge is found to be a channel constriction then it needs to be replaced with an appropriately sized bridge. Water quality should continue to be monitored within this watershed. Alternatives to traditional drainage design, such as wetland creation, floodplain development, and increasing channel curvature should also be considered. All recommendations should be discussed with the Drainage Superintendent.</p> <p><b>2. Miller Road (BDCMb):</b> This section of watercourse is managed as a municipal drain; Beaver Dam Drain. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. Bank instability is present on both sides of the channel in the form of bare soil extending up the bank; slumping; undercut banks; and fallen vegetation. For most of the field site there is no aquatic vegetation present within the channel. No pools exist but there is stagnant water present throughout the field site. Relatively deep unconsolidated sediment is deposited along the channel bed. Channel measurements indicate that the watercourse at this field site is entrenched to moderately entrenched which results in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil. Alternatives to traditional drainage design, such as wetland creation, floodplain development, and increasing channel curvature) should also be considered. Water quality should continue to be monitored within this watershed. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. All recommendations should be discussed with the Drainage Superintendent.</p> <p><b>3. Killaly Street (BDCMb-2):</b> This section of watercourse is managed as a municipal drain; Beaver Dam Drain. It has been channelized and lacks any depositional features along the stream bed which indicates little flow diversity within the channel. Bank instability is present in the form of steep banks with bare soil extending up the bank. No pools exist along the bed but there is stagnant water present throughout the field site. Relatively deep unconsolidated sediment is deposited along the channel bed. At least 5 debris jams were present within the study site which is most likely due to over steepened banks that have become unstable. Channel measurements would indicate that the watercourse at this field site is entrenched to moderately entrenched which results in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil.</p> |
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Alternatives to traditional drainage design, such as wetland creation, floodplain development, and increasing channel curvature should also be considered. Water quality should continue to be monitored within this watershed. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. All recommendations should be discussed with the Drainage Superintendent.

**4. Main Street East/White Road (BDCMb/BDCMc):** This section of watercourse is managed as a municipal drain; Beaver Dam Drain. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. The riparian buffer along this field site is small but it does contain a variety of vegetation types. Bank instability is present in the form of bare soil extending up the bank, as well as undercut banks. No pools exist but there is stagnant water present throughout the field site. A foot bridge that crosses the channel on private property may be narrower than the channel and therefore would be considered a constriction. A bank protection structure, consisting of a concrete block wall, exists in the downstream section of this field site protecting residential property. Numerous debris jams caused by fallen trees are present in the upstream section. Measurements taken at channel cross sections would indicate that the watercourse at this field site is moderately entrenched which results in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil. Alternatives to traditional drainage design, such as wetland creation, floodplain development, and increasing channel curvature should also be considered. If the foot bridge is found to be a channel constriction then it needs to be replaced with an appropriately sized bridge. All recommendations should be discussed with the Drainage Superintendent.

These four field sites are within the designated municipal drain Beaver Dam Drain. Bank instability can be identified at all four locations and some of the field sites had relatively deep unconsolidated sediment deposited along the bed. Excessive sediment deposition can cause problems in the watercourse, such as lateral channel adjustments, increased turbidity, filling in of pools, and impacting fish habitat. Long term monitoring of sediment accumulation should be completed to avoid any potential problems and can be done by the use of sediment traps. Water quality should continue to be monitored in this watershed. Foot bridges that are present along this watercourse should be measured to ensure that they are not constricting the channel. This is due to the fact that it can cause water to dam up behind it and therefore deposit sediment and/or scour the bed of the channel. The majority of the field sites are entrenched to moderately entrenched, which means that flood waters will have little to no access to the floodplain. Confining the flood waters to the channel results in the loss of the adjacent floodplain, which impacts the hydraulic function of the watercourse (floodplains are storage areas for flood waters) and the physical habitat (loss of floodplain vegetation and the organisms that live there). It will also change the channel geometry overtime due to increased velocity, stream power, and channel slope. Increasing the variety and diversity of native plant species will provide cover, habitat, and help to stabilize the soil along the banks. It will also help to filter sediment and pollutants which may enter the watercourse from runoff. All recommendations should be discussed with the Drainage Superintendent.

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| Naturalizing Drains and Drain Best Management Practices | In addition to having an impact on aquatic and riparian habitat, drain maintenance has the potential to become quite costly through repeated maintenance activities. Naturalizing drains can potentially lengthen the time between maintenance events by reducing the amount of sediment entering and remaining in the drain. Best Management |
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|                                                                    | <p>Practices for drain maintenance should be developed in consultation with, but not limited to, the following agencies; OMAFRA, DFO, MNR, Conservation Ontario, OFA, DSAO, CFFO, and the agricultural community to reduce ecological impacts to aquatic systems and to prevent sediment from returning to the drain. Any future maintenance of this watercourse should be done in accordance with Best Management Practices for drains. To review examples of current BMP mitigation measures, refer to Appendix I.</p> <p>Work with partnering stakeholders to promote shoreline that have been maintained naturally or restored to find a balance between natural processes and shoreline protection measures.</p> <p>Niagara Region and municipalities should work together to expand Niagara Region's IRVM Program. IRVM integrates the use of native vegetation with appropriate management techniques to produce a cost-effective, environmentally sound management alternative for roadside weed and erosion control while providing numerous ecological benefits (e.g. buffer strips). Focus of program expansion should be directed to main roads and roads in areas with a high shallow intrinsic susceptibility.</p> <p>Opportunity potential is present for creating ecological linkages between natural areas creating larger contiguous natural features. Such areas have the potential to enhance movement of flora and fauna between natural areas as well as provide habitat and ecological diversity for a wide range of species.</p> <p>Many landowners keep their properties manicured or plant crops to the edge of the creek. The NPCA's program aimed at educating landowners about the benefits of buffer zones along watercourses should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum of 75% of the cost of a project with caps between \$2,000 and \$10,000.</p> <p>Wetlands provide important water quality and ecological functions in a watershed by augmenting low flow, acting as natural filtration systems and helping to reduce flooding by acting like giant sponges and absorbing excess water. The Wetlands are Worth It Program through NPCA's Water Quality Improvement Program aims to assist landowners that are interested in restoring, protecting, rehabilitating and creating wetland habitat on their property by providing grants to a maximum of 75% of the cost of a project with a grant ceiling of \$10,000.</p> <p>By integrating golf course management practices with wildlife management, such as incorporating enhanced natural areas into the landscaping, golf courses have the potential to offer a wide range of habitat for wildlife. In addition, encouragement of environmentally responsible maintenance practices, if not already adopted, will be beneficial to water quality and the aquatic habitat. Investigation into the Audubon Cooperative Sanctuary Program for Golf Courses should be explored for golf courses if such a program has not already been adopted. In addition, environmentally friendly practices should be encouraged (e.g. chemical free practices).</p> <p>The NPCA's program aimed at educating landowners about the benefits of rural and agricultural best management practices should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum 75% of the cost of a project with caps between \$5,000 and \$12,000 depending on the project.</p> <p>Abandoned wells that are not properly decommissioned (capped and sealed) pose a threat to groundwater resources by providing a direct route to groundwater. The NPCA has a well decommissioning program in place for its jurisdiction. Grants are available for the decommissioning of unused water wells only. Priority is given to hydrogeologically sensitive areas, projects located in areas with a high density of domestic water wells, and areas where watershed plans have been completed or are ongoing (NPCA 2007). Approved grants will cover 90% of well decommissioning costs to a maximum of \$2,000 per well (limit of 2 wells per property). This is a reimbursement program, which means that the landowner will pay the full cost to the contractor, and will be reimbursed for 90% of</p> |
| Promote Good Shoreline Stewardship                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Integrated Roadside Vegetation Management (IRVM) Program           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Ecological Linkages between Natural Areas                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Riparian Buffer Education Program                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Wetlands are Worth It Program                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Environmentally Responsible Maintenance Practices for Golf Courses |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Agricultural Best Management Practices Program                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Abandoned Well Decommissioning Program                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

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|                                                         | the total project cost after all receipts, invoices, and water well decommissioning records are submitted to the NPCA.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Special Studies</b>                                  | <b>Recommendations for Further Study</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Riparian Buffer Tax Incentive Program                   | Partial exemption on property taxes for the establishment and maintenance of effective riparian and conservation buffers on property. Buffers provide a wide range of functions and benefits depending on their location (e.g. adjacent to watercourse or separating land uses).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Septic System Education and Funding Program             | Improperly functioning septic systems and abandoned septic systems are a known threat to water quality. A septic system education and funding program should be developed and implemented to ensure that private septic systems are functioning properly, and to ensure that abandoned systems are decommissioned.                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Septic System Re-Inspection Program                     | Areas that have been identified as „septic hotspots‘ through the <i>NPCA Groundwater Study</i> and areas that have a high intrinsic susceptibility should be considered priority for such a program. Municipal councils could approve and endorse the allocation of funds from property taxes or general revenue to fund the program. This approach may be facilitated with council knowledge that a percentage of inspected septic systems will also require remedial action on the part of some property owners, including the installation of new septic systems. Owners may also pro-actively undertake action if they are aware that a program is underway. Both will affect the number of permits issued in a municipality, and may generate revenue as a result (MMAH 2001). |
| Road Salt Impact Study                                  | Through RMN's <i>Salt Vulnerability Study</i> (2005) the entire LENS study area has been ranked as having a moderately high vulnerability to road salt from regional roads, however this study was not conducted on local municipal roads; therefore it is recommended that a similar study be completed by the respective local municipalities to determine the impact of road salt applications on local municipal roads to the surrounding natural features..                                                                                                                                                                                                                                                                                                                    |
| Subwatershed Hydrogeologic Characterization             | Development of subwatershed scale hydrogeologic characterizations would provide optimal information to make informed decisions in regard to applications and for use in planning decisions and policy development.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Fish Habitat Classification                             | The watercourses in this subwatershed have not been evaluated in terms of importance for fish habitat. It is recommended that this assessment be completed so this information can be used for proper resource management and land use planning decisions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Groundwater Intrinsic Susceptibility Studies            | The <i>Groundwater Study</i> (2005) has identified most of the Beaver Dam Creek P.C. subwatershed as having a high shallow intrinsic susceptibility (Figure 16a & 16b). The intrinsic susceptibility of groundwater considers only the physical factors affecting the flow of water to, and through, the groundwater resource. Additional studies should be conducted in this watershed to ensure that current and future land uses do not conflict with the protection of groundwater resources in susceptible areas as part of the NPCA's <i>Groundwater Study</i> (2005) and proposed <i>Source Protection Plan</i> .                                                                                                                                                            |
| Potential Contaminant Sources of Point Source Pollution | An inventory of potential contaminant sources and threats to water quality was identified as part of the objectives for the NPCA's <i>Groundwater Study</i> (2005). An updated inventory to confirm potential contaminant sources and locations is recommended as well as further investigation into the possible effects these potential contaminants may have on surface water quality and aquatic habitat and whether or not a contaminant management plan is needed.                                                                                                                                                                                                                                                                                                            |
| Site Specific Water Quality Sampling                    | Enhanced sampling methods upstream and downstream of potential points of contamination should be considered to help identify priority areas for remediation and/or restoration. For instance, partner with the Lorraine Bay Water Quality Group to help identify potential sites and to help initiate sampling.                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |



## **Oil Mill Creek Restoration Strategy**

Oil Mill Creek subwatershed is primarily drained by municipal drains; Oil Mill Creek Drain is a series of Class F drains. The watercourses in this subwatershed have not been evaluated in terms of importance for fish habitat and the NPCA does not conduct water quality sampling in this portion of the study area. However, the MNR has identified the Lake Erie shoreline in this area as fowler's toad habitat, a federally and provincially threatened species, of which Niagara is one of only three areas in Canada where this SAR is found.

Geomorphic assessments were conducted on 2 sites within Oil Mill Creek Drain. Both of the sites had areas of bank instability but only the upstream site had relatively deep unconsolidated sediment deposited along the channel bed. There are a number of small tributaries entering the main channel, as well as bare soil exposed along the banks. These two factors may be contributing to the sediment along the channel bed (NPCA 2009b).

Like most subwatersheds in the study area, land use in Oil Mill Creek is primarily agricultural with some strips of residential areas and a public along the shoreline; Humberstone Centennial Park Beach. Large sections of watercourse flow through agricultural fields with little to no riparian buffers. Promotion of the NPCA's education programs pertaining to agricultural best management practices and water quality would be beneficial for the landowners. These programs also include information on sources of funding for environmental projects on private land to encourage adoption and implementation of best management practices.

In terms of natural heritage features, numerous wetlands and wooded areas are scattered throughout the study area offering an abundance of opportunity for linkage and ecological corridor creation. Like other subwatersheds a challenge of Oil Mill Creek will be the establishment and preservation of riparian habitat when maintenance activities are necessary on the municipal drains to facilitate in proper drainage of the agricultural fields. However, these riparian habitats are important linkages between natural areas.

The Oil Mill Creek Subwatershed Restoration Strategy identifies one zone with specific stewardship and restoration recommendations (Table 20 and Figure 31).

**Table 20: Oil Mill Creek Subwatershed Restoration Strategy**

| Restoration Opportunities                                                                                                                                                                                                      | Recommended Restoration Strategies                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
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|                                                                                                                                                                                                                                | Riparian                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Wetland                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Upland and Ecological Linkages                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 1.                                                                                                                                                                                                                             | <ul style="list-style-type: none"> <li>priority should be the establishment of riparian buffer strips in areas with little to no existing riparian</li> <li>existing riparian should be maintained</li> <li>large sections of watercourse flow through agricultural fields and along roadways with little to no riparian; buffer strips will help to reduce sediment and contaminant loads from adjacent land uses, and cool the water to enhance water quality and fish habitat.</li> <li>watercourses are managed as municipal drains therefore establishment of riparian corridors (e.g. deep rooted grasses &amp; shrubs) should consider future maintenance activities (refer to engineers report and drainage BMP practice recommendations)</li> </ul>                                                                 | <ul style="list-style-type: none"> <li>wetland restoration suitability mapping indicates very high wetland restoration suitability for most of the subwatershed including wetland-riparian suitability providing important linkages between fragmented natural areas to facilitate in the movement of flora and fauna between natural areas: see map</li> <li>therefore focus should be on enhancement and filling in gaps creating larger contiguous natural blocks and creating ecological linkages between natural areas</li> <li>create/enhance wetlands in areas where the wetness index and soil drainage permit; priority should be given to areas adjacent to existing wetlands and high groundwater recharge areas</li> <li>protect and enhance existing wetlands (e.g., create a buffer of trees and shrubs between the wetlands and the agricultural activities)</li> </ul> | <ul style="list-style-type: none"> <li>high suitability for upland restoration surrounding southern complexes of Oil Mill Creek Wetland Complex; focus should be on enhancement of this feature creating a Critical Function Zone that would provide for wetland-associated species that extend beyond the wetland limit</li> <li>very high suitability for enhancement surrounding 3 small wooded areas on east side of subwatershed creating one large natural block. Opportunity exists to connect to watercourse and with riparian creation connect to fragmented natural areas</li> <li>existing natural areas should be preserved</li> </ul> |
| <ul style="list-style-type: none"> <li>All restoration measures should where possible, benefit Species at Risk and provincially rare species</li> <li>Carolinian and native species should be used for all projects</li> </ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Project Opportunities                                                                                                                                                                                                          | Recommended Action for Public and Private Lands                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                                                                                                                                                                                                                                | <p>1. <b>Vimy Road (OMCMA):</b> This section of watercourse is managed as a municipal drain; Oil Mill Creek Drain. It has been channelized and lacks any depositional features along the stream bed which indicates little flow diversity within the channel. Bank instability is present in the form of bare soil extending up the bank, as well as slumping. Bank protection structures exist along both banks at this field site. These structures consist of concrete blocks laid on top of each other forming a wall, as well as riprap lining the bank. There are numerous culverts found within this site and the water flows through some of these culverts for relatively long distances. A large amount of the buffer zone consists of a manicured lawn and the lack of large woody vegetation impacts habitat</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

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|                                               | <p>and cover. There is an area where vegetative debris is being thrown onto the bank. This debris will eventually end up in stream which can cause debris jams and impact water quality. Dense instream vegetation and algae were noted during a site visit in 2008. A grate covering the culvert at Vimy Road may restrict larger fish from entering the watercourse. Water quality should be monitored in this watershed. Due to the impact on water quality it is advised that landowners stop throwing vegetated debris over the bank. An assessment should be completed on whether or not the concrete block wall or the riprap could be replaced with a soil bio-engineering structure. This would increase habitat and cover along the channel and still provide bank stabilization. All recommendations should be discussed with the Drainage Superintendent.</p> <p>2. <b>Vimy Road (OMCMB):</b> This section of watercourse is managed as a municipal drain; Oil Mill Creek Drain. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. Bank instability is present in the wooded area as bare soil extending up the bank which may be due to the dense canopy cover over the channel. Small debris jams exist within the wooded area and there is some trees right at the edge of the channel indicating bank instability. In the open area of this park the buffer zone consists of a few trees and a manicured lawn that is mowed to the edge of the watercourse. Fairly large amounts of duckweed and algae were noted along this channel during a site visit in 2008. In the upstream sections of the study site there are areas where relatively deep unconsolidated sediment is deposited along the channel bed. Few to no pools exist along the bed but there is stagnant water present throughout the field site. Measurements taken at channel cross sections would indicate that the watercourse has varying degrees of entrenchment, from minor to complete entrenchment. This results in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil. Creating a buffer in the open area of the park with a variety of native plant species will help to create cover and habitat for fish, insects, and invertebrates. Water quality should be monitored in this watershed. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. Alternatives to traditional drainage design, such as wetland creation, floodplain development, and increasing channel curvature should also be considered. All recommendations should be discussed with the Drainage Superintendent.</p> <p>These two field sites are within the designated municipal drain Oil Mill Creek Drain. Both of the sites had areas of bank instability but only the upstream site had relatively deep unconsolidated sediment deposited along the channel bed. There are a number of small tributaries entering the main channel, as well as bare soil exposed along the banks. These two factors may be contributing to the sediment along the channel bed. Excessive sediment deposition can cause problems in the watercourse, such as lateral channel adjustments, increased turbidity, filling in of pools, and impacting fish habitat. Long term monitoring of sediment accumulation should be completed to avoid any potential problems and this can be done by the use of sediment traps. Increasing the variety and diversity of native plant species within small buffer zones increases canopy cover, habitat, and also provides a filter mechanism for sediment and chemicals from runoff of fields and roads. Water quality should be monitored in this watershed. All recommendations should be discussed with the Drainage Superintendent.</p> |
| Naturalizing Drains and Drain Best Management | <p>In addition to having an impact on aquatic and riparian habitat, drain maintenance has the potential to become quite costly through repeated maintenance activities. Naturalizing drains can potentially lengthen the time between</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

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| Practices                                                | <p>maintenance events by reducing the amount of sediment entering and remaining in the drain. Best Management Practices for drain maintenance should be developed in consultation with, but not limited to, the following agencies; OMAFRA, DFO, MNR, Conservation Ontario, OFA, DSAO, CFFO, and the agricultural community to reduce ecological impacts to aquatic systems and to prevent sediment from returning to the drain. Any future maintenance of this watercourse should be done in accordance with Best Management Practices for drains. To review examples of current BMP mitigation measures, refer to Appendix I.</p> <p>Work with partnering stakeholders to promote shoreline that have been maintained naturally or restored to find a balance between natural processes and shoreline protection measures.</p> <p>Work with partnering agencies to mitigate water quality issues and work towards Blue Flag Beach status. Blue Flag status meets high standards with respect to water quality, environmental management, environmental education and safety and services (Blueflag.ca) and is known globally. Blue Flag beaches have the potential to increase tourism in the area.</p> |
| Promote Good Shoreline Stewardship<br>Blue Flag Beaches  | <p>Niagara Region and municipalities should work together to expand Niagara Region's IRVM Program. IRVM integrates the use of native vegetation with appropriate management techniques to produce a cost-effective, environmentally sound management alternative for roadside weed and erosion control while providing numerous ecological benefits (e.g. buffer strips). Focus of program expansion should be directed to main roads and roads in areas with a high shallow intrinsic susceptibility.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Integrated Roadside Vegetation Management (IRVM) Program | <p>Opportunity potential is present for creating ecological linkages between natural areas creating larger contiguous natural features. Such areas have the potential to enhance movement of flora and fauna between natural areas as well as provide habitat and ecological diversity for a wide range of species.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Riparian Buffer Education Program                        | <p>Many landowners keep their properties manicured or plant crops to the edge of the creek. The NPCA's program aimed at educating landowners about the benefits of buffer zones along watercourses should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum of 75% of the cost of a project with caps between \$2,000 and \$10,000.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Wetlands are Worth It Program                            | <p>Wetlands provide important water quality and ecological functions in a watershed by augmenting low flow, acting as natural filtration systems and helping to reduce flooding by acting like giant sponges and absorbing excess water. The Wetlands are Worth It Program through NPCA's Water Quality Improvement Program aims to assist landowners that are interested in restoring, protecting, rehabilitating and creating wetland habitat on their property by providing grants to a maximum of 75% of the cost of a project with a grant ceiling of \$10,000.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Agricultural Best Management Practices Program           | <p>The NPCA's program aimed at educating landowners about the benefits of rural and agricultural best management practices should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum 75% of the cost of a project with caps between \$5,000 and \$12,000 depending on the project.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Abandoned Well Decommissioning Program                   | <p>Abandoned wells that are not properly decommissioned (capped and sealed) pose a threat to groundwater resources by providing a direct route to groundwater. The NPCA has a well decommissioning program in place for its jurisdiction. Grants are available for the decommissioning of unused water wells only. Priority is given to hydrogeologically sensitive areas, projects located in areas with a high density of domestic water wells, and areas where watershed plans have been completed or are ongoing (NPCA 2007). Approved grants will cover 90% of well decommissioning costs to a maximum of \$2,000 per well (limit of 2 wells per property). This is a reimbursement program, which means that the landowner will pay the full cost to the contractor, and will be reimbursed for 90% of the total project cost after all receipts, invoices, and water well decommissioning records are submitted to the</p>                                                                                                                                                                                                                                                                         |

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|                                                         | NPCA.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Special Studies</b>                                  | <b>Recommendations for Further Study</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Riparian Buffer Tax Incentive Program                   | Partial exemption on property taxes for the establishment and maintenance of effective riparian and conservation buffers on property. Buffers provide a wide range of functions and benefits depending on their location (e.g. adjacent to watercourse or separating land uses).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Septic System Education and Funding Program             | Improperly functioning septic systems and abandoned septic systems are a known threat to water quality. A septic system education and funding program should be developed and implemented to ensure that private septic systems are functioning properly, and to ensure that abandoned systems are decommissioned.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Septic System Re-Inspection Program                     | Faulty or improperly maintained septic systems have been identified as a concern by participants at public events for the study area. Therefore, areas along the lakeshore that have a high intrinsic susceptibility should be considered priority for such a program. Municipal councils could approve and endorse the allocation of funds from property taxes or general revenue to fund the program. This approach may be facilitated with council knowledge that a percentage of inspected septic systems will also require remedial action on the part of some property owners, including the installation of new septic systems. Owners may also pro-actively undertake action if they are aware that a program is underway. Both will affect the number of permits issued in a municipality, and may generate revenue as a result (MMAH 2001). |
| Road Salt Impact Study                                  | Through RMN's <i>Salt Vulnerability Study</i> (2005) the entire LENS study area has been ranked as having a moderately high vulnerability to road salt from regional roads, however this study was not conducted on local municipal roads; therefore it is recommended that a similar study be completed by the respective local municipalities to determine the impact of road salt applications on local municipal roads to the surrounding natural features.                                                                                                                                                                                                                                                                                                                                                                                       |
| Subwatershed Hydrogeologic Characterization             | Development of subwatershed scale hydrogeologic characterizations would provide optimal information to make informed decisions in regard to applications and for use in planning decisions and policy development.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Fish Habitat Classification                             | The watercourses in this subwatershed have not been evaluated in terms of importance for fish habitat. It is recommended that this assessment be completed so this information can be used for proper resource management and land use planning decisions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Groundwater Intrinsic Susceptibility Studies            | The <i>Groundwater Study</i> (2005) has identified the entire Oil Mill Creek subwatershed as having a high shallow intrinsic susceptibility (Figure 16a & 16b). The intrinsic susceptibility of groundwater considers only the physical factors affecting the flow of water to, and through, the groundwater resource. Additional studies should be conducted in this watershed to ensure that current and future land uses do not conflict with the protection of groundwater resources in susceptible areas as part of the NPCA's <i>Groundwater Study</i> (2005) and proposed <i>Source Protection Plan</i> .                                                                                                                                                                                                                                      |
| Potential Contaminant Sources of Point Source Pollution | An inventory of potential contaminant sources and threats to water quality was identified as part of the objectives for the NPCA's <i>Groundwater Study</i> (2005). An updated inventory to confirm potential contaminant sources and locations is recommended as well as further investigation into the possible effects these potential contaminants may have on surface water quality and aquatic habitat and whether or not a contaminant management plan is needed.                                                                                                                                                                                                                                                                                                                                                                              |
| Site Specific Water Quality Sampling                    | Enhanced sampling methods upstream and downstream of potential points of contamination should be considered to help identify priority areas for remediation and/or restoration.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

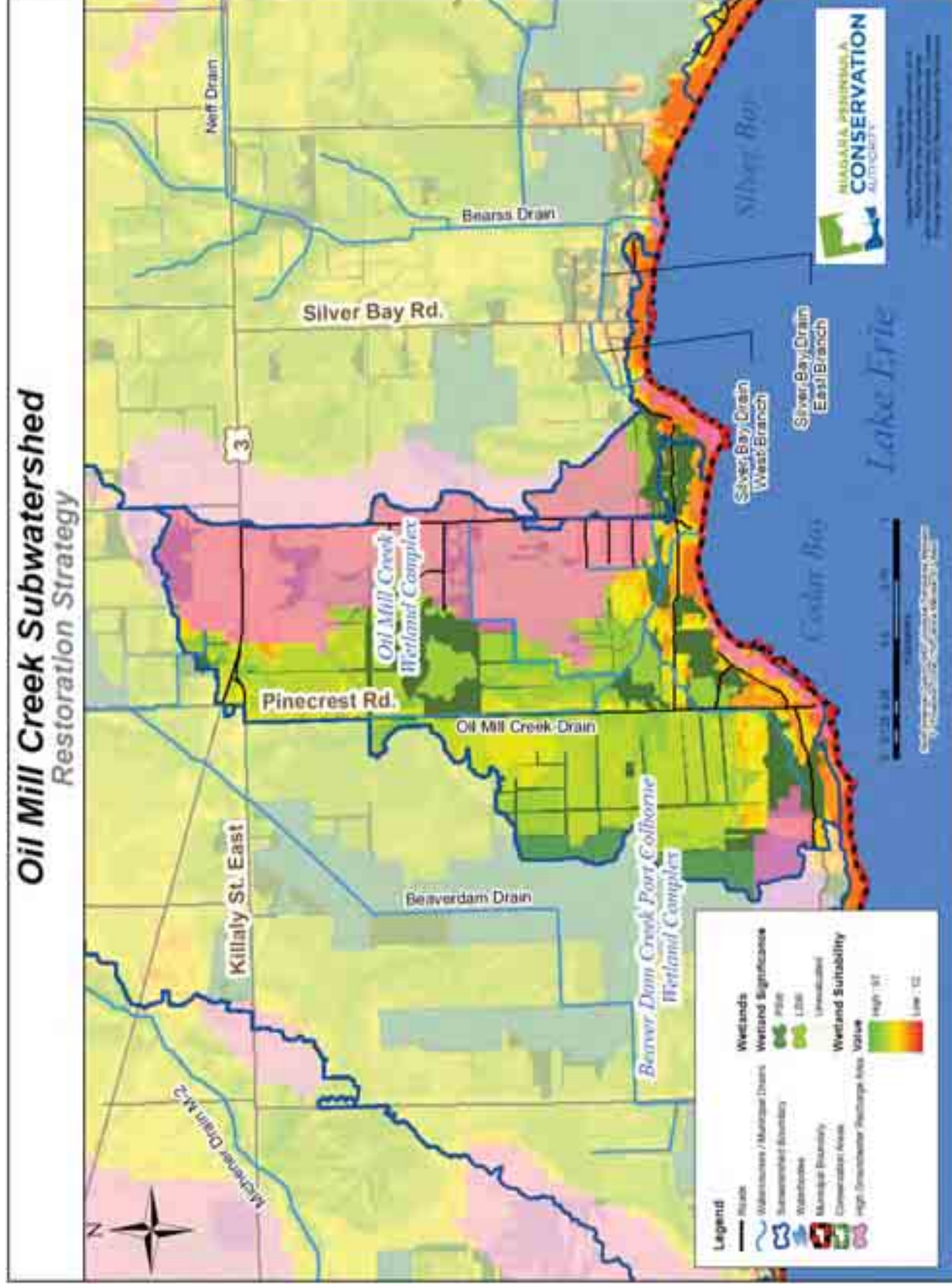


Figure 31: Oil Mill Creek Subwatershed Restoration Strategy Study Area

## **Bearss Drain Restoration Strategy**

Like several of the subwatersheds along the Lake Erie shoreline, the Bearss Drain subwatershed is drained predominately by a series of municipal drains; Neff Drain, Bearss Drain, Silver Bay Drain, and William-Michael Drain. Bearss Drain and Silver Bay Drain are both Class C municipal drains and Neff Drain and William-Michael Drain are Class F Drains. The main channel and some of its tributaries have been classified as important fish habitat. The remaining watercourses in this subwatershed have not been evaluated in terms of importance for fish habitat. The NPCA does not conduct water quality sampling in this subwatershed.

