March 2013

McLaughlin Bay Restoration Strategy

In partnership with:

Durham Region

Member of Conservation Ontario Natural Champions

Central Lake Ontario Conservation

EXECUTIVE SUMMARY

This is the 3rd and final report in a series of documents relating to Phase 1 of the McLaughlin Bay Restoration Project: *McLaughlin Bay Historical Background Report*; *McLaughlin Bay: Existing Conditions and Restoration Opportunities*; and, *McLaughlin Bay Restoration Strategy*. This report builds on the first two to develop a plan for restoring the Bay.

Although this plan was developed in consultation with a steering committee consisting of landowners, special interest groups, permitting agencies, and technical experts, it has not, at the time of publication, been circulated for public comment. Public consultation is an important component of the Environmental Assessment Act process, which is triggered by the need to undertake works in a Provincial Park; consequently, this strategy cannot be fully approved until it has been reviewed by members of the public. Therefore, this report, which presents a sound restoration plan based on science and expert advice, should be regarded as a guidance document for Ontario Parks as they initiate the Environmental Assessment process, and it should be recognized by the reader that, depending on the feedback that is received during the public consultations, the recommendations presented in this strategy may need to be modified.

This report is structured such that it progresses from a generic discussion of wetland restoration to one specific to McLaughlin Bay, and was written in this manner so as to include readers of all backgrounds. In sections 2 and 3, an overview of wetland restoration techniques is provided for those readers that are not well-versed in coastal wetlands or their processes, and they introduce the terminology used in later sections of the report. Recreational opportunities around coastal wetlands are also discussed, and the information presented in these sections can be applied to any of the coastal wetlands in Durham Region. Sections 4, 5, and 6 relate specifically to McLaughlin Bay. The merits and drawbacks of each of the previously introduced restoration techniques are discussed in detail, and conclusions are drawn as to which techniques should be applied at McLaughlin Bay. The last section summarizes these recommendations and groups them into restoration zones. These recommendations include:

1. Undertaking a partial drawdown at McLaughlin Bay.
2. Constructing cells in the north and southeast corners of the Bay.
3. Undertaking shoreline restoration works along the west and east shorelines.
4. Improving recreation along the shorelines by adding fishing groynes, a boardwalk, and/or viewing platforms.
5. Enhancing fish habitat by increasing basin diversity along the shoreline and adding structure, e.g., root wads, throughout the Bay.
6. Adding constructed wildlife habitat features, such as tern nesting platforms and turtle basking logs.
7. Reducing negative watershed inputs, such as road salt, by engaging nearby commercial and residential land owners.
8. Improving creek buffers throughout the watershed.

This strategy, which takes into account the biological, physical, and socio-political influences at McLaughlin Bay, will result in a much-improved wetland if implemented, and will in turn affect the enjoyment of its resources for all user groups.

ACKNOWLEDGEMENTS

This strategy could not have been completed without the funding provided by Environment Canada, as well as the generous support of the members of the McLaughlin Bay Steering Committee and the organizations for which they work. In particular, I would like to thank those individuals that made time in their busy schedules to regularly attend steering committee meetings and review the reports. Your comments have been invaluable.

The McLaughlin Bay Restoration Strategy is a true product of partnership, and is an example of what can be accomplished when agencies work together toward a common goal. Although there was often disagreement on the direction that should be taken to restore the Bay, a sincere effort was made by the members of the committee to listen to the points of view of others, consider them, and make concessions where appropriate in the interest of improving the habitat conditions at McLaughlin Bay. Because of these efforts, I can say with confidence that this report presents a scientifically and socially balanced restoration strategy; one that takes into account the need to restore the ecology of the wetland as well as the need to maintain its use as an important public recreation space.

Thank you,

Jackie Scott, Project Coordinator.

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TABLE OF CONTENTS

1. INTRODUCTION 1
1.1 Project background 2
1.2 Restoration Goals and Objectives 3
1.3 Socio-political Considerations 4
2. RESTORING COASTAL WETLANDS 9
2.1 Wetland Drawdown 9
2.2 Restoring Wetland Bathymetry 14
2.1 Creating Cells 18
2.2 Constructed Wildlife Habitat 20
2.3 Constructing Islands 22
2.4 Managing Invasive Species 23
2.5 Mitigating Upstream Impacts 24
3. INCORPORATING RECREATION INTO A RESTORATION STRATEGY 26
3.1 Nature Appreciation 26
3.2 Education 27
3.3 Fishing 27
3.4 Waterfowl Hunting 28
3.5 Boating 28
3.6 Ice Sports 29
4. RESTORING MCLAUGHLIN BAY 33
4.1 Wetland Drawdown in McLaughlin Bay 34
4.2 Restoring Wetland Bathymetry in McLaughlin Bay 41
4.3 Creating Cells in McLaughlin Bay 43
4.4 Constructed Wildlife Habitat 46
4.5 Constructing Islands 47
4.6 Managing Invasive Species 47
4.7 Mitigating Upstream Impacts 48
5. INCORPORATING RECREATION 50
5.1 Nature Appreciation 50
5.2 Education 50
5.3 Fishing 51
5.4 Waterfowl Hunting 51
5.5 Boating 51
5.6 Ice Sports 51
6. PROPOSED MCLAUGHLIN BAY RESTORATION STRATEGY 55
6.1 Implementing the Proposed strategy 57

LIST OF FIGURES

Figure 1: McLaughlin Bay and Surrounding Area 1
Figure 2: Stop log control structure at Cranberry Marsh. 11
Figure 3: Portable diesel pump. 12
Figure 4: Illustration of shoreline vegetation present in wetlands. 15
Figure 5: Illustration of the importance of shoreline vegetation to water quality and bank stabilization. 16
Figure 6: Shoreline restoration works at Tommy Thompson park showing creation of backwater lagoon and addition of shoreline structure (before and after). 17
Figure 7: Cells isolated from Common Carp in Duffins Creek Marsh. 19
Figure 8: Creek realignment at Oshawa Second Marsh. 24
Figure 9: Wildlife viewing platform at Oshawa Second Marsh. 27
Figure 10: Fishing groyne at Rouge River Marsh. 28
Figure 11: Wetland basin elevations, Average spring water level of 75.5 m IGLD (blue line), and projected limits of emergent vegetation growth following a partial drawdown to 74.5 m IGLD (dashed line). 36
Figure 12: McLaughlin Bay cross-sections at central wetland axes and illustrating sediment exposure at various water level drawdowns 37
Figure 13: McLaughlin Bay barrier beach stability analysis. aps this caption can 39
Figure 14: Potential hydro connection points and locations for a permanent electric pump house at McLaughlin Bay. 40
Figure 15: Wetland bathymetry restoration opportunities. 41
Figure 16: Map showing Potential cell locations within McLaughlin Bay. 43
Figure 17: potential berm locations in the southwest corner of McLaughlin Bay. 44
Figure 18: Sample cell in the north part of McLaughlin Bay. 45
Figure 19: Potential berm locations in southeast corner of McLaughlin Bay. 45
Figure 20: McLaughlin Bay watershed with stormwater ponds, potential point sources for contaminants, and creeks. 48
Figure 21: Existing and potential recreational opportunities at McLaughlin Bay. 52
Figure 22: Proposed Restoration Zones A & B 57

LIST OF TABLES

Table 1: McLaughlin Bay Restoration Project Steering Committee Members 3
Table 2: Cost analysis for drawing down water levels in McLaughlin Bay using a stop log control structure 38

REFERENCES 60

APPENDICES

Appendix A: Restoration Goals, Objectives, and Opportunities Chart I
Appendix B: Sample Cost Analysis for a McLaughlin Bay Drawdown IX
Appendix C: Sample Instructions for Constructing Wildlife Habitat XV
Appendix D: Spec Sheet for a Gormann – Rupp Portable Diesel Pump XXV
Appendix E: Sample Diesel PUmp Accessories XXIX

1. INTRODUCTION

Durham Region carries the distinction of containing the highest concentration of coastal wetlands in the Greater Toronto Area. These wetlands, extending from Rouge River Marsh in Pickering to Port Newcastle Marsh in Clarington, are protected from development through the Province of Ontario's Provincial Policy Statement, and are protected from alteration or destruction through Regulation 97/04 of the Conservation Authorities Act. The majority of these wetlands are publicly owned and are considered to be vital recreation areas, but also serve as important wildlife refuges in an increasingly urban landscape.

In 2002, Environment Canada (EC) and the Central Lake Ontario Conservation Authority (CLOCA) partnered to initiate the Durham Region Coastal Wetland Monitoring Project (DRCWMP). The goal of this project is to evaluate the health of the coastal wetlands in Durham Region by collecting data on metrics such as water quality; fish, bird, and amphibian diversity and abundance; surrounding land use; vegetation cover and diversity; and sediment quality. This information is then used to assess the health of individual wetlands, which enables them to be compared across the Region as well as across Lake Ontario.

Wetland health results[1] vary throughout the Region, and some wetlands are in poor shape. McLaughlin Bay Marsh is one such wetland, and has been identified as a good candidate for restoration in part because of its small watershed and proximity to Oshawa Second Marsh, the McLaughlin Bay Wildlife Reserve, and Darlington Provincial Park (figure 1).

FIGURE 1: MCLAUGHLIN BAY AND SURROUNDING AREA

[1] Information about the health of coastal wetlands in the DRCWMP program is documented in several publications, and can be obtained online at http://www.cloca.com/lwc/monitoring_coastal.php

1.1 PROJECT BACKGROUND

In 2010, CLOCA received funding through EC's Environmental Damages Fund program to develop a restoration strategy for McLaughlin Bay Marsh. A steering committee was formed, which had representation from landowners, technical experts, provincial and federal agencies, and key stakeholder groups (table 1), and a historical report was commissioned, with funding from Ontario Parks, to investigate the anthropogenic and natural processes that have influenced McLaughlin Bay in the past.

Additional data was collected at the marsh to address some known data gaps, including:

- water quality sampling in the marsh and in the creeks that outlet into it;
- sediment sampling to test for contamination;
- watershed boundary and drainage modeling;
- seedbank testing;
- sediment mapping throughout the Bay;
- basin elevation mapping (Canadian Wildlife Service);
- temperature and conductivity monitoring with the aid of a data logger.

This information, along with existing data collected for the marsh via the DRCWM project, was compiled and analysed in a report prepared for the steering committee titled "McLaughlin Bay: Existing Conditions and Restoration Opportunities" (CLOCA, 2012).

The Historical and Existing Conditions reports, as well as the project goals and objectives identified by the steering committee, formed the basis for deciding which restoration opportunities to carry forward into the final restoration strategy.

This document, which marks the completion of the first phase of the McLaughlin Bay Restoration Project, will:

1. Summarize the restoration and recreation options that are available for consideration when restoring coastal wetlands (sections 2 & 3). These sections are intended to be generic to coastal wetlands, not specific to McLaughlin Bay, and aim to provide the reader with some background knowledge about undertaking wetland restorations. Consequently, some of the conditions discussed here are not necessarily applicable to McLaughlin Bay.

2. Discuss the merits of each option as they relate to McLaughlin Bay (sections 4 & 5). These sections are specific to McLaughlin Bay and endeavour to rationalize how the restoration and recreation options presented in sections 2 and 3 could be applied at McLaughlin Bay. The pros and cons of adopting each option, as well as a conclusion as to which options to carry forward, is included for each restoration option.

3. Present a proposed strategy for restoring McLaughlin Bay that achieves the project goals and satisfies the needs of the landowners and key stakeholders (section 6). This section is a summary of the conclusions reached in sections 4 and 5. It also includes some discussion on how to implement the strategy in the future.

TABLE 1: MCLAUGHLIN BAY RESTORATION PROJECT STEERING COMMITTEE MEMBERS

NAME*	TITLE	ORGANIZATION	ROLE
Art Henry		Oshawa & Durham Region Métis Council	Stakeholder
Bill Slute	Manager, Parks Maintenance Services	City of Oshawa	Landowner
Brian Brasier	Executive Director	Friends of Second Marsh	Stakeholder
Bryan Swift	Director Environment & Energy	General Motors of Canada Limited (GMC)	Landowner
Corina Brdar	Southeast Zone Ecologist	Ontario Parks, Ontario Ministry of Natural Resources (MNR)	Landowner Representative
Curt Morris	Park Superintendent	Darlington Provincial Park, Ontario Parks	Landowner Representative
Dave Chin-Cheong	Section Manager – Environmental Compliance	Ontario Power Generation (OPG)	Stakeholder
Dave McLachlin	Ontario Habitat Restoration Program Head	Ducks Unlimited Canada (DUC)	Technical Expert
Faye Langmaid	Manager, Special Projects	Municipality of Clarington	Landowner
Greg Grabas	Habitat Ecologist	Canadian Wildlife Service, Environment Canada	Technical Expert
Heather Pankhurst	Wetland Biologist	Central Lake Ontario Conservation Authority	Technical Expert
Ian Kelsey	Aquatic Biologist	Central Lake Ontario Conservation Authority	Technical Expert
Jackie Scott	Terrestrial & Wildlife Resource Analyst	Central Lake Ontario Conservation Authority	Committee Chair
Jane Tymoshuk	Fish Habitat Biologist	Department of Fisheries and Oceans (DFO)	Permitting Agency
Shari Sokay	Land Use Specialist	Ontario Federation of Anglers and Hunters (OFAH)	Stakeholder
Steve Varga	Inventory Management Biologist	Ontario Ministry of Natural Resources	Permitting Agency
Tim Markus	Navigable Waters Protection Officer	Transport Canada	Permitting Agency

**Italicized names indicate resource members only.*

1.2 RESTORATION GOALS AND OBJECTIVES

The goals and objectives for the project were developed by the Steering Committee, and reflect both the need to achieve ecological health in the wetland as well as maintain its function as a recreational space. As such, the overall vision for the project is to **REHABILITATE THE FUNCTIONS OF THE WETLAND TO INCREASE ITS NATURAL AND SOCIAL VALUES**.

The project goals and their associated objectives are as follows:

1. IMPROVE WATER QUALITY IN THE MARSH
   - Reduce salt levels in the marsh by addressing parking lot management in the watershed.
   - Reduce nutrient and sediment levels entering into the marsh by addressing stormwater management in the watershed.
   - Reduce turbidity in the marsh by addressing impacts of carp and sediment re-suspension from wave action.
   - Reduce marsh temperature.

2. IMPROVE VEGETATION DIVERSITY IN THE MARSH
   - Increase the amount and diversity of native emergent and submergent vegetation in the marsh.
   - Increase the amount of submerged aquatic vegetation in the marsh by reducing turbidity.
   - Reduce impact of invasive alien plant species in the marsh through active management.

3. IMPROVE WILDLIFE HABITAT IN THE MARSH
   - Improve habitat for Species at Risk (SAR) via overall improvement and/or specific actions targeted at SAR.

- Increase fish spawning habitat by restoring marsh shorelines.
- Increase amount of vegetation in the marsh for reptiles, amphibians, fish, birds, and invertebrates.
- Improve water quality for amphibians, reptiles, fish, birds, and invertebrates.
- Provide nesting habitat for birds.
- Improve underwater cover for fish throughout marsh.
- Improve turtle habitat.
- Improve woodland frog habitat.

4. IMPROVE RECREATION ACTIVITIES IN THE MARSH
   - Increase vegetation and improve habitat for wildlife to improve hunting, fishing, and nature appreciation activities.
   - Improve water quality for improved fishing and nature appreciation experience.
   - Improve fishing access and enhance nature appreciation.

