LONG POINT
CAUSEWAY IMPROVEMENT PLAN

Prepared for:
Long Point World Biosphere Reserve
Foundation

Photo: S. Gillingwater

April 2008
A small group of thoughtful people could change the world.

Indeed, it's the only thing that ever has.

~ Margaret Mead
Paula Jongerden  
Chair, LPCIP Steering Committee  
Long Point World Biosphere Reserve Foundation  

Dear Paula, 

In association with McCormick Rankin Corporation, Ecoplans Limited is pleased to provide you with the Long Point Causeway Improvement Plan. The Plan presents the key findings of the Long Point Causeway Improvement Project Feasibility Study and will guide the implementation of future improvements to the causeway that seek to achieve the vision of the Long Point World Biosphere Reserve Foundation and its partners.

Please feel free to contact us if you have any questions.

Yours Truly, 

ECOPLANS LIMITED
The Long Point causeway is a vital community and recreational link that connects Highway 59 (a Norfolk County road) and Port Rowan to the cottage community on Long Point at the head of Long Point Inner Bay on Lake Erie, in Norfolk County.

Long Point is a World Biosphere Reserve and is one of the most important areas for reptiles and birds in Canada, acting as a refuge for Species-at-Risk in an area of southwestern Ontario otherwise fragmented by agriculture and development.

The Long Point causeway forms the east edge of the Big Creek Marsh, a 1200 ha wetland located at the mouth of Big Creek at the head of Inner Bay. However, it has isolated the Big Creek Marsh from the shoreline and nearshore habitat of Inner Bay, hindering wildlife movement opportunities, causing significant wildlife road mortality and reducing the open water connection. Wildlife mortality on the causeway has been well studied. The results show the causeway to have the 5th highest road mortality rate in the world for turtles.

This Improvement Plan shows that causeway improvement and mitigation measures are feasible and necessary to reduce the extent of wildlife road mortality, improve open water connections between Big Creek Marsh and the bay, and provide improved recreational opportunities.

On a global scale, even on a national scale, the cost of providing mitigation to reduce the road mortality is not significant when considering the potential loss of rare species from this area. A substantial reduction in wildlife road mortality is anticipated if the Improvement Plan is implemented. A reduction of even 50% of the wildlife road mortality would be a major success.

The Long Point Causeway Improvement Project is a “signature” project with international appeal and significance. This Feasibility Study and Causeway Improvement Plan is the first step in the project evolution.
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1. INTRODUCTION

1.1 STUDY AREA AND CONTEXT

The Long Point causeway (a road that is raised above surrounding wetland) connects Highway 59 (a Norfolk County road) and Port Rowan to the cottage community on Long Point at the head of Long Point Inner Bay on Lake Erie, in Norfolk County. The causeway forms the east edge of the Big Creek Marsh, a 1200 ha wetland located at the mouth of Big Creek at the head of Inner Bay.

The significance of Long Point, Big Creek Marsh and their associated habitat and wildlife is recognized worldwide. Long Point is designated as a World Biosphere Reserve (designated by UNESCO in 1986) and is included in the International Ramsar Convention on Wetlands, a treaty developed to conserve globally significant wetlands. Long Point is also considered a Canadian Important Bird Area and the east half of Big Creek Marsh is a National Wildlife Area. The site is one of the most important areas for reptiles and birds in Canada, acting as a refuge for Species-at-Risk in an area of southwestern Ontario otherwise fragmented by agriculture and development.

Locally, the Long Point causeway is located within the Norfolk County Lakeshore Special Policy Area (LSPA). A Secondary Plan is being prepared by the County to guide future community development within the LSPA that extends from the Elgin-Norfolk County Line to Port Dover.

The causeway is a vital community and recreational link to Long Point. However, it has isolated the Big Creek Marsh habitat from the shoreline and nearshore habitat of Inner Bay, hindering wildlife movement opportunities, fish passage, causing significant wildlife road mortality and reducing open water connections and associated flow that provides nutrient circulation and exchange.
The major effects of roads on wildlife include removal and fragmentation of habitat, population isolation, reduced access to food, mating opportunities, nesting sites and hibernation sites, mortality from vehicles and subsequently, greater potential for extirpation (loss of a species from a specific geographic area).

The impacts of the causeway on wildlife movement and resultant wildlife mortality are well documented. The Canadian Wildlife Service (Environment Canada) reports that traffic on the causeway between Port Rowan and Long Point is responsible for over 10,000 wildlife mortalities each year, including federal and provincial Species at Risk (Ashley and Robinson 1996). The Long Point Causeway has been deemed the fifth deadliest road in the world for turtles (Ashley 2006).

Studies in other jurisdictions indicate that roads built through or adjacent to wetlands are often a significant cause of reptile and amphibian mortality, population fluctuations, isolation, decline and extirpation or even extinction (Jackson and Tyning 1989; Aresco 2004; Puky 2005, Forman et al. 2003; Ecoplans Limited 2006; Cramer 2007; LesBarerres 2007) . Turtle populations are particularly at risk of decline from road mortality. High rates of mortality can have detrimental and irreversible impacts on turtle populations due to late age of sexual maturity and naturally low annual recruitment due to high rates of egg and juvenile mortality. Although the importance of reptiles and amphibians in an ecosystem is commonly overlooked, they play an essential role as both predator and prey throughout their life cycles. The loss or depletion of reptile and amphibian populations can have far reaching, detrimental effects in both terrestrial and aquatic communities.

To date, wildlife crossing signs installed at Long Point have had little effect on reducing incidences of vehicle-wildlife collisions.
1. INTRODUCTION continued...

While public education programs are on-going, a more intensive approach needs to be developed to address the extremely high wildlife mortality rates on the causeway.

The urgency for action to reduce wildlife road mortality is underscored by the fact that the marsh provides critical habitat for Federally designated Species at Risk and that these species are a component of the mortality recorded on the causeway by Environment Canada.

1.2 PROJECT PURPOSE

In an effort to address the issue of wildlife mortality and revitalize the causeway, the Long Point World Biosphere Reserve Foundation (LPWBRF) has formed a Steering Committee of representatives from a diverse group of local and national organizations to lead a Long Point Causeway Improvement Project Feasibility Study. The Long Point Causeway Improvement Project Steering Committee includes representatives from Environment Canada, the Canadian Wildlife Service, Bird Studies Canada, the Nature Conservancy of Canada, the Ontario Ministry of Natural Resources, the Ontario Ministry of Transportation, Norfolk County, the Norfolk Land Stewardship Council, the Long Point Region Conservation Authority, the Upper Thames River Conservation Authority, the Norfolk Field Naturalists, the Long Point Country Chamber of Commerce, the Long Point Ratepayers’ Association, the Long Point Anglers’ Association, the Toronto Zoo, The Long Point Waterfowlers’ Association and the Ruffed Grouse Society.
The LPWBRF has retained a team of Ecologists, Environmental Planners, Water Resources and Civil Engineers from Ecoplans Limited and McCormick Rankin Corporation to undertake the Feasibility Study and prepare a Plan to guide future improvements, including short and long term recommendations.

The intent of the Feasibility Study is to identify and develop practical solutions to reduce wildlife road mortality, improve habitat and open water connectivity and provide opportunity for safe wildlife movement between Big Creek Marsh and Inner Bay. Subsequent design phases will be required to further develop the Plan into a full design that can be constructed.

Because solutions to reduce wildlife road mortality and increase connectivity will likely involve road construction works, ancillary benefits of creating safer roadway conditions for motorists, pedestrians and cyclists and enhancing recreational opportunities (such as biking, birding and fishing) are incorporated into an overall Plan for the causeway.

Indeed, the success of implementing the recommended solutions presented in this Plan depend on the ability to unite efforts with Norfolk County planning, transportation and servicing initiatives.
The Feasibility Study has been divided into 3 phases:

**Phase 1 Project Implementation Plan:** the objective of this phase was to develop a solid technical understanding of the issues related to wildlife mortality on the causeway and explore the growing research and literature on the topic of road ecology, in the context of developing possible solutions for the causeway. The Implementation Plan document included a detailed summary of key findings from the Toronto Zoo Ecopassages Forum (March 20-22, 2007) that are relevant to the Feasibility Study. The Implementation Plan also included a review of a number of case studies focusing on mitigating the impacts of roads on wildlife through ecopassage design and implementation. The success, failures and recommendations stemming from these studies have been applied in the current Feasibility Study. The last component of Phase 1 was the preparation of a questionnaire-based survey to gauge public opinion on the wildlife mortality issue and potential solutions.