The NPCA conducted geomorphic assessments on four sites in the Bearss Drain subwatershed. Bank instability was present at all sites and two of the four sites have relatively deep unconsolidated sediment deposited along the channel bed. Excessive sediment deposition can cause problems in the watercourse, such as lateral channel adjustments, increased turbidity, filling in of pools, and impacting fish habitat (NPCA 2009b).

Land use in this study area is a mix of agriculture, rural residential and seasonal residential along the shoreline. Empire Beach Backshore Basin Forest PSW and Life Science ANSI are located along the Lake Erie shoreline and numerous wetlands and woodlots are scattered throughout the subwatershed. Several SAR have indentified by the MNR in the Bearss Drain subwatershed, including the endangered prothonotary warbler, the threatened fowler's toad, and the cerulean warbler which is a species of special concern. In addition, the MNR has identified Lake Erie's shoreline in this area as habitat for the fowler's toad of which Niagara is one of only three areas in Canada where this SAR is found.

The scattered arrangement of natural features in this subwatershed provides plenty of opportunity for infilling between natural areas and corridor creation providing linkages between features. Like other subwatersheds a challenge of Bearss Drain will be the establishment and preservation of riparian habitat when maintenance activities are necessary on the municipal drains to facilitate in proper drainage of the agricultural fields. However, these riparian habitats are important linkages between fragmented natural areas.

The Bearss Drain Subwatershed Restoration Strategy identifies two zones with specific stewardship and restoration recommendations (Table 21 and Figure 32).

**Table 21: Bearss Drain Subwatershed Restoration Strategy**

| <b>Recommended Restoration Strategies</b>              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
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| <b>Restoration Opportunities</b>                       | <b>Riparian</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Wetland</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Upland and Ecological Linkages</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 1. North of Highway 3 and Neff Drain: headwater region | <ul style="list-style-type: none"> <li>priority should be placed on establishing riparian buffer habitat; the headwaters run through agricultural lands and along roadway with little to no buffer strip</li> <li>riparian buffers will help to reduce sediment and contaminant loads from adjacent land uses, and cool the water to enhance water quality and fish habitat while creating corridors connecting fragmented natural areas providing cover for wildlife</li> <li>watercourses are managed as municipal drains(e.g. deep rooted grasses &amp; shrubs) therefore establishment of riparian corridors should consider future maintenance activities (refer to engineers report and drainage BMP practice recommendations)</li> </ul> | <ul style="list-style-type: none"> <li>protect existing wetlands (e.g., create a buffer of trees and shrubs between the wetlands and the agricultural activities)</li> <li>wetland restoration suitability mapping identifies very high suitability for enhancement and filling in gaps surrounding Bears Drain Wetland Complex, Humberstone Southwest Wetland Complex both extending into adjacent subwatersheds</li> <li>very high suitability for wetland-riparian restoration linking fragmented natural areas</li> <li>wetland restoration suitability mapping identifies numerous areas suitable for wetland creation: see map</li> </ul> | <ul style="list-style-type: none"> <li>high suitability exists for upland restoration surrounding natural areas along western and eastern portion of study area, extending into adjacent subwatershed creating ecological linkages or infilling increasing interior size of feature</li> <li>high suitability for creating a Critical Function Zone surrounding PSW's. This will provide for a variety of critical functions for wetland-associated fauna (e.g. nesting habitat)</li> <li>focus in this portion of the study area should be on enhancement of existing natural areas and the creation of ecological linkages</li> </ul> |
| 2 South of Highway 3 to Lake Erie                      | <ul style="list-style-type: none"> <li>watercourses receive partial cover from adjacent natural areas, however there are large sections of watercourse with little to no riparian habitat; therefore focus should be on establishment of riparian buffers in areas with little to no existing riparian</li> <li>the watercourses run through agricultural lands and along the roadways with little to no buffer strip</li> <li>riparian buffers will help to reduce sediment and contaminant loads from adjacent land uses, and cool the water to</li> </ul>                                                                                                                                                                                    | <ul style="list-style-type: none"> <li>high riparian-wetland restoration suitability linking fragmented natural areas</li> <li>suitability mapping indicates very high suitability surrounding Empire Beach Backshore Basin Forest ANSI and PSW, Bearss Drain Wetland and for wetland-riparian restoration along watercourses creating ecological linkages between fragmented natural areas and adjacent subwatersheds</li> <li>enhance existing or establish new wetlands as natural flood storage reservoirs and groundwater recharge areas in</li> </ul>                                                                                     | <ul style="list-style-type: none"> <li>very high suitability for infilling and enhancement surrounding Empire Beach Backshore Basin ANSI providing a Critical Function Zone, increasing interior size, and/or creating larger contiguous which would enhance the natural areas ability to support a larger diversity of flora and fauna</li> <li>opportunity for creation of ecological linkages between fragmented natural areas facilitating in the movement of flora and fauna between natural areas (e.g. between fragmented complexes of Empire Beach Backshore Basin Forest along western side of study area extending</li> </ul> |

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|                                                                                                                                                                                                                                | enhance water quality and fish habitat before outletting to Lake Erie <ul style="list-style-type: none"> <li>watercourses are in part managed as municipal drains therefore establishment of riparian corridors (e.g. deep rooted grasses &amp; shrubs) should consider future maintenance activities (refer to engineers report and drainage BMP recommendations)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | areas where the wetness index and soil drainage permit; wetland restoration suitability mapping identifies numerous areas suitable for wetland creation: see map | into adjacent subwatershed) |
| <ul style="list-style-type: none"> <li>All restoration measures should where possible, benefit Species at Risk and provincially rare species</li> <li>Carolinian and native species should be used for all projects</li> </ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                  |                             |
| <b>Project Opportunities</b>                                                                                                                                                                                                   | <b>Recommended Action for Public and Private Lands</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                  |                             |
| NPCA Lake Erie North Shore Geomorphic Assessment Study (NPCA 2009b)                                                                                                                                                            | <p>1. <b>Lake Erie Shoreline (BDMa):</b> This section of watercourse is managed as a municipal drain; Bearss Drain. It has been channelized and lacks any depositional features along the bed which indicate little flow diversity within the channel. A bank protection structure exists along both sides of the channel near the outlet into Lake Erie. Bank instability is present in the form of undercut banks. No pools exist but there is stagnant water present throughout the field site. Algae, a brown film and an oily sheen on the water surface were noted during a site visit in 2008. Measurements taken at channel cross sections indicate that the watercourse at this field site is moderately entrenched which results in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. Water quality testing should be completed in this watershed to determine any water quality issues. Native vegetation that can stabilize sandy banks should be planted at this field site. Increasing the variety and diversity of native plant species within the buffer zone will provide cover and habitat for fish, insects, and invertebrate along the watercourse. All recommendations should be discussed with the Drainage Superintendent.</p> <p>2. <b>Wyldeewood Road (BDMb):</b> This section of watercourse is managed as a municipal drain; Bearss Drain. It has been channelized but there are some bar formations and small bends throughout the study site. This site is also the only study site that contains riffles along the bed. Relatively deep unconsolidated sediment is deposited along the channel bed. Bank instability is present in the form of bare soil extending up the bank, and undercut banks. The buffer width is small but relatively dense in some areas. A number of small tributaries and possibly rills exist along the watercourse. The culvert at the Friendship Trail may be considered a channel constriction. Measurements taken at channel cross sections indicate that the watercourse at this field site is entrenched to moderately entrenched which results in flood waters having limited to no access to the floodplain. Therefore, the energy within the flow is contained in the channel. This can change the channel geometry overtime due to increased velocity, stream power, and channel slope. Increasing the variety and diversity of native plant species within the buffer zone will provide more stability for the channel banks. Projects to prevent and limit further development of rills adjacent to the watercourse should be implemented. Some examples include grassed waterways, chute spillways, tile drainage outlets, and proper tillage and cropping practices (OMAFRA 1997a, and OMAFRA 1997b). Monitoring the accumulation of sediment along the channel bed can be</p> |                                                                                                                                                                  |                             |

done by the use of sediment traps throughout the watercourse. It should be determined whether the culvert at the Friendship Trail is properly sized. All recommendations should be discussed with the Drainage Superintendent.

3. **Firelane Seventeen (BDTa):** This section of watercourse is managed as a municipal drain; William-Michael Drain. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. Bank instability is present in the form of bare soil extending up the bank and slumping. Relatively deep unconsolidated sediment is deposited along the channel bed. A small crossing over the channel has a blocked culvert on both the upstream and downstream sides which will cause flow problems and deposition upstream. For most of the field site there is no aquatic vegetation present within the channel. A large number of debris jams are present throughout the study site. An oily sheen on the water surface was identified throughout the watercourse during a site visit in 2008. Upstream of the blocked culvert there was also an orangey red mass present within the watercourse. Water quality testing should be completed in this watershed to determine any water quality issues. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. Debris and rocks should be removed from the culvert so that water can flow through the channel. The crossing should also be properly built and the culvert adequately sized. The presence of bank slumping usually indicates that vegetative roots are too shallow to stabilize the bank. All recommendations should be discussed with the Drainage Superintendent.

4. **Highway 3 (BDTb):** This section of the watercourse has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. The watercourse along this field site is not managed as a municipal drain. There is some bank instability in the form of slumping, undercut banks, and bare soil extending up the bank. The riparian buffer along this site is non-existent along the left bank and therefore habitat and shading over the stream will be impacted. There was a complaint by a landowner due to flooding on adjacent residential property. Dense vegetation exists within the channel, which includes long grasses and cattails. There is also a crossing that contains 3 culverts that may be constricting the flow of water through the channel. The main branch of Bearss Drain is close to this field site and when the channel is flooding there will be flow back-up as the tributary water is entering the main channel. All of these factors are going to influence the flow of water through the channel at this field site. It should be confirmed that the crossing is not constricting the channel and if it is then the crossing should be rebuilt and the culvert adequately sized. Another possibility is to increase the canopy cover over the channel and prevent excessive in-stream vegetation growth. The presence of bank slumping usually indicates that vegetative roots are too shallow to stabilize the bank.

Two of the four sites are within the designated municipal drain Bearss Drain and a third site is within the William-Michael Drain. Bank instability is present at all of the field sites and two of the four sites have relatively deep unconsolidated sediment deposited along the channel bed. The possibility of rills/gullies adjacent to the channel was only identified at one field site. Rill prevention measures such as slope re-grading, erosion control blankets, and seeding should be implemented along the adjacent property. Excessive sediment deposition can cause problems in the watercourse, such as lateral channel adjustments, increased turbidity, filling in of pools, and impacting fish habitat. Long term monitoring of sediment accumulation should be completed to avoid any

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|                                                          | potential problems and this can be done by the use of sediment traps. Increasing the variety and diversity of native plant species will provide cover, habitat, and help to stabilize the soil along the banks. It will also help to filter sediment and pollutants which may enter the watercourse from runoff. Water quality testing should be completed in this watershed. Three of the field sites along this watercourse potentially contain culverts that may be constricting the channel. This can cause flow problems in the watercourse and therefore the culverts should be measured and replaced if necessary. All recommendations should be discussed with the Drainage Superintendent.                                                                                                                                                             |
| Naturalizing Drains and Drain Best Management Practices  | In addition to having an impact on aquatic and riparian habitat, drain maintenance has the potential to become quite costly through repeated maintenance activities. Naturalizing drains can potentially lengthen the time between maintenance events by reducing the amount of sediment entering and remaining in the drain. Best Management Practices for drain maintenance should be developed in consultation with, but not limited to, the following agencies; OMAFRA, DFO, MNR, Conservation Ontario, OFA, DSAO, CFFO, and the agricultural community to reduce ecological impacts to aquatic systems and to prevent sediment from returning to the drain. Any future maintenance of this watercourse should be done in accordance with Best Management Practices for drains. To review examples of current BMP mitigation measures, refer to Appendix I. |
| Promote Good Shoreline Stewardship                       | Work with partnering stakeholders to promote shoreline that have been maintained naturally or restored to find a balance between natural processes and shoreline protection measures.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Blue Flag Beaches                                        | Work with partnering agencies to mitigate water quality issues and work towards Blue Flag Beach status. Blue Flag status meets high standards with respect to water quality, environmental management, environmental education and safety and services (Blueflag.ca) and is known globally. Blue Flag beaches have the potential to increase tourism in the area.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Integrated Roadside Vegetation Management (IRVM) Program | Niagara Region and municipalities should work together to expand Niagara Region's IRVM Program. IRVM integrates the use of native vegetation with appropriate management techniques to produce a cost-effective, environmentally sound management alternative for roadside weed and erosion control while providing numerous ecological benefits (e.g. buffer strips). Focus of program expansion should be directed to main roads and roads in areas with a high shallow intrinsic susceptibility.                                                                                                                                                                                                                                                                                                                                                             |
| Ecological Linkages between Natural Areas                | Opportunity potential is present for creating ecological linkages between natural areas creating larger contiguous natural features. Such areas have the potential to enhance movement of flora and fauna between natural areas as well as provide habitat and ecological diversity for a wide range of species.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Riparian Buffer Education Program                        | Many landowners keep their properties manicured or plant crops to the edge of the creek. The NPCA's program aimed at educating landowners about the benefits of buffer zones along watercourses should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum of 75% of the cost of a project with caps between \$2,000 and \$10,000.                                                                                                                                                                                                                                                                                                                                                              |
| Wetlands are Worth It Program                            | Wetlands provide important water quality and ecological functions in a watershed by augmenting low flow, acting as natural filtration systems and helping to reduce flooding by acting like giant sponges and absorbing excess water. The Wetlands are Worth It Program through NPCA's Water Quality Improvement Program aims to assist landowners that are interested in restoring, protecting, rehabilitating and creating wetland habitat on their property by providing grants to a maximum of 75% of the cost of a project with a grant ceiling of \$10,000.                                                                                                                                                                                                                                                                                               |
| Agricultural Best Management Practices                   | The NPCA's program aimed at educating landowners about the benefits of rural and agricultural best management practices should be extensively promoted. In addition, landowners should be made aware of and                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

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| Program                                      | encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum 75% of the cost of a project with caps between \$5,000 and \$12,000 depending on the project.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Abandoned Well Decommissioning Program       | Abandoned wells that are not properly decommissioned (capped and sealed) pose a threat to groundwater resources by providing a direct route to groundwater. The NPCA has a well decommissioning program in place for its jurisdiction. Grants are available for the decommissioning of unused water wells only. Priority is given to hydrogeologically sensitive areas, projects located in areas with a high density of domestic water wells, and areas where watershed plans have been completed or are ongoing (NPCA 2007). Approved grants will cover 90% of well decommissioning costs to a maximum of \$2,000 per well (limit of 2 wells per property). This is a reimbursement program, which means that the landowner will pay the full cost to the contractor, and will be reimbursed for 90% of the total project cost after all receipts, invoices, and water well decommissioning records are submitted to the NPCA. |
| <b>Special Studies</b>                       | <b>Recommendations for Further Study</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Riparian Buffer Tax Incentive Program        | Partial exemption on property taxes for the establishment and maintenance of effective riparian and conservation buffers on property. Buffers provide a wide range of functions and benefits depending on their location (e.g. adjacent to watercourse or separating land uses).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Septic System Education and Funding Program  | Improperly functioning septic systems and abandoned septic systems are a known threat to water quality. A septic system education and funding program should be developed and implemented to ensure that private septic systems are functioning properly, and to ensure that abandoned systems are decommissioned.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Septic System Re-Inspection Program          | Areas that have been identified as „septic hotspots’ through the <i>NPCA Groundwater Study</i> and areas that have a high intrinsic susceptibility should be considered priority for such a program. Municipal councils could approve and endorse the allocation of funds from property taxes or general revenue to fund the program. This approach may be facilitated with council knowledge that a percentage of inspected septic systems will also require remedial action on the part of some property owners, including the installation of new septic systems. Owners may also pro-actively undertake action if they are aware that a program is underway. Both will affect the number of permits issued in a municipality, and may generate revenue as a result (MMAH 2001).                                                                                                                                              |
| Road Salt Impact Study                       | Through RMN's <i>Salt Vulnerability Study</i> (2005) the entire LENS study area has been ranked as having a moderately high vulnerability to road salt from regional roads, however this study was not conducted on local municipal roads; therefore it is recommended that a similar study be completed by the respective local municipalities to determine the impact of road salt applications on local municipal roads to the surrounding natural features.                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Subwatershed Hydrogeologic Characterization  | Development of subwatershed scale hydrogeologic characterizations would provide optimal information to make informed decisions in regard to applications and for use in planning decisions and policy development.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Fish Habitat Classification                  | Not all the watercourses in this subwatershed have been evaluated in terms of importance for fish habitat. It is recommended that this assessment be completed so this information can be used for proper resource management and land use planning decisions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Groundwater Intrinsic Susceptibility Studies | The <i>Groundwater Study</i> (2005) has identified a large portion of the Bearss Drain subwatershed as having a high shallow intrinsic susceptibility (Figure 16a & 16b). The intrinsic susceptibility of groundwater considers only the physical factors affecting the flow of water to, and through, the groundwater resource. Additional studies should be conducted in this watershed to ensure that current and future land uses do not conflict with the protection of groundwater resources in susceptible areas as part of the NPCA's <i>Groundwater Study</i> (2005) and proposed                                                                                                                                                                                                                                                                                                                                       |

| <i>Source Protection Plan.</i>                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
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| Potential Contaminant Sources of Point Source Pollution | An inventory of potential contaminant sources and threats to water quality was identified as part of the objectives for the NPCA's <i>Groundwater Study</i> (2005). An updated inventory to confirm potential contaminant sources and locations is recommended as well as further investigation into the possible effects these potential contaminants may have on surface water quality and aquatic habitat and whether or not a contaminant management plan is needed. |
| Site Specific Water Quality Sampling                    | Enhanced sampling methods upstream and downstream of potential points of contamination should be considered to help identify priority areas for remediation and/or restoration.                                                                                                                                                                                                                                                                                          |

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## Point Abino Drain Restoration Strategy

The Point Abino Drain subwatershed is primarily drained by municipal drain; Point Abino Drain. The main channel is a Class B Drain and the northern branch is a Class F Drain. The outlet of the main channel is evaluated as critical fish habitat and the remainder of the main branch and its tributaries are classified as important fish habitat. The MNR has also identified the bay at the outlet as an important fish spawning area. The remaining watercourses in this subwatershed have not been evaluated in terms of importance for fish habitat.

Water quality sampling conducted near the outlet of the subwatershed indicates a water quality index of Fair and a BioMAP rating of Impaired. Factors affecting water quality include nutrient enrichment from upstream urban and agricultural areas. The water quality at this site is influenced by backflow from Lake Erie (NPCA 2010). Promotion of the NPCA's education programs pertaining to agricultural best management practices and water quality would be beneficial for the landowners. These programs also include information on sources of funding for environmental projects on private land to encourage adoption and implementation of best management practices.

Geomorphic assessments were conducted at six sites within Point Abino municipal drain. Relatively deep unconsolidated sediment and organic material was deposited along the bed throughout the watercourse and bank instability was noted near the outlet. Excessive sediment deposition can cause problems in a watercourse such as lateral channel adjustments, increased turbidity, filling in of pools, and impacting fish habitat (NPCA 2009b).

Land use in the subwatershed is a mix of agriculture, rural residential and seasonal and permanent dwellings along the Lake Erie shoreline, and western portion of the subwatershed where a seasonal trailer park is located. The shoreline in this subwatershed consists of private and public beaches. There are several significant natural features located in the Point Abino subwatershed, including 2 identified old growth forests, Point Abino Peninsula Sandland Forest Life Science ANSI, Carolinian Signature site and PSW, as well as numerous PSW's and woodlots. The MNR has identified 13 Species at Risk in this subwatershed including for example, the endangered prothonotary warbler, acadian flycatcher, the threatened fowler's toad and eastern hognosed snake, and the grass pickerel and woodland vole of which both are species of special concern. In addition, the MNR has identified the Lake Erie shoreline in this area as habitat for the fowler's toad of which Niagara is one of only three areas in Canada where this provincial and federal SAR is found.

One of the challenges presented in the Point Abino Drain subwatershed, like other subwatersheds along Lake Erie, is the establishment and maintenance of sufficient riparian habitat when maintenance activities are necessary on the municipal drains to facilitate proper drainage of the agricultural fields; primarily the headwaters where the watercourses flow through agricultural fields with little to no vegetative buffer. Existing riparian should be preserved in the lower half of the subwatershed where the watercourses receive cover from adjacent natural areas.

Ample of opportunity exists for filling in gaps and divots reducing edge-to-interior ratio and increasing core interior habitat. Plenty of opportunity for enhancement of existing natural areas and the establishment of ecological corridors is also present in this subwatershed.

The Point Abino Drain Subwatershed Restoration Strategy identifies two zones with specific stewardship and restoration recommendations (Table 22 and Figure 33).

**Table 22: Point Abino Drain Subwatershed Restoration Strategy**

| <b>Recommended Restoration Strategies</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
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| <b>Restoration Opportunities</b>          | <b>Riparian</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Wetland</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Upland and Ecological Linkages</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 1. Headwater region                       | <ul style="list-style-type: none"> <li>priority should be placed on establishing riparian buffer habitat; the headwaters run through agricultural lands and along roadways with little to no buffer strip</li> <li>riparian buffers will help to reduce sediment and contaminant loads from adjacent land uses, and cool the water to enhance water quality and fish habitat while creating corridors connecting fragmented natural areas providing cover for wildlife</li> <li>existing riparian should be maintained</li> <li>watercourses are in part managed as municipal drains therefore establishment of riparian corridors (e.g. deep rooted grasses &amp; shrubs) should consider future maintenance activities (refer to engineers report and drainage BMP practice recommendations)</li> </ul> | <ul style="list-style-type: none"> <li>protect existing wetlands (e.g., create a buffer of trees and shrubs between the wetlands and the agricultural activities)</li> <li>wetland restoration suitability mapping identifies very high suitability for enhancement and filling in gaps surrounding Point Abino Wetland Complex</li> <li>very high suitability for wetland-riparian restoration linking fragmented natural areas</li> <li>wetland restoration suitability mapping identifies numerous areas suitable for wetland creation: see map</li> </ul> | <ul style="list-style-type: none"> <li>very high suitability exists for upland restoration in and around Point Abino Wetland Complex extending into the adjacent subwatershed creating ecological linkages or infilling increasing interior size of feature</li> <li>high suitability for creating a Critical Function Zone surrounding PSW's. This will provide for a variety of critical functions for wetland-associated fauna (e.g. nesting habitat)</li> <li>focus in this portion of the study area should be on enhancement of existing natural areas and the creation of ecological linkages</li> </ul> |
| 2                                         | <ul style="list-style-type: none"> <li>watercourses receive cover from adjacent Point Abino Wetland Complex with small segments with little to no riparian habitat; focus should be on establishment and enhancement of riparian buffers in areas with little to no existing riparian (watercourse between ANSI complexes is critical fish habitat with little to no buffer strip)</li> <li>riparian buffers will help to reduce sediment and</li> </ul>                                                                                                                                                                                                                                                                                                                                                  | <ul style="list-style-type: none"> <li>protect existing wetlands</li> <li>suitability mapping indicates very high suitability for filling in gaps west of Mathews Road and for wetland-riparian restoration along watercourses segments between Point Abino Complex creating ecological linkages between fragmented natural</li> </ul>                                                                                                                                                                                                                        | <ul style="list-style-type: none"> <li>very high suitability for infilling and enhancement surrounding Point Abino Wetland Complex PSW and ANSI providing a Critical Function Zone, increasing interior size, and/or creating larger contiguous which would enhance the natural areas ability to support a larger diversity of flora and fauna</li> <li>opportunity for creation of ecological linkages between fragmented natural areas facilitating in the movement of flora and fauna</li> </ul>                                                                                                             |

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|                                                                                                                                                                                                       | <p>contaminant loads from adjacent land uses, and cool the water to enhance water quality and fish habitat before outletting to Lake Erie</p> <ul style="list-style-type: none"> <li>■ watercourses are in part managed as municipal drains therefore establishment of riparian corridors should consider future maintenance activities (refer to engineers report and drainage BMP recommendations)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |  | <p>between natural areas (e.g. between fragmented complexes of Point Abino Wetland Complex ANSI near point)</p> |
| <ul style="list-style-type: none"> <li>■ All restoration measures should, where possible, benefit Species at Risk</li> <li>■ Carolinian and native species should be used for all projects</li> </ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |  |                                                                                                                 |
| <b>Project Opportunities</b>                                                                                                                                                                          | <b>Recommended Action for Public and Private Lands</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |  |                                                                                                                 |
| <p>NPCA Lake Erie North Shore Geomorphic Assessment Study (NPCA 2009b)</p>                                                                                                                            | <p><b>1. Point Abino Road South (PADMa):</b> This section of watercourse is managed as a municipal drain; Point Abino Drain. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. Bank instability is present in the form of undercutting and leaning trees along the bank. Wooden planks were identified along the banks indicating that some bank stabilization measures have been implemented. The buffer zone adjacent to residential property and Abino Hills Road is small in width but upstream the buffer becomes much wider and the banks are less steep. The watercourse flows through a culvert for approximately 80 to 90m and then enters into Lake Erie. A grate covering the culvert may restrict larger fish from entering the watercourse. There are no pools along the bed but there is stagnant water present throughout the field site and an aquatic vine is present within the channel. Although no algae or duckweed was identified during the site visit, a landowner has complained about water quality at the outlet for Point Abino Drain. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil. Bank stability should be assessed to ensure that surrounding properties and roads are not in danger of collapsing. Increasing the variety and diversity of native plant species within the buffer zone will provide cover and habitat for fish, insects, and invertebrates along the watercourse. Water quality should continue to be monitored in this watershed. All recommendations should be discussed with the Drainage Superintendent.</p> |  |                                                                                                                 |
|                                                                                                                                                                                                       | <p><b>2. Point Abino Road South (PADMb):</b> This section of watercourse is managed as a municipal drain; Point Abino Drain. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. An oily sheen, a brown film on the water surface, and quite a bit of duckweed were noted during a site visit in 2008. The aquatic plant arrowhead was identified along the study site. There are no pools along the bed but there is stagnant water present throughout. There is relatively deep unconsolidated sediment and organic material along the stream bed indicating that the watercourse may not be able to transport it. Water quality should continue to be monitored in this watershed. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. All recommendations should be discussed with the Drainage Superintendent.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |                                                                                                                 |

**3. Point Abino Road South (PADMb-2):** This section of watercourse is managed as a municipal drain; Point Abino Drain. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. Quite a bit of duckweed was noted during a site visit in 2008. The aquatic plant arrowhead was identified along the study site. There are no pools along the bed but there is stagnant water present throughout. A large pile of concrete pieces lay adjacent to the channel on the left bank but it does not appear to be used for bank stabilization. There is relatively deep unconsolidated sediment and organic material along the stream bed indicating that the watercourse may not be able to transport it. Water quality should continue to be monitored in this watershed. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. All recommendations should be discussed with the Drainage Superintendent.