The 2012 Existing Conditions and Restoration Opportunities report identified numerous restoration opportunities that were available for consideration to achieve these goals and objectives, and many of them would help to achieve more than one goal (see Appendix A). While the decision to include some of the opportunities is relatively straightforward, choosing to include others is more complex, requiring some understanding of wetland functions and restoration techniques in order to assess their suitability for McLaughlin Bay. Consequently, section 2 of this report was included to present an overview of wetland functions and describe some wetland restoration techniques in an attempt to provide the reader with the background knowledge required to better understand the rationale for choosing which restoration opportunities to carry forward into the final restoration strategy.

A section has also been included on incorporating recreation into wetland restoration strategies, as recreation is an important use at coastal wetlands in Durham Region. Although improving recreational opportunities at coastal wetlands is not itself a restoration technique, recreation activities, and the infrastructure that is associated with them, may influence the restoration techniques that are chosen in a strategy, or may need to be incorporated into restoration works. Consequently, it is valuable to discuss recreation as a part of restoring coastal wetlands so that both human and ecological needs are being met.

1.3 SOCIO-POLITICAL CONSIDERATIONS

The Existing Conditions report is a technical document that focuses on the biological and physical influences occurring at McLaughlin Bay, but these are not the only factors that must be considered when deciding which restoration opportunities to carry forward.

At McLaughlin Bay, socio-political factors also play a role in the decision to choose some restoration opportunities over others. These include:

- legislative and permitting requirements;
- Environmental Assessment Act (EAA) and Provincial Parks and Conservation Reserves Act (PPCRA) approval to undertake works in a Provincial park;
- accommodating landowner and stakeholder interests;
- securing agreement between all project participants;
- landowner approval of proposed works;

- availability of funding;
- feasibility of proposed works;
- level of risk or uncertainty that project participants are willing to assume.

These factors feed into the restoration strategy decision-making process, and result in a strategy that is not strictly biological, but achieves the most improvement to wetland health possible within the defined constraints. In sections 4 and 5 of this report, both biological and socio-political considerations will be reflected in the discussion of the benefits and drawbacks of the restoration opportunities as they relate to McLaughlin Bay.

LEGISLATION AND PERMITS

A DFO review under the *Fisheries Act* is required for in-water works.

A permit to transfer more than 50,000 L water/day is required from the Ministry of the Environment.

A permit will be required from the Ministry of Natural Resources if restoration works impact Species at Risk, require fish rescue, or involve the Public Lands Act.

A Permit to conduct works in a wetland is required from CLOCA.

Works that take place in Darlington Provincial Park (including drawing down the wetland) must comply with the Environmental Assessment Act (EAA) and the Provincial Parks Conservation Reserves Act (PPRCA), which includes undertaking public consultation.

LANDOWNER/STAKEHOLDER INTERESTS

Fishing access and waterfowl hunting activities must be incorporated into the wetland restoration strategy.

LANDOWNER APPROVAL

The Canada Trust Co., City of Oshawa, Municipality of Clarington, General Motors of Canada Ltd., and Ontario Parks, as landowners and landowner representatives, have the final say in what restoration works are carried out.

RESTORING COASTAL WETLANDS: AN OVERVIEW

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2. RESTORING COASTAL WETLANDS

Coastal wetlands in Durham region are unique features in that they are exclusively located along the Lake Ontario shoreline, and consequently subject to processes not common in other wetlands. Their functions include filtering sediments and contaminants from outletting creeks before they reach Lake Ontario; providing important spawning habitat for fish and stopover habitat for migratory waterfowl; and, supporting a wide variety of birds, mammals, amphibians, and reptiles.

Many of the Great Lakes coastal wetlands have been destroyed or impacted to such an extent that they no longer provide the values and functions that they once did, so restoring them wherever possible is important.

Restoring a coastal wetland is not a straightforward task, as there are many factors to consider, and more often than not there are unknown elements to contend with. Consequently, successful restorations usually involve some trial and error. There are several recognized techniques that can be considered when undertaking a coastal wetland restoration, including drawing down water levels to facilitate vegetation growth; improving germination and growing conditions by modifying features such as wetland bathymetry; creating cells or islands to improve habitat; and, adding constructed wildlife habitat structures. Many of these techniques have been attempted at more than one coastal wetland in the Region to varying degrees of success.

Coastal wetlands vary widely in their vegetation composition, in-basin topography, and function, depending on their location and environmental conditions; therefore, restoration strategies need to be specific to each wetland. Biological and physical data, clear restoration goals, and an understanding of some of the more common restoration techniques will assist with the development of effective coastal wetland restoration strategies.

2.1 WETLAND DRAWDOWN

Coastal wetlands are dynamic ecosystems. Historically, alternating periods of high and low water levels occurred in Lake Ontario with amplitudes of fluctuation up to 2 meters. Periods of high water levels in coastal wetlands expand the aquatic zone upslope, restrict the growth of woody species and prevent aggressive species from dominating the wetland. Periods of low water levels maintain patchiness, promote expansion of wet meadow habitat and expose sediments containing the seedbank, thereby promoting growth of aquatic vegetation. Fluctuation between these high and low water level periods results in a high vegetation species diversity and a balance of submerged and emergent vegetation habitat.

Water levels on Lake Ontario and the St. Lawrence River have been artificially managed since 1960, under a regulation plan called 1958 D that is overseen by the International Joint Commission (IJC). This plan has reduced the amplitude of fluctuations in Lake Ontario, removing the periods of very low and very high water levels, and has generally resulted in the loss of wetland wet meadow habitat, structural complexity, and species diversity; in many wetlands it has also led to the dominance of cattails (*Typha* spp.) in the emergent vegetation communities.

A **DRAWDOWN**, which involves removing some or all of the water in a marsh, is a restoration tool designed to mimic the period of low water levels that were present in the historical water level cycle.

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Generally, low water levels are maintained over one or two growing seasons, exposing the sediments to oxygen, enabling seed germination, and thus promoting vegetation growth. As water levels are restored, either naturally or through human intervention, some vegetation die-off occurs, and the various plant species remain where water depths and conditions are suitable. This technique is effective at increasing vegetation abundance and diversity in marshes where mono-specific aquatic plant communities have developed or where aquatic plant growth is lacking, but is dependent on the presence of an existing seedbank.

An additional advantage of a drawdown is that as the in-basin organic substrates are exposed to air for an extended period of time, they dry out and consolidate. In wetlands where fine sediments are present and easily re-suspended through the activities of wildlife or wave action, the consolidation of organics can result in lower turbidity levels after re-flooding. High turbidity inhibits the ability of submerged and floating aquatic vegetation to grow, as it prevents light from penetrating very far into the water, so for wetlands with high turbidity levels, drawdowns may have an additional benefit.

Drawdowns can occur to varying degrees. A **FULL DRAWDOWN**, in which all of the water from the marsh is removed, may not be suitable for very large or very deep wetlands as it may not be feasible to remove all of the water. In such cases, and where cost is a concern, a **PARTIAL DRAWDOWN**, i.e., removal of some water, may be preferred. There are benefits and drawbacks associated with each drawdown type, and these should be considered when choosing which option to pursue.

It should also be noted that a Ministry of Environment (MOE) Certificate of Approval may be required to actively transfer water from a wetland into Lake Ontario, and this can influence to what level a drawdown occurs.

FULL DRAWDOWN

All of the water is removed and the maximum area of substrate is exposed. This results in:

- ✓ Maximum seedbank exposure and maximum vegetation growth
- ✓ Complete substrate consolidation (where organics present)
- ✓ Ability to eliminate Common Carp from wetland

- × Increased risk of barrier beach breaking
- × Increased cost to remove water as pumping is required
- × Increased potential for cost/timing constraints if permitting issues arise
- × May require removal of fish

PARTIAL DRAWDOWN

Only a portion of the water is removed and a partial area of substrate is exposed. This results in:

- ✓ Reduced cost to remove water
- ✓ Potential to complete drawdown passively
- ✓ Reduced risk of barrier beach breaking

- × Partial seedbank exposure, which may or may not achieve vegetation cover goals
- × Partial substrate consolidation, where organics present, so sediment re-suspension may still contribute to high turbidity
- × Common Carp survival, if present

2.1.1 UNDERTAKING A DRAWDOWN

Depending on the elevation of the wetland, i.e., how high above Lake Ontario the wetland is perched, water levels can be drawn down either passively or actively. Passive water removal generally involves the creation of a break in the wetland edge, usually the barrier beach, to allow water to flow out of the basin, thereby reducing the water level in the marsh. This can be achieved as simply as digging a trench, but more commonly involves the installation of a **STOP LOG CONTROL STRUCTURE** (figure 2). If water cannot be removed passively, then it must be removed actively, and generally requires the use of a heavy duty **PUMP**.

In some instances, both passive and active water removal may be an option, which can reduce costs over the long term, but some sort of pump will likely always be required, particularly if a drawdown is undertaken in a dry year and there is a need to pump water back into the wetland to support the newly germinated vegetation.

Choosing to remove water using a stop log control structure, a pump, or a combination of the two depends on a number of factors including wetland bathymetry (section 2.2), vegetative cover goals, fish habitat goals, the need to manage for Common Carp (section 2.6), cost, and feasibility. These factors will be unique to each wetland restoration project and should be considered carefully before proceeding.

STOP LOG CONTROL STRUCTURE

Stop log control structures are engineered openings along a wetland edge that can be opened and closed to allow water to flow out of a wetland. They are designed to manage water levels. When a log is removed, water flows out of the wetland until the water level reaches the height of the next log. In this way, the structure can be used to hold water at a variety of different heights or remove it as in a drawdown.

FIGURE 2: STOP LOG CONTROL STRUCTURE AT CRANBERRY MARSH.

Stop log control structures can also be modified and used to prevent Common Carp from entering into coastal marshes by inserting grates with spacing that allows some fish to pass, but is not large enough to accommodate adult carp. This is important because Common Carp contribute to high turbidity levels and vegetation decline in wetlands through their vegetation uprooting activities.

Placement of any water control structure in a dynamic beach environment must be carefully considered as changes to beach configuration and sand dune movement may result in the structure becoming redundant or obsolete in a relatively short period of time.

PUMP

There are two main options for pumping water out of a wetland: an electric pump and a diesel pump. Electric pumps are purchased outright and installed within a structure near the wetland edge. They require that electricity be available at the pump site. Diesel pumps can also be purchased and installed permanently, or rented and used temporarily (figure 3). There are pros and cons to each option, and they are discussed further below.

FIGURE 3: PORTABLE DIESEL PUMP.

ELECTRIC PUMP

Considerations for choosing an electric pump include:

1. Is electricity available, and if so, what type of electricity is it? Single phase power will only support engines up to 10 HP, while 3-phase power can support larger horsepower engines. (Higher horsepower = higher flow = less pumping time.) A converter can be installed to change single phase into 3-phase.
2. Where is the power located? Electricity, if not available at the pump site, will have to be run from a nearby location. This may involve burying wire or erecting hydro poles, and may also involve installing a transformer to maintain the power supply. Distance is a key factor in the gauge of wire required (longer distance = higher gauge = more expensive), and may be cost prohibitive.
3. What type of pump should be used? Fixed-in-place pumps and submersible pumps are two options that can be considered, but the feasibility of installing either must be determined by an expert.
4. What associated infrastructure is required? A fixed-in-place pump is above ground and needs a hut to protect it from the elements and vandalism. A submersible pump does not necessarily require such a building as it is underground and can be protected by a locked cover. Both require a dug well from which to draw water, but a submersible one needs to have high enough water levels for it to remain underwater. Both require a secure electrical connection to operate them.
5. One pump or two? If single phase electricity is the only option and a higher flow rate is desired, two pumps may be the best solution. Having two pumps is more costly.
6. What is the lifespan of the pump versus the cost? If a pump can only be expected to last 25-30 years, and the cost is high, then it may not be worth consideration.

7. How many drawdowns will occur? Typically, drawdowns can be expected to occur every 8 – 10 years, so a permanent pump might be used 4 or more times during its lifespan. Being able to use it more than once improves the cost over time, but being able to use a pump at multiple locations over time may make purchasing one significantly more attractive. Such is the case with submersible electric pumps.

If electricity can be provided at the pump site, and an electric pump is a feasible option, then one of its biggest advantages over diesel pumps is its ability to run continuously.

A secondary advantage is noise. Electric pumps are quieter than diesel pumps, and if the pump is to be located near a residential community, then noise may be an important factor, as pumps may be required to run during nighttime hours.

DIESEL PUMP

Choosing to use a diesel pump for a drawdown, rather than an electric one, is a less involved decision, as the availability of electricity is not a factor. The decision of whether to install a permanent one or rent one temporarily will be based mostly on cost.

In the case of a permanent pump, some infrastructure is required, in the form of a hut, in addition to the capital cost of purchasing it; however, these costs may be less significant as multiple drawdowns are undertaken. As with the electric pump, the expected lifespan of the pump needs to be factored in, which is not a consideration when a pump in rented.

Temporary pumps are advantageous in that they there is little up-front investment and no infrastructure required. However, they are more exposed because they are not installed in a hut, and therefore more prone to vandalism. Furthermore, the pumps available may not be suitable for the wetland or may not be available for rent when they are needed for the project.

For both permanent and temporary diesel pumps, a key consideration is labour. Unlike electric pumps, where the fuel supply is constant, diesel pumps must be visited daily to refuel them. This adds a considerable human resources cost to a project and may be one reason to favour an electric pump. Getting fuel to the site is another important point. Ideally, the pump site should be located such that it is accessible by truck so that fuel can be delivered in large quantities. It is possible to install a fuel storage tank on-site and have fuel delivered for regular re-fueling, or smaller quantities can be delivered daily by purchasing a fuel transfer tank and installing one in the back of a pickup truck. In either case, these are added expenses that need to be included in any cost analysis.

VANDALISM

Whether a control structure or pump is chosen to undertake a marsh drawdown, vandalism is something that must be considered. Examples of vandalism include the unwanted removal of stop logs or damage to the control structure/pump. Various solutions exist to reduce the effect that vandals may have on control structures, and the potential for vandalism to a pump may be one additional reason to opt for a permanent pump with a secure building.

2.2 RESTORING WETLAND BATHYMETRY

Just like terrestrial vegetation, wetland plants have growing preferences. Emergent, floating aquatic, and submerged aquatic vegetation species each have specific water depths in which they are able to grow, and consequently, the topography of the wetland basin (**BATHYMETRY**) plays an important role in maintaining plant diversity (figure 4).

Submerged plants can survive in depths beyond 3 m if the water turbidity is low enough to enable light penetration. In shallower waters, between 1 – 2 m, floating aquatic vegetation is predominant (OWWT, 2008). In waters less than 1 m in depth, emergent vegetation prevails; although, with the exception of a few species such as cattail, most emergent plants do not tolerate more than 60 cm of water.

The area in which wetland vegetation is able to grow within a marsh is therefore dependent on the water depths throughout the marsh. Ideally, a wetland should have depths that accommodate all forms of aquatic vegetation, but the size, shape and depth of the basin is unique to each wetland. Consequently, efforts should be made at the outset of a restoration project to understand what the historical condition of the wetland was and, if possible, the restoration plan should endeavour to return it to its original state. This may or may not be feasible, depending on the extent to which the wetland has changed over time.

It is also worth noting that organic soils within a wetland are important for establishing vegetation; if these soils are not present then vegetation growth, regardless of the basin depths, will be limited. When restoring wetland bathymetry to improve vegetation cover, efforts should be made to determine the extent of the organic horizon. If it is lacking, then the addition of this material to the areas of desired vegetation growth may be required.