**Phase 2 Develop and Present Mitigation Options:** the objective of this phase was to generate a long list of mitigation options through a review of all collected material, ongoing liaison with McCormick Rankin engineers, and consultation with the Steering Committee. The long list and proposed short list of options was evaluated by the Steering Committee at a meeting on December 11, 2007 and during follow up discussion on January 11, 2007. Based on valuable Steering Committee input, the short list of mitigation options was finalized and further developed into the Plan.

**Phase 3 Identify Management Actions and Develop the Improvement Plan:** The objective of this Phase was to use the short list of mitigation options, approved by the Steering Committee, to develop specific management actions and formulate a cohesive Improvement Plan (herein referred to as the Plan).
When implemented, the Plan will help to achieve the vision for the Long Point causeway, as articulated by the Steering Committee: *a causeway that substantially reduces wildlife mortality and improves the hydrological connectivity of the Big Creek Marsh and Long Point Inner Bay. The improved causeway should provide ancillary social benefits including improved road safety and enhanced recreational opportunities, while maintaining the rural character of the Long Point countryside.*

The Plan is presented as follows:

- Recommendations presented in a series of themes (Section 3);
- The Plan schematic that visually depicts the elements of the Plan (Section 4.1) and detailed descriptions of Plan zones;
- Implementation phasing and temporary measures to address priorities (Section 4.2);
- Preliminary cost estimates (Section 6); and
- Fact Sheets that provide technical details of specific aspects of the Plan (Appendix B).

The Norfolk County Lakeshore Special Policy Area Secondary Plan—Draft Lakeshore Options and Directions Report (Marshall Macklin Monaghan 2007a) and the Norfolk County Lakeshore Special Policy Area Secondary Plan—Lakeshore Profile (Marshall Macklin Monaghan 2007b), were specifically considered during the development of the Long Point Causeway Improvement Plan to ensure consistency between municipal policies and the Plan and to ensure that causeway improvement recommendations do not preclude potential future amenities identified in the Secondary Plan.

As noted previously, subsequent design phases will be required to further develop the Plan into a full design package that can be constructed. Final decisions with respect to design (plan and profile), materials and costing will be finalized during design phases.
3. RECOMMENDATIONS

The Plan recommendations are:
- Create an Ecopassage System
- Restore Hydraulic Connectivity
- Wildlife Habitat Enhancement
- Enhance the Recreational Experience
- Sign for Awareness
- Calm Traffic
- Provide Temporary Measures
- Monitor

The recommendations are based on solutions developed, implemented and monitored by Ecoplans on similar projects, research into solutions being developed in other jurisdictions, and consultation with the LPWBRF and a multi-stakeholder Steering Committee to determine what potential solutions are acceptable to the local community.

We encourage readers of this document to view these recommendations as adding value and quality to the public's mutual investments in transportation and resource conservation rather than adding cost to Norfolk County’s transportation infrastructure program.
3.1 CREATE AN ECOPASSAGE SYSTEM

A permanent ecopassage system is the cornerstone of the recommended mitigation strategy. The ecopassage system will increase road permeability and reconnect habitat east and west of the causeway. The design and installation of wildlife crossings, termed “ecopassages”, is a growing trend used to mitigate the effects of roads on wildlife. The ecopassage system consists of two elements:

1) a series of passages (culverts and/or bridges) designed to facilitate safe movement of wildlife under the roadway; and
2) a continuous funnel system (wall or fence) that prevents wildlife from entering the roadway and directs wildlife toward the passages.

1) Ecopassages

Ecopassages are essentially culverts that provide animals with an alternative to accessing otherwise fragmented habitat without having to cross the road overland.

To be successful, the design of an ecopassage should consider the biological constraints and requirements of a targeted species, including light, air flow and moisture. Some wildlife species have been shown to exhibit individual preference over ecopassage shape and size.

Ecopassage culverts for the causeway have been sized to maximize the overall light penetration in the culvert (referred to as openness ratio) as this has been shown to positively influence reptile and amphibian use in particular. As ectotherms (animals that regulate their body temperatures by exchanging heat with their surroundings), reptiles and amphibians are more sensitive to thermal differences between the culvert and surroundings; a larger culvert will allow for more light penetration and thus a reduced thermal gradient, and should result in higher usage.

LONG POINT CAUSEWAY IMPROVEMENT PLAN
3.1 CREATE AN ECOPASSAGE SYSTEM CONTINUED...

The maximum openness ratio that can be achieved (taking into consideration cost and the vertical road profile) should be provided to minimize the tunnel effect and increase the likelihood of wildlife crossing through the culvert. The culvert openings should be clear of vegetation, as vegetation can block light from penetrating through the culvert and subsequently discourage wildlife usage of the passage. The openness ratio recommended for the target wildlife species (turtles and snakes) at Long Point is 0.25 (cross sectional area of the culvert opening divided by the length of wildlife travel through the structure) based on our review of current literature.

The recommended culvert size also reflects the desire to minimize the required change in road profile, that is, how high the road must be raised to accommodate the culvert. As such, box culverts with a height of 1.7 m are generally recommended. Minimizing impacts to the road profile can be better achieved with a box culvert than with a round or arch culvert.

The culvert width required to achieve the desired openness ratio will depend on the overall culvert length required which, in turn, depends on the road cross section. Three options for road cross sections are shown in Section 5. Culvert width will also depend on whether the culvert is intended to provide terrestrial wildlife passage only or both aquatic and terrestrial passage and open water connection.

A total of 11 ecopassages are recommended to increase likelihood of use by the target species and decrease out of way travel. A target distance of 100 m to 300 m spacing has been used to guide culvert placement because reptiles are slow moving, have relatively small home ranges, and may become susceptible to predation if moving long distances. Section 5 includes plates depicting the Plan and culvert numbers are shown on the these plates. A table listing all culverts and recommended sizes is also provided in Section 4.
3.1 CREATE AN ECOPASSAGE SYSTEM CONTINUED...

2) Funnel Wall

While the funnel wall system may seem like a ‘hard’ or engineered solution, it will be the most effective long term way to keep wildlife off the road and will therefore directly result in reduced wildlife road mortality. The inclusion of passages or culverts is key to providing connections between fragmented habitats.

The development of the passage system was based on detailed road mortality data gathered by the Canadian Wildlife Service over a period of 10 years. These data indicate high mortality rates along the entire length of the causeway and it is difficult to identify distinct “hotspots”. However, there is a slight spatial variation in species killed along the causeway. Therefore proposed ecopassage placement was guided by the preference and behaviour of target species of amphibians and reptiles in different areas of the causeway.

There are many funnel wall material options that exist for Long Point, however the final selection of material will be made in the design stage, once additional information such as geotechnical or soil conditions is confirmed. Armourstone, sheet pile and concrete (pre-cast or cast-in-place) are materials that have been employed in similar projects elsewhere.

Preliminary costing provided in Section 7 is conservative and is based on using an armourstone treatment for the entire length of funnel wall. However, based on the information we have to date, sheet pile may be a desirable and less expensive option. Different wall treatments could be used for east and west sides of the causeway.
Regardless of the material used, the funnel wall system will exhibit some basic characteristics. Wall material should be durable and able to withstand temperature extremes, erosion, water, winter road maintenance activities and ice build up, particularly along the east side of the causeway. Wall material should also be relatively smooth to inhibit climbing by certain species.

Wall height is governed by the target species. A wall height of at least 1 m is recommended to prevent Leopard Frogs from jumping over. A ‘lip’ or ‘cap’ will deter animals, particularly Fox Snakes, from scaling the wall and moving onto the causeway. The lip or cap may not prevent all animals from scaling the wall, however it will reduce the numbers.

The wall terminus should ideally curl back in a 120 degree curve away from the roadway rather than end abruptly to prevent ‘end runs. The wall should extend back as much as is feasible to reduce the risk of wildlife reaching the end of the wall then moving toward the road.

Regular maintenance should be implemented to limit the growth of vegetation, especially cattails, near the base of the wall. Vegetation growing close to the wall may provide wildlife with an opportunity to climb over the wall and access the causeway. A barrier such as landscape fabric can buried in the ground to discourage plant growth.