**4. Wildwood Avenue (PADMb-3):** This section of watercourse is managed as a municipal drain; Point Abino Drain. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. An oily sheen, an orangey red mass, and quite a bit of duckweed were noted during a site visit in 2008. There are no pools along the bed but there is stagnant water present throughout. There is relatively deep unconsolidated sediment and organic material along the stream bed indicating that the watercourse may not be able to transport it. Water quality should continue to be monitored in this watershed. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. All recommendations should be discussed with the Drainage Superintendent.

**5. Matthews Road North (PADMc):** This section of watercourse is managed as a municipal drain; Point Abino Drain. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. Quite a bit of duckweed was noted during a site visit in 2008. The aquatic plant arrowhead was identified along the study site. There are no pools along the bed but there is stagnant water present throughout. A foot bridge exists across the channel and erosion is present on both sides indicating that the bridge may be constricting the channel. There is relatively deep unconsolidated sediment and organic material along the stream bed. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil. Water quality should continue to be monitored in this watershed. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. The foot bridge should be replaced with one that it is properly sized. Alternatives to traditional drainage design, such as wetland creation, floodplain development, and increasing channel curvature should also be considered. All recommendations should be discussed with the Drainage Superintendent.

**6. Fire Lane 27 (PADTa):** This section of watercourse is managed as a municipal drain; Point Abino Drain. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. Throughout the study site there is relatively deep unconsolidated sediment and organic material deposited along the channel bed. Jewel weed, which has a shallow root system, is the dominant vegetation type at the edge of the watercourse. There are no pools along the bed but there is stagnant water present in some areas. Duckweed was noted during a site visit in 2008. Abutments from an old

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|                                                          | <p>crossing are present. Downstream from the abutments the stream banks are steeper. Recommendations for this site include not grading the channel banks too steep during the dredging process so that deep rooted vegetation can become established along the banks and stabilize the soil. Water quality should continue to be monitored within the watershed. Monitoring the accumulation of sediment along the channel bed can be done by the use of sediment traps throughout the watercourse. Alternatives to traditional drainage design, such as wetland creation, floodplain development, and increasing channel curvature should also be considered. All recommendations should be discussed with the Drainage Superintendent.</p> <p>All of the field sites are within the designated municipal drain Point Abino Drain. Relatively deep unconsolidated sediment and organic material was deposited along the bed throughout the watercourse but bank instability was only noted near the outlet. Excessive sediment deposition can cause problems in a watercourse, such as lateral channel adjustments, increased turbidity, filling in of pools, and impacting fish habitat. Long term monitoring of sediment accumulation should be completed and this can be done by the use of sediment traps. Duckweed was identified throughout the watercourse and it covered the surface of the channel at 4 of the 6 field sites. Water quality should continue to be monitored in this watershed. All recommendations should be discussed with the Drainage Superintendent.</p> |
| Naturalizing Drains and Drain Best Management Practices  | <p>In addition to having an impact on aquatic and riparian habitat, drain maintenance has the potential to become quite costly through repeated maintenance activities. Naturalizing drains can potentially lengthen the time between maintenance events by reducing the amount of sediment entering and remaining in the drain. Best Management Practices for drain maintenance should be developed in consultation with, but not limited to, the following agencies; OMAFRA, DFO, MNR, Conservation Ontario, OFA, DSAO, CFFO, and the agricultural community to reduce ecological impacts to aquatic systems and to prevent sediment from returning to the drain. Any future maintenance of this watercourse should be done in accordance with Best Management Practices for drains. To review examples of current BMP mitigation measures, refer to Appendix I.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Promote Good Shoreline Stewardship                       | <p>Work with partnering stakeholders to promote shoreline that have been maintained naturally or restored to find a balance between natural processes and shoreline protection measures.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Blue Flag Beaches                                        | <p>Work with partnering agencies to mitigate water quality issues and work towards Blue Flag Beach status. Blue Flag status meets high standards with respect to water quality, environmental management, environmental education and safety and services (Blueflag.ca) and is known globally. Blue Flag beaches have the potential to increase tourism in the area.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Integrated Roadside Vegetation Management (IRVM) Program | <p>Niagara Region and municipalities should work together to expand Niagara Region's IRVM Program. IRVM integrates the use of native vegetation with appropriate management techniques to produce a cost-effective, environmentally sound management alternative for roadside weed and erosion control while providing numerous ecological benefits (e.g. buffer strips). Focus of program expansion should be directed to main roads and roads in areas with a high shallow intrinsic susceptibility.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Ecological Linkages between Natural Areas                | <p>Opportunity potential is present for creating ecological linkages between natural areas creating larger contiguous natural features. Such areas have the potential to enhance movement of flora and fauna between natural areas as well as provide habitat and ecological diversity for a wide range of species.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Riparian Buffer Education Program                        | <p>Many landowners keep their properties manicured or plant crops to the edge of the creek. The NPCA's program aimed at educating landowners about the benefits of buffer zones along watercourses should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum of 75% of the cost</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

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|                                                | of a project with caps between \$2,000 and \$10,000.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Wetlands are Worth It Program                  | Wetlands provide important water quality and ecological functions in a watershed by augmenting low flow, acting as natural filtration systems and helping to reduce flooding by acting like giant sponges and absorbing excess water. The Wetlands are Worth It Program through NPCA's Water Quality Improvement Program aims to assist landowners that are interested in restoring, protecting, rehabilitating and creating wetland habitat on their property by providing grants to a maximum of 75% of the cost of a project with a grant ceiling of \$10,000.                                                                                                                                                                                                                                                                                                                                                                |
| Agricultural Best Management Practices Program | The NPCA's program aimed at educating landowners about the benefits of rural and agricultural best management practices should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum 75% of the cost of a project with caps between \$5,000 and \$12,000 depending on the project.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Abandoned Well Decommissioning Program         | Abandoned wells that are not properly decommissioned (capped and sealed) pose a threat to groundwater resources by providing a direct route to groundwater. The NPCA has a well decommissioning program in place for its jurisdiction. Grants are available for the decommissioning of unused water wells only. Priority is given to hydrogeologically sensitive areas, projects located in areas with a high density of domestic water wells, and areas where watershed plans have been completed or are ongoing (NPCA 2007). Approved grants will cover 90% of well decommissioning costs to a maximum of \$2,000 per well (limit of 2 wells per property). This is a reimbursement program, which means that the landowner will pay the full cost to the contractor, and will be reimbursed for 90% of the total project cost after all receipts, invoices, and water well decommissioning records are submitted to the NPCA. |
| <b>Special Studies</b>                         | <b>Recommendations for Further Study</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Riparian Buffer Tax Incentive Program          | Partial exemption on property taxes for the establishment and maintenance of effective riparian and conservation buffers on property. Buffers provide a wide range of functions and benefits depending on their location (e.g. adjacent to watercourse or separating land uses).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Septic System Education and Funding Program    | Improperly functioning septic systems and abandoned septic systems are a known threat to water quality. A septic system education and funding program should be developed and implemented to ensure that private septic systems are functioning properly, and to ensure that abandoned systems are decommissioned.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Septic System Re-Inspection Program            | Areas that have been identified as „septic hotspots“ through the <i>NPCA Groundwater Study</i> and areas that have a high intrinsic susceptibility should be considered priority for such a program. Municipal councils could approve and endorse the allocation of funds from property taxes or general revenue to fund the program. This approach may be facilitated with council knowledge that a percentage of inspected septic systems will also require remedial action on the part of some property owners, including the installation of new septic systems. Owners may also pro-actively undertake action if they are aware that a program is underway. Both will affect the number of permits issued in a municipality, and may generate revenue as a result (MMAH 2001).                                                                                                                                              |
| Road Salt Impact Study                         | Through RMN's <i>Salt Vulnerability Study</i> (2005) the entire LENS study area has been ranked as having a moderately high vulnerability to road salt from regional roads, however this study was not conducted on local municipal roads; therefore it is recommended that a similar study be completed by the respective local municipalities to determine the impact of road salt applications on local municipal roads to the surrounding natural features.                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Subwatershed Hydrogeologic Characterization    | Development of subwatershed scale hydrogeologic characterizations would provide optimal information to make informed decisions in regard to applications and for use in planning decisions and policy development.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

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| Fish Habitat Classification                             | Not all the watercourses in this subwatershed have been evaluated in terms of importance for fish habitat. It is recommended that this assessment be completed so this information can be used for proper resource management and land use planning decisions.                                                                                                                                                                                                                                                                                                                                                      |
| Groundwater Intrinsic Susceptibility Studies            | The <i>Groundwater Study</i> (2005) has identified the entire Point Abino Drain subwatershed as having a high shallow intrinsic susceptibility (Figure 16a & 16b). The intrinsic susceptibility of groundwater considers only the physical factors affecting the flow of water to, and through, the groundwater resource. Additional studies should be conducted in this watershed to ensure that current and future land uses do not conflict with the protection of groundwater resources in susceptible areas as part of the NPCA's <i>Groundwater Study</i> (2005) and proposed <i>Source Protection Plan</i> . |
| Potential Contaminant Sources of Point Source Pollution | An inventory of potential contaminant sources and threats to water quality was identified as part of the objectives for the NPCA's <i>Groundwater Study</i> (2005). An updated inventory to confirm potential contaminant sources and locations is recommended as well as further investigation into the possible effects these potential contaminants may have on surface water quality and aquatic habitat and whether or not a contaminant management plan is needed.                                                                                                                                            |
| Site Specific Water Quality Sampling                    | Enhanced sampling methods upstream and downstream of potential points of contamination should be considered to help identify priority areas for remediation and/or restoration.                                                                                                                                                                                                                                                                                                                                                                                                                                     |



## **Bay Beach Area Drain Restoration Strategy**

The Bay Beach Area Drain subwatershed is drained by a Class E municipal drain; Bay Beach Area Drain. This watercourse has not been evaluated in terms of importance for fish habitat and the NPCA does not conduct water quality sampling in this subwatershed. One geomorphic assessment was conducted along Bay Beach Area Drain. Bank instability was present in the form of bare soil extending up the bank and relatively deep unconsolidated sediment was deposited along the channel bed.

Land use is primarily residential in this subwatershed, with one large wetland complex in the south-west portion of the study area and some agricultural areas in the north-west portion section. The shoreline in this area is a very popular public beach; Crystal Beach.

The MNR has identified a number of Species at Risk in this subwatershed including for example, the endangered small white lady's-slipper and piping plover, and the threatened common hop tree, eastern hognosed snake and fowler's toad. The MNR has identified the Lake Erie shoreline in this area as habitat for the fowler's toad of which Niagara is one of only three areas in Canada where this provincial and federal SAR is found.

The Bay Beach Area Drain Subwatershed Restoration Strategy identifies one zone with specific stewardship and restoration recommendations (Table 23 and Figure 34).

**Table 23: Bay Beach Area Drain Subwatershed Restoration Strategy**

| <b>Recommended Restoration Strategies</b>                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Restoration Opportunities</b>                                                                                                                                                                                                    | <b>Riparian</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Wetland</b>                                                                                                                                                                                                                                                                                                            | <b>Upland and Ecological Linkages</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 1.                                                                                                                                                                                                                                  | <ul style="list-style-type: none"> <li>■ priority should be placed on establishing riparian buffer habitat in areas with little to no buffer strip</li> <li>■ riparian buffers will help to reduce sediment and contaminant loads from adjacent land uses, and cool the water to enhance water quality and fish habitat before outletting to Lake Erie</li> <li>■ watercourses are managed as municipal drains therefore establishment of riparian corridors (e.g. deep rooted grasses &amp; shrubs) should consider future maintenance activities (refer to engineers report and drainage BMP practice recommendations)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <ul style="list-style-type: none"> <li>■ protect existing wetlands (e.g., create a buffer of trees and shrubs between the wetlands and the agricultural activities)</li> <li>■ wetland restoration suitability mapping identifies moderate suitability for enhancement surrounding Point Abino Wetland Complex</li> </ul> | <ul style="list-style-type: none"> <li>■ very high suitability exists for upland restoration in and around Point Abino Wetland Complex extending into the adjacent subwatershed creating ecological linkages or infilling increasing interior size of feature</li> <li>■ high suitability for creating a Critical Function Zone surrounding PSW's. This will provide for a variety of critical functions for wetland-associated fauna (e.g. nesting habitat)</li> <li>■ focus in this portion of the study area should be on enhancement of existing natural areas and the creation of ecological linkages</li> </ul> |
| <ul style="list-style-type: none"> <li>■ All restoration measures should, where possible, benefit Species at Risk and provincially rare species</li> <li>■ Carolinian and native species should be used for all projects</li> </ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Project Opportunities</b>                                                                                                                                                                                                        | <b>Recommended Action for Public and Private Lands</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| NPCA Lake Erie North Shore Geomorphic Assessment Study (NPCA 2009b)                                                                                                                                                                 | <p><b>1. Erie Road (BBADMa):</b> This section of watercourse is managed as a municipal drain; Bay Beach Area Drain. It has been channelized and lacks any depositional features along the stream bed which indicate little flow diversity within the channel. Bank instability is present in the form of bare soil extending up the bank and relatively deep unconsolidated sediment is deposited along the channel bed. No pools exist but there is stagnant water present throughout the field site. There is an area where the lawn is mowed to the edge of the channel. This watercourse becomes part of the roadside ditch for a short distance. Alterations to the watercourse, such as straightening and dredging can cause changes to channel geometry as well as bank stability. Confining the flood waters to the channel results in the loss of the adjacent floodplain, which impacts the hydraulic function of the watercourse (floodplains are storage areas for flood waters) and the physical habitat (loss of floodplain vegetation and the organisms that live there). Recommendations for this watercourse include not mowing to the edge of the channel and allowing vegetation to grow to provide cover, habitat, and a filter for sediment and chemicals that may enter the channel from runoff of fields and roads. Monitoring the accumulation of sediment can be done by the use of sediment traps throughout the watercourse. All recommendations should be discussed with the Drainage Superintendent.</p> |                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

|                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
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| Naturalizing Drains and Drain Best Management Practices  | In addition to having an impact on aquatic and riparian habitat, drain maintenance has the potential to become quite costly through repeated maintenance activities. Naturalizing drains can potentially lengthen the time between maintenance events by reducing the amount of sediment entering and remaining in the drain. Best Management Practices for drain maintenance should be developed in consultation with, but not limited to, the following agencies; OMAFRA, DFO, MNR, Conservation Ontario, OFA, DSAO, CFFO, and the agricultural community to reduce ecological impacts to aquatic systems and to prevent sediment from returning to the drain. Any future maintenance of this watercourse should be done in accordance with Best Management Practices for drains. To review examples of current BMP mitigation measures, refer to Appendix I. |
| Blue Flag Beaches                                        | Work with partnering agencies to mitigate water quality issues and work towards Blue Flag Beach status. Blue Flag status meets high standards with respect to water quality, environmental management, environmental education and safety and services (Blueflag.ca) and is known globally. Blue Flag beaches have the potential to increase tourism in the area.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Integrated Roadside Vegetation Management (IRVM) Program | Niagara Region and municipalities should work together to expand Niagara Region's IRVM Program. IRVM integrates the use of native vegetation with appropriate management techniques to produce a cost-effective, environmentally sound management alternative for roadside weed and erosion control while providing numerous ecological benefits (e.g. buffer strips). Focus of program expansion should be directed to main roads and roads in areas with a high shallow intrinsic susceptibility.                                                                                                                                                                                                                                                                                                                                                             |
| Ecological Linkages between Natural Areas                | Opportunity potential is present for creating ecological linkages between natural areas creating larger contiguous natural features. Such areas have the potential to enhance movement of flora and fauna between natural areas as well as provide habitat and ecological diversity for a wide range of species.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Riparian Buffer Education Program                        | Many landowners keep their properties manicured or plant crops to the edge of the creek. The NPCA's program aimed at educating landowners about the benefits of buffer zones along watercourses should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum of 75% of the cost of a project with caps between \$2,000 and \$10,000.                                                                                                                                                                                                                                                                                                                                                              |
| Wetlands are Worth It Program                            | Wetlands provide important water quality and ecological functions in a watershed by augmenting low flow, acting as natural filtration systems and helping to reduce flooding by acting like giant sponges and absorbing excess water. The Wetlands are Worth It Program through NPCA's Water Quality Improvement Program aims to assist landowners that are interested in restoring, protecting, rehabilitating and creating wetland habitat on their property by providing grants to a maximum of 75% of the cost of a project with a grant ceiling of \$10,000.                                                                                                                                                                                                                                                                                               |
| Agricultural Best Management Practices Program           | The NPCA's program aimed at educating landowners about the benefits of rural and agricultural best management practices should be extensively promoted. In addition, landowners should be made aware of and encouraged to participate in the Conservation Authority's Water Quality Improvement Program. This program provides grants to a maximum 75% of the cost of a project with caps between \$5,000 and \$12,000 depending on the project.                                                                                                                                                                                                                                                                                                                                                                                                                |
| Abandoned Well Decommissioning Program                   | Abandoned wells that are not properly decommissioned (capped and sealed) pose a threat to groundwater resources by providing a direct route to groundwater. The NPCA has a well decommissioning program in place for its jurisdiction. Grants are available for the decommissioning of unused water wells only. Priority is given to hydrogeologically sensitive areas, projects located in areas with a high density of domestic water wells, and areas where watershed plans have been completed or are ongoing (NPCA 2007). Approved grants will cover 90% of well decommissioning costs to a maximum of \$2,000 per well (limit of 2 wells per property). This is a reimbursement program, which means that the landowner will pay the full cost to the contractor, and will be                                                                             |

|                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|---------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                         | reimbursed for 90% of the total project cost after all receipts, invoices, and water well decommissioning records are submitted to the NPCA.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Special Studies</b>                                  | <b>Recommendations for Further Study</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Riparian Buffer Tax Incentive Program                   | Partial exemption on property taxes for the establishment and maintenance of effective riparian and conservation buffers on property. Buffers provide a wide range of functions and benefits depending on their location (e.g. adjacent to watercourse or separating land uses).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Septic System Education and Funding Program             | Improperly functioning septic systems and abandoned septic systems are a known threat to water quality. A septic system education and funding program should be developed and implemented to ensure that private septic systems are functioning properly, and to ensure that abandoned systems are decommissioned.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Septic System Re-Inspection Program                     | Faulty or improperly maintained septic systems have been identified as a concern by participants at public events for the study area. Therefore, areas along the lakeshore that have a high intrinsic susceptibility should be considered priority for such a program. Municipal councils could approve and endorse the allocation of funds from property taxes or general revenue to fund the program. This approach may be facilitated with council knowledge that a percentage of inspected septic systems will also require remedial action on the part of some property owners, including the installation of new septic systems. Owners may also pro-actively undertake action if they are aware that a program is underway. Both will affect the number of permits issued in a municipality, and may generate revenue as a result (MMAH 2001). |
| Road Salt Impact Study                                  | Through RMN's <i>Salt Vulnerability Study</i> (2005) the entire LENS study area has been ranked as having a moderately high vulnerability to road salt from regional roads, however this study was not conducted on local municipal roads; therefore it is recommended that a similar study be completed by the respective local municipalities to determine the impact of road salt applications on local municipal roads to the surrounding natural features.                                                                                                                                                                                                                                                                                                                                                                                       |
| Subwatershed Hydrogeologic Characterization             | Development of subwatershed scale hydrogeologic characterizations would provide optimal information to make informed decisions in regard to applications and for use in planning decisions and policy development.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Fish Habitat Classification                             | The watercourses in this subwatershed have not been evaluated in terms of importance for fish habitat. It is recommended that this assessment be completed so this information can be used for proper resource management and land use planning decisions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Groundwater Intrinsic Susceptibility Studies            | The <i>Groundwater Study</i> (2005) has identified nearly the entire Bay Beach Area Drain subwatershed as having a high shallow intrinsic susceptibility (Figure 16a & 16b). The intrinsic susceptibility of groundwater considers only the physical factors affecting the flow of water to, and through, the groundwater resource. Additional studies should be conducted in this watershed to ensure that current and future land uses do not conflict with the protection of groundwater resources in susceptible areas as part of the NPCA's <i>Groundwater Study</i> (2005) and proposed <i>Source Protection Plan</i> .                                                                                                                                                                                                                         |
| Potential Contaminant Sources of Point Source Pollution | An inventory of potential contaminant sources and threats to water quality was identified as part of the objectives for the NPCA's <i>Groundwater Study</i> (2005). An updated inventory to confirm potential contaminant sources and locations is recommended as well as further investigation into the possible effects these potential contaminants may have on surface water quality and aquatic habitat and whether or not a contaminant management plan is needed.                                                                                                                                                                                                                                                                                                                                                                              |
| Site Specific Water Quality Sampling                    | Enhanced sampling methods upstream and downstream of potential points of contamination should be considered to help identify priority areas for remediation and/or restoration.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |



## Overview of Restoration Strategy

The Lake Erie North Shore watershed faces many challenges and its restoration requires a collaboration of all stakeholders with a vested interest in this study area. As outlined in the Restoration Strategy, many of the subwatersheds are drained by municipal drains. Therefore finding a balance between form and function is critical to this study area. The Restoration Strategy identifies numerous priority areas for the potential establishment of riparian buffer areas. The establishment and maintenance of riparian buffer zones plays an important role in terms of water quality and fish habitat not only for the subwatersheds but for Lake Erie. Upstream activities need to be managed in a sustainable manner as these actions affect not only the ecosystem in its direct and surrounding vicinity, but Lake Erie and its related ecosystems. In addition, maintaining a healthy shoreline is also important in protecting the overall water quality of Lake Erie.



The Restoration Strategy also identifies numerous potential opportunities for enhancement of existing natural areas; bulking them up to increase patch size. Larger patches tend to have a greater *“diversity of habitat niches and therefore are more likely to support a greater richness and/or diversity of wildlife species”* (EC 2004c). The Restoration Strategy also identifies opportunities for the establishment of Critical Functions Zones. A Critical Function Zone *“describes non-wetland areas within which biophysical functions or attributes directly related to the wetland [of interest] occur”* (EC 2004c). These areas are functional

extensions of the wetland into the upland area and provide a number of functions for wetland-associated fauna that extend beyond the wetland boundary (e.g. nesting habitats, foraging areas). When the planning process is initiated to implement a restoration project in the study area, prairies and meadows should be given consideration and incorporated in habitat creation as they play an important role in creating habitat diversity and foraging areas for wildlife.

Opportunities for the establishment of corridor connections between fragmented areas are also identified. Such linkages not only provide shelter to facilitate in the movement of wildlife between natural areas, but they also promote seed dispersal and biodiversity in the watershed. The Restoration Strategy identifies core natural areas that should act as building blocks in which to connect and restore gaps in the surrounding landscape.



Throughout the Restoration Strategy the establishment of a number of buffers types and locations for these buffers have been recommended (e.g. riparian, buffering land uses). It is important to note that the role of a buffer and its function is directly related to its location. For a list of objectives and functions for conservation buffers, please refer to the chart in Appendix G. This chart was taken directly from *Conservation Buffers; Design Guidelines for Buffers, Corridors, and Greenways* (Bentrup 2008) and can be a useful tool when planning such a restoration project.

As indicated earlier, the Lake Erie North Shore watershed currently contains approximately 16 percent wetland cover, 20 percent forest cover, and approximately 64 percent of the watercourses in

the watershed have riparian cover. Once again, Environment Canada recommends at least 30 percent of the watershed should be in forest cover, 10 percent wetland cover, and at least 75 percent of the watercourses should have a recommended 30 meter riparian buffer. The guidelines are intended as minimum ecological requirements and are meant to provide guidance in setting local habitat restoration and protection targets.

The following chart (Table 24) specifies the upland, wetland and riparian habitat percentages for each subwatershed in the study area. This chart should be used in conjunction with the Restoration Strategy to prioritize the implementation of riparian, upland and wetland restoration projects.

| <b>Table 24: Subwatershed Habitat Statistics</b> |                       |                         |                         |
|--------------------------------------------------|-----------------------|-------------------------|-------------------------|
| <b>Subwatershed Name</b>                         | <b>Percent Upland</b> | <b>Percent Wetlands</b> | <b>Percent Riparian</b> |
| Lowbanks Drain                                   | 20.1                  | 21.7                    | 23.6                    |
| Hoover Drain                                     | 19.4                  | 13.1                    | 64.0                    |
| Lake Erie 8                                      | 13.6                  | 8.0                     | 12.9                    |
| Lake Erie 7                                      | 37.4                  | 21.8                    | 31.6                    |
| Lake Erie 6                                      | 9.5                   | 17                      | 29.3                    |
| Casey Drain                                      | 21.8                  | 16.1                    | 12.5                    |
| Lake Erie 5                                      | 13.9                  | 3.4                     | 13.1                    |
| Wainfleet Marsh                                  | 31.7                  | 20.4                    | 98.9                    |
| Lake Erie 4                                      | 10.4                  | 0                       | 8.1                     |
| Lake Erie 3                                      | 13.4                  | 16.0                    | 30.1                    |
| Eagle Marsh Drain                                | 11.8                  | 12.8                    | 32.0                    |
| Welland Canal South                              | 7.2                   | 1.1                     | 11.3                    |
| Lake Erie 2                                      | 13.6                  | 16.9                    | 25.2                    |
| Wignell Drain                                    | 9.3                   | 5.6                     | 17.4                    |
| Beaver Dam Creek P.C.                            | 28.3                  | 21.2                    | 20.8                    |
| Oil Mill Creek                                   | 21.1                  | 10.2                    | 39.0                    |
| Bearss Drain                                     | 20.3                  | 13.9                    | 24.3                    |
| Point Abino Drain                                | 38.6                  | 18.9                    | 43.4                    |
| Bay Beach Area Drain                             | 20.5                  | 11.6                    | 35.1                    |

## Estimating Ecosystem Services

Ecosystem services „are the benefits that people obtain, either directly or indirectly, from our ecological systems. These services can be understood in ecological terms and they can also be translated into economic terms through valuation studies (MNR 2009c)’. The Ministry of Natural Resources commissioned a study intended to understand the socio-economic value of our ecological systems and how this information could be used as a tool to support policy and planning decisions as well as to develop a defensible economic rationale for the conservation of southern Ontario’s natural heritage systems. Although ecosystem services form the “*foundation of human well-being and they also represent a significant part of the total economic value of our landscape and economy*” (MNR 2009c), their value is often not considered.

The pilot study methodology was approached by assigning a value to each respective ecosystem category based on an average derived from research for similar research sites. This method is known as „value transfer’ or „benefits transfer’ and was used because it is not feasible to conduct valuation studies on the entire study area due to significant time and financial constraints. The project generated estimates for southern Ontario for the yearly value of ecosystem services. However, one of the key findings of the study was that due to the number of gaps in existing valuation study data, the results present a greatly under-estimated value of the natural systems. The science of Ecosystem Services Valuation is still relatively young and has not yet “*progressed to the point of matching changes in landscape configuration and ecosystem processes to levels of the provision and the values of the corresponding services. These processes affect ecological indicators like net primary productivity, biodiversity, soil quality, runoff, sedimentation rates, nutrient cycling, and natural disturbance processes, which in turn underlie the provision of most ecosystem services*” (MNR 2009c).