2.2.1 RESTORING THE BASIN

Historically, land clearing in the upper extents of Lake Ontario watersheds led to significant soil loss from surface water runoff. This material was carried into creeks and deposited into the coastal wetlands at the bottom of the watersheds, causing them, in some cases, to be shallower in some areas than they were originally. In such circumstances, **DREDGING** may be required to remove some wetland sediments to restore deeper water depths in the marsh. Alternatively, moving sediments around to create deeper and shallower areas, i.e., **RE-PROFILING**, may be sufficient for restoration. For wetlands that have experienced sediment loss, for example along the shorelines as a result of erosion, **SURCHARGING** may be needed. This activity involves adding soils to raise the elevation in parts of the basin to create shallower depths to support vegetation growth.

In-water works, such as dredging, re-profiling, and surcharging, are intensive restoration techniques, requiring permits from DFO, the Conservation Authority, and MNR, so these options should be considered carefully, as they may not be consistent with the goals of a project. Additionally, sediment contamination must be explored before moving soils around, as disturbing the sediments may result in the release of dangerous contaminants. In Lake Ontario coastal wetlands, PCBs, heavy metals, and pesticides are among the pollutants that have been found in wetland sediments (EC and CLOCA, 2004).

The areas in which vegetation is growing in coastal wetlands are highly productive. Numerous wetland birds nest within the stands of emergent vegetation, which can constitute a very large area if the marsh is shallow enough, and many other animals find refuge therein. Floating and submerged aquatic vegetation in the deeper sections provide cover for fish and amphibians and are excellent foraging sites for waterfowl. Consequently, restoring wetland depths to support vegetation growth can be an important tool for restoring wetland health.

2.2.2 RESTORING THE SHORELINE

Along the edges of the wetland basin, where the water meets the land, is the **SHORELINE**. This zone is dynamic, with some areas being underwater when water levels are high and exposed when they are low. It is also the transition zone for wildlife that inhabit both aquatic and terrestrial habitats.

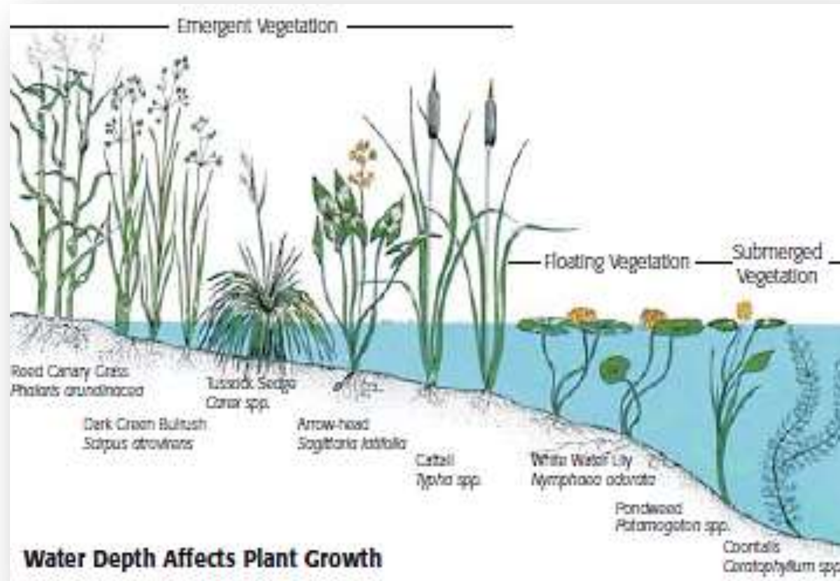
Shoreline functions are varied and are important for maintaining wetland health. Restoring a degraded shoreline helps to improve conditions throughout the marsh, and will aid in preventing future wetland degradation. There are various techniques that can be used to restore shorelines, and they are discussed in more detail below.

It is worth noting here that in general, shoreline restoration is less invasive than dredging, or re-profiling the wetland basin as it occurs along the edge and the interior of the marsh can remain undisturbed.

RESTORING SHORELINE VEGETATION ZONES

As previously described, water depth is important for wetland plants. Some grow in deeper water while others thrive in shallower conditions. Changes in depth are often most pronounced along the shoreline, and as such it can support a wide variety of plant species, which contributes greatly to biodiversity in the wetland. Figure 4 illustrates the plant diversity that can be observed along the shoreline.

FIGURE 4: ILLUSTRATION OF SHORELINE VEGETATION PRESENT IN WETLANDS.



(DUC, 2011)

In wetlands where the shoreline has become undercut or degraded, work may be required to re-define and re-stabilize it. Generally, this involves grading the shoreline to a slope between 4:1 and 6:1 (horizontal distance : vertical drop), which will prevent it from future erosion and ensure plant growth (Sargent and Carter, 1999). Active planting will need to be done to help re-establish vegetation as the seedbank may be lacking, and plantings will help to hold soils in place and prevent invasive plants from becoming dominant. Soil amendment may also be required if existing soils are not suitable to support vegetation growth.

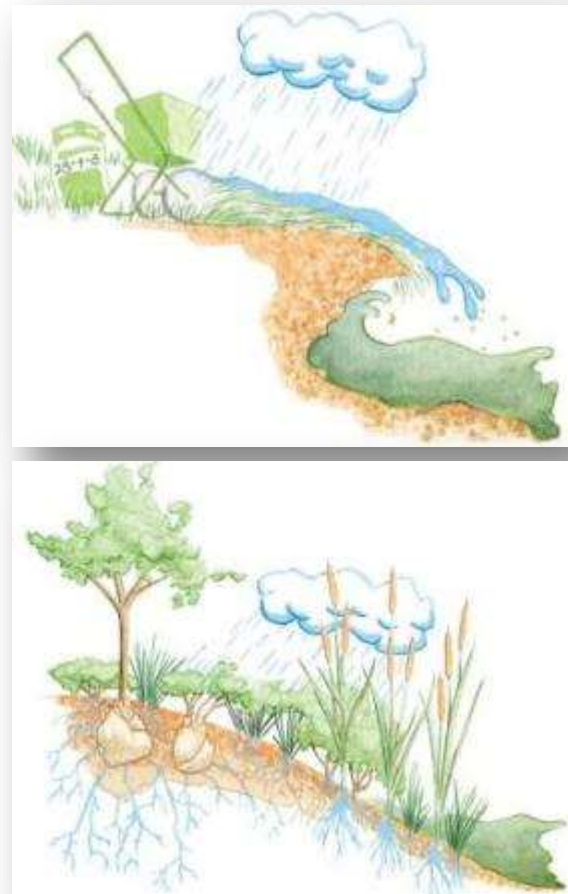
Protection of new plantings from wildlife is generally required for active planting to be successful, as geese, swans, and Common Carp will devour and uproot new growth. Erecting snow fencing around groups of plants is an effective means of preventing such wildlife from accessing them, and barriers should be kept in place until the vegetation is established.

Shoreline vegetation is also important fish habitat. Some fish species rely on shoreline areas for spawning, and most species benefit from the cover and foraging associated with shoreline vegetation. Vegetation on the upland side of the wetland edge, such as overhanging trees, provides cover and food for fish as well.

Shoreline vegetation also plays an important role in maintaining water quality. During rain events, overland flow picks up nutrients, contaminants, and soils, and carries them into creeks and wetlands. Vegetated buffers around creeks and wetlands impede such flows, reducing the energy that they contain and thus preventing them from carrying unwanted matter into the creek system (figure 5). Consequently, improving the quality of the terrestrial vegetation on the upland edge of a wetland should be considered when restoring wetland shorelines as well.

Finally, aquatic vegetation along the shoreline plays a key role in preventing erosion in wetlands (figure 5). Root systems help to hold sediments in place, which not only keeps them from being suspended in the water column and contributing to high turbidity levels, but prevents them from being taken away from the shoreline by wave action. Shoreline plants further diminish the negative effects of wave action by absorbing wave energy, thereby reducing the impact that breaking waves have on the edge of the wetland, and trapping the sediments that may be suspended by them. These functions are important for maintaining overall wetland health.

FIGURE 5: ILLUSTRATION OF THE IMPORTANCE OF SHORELINE VEGETATION TO WATER QUALITY AND BANK STABILIZATION.



(DFO, 2010)

Vegetation loss along shorelines often leads to undercutting of the wetland edge as a result of wave action and soil loss. Once this occurs it is very difficult for plants to become re-established, and active restoration is required to return a stable slope and appropriate soils to the shoreline.

CREATING BACKWATER LAGOONS, POOLS AND SHOALS

Contouring of shorelines to create areas that hold water, either temporarily or permanently, can provide habitats that are not present in the larger wetland. The creation of **BACKWATER LAGOONS** (figure 6), which are wet depressions or channels behind the shoreline, and **POOLS**, which are pockets of deeper water within a shoreline, can easily be incorporated into shoreline restoration works to improve habitat structure, enhance diversity of vegetation, and improve forage and habitat for fish and wildlife. Elevated (shallow) sections underwater along a shoreline, i.e., **SHOALS**, can be created with a variety of materials including stone, fill, and woody debris. These too increase habitat structure and improve forage and habitat for fish and wildlife.

ADDING SHORELINE STRUCTURE

Placing boulders, logs, and tree stumps along the shoreline during restoration works is an effective means of holding down new soils and preventing future shoreline erosion (figure 6). These materials also provide areas of cover for fish and other aquatic wildlife, and increase the diversity of habitats available in the wetland.

FIGURE 6: SHORELINE RESTORATION WORKS AT TOMMY THOMPSON PARK SHOWING CREATION OF BACKWATER LAGOON AND ADDITION OF SHORELINE STRUCTURE (BEFORE AND AFTER).

2.1 CREATING CELLS

A wetland **CELL** is created when a smaller area of a wetland is separated from the main wetland, often through the construction of a berm or the installation of an aqua dam or similar structure. This berm can be open or closed, and may contain a control structure to enable the management of water flow or fish access between the cell and the main marsh. In any case, its purpose is to make the management of some aspect of the wetland easier, and its application is generally limited to very large wetlands; in particular, ones with impacts that can be specifically dealt with by creating smaller zones within the greater wetland.

Impacts that may be mitigated by creating cells include sediment or nutrient loading from an upstream creek system, high turbidity or vegetation loss due to Common Carp, high turbidity as a result of wave action, and the inability to drawdown an entire marsh to initiate vegetation growth. There may be additional reasons to consider constructing cells within a marsh, but these are the most common and are explained further below.

MODERATING STREAM IMPACTS

In developed landscapes, where riparian buffers have been lost, surface water runs across the terrain, collects soils, nutrients, pesticides, road salts, and other contaminants, and deposits them into the creek system. These materials are carried downstream and deposited along the way or where they outlet, which, in southern Ontario, is often at a coastal wetland. This deposition contributes to wetland turbidity and increases sediment loading. One technique for alleviating this stressor on a wetland is to isolate sections of the marsh to prevent turbid or poor quality water from entering into them.

REDUCING WAVE ACTION

In large marshes, wave action can have a significant impact on turbidity. The movement of the water disrupts fine sediments, which may be unconsolidated due to sediment loading, nutrient loading, sustained water levels, lack of vegetation, wildlife activities, or a combination of these, and they become suspended in the water column. Continuous re-suspension of sediments acts as a barrier to light, and inhibits the ability of aquatic vegetation to grow.

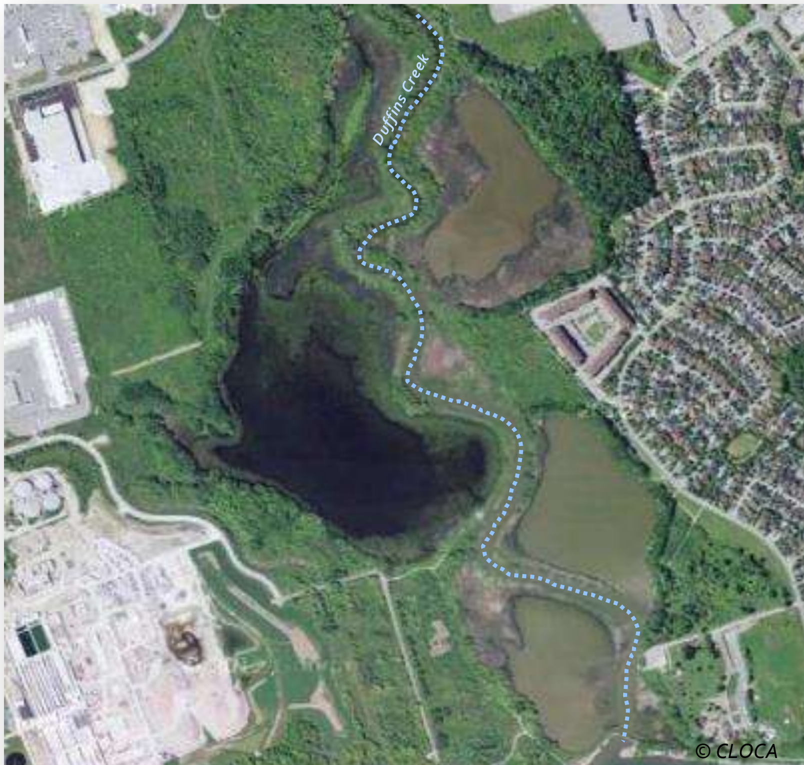
Wave action can be reduced by creating a series of cells within a wetland: the berms that isolate them act as wave breaks, and the areas within the cells are protected. Over time, there is the potential to reduce water turbidity, resulting in increased plant growth.

COMMON CARP

High turbidity levels, particularly in coastal wetlands, are often attributed to the presence of Common Carp. These non-native fish enter into wetlands via Lake Ontario to spawn and forage on plant roots. The action of uprooting plants not only impacts the existing vegetation in the marsh, but also disturbs the sediments, causing them to be suspended in the water column. As a result, vegetation is unable to grow or re-establish itself because the turbidity prevents sunlight from penetrating sufficiently deep into the water.

Creating cells in a wetland is one way of isolating sections from carp. A solid berm will prevent all fish from accessing the cell, which may or may not be desirable. Alternatively, a control structure, located within the berm, could incorporate a grate that has openings large enough to permit some fish passage but not large enough to accommodate adult carp. An example of the latter can be seen at Duffins Creek Marsh in Pickering (figure 7). Reduced turbidity is apparent in the left cell, where Common Carp have been excluded resulting in the establishment and maintenance of floating and submerged aquatic vegetation.

FIGURE 7: CELLS ISOLATED FROM COMMON CARP IN DUFFINS CREEK MARSH.



ENABLING DRAWDOWNS

As has been previously explained, the ability to create variations in wetland water levels or expose sediments to initiate vegetation growth is important for maintaining wetland health. In large wetlands, where drawdowns are not feasible or cost effective, creating cells, with the ability to drawdown one cell at a time, may be a good solution. Depending on the elevation of the cell compared to the main marsh, a stop log control structure in the dividing berm can be used to achieve water level reduction, or water can be actively pumped in and out of the cell if a control structure is not an option.

MANAGING VEGETATION

An additional advantage to creating cells within a large wetland is the ability to manage for specific vegetation communities. A cell may be able to support some plant species that do not grow as well in other cells or in the larger marsh. This cell then not only contributes to plant and habitat diversity for the whole wetland, but acts as a permanent seed source of its plant species for the rest of the marsh, thereby maintaining the potential for those species to be re-established elsewhere during future drawdowns or if conditions improve.

As a final note, the goals and objectives of the project should be taken into account when contemplating constructing cells, as it is a highly invasive technique.