The full ecopassage system proposed for the causeway is described in more detail in Section 4.1. The description is supported by colour plates that visually depict the Plan.
3.2 RESTORE HYDRAULIC CONNECTIVITY

Big Creek Marsh formed as a delta where Big Creek deposited sediment at its outlet in the relatively shallow Inner Bay. Historically, flushing and circulation within the marsh occurred when flows from Big Creek flooded the delta, creating and regularly redefining the internal channel system. Natural rejuvenation also occurred from wind set-up or seiches on Inner Bay pushing bay water into the marsh, and from storms on Lake Erie breaching the sand spit and allowing entry of lake water into the marsh from the south.

Until the 19th century, Big Creek Marsh was relatively undisturbed, and its evolution involved the factors described above. As the area was settled, access to Long Point was obtained along the sand spit or by boat. Eventually the causeway was constructed. Initially the causeway had minor impacts on the marsh as the profile was low and subject to frequent flooding. In the early 20th century however, a more permanent causeway was constructed. Simple dam structures were also installed for controlling water levels in the marsh for muskrat ranching.

While the causeway reduced the exchange of water with Inner Bay, it did have several outlets that maintained the circulation within the marsh. However, by the mid 20th century, the southern outlets to Inner Bay had been closed and the control structures removed as they fell into disrepair. Today, the only outlet to Inner Bay is the main channel of Big Creek. An impoundment in the western portion of the marsh (see Overview Map on page 2) was constructed to manage the marsh ecosystem. The water levels in the impoundment are maintained by pumping.
3.2 RESTORE HYDRAULIC CONNECTIVITY CONTINUED...

Improvement of the existing hydraulic conditions can be achieved relatively simply by re-creating openings through the causeway that allow for the exchange of bay water with the marsh.

Opportunities and recommended locations for restoring open water connections along the causeway are identified in Section 4.1. The key opportunity is located immediately south of the Canadian Wildlife Service office where an existing small corrugated steel pipe culvert has been clogged for some time. A larger structure, for example, a larger culvert or bridge, combined with dredging to extend the existing channel and re-establish the open water link through the structure, would allow for a larger interchange volume with the bay, and would also provide for wildlife movement.

Another opening could be considered further south, at the north end of the existing marina. Dredging would also be required in this location to re-establish an open water connection with the bay. Implementation of this option depends on landowner agreement to the design. Maintenance, including possible sediment removal, will be a consideration during design.

These two sites mimic the historical connections to the bay. The upstream sediment load to the marsh would not be changed, so that over time, the circulation pattern in the marsh would adjust to the new openings, with associated changes in sediment distribution patterns. The larger impact would probably be due to littoral sediment transport in Inner Bay, where there is some potential for sedimentation at the outlets.

An option to ‘improve’ channel configuration through the marsh, for example at the Big Creek split to Old Big Creek is not being recommended due to the risk of potential adverse effects. Although improving the internal channel system may allow more flow into Old Big Creek and possibly enhance circulation patterns in the marsh, increased sedimentation within the marsh could result in detrimental effects on sensitive wildlife species and their habitat.
3.3 WILDLIFE HABITAT ENHANCEMENT

The creation and/or enhancement of turtle nesting habitat can play an indirect role in reducing turtle road mortality. The Long Point causeway bisects the Big Creek Marsh that provides critical habitat for a number of turtles, including Species-at-Risk (SAR). Turtles cross the Long Point causeway through random wandering (particularly with Blanding’s Turtles), direct, intentional movement either towards critical habitat (nesting, foraging or over-wintering habitat) or in search of a mate. Turtles are attracted to the loose, gravelly substrates and open canopy conditions of the road shoulder for nesting. This puts both nesting females and emerging hatchlings at risk of road mortality.

By creating new nesting sites within the Big Creek Marsh, turtle species will gain safe access to a greater variety of habitat conditions, not fragmented by the causeway.

Choosing ideal turtle nesting habitat enhancement sites is based on knowledge of local population movement and site surveys to ensure key criteria are met. Where possible, new nesting habitat should be created in proximity to confirmed existing nesting sites to increase the likelihood of use.
3.3 WILDLIFE HABITAT ENHANCEMENT CONTINUED...

The *key criteria* that are considered in the creation of turtle nesting habitat, include:

- substrate type;
- moisture content;
- temperature (sun exposure and canopy cover);
- ground cover; and
- nesting depth and risk of predation (both from wildlife and humans).

A long-term monitoring and maintenance program are important considerations that should be incorporated in the habitat construction plan. These factors are discussed in more detail in the Wildlife Habitat Enhancement—Construction of Turtle Nesting Habitat Factsheet (Appendix B).

Long Point is one of the most important areas for reptiles in all of Canada, and may provide habitat for the only viable populations of certain SAR reptiles in the near future (S. Gillingwater 2008, personal communication). Providing turtles with nesting habitat while taking measures to reduce road mortality is critical to the conservation of the turtles at Long Point.
3.4 ENHANCE THE RECREATIONAL EXPERIENCE

*Trail System*

The *Norfolk County Lakeshore Special Policy Area Secondary Plan* identifies the wetlands and natural heritage resources of Turkey Point and Long Point as natural “gems” along the northern coast of Lake Erie. The *Secondary Plan* process intends to “capitalize on the amenities offered by the lakeshore area” by planning for a safe, connected system of recreation trails/cycling routes to connect communities, parks, natural areas and centres of activity along the lakeshore.

The causeway is identified in the *Secondary Plan* as a candidate trail route and is, on a preliminary basis, indicated as an on-road cycling route, extending from Long Point Provincial Park, along the causeway, up to and connecting with a trail system on Front Road. It is likely that the potential future trail system would be located along the west side of the causeway.

Roadway improvement works required to implement the ecopassage system present an excellent opportunity to consider the potential for a multi-use trail system along the west side of the causeway. A multi-use trail, on-road cycling facility or a combination thereof, would provide safe opportunity for both pedestrian and cyclist use. The expanded road footprint required for the ecopassage system will easily accommodate a multi-use trail, safely set back from the roadway, as well as landscaping, while remaining within the existing County road allowance. This Plan does not provide a recommendation on the type of trail system to be developed, only that the proposed causeway improvements will not preclude, and may actually facilitate, the creation of a trail system.
3.4 ENHANCE THE RECREATIONAL EXPERIENCE CONTINUED...

*Nodes, Destinations and Connections*

The causeway functions as a travel corridor as well as a destination, with several nodes or points of interest providing recreational opportunities. These include the Canadian Wildlife Service office, the Big Creek Marsh observation deck and berm system, the Inner Bay observation deck (just north of the marina) and the Big Creek bridge. Commercial fishing and recreational hunting are traditional uses on the west side of the causeway.

Opportunities to enhance the recreational experience by providing larger viewing/activity platforms are recommended. Platforms can provide for active or passive use, depending on location. For example, viewing platforms along Inner Bay will provide safe waterfowl viewing opportunities while platforms provided at Big Creek offer safe angling opportunities. Viewing platform locations, detailed in Section 4.1, have been identified based on current use patterns observed along the causeway.

Linkages between viewing platforms and the cycling route and/or multi-use trail system can be provided through a series of pedestrian crosswalks. Crosswalks are strategically located to connect the trail and parking areas along the west side of the causeway, to nodes along the east side of the causeway. Additional linkages between the multi-use trail or cycling route and the Big Creek Marsh berm could be considered in the future.
3.4 ENHANCE THE RECREATIONAL EXPERIENCE CONTINUED...

Parking

Formal parking areas for causeway users exist at three locations along the causeway: on the west side at the Big Creek Marsh observation deck, on the west side at the Canadian Wildlife Service office and on the east side just north of the marina. Expanded parking facilities are not among the recommended improvements for the causeway in an effort to manage the causeway being used as a “vehicle destination”. The intent is to maintain existing parking facilities but encourage causeway use through a cycle route or multi-use trail. Existing parking areas will continue to service viewing platforms and other nodes and destinations along the causeway. Parking trends should be monitored on the causeway and opportunities for future parking at the south end of the causeway should be examined.
3.5 SIGN FOR AWARENESS

Signage will not directly or immediately address the issue of wildlife mortality on the causeway but a signage program can be used to achieve objectives related to:

**Driver awareness:** signs are recommended to raise driver awareness about the potential for wildlife on the road. Through raising awareness, it is possible that drivers may make efforts to safely avoid wildlife that are on the roadway. Research has shown that drivers quickly become habituated to permanent static sign boards. To address this concern, mobile, seasonal signs are recommended for installation at key locations along the causeway during key periods of wildlife movement: April to October. Messages should be short, direct and command based. Research from other jurisdictions indicates that signs can be more effective when combined with a mechanism that slows traffic or attracts driver attention, such as rumble strips.