Although still a relatively new science, it is hopeful that as the science improves and data gaps are filled that Ecosystem Services will be considered in future provincial and local policy decision making. This tool would enhance the ability of decision makers to make informed decisions in areas such as cost-benefit analysis and to compare outcomes of various scenarios of different policy criteria (MNR 2009c).

## Implementation Responsibilities and Recommended Management Actions

The Lake Erie North Shore Watershed Restoration Strategy is guided by an implementation framework (Table 24). The implementation framework has been designed to account for the watershed plan objectives which were derived from key issues in the watershed and extensive public input. The implementation framework is guided by the Government of Canada’s vision for integrated community sustainability planning, which envisions all parties involved to focus limited financial and human resources in ways that will best serve common objectives at all levels of government (Godfrey 2005). To this end, the implementation framework identifies project stakeholders (e.g., provincial agencies, regional government watershed municipalities, public interest groups and landowners), and recommended management actions for each watershed plan objective.

### Implementing the Recommended Actions

Lead project stakeholders and those who should be involved in the project have been identified in the following framework. The recommended management actions for the Lake Erie North Shore Watershed include planning and regulatory actions (e.g., Official Plan amendments), project opportunities on private and public lands (e.g., riparian buffer planting, wetland creation), and areas requiring additional research and monitoring (e.g., ecological linkages, geomorphic assessments) in the watershed. The budget for NPCA restoration projects is identified in the table. If the project is

identified as ongoing then it is likely an action that requires continual updating such as the five year review process for regional and municipal Official Plans, which is not allocated a dollar amount. If an existing program already has funding, and the project and funding have a termination date, then these projects have a specific dollar amount attached to them. In addition, funds allocated as part of annual budgeting have also been assigned dollar amounts.

The recommended actions have also been identified in terms of their implementation. Green denotes short term implementation, yellow represents medium term implementation and red is used to indicate long term implementation. For example, projects that are ongoing are almost always implemented over the long term and are therefore, represented in red. Projects that have specific funding requirements or require approvals, for example, are often represented in green and yellow, thereby indicating short term or medium term implementation respectively.

| WATERSHED PLAN OBJECTIVE                                   |                                                                                                                                                            | RESPONSIBLE STAKEHOLDER                                  |                |                  |                  |     |     |        |     |                     |                        | RECOMMENDED MANAGEMENT OPTION |                    |                                                                                                                                                                                                |                                                                                                                                                                             |
|------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|----------------|------------------|------------------|-----|-----|--------|-----|---------------------|------------------------|-------------------------------|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                            |                                                                                                                                                            | NPCA                                                     | MUNICIPALITIES | REGIONAL NIAGARA | HALDIMAND COUNTY | MNR | MOE | OMAFRA | DFO | CONSERVATION GROUPS | AGRICULTURAL COMMUNITY | PRIVATE LANDOWNERS            | ENVIRONMENT CANADA | Lead Stakeholder<br>Involved Stakeholder<br>Short Term<br>Medium Term<br>Long Term                                                                                                             | IMPLEMENTATION                                                                                                                                                              |
| Sources                                                    | Prevent erosion, maintain or protect water quality and/or processes to support human uses and activities in accordance with Provincial Water Resources Act |                                                          | ▲              | ▲                | ▲                |     |     |        |     |                     |                        |                               |                    | 1. Include water quality protection in regional and municipal planning documents                                                                                                               | C                                                                                                                                                                           |
|                                                            |                                                                                                                                                            | ▲                                                        | ●              | ●                | ●                | ●   |     |        |     | ●                   |                        |                               |                    | 2. Continue to restrict no new on-line pond construction                                                                                                                                       | C                                                                                                                                                                           |
|                                                            |                                                                                                                                                            | ▲                                                        | ●              | ▲                | ▲                |     | ▲   | ●      |     |                     | ●                      |                               |                    | 3. Continue to monitor water quality to achieve Provincial Water Quality Objectives                                                                                                            | 1                                                                                                                                                                           |
|                                                            | Restore or restore all vulnerable areas (surface water features that can be easily changed or degraded by activities or events)                            | ▲                                                        | ●              | ●                | ●                | ●   | ▲   |        |     |                     |                        |                               |                    | 4. Develop and implement a specific Groundwater and Management Protection Strategy for high susceptibility areas identified in the <i>Groundwater Study</i> (WHI 2005)                         | E<br>P                                                                                                                                                                      |
|                                                            |                                                                                                                                                            | ▲                                                        | ●              | ●                | ●                |     | ●   |        |     |                     |                        | ●                             |                    | 5. Continue to implement the water well decommissioning program in the Lake Erie North Shore watershed through NPCA Decommissioning Program                                                    | E<br>P                                                                                                                                                                      |
|                                                            |                                                                                                                                                            | ▲                                                        | ●              | ▲                | ▲                |     | ●   |        |     |                     |                        |                               |                    | 6. Continue to identify and map surface and groundwater "hot spots" to determine areas with poor water quality including salt vulnerable areas through Water Quality Program and Annual Report | E<br>P                                                                                                                                                                      |
|                                                            |                                                                                                                                                            | ▲                                                        |                |                  |                  |     |     |        |     |                     | ●                      | ●                             |                    | 7. Continue to promote the NPCA's Water Quality Improvement Program                                                                                                                            | 1                                                                                                                                                                           |
|                                                            | Maintain ecologically compatible balance between drainages and function                                                                                    | ▲                                                        |                |                  |                  |     | ▲   |        |     |                     |                        |                               |                    | 8.Examine the ongoing effect of quarries and sand/gravel pits on groundwater, the impacts when they cease dewatering, and the potential for long-term augmentation of base flows               | C                                                                                                                                                                           |
|                                                            |                                                                                                                                                            | ●                                                        | ▲              | ▲                | ▲                |     | ●   |        |     |                     |                        |                               |                    | 9. Incorporate surface and groundwater protection policies into regional and municipal planning documents                                                                                      | C                                                                                                                                                                           |
|                                                            |                                                                                                                                                            | ▲                                                        | ●              | ●                | ●                | ▲   |     |        |     | ▲                   | ▲                      |                               | ●                  |                                                                                                                                                                                                | 10. Best Management Practices for drain maintenance should be developed to reduce ecological impacts to aquatic systems and to prevent sediment from returning to the drain |
| Aquatic Habitat                                            | Implement storm water management practices minimize erosion and sediment loads, and protect riparian habitat                                               | ▲                                                        | ▲              | ▲                | ▲                |     |     |        |     |                     |                        |                               |                    | 11. Continue to implement NPCA Stormwater Policies and BMPs into regional and municipal planning documents                                                                                     | C                                                                                                                                                                           |
|                                                            |                                                                                                                                                            |                                                          | ▲              |                  |                  |     |     |        |     |                     |                        | ▲                             |                    | 12. Continue to implement the Extraneous Flow Reduction Program in the City of Port Colborne                                                                                                   | C                                                                                                                                                                           |
|                                                            |                                                                                                                                                            |                                                          | ▲              | ▲                | ▲                |     |     |        |     |                     |                        | ▲                             |                    | 13. Continue to implement a rain barrel program for urban areas in watershed                                                                                                                   | E<br>P                                                                                                                                                                      |
|                                                            | Reduce erosion caused by human activity through the implementation of a comprehensive, erosion control program                                             | ▲                                                        | ●              | ●                | ●                |     |     |        |     |                     | ●                      | ●                             |                    | 14. Continue to permit no new development in the 1 in 100 year floodplain                                                                                                                      | C                                                                                                                                                                           |
|                                                            |                                                                                                                                                            | ▲                                                        | ●              | ●                | ●                | ●   |     |        |     | ●                   | ●                      | ●                             |                    | 15. Implement the recommended restoration actions outlined in Lake Erie North Shore Watershed Geomorphic Assessment (NPCA 2009)                                                                | 5                                                                                                                                                                           |
|                                                            |                                                                                                                                                            | ●                                                        | ●              | ▲                | ▲                |     | ▲   |        |     |                     | ●                      |                               | ●                  | 16. Work with partnering agencies to mitigate water quality issues and work towards Blue Flag Beach status                                                                                     | E<br>P                                                                                                                                                                      |
|                                                            | Mitigate flooding risks to human life and acceptable limits                                                                                                | ▲                                                        | ●              | ●                | ●                |     |     |        |     |                     |                        |                               |                    | 17. Maintain NPCA flood warning system                                                                                                                                                         | C                                                                                                                                                                           |
|                                                            |                                                                                                                                                            | ▲                                                        | ●              | ●                | ●                |     |     |        |     |                     |                        | ●                             |                    | 18. Continue to implement regulations adopted under Section 28 of the Conservation Authorities Act                                                                                             | C                                                                                                                                                                           |
|                                                            |                                                                                                                                                            |                                                          |                |                  |                  |     |     |        |     |                     |                        |                               |                    |                                                                                                                                                                                                |                                                                                                                                                                             |
|                                                            | Management plans for Species at Risk into Watershed and make scientific recommendations for their recovery                                                 | Develop management plans for invasive species and fauna) | ▲              | ●                | ●                | ●   | ▲   |        | ●   | ▲                   | ▲                      | ●                             | ●                  |                                                                                                                                                                                                | 19. Identify and remove human created barriers to fish movement                                                                                                             |
| ▲                                                          |                                                                                                                                                            |                                                          |                |                  |                  | ▲   |     |        |     |                     |                        | ●                             |                    | 20. Identify and evaluate online ponds to determine value to fish habitat and function in watershed                                                                                            | C                                                                                                                                                                           |
| ▲                                                          |                                                                                                                                                            |                                                          | ▲              | ▲                | ▲                |     |     | ●      | ●   | ●                   | ●                      | ●                             |                    | 21. Establish and/or enhance riparian buffer strips around watercourses and wetlands                                                                                                           | 3                                                                                                                                                                           |
| ▲                                                          |                                                                                                                                                            |                                                          |                |                  |                  | ▲   |     |        | ▲   |                     |                        |                               |                    | 22. Develop recovery strategies for critical habitat (e.g. spawning areas)                                                                                                                     | C                                                                                                                                                                           |
| Recommend management plans for invasive species and fauna) | Develop management plans for invasive species and fauna)                                                                                                   | ▲                                                        | ●              | ●                | ●                | ▲   |     | ●      | ▲   |                     |                        |                               | ▲                  | 23. Review SAR management plans and work with partnering agencies to incorporate recommendations into restoration projects to benefit SAR where possible                                       | E<br>P                                                                                                                                                                      |
|                                                            |                                                                                                                                                            | ▲                                                        | ●              | ●                | ●                | ▲   |     |        |     | ▲                   | ●                      | ●                             |                    | 24. Identify the extent of both flora and fauna invasive species in the LENS watershed and make scientific recommendations for their recovery                                                  | E                                                                                                                                                                           |



## Monitoring

Monitoring serves two purposes in watershed planning. Monitoring is required to update the watershed plan as land uses change and new issues are identified, and monitoring serves to measure the success of restoration projects in terms of enhancing and protecting water quality for all users in a watershed. Monitoring the achievement of a watershed plan's objectives involves continually reviewing the Lake Erie North Shore Watershed Plan. The Plan will be reviewed by the NPCA Restoration Team and the Lake Erie North Shore Watershed Plan Implementation Committee (comprised of public interest groups, watershed municipalities, agency, and citizen representatives) annually. As part of the review process, the plan will be amended whenever necessary to reflect the changing environmental, economic, technical, or social trends within the jurisdiction of the NPCA, and more specifically within the Lake Erie North Shore watershed. A complete review and necessary revisions is slated to occur every 5 years.

| <b>Table 26: Watershed Monitoring Schedule</b> |                                                                                                                                                                                                         |
|------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Time Frame</b>                              | <b>Action</b>                                                                                                                                                                                           |
| Monthly during ice free season(April-November) | Surface water quality sampling                                                                                                                                                                          |
| Yearly                                         | Project Monitoring: photos and notes of restoration projects are taken to document status of project(i.e., improvements, growth, change)                                                                |
| Typically every 3 years (spring and fall)      | Biological Monitoring and Assessment Program (BioMAP) sampling                                                                                                                                          |
| 5 Year Review                                  | Review of the Watershed Plan: Investigation of identified issues and status of recommended actions is completed. Any new issues will be identified and an updated restoration strategy will be created. |
| Continuous Monitoring                          | Landowners are given a monitoring journal to document any changes they observe occurring in the project area.                                                                                           |
| Continuous Monitoring                          | Update Natural Heritage Information Database and GIS layers to reflect Natural Heritage Areas Inventory field surveys and project findings.                                                             |

In addition to monitoring the objectives or outcomes of the Watershed Plan, the monitoring process includes measuring the performance and success of the management actions used to achieve the objectives. In this regard, monitoring serves to collect and analyze aquatic, terrestrial and socio-economic data to identify changes in the watershed; both from restoration activities, and growth and development. This component of the monitoring program should include:

- Water quality sampling, benthic studies (BioMAP), and water temperature monitoring through the NPCA's Water Quality Monitoring Program. This data can

be used as an indicator of whether or not the recommendations provided in the Watershed Plan have maintained and/or improved the physical and chemical characteristics of water quality in the watershed.

- On-going classification of vegetative communities using standardized protocols (Ecological Land Classification). These habitat areas are recorded as Geographic Information System layers and are updated bi-annually to evaluate changes in community composition, habitat size and fragmentation.
- Biological life assessments (qualitative and quantitative) such as insects/pollinators, fish and birds.
- A compilation of the number and location of BMPs implemented in the watershed. This will also include pollutant loading reduction measurements. This information will be housed in a restoration database and updated as projects are completed.
- Watershed landowners should also be surveyed (at least every 5 years prior to the Watershed Plan review) to help watershed planners and the restoration team identify new watershed issues, and evaluate changes in knowledge and behaviour.

Land use and land use change in the watershed will also be evaluated. One option of evaluation methodology is by using the Agricultural Non-Point Source Pollution (AGNPS) model. AGNPS is a computer model that is used for evaluating the effect of management decisions impacting a watershed system, such as predicting nonpoint source pollutant loadings within agricultural watersheds. For example, AGNPS can simulate the effects of various management practices on pollution in the watershed. The model can predict where runoff from rain, snowmelt, or irrigation may carry pesticides, fertilizers, or sediment throughout a watershed.

It is recommended that the AGNPS model be executed for the Lake Erie North Shore Watershed Plan study area to assist the Implementation Committee in identifying 'hot spots' in the watershed and therefore priority areas for remediation or restoration. In addition, the AGNPS model can be used to evaluate the success of restoration measures in subsequent years after the Watershed Plan has been implemented by re-evaluating pollutant loadings in the watershed.

The overall objectives of the Lake Erie North Shore Watershed Plan monitoring program are to:

- continually evaluate and amend the watershed plan whenever necessary to reflect changing environmental, economic, technical, or social trends;
- continually assess the overall health and water quality of watercourses;
- improve the AGNPS model calibration; and
- gauge the success of the restoration action plans in protecting and improving water quality and aquatic health.

## Conclusion

The Lake Erie North Shore watershed supports a unique environmental character and subsequent set of watershed issues. Contributing to the distinctiveness of this watershed are, for example, sand dunes that line the shoreline, diversity of natural heritage features, the Onondaga Escarpment features, the wealth of endangered and threatened species, and the abundance of recreational opportunities that are abundant throughout the study area. A wide-ranging set of watershed issues have been gathered resulting in a set of watershed objectives that includes water resources, fish and aquatic habitat, natural heritage and resources, urban development, and communication and education.

The watershed objectives have formed the basis of restoration strategies at the watershed level for riparian, wetland and upland habitat that have been derived from detailed restoration suitability mapping. In addition, project opportunities on private and public lands have been identified such as erosion control and upland forest restoration to create ecological linkages between existing forested areas. Special studies, including policy tools, education programs and tax incentive programs have also been proposed.

The implementation plan identifies responsible stakeholders for each recommended management action. The recommended management actions have been organized to include riparian, wetland and upland and ecological linkages; to enhance water quality, fish habitat and recreation; specific policy tools including municipal and regional official plan amendments; outreach and communication for various aspects of water resources management; and research and monitoring programs to obtain additional data from which the Lake Erie North Shore Watershed Plan can be updated and revised every 5 years.

The Niagara Peninsula Conservation Authority will oversee the implementation of the Lake Erie North Shore watershed strategy and recommendations made in this report with the assistance of the Lake Erie North Shore Watershed Plan Implementation Committee, which is comprised of public interest groups, watershed municipalities, agencies and landowners. Watershed plan progress will be communicated annually by means of a qualitative report card that details progress in the watershed.

As indicated earlier, implementation of the Lake Erie North Shore Watershed Plan should be integrated into planning initiatives and roles of regulation by all levels of government. Land use changes in the Lake Erie North Shore watershed should also consider recommendations put forth by the Watershed Plan and supporting studies and documents where appropriate. The NPCA and the Lake Erie North Shore Watershed Plan Implementation Committee will also work with Lake Erie managers to identify restoration actions that are supportive of the Lake Erie Binational Nutrient Strategy. Implementation of such actions will benefit both the watershed and the lake.

Together the watershed strategy and recommended management actions aim to contribute to supporting healthy natural areas, farms, watercourses, and habitat for a diversity of flora and fauna. Through this plan, the preservation, conservation and restoration of the watershed's ecosystem will protect society's resource needs by sustaining the ecological processes that naturally protect air, water and land resources. All of this will be achieved through environmental stewardship that fosters a collaborative approach to conservation that respects landowners while providing exciting opportunities for education and recreation for all citizens in the Lake Erie North Shore watershed.

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## Acronyms

ANSI: Area of Natural and Scientific Interest  
BC MOE: British Columbia Ministry of Environment  
BioMAP: Biological Monitoring and Assessment Program  
BMP: Best Management Practice  
CLI: Canada Land Inventory Classification System  
CLTIP: Conservation Land Tax Incentive Program  
COSEWIC: Committee on the Status of Endangered Wildlife in Canada  
COSSARO: Committee on the Status of Species at Risk in Ontario  
CSO: Combined Sewer Overflows  
CWQG: Canadian Water Quality Guidelines  
DFO: Department of Fisheries and Oceans  
*E. Coli*: Escherichia coli  
ELC: Ecological Land Classification  
EA: Environmental Assessment  
GTA: Greater Toronto Area  
GGH: Growth Plan for the Greater Golden Horseshoe  
GMS: Regional Growth Management Strategy  
HADD: Harmful Alteration, Disruption or Destruction  
IBA: Important Bird Area  
IPZ: Intake Protection Zone  
LENS: Lake Erie North Shore  
LMA: Local Management Area  
LSW: Locally Significant Wetland  
MFTIP: Managed Forest Tax Incentive Program  
MMAH: Ontario Ministry of Municipal Affairs  
MNR: Ministry of Natural Resources  
MOE: Ministry of the Environment  
MPIR: Ontario Ministry of Public Infrastructure Renewal  
NAI: Natural Areas Inventory  
NMP: Nutrient Management Plan  
NMS: Nutrient Management Strategy  
NPCA: Niagara Peninsula Conservation Authority  
NPSPC: Niagara Peninsula Source Protection Committee  
NU: Nutrient Unit  
NWS: Niagara Water Strategy  
OMAFRA: Ontario Ministry of Agriculture, Food and Rural Affairs  
OMNR: Ontario Ministry of Natural Resources  
OMOE: Ontario Ministry of the Environment  
OWES: Ontario Wetland Evaluation System  
PPS: Provincial Policy Statement  
PSW: Provincially Significant Wetland  
PTTW: Permit To Take Water  
PWQO: Provincial Water Quality Objectives  
RMN: Regional Municipality of Niagara  
SAR: Species at Risk  
WAS: Water Availability Study  
WTP: Water Treatment Plant  
WQI: Water Quality Index

## Glossary

**Area of Natural and Scientific Interest:** Areas of land and water containing natural landscapes or features that have been identified as having life science or earth science values related to protection, scientific study or education (Provincial Policy Statement 2005).

**Best Management Practice:** A land management practice implemented to control sources or causes of pollution. The 3 types of Best Management Practices that treat, prevent, or reduce water pollution include: structural, vegetative and managerial.

**Bioengineering:** Combination of vegetative and structural practices to prevent erosion or stabilize slopes or streambanks

**Biological Monitoring and Assessment Program:** The use of benthic invertebrates as indicators of water quality.

**Carolinian Life Zone:** Also known as the Eastern Deciduous Forest Region, the Carolinian Life Zone stretches across southwestern Ontario from Toronto to Grand Bend. It is estimated that approximately one third of Canada's rare and endangered species are found within this zone.

**Committee on the Status of Endangered Wildlife in Canada:** Is an independent body responsible for identifying species that are considered to be at risk in Canada. Their findings are reported to the federal government who then determines which at-risk species qualify for protection under the Species At Risk Act (2003).

**Committee on the Status of Species at Risk in Ontario:** The provincial review body implemented by the Ontario Ministry of Natural Resources: also an independent body made up of non-OMNR members.

**Ecological function:** The natural processes, products, or services that living and non-living environments provide or perform within or between species, ecosystems and landscapes. These may include biological, physical and socio-economic interactions (Provincial Policy Statement 2005).

**Ecosystem services:** The benefits that people obtain, either directly or indirectly, from our ecological systems. These services can be understood in ecological terms and they can also be translated into economic terms through valuation studies (MNR 2009c).

**Endangered Species:** A species facing imminent extinction or extirpation in Ontario which has been regulated under Ontario's Endangered Species Act (MNR No Date)

**Entrenched Channel:** A channel that has eroded downward or was constructed such that it no longer has access to its original floodplain during moderate flow events.

**Eutrophication:** the process by which a lake becomes rich in dissolved nutrients and deficient in oxygen, occurring either as a natural stage in lake maturation or artificially induced by human activities such as the addition of fertilizers and organic wastes from runoff.

**Fish Habitat:** means spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes [Fisheries Act, Section 31 (5)].

**Geomorphic:** Relates to the physical properties of the rock, soil, and water in and around the stream.

**Important Bird Area:** Sites critical to the long-term viability of bird populations and are priority areas for the conservation of globally threatened, range restricted and congregatory birds (Bird Life International No Date)

**Intake Protection Zone:** Protected area (land and water) surrounding a surface water intake

**Intrinsic Susceptibility:** The vulnerability of the groundwater system to potential contamination from surface sources.

**Local Management Area:** As part of the Niagara Water Quality Protection Strategy, Niagara Peninsula Conservation Authority's district was divided into 32 Local Management Areas, each representing an ecologically valid and functioning water management unit derived from the over 140 subwatersheds in its jurisdiction.

**Municipal Drain:** Municipal drains can be either open watercourses or closed systems buried in the ground (i.e., tiles, pipes) designed and constructed to primarily improve drainage of agricultural lands, but also improve drainage of roads and rural lands.

**Niagara Water Quality Protection Strategy:** The strategy is part of a multi-stakeholder and multi-jurisdictional effort to work towards the common goal of management, restoration and protection of water resources across Niagara's watershed.

**Old Growth Ecosystems:** The presence of old trees and their associated plants, animals, and ecological processes. They show little or no evidence of human disturbance (MNR 1994).

**Permeability:** The measure of the ability of a material to transmit fluids through it.

**Pervious:** Allows the relatively free passage of liquid.

**Physiography:** The natural configuration of the landscape.

**Potentiometric Surface:** The area where the ground surface intersects the water table

**Provincial Significance:** Important on a provincial scale; this may refer to a species; a habitat; or a natural area.

**Provincially Significant Wetland:** A Class I, II and III Wetland identified as provincially significant as defined in 'An Evaluation System for Wetlands of Southern Ontario, South of the Precambrian Shield, Third Edition.'

**Species of Special Concern:** A species with characteristics that make it sensitive to human activities or natural events (MNR No Date).

**Subwatershed:** A subunit of a watershed; often defined as the drainage area of a tributary or watercourse (e.g. Wignell Drain).

**Threatened Species:** A species that is at risk of becoming endangered in Ontario if limiting factors are not reversed (MNR No Date)

**Topography:** The relief of the land surface.

**Watershed:** An area of land from which surface runoff (water, sediments, nutrients and contaminants) drain into a common water body (e.g. Lake Erie).

**Watershed Management Plan:** A proactive document created cooperatively by government agencies and the community to manage the water, land/water interactions, aquatic life and aquatic resources within a particular watershed to protect the health of the ecosystem as land uses change (Ministry of Environment and Energy and Ministry of Natural Resources 1993).

**Wetlands:** Lands that are seasonally or permanently covered by shallow water, as well as lands where the water table is close to or at the surface. In either case the presence of abundant water has caused the formation of hydric soils and has favoured the dominance of either hydrophytic plants or water tolerant plants. The four major types of wetlands are swamps, marshes, bogs and fens (Provincial Policy Statement 2005).

**Wildlife Habitat:** Areas where plants, animals and other organisms live, and find adequate amounts of food, water, shelter and space needed to sustain their populations. Specific wildlife habitats of concern may include areas where species concentrate at a vulnerable point in the annual or life cycle; and areas which are important to migratory or non-migratory species (Provincial Policy Statement 2005).

**Woodlands:** Treed areas that provide environmental and economic benefits to both the private landowner and the general public, such as erosion prevention, hydrological and nutrient cycling, provision of clean air and the long-term storage of carbon, provision of wildlife habitat, outdoor recreational opportunities, and the sustainable harvest of a wide range of woodland products (Provincial Policy Statement 2005).

**Appendix A:  
Land Management Issues and Agricultural Best Management  
Practices Survey**

(Sample Survey Form)

## Land Management Issues and Agricultural Best Management Practices

*Please complete the following survey and return in the self-addressed, stamped envelope.*

"The Niagara Peninsula Conservation Authority collects and uses your personal information pursuant to Section 29(2) of the Municipal Freedom of Information Act 1991, and under the legal authority of the Conservation Authorities Act R.S.O. 1990 as amended." Questions regarding the policy or its administration should be directed to: Niagara Peninsula Conservation Authority, 250 Thorold Rd. W., 3<sup>rd</sup> Floor, Welland, ON L3C 2W3, Attn: Privacy Officer

### Background Information

1. Please indicate the municipality in which you live.

☐ Fort Erie   ☐ Niagara Falls   ☐ Niagara-on-the-Lake   ☐ Thorold   ☐ Welland   ☐ \_\_\_\_\_

2. Please indicate, based on the map provided, the watershed in which you live?

☐ Fort Erie Creeks   ☐ Niagara-on-the-Lake   ☐ South Niagara Falls

3. Please indicate the title that best describes your situation.

- ☐ Non-farm Landowner  
☐ Landowner / Farm Operator  
☐ Absentee Landowner  
☐ Tenant Farm Operator  
☐ Landowner / Farm Operator / Tenant Farm Operator  
☐ Other (specify): \_\_\_\_\_

4. How much agricultural land do you currently own in the watershed? \_\_\_\_\_

5. How much agricultural land do you currently rent in the watershed? \_\_\_\_\_

6. How much land do you have in production? \_\_\_\_\_  
and/or how many livestock do you have? \_\_\_\_\_

7. What type of agricultural commodity(s) do you produce? \_\_\_\_\_

8. Are you a member of any agricultural associations?

☐ Yes   ☐ No

If yes, please specify the name of the organization(s): \_\_\_\_\_

9. Do you make land management decisions for property that borders a stream or creek?

☐ Yes   ☐ No   ☐ Not Sure

10. What is the source of your drinking water (e.g., water well, cistern)? \_\_\_\_\_

11. Do you rely on a septic system for wastewater treatment?

☐ Yes   ☐ No



### Land Management Issues and Concerns

12. Please rank your top three concerns related to your land.

A rank of 1 would represent your most important concern, a rank of 2 would represent your next most important concern, and a rank of 3 would represent the least of your top three most important concerns.