2.2 CONSTRUCTED WILDLIFE HABITAT

In addition to restoring natural wildlife habitat, built structures can be constructed and installed in wetlands to attract specific wildlife. Depending on the goals of the project, the following constructed habitats may be suitable options to consider.

- **OSPREY NESTING PLATFORMS** are commonly constructed in and around marshes in Ontario. These structures are elevated platforms upon which osprey build stick nests. Depending on the design, they can be costly to install, as specialized equipment may be required, and their use is not guaranteed. See Appendix B for sample instructions from the Ministry of Natural Resources (1999).

  It is also worth noting that the presence of Osprey in an area may not be compatible with other wildlife, such as terns (TRCA, pers. comm.). Research into site preference for targeted species should be undertaken as part of any restoration strategy.

- **TERN NESTING RAFTS** are anchored floating boxes that are filled with gravel to encourage tern colonies to nest where suitable habitat does not already exist. They are readily used by terns, as they offer refuge from numerous predators, e.g., raccoons, although mink have been known to access and predate them. Installations can be modified over time as issues are identified, or adapted to accommodate multiple uses, e.g., fish habitat underneath. Appendix B contains more detailed information on constructing tern nesting rafts in wetlands from the Toronto Region Conservation Authority (TRCA) and EC (1996).

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- **FISH CRIBS** come in a variety of forms, but essentially try to create structure and complexity within the wetland to provide fish with cover. The simplest structures include root wads and Christmas trees, which can sometimes be obtained free of charge. The tangled roots and branches provide gaps for fish to enter and hide in. More complex fish cribs involve attaching a variety of materials together, such as pallets and logs, to create the desired gaps and cover. Rocks or cinderblocks can be used to weigh down the cribs and ensure that they remain at the bottom of the wetland.

  Whichever form the final structure takes, fish cribs can be installed along the edges of the wetland at any time of year, or in the deeper sections by constructing them on the ice in the winter and allowing them to sink to the bottom when the ice melts. See Appendix B for sample instructions from eHow.com (2011).

- **TURTLE BASKING AREAS** are exposed surfaces within a wetland upon which turtles can bask in the sun. They can be engineered, e.g., floating logs anchored in the middle of the wetland, or simple, e.g., tree trunks set between the shoreline and water or large boulders. These habitats are readily used by turtles as long as they are able to climb up and are in a suitable location. If turtles are present in a wetland and this type of habitat is lacking, then basking logs are an inexpensive addition to a restoration project.

- **TURTLE NESTING AREAS** are easy to construct and may provide valuable habitat for turtles. First, an appropriate location must be identified; one that is sunny and away from vehicle access. Then, a sandy substrate is added at the site for turtles to nest in. Regular maintenance is required to prevent vegetation from growing at the site, and nest protection structures may be needed if nest predation becomes an issue.

When constructing any wildlife habitat, it is worth noting that natural materials are always preferred, but it means that breakdown of the materials will occur over time. As such, a restoration plan should acknowledge the periodic replacement of these constructed habitats over the long term.

Numerous resources exist in the literature and on the internet to construct the various artificial wildlife habitats presented in this section, and Appendix B highlights a few of these resources.

Central Lake Ontario Conservation

2.3 CONSTRUCTING ISLANDS

Structural diversity or habitat can be increased in a wetland by constructing islands. Constructed **ISLANDS**, which are engineered from rock and soil and are designed to mimic a naturally occurring feature, may be regarded as less of a restoration technique and more of a wetland enhancement technique if islands are being added to a wetland where none existed previously.

Constructing an island generally requires assistance from an engineer to ensure that wetland processes don't degrade the island over time. Some general rules for constructing islands include:

- In wetlands larger than 2 – 3 acres, 1 island may be suitable;
- Marshes from 4 – 25 acres in size should feature a maximum density of one island per four acres;
- Marshes larger than 25 acres can support a higher density, and islands should be at least 200 feet apart and 100 feet from the mainland to protect nesting waterfowl from predators

(Sargent and Carter, 1999)

While constructed islands can enhance marsh use by wildlife, it is a costly and invasive option, which may not be in keeping with the goals and objectives of a project. A less invasive alternative is to increase shoreline irregularity by creating peninsulas (Sargent and Carter, 1999).

STRUCTURAL DIVERSITY

In large wetlands, where wetland bathymetry is homogeneous, the addition of islands can help to diversify the range of water depths. This increases the potential growing area for aquatic plants, such as floating and emergent vegetation, and thereby increases habitat for wildlife.

Increased plant growth also helps to reduce turbidity, as plant roots hold sediments in place and vegetation stands minimize the impacts of wave action.

WILDLIFE HABITAT

In addition to increasing wildlife habitat area, as described above, islands themselves can provide specialized wildlife habitat, and can be designed to target species of interest, though care must be taken to ensure that islands are not easily accessible to predators or become nesting refuges for geese. Colonial nesters, such as terns, benefit from islands that are permanently exposed and have gravel substrate. Similarly, turtles may be encouraged to nest on islands with dry sand, and could prove to be high quality habitat due to reduced predator access.

Islands that are designed to be underwater for some part of the year, but exposed periodically when water levels are low, may benefit shorebirds that are attracted to mudflats to forage.

REDUCING TURBIDITY

Strategically-placed islands in very large wetlands may be a consideration for breaking wave action. Determining island placement, size, and structure to reduce wave action requires the services of an engineer, but could be an effective option, improving water quality while increasing habitat area at the same time.

2.4 MANAGING INVASIVE SPECIES

Invasive species have been present in coastal wetlands since Europeans settled into Ontario, but in the last few decades, concern for their impacts on wetlands has increased. Plant species such as Common Reed (*Phragmites australis*) are aggressive invaders, often displacing native species from wetlands, and providing poor quality habitat for wildlife.

Invasive aquatic wildlife, such as Common Carp, are almost ubiquitous in coastal wetlands today, unless access to the wetlands is permanently blocked off. The only way to prevent them from degrading a wetland is to prevent them from entering the wetland either by separating it from Lake Ontario, which impacts access for all fish species, or by installing a control structure with a grate that allows some fish species to pass but blocks adult carp from entering. While the use of a grated control structure seems like a straightforward option to implement, it is not, as carp are notoriously persistent about trying to access a marsh and have been known to dig around such structures.

It is important, when developing a wetland restoration strategy, to identify the invasive species that may be present in the marsh and have a plan in place to deal with them. It should also be recognized that some restoration activities may have a positive or negative influence on certain invasive species, and those influences may need to be addressed, if applicable, in the restoration strategy.

Photos (clockwise from top left): Yellow Flag Iris (Ontario Ministry of Agriculture); Round Goby (National Wildlife Federation); Eurasian Water Milfoil (High Country Resource Conservation and Development Council); Common Reed (Ministry of Natural Resources); European Frog-bit (Environment Canada); Goldfish (M. Ool).

2.5 MITIGATING UPSTREAM IMPACTS

The influences that upstream activities can have on a coastal wetland must not be overlooked. Inputs to the water system, such as nutrients, sediments, and pollutants, are carried downstream to coastal wetlands, and eventually make their way into Lake Ontario.

Watershed impacts vary significantly for each wetland; watershed size and land uses being two important variables. Large watersheds collect surface water from a large land base, and consequently contribute a lot of water to the receiving coastal wetlands. Where that surface water is travelling over developed or disturbed land, there is the potential to pick up contaminants that ultimately affect coastal wetland health. In small watersheds, where there is less land over which to travel, there are typically fewer land use contributions to impact the wetland, or at least contaminant point sources may be easier to identify and manage.

Land uses within a watershed are an important consideration when undertaking a wetland restoration strategy. Urbanized watersheds, which have more impervious surface area than non-urbanized watersheds, have reduced groundwater recharge functions and contribute warmer water to creeks. Petrochemicals and heavy metals from automobiles, as well as road salt, are distributed onto road infrastructure and make their way into coastal wetlands following rain events or snowmelt. Residential and commercial lands often contribute fertilizers and pesticides, among other things, to the creek system, which can adversely affect water quality and impair fisheries. Rural watersheds generally have fewer impacts, although some agricultural activities can still have a negative impact downstream. Practices such as allowing livestock to access creeks, lack of soil conservation in crop fields, and high use of fertilizers and pesticides, can all affect coastal wetland health.

For some coastal wetlands, the watershed influences are significant obstacles to overcome. In such cases extreme measures, such as re-aligning a creek so that it bypasses the coastal wetland and outlets directly into Lake Ontario, can be taken to prevent creek systems from contributing poor quality water to the wetland (figure 8). This is an expensive and invasive option, and is generally only considered in extreme cases. It can also negatively impact the wetland, as flows through the wetland help to draw fish into it. Furthermore, it does not address the ultimate issue of land use and its impact on the water system, and displaces the problem to Lake Ontario, which continues to receive poor quality water from the watershed, but no longer receives the filtration services provided by the wetland.

FIGURE 8: CREEK REALIGNMENT AT OSHAWA SECOND MARSH.

2.5.1 IMPROVING WATER QUALITY

In large, urbanized watersheds, improving water quality from outletting creeks can be a difficult problem to solve. It often requires widespread changes to occur, which involves the participation of private landowners, municipal governments, and local industry. Developing watershed management plans to help guide development and restoration in a watershed is a direct way of addressing existing issues and avoiding future ones. In the CLOCA jurisdiction, such plans exist, and all of them include strategies for maintaining healthy coastal wetlands.

Recommendations to improve water quality include:

- Ensuring that all creeks have adequate vegetation buffers to filter contaminants from surface water and slow down overland flows;
- Encouraging municipalities to keep impervious cover in the watersheds low to improve absorption and minimize overland flow into creeks (reduce erosion);
- Minimizing the use of road salt in the watershed;
- Encouraging reduced use of fertilizers and pesticides in residential areas;
- Ensuring that new developments include stormwater management practices;
- Promoting the use of low impact development technologies for new construction and retrofits;
- Ensuring that wetlands throughout the watershed are protected from development;
- Promoting education and stewardship to improve land functions that may have been lost.

2.5.2 IMPROVING WATER TEMPERATURE

Temperature is considered the single most important factor influencing fish distribution (Jenkins and Burkhead, 1993; MacCrimmon and Campbell, 1969). Temperature monitoring provides a good indicator of habitat suitability and allows one to assess the impacts of landscape changes on stream health. There is a range of temperature within which each fish species can survive, and species are roughly divided into three groups based on their temperature tolerances: coldwater, coolwater, and warmwater. Any deviation from historical temperature of a water body could result in fish community changes because the fishes that used to be best-suited for the area may no longer be. Groundwater and riparian areas, i.e., natural vegetation along the creeks, are necessary to maintain the thermal regime of that waterbody. This underlines the importance of protecting groundwater recharge/discharge areas throughout the watershed, especially in headwaters, and allowing sufficient shading of the creeks by riparian buffers.

Inputs into the creeks from stormwater ponds also have the potential to contribute to water temperature increases. This is because these large open bodies of water are not shaded and are able to warm in the sun. To prevent warming impacts, water drawn out of stormwater ponds into adjacent creeks is taken from the bottom of the pond rather than the top. This practice is standard for stormwater ponds in new developments in the CLOCA jurisdiction.

3. INCORPORATING RECREATION INTO A RESTORATION STRATEGY

Wetlands in Ontario have different values for different user groups, depending on their size and where they are located, particularly in relation to urban areas. Coastal wetlands along the Lake Ontario shoreline are predominantly publicly-owned, and, in part due to the presence of a waterfront trail system along the shoreline, are widely regarded as places for recreation. Activities such as biking and walking are encouraged, and many wetlands have lookouts and boardwalks that facilitate nature appreciation activities, like birding. Canoeing and kayaking, and even boating if access is available, are popular activities as well.

Wetlands are also widely used by anglers and hunters, as large marshes act as stopover sites for various species of waterfowl. In fact, many wetland restoration projects are accomplished in support of hunting and fishing activities. Organizations such as Ducks Unlimited Canada actively raise money and awareness for wetland conservation, and are considered to be experts in wetland restoration.

When restoring a wetland, consideration should be given to the existing recreational uses within the marsh and whether these activities are compatible with the goals and objectives outlined for the project. If a use is deemed to be incompatible, such as motorized boating in a sensitive marsh habitat, then the restoration plan will need to include strategies for eliminating that use. Existing recreational activities that may not be ideal from an ecological perspective within a wetland, but must be maintained for social or political reasons, should be acknowledged and accommodated in the restoration strategy.

Opportunities to improve recreational experiences within wetlands should also be considered as part of any restoration strategy, as this will encourage people to visit wetlands and help them to understand what they have to offer.

3.1 NATURE APPRECIATION

Being in a natural environment and observing wildlife are among the primary reasons that people visit coastal wetlands in southern Ontario, and they sometimes travel great distances for the experience, so providing access to wetlands is important. Establishing trails is an excellent means of enabling people to view a wetland and enjoy nature with minimal disturbance to the ecosystem. If no trails exist, then many people will be discouraged from visiting, while others might create their own paths to gain access, sometimes in areas that are sensitive or unsuited to public use. By putting in and maintaining a trail network, user groups are discouraged from entering into sensitive habitat areas, and the negative impacts associated with accessing sensitive areas, such as ground compaction, trash, and noise, are limited.

Infrastructure, such as a boardwalk from the shoreline into the wetland, can enhance the experience for many people, and can lessen the presence of unsanctioned shoreline trails by offering people access to the water. They can be costly to construct, however, and if not designed properly may be prone to vandalism. Periodic maintenance, as with any infrastructure, is also a requirement.

One of the more recognized wetland user groups is bird watchers, and a good way of improving the bird-watching experience in very large marshes is by constructing viewing platforms (figure 9). They may be elevated, allowing people to see farther into the marsh, or may be at ground level at the edge of the wetland. Elevated structures are ideal in wetlands where views of open water are difficult to achieve. Ground level platforms at the edge of the water are less costly and better-suited to wetlands where open water can be readily accessed and there is a desire to avoid trampling shoreline vegetation. As with boardwalks, periodic maintenance and the potential for vandalism should be factored into any decisions.

FIGURE 9: WILDLIFE VIEWING PLATFORM AT OSHAWA SECOND MARSH.

Dog-walking and wildlife feeding are extremely popular activities in urban areas, but are not good activities to promote around wetlands. Dogs can be very detrimental to wetland habitats as they may harass or kill wildlife, trample sensitive plant species, and spread invasive plants. Feeding wildlife is not a good idea as it habituates wildlife to people, which can lead to negative wildlife-human interactions later on, e.g., aggressive behaviour; it causes animals to become dependent on unnatural food sources; it may spread disease; and, it is unhealthy if the food is not natural.

3.2 EDUCATION

Educating the public about the importance of wetland ecosystems has become increasingly important as it helps people to understand the value of wetlands, and generates public support for protecting these features.

Education programs come in many forms. Signage along trails or at viewing platforms is a very common and effective means of disseminating information to people about the flora and fauna inhabiting an ecosystem, as well as the functions/values provided by a wetland. They can be costly, particularly if they are designed to withstand vandalism; however, they have the potential of reaching every visitor to the wetland. Active programs, such as walking tours and school group programs, are more engaging for people, as they are able to interact with an expert, and may reach a wider audience in the case of school children who might not have the opportunity to visit a wetland otherwise. Such programs require staff resources to be available, but these costs can be recouped by charging small program fees.

3.3 FISHING

Fishing requires access to open water, which is problematic in some wetlands where the shoreline is vegetated. Consequently, many anglers push through the vegetation to gain access, compacting the soil and creating a permanent path if continuously walked on. Such activities can lead to shoreline degradation over time and should be discouraged by providing designated fishing locations for people.