**Raising the profile of the World Biosphere Reserve:** the intersection of Front Road and Highway 59 serves as a gateway to Long Point and opportunity exists to place entrance feature signage near this location. The sign could clearly indicate the driver is now entering the Long Point portion of the World Biosphere Reserve drawing attention to the significance of the area as well as specific conservation efforts and programs. Recognizing that the World Biosphere Reserve extends beyond Long Point to encompass Turkey Point, Port Rowan and a portion of Norfolk County west of Highway 59, a Long Point entrance feature sign could be part of a larger World Biosphere Reserve awareness initiative that includes other signs/entrance features at various entrance points to the Reserve.

**Education:** interpretive signage is recommended at recreational nodes along the causeway. These include: trail heads, viewing platforms, parking lots and along a potential future multi-use trail. Outreach and education programs should clearly explain that vehicular-wildlife collisions are important highway safety issues that cause unnecessary wildlife mortality, and that highways contribute to habitat loss and fragmentation. Education and outreach will continue to be an important part of the mandate of the Long Point World Biosphere Reserve Foundation and are inherent in any LPWBRF initiative.
3.6 CALM TRAFFIC

Wildlife mortality studies in Point Pelee National Park and Rondeau Provincial Park found that speed limit (which may be closely related to traffic volume) was consistently, positively and strongly correlated with road mortality for all wildlife species and in both parks.

A reduction in the speed limit along the causeway, either permanent or seasonal (during spring and summer), was an option explored during the Feasibility Study. With support and public buy-in, reducing the speed limit along the causeway would likely contribute to reducing the number of vehicular-wildlife collisions. Response a speed limit reduction was mixed however, based on resident concerns and traffic warrants, and the County is continuing to examine this option.

Although a reduction in speed limit may not be approved, other measures may assist in calming traffic along the causeway. Traffic calming measures alone are not likely to result in a significant reduction in wildlife mortality rates, however measures such as digital speed signs and rumble strips may draw driver attention to their speed relative to the posted limit, other road users (cyclists, pedestrians), wildlife on the road, and causeway residents trying to enter or exit safely from their driveways. Traffic calming signage could be considered in combination with other signage, as described in Recommendation 3.5, although aesthetics and causeway residence ‘viewscape’ must be considered in the sign placement.

The noise associated with rumble strip is an obvious concern for causeway residents. Rumble strip placement should consider proximity to residents so as to minimize noise effects.
3.7 PROVIDE TEMPORARY MEASURES

Temporary or interim measures may be employed along the causeway in an effort to immediately address the issue of wildlife mortality. Measures such as the installation of silt fencing have been implemented as short term options in other jurisdictions usually because of the costs associated with implementing permanent ecopassage systems. The Long Point World Biosphere Reserve Foundation is currently pursuing opportunities to develop a temporary fencing program, aimed at curtailing wildlife road mortality in the more sensitive areas of the causeway.

However, temporary systems are costly in and of themselves, are not permanent solutions and would only address part of the issue identified at the causeway. Although temporary fencing will prevent wildlife from entering the roadway, it does not serve to reconnect habitat by providing safe wildlife passage opportunities nor does it restore open water connections. As such caution should be applied in spending time and resources developing and maintaining temporary measures when focus may be better placed on implementing a permanent system to fully address the range of issues at the causeway.

Temporary fencing systems should be professionally installed and require intensive daily monitoring to maintain them. Other jurisdictions have noted that certain species of turtles are able to climb the fencing, and daily monitoring is required to ensure that wildlife do not become trapped in fencing material. In some jurisdictions, silt fencing has been installed to function as a more ‘permanent’ funnel wall for wildlife culverts. This is not recommended as part of the causeway Plan because temporary fencing is not resilient to winter weather conditions and may be damaged by heavy snow fall and road winter maintenance activities. Continual monitoring and repair make this an undesirable option for a long term plan.

For the Long Point causeway, temporary fencing may be appropriate as a short term solution in critical areas in an attempt to immediately address the issue of wildlife road mortality. Selected candidate areas for potential temporary fencing are identified in Section 4.1.
Multi year monitoring of mitigation measures and wildlife ecopassage use is recommended. Monitoring surveys should be carried out both prior to construction and following construction to determine true impacts and success of mitigation measures. Long term monitoring shows population trends with changes in landscape, management decisions and predator-prey relationships. Road mortality monitoring at the causeway was undertaken from 1996 to 2006 and provides an excellent baseline of mortality information.

Monitoring activities including amphibian call surveys, night vision recordings on digital recorders and road mortality counts, following the protocol used by Canadian Wildlife Service, should form the basis of the core monitoring program. Remote detection camera systems provide an effective way to track and photograph wildlife use of ecopassages. These systems have been implemented successfully in York Region.

Use of sand substrates to pick up animal tracks, inspection of cover objects placed along fences for animals or signs of animals may be used to augment the core monitoring program.

Driving surveys are generally considered ineffective at assessing reptile and amphibian road mortality due to: 1) the small size of many species and 2) the likelihood of individuals, especially turtles, being launched into adjacent areas off the road. For these reasons road mortality surveys at Long Point should be completed on foot.
Establishing a partnership with a local Environmental group, College or University is a cost effective way to implement a monitoring program. While volunteers can be integrated into the overall monitoring program, the program is best overseen by wildlife experts who can provide guidance and interpretation.

The success of the Plan can be evaluated quantitatively in various ways. The most important measure will be in the reduction of wildlife road mortality. Based on mortality rates, species and distribution patterns along the causeway, areas that remain vulnerable to wildlife kills, even after the installation of the ecopassage system, can easily be identified and addressed through design additions or enhancements.

New open water connections through culverts must also be monitored for sedimentation. Appropriate measures to clean out sediment will be developed in consultation with the Long Point Region Conservation Authority, Ministry of Natural Resources and Fisheries and Oceans Canada.
4. THE PLAN

The Improvement Plan recommendations are outlined in Section 3.

This section provides a detailed account of specific features of the Plan in three distinct zones along the causeway with plates that visually depict the Plan.

Additional concepts provide a visualization of key aspects of the Plan. These are provided in Appendix A.
4.1 THE PLAN - DETAILS

Zone 1

“Zone 1” extends from the intersection of Front Road and Highway 59, south to the Big Creek bridge. The Plan for this zone is shown on Zone 1, Plates 1 to 3 and includes:

An entrance feature sign at the gateway to Long Point is recommended, located near the entrance to the causeway. The entrance feature sign will clearly indicate the driver is now entering the Long Point portion of the World Biosphere Reserve and will draw attention to the significance of the area as well as specific conservation efforts and programs. Opportunities to partner with the Chamber of Commerce to create a community sign board or message board could also be explored. Recognizing that the World Biosphere Reserve extends beyond Long Point to encompass Turkey Point, Port Rowan and a portion of Norfolk County west of Hwy 59, a Long Point entrance feature sign could be part of a larger World Biosphere Reserve awareness initiative that includes other signs/entrance features at various entrance points to the Reserve.

Seasonal, mobile signage to alert drivers to the possibility of wildlife being on the roadway is proposed at the entrance to the marsh. Messages should be short, direct and command based. Research indicates that signs can be more effective when combined with a mechanism that slows traffic or attracts driver attention, such as rumble strips. The use of seasonal, mobile signage should help prevent driver habituation.
4.1 THE PLAN - DETAILS

As a minimum, 2 terrestrial wildlife ecopassages are recommended in this area (C1 and C2). Based on the target species (turtles, snakes and amphibians) an ideal distance between ecopassage is approximately 100 m to 300 m. The culvert placement on the Plan depicts recommended locations based on this distance, however locations are approximate and will be refined during the design process. The Plan plates show examples of what the aquatic and terrestrial ecopassages may look like.

A funnel wall will extend along both west and east sides of the causeway to both prevent wildlife from entering the roadway and direct them to the culverts for safe passage under the causeway. Regardless of the funnel wall material, the wall will be at least 1 m in height and will include a ‘lip’ or ‘cap’ to deter wildlife from scaling the wall.

Rather than have the wall end abruptly, the wall terminus should be curled back on itself, to redirect wildlife and to prevent end runs. An example of what the ecopassage system might look like is provided in the concept drawings. As depicted in the concept drawings the ecopassages and funnel wall will likely not be visible from the roadway.