First Concern: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Second Concern: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Third Concern: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

13. Please estimate how much of a problem you think each of the following issues will be in the next 5 to 10 years.

| Issue                                                                   | Not a Problem         | Slight Problem        | Moderate Problem      | Serious Problem       | Do Not Know           |
|-------------------------------------------------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| a. Nitrate, phosphate and bacteria levels in streams, rivers, and lakes | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| b. Nitrate, phosphate and bacteria levels in groundwater                | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| c. Pesticide levels in streams, rivers and lakes                        | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| d. Pesticide levels in groundwater                                      | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| e. Soil deposition in streams, rivers and lakes                         | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| f. Drinking water quality                                               | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| g. Soil loss from agricultural fields                                   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| h. Rivers and streams with eroding banks                                | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| i. Smells, noise, or dust from livestock operations                     | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| j. Smells, noise, or dust from non-agricultural business                | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| k. Seepage from septic tanks                                            | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |



| Issue                                                    | Not a Problem         | Slight Problem        | Moderate Problem      | Serious Problem       | Do Not Know           |
|----------------------------------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| l. Solid waste disposal                                  | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| m. Frequency of flooding                                 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| n. Economic losses due to flooding                       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| o. Economic costs of complying with land-use regulations | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| p. Loss of wetlands                                      | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| q. Loss of forested or wooded areas                      | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| r. Loss of agricultural land to development              | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| s. Loss of agricultural land to natural land             | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| t. Loss of natural land to development                   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| u. Loss of natural land to agricultural production       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| v. Wells drying up                                       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| w. Low surface water conditions (drought)                | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| x. Other (please specify):                               | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

#### Best Management Practices and Restoration Resources

14. Which of the following Best Management Practices (BMPs) do you currently use? Please select all that apply and specify the specific BMP.

|                                                                  |                                                                   |
|------------------------------------------------------------------|-------------------------------------------------------------------|
| <input type="checkbox"/> Tillage and seeding practices:<br>_____ | <input type="checkbox"/> Erosion control:<br>_____                |
| <input type="checkbox"/> Crop rotations:<br>_____                | <input type="checkbox"/> Residue management:<br>_____             |
| <input type="checkbox"/> Nutrient management:<br>_____           | <input type="checkbox"/> Pest management and pesticides:<br>_____ |
| <input type="checkbox"/> Irrigation:<br>_____                    | <input type="checkbox"/> Other (please specify):<br>_____         |



15. In your opinion, how would you rate the availability of restoration/conservation resources in the watershed?

|                                                                      | Bad                   | Poor                  | Fair                  | Good                  | Excellent             | Do Not Know           |
|----------------------------------------------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| a. The availability of restoration/conservation funding programs     | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| b. The availability of restoration/conservation technical assistance | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

16. List the restoration/conservation funding programs that you are aware of:

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17. If funding was available, would you be interested in pursuing a project on your property? If yes, please identify the type of project you would be interested in.

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### Communication

18. How do you prefer to obtain information about watershed planning in your watershed? Please select all that apply.

- ☐ Local newspaper (please indicate which newspaper) \_\_\_\_\_
- ☐ Direct mail newsletter
- ☐ Email
- ☐ Website
- ☐ Meetings of local groups and organizations
- ☐ Other (please specify): \_\_\_\_\_
- ☐ None

19. Please provide any additional comments:

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~ Thank you ~



## **Appendix B: Best Management Practices**

The following includes potential best management practices for the Lake Erie North Shore watershed derived in part from Niagara Region's and NPCA's policies regarding stormwater management; *Stormwater Management Policies and Guidelines, January 2010*. For detailed information regarding the policies please refer to directly to the document.

| Management Alternative                              | Description                                                                                                                                                                                                                                                                                                                                           |
|-----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Stormwater Best Management Practices</b>         |                                                                                                                                                                                                                                                                                                                                                       |
| <b>At Source and Lot-Level Quantity Controls</b>    |                                                                                                                                                                                                                                                                                                                                                       |
| Retrofit Existing Stormwater Basins                 | Modify older basins that were designed to control only the 100-year storm into multi-functional stormwater wetlands or conventional wet ponds.                                                                                                                                                                                                        |
| Retrofit Existing Detention Devices                 | Modify to incorporate forebays. Sediment forebays allow polluted sediments to settle out before water is discharged into the detention pond, thereby increasing treatment time and capacity.                                                                                                                                                          |
| Retrofit Infiltration Devices                       | Where soil permeability and depth to groundwater are sufficient, infiltration measures such as permeable pavement and infiltration trenches should be considered for introduction.                                                                                                                                                                    |
| Lot Control                                         | Ensure proper foundation drainage and type of soil and long-term behaviour as far as compaction should be considered. Reduced lot grading can be implemented for soil types with a minimum infiltration rate of 15mm/hr or greater.                                                                                                                   |
| Off-line Infiltration Basin                         | In new development areas design drainage corridors to include an infiltration basin which is not part of the main channel to capture water and allow it to slowly infiltrate into the soil.                                                                                                                                                           |
| Extended Detention Dry Basin                        | Design new developments to include stormwater basins that capture water and detain it for 24-40 hours before releasing it.                                                                                                                                                                                                                            |
| Catch Basin Restrictors                             | Detain storm water on parking lots or divert flows onto road surfaces, delaying the entry of storm water into the conveyance system.                                                                                                                                                                                                                  |
| Green Parking Lots                                  | Install new bioretention areas, infiltration areas, underground vaults, or other practices to detain and clean parking lot storm water before discharging. Encourage businesses to share parking space, require that vegetated spaces in parking lots be used to treat stormwater, encourage mass transit, and encourage permeable spillover parking. |
| Rain Gardens                                        | Planted depressions designed to receive excess rainwater runoff from buildings and associated landscape. During a storm event the rain garden fills with water and slowly percolates into the ground rather than draining towards a storm drain.                                                                                                      |
| Porous Paving for Low Traffic Roadways and Pathways | Parking areas, fire lanes, bicycle paths that consists of open-graded asphalt on a crushed stone base are capable of absorbing water reducing the amount of runoff entering the storm sewers.                                                                                                                                                         |
| <b>Conveyance Controls</b>                          |                                                                                                                                                                                                                                                                                                                                                       |
| "Daylighting" Storm Sewers                          | Eliminate a storm sewer or culvert and replace it with an open, vegetated channel.                                                                                                                                                                                                                                                                    |
| Vegetated Swales vs. Curb and Gutter                | Where density, topography, soils, and slope permit, vegetated open channels should be used in the street right-                                                                                                                                                                                                                                       |

|                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                  |
|--------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                          | of-way to convey and treat stormwater runoff instead of curb and gutter systems.                                                                                                                                                                                                                                                                                                                 |
| Vegetated Swale                                                          | Compared to storm sewers, overland flow offers longer contact time with the soil and allows settling of pollutants, nutrient uptake by vegetation and complete infiltration of smaller events.                                                                                                                                                                                                   |
| Road and highway runoff improvements                                     | Construct stormwater wetlands, pond systems, grassed swales, natural vegetation in highway rights-of-way open space.                                                                                                                                                                                                                                                                             |
| Pervious Pipe Systems                                                    | Convey runoff below ground level by allowing water to infiltrate through the pipe into adjacent soils, providing pollutant removal and reducing the amount of runoff in the storm sewer system                                                                                                                                                                                                   |
| Pervious Catch Basins                                                    | These are normal catch basins with a large sump connected to an exfiltration storage area. The storage area may be located either directly below the catch basin floor through a series of holes or beside the catch basin where low flows discharge through the wall of the catch basin into the exfiltration storage area.                                                                     |
| <b>End-of-Pipe Controls</b>                                              |                                                                                                                                                                                                                                                                                                                                                                                                  |
| Wet pond                                                                 | In new development areas include wet ponds that use a permanent storage pool to capture or transform dissolved pollutants thereby holding water and releasing it slowly back to the environment. Wet ponds also reduce peak flows and assist in sedimentation control.                                                                                                                           |
| Dry Ponds                                                                | Dry ponds only contain water during runoff events and for the length of time it takes for draw down. Dry ponds also provide storage, reduce peak flows, and assist in sedimentation control and pollutant removal.                                                                                                                                                                               |
| Constructed Wetlands                                                     | Offer peak flow reduction, storage, filtration, sedimentation, biological uptake, and absorption. Beneficial from a water quality perspective as they have the ability to trap and hold contaminants and pollutants.                                                                                                                                                                             |
| Infiltration Trench or Dry Well                                          | Design new developments to include an infiltration trench, which receives runoff in a shallow excavated trench that has been backfilled with stone to form a below-grade reservoir. Water can then slowly infiltrate into the soil.                                                                                                                                                              |
| Sand Filters                                                             | Sand filters can be used for smaller developments and urban areas with limited open space. This system uses sand in an underground catchment to filter stormwater.                                                                                                                                                                                                                               |
| Screening                                                                | Generally installed upstream of storage facilities or overflow structures to remove floatable material before water discharges into the receiving waters. Screening requires maintenance and can be prone to clogging.                                                                                                                                                                           |
| Oil/Grit Separators                                                      | Located in the place of conventional manhole below the ground in a storm drain system. Sediment in the runoff entering the separator is settled out and oil is removed through skimming and trapping. The separator implements the use of a permanent pool storage in the removal of hydrocarbons and sediment from storm water runoff before discharging into receiving waters or storm sewers. |
| <b>Rural/Urban Best Management Practices</b>                             |                                                                                                                                                                                                                                                                                                                                                                                                  |
| Conservation Tillage/Agricultural Filter Strips/Buffer and Filter Strips | Alter agricultural practices to encourage naturally vegetated buffers/filters around streams and rivers. Discourage landowners adjacent to watercourse from mowing to streambank.                                                                                                                                                                                                                |
| Lawn Debris Management                                                   | Grass trimmings and leaf litter can be controlled by                                                                                                                                                                                                                                                                                                                                             |

|                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                 |
|-----------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                 | composting or by community curb side collection programs. Compost can be converted to mulch, which when applied in lieu of fertilizer, can reduce nutrient excess into watercourses.                                                                                                                                                                                                            |
| Protect receiving waters from bank erosion                      | Stabilize existing steep slopes with bioengineering methods, and preserve and plant trees along streams to reduce bank erosion.                                                                                                                                                                                                                                                                 |
| Stream Channel Restoration/Stabilization                        | Construct pipe outlets and bank stabilization measures to prevent streambank erosion due to excessive discharge velocities (usually bioengineered).                                                                                                                                                                                                                                             |
| Constructed Wetland                                             | Build wetlands to capture pollutants from runoff draining urban and agricultural areas. Wetlands differ from basins in that they are shallower, and are planted with wetland plants to filter the water.                                                                                                                                                                                        |
| Rain Barrels                                                    | Rain barrels can be used to catch rooftop runoff for later use (e.g. watering gardens and lawns)                                                                                                                                                                                                                                                                                                |
| Downspout Disconnection                                         | Disconnecting downspouts from storm drains, or directing them away from paved surfaces that lead directly to the stormwater system allows water to infiltrate into unpaved soils. An education and incentive program should also be created for this alternative.                                                                                                                               |
| Native landscaping and/or tree planting                         | This measure includes planting street trees, and planting trees and plants in parking lot medians or in other landscapes. They can be designed so water flows into these areas before flowing into the stormwater system. Native plants do not need fertilizers, irrigation, or mowing, which can reduce phosphorus and possibly runoff.                                                        |
| Encourage diverse non-turf vegetation at stormwater basin edges | Educate landowners to allow long grasses and wetland plants to flourish in stormwater basins to filter the waste of, and discourage large populations of waterfowl.                                                                                                                                                                                                                             |
| <b>Planning and Development</b>                                 |                                                                                                                                                                                                                                                                                                                                                                                                 |
| Establish better enforcement, fines to ensure compliance        | May include hiring more staff to inspect and enforce regulations.                                                                                                                                                                                                                                                                                                                               |
| Improve septic system maintenance                               | Require septic system inspection and compliance at point-of-sale; encourage regular maintenance through incentive and/or education programs; and identify any currently failing systems so they can be fixed.                                                                                                                                                                                   |
| New/Revised Zoning By-Laws                                      | If necessary, a zoning by-law should be created or revised to meet water quality/quantity needs so that planning decisions based on that by-law are defensible.                                                                                                                                                                                                                                 |
| Conduct Zoning By-Law review                                    | Establish a committee to conduct a formal review of zoning by-laws from a planning perspective for open space and natural features protection/restoration.                                                                                                                                                                                                                                      |
| Adopt stormwater policies for new developments                  | This policy tool can be used to control and treat stormwater discharges whereas stormwater management must be addressed before building permits are issued.                                                                                                                                                                                                                                     |
| Encourage and/or regulate land use planning and management      | Develop policies limiting pavement, preserving open space and define locations for more on-site storm water management facilities, and zone/sizing criteria for on-site facilities.                                                                                                                                                                                                             |
| Integrate natural features into the planning process            | Through overlay zoning and other methods, valuable natural features should be taken into account when zoning and making planning decisions where such policies are not present. Coordination with municipalities in this area is necessary to preserve systems of open space, and reduce fragmentation of the natural complex of woodlands, prairies and other natural water filtering systems. |

|                                                                                               |                                                                                                                                                                                                                                                                                                         |
|-----------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Encourage open space site design                                                              | Reduction in lot size to preserve common open space of woodlands and wetlands; shared driveways, chipped paths, swales, reduction in road widths, and so forth.                                                                                                                                         |
| New/Revised Master Plans                                                                      | If substantial changes are made to implement stormwater quantity and quality measures, the master plan should be revisited so that it upholds the changes in natural features inventories, zoning priorities, and so forth to ensure that stormwater measures are not in conflict with the master plan. |
| Downzoning                                                                                    | Changes an established zone to a lower density level or less intense use. Can be used on strips of land adjacent to waterways to provide a buffer between industrial sites and the streambank or on a whole area surrounding a water body to reverse or prevent pollution.                              |
| Encourage and/or regulate land use planning and management                                    | Develop policies limiting pavement, preserving open space and define locations for more on-site storm water management facilities, and zone/sizing criteria for on-site facilities.                                                                                                                     |
| <b>Public Education and Participation</b>                                                     |                                                                                                                                                                                                                                                                                                         |
| Storm Drain Stencilling Program – Trout Unlimited “Yellow Fish” Program                       | Residents are frequently unaware that materials dumped down storm drains may be discharged to a local water body. Stencilling can create awareness and prevention.                                                                                                                                      |
| Citizen Monitoring (Adopt-a-Stream Program)                                                   | Citizen groups can collect valuable information on basic parameters – they can monitor and identify problems, collect surface water samples, and measure turbidity.                                                                                                                                     |
| Promotion of NPCAs Water Quality Improvement Program and Funding Opportunities for Landowners | This program guides restoration activities in the watershed, educates land-owners on how to do restoration and/or manage their land, organizes volunteers, and encourages stewardship.                                                                                                                  |
| Promote Incentive Programs for preservation of farmland, wooded areas and open space          | Work with agencies, organizations and individuals to promote incentive programs such as Conservation Land Tax Incentive Program, Managed Forest Tax Incentive Program and Farm Property Tax Class Tax Rate.                                                                                             |
| Reduce excess fertilizer nutrients applied to lawns                                           | Change excessive homeowner and golf course lawn fertilizer application habits by educating homeowners and managers about proper soil testing and lawn care practices.                                                                                                                                   |
| Reduce/apply only appropriate level of fertilizer to farm fields                              | Educate farmers and/or offer incentives to have soils tested for the appropriate application of fertilizers.                                                                                                                                                                                            |
| Develop an education program to encourage proper septic system maintenance                    | Proper maintenance of septic systems is essential in preventing septic failure, which pollutes natural water systems. Landowners must refrain from inappropriate plantings and uses on the septic field, and periodically arrange for the removal of solids from the system.                            |
| Utilize parks and public land for hands-on educational projects                               | Public places, especially along a watercourse/wetland, provide opportunities for public involvement and education. Projects could include streambank stabilization, native planting, invasive plant removal, logjam removal, wetland creation and so forth.                                             |
| Use recreational areas as demonstration/education opportunities                               | In park areas, develop educational signage (watershed awareness, natural vegetation and so forth) and/or create a demonstration/ interpretive area to illustrate natural landscaping, detention basin landscaping, and wetlands to teach about best management practices.                               |
| Watershed Signs/Project Signs                                                                 | Signs can be used to mark watershed boundaries, identify critical areas, promote specific behaviours in specific places, identify co-operators in a project, explain a project and its BMPs, and provide interpretive natural resources                                                                 |

|                                         |                                                                                                                                                                                                                                                                            |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                         | information.                                                                                                                                                                                                                                                               |
| Newspaper Articles                      | Newspaper articles provide detail about local success stories; photos of citizen activities; and feature stories provide information about problems and solutions. They can also be used to announce meetings or public involvement opportunities.                         |
| Newsletters                             | Newsletters are a good way to provide key messages and contribute a series of watershed management articles. They can also be used to announce meeting times and dates, update information on actions already taken, and list issues to be discussed at upcoming meetings. |
| Meetings/Open Houses                    | Public gatherings, club meetings, special conferences, and workshops can be used to explain a program and receive input, share information, plan actions, and evaluate progress.                                                                                           |
| Events                                  | Watershed displays should be set up at every opportunity – fairs, local Earth Day events, conferences, and school events.                                                                                                                                                  |
| Awards                                  | Recognize good work, and gain a variety of advocates for your program through conservation awards for young people, public service awards, and participation and sponsorship awards.                                                                                       |
| Use a website to host information       | Develop a Lake Erie North Shore Watershed website to keep agencies, organizations, and others updated about restoration programs.                                                                                                                                          |
| Training/workshops/presentations        | Many times, people do not change their habits and behaviours because they do not know what to do instead (composting, native landscaping, no-phosphorus lawn care, and so forth).                                                                                          |
| Involve Schools                         | Make presentations to classes or conduct field trips. Find out what schools are already doing and see how water quality education can fit into the curriculum.                                                                                                             |
| Form a committee/task force of citizens | Create a committee to work on specific aspects of the watershed program; try to include representatives from all interest groups.                                                                                                                                          |

**Appendix C:**  
**Examples of key Ontario ecological, infrastructure, and social**  
**values likely to be affected by climate change**

The following chart lists examples of key Ontario ecological, infrastructure, and social values likely to be affected by climate change. This chart is taken directly from a report published by the Ontario Ministry of Natural Resources entitled *Climate Change Projections for Ontario: Practical Information for Policymakers and Planners (2007b)*

| Area                   | Climate Change Impacts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Agriculture            | <ul style="list-style-type: none"> <li>Reduced productivity where temperature rises without a compensatory increase in precipitation</li> <li>Change in crops that can be grown</li> <li>Less suitable climate to produce ice wine in southern Ontario</li> <li>Longer growing season</li> <li>Expansion of agriculture into new areas of northern Ontario where soils are productive</li> </ul>                                                                                                                                                                                     |
| Environment            | <ul style="list-style-type: none"> <li>Changes in the biodiversity of species and ecosystems</li> <li>Increased difficulties for species currently at risk to survive or maintain their status</li> <li>New species at risk because of disequilibrium with climate</li> <li>Increased opportunity for natural migration of invasive species to Ontario</li> <li>Loss of plants and animals for which some protected areas were established</li> </ul>                                                                                                                                |
| Forestry               | <ul style="list-style-type: none"> <li>Increased frequency and more area burned by forest fires, placing stress on firefighting infrastructure and increasing the number and length of shutdowns of bush operations</li> <li>Regional changes in timber supply (some may increase while others decrease)</li> <li>Less access for forestry operations due to late freeze-up and mid-winter thaws</li> <li>Opportunities to plant faster-growing, less cold hardy tree species</li> <li>Migration of mountain pine beetle from Alberta threatening old-growth pine forests</li> </ul> |
| Human Health           | <ul style="list-style-type: none"> <li>Fewer winter cold alerts but more summer heat alerts</li> <li>More SMOG days</li> <li>Appearance of new insect-borne diseases</li> <li>Increased water quality issues due to less total precipitation but more extreme rainfall events</li> </ul>                                                                                                                                                                                                                                                                                             |
| Northern Communities   | <ul style="list-style-type: none"> <li>Threats to northern communities by forest fires will be more frequent</li> <li>Soil instability and shifting of houses and other structures due to melting permafrost</li> <li>Increased community isolation and higher cost of living due to shortened winter road season</li> </ul>                                                                                                                                                                                                                                                         |
| Power Generation       | <ul style="list-style-type: none"> <li>Higher maximum summer power requirements due to increased summer temperatures</li> <li>Lower winter maximum power requirements due to warmer winters</li> <li>Reduced hydroelectric power generation due to lower stream/river flow and lower lake levels</li> <li>More risk to power transmission lines from ice storms</li> </ul>                                                                                                                                                                                                           |
| Tourism and Recreation | <ul style="list-style-type: none"> <li>Fewer winter outdoor recreation opportunities in southern Ontario (e.g., less reliable skiing, snowmobiling, ice fishing, and outdoor ice skating)</li> <li>Longer warm weather outdoor recreation season (e.g., boating, camping, and golf)</li> </ul>                                                                                                                                                                                                                                                                                       |
| Transportation         | <ul style="list-style-type: none"> <li>Shorter road snow-clearing season</li> <li>Greater risk of freezing rain and need for de-icing in southern Ontario</li> <li>Longer Great Lakes shipping season</li> <li>More shipping disruptions and channel/harbour dredging due to lower Great Lakes water levels</li> </ul>                                                                                                                                                                                                                                                               |

The following table summarizes commonly identified changes to the hydrological cycle that are expected in the Great Lakes Basin resulting from climate change. This chart is taken directly from *Mainstreaming Climate Change in Drinking Water Source Protection Planning* (de Loe and Berg 2006).

| Hydrological Parameter | Expected Change in the 21 <sup>st</sup> Century, Great Lakes Basin                                                                                                                                                                                                                                                                              |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Runoff                 | <ul style="list-style-type: none"> <li>■ Decreased annual runoff, but increased winter runoff</li> <li>■ Earlier and lower spring freshet (the flow resulting from melting snow and ice)</li> <li>■ Summer and fall flows are lower and last longer</li> <li>■ Increased frequency of high flows due to extreme precipitation events</li> </ul> |
| Lake Levels            | <ul style="list-style-type: none"> <li>■ Lower net basin supplies and declining levels due to increased evaporation and timing of precipitation</li> <li>■ Increased frequency of low water levels</li> </ul>                                                                                                                                   |
| Groundwater Recharge   | <ul style="list-style-type: none"> <li>■ Decreased groundwater recharge, with shallow aquifers being especially sensitive</li> </ul>                                                                                                                                                                                                            |
| Groundwater Discharge  | <ul style="list-style-type: none"> <li>■ Changes in amount and timing of baseflow to streams, lakes and wetlands</li> </ul>                                                                                                                                                                                                                     |
| Ice Cover              | <ul style="list-style-type: none"> <li>■ Ice cover season reduced, or eliminated completely</li> </ul>                                                                                                                                                                                                                                          |
| Snow Cover             | <ul style="list-style-type: none"> <li>■ Reduced snow cover (depth, area, and duration)</li> </ul>                                                                                                                                                                                                                                              |
| Water Temperature      | <ul style="list-style-type: none"> <li>■ Increased water temperature in surface and water bodies</li> </ul>                                                                                                                                                                                                                                     |
| Soil Moisture          | <ul style="list-style-type: none"> <li>■ Soil moisture may increase by as much as 80% during winter in the basin, but decrease by as much as 30% in summer and autumn</li> </ul>                                                                                                                                                                |

**Appendix D:  
Summary of Legislation Governing  
Management in Ontario**

The following is not an exhaustive list of legislation governing management in Ontario. The purpose of the following chart is to provide insight into some of the management tools used in the province of Ontario.

| SUMMARY OF LEGISLATION GOVERNING MANAGEMENT IN ONTARIO |                                                                                                                                                                                                                                                                                                                             |                                                  |
|--------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
| MANAGEMENT TOOL                                        | DESCRIPTION                                                                                                                                                                                                                                                                                                                 | GOVERNMENT AGENCY                                |
| FEDERAL LEGISLATION                                    |                                                                                                                                                                                                                                                                                                                             |                                                  |
| Fisheries Act                                          | Established to manage and protect Canada's fisheries resources. It applies to all fishing zones, territorial seas and inland waters of Canada and is binding to federal, provincial and territorial governments                                                                                                             | Fisheries and Oceans Canada                      |
| Environmental Contaminants Act                         | Prevents dangerous contaminants from entering the environment.                                                                                                                                                                                                                                                              | Environment Canada                               |
| Canada Shipping Act                                    | Controls water pollution from ships by imposing penalties for dumping pollutants or failing to report a spill.                                                                                                                                                                                                              | Transport Canada                                 |
| Canada Water Act                                       | Authorizes agreements with provinces for the designation of water quality and quantity management.                                                                                                                                                                                                                          | Environment Canada                               |
| Canadian Environmental Protection Act                  | An Act respecting pollution prevention and the protection of the environment and human health in order to contribute to sustainable development. The Act is intended to protect the environment and human health from the risks posed by harmful pollutants and to prevent new ones from entering the Canadian environment. | Environment Canada                               |
| Canadian Environmental Assessment Act                  | Requires federal departments to conduct environmental assessments for prescribed projects and activities before providing federal approval or financial support.                                                                                                                                                            | Canadian Environmental Assessment Agency         |
| Pest Control Products Act                              | Regulates products used to control pests through a registration process based on prescribed standards.                                                                                                                                                                                                                      | Agriculture Canada                               |
| Navigable Waters Protection Act                        | Prohibits construction in navigable waters.                                                                                                                                                                                                                                                                                 | Transport Canada                                 |
| International Rivers Improvement Act                   | Prohibits damming or changing the flow of a river flowing out of Canada.                                                                                                                                                                                                                                                    | Foreign Affairs and Environment Canada           |
| Boundary Waters Treaty                                 | Established principles and procedures to prevent and resolve disputes, primarily those concerning the quantity and quality of boundary waters between Canada and the United States.                                                                                                                                         | International Joint Commission                   |
| International Boundary Waters Treaty Act               | The Act gives the federal government jurisdiction over boundary waters, such as the Great Lakes, in order to fulfill Canada's obligation under the Treaty not to affect unilaterally the level and flow of waters on the U.S. side of the boundary                                                                          | International Joint Commission                   |
| Canadian-Ontario Agreement                             | Federal-provincial agreement that supports the restoration and protection of the Great Lakes Basin Ecosystem. The Agreement between the governments of Canada and Ontario outlines how the two governments will cooperate and coordinate their efforts to restore, protect and conserve the Great Lakes basin ecosystem.    | Environment Canada & Ministry of the Environment |