Boardwalks, viewing platforms, fishing groynes (figure 10), or any other infrastructure that provides people with access to open water can be used for fishing. Signs that encourage people to stay on trails and regular enforcement of trail use will ensure that fishing remains a compatible recreational use without compromising the integrity of the wetland.

FIGURE 10: FISHING GROYNE AT ROUGE RIVER MARSH.

In the CLOCA jurisdiction, fishing activities throughout the watersheds, including at the coastal wetlands, are promoted as part of the 2007 Fisheries Management Plan. A recommendation of this plan is to:

> Promote the fishery and encourage involvement by identifying public access areas and fishing opportunities, and support "no net loss" of fishing access.
>
> (CLOCA & MNR, 2007)

3.4 WATERFOWL HUNTING

Waterfowl hunting is regulated by the federal government through the Migratory Birds Convention Act (1994). In Ontario, user groups such as the Ontario Federation of Anglers and Hunters are interested in promoting and providing hunting opportunities, especially near urban areas and in southern Ontario where opportunities are often limited by access to public land.

3.5 BOATING

Depending on the accessibility of the wetland, as well as its size and depth, boating may be a feasible form of recreation. Generally, non-motorized boating, such as canoeing and kayaking, is better-suited to maintaining sensitive wetland habitats than motorized boating. Motors generate noise, which may disrupt the breeding/nesting habits of some wildlife, and emit fumes and fluids into the marsh environment that are harmful. Propellers are also prone to getting caught in and uprooting submerged vegetation, as well as increasing turbidity by stirring up bottom sediments in shallower areas, and can be harmful to wildlife such as turtles.

For coastal wetlands with permanent access to Lake Ontario, preventing wetland use by motorized boats may or may not be possible, as this activity is subject to the Navigation Protection Act. If restricting boating is desired, then a review needs to be conducted for the wetland in question.

Boat access for non-motorized boats, if deemed an appropriate use in the wetland, should be maintained, but does not need to be extensive as such boats can generally be carried into the water.

3.6 ICE SPORTS

Coastal marshes in urban areas are readily used by nearby residents as skating rinks or for ice fishing in the winter months. These activities generally have minimal impacts on the health of the wetland, particularly since the ground is frozen in the winter, vegetation is not growing, and sensitive wildlife are either dormant or have migrated south for the winter. One impact that can result from winter recreation, however, is the introduction of garbage into the wetland. Materials, such as huts, hockey nets, etc., are often brought out and left on the ice over the winter for repeated use. If these items are not removed before the ice melts, then they fall through into the wetland in the spring, and this can negatively affect wetland health over time.

Another consideration for landowners on whether or not to permit winter use is liability. There is always a danger of someone getting hurt or falling through ice, and it is up to the landowner to determine whether or not such risks can be managed.

RESTORING MCLAUGHLIN BAY: A DISCUSSION

Central Lake Ontario Conservation

4. RESTORING MCLAUGHLIN BAY

Choosing which restoration strategies to utilize at a given wetland depends on a number of factors. Ideally, decisions are based on the biology of the wetland, but in reality, social, economic, and political factors must also be considered.

At McLaughlin Bay Marsh, an investigation into the historical and biological factors at play has been undertaken, and this information is contained in the McLaughlin Bay Historical Report (CLOCA and MNR, 2012) and the McLaughlin Bay Existing Conditions and Restoration Opportunities report (CLOCA, 2012) respectively. The following information was included and/or derived from these reports:

- The shoreline at McLaughlin Bay has undergone major alterations over the last 200 years (natural), and the Bay had been previously more open to Lake Ontario than it has been in the last few decades.
- The barrier beach is very dynamic, and shifts over time.
- Some dredging may have occurred in the Bay in the past, and historical air photos suggest that the west shoreline was straightened in the 1960s.
- Agriculture was the dominant land use in the McLaughlin Bay watershed in the past.
- McLaughlin Bay is jointly owned by the Ministry of Natural Resources – Ontario Parks, the Canada Trust Company (managed by General Motors of Canada Limited), the City of Oshawa, and the Municipality of Clarington.
- Extensive upland restoration work has occurred in the McLaughlin Bay Wildlife Reserve (west side of the Bay).
- Water quality in the Bay is poor, with elevated salt content and high turbidity.
- Reasons for the high wetland turbidity include the presence of Common Carp, sediment re-suspension from wave action, and possibly seasonal algal blooms.
- Aquatic vegetation cover has decreased significantly since the mid-1900s.
- Wildlife diversity is low as a result of lack of habitat.
- There is little water exchange between Lake Ontario and McLaughlin Bay, contributing to poor water quality.
- The wetland bathymetry is bowl-shaped, i.e., deepest in the middle, and depths range between 0 – 3 m, depending on the time of year and the weather in a given year.
- Water levels tend to decrease in the wetland over the course of the year.
- Sediments in the Bay are not contaminated, and there is a mix of soil types including silt, clay, sand, cobble, and some organic content.
- Numerous sections of shoreline have become undercut and are eroding.
- McLaughlin Bay, like other coastal wetlands, has suffered as a result of controlled water levels in Lake Ontario.

The potential to address these issues was also presented in the 2012 Existing Conditions and Restoration Opportunities report, and some discussion of the pros and cons of each opportunity was included (see Appendix A).

This section will discuss the suitability of implementing these restoration opportunities (as previously discussed in sections 2 and 3) at McLaughlin Bay in more detail, and address some of the socio-political factors that influence the opportunities.

4.1 WETLAND DRAWDOWN IN MCLAUGHLIN BAY

Static higher water levels, nutrient loading, algal blooms, carp activity causing high turbidity, past dredging and infilling activities, elevated salt concentrations, and the increasing permanence of the barrier beach have all impacted the vegetation community at McLaughlin Bay. A drawdown of this wetland is necessary to re-establish healthy wetland vegetation communities, and would temporarily improve water quality by reducing turbidity and lowering salt levels. The issue that needs to be explored is to what extent it should be drawn down and how best to undertake it.

4.1.1 FULL VS PARTIAL DRAWDOWN

FULL DRAWDOWN

McLaughlin Bay contains around 600,000 m^3 (161,000,000 USG) of water at its average spring water level of 75.5 m IGLD. Removing this volume of water from the basin will be costly, and raises the question of whether it should be emptied entirely or partially.

Under ideal circumstances a full drawdown would achieve:

- Maximum vegetation growth, the extent of which would be regulated by rebounding water levels.
- Substrate consolidation, which will help to keep turbidity down while plants are growing.
- Temporary elimination of Common Carp from the Bay, thereby improving growing conditions for vegetation.
- Removal of all existing poor quality water, temporarily improving growing conditions.

However, the conditions at McLaughlin Bay are not ideal, leading to some uncertainty about the ability to a) undertake a full drawdown and b) to achieve the benefits associated with a full drawdown.

Organic soils within the Bay are limited to the north end and along the shorelines (CLOCA, 2012), so it is unlikely that vegetation growth would occur or be supported throughout the basin if it were exposed entirely. Similarly, substrate consolidation is dependent on the presence of organics; without these, re-suspension of sediments is likely to occur as soon as the Bay is re-flooded.

Of additional concern is the potential for the barrier beach to break open during a full drawdown as a result of the difference in water levels on either side of the beach. It is possible that the beach will be unable to withstand this pressure and break, causing the Bay to be re-flooded, undermining the drawdown.

Finally, a full drawdown of the Bay would interfere with recreation at Darlington Provincial Park, would temporarily reduce the wildlife habitat available in the area for mobile species such as amphibians and reptiles, and would result in the mortality of some immobile species, such as larvae or invertebrates. Fish mortality, with the exception of Common Carp, would not be an issue as they could be rescued as water levels drop.

Given the uncertainty of achieving all of the benefits of a full drawdown, the risk to wildlife, and the potential for a break to undermine the drawdown, a full drawdown of the Bay is not a recommended option.

PARTIAL DRAWDOWN

A partial drawdown, by comparison, would achieve some of the same benefits as a full drawdown, but with a lower risk of failure. If water levels were drawn down to a basin elevation of 74.5 m IGLD (dashed line in figure 11), then it would expose the substrate in the wetland that typically has a water depth of 0 – 1 m: the growing zone for emergent vegetation. The substrate in this area, outside of the dashed line in figure 11, does contain an organic component, for the most part, and would therefore support vegetation growth. Overall, it could increase vegetative cover in the marsh by 10 ha.

Unfortunately, substrate consolidation, temporary removal of turbid water, and elimination of Common Carp will not occur with a partial drawdown, which may result in the loss of the vegetation that does germinate through a drawdown. Furthermore, drawing down water levels by 1 m only exposes the substrate along the shoreline, which will not support enough vegetation to achieve the desired cover in the marsh. These factors may lead to the conclusion that a partial drawdown is not worth undertaking, but it must be noted that one of the reasons that the exposed area in the partial drawdown scenario is so small is because of the steep wetland edges that currently exist (see figure 12). If these edges were graded, both upland and into the water, then the area along the shoreline that sustains 0 – 1 m water depths would be much larger. As such, a partial drawdown must be paired with shoreline restoration works for it to be worthwhile, and additional options, such as creating cells, must be considered in order to meet the goal of increased vegetation cover. These options are discussed further in sections 4.2 and 4.3.

Given that a 1 m drawdown is a low-risk undertaking at McLaughlin Bay, as it is already known from historical water level monitoring that the beach can support a differential of 1.2 m (observed in 2010); and that it is an effective option for restoring shoreline vegetation if shoreline restoration efforts are completed; a partial drawdown is recommended.

The first consideration in undertaking a partial drawdown at the Bay will be timing. Since 2004, when monitoring of the water levels in the wetland began, the average spring water level in the Bay has been around 75.5 m (highest = 75.9 m; lowest = 75.2 m). Using the average, undertaking a partial drawdown in a high water year could require the removal of an additional 40 cm of water compared to an average year, and drawing down the wetland in a low water year could save having to remove as much as 30 cm. Consequently, it is far more cost effective to plan for a drawdown in a drier year.

Water levels for an upcoming year can be predicted to some extent by contacting the National Oceans and Atmospheric Administration – Great Lakes Environmental Research Laboratory (http://www.glerl.noaa.gov), as water levels in the Bay are generally close to those in Lake Ontario in the spring; however, predicting water levels for the year following a drawdown, which is also important because high water levels negatively affect the survival of any vegetation that is germinated as a result of the drawdown, is less certain. The water level for the year following a drawdown will have to be measured at that time and a decision made as to whether or not it needs to be lowered.

The next consideration is how to go about removing water from the Bay. As is outlined in section 2.1.1, there are two main options: passive removal through the use of a stop log control structure, and active removal through the use of a pump. Volume of water to be removed / timing of removal (desired water level should be achieved by the 1st week of June), cost, and feasibility will be the driving factors in deciding which drawdown option to choose. These are discussed as they relate to McLaughlin Bay in the next subsections.

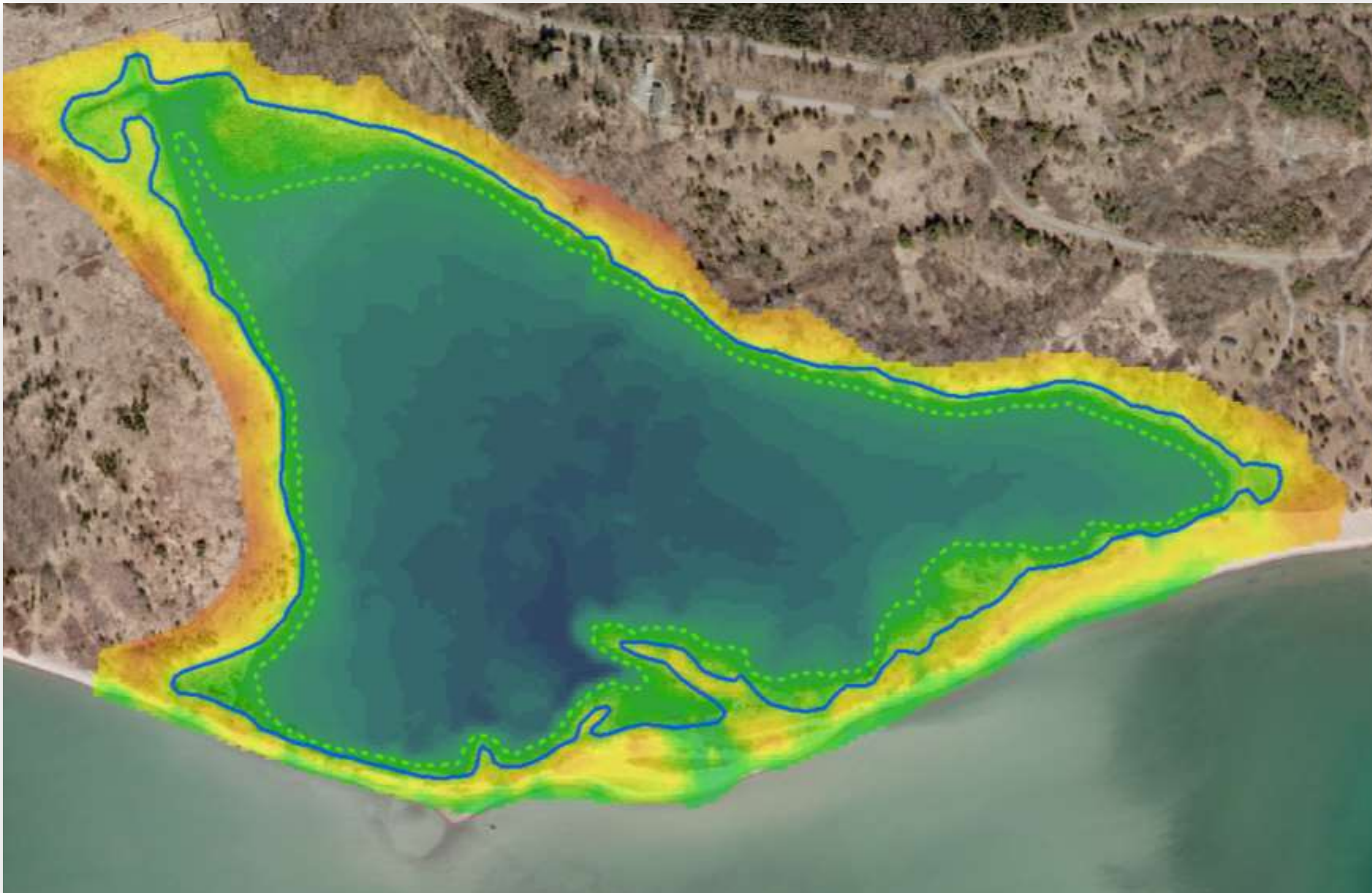
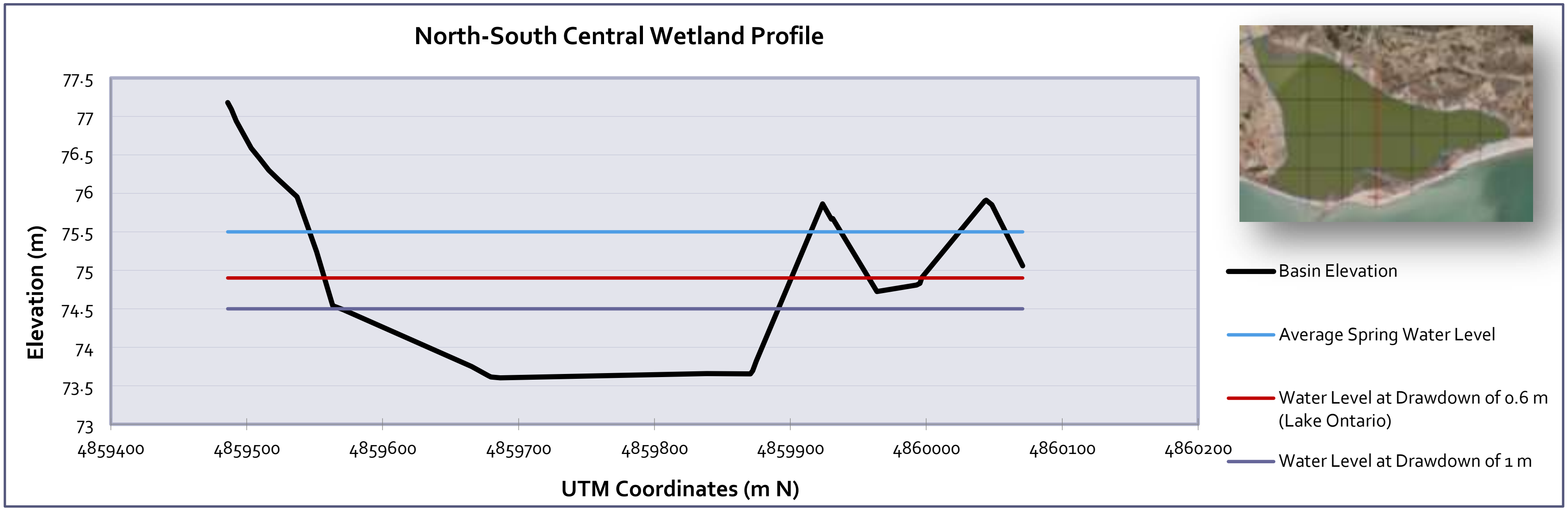
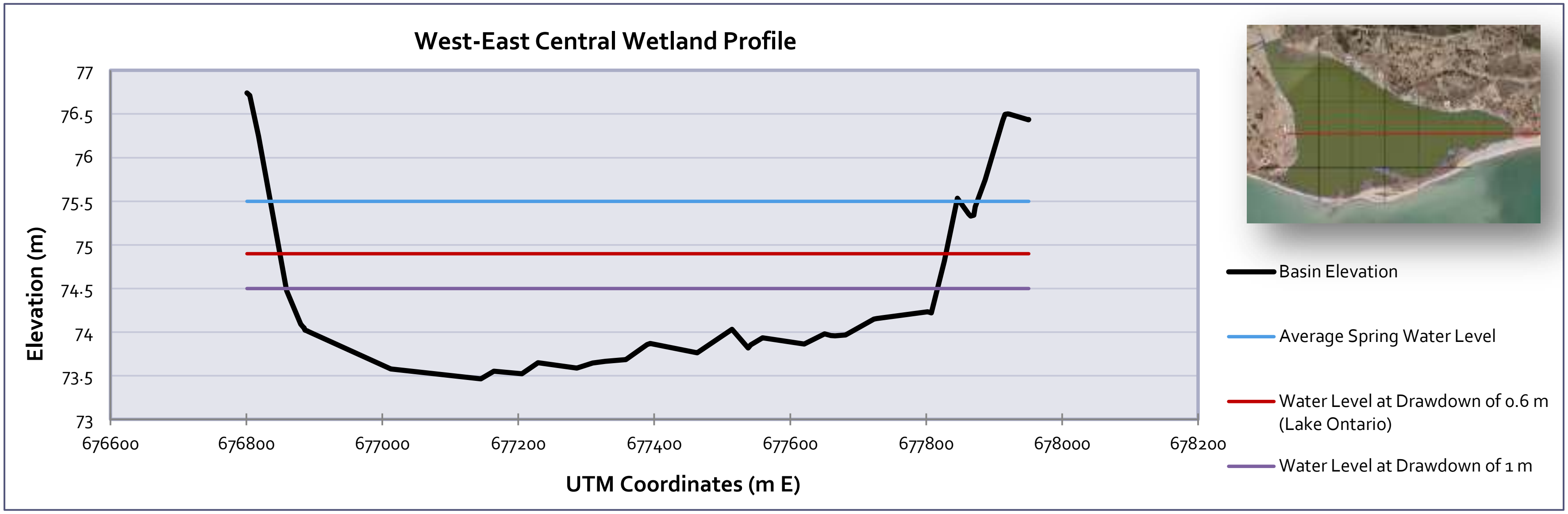