Improved open water connection between the north portion of the Big Creek Marsh and the Smith Marsh could also be considered at these culverts. In this scenario, the ecopassage culverts would provide for both aquatic and terrestrial wildlife passage. Dredging would be required to create an open water connection under the causeway. A channel system in the Smith Marsh opens up the Dedrick Creek and Inner Bay. Circulation patterns and flow exchange between Big Creek Marsh and Smith Marsh would vary depending on flow volumes from Big Creek, Dedrick Creek and the degree of wind set-up or seiche from Inner Bay. As the Plan plates depict, flow arrows show variable circulation directions.
Zone 1 continued…

A third culvert, providing open water connection and aquatic passage only (not shown on the Plan plates), could be considered on the north side of the Big Creek bridge. A culvert in this location is not critical to improving open water connectivity but would likely contribute to it by providing a more direct link between Inner Bay and the north portion of the Big Creek Marsh. Potential for sedimentation in the channel on the east side of the causeway is a consideration if this open water connection is explored in a subsequent design stage.

A possible location for a wildlife viewing or angling platform is shown adjacent to Big Creek, north of the bridge. A conceptual design of a viewing platform is provided in Appendix A. Viewing platforms would be considered a recreational destination or node and could include amenities such as a shading trellis, bench and rock seating and interpretive signage. These are the first of several potential locations identified along the causeway for viewing platforms.
A minimum of two ecopassages are proposed in this section of the causeway to provide terrestrial wildlife passage. Improved hydraulic connectivity could also be considered at these culverts. The ecopassages would provide both terrestrial and aquatic passage. Dredging would be required to achieve the connection.

As depicted by the arrows, hydraulic circulation would be variable depending on flows from Big Creek and Dedrick Creek and seiches from Inner Bay.

Mobile seasonal message boards will alert drivers of the possibility of encountering wildlife on the road from April to October. Signs could also be relocated to other areas along the causeway during this period to maintain driver awareness and track wildlife movement.

An entrance feature sign at the gateway to Long Point is recommended, located near the entrance to the causeway. The entrance feature sign will clearly indicate the driver is now entering the Long Point portion of the World Biosphere Reserve and will draw attention to the significance of the area as well as specific conservation efforts and programs.

Opportunities to partner with the Chamber of Commerce to create a community sign board or message board could also be explored.

Recognizing that the World Biosphere Reserve extends beyond Long Point to encompass Turkey Point, Port Rowan, and a portion of Norfolk County west of Hwy 59, a Long Point entrance feature sign could be part of a larger World Biosphere Reserve awareness initiative that includes other signs/entrance features at various entrance points to the Reserve.
The design of the ecopassage system in the vicinity of the Big Creek bridge will have to ensure wildlife are not able to enter the roadway adjacent to the bridge.

A minimum of two ecopassages are proposed in this section of the causeway to provide terrestrial wildlife passage. Improved hydraulic connectivity could also be considered at these culverts. The ecopassages would provide both terrestrial and aquatic passage. Dredging would be required to achieve the connection.

As depicted by the arrows, hydraulic circulation would be variable depending on flows from Big Creek and Dedrick Creek and seiches from Inner Bay.
The design of the ecopassage system in the vicinity of the Big Creek bridge will have to ensure wildlife are not able to enter the roadway adjacent to the bridge.

A minimum of two ecopassages are proposed in this section of the causeway to provide terrestrial wildlife passage. Improved hydraulic connectivity could also be considered at these culverts. The ecopassages would provide both terrestrial and aquatic passage. Dredging would be required to achieve the connection.

As depicted by the arrows, hydraulic circulation would be variable depending on flows from Big Creek and Dedrick Creek and seiches from Inner Bay.

A third culvert could be considered immediately north of the bridge. This culvert could provide more direct circulation to the north portion of the marsh, but sedimentation could limit the effectiveness of the culvert.

Implementation of traffic calming measures may enhance safety of residents, cyclists and pedestrians. Measures could include signage or rumble strips to alert drivers of their speed and of potential hazards ahead.
Zone 2

This zone extends from south of the Big Creek bridge to the Canadian Wildlife Service office. The Plan for this zone is shown on Zone 2, Plates 1 to 3 and includes:

A minimum of 5 terrestrial wildlife ecopassages are recommended along the 1.5 km length of this zone (C3 to C7).

The proposed funnel wall system is continuous on the west side of the causeway and discontinuous on the east, adjacent to the residences. The movement of wildlife from the Inner Bay, west to Big Creek marsh at this location is not well understood and is likely hindered by the presence of the sheet pile and other shore protection measures adjacent to the residences. Once the ecopassage system is implemented along the west side of the causeway, wildlife movement from Big Creek Marsh to Inner Bay across the causeway will be significantly reduced. Potential for wildlife movement from Inner Bay, west to Big Creek Marsh can then be monitored and better understood.

A key location for restoring open water connectivity is located in Zone 2, adjacent to the Canadian Wildlife Service office (C8). This crossing will also provide for both aquatic and terrestrial wildlife passage. The minimum structure size here is larger than other ecopassages in order to accommodate the larger flow channel and dry banks. Dredging will be required to open a channel from Big Creek Marsh across the causeway. The use of a single span girder bridge in this location has been considered, however, it is not likely that this type of structure will achieve any greater or improved function, in terms of hydraulics or ecopassage, than a large culvert, with the cost for a bridge being significantly higher. As such, a 10 m wide structure (precast concrete) is proposed and will be sufficient to achieve the desired function at this location.
4.1 THE PLAN · DETAILS CONTINUED...

Zone 2 continued...

A potential zone for traffic calming measures has been identified within Zone 2, adjacent to the residences. While traffic calming is not likely to result in a significant reduction in wildlife road mortality rates, measures such as digital speed signs and rumble strips may draw driver attention to their speed, other roads users (cyclists, pedestrians), wildlife on the road and causeway residents trying to enter or exit safely from their driveways. An active sign in combination is recommended to reduce the potential for driver habituation. Rumble strips could also be used to alert drivers however, the placement of these should consider proximity to residents, so as to minimize noise effects.

Three possible viewing platform locations are identified: one on the west side, south of the Big Creek bridge; one on the east side of the causeway, across from the Big Creek Marsh parking area; and a third located on the east side of the causeway, across from the Canadian Wildlife Service office. Viewing platforms along the east side of the causeway will enhance waterfowl viewing opportunities. Pedestrian crosswalks are shown at the viewing platform locations to provide a linkage between parking areas, a future trail system and the viewing platforms.
The design of the ecopassage system in the vicinity of the Big Creek bridge will have to ensure wildlife are not able to enter the roadway adjacent to the bridge.

A minimum of two ecopassages are proposed in this section of the causeway to provide terrestrial wildlife passage. Improved hydraulic connectivity could also be considered at these culverts. The ecopassages would provide both terrestrial and aquatic passage. Dredging would be required to achieve the connection.

As depicted by the arrows, hydraulic circulation would be variable depending on flows from Big Creek and Dedrick Creek and seiches from Inner Bay.

A third culvert could be considered immediately north of the bridge. This culvert could provide more direct circulation to the north portion of the marsh, but sedimentation could limit the effectiveness of the culvert.

Implementation of traffic calming measures may enhance safety of residents, cyclists and pedestrians. Measures could include signage or rumble strips to alert drivers of their speed and of potential hazards ahead.
Three ecopassages in this portion of the causeway will provide terrestrial wildlife passage.

Historic connections were considered in this area but were not carried forward as recommendations. Historic hydraulic connectors between Big Creek Marsh and Inner Bay were never present in this location.

Cost and maintenance considerations were factors in not carrying the recommendations forward.

Implementation of traffic calming measures may enhance safety of residents, cyclists and pedestrians.

Measures could include signage or rumble strips to alert drivers of their speed and of potential hazards ahead.

The extension of the funnel wall around parking areas may be difficult to achieve due to design and implementation challenges.

Parking areas may thus provide wildlife with an access point onto the causeway.

Alternative treatments such as rip rap or sediment fencing may hinder or discourage wildlife movement into the road. These areas should be monitored to determine how vulnerable they are to wildlife "escape".
The extension of the funnel wall around parking areas may be difficult to achieve due to design and implementation challenges. Parking areas may thus provide wildlife with an access point onto the causeway. Alternative treatments such as rip rap or sediment fencing may hinder or discourage wildlife movement into the road. These areas should be monitored to determine how vulnerable they are to wildlife "escape".