|                                          |                                                                                                                                                                                                                                                                                                                                    |                                              |
|------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|
| Agricultural & Rural Development Act     | An Act to provide for federal-provincial agreements for the rehabilitation and development of rural areas in Canada                                                                                                                                                                                                                | Ministry of Industry, Science and Technology |
| Migratory Birds Convention Act, 1994     | The Act ensures the conservation of migratory bird populations by regulating potentially harmful human activities. A permit must be issued for all activities affecting migratory birds, with some exceptions detailed in the Regulations.                                                                                         | Environment Canada                           |
| Canada Wildlife Act                      | The Act allows for the creation, management and protection of wildlife areas for wildlife research activities, or for conservation or interpretation of wildlife.                                                                                                                                                                  | Environment Canada                           |
| Species at Risk Act                      | To prevent wildlife species in Canada from disappearing and to provide for the recovery of wildlife species that are extirpated (no longer exist in the wild in Canada), endangered, or threatened as a result of human activity, and to manage species of special concern to prevent them from becoming endangered or threatened. | Environment Canada                           |
| <b>PROVINCIAL LEGISLATION</b>            |                                                                                                                                                                                                                                                                                                                                    |                                              |
| Ontario Water Resources Act              | Protects the quality and quantity of Ontario's surface and ground water resources (includes Permits to Take Water).                                                                                                                                                                                                                | Ministry of the Environment                  |
| Clean Water Act                          | Protects the natural sources of drinking water. Sources of drinking water are to be mapped by municipalities and conservation authorities, especially vulnerable areas that require protections.                                                                                                                                   | Ministry of the Environment                  |
| Environmental Protection Act             | Protects Ontario's land, water, and air resources from pollution (includes Certificates of Approval for landfills, sewage treatment, etc.).                                                                                                                                                                                        | Ministry of the Environment                  |
| Environmental Assessment Act             | Requires an environmental assessment of any major public or designated private undertaking.                                                                                                                                                                                                                                        | Ministry of the Environment                  |
| Sustainable Water and Sewage Systems Act | To ensure clean, safe drinking water for Ontario residents by making it mandatory for municipalities to assess the costs of providing water and sewage services and to recover the amount of money needed to operate, maintain, and replace them.                                                                                  | Ministry of the Environment                  |
| Pesticides Act                           | Protects Ontario's land, and surface and ground water resources from damage due to improper use of pesticides.                                                                                                                                                                                                                     | Ministry of the Environment                  |
| Endangered Species Act                   | The purpose of the Act is to identify species at risk based on the best available scientific information, protect species that are at risk and their habitats, and promote the recovery of species that are at risk, and promote stewardship activities to assist in the protection and recovery of species that are at risk.      | Ministry of Natural Resources                |
| Fish and Wildlife Conservation Act, 1997 | This Act enables the Ministry of Natural Resources to provide sound management of the province's fish and wildlife game                                                                                                                                                                                                            | Ministry of Natural Resources                |
| Nutrient Management Act                  | The purpose of the Act is to provide for the management of materials, containing nutrients in ways that will enhance protection of the natural environment and provide a sustainable future for agricultural operations and rural development.                                                                                     | Ministry of the Environment                  |
| Conservation Authorities Act             | Ensures the conservation, restoration and responsible management of Ontario's water, land and natural habitats through programs that balance human, environmental and economic needs (includes floodplains).                                                                                                                       | Conservation Authorities                     |
| Lakes and Rivers                         | Ensures flow and water level characteristics of lakes and rivers are not altered to the point of                                                                                                                                                                                                                                   | Ministry of Natural                          |

|                                         |                                                                                                                                                                                                            |                                                 |
|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|
| Improvement Act                         | disadvantaging other water users.                                                                                                                                                                          | Resources                                       |
| Beds of Navigable Waters Protection Act | Declares the beds of navigable waters as the Crown's responsibility.                                                                                                                                       | Ministry of Natural Resources                   |
| Planning Act                            | Provides for and governs land use planning including the provision of statements of provincial interest to be regarded in the planning process.                                                            | Ministry of Municipal Affairs and Housing       |
| Ontario Planning and Development Act    | Authorizes Minister to establish development planning areas for promotion of the economic and environmental condition of areas                                                                             | Ministry of Municipal Affairs and Housing       |
| Development Charges Act                 | Empowers municipalities to impose development charges against land to be developed where the development will increase the need for municipal services.                                                    | Ministry of Municipal Affairs and Housing       |
| Greenbelt Plan (Act)                    | Identifies where urbanization should not occur in order to provide permanent protection to the agricultural land base and the ecological features and functions occurring on this landscape.               | Ministry of Municipal Affairs and Housing       |
| Provincial Policy Statement             | Issued under the Planning Act, it provides direction on matters of provincial interest related to land use planning and development, and promotes the provincial "policy-led" planning system.             | Ministry of Municipal Affairs and Housing       |
| Places to Grow Act                      | Ontario government's program to manage growth and development in Ontario in a way that supports economic prosperity, protects the environment and helps communities achieve a high quality of life         | Ministry of Energy and Infrastructure           |
| Public Lands Act                        | Protects and perpetuate public lands and waters for the citizens of Ontario.                                                                                                                               | Ministry of Natural Resources                   |
| Public Utilities Act                    | Empowers municipalities to acquire and operate water works and divert a lake or river for their purposes.                                                                                                  | Ministry of Municipal Affairs and Housing       |
| Drainage Act                            | Facilitates the construction, operation and maintenance of rural drainage works.                                                                                                                           | Ministry of Agriculture, Food and Rural Affairs |
| Tile Drainage Act                       | Provides for low interest loans to farmers from municipalities for tile drainage on their property.                                                                                                        | Ministry of Agriculture, Food and Rural Affairs |
| Building Code Act                       | The Building Code regulates standards for the construction and demolition of new buildings                                                                                                                 | Ministry of Municipal Affairs and Housing       |
| <b>UPPER AND LOWER TIER LEGISLATION</b> |                                                                                                                                                                                                            |                                                 |
| Municipal Act                           | Provides for the structure of single, upper and lower tier municipalities, and sets out their basic powers including the ability to regulate (e.g. licensing), provision of services, finances and roads.. | Ministry of Municipal Affairs and Housing       |
| Regional Municipalities Act             | This Act puts forth the structuring and governance of municipalities in support of the Municipal Act                                                                                                       | Ministry of Municipal Affairs and Housing       |
| Regional Municipality of Niagara Act    | This Acts puts forth the structuring and governance of municipalities in support of the Municipal Act and Regional Municipalities Act.                                                                     | Ministry of Municipal Affairs and Housing       |
| Town of Haldimand Act                   | Establishes a new single tier Town of Haldimand effective January 1, 2001. Establishes the composition of the Town council and sets out certain financial and other powers and duties of the new Town.     | Ministry of Municipal Affairs and Housing       |

|                                                                                                                   |                                                                                                                                                                                                                                                                                                                                   |                                                                                                              |
|-------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| City of Hamilton Act                                                                                              | Establishes a new single tier city of Hamilton effective January 1, 2001. Establishes the composition of the new City council and sets out certain financial and other powers and duties of the new city.                                                                                                                         | Ministry of Municipal Affairs and Housing                                                                    |
| Municipal Affairs Act                                                                                             | Give municipalities the power to be responsible and accountable governments with respect to matters within their jurisdiction and each municipality is given powers and duties under this Act and many other Acts for the purpose of providing good government with respect to those matters                                      | Ministry of Municipal Affairs and Housing                                                                    |
| Official Plans and Policy Plans                                                                                   | An official plan and/or policy plan describes your upper, lower or single-tier municipal council's policies on how land in your community should be used. It is prepared with input from you and others in your community and helps to ensure that future planning and development will meet the specific needs of your community | Regional or Municipal respective jurisdiction upon approval by the Ministry of Municipal Affairs and Housing |
| <b>CONSERVATION AUTHORITIES</b>                                                                                   |                                                                                                                                                                                                                                                                                                                                   |                                                                                                              |
| Conservation Authorities Act                                                                                      | Ensures the conservation, restoration and responsible management of Ontario's water, land and natural habitats through programs that balance human, environmental and economic needs (includes floodplains).                                                                                                                      | Ministry of Natural Resources                                                                                |
| Ontario Regulation 155/06- Development, Interference with Wetlands and Alterations to Shorelines and Watercourses | This regulation and associated policies are used by Conservation Authorities to regulate all watercourses, floodplains, valley lands, hazardous lands, wetlands, shorelines, and lands adjacent to these features/functions within their respective jurisdictions.                                                                | Ministry of Natural Resources                                                                                |

**Appendix E:  
NPCA Lake Erie North Shore Watershed Geomorphic  
Assessment**

| Lake Erie North Shore Visual Assessment |                        |                |                 |                   |                      |                            |                      |        |                       |               |                  |           |                      |                                         |                                                 |                                                                                                                                                                                                                                                             |
|-----------------------------------------|------------------------|----------------|-----------------|-------------------|----------------------|----------------------------|----------------------|--------|-----------------------|---------------|------------------|-----------|----------------------|-----------------------------------------|-------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Channel Condition:                      | Hydrologic Alteration: | Riparian Zone: | Bank Stability: | Water Appearance: | Nutrient Enrichment: | Barriers to Fish Movement: | Instream Fish Cover: | Pools: | Invertebrate Habitat: | Canopy Cover: | Manure Presence: | Salinity: | Riffle Embeddedness: | Macroinvertebrates observed (optional): | Overall Score (Total divided by number scored): | Rank:                                                                                                                                                                                                                                                       |
| Suspected Causes of Observed Problems   |                        |                |                 |                   |                      |                            |                      |        |                       |               |                  |           |                      |                                         |                                                 |                                                                                                                                                                                                                                                             |
| Recommendations                         |                        |                |                 |                   |                      |                            |                      |        |                       |               |                  |           |                      |                                         |                                                 |                                                                                                                                                                                                                                                             |
| 6                                       | 8                      | 4              | 6               | 8                 | 10                   | 4                          | 1                    | 7      | 10                    | N/A           | N/A              | N/A       | N/A                  | N/A                                     | 6.3                                             | Fair                                                                                                                                                                                                                                                        |
|                                         |                        |                |                 |                   |                      |                            |                      |        |                       |               |                  |           |                      |                                         |                                                 | Don't mow to the edge of the channel and allow vegetated habitat, as well as filter sediment and chemicals that may be contributing to sediment accumulation should be completed.                                                                           |
| 1                                       | 1                      | 1              | 5               | 1                 | 10                   | 5                          | 2                    | 3      | 1                     | N/A           | N/A              | N/A       | N/A                  | N/A                                     | 2.8                                             | Poor                                                                                                                                                                                                                                                        |
|                                         |                        |                |                 |                   |                      |                            |                      |        |                       |               |                  |           |                      |                                         |                                                 | Classified as Municipal drain; Channelized, no depositional features on the bed, and no deep pools; Steep banks with slumping occurring, there is also a bank revetment with some failure; Small riparian buffer; Algae and duckweed present.               |
| 3                                       | 10                     | 1              | 7               | 7                 | 10                   | 5                          | 1                    | 10     | 10                    | N/A           | N/A              | N/A       | N/A                  | N/A                                     | 6                                               | Poor                                                                                                                                                                                                                                                        |
|                                         |                        |                |                 |                   |                      |                            |                      |        |                       |               |                  |           |                      |                                         |                                                 | Classified as Municipal drain; Channelized, no depositional features on the bed, and no deep pools; Bank instability is present on both sides of channel; Deep unconsolidated sediment deposited along the bed.                                             |
| 3                                       | 5                      | 3              | 7               |                   | 10                   | 10                         | 3                    | 10     | 10                    | N/A           | N/A              | N/A       | N/A                  | N/A                                     | 6.2                                             | Fair                                                                                                                                                                                                                                                        |
|                                         |                        |                |                 |                   |                      |                            |                      |        |                       |               |                  |           |                      |                                         |                                                 | Classified as Municipal drain; Channelized, no depositional features on the bed, and no deep pools; Riparian buffer is small; Bank instability is present; Numerous debris jams in the upstream section; Bank revetment adjacent to a residential property. |
| 5                                       | 10                     | 5              | 8               | 8                 | 10                   | 5                          | 1                    | 7      | 10                    | N/A           | N/A              | N/A       | N/A                  | N/A                                     | 6.5                                             | Fair                                                                                                                                                                                                                                                        |
|                                         |                        |                |                 |                   |                      |                            |                      |        |                       |               |                  |           |                      |                                         |                                                 | Classified as Municipal drain; Channelized, no depositional features on the bed, and no deep pools; Deep unconsolidated sediment deposited along the bed; Bank instability present and at least 5 debris jams.                                              |
| 1                                       | 10                     | 5              | 3               | 4                 | 10                   | 7                          | 1                    | 10     | 7                     | N/A           | N/A              | N/A       | N/A                  | N/A                                     | 5.7                                             | Poor                                                                                                                                                                                                                                                        |
|                                         |                        |                |                 |                   |                      |                            |                      |        |                       |               |                  |           |                      |                                         |                                                 | Classified as Municipal drain; Channelized, no depositional features on the bed, and no deep pools; Bank revetment exists near outlet; Bank instability present; Algae, a brown film, and an oily sheen noted during site visit in 2008.                    |
| 3                                       | 5                      | 3              | 7               | 7                 | 10                   | 10                         | 7                    | 10     | 10                    | N/A           | N/A              | N/A       | N/A                  | N/A                                     | 7                                               | Fair                                                                                                                                                                                                                                                        |
|                                         |                        |                |                 |                   |                      |                            |                      |        |                       |               |                  |           |                      |                                         |                                                 | Classified as Municipal drain; Channelized; Deep unconsolidated sediment deposited along the bed; Bank instability present; Buffer small in areas; Small tributaries and/or rills/gullies present.                                                          |
| 8                                       | 10                     | 3              | 1               | 5                 | 10                   | 3                          | 1                    | 3      | 10                    | N/A           | N/A              | N/A       | N/A                  | N/A                                     | 5.4                                             | Poor                                                                                                                                                                                                                                                        |
|                                         |                        |                |                 |                   |                      |                            |                      |        |                       |               |                  |           |                      |                                         |                                                 | Classified as Municipal drain; Channelized, no depositional features on the bed, and no deep pools; Deep unconsolidated sediment deposited along the bed; Blocked culvert; Debris jams; Oily sheen and orangey red mass present.                            |
|                                         |                        |                |                 |                   |                      |                            |                      |        |                       |               |                  |           |                      |                                         |                                                 | Monitor water quality in this watershed; Remove debris whether it is adequately sized.                                                                                                                                                                      |

| Lake Erie North Shore Visual Assessment |                        |                |                 |                   |                      |                            |                      |        |                       |               |                  |           |                      |                                         |                                                 |       |                                                                                                                                                                                                                                                                 |
|-----------------------------------------|------------------------|----------------|-----------------|-------------------|----------------------|----------------------------|----------------------|--------|-----------------------|---------------|------------------|-----------|----------------------|-----------------------------------------|-------------------------------------------------|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Suspected Causes of Observed Problems   |                        |                |                 |                   |                      |                            |                      |        |                       |               |                  |           |                      |                                         |                                                 |       |                                                                                                                                                                                                                                                                 |
| Channel Condition:                      | Hydrologic Alteration: | Riparian Zone: | Bank Stability: | Water Appearance: | Nutrient Enrichment: | Barriers to Fish Movement: | Instream Fish Cover: | Pools: | Invertebrate Habitat: | Canopy Cover: | Manure Presence: | Salinity: | Riffle Embeddedness: | Macroinvertebrates observed (optional): | Overall Score (Total divided by number scored): | Rank: |                                                                                                                                                                                                                                                                 |
|                                         |                        |                |                 |                   |                      |                            |                      |        |                       |               |                  |           |                      |                                         |                                                 |       |                                                                                                                                                                                                                                                                 |
| 10                                      | 5                      | 5              | 7               | 7                 | 7                    | 10                         | 3                    | 1      | 3                     | 1             | N/A              | N/A       | N/A                  | N/A                                     | 5.2                                             | Poor  | Channelized, no depositional features on the bed; Bank instability present; No riparian buffer exists along left bank; Landowner complaint about flooding (dense instream vegetation and culvert present, confluence is very close to this site).               |
| 4                                       | 8                      | 6              | 7               | 7                 | 7                    | 10                         | 5                    | 2      | 7                     | 10            | N/A              | N/A       | N/A                  | N/A                                     | 6.5                                             | Fair  | Classified as Municipal drain; Channelized, no depositional features on the bed, and no deep pools; Bank instability present; Debris jams; Small tributaries and/or rills/gullies present; Dense in-channel vegetation.                                         |
| 2                                       | 5                      | 9              | 7               | 8                 | 10                   | 8                          | 1                    | 10     | 10                    | 10            | N/A              | N/A       | N/A                  | N/A                                     | 7.2                                             | Fair  | Classified as Municipal drain; Channelized, no depositional features on the bed; Small buffer; Deep unconsolidated sediment deposited along the bed; Wire mesh and small stones along bank; Vegetative debris thrown on bank; Possible degradation.             |
| 5                                       | 10                     | 5              | 6               | 5                 | 10                   | 5                          | 1                    | 3      | 1                     | 1             | N/A              | N/A       | N/A                  | N/A                                     | 4.9                                             | Poor  | Classified as Municipal drain; Channelized, no deep pools; Deep unconsolidated sediment on bed; Bank instability along both banks; Algae and oily sheen identified during site visit; Small tributaries and/or rills/gullies present.                           |
| 2                                       | 8                      | 5              | 2               | 5                 | 10                   | 3                          | 1                    | 1      | 1                     | 1             | N/A              | N/A       | N/A                  | N/A                                     | 3.7                                             | Poor  | Classified as Municipal drain; Channelized, no depositional features on the bed, no deep pools; Deep unconsolidated sediment deposited; Algae and turbid water noted; Small tributaries and/or rills/gullies present; Failed culvert present; Bank instability. |
| 3                                       | 10                     | 5              | 6               | 5                 | 10                   | 5                          | 5                    | 1      | 1                     | 1             | N/A              | N/A       | N/A                  | N/A                                     | 4.9                                             | Poor  | Classified as Municipal drain; Channelized, no deep pools; Deep unconsolidated sediment deposited; Algae noted; Small tributaries and/or rills/gullies present; Buffer consists mostly of herbaceous & shrubs; Bank instability on both banks.                  |
| 2                                       | 4                      | 1              | 5               | 5                 | 10                   | 6                          | 2                    | 6      | 1                     | 1             | N/A              | N/A       | N/A                  | N/A                                     | 4                                               | Poor  | Classified as Municipal drain; Channelized, no deep pools; Deep unconsolidated sediment deposited; Algae noted during site visit; Small tributaries and/or rills/gullies present; Small buffer; Bank instability on both banks.                                 |
| 6                                       | 10                     | 8              | 3               | 4                 | 10                   | 4                          | 1                    | 7      | 10                    | 10            | N/A              | N/A       | N/A                  | N/A                                     | 6.1                                             | Fair  | Classified as Municipal drain; Channelized, no deep pools; Deep unconsolidated sediment deposited (odour emitted when sediment disturbed which may be decomposing vegetation); Algae, duckweed, and turbid water noted during site visit.                       |
|                                         |                        |                |                 |                   |                      |                            |                      |        |                       |               |                  |           |                      |                                         |                                                 |       | Continue to monitor water quality and identify potential s limit the amount entering the channel.                                                                                                                                                               |

| Lake Erie North Shore Visual Assessment |                        |                |                 |                   |                      |                            |                            |              |                            |               |                  |           |                      |                                         |                                                 |       |                                                                                                                                                                                                                                                            |                                                                                                                                                                                   |
|-----------------------------------------|------------------------|----------------|-----------------|-------------------|----------------------|----------------------------|----------------------------|--------------|----------------------------|---------------|------------------|-----------|----------------------|-----------------------------------------|-------------------------------------------------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Channel Condition:                      | Hydrologic Alteration: | Riparian Zone: | Bank Stability: | Water Appearance: | Nutrient Enrichment: | Barriers to Fish Movement: | Instream Fish Cover:       | Pools:       | Invertebrate Habitat:      | Canopy Cover: | Manure Presence: | Salinity: | Riffle Embeddedness: | Macroinvertebrates observed (optional): | Overall Score (Total divided by number scored): | Rank: | Suspected Causes of Observed Problems                                                                                                                                                                                                                      | Recommendations                                                                                                                                                                   |
|                                         | 3                      | 1              | 3               | 1                 | 7                    | 10                         | 2 (can not see stream bed) | N/A (outlet) | 1 (can not see stream bed) | N/A           | N/A              | N/A       | N/A                  | N/A                                     | 3.2                                             | Poor  | Classified as Municipal drain; Channelized; Concrete and steel structures exist along both banks therefore impacting habitat and cover; Small buffer; Turbid water was noted; Floodgate present across the channel.                                        | Increase habitat and shading along the watercourse upstream and natural channel design; Increase the buffer size; Consider natural channel design.                                |
| 6                                       | 5                      | 7              | 3               | 7                 | 7                    | 10                         | 5                          | 1            | 9                          | 1             | N/A              | N/A       | N/A                  | N/A                                     | 5.4                                             | Poor  | Classified as Municipal drain; Channelized; Deep unconsolidated sediment deposited on bed; Turbid water noted; Buffer smaller adjacent to road and residential property; Some bank instability present; Some vegetative debris being thrown onto the bank. | Increase buffer; Long term monitoring of sediment accumulation; Don't throw vegetated debris over the bank.                                                                       |
| 6                                       | 3                      | 5              | 6               | 6                 | 10                   | 8                          | 8                          | 8            | 10                         | 1             | N/A              | N/A       | N/A                  | N/A                                     | 5.9                                             | Poor  | Classified as Municipal drain; Channelized; Deep unconsolidated sediment deposited on bed; Bank instability present; Small buffer along the right bank (some trees have been planted); Turbid water and carp were noted during site visit.                 | Increase the size of the buffer along the right bank; Long term monitoring of sediment accumulation; Continue to monitor water quality.                                           |
| 4                                       | 8                      | 5              | 7               | 8                 | 10                   | 10                         | 10                         | 1            | 7                          | 10            | N/A              | N/A       | N/A                  | N/A                                     | 6.6                                             | Fair  | Classified as Municipal drain; Channelized, no deep pools; Deep unconsolidated sediment deposited on bed; Bank instability and fallen vegetation; Oily sheen on water surface noted; Riprap identified along outer bend.                                   | Don't grade channel banks too steep during dredging so they become established & stabilize the soil; Continue to monitor sediment accumulation; Ensure proper bank stabilization. |
| 6                                       | 7                      | 4              | 1               | 5                 | 10                   | 5                          | 6                          | 7            | 7                          | 10            | N/A              | N/A       | N/A                  | N/A                                     | 6.1                                             | Fair  | Classified as Municipal drain (hasn't been cleaned out in some time); Channelized; Bank instability present; Deep unconsolidated sediment deposited on bed upstream; Algae and oily sheen noted; Grass clippings thrown onto bank.                         | Monitor water quality; Stop throwing grass clippings onto bank; Continue bank stabilization used; Long term monitoring of sediment accumulation.                                  |
| 2                                       | 4                      | 4              | 7               | 3                 | 10                   | 6                          | 2                          | 7            | 7                          | 10            | N/A              | N/A       | N/A                  | N/A                                     | 5.3                                             | Poor  | Classified as Municipal drain; Channelized, no deep pools; Deep unconsolidated sediment deposited on bed; Bank instability present; Algae noted; Small buffer; Small tributaries and/or rills/gullies present; Dense aquatic vine present.                 | Don't grade channel banks too steep during dredging so they become established & stabilize the soil; Long term monitoring of sediment accumulation; Implement rill prevention.    |

| Lake Erie North Shore Visual Assessment |                        |                |                 |                   |                      |                            |                      |        |                       |               |                  |           |                      |                                         |                                                 |       |                                                                                                                                                                                                                                                       |                                                                                                                                                                                             |
|-----------------------------------------|------------------------|----------------|-----------------|-------------------|----------------------|----------------------------|----------------------|--------|-----------------------|---------------|------------------|-----------|----------------------|-----------------------------------------|-------------------------------------------------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Suspected Causes of Observed Problems   |                        |                |                 |                   |                      |                            |                      |        |                       |               |                  |           |                      |                                         |                                                 |       |                                                                                                                                                                                                                                                       |                                                                                                                                                                                             |
| Recommendations                         |                        |                |                 |                   |                      |                            |                      |        |                       |               |                  |           |                      |                                         |                                                 |       |                                                                                                                                                                                                                                                       |                                                                                                                                                                                             |
| Channel Condition:                      | Hydrologic Alteration: | Riparian Zone: | Bank Stability: | Water Appearance: | Nutrient Enrichment: | Barriers to Fish Movement: | Instream Fish Cover: | Pools: | Invertebrate Habitat: | Canopy Cover: | Manure Presence: | Salinity: | Riffle Embeddedness: | Macroinvertebrates observed (optional): | Overall Score (Total divided by number scored): | Rank: |                                                                                                                                                                                                                                                       |                                                                                                                                                                                             |
| 2                                       | 7                      | 6              | N/A             | 7                 | 10                   | 3                          | 1                    | 3      | 1                     | 1             | N/A              | N/A       | N/A                  | N/A                                     | 4.2                                             | Poor  | Classified as Municipal drain; Channelized, no deep pools; Deep unconsolidated sediment deposited on bed; Small tributaries and/or rills/gullies present; Small buffer; Dense instream vegetation (herbaceous).                                       | Don't grade channel banks too steep during dredging so they become established & stabilize the soil; Long term monitoring; Implement rill prevention measures; Increase buffer.             |
| 3                                       | 4                      | 5              | 8               | 8                 | 10                   | 5                          | 2                    | 4      | 10                    | 10            | N/A              | N/A       | N/A                  | N/A                                     | 5.2                                             | Poor  | Classified as Municipal drain; Channelized, no deep pools; Deep unconsolidated sediment deposited on bed; Bank instability present; Small tributaries and/or rills/gullies present; Small buffer; Dense instream vegetation (herbaceous).             | Don't grade channel banks too steep during dredging so they become established & stabilize the soil; Long term monitoring; Implement rill prevention measures; Increase buffer.             |
| 4                                       | 10                     | 5              | 6               | 6                 | 10                   | 5                          | 8                    | 7      | 10                    | 10            | N/A              | N/A       | N/A                  | N/A                                     | 6.7                                             | Fair  | Classified as Municipal drain; Channelized, no deep pools; Deep unconsolidated sediment deposited on bed; Bank instability present; Small tributaries and/or rills/gullies present; Algae & oily sheen noted; Dense instream vegetation (herbaceous). | Don't grade channel banks too steep during dredging so they become established & stabilize the soil; Long term monitoring; Implement rill prevention; Increase buffer; Continue to monitor. |
| 7                                       | 4                      | 8              | 3               | 5                 | 10                   | 5                          | 2                    | 7      | 1                     | 1             | N/A              | N/A       | N/A                  | N/A                                     | 5.4                                             | Poor  | Classified as Municipal drain; Channelized, no deep pools; Deep unconsolidated sediment deposited on bed; Oily sheen noted; Small tributaries and/or rills/gullies present; Little canopy cover; Crossing with no culvert; Dense instream vegetation. | Increase large woody vegetation in buffer; Long term monitoring; sediment accumulation; Implement rill prevention measures; Consider installing a culvert at crossing.                      |
| 7                                       | 9                      | 8              | 4               | 8                 | 10                   | 5                          | 1                    | 3      | 1                     | 1             | N/A              | N/A       | N/A                  | N/A                                     | 5.7                                             | Poor  | Classified as Municipal drain; Channelized, no deep pools; Deep unconsolidated sediment deposited on bed (odour emitted when disturbed); Small tributaries and/or rills/gullies present.                                                              | Long term monitoring of sediment accumulation; Implement riparian zone measures.                                                                                                            |
| 6                                       | 8                      | 7              | N/A             | N/A               | 10                   | 5                          | 1                    | 6      | 10                    | 10            | N/A              | N/A       | N/A                  | N/A                                     | 6.7                                             | Fair  | Classified as Municipal drain; Channelized, no deep pools; Small tributaries and/or rills/gullies present.                                                                                                                                            | Implement rill prevention measures.                                                                                                                                                         |
| 5                                       | 5                      | 6              | 8               | 10                | 10                   | 4                          | 1                    | 3      | 1                     | 1             | N/A              | N/A       | N/A                  | N/A                                     | 5.3                                             | Poor  | Channelized; Small buffer along the right bank; Some bank instability adjacent to the garage in the form of bare soil extending up the bank.                                                                                                          | Don't grade channel banks too steep during dredging so they become established & stabilize the soil; Proper bank protection; Implement riparian zone stabilization of bank area.            |