FIGURE 11: WETLAND BASIN ELEVATIONS, AVERAGE SPRING WATER LEVEL OF 75.5 M IGLD (BLUE LINE), AND PROJECTED LIMITS OF EMERGENT VEGETATION GROWTH FOLLOWING A PARTIAL DRAWDOWN TO 74.5 M IGLD (DASHED LINE).

Figure 12: McLaughlin Bay cross-sections at central wetland axes and illustrating sediment exposure at various water level drawdowns





STOP LOG CONTROL STRUCTURE

The decision of whether or not to draw down a coastal wetland using a stop log control structure depends on how much of the wetland bottom can be exposed through passive water removal in comparison with the cost of actively pumping the same volume of water out of the wetland. In the case of McLaughlin Bay, water level logger data (2004-2011) suggests that water levels in the marsh tend to be higher than Lake Ontario water levels in the spring, but this difference can vary significantly. Differences in springtime water levels between McLaughlin Bay and Lake Ontario, between 2004 and 2011, have ranged from as little as 10 cm in low water years to 1.2 m in high water years. The average difference between the levels in early May is 60 cm. If a marsh drawdown to 74.5 m or lower (as described in the previous subsection) is desired, then a control structure alone would not be sufficient to achieve the desired result.

The cost to remove 60 cm of water from McLaughlin Bay using a stop log control structure is equal to the cost of installing the structure, at least for the first drawdown. Exact costs are unknown, but the cost to install a stop log control structure at Cranberry Marsh in 2001 was $50,000: given inflation and the need for a much larger structure than the one at Cranberry Marsh, it is probably reasonable to assume that the cost to install a stop log control structure at McLaughlin Bay would be between $150,000 and $200,000. Assuming a $150,000 installation cost, the price to remove 60 cm of water from the Bay is ¢0.23 /USG (table 2).

Although the capital costs are high, once a stop log structure is in place drawing down water levels in subsequent years is free (aside from maintenance), so it is worth considering the cost of a stop log control structure over time. At McLaughlin Bay, where a comparison of barrier beach size, shape and location over several decades was done as part of the Existing Conditions and Restoration Opportunities report (CLOCA, 2012) and showed the beach to be very dynamic, there is a risk that the investment in a stop log control structure may not be realized over time.

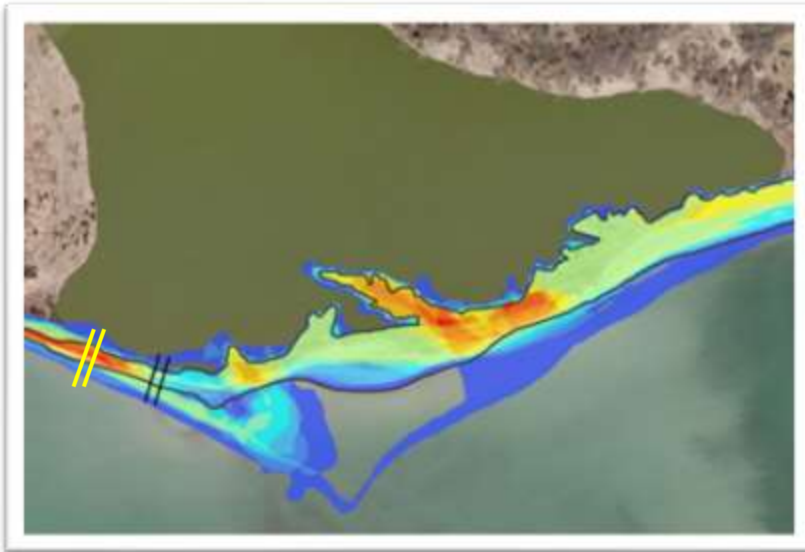
TABLE 2: COST ANALYSIS FOR DRAWING DOWN WATER LEVELS IN MCLAUGHLIN BAY USING A STOP LOG CONTROL STRUCTURE

AVERAGE WATER LEVELS IN MAY	WATER LEVEL (m)	WETLAND VOLUME (USG)	DRAWDOWN VOLUME (USG)
McLaughlin Bay	75.5	160,741,529	0
Lake Ontario	74.9	95,477,308	65,264,221
Capital Cost (estimated)			$150,000
Cost (¢/USG) for 1st drawdown			0.23
Average cost per drawdown (¢/USG) after 8 drawdowns			0.028

Figure 13 highlights the barrier beach movement at McLaughlin Bay since the 1920s, and shows the location of the current break site (double black line). The sections in red are the most stable, while the sections in blue are the most dynamic (and in some cases no longer exist). The area of the beach that contains the current break site has been stable for about 10 years, so it might be reasonable to place a 10-year lifespan on a control structure installed at this location, during which time you might expect to use it for a drawdown once or twice. A control structure installed at a more stable place along the beach, however, could dramatically increase its life expectancy. The southwest corner (see double yellow line in figure 13), for example, has remained stable since at least 1927. Unfortunately, it may not be the most effective location for a control structure because it is fairly shallow in this corner and drawdown potential will be limited, but a control structure in this location could potentially have a lifespan of 80 years or more.

Over an 80 year period, several drawdowns would likely occur (assume 1 every 10 years), making the initial cost of the structure more justifiable with each drawdown. Assuming the same installation fee of $150,000, after 8 drawdowns the cost of removing 60 cm of water from McLaughlin Bay, drops to ¢0.03/USG (table 2).

FIGURE 13: MCLAUGHLIN BAY BARRIER BEACH STABILITY ANALYSIS.



Despite the value of a control structure over time, it is not the preferred means of drawing down McLaughlin Bay because the desired drawdown level of 1 m cannot be achieved without also using a pump, which makes it less cost-effective. It is also a risky option due to the uncertainty of barrier beach stability, and it has a potentially negative impact on sensitive beach plants, specifically the locally rare *Potentilla paradoxa*. Therefore, a stop log control structure is not recommended at McLaughlin Bay.

PUMP

As the previous section demonstrates, pumping will be required to achieve the desired drawdown level at McLaughlin Bay. There are several choices when considering pumping, the broadest choice being between an electric and diesel pump, and then between installing a permanent pump or renting a portable one. These options are discussed in section 2.1.1, and will be explored further in this section as they relate to McLaughlin Bay, but no concrete conclusions have been drawn in this report as the variables involved are extensive, and are subject to change overtime.

Although this report will make a recommendation as to which pumping option is best-suited to McLaughlin Bay, in terms of broad cost estimates and the preferences of the steering committee, it must be recognized that a qualified professional needs to be engaged to fully assess the options for McLaughlin Bay.

ELECTRIC PUMP

Electricity at McLaughlin Bay is not readily available at the wetland edge and will have to be brought in, either by hydro lines or by direct burial underground. The two most likely locations for connecting to the grid are from the north, where hydro is supplied to the commercial buildings along Colonel Sam Drive, or from the east through Darlington Provincial Park. Figure 14 shows the approximate location of these connection points. In the first instance, the pump site would be located at the southwest corner of the wetland; in the second instance, the pump site would be at the southeast corner of the wetland (red stars in figure 14).

The distance to run wire from the north (blue bolt) is just over 1 km, and the distance from the east is between 200 and 500 m, depending on whether a connection could be made from one of the closer outbuildings (purple bolts) or if it would have to originate from the main park office (red bolt) (figure 14). Clearly, running electricity from the east is the shortest distance and therefore the least expensive option; however, Ontario Parks is not prepared to host the electrical infrastructure that would be required to provide power to the southeast corner of the Bay at this time. Consequently the only alternative for installing an electric pump at McLaughlin Bay would be to draw power from the north.

FIGURE 14: POTENTIAL HYDRO CONNECTION POINTS AND LOCATIONS FOR A PERMANENT ELECTRIC PUMP HOUSE AT MCLAUGHLIN BAY.

Although the cost of installing an electric pump cannot be determined without professional assistance, a sample cost analysis for an electric pump has been included in Appendix B. It is not meant to be definitive, as it has already been stated that all of the variables are too complex to consider in this report; however, it does offer some insight into the potential costs and can be used at a later time to help conduct a more thorough analysis.

DIESEL PUMP

Given the constraints associated with installing electricity on-site at McLaughlin Bay, a diesel pump may be a more realistic option. A sample cost analysis comparing the cost of renting a diesel pump versus purchasing one has also been included in Appendix B. Although the variables involved in this analysis are less extensive than with the electric pump, and therefore the cost is a bit easier to estimate, there is a lot of variability in pump sizes and styles that cannot be included in this report. Therefore, pumps of a comparable size were used in the sample analysis in Appendix B to highlight the differences, similarities, and the costs of each over time, but the variations, such as the cost-benefits of using larger diameter pumps, has not been explored. Similarly, pumping can be achieved by renting a tractor and attaching an irrigation pump, but this option has not been accounted for in Appendix B.

CONCLUSIONS

When the physical and political constraints, the uncertainty associated with any first drawdown, and the relative costs from the sample cost analysis in Appendix B are considered, the preferred drawdown option is to rent a temporary diesel pump and to install it at the southwest corner of the Bay in order to reduce noise impacts to the adjacent Park.

Central Lake Ontario Conservation

4.2 RESTORING WETLAND BATHYMETRY IN MCLAUGHLIN BAY

It is unknown what the bathymetry of McLaughlin Bay was in the past. Historical air photos and maps exist for the area dating as far back as 1795, and considerable change, particularly with respect to the barrier beach, has occurred over this time period. Evidence of shoreline straightening along the western edge can be seen in the late 1950s or early 1960s, and infilling has potentially occurred in some of the wetland corners. There is also current evidence of shoreline undercutting in some areas of the Bay.

The decision of how much of the bathymetry to restore and how far back to go is influenced by the project goals, resource availability, and feasibility. At McLaughlin Bay, the need to restore biological integrity must be balanced with the limited resources that are available to carry out restoration activities.

4.2.1 RESTORING THE BASIN

Major in-water works, such as re-profiling the Bay, have been identified as too costly/intensive for the benefits that may result, so are not preferred restoration options. Such works are also not compatible with the need to avoid interrupting recreational activities in the Bay.

One area of potential basin restoration, however, is at the north end of the wetland where the shoreline has been altered in the past. Surcharging in this area (within yellow dashed lines in figure 15) would be minor in nature, would not interfere with recreation activities, and could improve vegetation cover in this section of the Bay as it is currently too deep in some areas to support emergent vegetation.

FIGURE 15: WETLAND BATHYMETRY RESTORATION OPPORTUNITIES.

4.2.2 RESTORING THE SHORELINE

Shoreline restoration activities, which can generally be accomplished without impacting recreation, and which will help to achieve the goals of improving vegetation cover and water quality, is a feasible option for this wetland. The main objectives in undertaking such works are to reduce erosion and to expand the area that will support emergent vegetation growth.

Recreational enhancements, such as boardwalks or fishing platforms, may also be done in conjunction with shoreline restoration works, and these opportunities are discussed in more detail in section 5.

RESTORING SHORELINE VEGETATION ZONES

Both the west and east shorelines of McLaughlin Bay contain sections where steep slopes exist and undercutting has occurred. In these areas, shoreline stabilization should be done (red lines in figure 15).