Key location for providing aquatic/terrestrial ecopassage and hydraulic connection to Inner Bay. Minimum structure size is larger than other terrestrial ecopassages to accommodate low flow channel and dry banks.
4.1 THE PLAN · DETAILS CONTINUED...

Zone 3
This zone extends from south of the Canadian Wildlife Service office to Hastings Drive. The Plan for this zone is shown on Zone 3, Plates 1 to 3 and includes:

A minimum of 2 terrestrial wildlife ecopassages are recommended along the 1.3 km length of this zone (C9 and C10). Ecopassages are generally not recommended in the portion of the Zone 3 adjacent to the marina. Although wildlife movement presently occurs here, there is concern with directing sensitive wildlife species into an active marina and the potential for conflict between boat traffic and wildlife.

The proposed funnel wall system is continuous on the west side of the causeway and discontinuous on the east; in the short-term, the wildlife funnel wall along the east side of the causeway (and associated ecopassages) is not proposed adjacent to the marina. The movement of wildlife from the Inner Bay, west to the Big Creek Marsh at this location is not well understood. Wildlife movement from the east is likely hindered by the presence of the vertical sheet piling and general human activity in the marina.

Once the ecopassage system is implemented along the west side of the causeway, wildlife movement from Big Creek Marsh east to Inner Bay over the causeway will be significantly reduced. Potential for wildlife movement from Inner Bay (the marina), west to Big Creek marsh can then be monitored and better understood and appropriate mitigation measures developed should the need be identified.
Zone 3 continued…

A single open water connection between Big Creek Marsh and Inner Bay is proposed just north of the marina (C11). Dredging and ditching will be required to create a channel from the open water areas in Big Creek Marsh across the causeway to the Inner Bay. It is recommended that the dredging to create an open water connection be confined to a zone along the east edge of the marsh, beside the causeway, to minimize impacts to sensitive wildlife habitat further west in the marsh.

Although the historical outlet of Old Big Creek is located to the south and the open water channel in that area is closer to the causeway, restoring an open water connection at the historical creek outlet is not recommended for two reasons. There is concern with directing wildlife species into an active marina and potential for conflict between boat traffic and wildlife. The marina owner has also expressed a preference for culverts not being located in the marina.

Two possible viewing platform locations are proposed along the east side of the causeway. These would expand on viewing opportunities afforded by the existing observation platform. Pedestrian crosswalks are shown at the viewing platform locations to provide a linkage to the future trail system along the west side of the causeway. Two existing parking areas, one on the east side of the causeway just north of the marina and one on the west side of the causeway at the CWS office, would provide nearby parking opportunities.
The extension of the funnel wall around parking areas may be difficult to achieve due to design and implementation challenges. Parking areas may thus provide wildlife with an access point onto the causeway. Alternative treatments such as rip rap or sediment fencing may hinder or discourage wildlife movement into the road. These areas should be monitored to determine how vulnerable they are to wildlife "escape".
A viewing platform located on the east side of the causeway would enhance waterfowl viewing opportunities. The platform would be pedestrian-accessible, supported by a crosswalk linking the recreational trail on the west side of the causeway.

Other potential locations for viewing platforms area shown along the causeway.

This location for a hydraulic connection to Inner Bay was considered. However, there is a concern with directing wildlife species into an active marina and potential for conflict between boat traffic and wildlife. Therefore this location is not recommended.

Key location for providing hydraulic connection to Inner Bay. Ditching would be required to achieve the connection. A culvert would accomplish the same effect as a bridge, and is significantly more cost effective.

Maintenance (possible sediment removal) will be a consideration during design.
A future recreational trail (on-road cycle route or multi-use trail) is proposed along the west side of the causeway for the entire length from Hastings Drive to Front Road.

Any breaks in the barrier wall and the end of the barrier wall will include a hook or wrap around to discourage wildlife from travelling around the end of the wall.

LEGEND
- Terrestrial Wildlife Passage
- Aquatic and Terrestrial Passage
- Aquatic Passage
- Funnel Fence
- C2 Culvert Numbers
- P4 Photo Location & Direction
Culvert summary table showing road cross-section alternatives and the associated culvert dimensions required to achieve the recommended openness ratio (OR) for wildlife passage. Road cross section alternatives are provided in Section 5.

### Culvert Summary Table

<table>
<thead>
<tr>
<th>Culvert Number</th>
<th>Minimum Desired Openness Ratio Wildlife Passage</th>
<th>Culvert Height (m)</th>
<th>Culvert Width (m)</th>
<th>Openness Ratio Achieved (2)</th>
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<td>1.7</td>
<td>2.6</td>
<td>3.8</td>
</tr>
<tr>
<td>C2</td>
<td>0.25</td>
<td>1.7</td>
<td>2.6</td>
<td>3.8</td>
</tr>
<tr>
<td>C3</td>
<td>0.25</td>
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<td>3.8</td>
</tr>
<tr>
<td>C4</td>
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<tr>
<td>C5</td>
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<td>C6</td>
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<td>3.8</td>
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<tr>
<td>C8</td>
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<td>2.6</td>
<td>3.8</td>
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<tr>
<td>C9</td>
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<td>3.8</td>
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<tr>
<td>C10</td>
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<td>2.6</td>
<td>3.8</td>
</tr>
<tr>
<td>C11</td>
<td>N/A</td>
<td>1.7</td>
<td>2.6</td>
<td>3.8</td>
</tr>
</tbody>
</table>

Notes:
1. See Appendix A for Plan Profiles
2. Minimum OR achieved assuming the addition of 200-300 mm of local, sandy substrates in wildlife passages
4.2 APPROACHES TO IMPLEMENTATION

Mitigating high wildlife mortality rates and restoring open water connectivity between the Big Creek Marsh and Inner Bay are the main objectives of the Plan. Ancillary benefits of improving recreational opportunities and safety on the causeway can be achieved at the same time.

The cornerstone of the Improvement Plan is the implementation of a permanent ecopassage system, including a series of culverts that increase road permeability, provide opportunity for safe wildlife passage under the causeway and reconnect fragmented habitat. A funnel wall system physically prevents wildlife from entering the roadway, instead directing wildlife to safe passages under the causeway.

The implementation of a permanent system should be the main focus of the Long Point World Biosphere Reserve Foundation and interested stakeholders, represented by the Steering Committee. However, it is recognized that the cost of implementing the Plan is a significant factor. Accordingly, it should be recognized that some works will likely be staged and that the entire Plan may take years to fully implement.
The funnel/exclusion wall system along the west side of the causeway in Zone 3 is seen as a priority given the wildlife movement from west to east and the number of sensitive species being killed in this area of the causeway. Installation and monitoring of a temporary fence in this location is recommended as an interim measure in an effort to immediately address wildlife road mortality. The exclusion fencing in this area will preclude animals from entering the roadway but will not provide passage opportunities to the marina, which meshes with the recommended permanent system in this area. The end treatments of the temporary fencing will be a special consideration in order to prevent end runs and high mortality rates just beyond the fence terminus. A monitoring program and daily fence checks can be implemented by the LPWBRF through partners and volunteers. While temporary fencing provides a means of addressing wildlife road mortality along some sections of the causeway in the short term, intensive monitoring and maintenance requirements make this option unsustainable in the long term. Additional details on temporary fencing are provided in the Fact Sheet in Appendix B.

The entire portion of Zone 2 is considered a priority for implementation of the permanent system. This zone contains the key open water connection and several ecopassages that will provide for safe wildlife passage. Wildlife road mortality is high across the entire length of this zone, making it a large ‘hotspot’. Again, temporary fencing is an option to address wildlife mortality in the short term, recognizing the limitations noted above.

Zone 1 is considered a lower priority for implementation. Road mortality rates are not as high in this section as they are in Zones 2 and 3.
5. ROAD CROSS SECTIONS

The implementation of the Improvement Plan will require changes to the existing causeway ‘footprint’. The extent of these changes will depend on the desired future amenities along the causeway (the type of trail system and the desire for ‘streetscape’ enhancements such as roadside plantings) and other engineering considerations.

Three possible road cross sections are shown, each depicting a slightly different arrangement of recreational trail types, trail buffers and planting areas:

- The “minimum” cross section represents the minimum level of change required to accommodate the main elements of the Plan (ecopassage system, open water connections and trail).
- The “typical” cross section provides a wider footprint for a multi-use trail adjacent to the roadway and an area to safely accommodate tree planting along one side of the causeway.
- The “enhanced” cross section provides a footprint for a multi-use trail separated from the roadway by a wide buffer and area to safely accommodate tree planting along both sides of the causeway.