| Lake Erie North Shore Visual Assessment |                        |                |                 |                   |                      |                            |                      |        |                       |               |                  |           |                      |                                         |                                                 |       |                                                                                                                                                                                                                                                                |                                                                                                                                                                                                              |
|-----------------------------------------|------------------------|----------------|-----------------|-------------------|----------------------|----------------------------|----------------------|--------|-----------------------|---------------|------------------|-----------|----------------------|-----------------------------------------|-------------------------------------------------|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Suspected Causes of Observed Problems   |                        |                |                 |                   |                      |                            |                      |        |                       |               |                  |           |                      |                                         | Recommendations                                 |       |                                                                                                                                                                                                                                                                |                                                                                                                                                                                                              |
| Channel Condition:                      | Hydrologic Alteration: | Riparian Zone: | Bank Stability: | Water Appearance: | Nutrient Enrichment: | Barriers to Fish Movement: | Instream Fish Cover: | Pools: | Invertebrate Habitat: | Canopy Cover: | Manure Presence: | Salinity: | Riffle Embeddedness: | Macroinvertebrates observed (optional): | Overall Score (Total divided by number scored): | Rank: |                                                                                                                                                                                                                                                                |                                                                                                                                                                                                              |
| 1                                       | 5                      | 4              | 4               | 4                 | 3                    | 10                         | 3                    | 1      | 3                     | 1             | N/A              | N/A       | N/A                  | N/A                                     | 3.4                                             | Poor  | Channelized; Bank instability present; Small buffer along left bank due to road; Failed culvert at Lakeshore Road; Vegetative debris being thrown onto bank; Algae, duckweed, and dense aquatic vegetation noted; Water pumped in from Quarry.                 | Plant deep rooted vegetation along the bank; Continue throwing vegetative debris over the bank; Replace/fix failed culvert.                                                                                  |
| 7                                       | 1                      | 1              | 7               | 7                 | 4                    | 10                         | 3                    | 1      | 3                     | 1             | N/A              | N/A       | N/A                  | N/A                                     | 3.5                                             | Poor  | Classified as Municipal drain; Channelized; Bank instability present; Riprap & a concrete block wall present; Numerous culverts at this location; Small buffer; Vegetated debris being thrown onto the bank; Algae noted; Grate covering culvert at Vimy Road. | Determine whether hard engineering structures can be used to stabilize the bank; Increase cover & habitat within riparian zone; Monitor water quality in this watershed; Stop throwing debris into the lake. |
| 8                                       | 5                      | 8              | 4               | 4                 | 3                    | 10                         | 3                    | 1      | 7                     | 10            | N/A              | N/A       | N/A                  | N/A                                     | 6.1                                             | Fair  | Classified as Municipal drain; Channelized; Bank instability present; Buffer in open area of park consists of few trees and manicured lawn; Algae and duckweed noted; Upstream there is deep unconsolidated sediment deposited on the bed (odour emitted).     | Don't grade channel banks too steep during dredging so they don't erode; Establish native vegetation; Create a buffer strip; Monitor water quality; Long term monitoring of sediment accumulation.           |
| 3                                       | 5                      | 3              | 6               | 6                 | 6                    | 10                         | 5                    | 1      | 7                     | 1             | N/A              | N/A       | N/A                  | N/A                                     | 4.6                                             | Poor  | Classified as Municipal drain; Channelized; Bank instability present; Small buffer adjacent to residential property and road; Flows through a culvert for 80-90m (grate covering culvert may restrict larger fish from entering watercourse).                  | Don't grade channel banks too steep during dredging so they don't erode; Establish native vegetation; Assess bank stability; Monitor water quality.                                                          |
| 10                                      | 10                     | 10             | 5               | 2                 | 10                   | 5                          | 1                    | 7      | 10                    | 10            | N/A              | N/A       | N/A                  | N/A                                     | 6.8                                             | Fair  | Classified as Municipal drain; Channelized; Oily sheen, brown film, duckweed, and algae noted; Deep unconsolidated sediment and organic material deposited on the bed.                                                                                         | Continue to monitor water quality; Long term monitoring of sediment accumulation.                                                                                                                            |
| 8                                       | 10                     | 10             | 5               | 3                 | 10                   | 5                          | 1                    | 7      | 10                    | 10            | N/A              | N/A       | N/A                  | N/A                                     | 6.7                                             | Fair  | Classified as Municipal drain; Channelized; Duckweed noted; Deep unconsolidated sediment and organic material deposited on the bed.                                                                                                                            | Continue to monitor water quality; Long term monitoring of sediment accumulation.                                                                                                                            |
| 10                                      | 10                     | 10             | 2               | 3                 | 10                   | 5                          | 1                    | 7      | 10                    | 10            | N/A              | N/A       | N/A                  | N/A                                     | 6.6                                             | Fair  | Classified as Municipal drain; Channelized; Oily sheen, orangey red mass, and duckweed noted during site visit; Deep unconsolidated sediment and organic material deposited on the bed.                                                                        | Continue to monitor water quality; Long term monitoring of sediment accumulation.                                                                                                                            |
| 10                                      | 10                     | 9              | 5               | 3                 | 10                   | 5                          | 1                    | 7      | 10                    | 10            | N/A              | N/A       | N/A                  | N/A                                     | 6.8                                             | Fair  | Classified as Municipal drain; Channelized; Duckweed noted during site visit; Erosion on both sides of foot bridge indicating that bridge may be constricting the channel; Deep unconsolidated sediment and organic material deposited on the bed.             | Don't grade channel banks too steep during dredging so they don't erode; Establish native vegetation; Continue to monitor water quality; Replace the foot bridge.                                            |

| Lake Erie North Shore Visual Assessment |                        |                |                 |                   |                      |                            |                      |        |                       |               |                  |           |                      |                                         |                                                 |      |                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                         |
|-----------------------------------------|------------------------|----------------|-----------------|-------------------|----------------------|----------------------------|----------------------|--------|-----------------------|---------------|------------------|-----------|----------------------|-----------------------------------------|-------------------------------------------------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Suspected Causes of Observed Problems   |                        |                |                 |                   |                      |                            |                      |        |                       |               |                  | Rank:     |                      | Recommendations                         |                                                 |      |                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                         |
| Channel Condition:                      | Hydrologic Alteration: | Riparian Zone: | Bank Stability: | Water Appearance: | Nutrient Enrichment: | Barriers to Fish Movement: | Instream Fish Cover: | Pools: | Invertebrate Habitat: | Canopy Cover: | Manure Presence: | Salinity: | Riffle Embeddedness: | Macroinvertebrates observed (optional): | Overall Score (Total divided by number scored): |      |                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                         |
| 7                                       | 10                     | 7              | 5               | 5                 | 5                    | 10                         | 5                    | 3      | 7                     | 10            | N/A              | N/A       | N/A                  | N/A                                     | 6.7                                             | Fair | Classified as Municipal drain; Channelized; Deep unconsolidated sediment and organic material deposited on the bed; Duckweed was noted during site visit.                                                                                                  | Don't grade channel banks too steep during dredging so they become established & stabilize the soil; Continue to monitor for accumulation of sediment.                                                                                                  |
| 5                                       | 5                      | 5              | 7               | 5                 | 5                    | 10                         | 5                    | 1      | 7                     | 10            | N/A              | N/A       | N/A                  | N/A                                     | 6.1                                             | Fair | Classified as Municipal drain; Channelized; Bank instability present; Lack of buffer in some areas; Failed culvert present; Asphalt adjacent to foot bridge cracking indicating constriction; Deep sediment on bed; Oily sheen; Potential rills/gullies.   | Increase buffer; Replace foot bridge if constricting; Replenish riparian vegetation; Monitor water quality; Continue sediment monitoring of sediment accumulation.                                                                                      |
| 3                                       | 8                      | 3              | 7               | 6                 | 10                   | 10                         | 7                    | 10     | 10                    | 10            | N/A              | N/A       | N/A                  | N/A                                     | 6.9                                             | Fair | Classified as Municipal drain; Channelized; Bank instability present; Duckweed and oily sheen noted; Floodgate present which would constrict the channel; Sediment deposition near floodgate; Concrete slabs used as bank protection.                      | Don't grade channel banks too steep during dredging so they become established & stabilize the soil; Continue to monitor for accumulation of sediment; Ensure proper bank stabilization measures.                                                       |
| 5                                       | 5                      | 5              | 8               | 5                 | 10                   | 5                          | 1                    | 7      | 1                     | 1             | N/A              | N/A       | N/A                  | N/A                                     | 5                                               | Poor | Classified as Municipal drain; Channelized; Bank instability present; Lawn mowed to edge in some areas; Lack of large woody vegetation in some areas; Duckweed noted; Deep unconsolidated sediment deposited on bed.                                       | Don't grade channel banks too steep during dredging so they become established & stabilize the soil; Increase buffer width; Monitor water quality; Continue sediment monitoring.                                                                        |
| 3                                       | 3                      | 5              | 6               | 1                 | 10                   | 3                          | 1                    | 5      | 1                     | 1             | N/A              | N/A       | N/A                  | N/A                                     | 3.5                                             | Poor | Classified as Municipal drain; Channelized; Bank instability present; Concrete block wall exists along the right bank; Lack of large woody vegetation impacting canopy cover; Duckweed, algae, and an oily sheen noted; Possible rill/gulley formation.    | Don't grade channel banks too steep during dredging so they become established & stabilize the soil; Increase buffer width; Implement riparian zone measures.                                                                                           |
| 5                                       | 9                      | 5              | 2               | 3                 | 10                   | 3                          | 1                    | 1      | 1                     | 1             | N/A              | N/A       | N/A                  | N/A                                     | 3.9                                             | Poor | Classified as Municipal drain; Channelized; Algae and duckweed noted; Turbid water noted upstream; Small tributaries and/or rills/gullies present; Old bridge abutments are narrower than current channel width indicating widening; Deep sediment on bed. | Don't grade channel banks too steep during dredging so they become established & stabilize the soil; Increase large woody vegetation; Monitor water quality; Implement riparian zone measures.                                                          |
| 4                                       | 7                      | 2              | 5               | 4                 | 10                   | 5                          | 1                    | 7      | 1                     | 1             | N/A              | N/A       | N/A                  | N/A                                     | 4.5                                             | Poor | Classified as Municipal drain; Channelized; Bank instability present; Algae and duckweed noted; Deep unconsolidated sediment deposited on the bed; Small buffer and lack of large woody vegetation.                                                        | Don't grade channel banks too steep during dredging so they become established & stabilize the soil; Increase buffer width; Continue sediment monitoring of sediment accumulation; Continue to monitor water quality.                                   |
| 8                                       | 6                      | 7              | 6               | 6                 | 10                   | 5                          | 2                    | 3      | 10                    | 10            | N/A              | N/A       | N/A                  | N/A                                     | 6.0                                             | Poor | Classified as Municipal drain; Channelized; Deep unconsolidated sediment deposited on the bed in some areas; Small buffer in some areas.                                                                                                                   | Increase buffer zone; Long term monitoring of sediment accumulation; Monitor water quality.                                                                                                                                                             |
| 3                                       | 5                      | 3              | 3               | 5                 | 10                   | 8                          | 7                    | 7      | 10                    | 10            | N/A              | N/A       | N/A                  | N/A                                     | 5.8                                             | Poor | Classified as Municipal drain; Channelized; Bank instability present; Algae noted; Deep unconsolidated sediment deposited on the bed in some areas; Small tributaries and/or rills/gullies present.                                                        | Don't grade channel banks too steep during dredging so they become established & stabilize the soil; Increase buffer width; Continue sediment monitoring of sediment accumulation; Continue to monitor water quality; Implement riparian zone measures. |

| Lake Erie North Shore Visual Assessment |                        |                |                 |                   |                      |                            |                      |        |                       |               |                  |           |                      |                                         |                                                 |       |                                                                                                                                                                                                                                                           |                                                                                                                                                                   |
|-----------------------------------------|------------------------|----------------|-----------------|-------------------|----------------------|----------------------------|----------------------|--------|-----------------------|---------------|------------------|-----------|----------------------|-----------------------------------------|-------------------------------------------------|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Suspected Causes of Observed Problems   |                        |                |                 |                   |                      |                            |                      |        |                       |               |                  |           |                      | Recommendations                         |                                                 |       |                                                                                                                                                                                                                                                           |                                                                                                                                                                   |
| Channel Condition:                      | Hydrologic Alteration: | Riparian Zone: | Bank Stability: | Water Appearance: | Nutrient Enrichment: | Barriers to Fish Movement: | Instream Fish Cover: | Pools: | Invertebrate Habitat: | Canopy Cover: | Manure Presence: | Salinity: | Riffle Embeddedness: | Macroinvertebrates observed (optional): | Overall Score (Total divided by number scored): | Rank: |                                                                                                                                                                                                                                                           |                                                                                                                                                                   |
|                                         | 5                      | 3              | 5               | 5                 | 5                    | 10                         | 8                    | 5      | 3                     | 10            | N/A              | N/A       | N/A                  | N/A                                     | 5.6                                             | Poor  | Classified as Municipal drain; Channelized; Bank instability present; Small buffer adjacent to residential property; Algae noted during site visit.                                                                                                       | Don't grade channel banks too steep during dredging so they become established & stabilize the soil; Increase buffer quality.                                     |
| 7                                       | 5                      | 5              | 5               | 8                 | 8                    | 10                         | 3                    | 5      | 3                     | 10            | N/A              | N/A       | N/A                  | N/A                                     | 6                                               | Poor  | Classified as Municipal drain; Channelized; Bank instability present; Small buffer zone; Small tributaries and/or rills/gullies present.                                                                                                                  | Increase size of buffer zone; Implement rill prevention measures.                                                                                                 |
|                                         | 5                      | 5              | 6               | 7                 | 8                    | 10                         | 3                    | 4      | 5                     | 10            | N/A              | N/A       | N/A                  | N/A                                     | 6.2                                             | Fair  | Classified as Municipal drain; Channelized; Small buffer in various locations.                                                                                                                                                                            | Increase buffer zone.                                                                                                                                             |
| 5                                       | 5                      | 5              | 5               | N/A               | 8                    | 10                         | 3                    | 1      | 5                     | 10            | N/A              | N/A       | N/A                  | N/A                                     | 5.7                                             | Poor  | Classified as Municipal drain; Channelized; Very steep banks and small buffer in various locations; A watercourse flows between the agricultural fields and into this drain (this watercourse could be a rill/gulley).                                    | Increase buffer zone; Monitor watercourse (between agricultural fields) to prevent additional sediment from entering the main watercourse.                        |
| 3                                       |                        |                |                 |                   | 7                    | 10                         | 3                    | 1      | 7                     | 1             | N/A              | N/A       | N/A                  | N/A                                     | 4.9                                             | Poor  | Classified as Municipal drain; Channelized; Bank instability present; Lack of large woody vegetation; Algae noted during site visit; Small tributaries and/or rills/gullies present.                                                                      | Don't grade channel banks too steep during dredging so they become established & stabilize the soil; Increase buffer quality; Implement rill prevention measures. |
| 7                                       | 2                      | 7              | 5               | 3                 |                      | 10                         | 3                    | 3      | 3                     | 1             | N/A              | N/A       | N/A                  | N/A                                     | 4.5                                             | Poor  | Classified as Municipal drain; Channelized; Lack of large woody vegetation; Small buffer adjacent to agricultural field; Algae noted; Deep unconsolidated sediment deposited along the bed in some areas; Small tributaries and/or rills/gullies present. | Increase buffer zone; Implement rill prevention measures to prevent sediment accumulation; Continue to monitor water quality.                                     |
|                                         | 5                      | 8              | 5               | 7                 | 3                    | 10                         | 7                    | 3      | 7                     | 10            | N/A              | N/A       | N/A                  | N/A                                     | 5.9                                             | Fair  | Channelized; Dense instream vegetation noted; Bank instability present; Small tributaries and/or rills/gullies present.                                                                                                                                   | Implement rill prevention measures.                                                                                                                               |

## Reach Locations





## **Appendix F: Natural Heritage Species Reference List**

| Common Name           | Scientific Name                          |
|-----------------------|------------------------------------------|
| American Beech        | <i>Fagus grandifolia</i>                 |
| American Elm          | <i>Ulmus americana</i>                   |
| Arrow-wood            | <i>Viburnum dentatum</i>                 |
| Avens                 | <i>Geum sp.</i>                          |
| Awl fruited Sedge     | <i>Carex stipata</i>                     |
| Basswood              | <i>Tilia americana</i>                   |
| Beach Pea             | <i>Lathyrus japonicus</i>                |
| Bebb's Willow         | <i>Salix bebbiana</i>                    |
| Bitternut Hickory     | <i>Carya cordiformis</i>                 |
| Black Ash             | <i>Fraxinus nigra</i>                    |
| Black Cherry          | <i>Prunus serotina</i>                   |
| Black Maple           | <i>Acer nigrum</i>                       |
| Black Raspberry       | <i>Rbus occidentalis</i>                 |
| Black Walnut          | <i>Juglans nigra</i>                     |
| Bladdernut            | <i>Staphylea trifolia</i>                |
| Bladder Sedge         | <i>Carex intumescens</i>                 |
| Blue Cohosh           | <i>Caulophyllum thalictroides</i>        |
| Blueflag              | <i>Iris versicolor</i>                   |
| Broad leaved Cattails | <i>Typha latifolia</i>                   |
| Bulrush spp.          | <i>Scirpus spp.</i>                      |
| Bur Oak               | <i>Quercus macrocarpa</i>                |
| Canada Blue joint     | <i>Calamagrostis canadensis</i>          |
| Cattails              | <i>Typha sp.</i>                         |
| Choke Cherry          | <i>Prunus virginiana ssp. virginiana</i> |
| Clammy Weed           | <i>Polanisia dodecandra</i>              |
| Climbing Poison ivy   | <i>Rhus radicans ssp. negundo</i>        |
| Common Buckthorn      | <i>Rhamnus cathartica</i>                |
| Common Duckweed       | <i>Lemna minor</i>                       |
| Common Reed           | <i>Phragmites australis</i>              |
| Coontail              | <i>Ceratophyllum demersum</i>            |
| Crested Sedge         | <i>Carex cristatella</i>                 |
| Dogwood spp.          | <i>Cornus spp.</i>                       |
| Eastern Cottonwood    | <i>Populus deltoides ssp. deltoides</i>  |
| Eastern Hemlock       | <i>Tsuga canadensis</i>                  |
| False Nettle          | <i>Boehmeria cylindrica</i>              |
| False Solomon's Seal  | <i>Maianthemum racemosum</i>             |
| Freeman's Maple       | <i>Acer fremanii</i>                     |
| Fox Sedge             | <i>Carex vulpinoidea</i>                 |
| Fowl Manna Grass      | <i>Glyceria striata</i>                  |
| Garlic Mustard        | <i>Allaria petiolata</i>                 |
| Gray Dogwood          | <i>Cornus foemina ssp. racemosa</i>      |
| Green Ash             | <i>Fraxinus pennsylvanica</i>            |
| Goldenrods            | <i>Solidago sp.</i>                      |
| Hemlock               | <i>Tsuga Canadensis</i>                  |
| Herb Robert           | <i>Geranium robertianum</i>              |
| Hop Hornbeam          | <i>Ostrya virginiana</i>                 |
| Jewelweed             | <i>Balsaminaceae</i>                     |
| Lesser Duckweed       | <i>Lemna minor</i>                       |
| Maple                 | <i>Acer spp.</i>                         |

DRAFT  
LAKE ERIE NORTH SHORE WATERSHED PLAN

|                           |                                      |
|---------------------------|--------------------------------------|
| Manitoba Maple            | <i>Acer negundo</i>                  |
| Nannyberry                | <i>Viburnum lentago</i>              |
| Narrow-leaved Meadowsweet | <i>Spiraea alba</i>                  |
| Nodding Fescue            | <i>Festuca subverticillata</i>       |
| Oak spp.                  | <i>Quercus spp.</i>                  |
| Pickernelweed             | <i>Pontederia cordata</i>            |
| Pignut Hickory            | <i>Carya glabra</i>                  |
| Pin Oak                   | <i>Quercus palustris</i>             |
| Pondweed                  | <i>Potamogetonaceae</i>              |
| Poplar                    | <i>Populus fastigiata</i>            |
| Porcupine Sedge           | <i>Carex hystercina</i>              |
| Radiate Sedge             | <i>Carex radiata</i>                 |
| Red Ash                   | <i>Fraxinus pennsylvanica</i>        |
| Red Elm                   | <i>Ulmus rubra</i>                   |
| Red Maple                 | <i>Acer rubrum</i>                   |
| Red Oak                   | <i>Quercus rubra</i>                 |
| Red Pine                  | <i>Pinus resinosa</i>                |
| Reed Canary Grass         | <i>Phalaris arundinacea</i>          |
| Rice Cut Grass            | <i>Leersia oryzoides</i>             |
| River bank grape          | <i>Vitis riparia</i>                 |
| Running Strawberry        | <i>Euonymus obovata</i>              |
| Rushes                    | <i>Juncus sp</i>                     |
| Scotts Pine               | <i>Pinus sylvestris</i>              |
| Sea Rocket                | <i>Cakile edentula</i>               |
| Sedges                    | <i>Carex sp.</i>                     |
| Sensitive Fern            | <i>Onoclea sensibilis</i>            |
| Shagbark Hickory          | <i>Carya ovata</i>                   |
| Silky Dogwood             | <i>Cornus amomum ssp. obliqua</i>    |
| Silver Maple              | <i>Acer saccharinum</i>              |
| Solomon's Seal            | <i>Polygonatum canalicalatum</i>     |
| Southern Arrow-wood       | <i>Viburnum recognitum</i>           |
| Spicebush                 | <i>Lindera benzoin</i>               |
| Spotted Touch-me-nots     | <i>Impatiens capensis</i>            |
| Staghorn Sumac            | <i>Rhus typhina</i>                  |
| Stout Woodreed            | <i>Cinna arundinacea</i>             |
| Sugar Maple               | <i>Acer saccharum ssp. saccharum</i> |
| Swamp Maple               | <i>Acer fremanii</i>                 |
| Swamp Rose                | <i>Rosa palustris</i>                |
| Swamp White Oak           | <i>Quercus bicolor</i>               |
| Thicket Creeper           | <i>Parthenocissus inserta</i>        |
| Three-lobed Beggar-ticks  | <i>Bidens tripartita</i>             |
| Trembling Aspen           | <i>Populus tremuloides</i>           |
| Tulip Tree                | <i>Liriodendron tulipifera</i>       |
| Watermilfoil              | <i>Haloragidaceae</i>                |
| Water Plantain            | <i>Alismataceae</i>                  |
| Western Poison ivy        | <i>Rhus radicans ssp. rydbergii</i>  |
| White Ash                 | <i>Fraxinus americana</i>            |
| White Elm                 | <i>Ulmus americana</i>               |
| White Pine                | <i>Pinus strobus</i>                 |
| White Trillium            | <i>Trillium grandiflorum</i>         |
| White Oak                 | <i>Quercus alba</i>                  |

**DRAFT**  
LAKE ERIE NORTH SHORE WATERSHED PLAN

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|              |                              |
|--------------|------------------------------|
| Wild Leeks   | <i>Allium tricoccum</i>      |
| Willow       | <i>Salix sp.</i>             |
| Winterberry  | <i>Gaultheria procumbens</i> |
| Yellow Birch | <i>Betula alleghaniensis</i> |
| Yew Tree     | <i>Taxus canadensis</i>      |

## **Appendix G: Riparian, Wetland and Upland Habitat Restoration Guidelines**

Restoration guidelines for riparian, wetland and forest habitat as recommended by Environment Canada (2005) in its *How Much Habitat is Enough?* document. This framework was used as a guideline in the Lake Erie North Shore Restoration Strategy.

| RIPARIAN HABITAT GUIDELINES                           |                                                                                                                                                                                                                                                                                                          |
|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Parameter                                             | Guideline                                                                                                                                                                                                                                                                                                |
| Percent of stream naturally vegetated                 | 75 percent of stream length should be naturally vegetated.                                                                                                                                                                                                                                               |
| Amount of natural vegetation adjacent to streams      | Streams should have a minimum 30 metre wide naturally vegetated adjacent-lands area on both sides, greater depending on site-specific conditions.                                                                                                                                                        |
| Total suspended sediments                             | Where and when possible suspended sediment concentrations should be below 25 milligrams/litre or be consistent with Canadian Council of Ministers of the Environment (1999) guidelines.                                                                                                                  |
| Percent of an urbanizing watershed that is impervious | Less than 10 percent imperviousness in an urbanizing watershed should maintain stream water quality and quantity, and preserve aquatic species density and biodiversity. An upper limit of 30 percent represents the threshold for degraded systems.                                                     |
| Fish communities                                      | Watershed guidelines for fish communities can be established based on knowledge of underlying characteristics of a watershed (e.g., drainage area, surficial geology, flow regime), historic and current fish communities, and factors (and their relative magnitudes) that currently impact the system. |

| WETLAND HABITAT GUIDELINES                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Parameter                                            | Guideline                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Percent wetlands in watersheds and subwatersheds     | Greater than 10 percent of each major watershed in wetland habitat; greater than 6 percent of each subwatershed in wetland habitat; or restore to original percentage of wetlands in the watershed.                                                                                                                                                                                                                                              |
| Amount of natural vegetation adjacent to the wetland | For key wetland functions and attributes, the identification and maintenance of the Critical Function Zone and its protection, along with an appropriate Protection Zone is the primary concern. Where this is not derived from site-specific characteristics, the following are minimum guidelines:<br>Bog – the total catchment area<br>Marsh – 100 metres<br>Fen – 100 metres or as determined by hydrogeological study<br>Swamp – 100 metres |
| Wetland Type                                         | The only 2 wetland types suitable for widespread rehabilitation are marshes and swamps.                                                                                                                                                                                                                                                                                                                                                          |
| Wetland Location                                     | Wetlands can provide benefits anywhere in the watershed, but particular wetland functions can be achieved by rehabilitating wetlands in key locations, such as headwater areas for groundwater discharge and recharge, flood plains for flood attenuation, and coastal wetlands for fish production. Special attention should be paid to historic wetland locations or site and soil conditions.                                                 |
| Wetland Size                                         | Wetlands of a variety of sizes, types, and hydroperiods should be maintained across a landscape. Swamps and marshes of sufficient size to support habitat heterogeneity are particularly important.                                                                                                                                                                                                                                              |
| Wetland Shape                                        | As with upland forests, in order to maximize habitat opportunities for edge-tolerant species, and where the surrounding matrix is not natural habitat, swamps should be regularly shaped with minimum edge and maximum interior habitat.                                                                                                                                                                                                         |

| FOREST HABITAT GUIDELINES                                                            |                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Parameter                                                                            | Guideline                                                                                                                                                                                                                                                                                                                                                                                          |
| Percent forest cover                                                                 | At least 30 percent of the watershed should be in forest cover.                                                                                                                                                                                                                                                                                                                                    |
| Size of largest forest patch                                                         | A watershed or other land unit should have at least one 200 hectare forest patch that is a minimum 500 metres in width.                                                                                                                                                                                                                                                                            |
| Percent of watershed that is forest cover 100 metres and 200 metres from forest edge | The proportion of the watershed that is forest cover 100 metres or further from the forest edge should be greater than 10 percent. The proportion of the watershed that is forest cover 200 metres further from the forest edge should be greater than 5 percent.                                                                                                                                  |
| Forest shape                                                                         | To be of maximum use to species such as forest-breeding birds that are intolerant of edge habitat, forest patches should be circular or square in shape.                                                                                                                                                                                                                                           |
| Proximity to other forested patches                                                  | To be of maximum use to species such as forest-breeding birds, forest patches should be within 2 to 1 kilometre of one another or other supporting habitat features.                                                                                                                                                                                                                               |
| Fragmented landscapes and the role of corridors                                      | Connectivity width will vary depending on the objectives of the project and the attributes of the nodes that will be connected. Corridors designed to facilitate species movement should be a minimum of 50 metres to 100 metres in width. Corridors designed to accommodate breeding habitat for specialist species need to be designed to meet the habitat requirements of those target species. |
| Forest quality – species composition and age structure                               | Watershed forest cover should be representative of the full diversity of forest types found at that latitude.                                                                                                                                                                                                                                                                                      |

The following chart is taken directly from *Conservation Buffers; Design Guidelines for Buffers, Corridors, and Greenways* (Bentrup 2008).

| Issue and Objectives                                                             | Buffer Functions                                                                                                      |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| <b>Water Quality</b>                                                             |                                                                                                                       |
| Reduce erosion and runoff of sediment, nutrients, and other potential pollutants | Slow water runoff and enhance infiltration<br>Trap pollutants in surface runoff<br>Trap pollutants in subsurface flow |
| Remove pollutants from water runoff and wind                                     | Stabilize soil<br>Reduce bank erosion                                                                                 |
| <b>Biodiversity</b>                                                              |                                                                                                                       |
| Enhance terrestrial habitat                                                      | Increase habitat area<br>Protect sensitive habitats<br>Restore connectivity                                           |
| Enhance aquatic habitat                                                          | Increase access to resources<br>Shade stream to maintain temperature                                                  |
| <b>Productive Soils</b>                                                          |                                                                                                                       |
| Reduce soil erosion                                                              | Reduce water runoff energy<br>Reduce wind energy                                                                      |
| Increase soil productivity                                                       | Stabilize soil<br>Improve soil quality<br>Remove soil pollutants                                                      |
| <b>Economic Opportunities</b>                                                    |                                                                                                                       |
| Provide income sources                                                           | Produce marketable products                                                                                           |
| Increase economic diversity                                                      | Reduce energy consumption<br>Increase property values                                                                 |
| Increase economic value                                                          | Provide alternative energy sources<br>Provide ecosystem services                                                      |
| <b>Protection and Safety</b>                                                     |                                                                                                                       |
| Protect from wind or snow                                                        | Reduce wind energy                                                                                                    |
| Increase biological control of pests                                             | Modify microclimate<br>Enhance habitat for predators of pests                                                         |
| Protect from flood waters                                                        | Reduce flood water levels and erosion                                                                                 |
| Create a safe environment                                                        | Reduce hazards                                                                                                        |
| <b>Aesthetics and Visual Quality</b>                                             |                                                                                                                       |
| Enhance visual quality                                                           | Enhance visual interest<br>Screen undesirable views                                                                   |
| Control noise levels                                                             | Screen undesirable noise                                                                                              |
| Control air pollutants and odor                                                  | Filter air pollutants and odors<br>Separate human activities                                                          |
| <b>Outdoor Recreation</b>                                                        |                                                                                                                       |
| Promote nature-based recreation                                                  | Increase natural area<br>Protect natural areas<br>Protect soil and plant resources                                    |
| Use buffers as recreational trails                                               | Provide a corridor for movement<br>Enhance recreational experience                                                    |

## **Appendix H: Restoration Suitability Criteria and Weighting Scheme**

RATIONALE

Areas within closest proximity to watercourses or waterbodies will be most suitable to restoration. These areas contribute to both riparian buffer and floodplain. Restoration in these areas will improve hydrological, habitat and water quality functions.