The shorelines should be graded in these areas to remove undercutting and form a stable slope to prevent erosion from occurring in the future. The grading should begin on the upland edge of the shoreline and extend into the water so that there is a gradual transition of water depths in the wetland, enabling the growth of a diversity of emergent vegetation and increasing the area of the shoreline that will support such plants. This, paired with a partial drawdown to temporarily expose the substrate, will help achieve the goals of improved plant diversity and vegetation cover.

Soil amendment, if necessary, should be done to improve organic content and support plant growth. Active planting, to initiate vegetation cover along the shoreline, will need to be done, and these plantings will need to be temporarily protected from wildlife by erecting barriers, such as snow fencing, until they are established.

The terrestrial edge of the shoreline should also be evaluated at the time of the shoreline works to determine if additional plantings, such as trees or shrubs, would improve the quality of the shoreline and help maintain water quality.

CREATING BACKWATER LAGOONS, POOLS AND SHOALS

Additional elements, such as creating backwater lagoons, would be good to include in the shoreline restoration work to enhance wildlife habitat or create structural diversity within the wetland. Many wildlife species benefit from channels, pools, or seasonally exposed sediments, and adding such features would help achieve the goal of improved wildlife habitat. The size, location, and suitability of such elements can be investigated more closely in the implementation phase of this project when a design will be needed.

ADDING SHORELINE STRUCTURE

The placement of stumps, logs, and boulders along the shoreline to improve underwater cover and basking habitat should also be done along with other shoreline restoration works. Adding structures along the shoreline will further help to stabilize the edge against erosion.

4.2.3 COST

Determining the cost of doing shoreline restoration works requires the assistance of a qualified consultant or contractor. This can be done through a bidding process, whereby several contractors submit designs along with cost estimates and the preferred bid is chosen; alternatively, a specific contractor can be approached to design the restored shoreline and estimate the costs of implementing the project.

Some cost variables will include:

- Equipment required
- Estimated length of the project
- Complexity of project
- Volume of fill required
- Type and source of fill required
- Cost of plantings
- Site accessibility
- Permitting requirements

4.3 CREATING CELLS IN MCLAUGHLIN BAY

McLaughlin Bay is very large (40 ha), and has the potential to accommodate constructed cells, particularly in its corners. As discussed previously, creating cells within a wetland can be effective for managing issues, such as water quality, that may be difficult to address in the whole wetland, and McLaughlin Bay is a good example of this.

Specifically, creating cells within McLaughlin Bay would:

- reduce turbidity by limiting wave action across the wetland (cell edges would act as wave breaks);
- allow for the management or exclusion of Common Carp within individual cells, thereby reducing turbidity and improving aquatic vegetation growing conditions;
- enable water level management within the cells without affecting the entire marsh, thereby accommodating recreational activities without interruption;
- improve wildlife habitat diversity;
- create zones that can be managed for specific aquatic vegetation.

The southwest, north, and southeast corners of the wetland are the most obvious locations to create cells in the Bay (figure 16), and it is worth discussing the merits of each location to help decide which cells, or which combination of cells, to carry forward as part of the restoration strategy.

Constructing cells in any of these areas of the Bay will be expensive, requiring site specific in-basin surveys to determine feasibility, and will include infrastructure costs beyond just the construction of a berm, for example, the inclusion of a stop log control structure to maintain water levels and manage fish passage. Managing water levels over the long run may also require pumping, so a plan will need to be developed with respect to how to actively remove water from the cells to facilitate future drawdowns.

Finally, constructing wetland cells, while probably the most effective option for improving water quality, and increasing vegetation cover and wildlife habitat area in McLaughlin Bay, is a major undertaking and will significantly alter the structure of the wetland.

FIGURE 16: MAP SHOWING POTENTIAL CELL LOCATIONS WITHIN MCLAUGHLIN BAY.

4.3.1 CREATING A CELL IN THE SOUTHWEST CORNER OF MCLAUGHLIN BAY

A cell in the southwest corner of the Bay would include a portion of the west shoreline and part of the barrier beach (figure 17). An immediate limitation of this cell location is the barrier beach and its dynamic nature. Movement of the beach over time could undermine the cell and result in wasted effort. Furthermore, the current break in the beach (black lines in figure 17) is located in this corner of the wetland, which limits the placement of a berm as it is not desirable to include the break within the cell. Consequently, a berm in location 'a' (figure 17) is not a good option.

Constructing a berm to the west of the current break site, line 'b' in figure 17, would be less risky but would involve constructing a very long berm (200 + m) and would result in a cell that is only 1.2 ha in size. At a cost of 167 m of berm per hectare of habitat, it is clear that a cell in this location is not cost-effective; therefore, it is not recommended as an option.

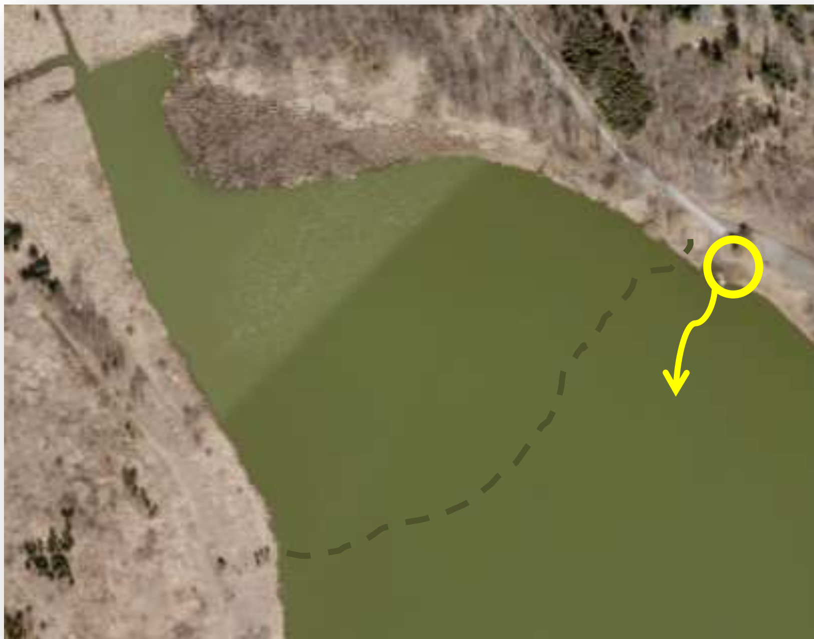
4.3.2 CREATING A CELL IN THE NORTH CORNER OF MCLAUGHLIN BAY

The north end of the wetland is also a suitable location for a cell, and is advantageous in that none of its shorelines are dynamic. This cell could be created in a range of sizes, an example of which is shown in figure 18 (dashed line), but could not be larger than this at the present time as it would interfere with the existing boat launch at Darlington Provincial Park (yellow circle in figure 18), which must be maintained for scientific and safety purposes. A larger cell could be considered if the boat launch was to be re-located, but this is an option that would need to be examined more closely in the future.

FIGURE 17: POTENTIAL BERM LOCATIONS IN THE SOUTHWEST CORNER OF MCLAUGHLIN BAY.

A berm constructed at the sample location in figure 18 would be approximately 330 m in length and would create just under 6 ha of habitat. This is a relatively cost-effective option at around 57 m of berm per hectare of habitat. A further advantage of this cell location is that it should not impede the waterfowl hunt and could provide increased recreational opportunities in the form of a path along the constructed berm (see section 5). As such, creating a cell in the north corner of the Bay is recommended.

FIGURE 18: SAMPLE CELL IN THE NORTH PART OF MCLAUGHLIN BAY.



4.3.3 CREATING A CELL IN THE SOUTHEAST CORNER OF MCLAUGHLIN BAY

A cell in the southeast corner of the Bay is probably the most cost-effective location to create such a feature, as a relatively short berm would be needed to close off this part of the wetland. A range of cell sizes could be accommodated in this location and some sample berm locations are shown in figure 19.

The cost-effectiveness of constructing each of these cells is comparable, though the largest of the sample berms, 'a' in figure 19, is the least expensive (in terms of metres of berm per hectare of habitat) of all of the options presented in this section. In location 'a', the berm would be around 320 m in length and would create 10 ha of habitat. In location 'b', the berm would be 325 m, and would create roughly 8 ha of habitat. In location 'c', the berm would be 185 m, and would create 5 ha of habitat. Respectively, the m/ha costs would be 31, 40, and 37 for each of the sample cells in figure 19.

As with the southwest corner, the barrier beach would make up a portion of this cell. This has the potential to undermine it if the beach were to move significantly, but the beach stability analysis conducted as part of the 2012 Existing Conditions and Restoration Opportunities report shows this to be a fairly stable section of beach, and given the potential habitat gains associated with a cell in the southwest corner, it is recommended as a restoration option.

FIGURE 19: POTENTIAL BERM LOCATIONS IN SOUTHEAST CORNER OF MCLAUGHLIN BAY.

4.3.4 COST

Estimating the cost of constructing cells in McLaughlin Bay cannot be undertaken in this document as it requires the assistance of a qualified engineer or contractor. Some of the variables that will need to be considered, however, include:

- Need for additional data.
- Type and volume of material required to construct a berm.
- Slope stability.
- Feasibility of construction.
- Equipment required.
- Need for additional work in the cells, e.g. surcharging, plantings, or habitat creation.
- Inclusion of recreational features, such as a trail.
- Cost of control structure or grate to exclude Common Carp.
- Need for a pump.

In addition, the construction of berms in a Provincially Significant Wetland will require a Work Permit approval from the MNR as well as a permit from CLOCA. A DFO review will also be required under the Fisheries Act, as the work will be taking place in fish habitat. Therefore, the final size, shape, and location of cells in McLaughlin Bay will be decided not only through a cost-benefit analysis, but also with the aid of professional consultation and inter-agency discussion.

4.4 CONSTRUCTED WILDLIFE HABITAT

Of the five habitat options discussed in section 2.4, tern nesting rafts, fish cribs, and turtle basking areas are the most suitable constructed habitat options to carry forward into the restoration strategy for McLaughlin Bay.

Osprey platforms already exist within the adjacent McLaughlin Bay Wildlife Reserve, and have had limited success to date. It is unknown if they would be used if erected in the Bay, but given the cost of installing them, it is not a recommended option.

Tern nesting platforms are easy to construct and install, and effectively attract terns. There is currently a lack of tern habitat in McLaughlin Bay, and as terns already nest in Oshawa Second Marsh it is likely that they would use such platforms if introduced. The low risk level associated with this option, combined with its potential to help achieve the goal of increasing wildlife diversity in the Bay, makes this a recommended restoration option.

Improving fish habitat is a priority at McLaughlin Bay, and installing fish cribs or root wads is an easy habitat enhancement solution, and is a recommended restoration action.

Turtle basking areas can be easily incorporated into the shoreline restoration works by including partly submerged logs and boulders large enough to break the surface of the water along the shoreline; therefore, it is recommended for inclusion in the strategy. Constructing nesting areas for turtles is a less desirable option because of the labour required to maintain such areas. The Bay is already adjacent to a long stretch of south-facing beach, which is a suitable nesting site for turtles, and one that is maintained naturally; therefore, adding new nesting sites is not recommended.

4.5 CONSTRUCTING ISLANDS

Although islands could be an effective means of addressing wave action in McLaughlin Bay, the high cost of creating such features, combined with the uncertainty of their effectiveness at reducing wetland turbidity, makes this an undesirable restoration option for McLaughlin Bay.

4.6 MANAGING INVASIVE SPECIES

Invasive species are present in McLaughlin Bay, and include Common Carp, Common Reed, Eurasian Water Milfoil, European Frog-bit, Flowering Rush, and Yellow Flag Iris. While some of these populations are small, and removal or management is possible, for other more widespread species management will be difficult. Plans to deal with specific species should be in place prior to undertaking restoration works where invasive species may be located.

In McLaughlin Bay, Common Carp are highly destructive, as their foraging and spawning activities increase turbidity levels and remove vegetation. Removing carp from the Bay would involve drawing down the wetland completely, so that there is no refuge for them, and installing a control structure designed to prevent them from re-entering into the Bay in the future. As has been noted previously, there is a very high risk associated with a complete drawdown, so it is unlikely that all carp could ever be completely removed from the Bay. Furthermore, improving fish habitat is one of the restoration goals for McLaughlin Bay, so preventing access to all fish species by installing an impassable control structure is not preferable. Consequently, carp will continue to inhabit the Bay, but their impacts can effectively be mitigated in some areas by constructing cells with carp exclusion barriers.

Common Reed is an aggressive invader, and has the potential to reduce plant diversity in McLaughlin Bay. Currently, this plant is present in the marsh in small pockets, but the possibility for it to spread is high, particularly following a drawdown or restoration works that disturb the soils. A containment and removal strategy for this species should form part of any restoration activities, and should be done following best management practices to avoid impacting the wetland.

4.7 MITIGATING UPSTREAM IMPACTS

McLaughlin Bay has a relatively small watershed, with a mix of commercial, residential, agricultural, and natural land uses (figure 20). All of these land uses are potential contributors to poor water quality in the Bay, so samples were taken from outletting creeks in the watershed and analyzed for contamination. The results of the analyses are contained in the 2012 Existing Conditions and Restoration Opportunities report.

The report identified the following key watershed factors to consider in the wetland restoration strategy:

- The presence of three stormwater ponds in the watershed.
- High salt levels originating from nearby commercial parking lots, and some automobile-related heavy metal and petrochemical contaminants from Highway 401 and other roads in the watershed.
- Moderate nutrient inputs, possibly from residential and/or agricultural activities.

4.7.1 IMPROVING WATER QUALITY

The stormwater ponds in the watershed were designed to control water quantity, not water quality, so there is little that can be done aside from investigating retrofit opportunities to improve their ability to remove contaminants from the system. The most effective means of reducing chemical pollutant levels in the outletting creeks will be to address their usage before they enter into the system.

Reducing contaminants from Highway 401 will be difficult to achieve; the only options are to encourage the operator to use an alternative to road salt around coastal wetlands, which may or may not introduce a new set of undesirable pollutants, or to construct stormwater management facilities such as ponds along the highway right-of-way. Inputs from cars themselves are relatively minor, excluding the potential for major spills, and do not severely impact the water quality in McLaughlin Bay at present.

FIGURE 20: MCLAUGHLIN BAY WATERSHED WITH STORMWATER PONDS, POTENTIAL POINT SOURCES FOR CONTAMINANTS, AND CREEKS.

Reducing salt contributions from the commercial properties in the watershed, most notably Minacs and GMC, is more straightforward and involves discussing alternatives, e.g., using less salt or researching alternative products, with the property managers.

High salt levels in urban water systems are a widespread issue: it is hoped that over time better technologies will emerge that will help remove this contaminant from aquatic systems. The potential for new innovations in salt management technologies to improve water quality at McLaughlin Bay should be considered as they are made available, and implemented if possible.

4.7.2 IMPROVING WATER TEMPERATURE

Being that McLaughlin Bay has a relatively small watershed, and that the Bay itself is such a large and open body of water, making significant improvements to water temperature by modifying upstream land uses could prove to be difficult. However, ensuring that impervious cover in the watershed remains low through responsible land use planning, and safeguarding the creeks in the watershed by buffering them with trees and shrubs to keep water cool as it moves through the system, will help to maintain or reduce water temperatures in the Bay.

Improving water temperature can also be achieved through private landowner stewardship activities and by engaging the municipality to protect existing stream corridors from encroachment and development.