These examples show typical cross sections that are possible, although numerous variations exist and can be considered in subsequent design stages.

It is likely that the proposed Plan will result in the removal of many of the existing trees along the causeway. Ideally they would be replaced with large stock native plantings of trees and possibly shrubs, appropriate to the site conditions (soil, moisture and wind). Replacement plantings will help to maintain the rural character of the road, an aspect that is valued by visitors and the community.
5.1 ROAD CROSS SECTION 1 - MINIMUM
5.3 ROAD CROSS SECTION 3 - ENHANCED
6. PRELIMINARY COST ESTIMATES

Preliminary cost estimates were developed for each “zone” of the causeway (zones are discussed in Section 4.1). Within each zone, costs estimates reflect the three possible road cross sections described in Section 5. A cost summary table is provided, showing all zones and road cross sections.

Preliminary cost estimates do not include items such as restoration planting and viewing platforms.

Note: All cost estimates are very preliminary in nature, and are subject to revision in future, once design and construction details are complete.
## 6. Preliminary Cost Estimates · Zone 1

### Zone 1

<table>
<thead>
<tr>
<th>Description</th>
<th>Minimum</th>
<th>Typical</th>
<th>Enhanced</th>
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<tbody>
<tr>
<td><strong>Road Improvements</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Costs (per m)</td>
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<td>$790</td>
<td>$965</td>
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<tr>
<td>Length of Zone (m)</td>
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<td><strong>Total Road</strong></td>
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<td><strong>Ecopassage System</strong></td>
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<tr>
<td>Culverts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1 4.0m x 1.7m box</td>
<td>$200,000</td>
<td>$240,000</td>
<td>$255,000</td>
</tr>
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<td>C2 4.0m x 1.7m box</td>
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<td>$240,000</td>
<td>$255,000</td>
</tr>
<tr>
<td><strong>Total Culverts</strong></td>
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<tr>
<td>Wall</td>
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<tr>
<td>Costs (per m)</td>
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<td>Engineering Design (15%)</td>
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<td><strong>Grand Total</strong></td>
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### 6. PRELIMINARY COST ESTIMATES · ZONE 2

#### Zone 2

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<tr>
<td><strong>Road Improvements</strong></td>
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<tr>
<td>Costs (per m)</td>
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<td>Length of Zone (m)</td>
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<td><strong>Total Road</strong></td>
<td>$1,012,500</td>
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|                         |         |         |          |
| **Ecopassage System**   |         |         |          |
| **Culverts**            |         |         |          |
| C3 4.0m x 1.7m box      | $200,000 | $240,000 | $255,000 |
| C4 4.0m x 1.7m box      | $200,000 | $240,000 | $255,000 |
| C5 4.0m x 1.7m box      | $200,000 | $240,000 | $255,000 |
| C6 4.0m x 1.7m box      | $200,000 | $240,000 | $255,000 |
| C7 4.0m x 1.7m box      | $200,000 | $240,000 | $255,000 |
| C8 10.0m x 12.5m        | $395,000 | $395,000 | $395,000 |
| **Total Culverts**      | $1,395,000 | $1,595,000 | $1,670,000 |
| **Wall**                |         |         |          |
| Costs (per m)           | $1,000  | $1,000  | $1,000  |
| Length (m)              | 2,480   |         |          |
| **Total Wall**          | $2,480,000 | $2,480,000 | $2,480,000 |
| **Total Ecopassage**    | $3,875,000 | $4,075,000 | $4,150,000 |
| **Engineering Design (15%)** | $581,250 | $611,250 | $622,500 |
| **Grand Total**         | $4,456,250 | $4,686,250 | $4,772,500 |
## 6. PRELIMINARY COST ESTIMATES · ZONE 3

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<td><strong>Road Improvements</strong></td>
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<tr>
<td>Costs (per m)</td>
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<td>C11</td>
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<td><strong>Total Culverts</strong></td>
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<td>Wall</td>
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<td><strong>Total Ecopassage</strong></td>
<td>$ 2,470,000</td>
<td>$ 2,575,000</td>
<td>$ 2,635,000</td>
</tr>
<tr>
<td>Engineering Design (15%)</td>
<td>$ 370,500</td>
<td>$ 386,250</td>
<td>$ 395,250</td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td>$ 2,840,500</td>
<td>$ 2,961,250</td>
<td>$ 3,030,250</td>
</tr>
</tbody>
</table>
6. PRELIMINARY COST ESTIMATES - SUMMARY

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>Typical</th>
<th>Enhanced</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ecopassage System</td>
<td>Road Improvements</td>
<td>Ecopassage System</td>
</tr>
<tr>
<td></td>
<td>(culverts and funnel wall)</td>
<td></td>
<td>(culverts and funnel wall)</td>
</tr>
<tr>
<td>Zone 1</td>
<td>$1,800,000</td>
<td>$506,250</td>
<td>$1,880,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$1,910,000</td>
</tr>
<tr>
<td>Zone 2</td>
<td>$3,875,000</td>
<td>$1,012,500</td>
<td>$4,075,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$4,150,000</td>
</tr>
<tr>
<td>Zone 3</td>
<td>$2,470,000</td>
<td>$877,500</td>
<td>$2,575,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$2,635,000</td>
</tr>
<tr>
<td>Subtotal</td>
<td>$8,145,000</td>
<td>$2,396,250</td>
<td>$8,530,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$8,695,000</td>
</tr>
<tr>
<td>Combined Subtotal</td>
<td>$10,541,250</td>
<td>$11,334,500</td>
<td>$12,120,750</td>
</tr>
<tr>
<td>Engineering (15%)</td>
<td>$1,581,188</td>
<td>$1,700,175</td>
<td>$1,818,113</td>
</tr>
<tr>
<td>Contingency (20%)</td>
<td>$2,108,250</td>
<td>$2,266,900</td>
<td>$2,424,150</td>
</tr>
<tr>
<td>Top layer paving</td>
<td>$150,000</td>
<td>$150,000</td>
<td>$150,000</td>
</tr>
<tr>
<td>Total</td>
<td>$14,380,688</td>
<td>$15,451,575</td>
<td>$16,513,013</td>
</tr>
<tr>
<td>Rounded Grand Total</td>
<td>$14,400,000</td>
<td>$15,500,000</td>
<td>$16,600,000</td>
</tr>
</tbody>
</table>
### 7. Cost Comparison to Similar Projects

| Project Name and Location                  | Brief Description                                                                                                                                                                                                 | Mitigation Measure Details                                                                                                                                                                                                 | Final Cost          |
|-------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| **Victoria Street Widening**               | Municipal Class Environmental Assessment and Preliminary Design Reconstruction/widening of Victoria Street from two lanes to four lanes, including a 600 m segment through the provincially significant Lynde Creek Marsh, a Great Lakes coastal wetland. Approximate length 1.1 km through marsh. | Exclusion walls along north and south side of the road platform. Widening / replacement of existing bridge, addition of four ecopassages, as well as multi-use community trail and viewing platform                                                                                           | $13,000,000         |
| **Durham Region, ON**                      |                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                    | $11.8 M / km        |
| **Project Status**                         | Project in EA phase, construction planned for 2010.                                                                                                                                                              |                                                                                                                                                                                                                                                                                    |                    |
| **St. John's Sideroad**                   | Detailed Design and reconstruction Widening of St. John's Sideroad from two to four lanes for a 400 m length through the McKenzie Marsh.                                                                             | Significant raise in grade, extensive urban design features, including wide pedestrian walkways, wildlife funnel walls, addition/expansion of wildlife ecopassages along wetland sections                                                                                               | $20,000,000         |
| **Town of Aurora, ON**                    |                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                    | $50 M / km          |
| **Project Status**                         | Project construction completed.                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                    |                    |
| **Long Point Causeway**                   | Feasibility Study and Improvement Plan Identify and develop practical solutions to reduce wildlife road mortality, improve hydraulic and habitat connectivity and provide opportunity for safe wildlife movement between Big Creek Marsh and Inner Bay.   | Road reconfiguration (within right of way) to accommodate recreational trail, wildlife funnel wall system, eleven wildlife/aquatic/hydraulic ecopassages (requiring a raise in road grade at ecopassage locations and approaches). Three optional roadway cross sections developed to accommodate these improvements. | $14.4 - 16.6 M     |
| **Norfolk County, ON**                    |                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                    | $4.0 - 4.6 M / km   |
| **Project Status**                         | Feasibility Study and Improvement Plan complete Subsequent design phases will be required to further develop the Plan into a full design.                                                                        |                                                                                                                                                                                                                                                                                    |                    |
|                                           |                                                                                                                                                                                                                   | Note - these costs are preliminary and subject to change during design                                                                                                                                                    |                    |
8. SUMMARY AND NEXT STEPS

Big Creek Marsh is part of the Long Point World Biosphere Reserve, one of the most important areas for reptiles and birds in Canada. At the same time, the causeway through the marsh has the 5th highest road mortality rate for turtles in the world. On a global scale, even on a national scale, the cost of providing mitigation to reduce the road mortality is not significant when considering the potential loss of rare species from this area. However, the cost is significant in the context of the Norfolk County and local community.