In terms of potential conflict, existing land use type is scaled in terms of suitability to restoration. Areas classified as scrub, low intensity agriculture, or natural area are much more suitable to restoration than areas classified as industrial or built-up urban.

Considers the presence of vegetation in terms of hydrological and mechanical contribution to bank stability and erosion control. As slope increases, restoration suitability increases.

Catchments which drain to watercourses classified as Fish Habitat are considered more suitable, as restoration projects will contribute to food, shelter, temperature moderation and oxygen production.

Catchments which drain to watercourses in headwater streams are considered more suitable for restoration than those that drain to higher ordered streams in terms of water quality improvement.

It is more suitable to restore habitat where vegetation does not presently exist, or where infilling may be necessary from a previous restoration project.

Riparian areas identified as having high erosion rates resulting from upslope contributing area and slope gradient analysis are most suitable to restoration with bioengineering.

Areas within C.A. boundaries are protected from development pressure and destruction. Areas in close proximity to these boundaries are good areas to restore in terms of establishing connectivity.

METHODOLOGY

Generate straight line distance surface from watercourses and waterbodies. Reclassify surface values where lowest distances have highest suitability values, reflecting riparian and floodplain location.

Generate Land Use surface on Land Use Type value. Reclassify Land Use values where low conflict land use types have higher suitability values than high conflict land use types.

Generate slope surface from DEM. Reclassify surface where higher slope values have higher suitability values.

Generate surface from catchment polygons on fish habitat classification value. Reclassify values according to restoration suitability.

Generate surface from catchment polygons on stream order value. Reclassify values according to restoration suitability.

Generate surface from natural vegetation polygons based on vegetation type. Reclassify cells lacking forest cover as highest suitability values.

Generate wetness index surface from topographic analysis. Reclassify surface where highest erosion rates have highest suitability values.

Generate straight line distance surface from Conservation Area boundary polygons. Reclassify surface values according to restoration suitability.

REFERENCE

Niagara River AOC RAP  
Riparian Habitat Guidelines

Niagara Peninsula Conservation  
Authority

Niagara Peninsula Conservation  
Authority

Niagara Peninsula Conservation  
Authority

Niagara River AOC RAP  
Riparian Habitat Guidelines

Niagara River AOC RAP  
Riparian Habitat Guidelines

Niagara Peninsula Conservation  
Authority

Niagara Peninsula Conservation  
Authority

| RATIONALE              |                                                                                                                                                                                                                                                                               | METHODOLOGY                                                                                                                                                                                               | REFERENCE                                                              |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| Wetland Patch          | Areas within closest proximity to existing wetland patches of highest Natural Heritage Score (core size) will be most suitable to restoration of increased interior habitat.                                                                                                  | Select existing patches with highest size significance value. Generate distance surface from selected patches. Reclassify surface values where lowest distances have highest suitability values.          | Niagara River AOC RAP<br>Wetland Extent Guidelines                     |
|                        | Areas within closest proximity to existing wetland patches of highest Natural Heritage score (nearest neighbor) will be most suitable to restoration.                                                                                                                         | Select existing patches with highest size significance value. Generate distance surface from selected patches. Reclassify surface values where lowest distances have highest suitability values.          | Niagara River AOC RAP<br>Wetland Extent Guidelines                     |
| Waterbody              | Areas within closest proximity to watercourses or waterbodies will be most suitable to restoration. These areas contribute to both riparian buffer and floodplain. Restoration in these areas will improve hydrological, habitat and water quality functions.                 | Generate straight line distance surface from watercourses and waterbodies. Reclassify surface values where lowest distances have highest suitability values, reflecting riparian and floodplain location. | Niagara River AOC RAP<br>Wetland Extent Guidelines                     |
| Wetland by Agriculture | The drainage class of the underlying soil determines the amount of water the soil can receive and store before runoff. The more poorly drained the underlying soil, the more suitable the area to wetland restoration.                                                        | Generate surface from OMAF soil polygons based on drainage class. Reclassify surface according to suitability values.                                                                                     | North Carolina<br>Coastal Region Evaluation of<br>Wetland Significance |
|                        | In terms of potential conflict, existing land use type is scaled in terms of suitability to restoration. Areas classified as scrub, low intensity agriculture, or natural area are much more suitable to restoration than areas classified as industrial or built-up urban.   | Generate Land Use surface on Land Use Type value. Reclassify Land Use values where low conflict land use types have higher suitability values than high conflict land use types.                          | Niagara Peninsula Conservation<br>Authority                            |
| Wetland Catchment      | Catchments which drain to watercourses classified as Fish Habitat are considered more suitable, as restoration projects will contribute to food, shelter, temperature moderation and oxygen production.                                                                       | Generate surface from catchment polygons on fish habitat classification value. Reclassify values according to restoration suitability.                                                                    | Niagara Peninsula Conservation<br>Authority                            |
|                        | Catchments which drain to watercourses in headwater streams are considered more suitable for restoration than those that drain to higher ordered streams in terms of water quality improvement.                                                                               | Generate surface from catchment polygons on stream order value. Reclassify values according to restoration suitability.                                                                                   | Niagara River AOC RAP<br>Wetland Extent Guidelines                     |
| Wetland by Agriculture | The wetness index equation predicts zones of water saturation where steady-state conditions and uniform soil properties are assumed. It is a function of upslope contributing area and slope gradient. Areas of highest W.I. values are most suitable to wetland restoration. | Generate wetness index surface from slope gradient and flow accumulation. Reclassify surface where highest Wetness Index values have highest suitability values.                                          | Niagara Peninsula Conservation<br>Authority                            |

## CRITERIA: UPLAND HABITAT

## RATIONALE

## METHODOLOGY

## REFERENCE

*Areas within C.A. boundaries are protected from development pressure and destruction. Areas in close proximity to these boundaries are more suitable to restore in terms of establishing connectivity.*

Generate straight line distance surface from Conservation Area boundary polygons. Reclassify surface values according to restoration suitability.

*Areas within closest proximity to existing forest patches of highest of Natural Heritage Score (core size) will be most suitable to restoration increased interior habitat.*

Select existing patches with highest size significance value.  
Generate distance surface from selected patches. Reclassify surface values where lowest distances have highest suitability values.

*Areas within closest proximity to existing forest patches of highest Natural Heritage score (nearest neighbor) will be most suitable to restoration of wildlife corridors.*

Select existing patches with highest proximity significance value.  
Generate distance surface from selected patches. Reclassify surface values where lowest distances have highest suitability values.

Areas within closest proximity to watercourses or waterbodies will be most suitable for restoration. These areas contribute to both riparian buffer and floodplain. Restoration in these areas will improve hydrological, habitat and water quality functions.

Generate straight line distance surface from watercourses and waterbodies. Reclassify surface values where lowest distances have highest suitability values, reflecting riparian and floodplain location.

*In terms of potential conflict, existing land use type is scaled in terms of suitability to restoration. Areas classified as scrub, low intensity agriculture, or natural area are much more suitable to restoration than areas classified as industrial or built-up urban.*

Generate surface from 1992 Landsat 7 Landuse Classification on Land Use Type value . Reclassify Land Use values where low conflict land use types have higher suitability values than high conflict land use types.

*Catchments which drain to watercourses classified as Fish Habitat are considered more suitable, as restoration projects will contribute to food, shelter, temperature moderation and oxygen production.*

Generate surface from catchment polygons on fish habitat classification value. Reclassify values according to restoration suitability.

*Catchments which drain to watercourses in headwater streams are considered more suitable for restoration than those that drain to higher ordered streams in terms of water quality improvement.*

Generate surface from catchment polygons on stream order value. Reclassify values according to restoration suitability.

*Areas within these buffer distances contribute to a range of habitat*

Generate straight line distance surface from wetlands. Reclassify

Niagara Peninsula Conservation  
AuthorityNiagara River AOC RAP  
Evaluation of Upland HabitatNiagara River AOC RAP  
Evaluation of Upland HabitatNiagara River AOC RAP  
Riparian Habitat GuidelinesNiagara Peninsula Conservation  
AuthorityNiagara Peninsula Conservation  
AuthorityNiagara River AOC RAP  
Evaluation of Upland Habitat

Niagara River AOC RAP

|                                                                                                                                                                                                                                                        |                                                                                                                                                          |                                                                         |                                   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|-----------------------------------|
| <p>transitions within vegetation. Vegetation within 500m of proximity to the wetland provides the greatest benefit to that wetland. These areas are thus considered most suitable to restoration.</p>                                                  | <p>Generate straight line distance surface from Conservation Area boundary polygons. Reclassify surface values according to restoration suitability.</p> | <p>Niagara Peninsula Conservation Authority</p>                         | <p>Wetland Expert Consultancy</p> |
| <p>Areas within C.A. boundaries are protected from development pressure and destruction. Areas in close proximity to these boundaries are good areas to restore in terms of establishing connectivity.</p>                                             | <p>Generate slope surface from DEM. Reclassify surface where higher slope values have higher suitability values.</p>                                     | <p>North Carolina Coastal Region Evaluation of Wetland Significance</p> |                                   |
| <p>Considers the presence of forest cover in terms of hydrological and mechanical contribution to slope stability and erosion control. As slope increases, restoration suitability increases.</p>                                                      | <p>Generate surface from natural vegetation polygons based on vegetation type. Reclassify areas lacking forest cover as highest suitability values.</p>  | <p>Niagara River AOC RAP Evaluation of Upland Habitat</p>               |                                   |
| <p>The amount of forest cover must be increased in order to meet habitat targets. It is obviously more suitable to restore forest habitat where it does not presently exist, or where infilling may be necessary from a previous restoration site.</p> |                                                                                                                                                          |                                                                         |                                   |

## **Appendix I: Mitigation Measures for Drain Maintenance**

Mitigation Measures implemented in drains. This information was taken directly from Fisheries and Oceans Canada publication *The Drain Primer: A Guide to Maintaining and Conserving Agricultural Drains and Fish Habitat*

## MITIGATION MEASURES

### Timing

Digging should be done so as to avoid local fish spawning or nursing periods. If done at the wrong time, suspended sediments from the maintenance work might prevent spawning, smother eggs, or kill young fish.

### Option: Do the Project in the Summer

Summer may be a good time to do maintenance work when drains are dry or have little flow. This way the crane or backhoe operators can see exactly what needs to be cleaned out without the obstruction of clouded water. Doing the work when the ditch is relatively dry also

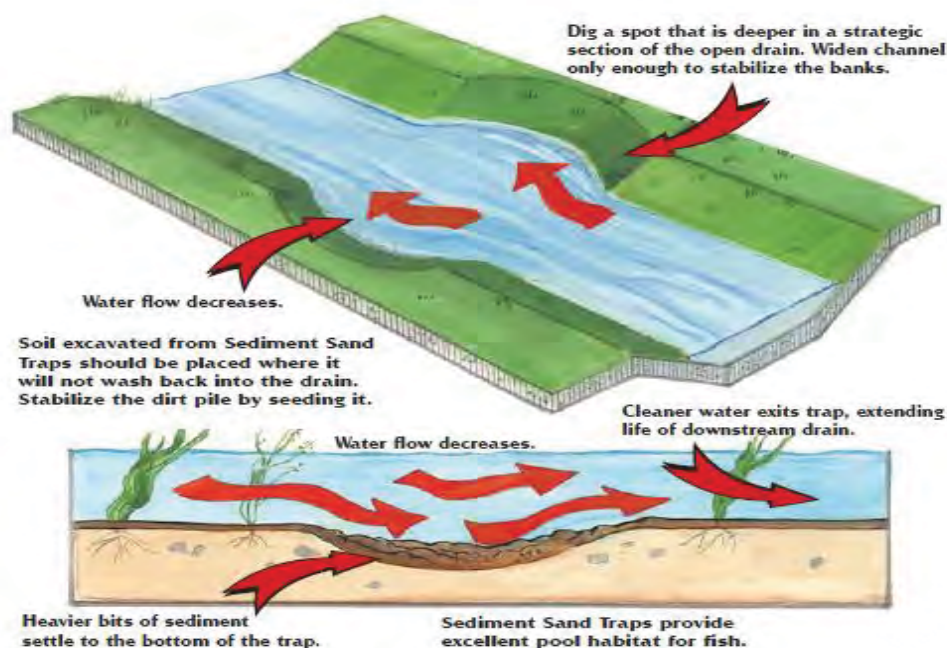
ensures that little, if any, sediment will float downstream where it might impact fish. As well, maintenance should be done as quickly as possible in order to limit the amount of disruption to fish migration and habitat

### Sediment Controls

If work is undertaken while water is still flowing in the drain, controls need to be put in place to prevent the flow of sediment downstream. The following options are essentially designed for areas with sandy or sandy loam soils.

### Option: Sediment Sand Traps

Sediment sand traps are created by strategically digging a spot that is deeper in the open drain. Excessive widening of the channel should be avoided, however the channel should be widened enough to stabilize the banks. This larger hole acts as a settling pond, slowing down water as it drops into the deeper spot. As the water flow decreases, heavier sediments and debris settle to the bottom of the trap, somewhat improving the quality of the water leaving the trap and moving downstream.



The sediment sand trap technique can be low cost when compared to other conventional methods. Farmers and municipalities need only worry about cleaning the trap out, which is a lot cheaper than paying for a full-scale clean out. Less of the drain is disturbed and clean out is quicker. Sand traps should be placed in spots easily accessible so as to avoid having to drive over planted crops in order to get maintenance equipment to the site.

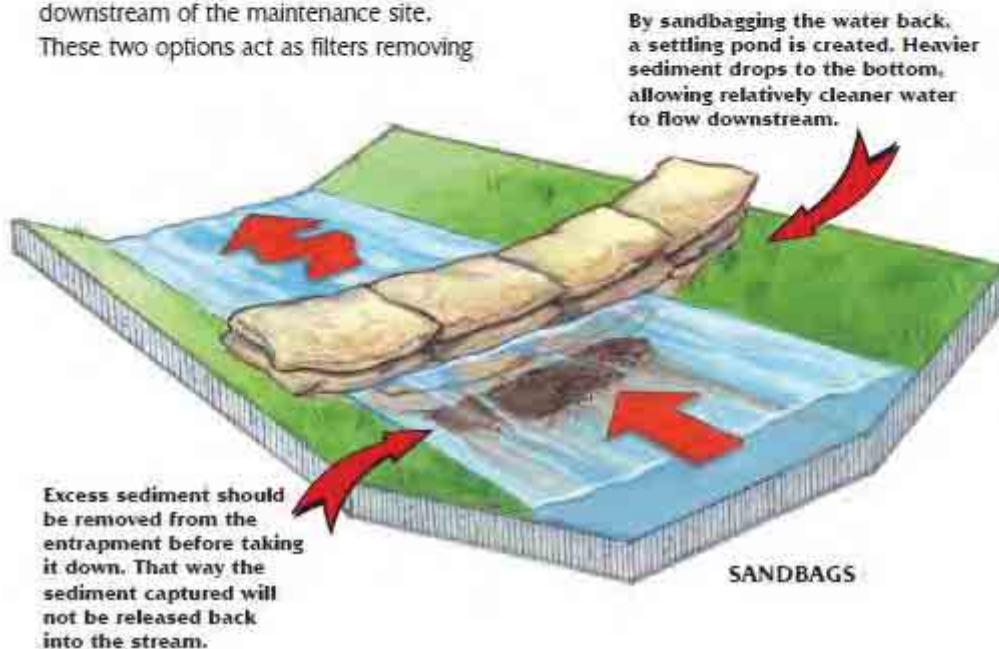
**Option: Silt Fences /Straw Bales/Sandbags**

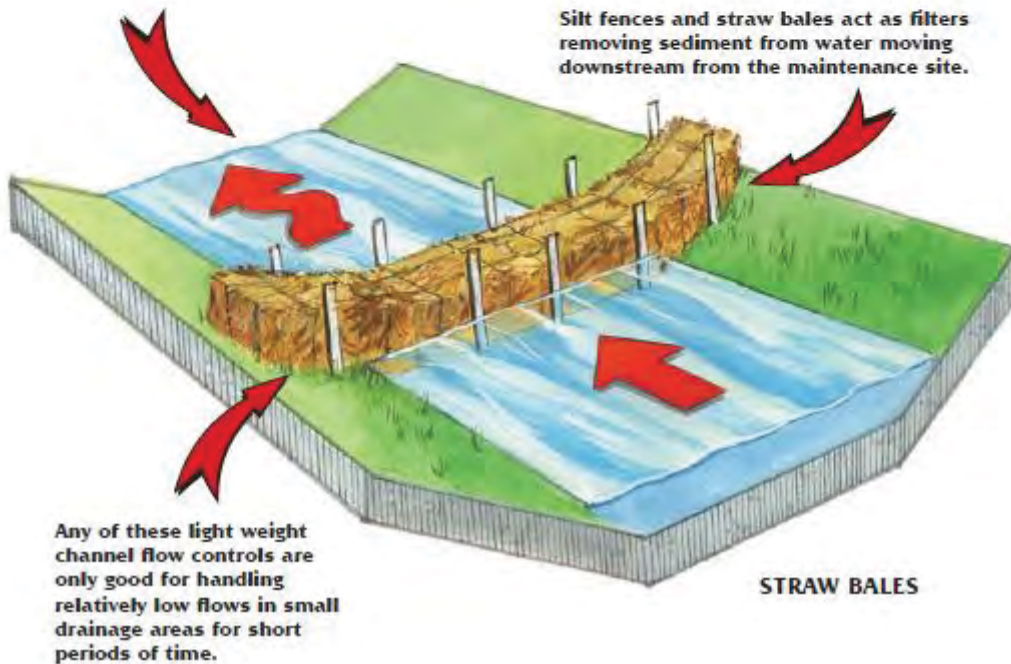
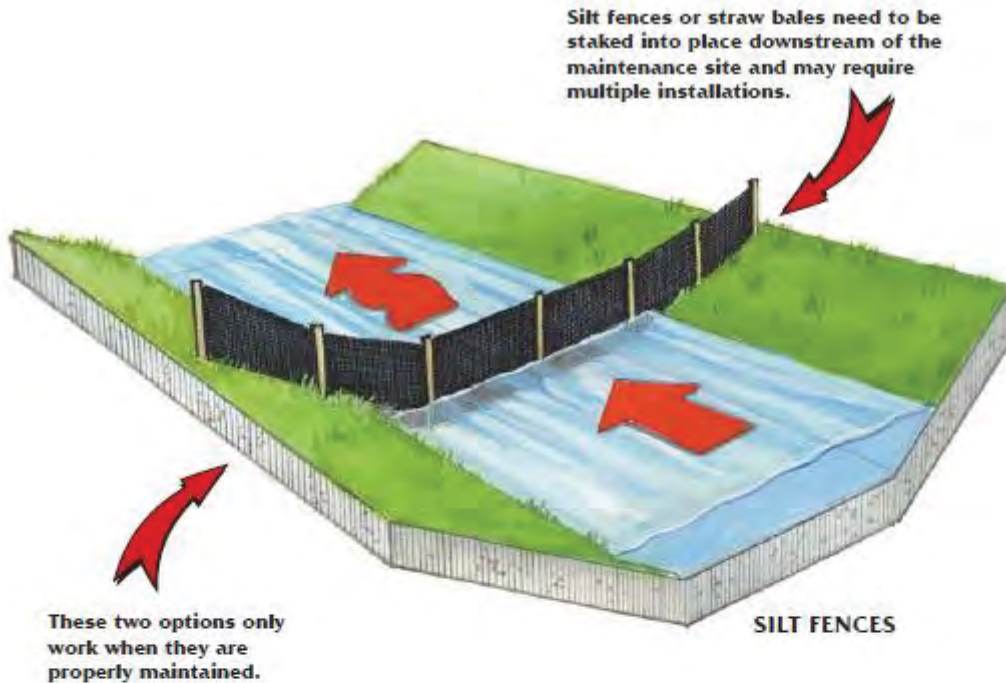
Silt fences (those little black curtains we see between construction sites and watercourses), straw bales, and sandbags are inexpensive ways to prevent the flow of sediments downstream. Silt fences or straw bales need to be staked into place downstream of the maintenance site. These two options act as filters removing

sediment from water. More than one set of curtains or bales may be required.

Sandbags act much like sand traps. By sandbagging the water back, one creates a settling pond where heavier sediment can drop out, allowing relatively cleaner water to flow downstream.

Any of these light-weight channel flow controls are only good for handling relatively low flows in small drainage areas for short periods of time. These options only work when they are properly maintained. Care also needs to be taken when removing these controls. Excess sediment should be removed from the entrapment before taking down a sediment control structure. That way, the sediment captured will not be released back into the stream.







To extend drain life, save money on routine maintenance and enhance fish and wildlife habitat, banks need to be protected from erosion.

#### **Erosion Control and Bank Stabilization**

Eroding drain banks can be costly to farmers, municipalities and the environment. The more soil collapses into a drain, the more that drain's flow is disrupted. The extra soil entering the system is unlikely to be carried very far in the water, resulting in an accumulation of sediment, which in turn fills the drain. Eroding banks may lead to trees and other vegetation falling into the watercourse, further diverting and slowing water flow and leading to more erosion. Eventually, the ability of the open ditch to drain surrounding land is hampered and further maintenance is required sooner than was originally planned. To extend the life of the drain, save money, and help the environment, a number of techniques can be used.

#### ***Option: Leave the Banks Alone***

Bank erosion is best prevented by not disturbing the banks at all. Stable banks usually have grass, shrubs and trees growing along them. Vegetation adjacent to the bank helps slow down runoff from the fields, which in turn helps to minimize erosion of the bank. As well, the root systems of vegetation along the banks hold the sides together and stabilize the slopes. Environmentally, the stalks and leaves from the different types of plants slow down runoff and act as a filter by trapping sediment, pesticides and other pollutants – improving the quality of water entering the drain.

***Option: Plant Bigger Buffers***

Other means to prevent erosion, extend the life of the drain and improve habitat is to plant shrubs and trees and to increase the size of the vegetated buffer between the field and drain.



**Conservation cropping, such as the soy beans planted to the left of the drain above, can help stabilize the bank, reduce future drain maintenance, and improve habitat for a wide variety of species.**

Bigger buffers can help remove more of the sediment carried by field runoff into the open ditch, and thus minimize the need for drain maintenance. This option might involve taking productive land out of operation. The alternative may be to look at planting such crops as hay or alfalfa as buffers along the drain. Once these crops are planted, the land can go a number of years without the need for being plowed up, crops can be harvested annually, and the root systems remain undisturbed.

***Option: Work from One Side of Drain***

If vegetation needs to be removed from a ditch, it would be best to remove it from one side only. That way, one side of the ditch is better protected from erosion, less movement of equipment is needed, clean-out is quicker, and there is less disruption. Where applicable, it is best to leave the south side of the drainage bank alone as that will ensure shade, cover and food sources for fish.

***Option: Remove Vegetation at Intervals***

Depending on various circumstances, another option may be to remove vegetation at certain intervals. If an open drain has gone several years without maintenance – trees, shrubs and other brush may have grown to the point where removal of vegetation is required to allow a crane or backhoe access for proper drain clean out.



**Mature or young trees should be left on either bank. These trees help stabilize the ditch, provide cover and insect food for fish, and shade the banks and the water. The shade from the trees also helps prevent the growth of vegetation that may create blockages to drain flow.**

Rather than clearing out all the vegetation, one can remove for example, 20 metres of vegetation on one side of the bank, skip 20 metres, and then continue so on down the one side of the drain. Then to ensure total bottom clean out, do the same on the opposite bank. Later, when one needs to maintain the drain, vegetation removal and drain maintenance can be done from the spots that were originally left untouched. While this option may be a bit more costly and time-consuming, the landowner is always guaranteed that there will be mature vegetation along the drain to help stabilize it.

**Option: Brushing**

Brushing involves using large mowers to cut the vegetation along the bank. The trimming of the plants and shrubs should improve water flow and thus



**Brushing leaves the root systems intact, stabilizing the banks from erosion. Debris from the brushing protects the banks from wind and rain erosion.**



**Gentle bank slopes help reduce erosion by reducing runoff speed.**

cause the drain to naturally deepen on its own, as faster water tends to scour a watercourse. As well, runoff from the surrounding land is less impeded by mature vegetation when entering the drain. Brushing can also be a helpful step in providing access spots for maintenance equipment to the drain bottom. Regardless of the reason for using the technique, the key to brushing is that it leaves the root system untouched. Thus the drain's banks are stabilized, the mulch from the mowing protects the surface from wind and rain erosion, and reseeding the slope is unnecessary. Care must be taken to make sure that the mulch from the brushing that ends up in the waterway is removed so that the drain does not get clogged downstream.

***Option: Reseeding***

As soon as the drain maintenance is done, one should consider leveling the spoils, or excavated material, created from clear-out and reseed the work area while the soil is still moist in order to reestablish vegetation and stabilize the bank. If immediate revegetation is not an option (maybe the growing season has passed) then using filter cloth, various mulches or erosion blankets made of natural material might help in protecting the banks from erosion.

***Option: Sloping***

When maintaining a drain, it is preferable to have gentle slopes on the banks rather than steep ones. The steeper the grade, the quicker the water enters the drain, the more unstable banks become, and the more likely erosion will take place.



Straw blankets, such as the one seen above, help protect the exposed area from wind and rain erosion, and incorporate natural materials to help vegetation get reestablished.



Natural channel design features can be incorporated into drains where appropriate. Natural channels are efficient at moving both water and sediment, as well as providing long-term stability for the drain and enhancing fish habitat.