Along with these options, opportunities for Low Impact Development (LID) retrofits should be explored for existing development. A Watershed Plan does not currently exist for the McLaughlin Bay watershed, but LID is a recommended action in the 2012 Watershed Plan for the Black/Harmony/Farewell watersheds. The retrofit recommendations included in the Plan can generally be applied to the McLaughlin Bay watershed and will achieve the same water quality and temperature benefits.

5. INCORPORATING RECREATION

McLaughlin Bay is widely used for recreation, so it is a primary consideration in the development of the restoration strategy. Existing recreational uses (figure 21); potential impacts to recreation as a result of restoration works; and, opportunities to improve these uses following restoration will be examined in the subsections below.

5.1 NATURE APPRECIATION

Many of the visitors to Darlington Provincial Park and the McLaughlin Bay Wildlife Reserve come to observe nature, and McLaughlin Bay is an important feature in the natural landscape. Currently, the wetland is in poor condition, having turbid water, low vegetation cover, and little wildlife habitat. Improvements to all of these aspects would attract wildlife to the marsh, and greatly enhance the viewing opportunities for Park and Reserve visitors. Therefore, the restoration recommendations made in Section 4 of this report complement the goal of improving recreational activities in the Bay.

The creation of one or more cells in the Bay would further improve vegetation growth and wildlife habitat, and could create the opportunity for walking trails along the created berms, providing access to wetland habitats for wildlife viewing (figure 21).

A boardwalk along the eastern edge is another consideration for improving recreation (figure 21). It would provide people with unobstructed views of the water without hardening the shoreline, provide interpretive education opportunities, and may provide nesting habitat for Barn Swallows, a Species at Risk in Ontario. Boardwalks also provide cover for fish, which would contribute to fish habitat improvements; however, such a structure would need to be approved and maintained by Darlington Provincial Park.

A viewing platform over the Bay could also be a good addition for birders, and may even attract people to the area if a restored wetland supported good wildlife biodiversity. The decision of whether or not to incorporate a platform should be made after major restoration works, such as a drawdown, shoreline restoration, or cell creation have been undertaken, as this will help determine the best location for such a structure.

5.2 EDUCATION

Educational programs at Darlington Provincial Park exist in the summer months, and for all of the reasons stated above, the quality of such programs would be greatly enhanced by having a restored wetland with infrastructure that facilitated marsh viewing.

Signage highlighting the wetland features that can be seen would also be a good addition at McLaughlin Bay. This would provide year-round education for wetland visitors and help people to understand and appreciate the value of coastal wetlands.

The Friends of Second Marsh, whose *Great Lakes Wetland Centre* is to be constructed on the north side of McLaughlin Bay, will also be conducting active educational programs for school groups. Currently, their visits would be focused on the high quality habitats at Oshawa Second Marsh, but could include McLaughlin Bay if its habitats were to be restored.

5.3 FISHING

Fishing is a popular activity at McLaughlin Bay. Currently, there are several un-sanctioned entry points along the east and west shorelines that are used to access the water for fishing, and many more people fish along the east shoreline at the Darlington Park day use area. Maintained access points for fishing should be built into the restoration strategy to enhance the quality of the fishing opportunities in the Park while mitigating some of the impacts of shoreline use. Options might include a boardwalk along the east shoreline, or a series of fishing groynes that can be constructed in conjunction with shoreline restoration works (figure 21).

Any improvements related to fishing at McLaughlin Bay should be consistent with the Fisheries Management Plan for this Zone (17):

- Protect and enhance the biological integrity of the aquatic ecosystem.
- Promote the sustainable utilization of fisheries resources.
- Develop a greater knowledge of fish populations, fish habitat and aquatic ecosystems.
- Describe the existing conditions of the fish community to establish a benchmark of ecosystem health.
- Provide a framework for fisheries management.
- Rehabilitate degraded fish communities and fish habitat, for self-sustaining, native stocks.
- Promote public awareness, appreciation and understanding of fisheries resources and the aquatic habitats on which they depend.
- Involve organized angling associations, environmental interest groups and the general public in fisheries management activities.

5.4 WATERFOWL HUNTING

Waterfowl hunting is a permitted use at McLaughlin Bay in the fall. Blinds are set up on the Darlington Park side of the Bay each year by OFAH, and hunters pay a fee to use them (figure 21). Because McLaughlin Bay is located in an urban area, where hunting is usually not permitted, it is important that this activity be maintained uninterrupted, as there are no alternative locations nearby.

A partial drawdown may have a short-term impact on hunting opportunities, but none of the other restoration techniques put forward in this report should negatively impact waterfowl hunting. Ideally, improving the health of McLaughlin Bay will positively affect the diversity of species that it attracts.

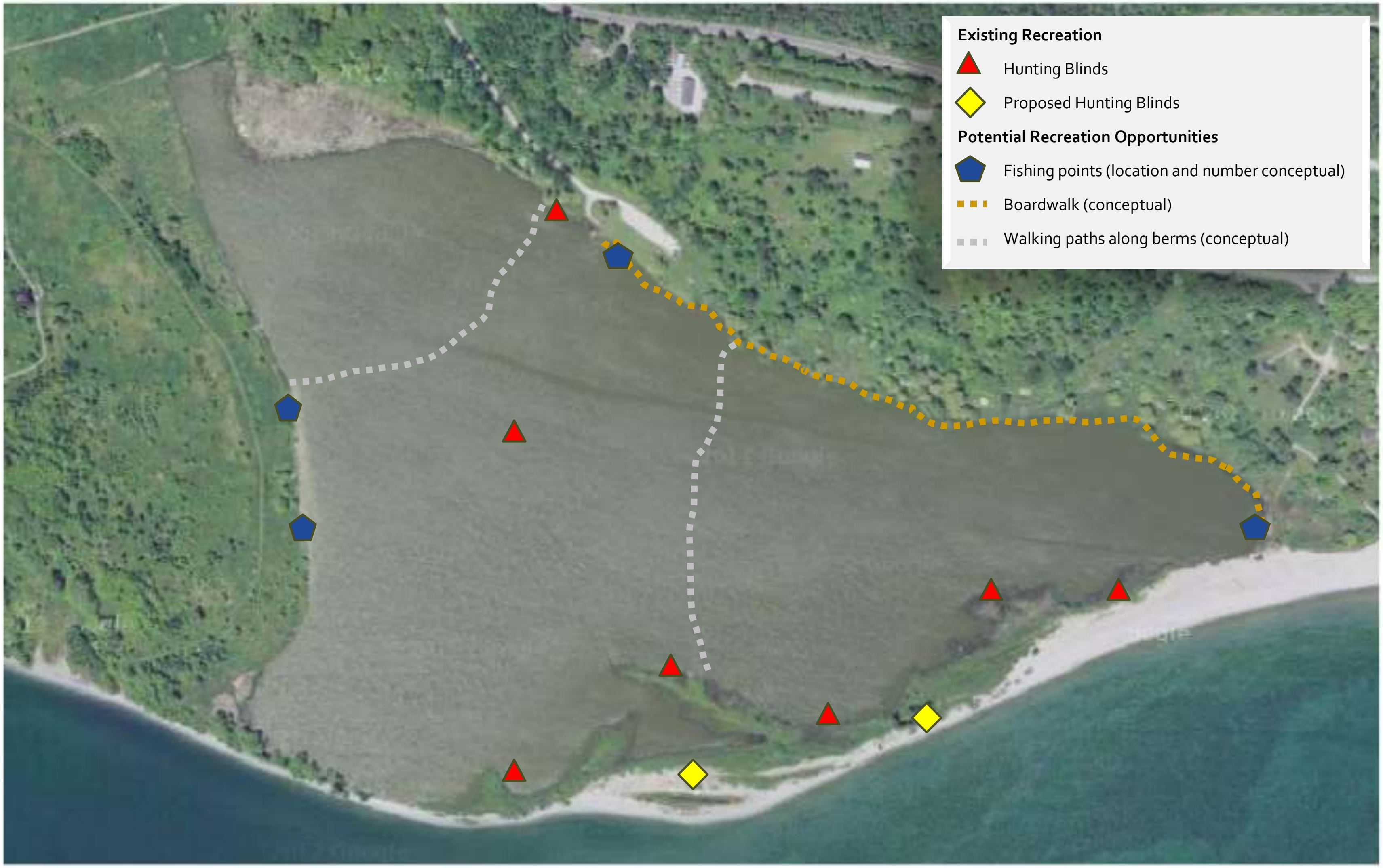
5.5 BOATING

Canoeing is permitted in McLaughlin Bay, and some motorized boat use (under 10 hp) occurs for safety or scientific research reasons. A partial drawdown of water levels, which has been recommended to rejuvenate vegetative cover in the marsh, may impact canoeing and boating activities while the drawdown is being undertaken, but has the potential to increase the popularity of canoeing in the long term if habitat conditions improve.

5.6 ICE SPORTS

McLaughlin Bay is often used as an unofficial ice rink in the winter by people accessing the Bay through the GMC property. At present, this activity is not encouraged by Ontario Parks.

FIGURE 21: EXISTING AND POTENTIAL RECREATIONAL OPPORTUNITIES AT MCLAUGHLIN BAY.



Developing A Final Restoration Strategy

Central Lake Ontario Conservation

6. PROPOSED MCLAUGHLIN BAY RESTORATION STRATEGY

Sections 4 and 5 included a detailed discussion of the benefits and drawbacks of choosing certain restoration opportunities over others, and this section summarizes the recommendations that were made for each of the options presented in the previous sections.

Beside each restoration technique, symbols have been added to highlight which of the four restoration goals this action will help to achieve.

Improve Water Quality in the Marsh

Improve Vegetation Diversity in the Marsh

Improve Wildlife Habitat in the Marsh

Improve Recreational Opportunities in the Marsh

DRAWDOWN

Conduct a partial drawdown of the Bay. The drawdown depth should be to 1 m IGLD to expose substrates that support emergent vegetation growth.

Undertake the first drawdown using a rented portable diesel pump. Upon completion, the success of the drawdown should be measured and the value/feasibility of installing a permanent pump should be re-evaluated.

BATHYMETRY

Surcharging is recommended at the north end of the Bay to restore depths where historical channelization has occurred.

Restore the west and east shorelines to improve slope, stability, control erosion, and improve vegetation growth. Works should include grading, soil amendment if required, active planting, planting protection, and placement of boulders and logs for stabilization

Inclusion of habitat features, such as backwater lagoons, pools, or shoals is recommended in appropriate locations, and will help improve habitat for a wide variety of species. Inclusion of these features should be further evaluated at the implementation phase.

CELLS

Recommend constructing cells at the north and southeast corners of the Bay. The size and shape of these cells should be determined at the implementation phase of the project with the assistance of a qualified contractor.

Cell creation is expected to result in reduced turbidity (wave break) and improved vegetation growth, and will enable wetland managers to drawdown the cells independently in the future, eliminating interruption to recreation. Both cells should include carp management structures.

CONSTRUCTED WILDLIFE HABITAT

Recommend including tern nesting rafts, basking logs for turtles, and fish cribs/root wads at McLaughlin Bay to provide additional habitat.

Regular inspection and periodic replacement of the structures will be required.

MANAGING INVASIVE SPECIES

High risk species, as identified by groups such as the Ontario Invasive Plant Council, should be identified for management prior to the commencement of each restoration activity, so that species in the area of the proposed works can be effectively dealt with and actions taken to prevent further invasions. Best management practices should be followed to remove them from the restoration area.

Carp management should be undertaken, and is best achieved by creating cells in the Bay.

MITIGATING UPSTREAM IMPACTS

Reduce salt levels in outletting creeks by working with nearby landowners to minimize road salt application in parking lots and/or find alternative products to salt.

As salt removal technologies improve and become more cost-effective, they should be considered for inclusion in existing stormwater management systems.

Improve vegetation buffers along creeks in the watershed to help maintain cooler water temperatures and improve water quality.

Continue to practice environmentally-sound landuse planning and implement Low Impact Development technologies to reduce imperviousness in the watershed and help maintain cooler water temperatures/improve water quality.

RECREATION

Recommend adding a boardwalk or fishing groynes along the east shoreline to improve nature appreciation, education, and enhance fishing opportunities.

Walking paths should be included along berms of created cell(s) to improve nature appreciation, education, and provide increased access for fishing.

Construct fishing groynes along west shoreline in conjunction with shoreline restoration works to improve fishing access.

Viewing platforms should be added in the future, but it is recommended that construction of these features be postponed until restoration works have been completed and the best location(s) can be determined.

Pumping of some lake water back into the Bay may be required in the fall of the drawdown year to facilitate the fall waterfowl hunt. The need for this will have to be evaluated at the time of the drawdown, but additional pump rental fees should be factored into the drawdown costs and set aside for this purpose.

6.1 IMPLEMENTING THE PROPOSED STRATEGY

Conducting restoration works in McLaughlin Bay is complicated by the number of landowners and the varying set of processes that they must undergo to initiate such works. Fortunately, some of the recommended options can be undertaken independently of others, and as such, implementation of the proposed strategy has been broken down into four zones (figure 22):

ZONE A covers the Minacs and GMC commercial areas, and is intended to address salt management issues. No permits or in-water works are required to implement the options in this zone, so incorporation of new salt management technologies in the future can occur whenever they become available.

ZONE B includes the west shoreline, which is under Canada Trust Company ownership and is managed by GMC. Works in this zone are shoreline restoration works, including constructing fishing groynes, and require a DFO review, a permit from CLOCA, and potentially require approvals from EC-Canadian Wildlife Service (CWS) and MNR. Works can be undertaken anytime, outside of wildlife windows, and do not impede any of the currently identified recreation activities.

FIGURE 22: PROPOSED RESTORATION ZONES A & B

Central Lake Ontario Conservation

FIGURE 23: PROPOSED RESTORATION ZONES C & D

ZONE C encompasses all of the lands owned by Ontario Parks. Recommended works include creating cells in the north and southeast corners of the Bay, restoring degraded shoreline areas and improving recreation opportunities, e.g., boardwalk or fishing groynes. All of these works must comply with the EAA and the PPRCA, and will require DFO review, a permit from CLOCA, and potentially approvals from EC-CWS, MNR, and Transport Canada.

It should be noted that the construction of a cell in the north end of the Bay would also require approval from the Municipality of Clarington and Canada Trust Co./GMC, as this restoration option does involve works on their properties.

ZONE D covers the entire Bay, and addresses a drawdown. This option requires approval from all landowners and should be undertaken in conjunction with or following the completion of works in Zones A-C. Permits from MOE, DFO, CLOCA, MNR, EC-CWS, and Transport Canada may all be required, and the work is subject to the EAA and the PPRCA.

Additional works in Zone D include adding constructed habitat to the Bay, and can be initiated anytime following the drawdown.

Watershed-wide improvements, such as improving creek buffers, have not been identified in the zones, as they can be addressed at any time, and may be ongoing over long periods of time.

TIMELINES

The timeframe for the completion of restoration works will differ for each Zone.

In Zone A, success will depend on the ability to impact salt distribution in the Minacs and GMC parking lots, and will be a long-term timeframe if yet undeveloped salt management technologies are to be incorporated into the strategy.

In Zone B, funding will be the biggest factor affecting time. If funding can be obtained relatively quickly, then shoreline restoration works on the west side of the marsh should be easy to implement.

In Zones C and D, the timelines are greatly affected by both approvals and funding, and the ability to undertake some of the proposed works are dependent on the outcome of planned public consultations. The expected completion of the public consultations is 2013-2014.

As was previously noted, works in Zones A-C should occur before works in Zone D.

Watershed wide improvements can occur at any time and do not need to occur before or after any other recommended works.

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