A reduction in even 50% of the wildlife road mortality would be a major success; the proposed Improvement Plan is likely to reduce road mortality by well more than 50%, showcasing the efforts of all involved.

A project of this significance needs a champion. It needs someone or some organization that has the commitment to see it to completion, through the approvals, through the funding commitments and through construction. On a world stage this project would be a major milestone and would certainly be a candidate for recognition or award in a number of areas (engineering, environmental).

The Long Point Causeway Improvement Project is a “signature” project with international appeal and significance. The Causeway Improvement Plan is the first step in the project evolution.

This work has shown that causeway improvements are feasible and necessary to reduce the incidences of wildlife road mortality, improve open water connections between Big Creek Marsh and the bay, and provide improved recreational opportunities.

With the endorsement of the Causeway Improvement Plan and securing of funding, steps can be set in motion to advance the undertaking, all of which would include continued agency and public liaison. These steps include the following:
Undertake an Environmental Assessment

- A Municipal Class Environmental Assessment (EA) is anticipated to be required for the proposed road improvements. The EA process typically takes 12 to 18 months to complete and usually includes a preliminary design of the recommended alternative. The EA process:
  - Confirms the project need and justification;
  - Develops and evaluates various design alternatives;
  - Identifies a technically recommended design alternative, building on the Improvement Plan recommendations, with design treatments that may vary along the alignment;
  - Develops any required mitigation/compensation plan approaches related to fisheries habitat protection, wildlife habitat protection, and water quality protection in consultation with the Long Point Conservation Authority, Ministry of Natural Resources, and Department of Fisheries and Oceans;
  - Identifies project phasing and traffic management requirements for future construction;
  - Identifies any impacts and associated mitigation measures required to implement the causeway improvements, while recognizing the substantial environmental benefits (safer wildlife passage for wildlife including SAR, wetland and water quality benefits, public safety and recreational access benefits) associated with the undertaking;
  - Prepares a Preliminary Design level of detail, and documents in an Environmental Study Report (ESR); and
  - Requires review and approval through public and agency liaison.
8. SUMMARY AND NEXT STEPS CONTINUED...

Undertake Detailed Design

- Detailed advances the approved Preliminary Design to a greater level of detail (typically 1:500 scale) that addresses all aspects of the undertaking (final ecopassage structure sizing, road profile and grading requirements, drainage requirements, environmental management and protection measures). This stage typically takes 12 to 18 months to complete.

- During detailed design, the need for Canadian Environmental Assessment Act (CEAA) screening will be identified and screening report completed, as required.

- Further public and agency liaison occurs and all necessary permits/approvals are obtained.

- Detailed design culminates in the preparation of construction plans (including construction staging plan) and contract documents necessary to tender the construction project.

Construction

- Causeway improvements are implemented through the construction process, as detailed in contract documents.

- Duration depends on construction staging requirements, weather conditions etc.
8. SUMMARY AND NEXT STEPS CONTINUED...

*Grand Opening*

For a signature project of this nature, a Grand Opening would be anticipated to herald the completion of construction.

The result is a causeway facility that “re-connects” the human and natural ecosystem, protects wildlife Species at Risk, and enhances the recreational experience for residents and visitors alike.
9. REFERENCES


APPENDIX A: THE PLAN · CONCEPTS
CONCEPT - ECOPASSAGE AND FUNNEL WALL
CONCEPT · ON-ROAD CYCLE ROUTE ALONG WEST SIDE OF CAUSEWAY
CONCEPT · MULTI-USE TRAIL ALONG WEST SIDE OF CAUSEWAY
CONCEPT · VIEWING PLATFORM

LONG POINT CAUSEWAY IMPROVEMENT PLAN

ROLLING HEIGHT STANDARDS:
- Railing to be a minimum height 1066mm.
- Opportunity to incorporate modified or lowered railings at designated viewing platforms in order to accommodate persons in wheelchairs or mobility devices to be explored during detailed design.
- Platforms which will incorporate angling opportunities to be determined at detailed design.

All railing heights to meet standards outlined in the Ontario Building Code as well as any additional local bylaws and / or specifications.
LONG POINT CAUSEWAY IMPROVEMENT PLAN
Wildlife Mitigation Approaches

<table>
<thead>
<tr>
<th>Wildlife Underpass: Bridge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DESCRIPTION</strong></td>
</tr>
<tr>
<td>• A single span structure located immediately south of the Canadian Wildlife Service Office could be installed to facilitate wildlife movement and restore hydraulic connectivity with the Big Creek Marsh.</td>
</tr>
<tr>
<td>• A single span bridge rests on abutments with no intermediate support columns (also called open span bridge).</td>
</tr>
<tr>
<td>• Multi-span bridge has one or more intermediate support columns between abutments. A multi-span bridge is not recommended for Long Point because it is expensive and does not achieve net benefits beyond what is achieved by a single span bridge or multi-cell culvert.</td>
</tr>
</tbody>
</table>

![Bridge providing aquatic and terrestrial passage opportunities, Chatham, ON](image)

<table>
<thead>
<tr>
<th>RECOMMENDED LOCATIONS AT LONG POINT</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Big Creek Canal</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TARGET WILDLIFE GROUPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>• This type of structure will typically enable movement by a wide variety of wildlife, depending on final clearance.</td>
</tr>
<tr>
<td>• Allows for the unimpeded movement of amphibians and reptiles beneath the structure, provided favourable habitat and substrate conditions are present (e.g. cover, damp conditions) and barriers (e.g. heavy rock rip rap) are absent.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>APPLICATION SUITABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Numerous examples in many provinces, including Ontario.</td>
</tr>
<tr>
<td>• Typically installed at larger watercourses and valleys to address hydrology, navigable waters, floodplain, and/or other landscape connectivity requirements/ desires.</td>
</tr>
<tr>
<td>• A bridge that is oversized and spans the dry banks/riparian zone adjacent to the watercourse channel will provide crossing opportunities for terrestrial wildlife.</td>
</tr>
</tbody>
</table>
### Wildlife Underpass: Bridge

**ADVANTAGES**
- A spanning structure will facilitate the movement of a broad range of terrestrial and aquatic wildlife species, coupled with an improved hydraulic connection between the marsh and Inner Bay.
- Open views of adjacent habitat will be provided from either direction to minimize/eliminate a tunnel effect and increase the likelihood of wildlife crossing under the bridge.
- Better penetration of natural light (in comparison to culverts) will increase the ambient temperature and humidity beneath the structure, increasing the suitability of the structure to reptiles and amphibians.
- Restored hydraulic connectivity may improve water circulation and facilitate the exchange of sediment and nutrients between Big Creek Marsh and the Inner Bay.

**DISADVANTAGES**
- High construction cost compared with smaller structures and culverts.
- High cost of bridge may not yield benefits (wildlife passage and hydraulic connection) beyond what could be achieved with a culvert system.
- Crossing environment can be noisy depending on traffic volumes.
- Restoring the hydraulic connection will likely result in a period of adjustment or ‘equilibration’ of water levels and associated vegetation.

**IMPLEMENTATION CONSIDERATIONS**
- The bridge structure should be tied in with a barrier wall system that will funnel wildlife to the bridge underpass and prevent them from crossing the road overland.
- A bridge can integrate a multi-use recreational trail as well, if desired.
- Various substrate treatments can be explored however rock protection may be required to prevent erosion on shaded slopes under the bridge where vegetation growth may not be supported. Given the low-energy environment of the marsh (i.e. low flows), the composition of native, local substrates and the focus on facilitating terrestrial wildlife movement of amphibians and reptiles, sandy, substrates are recommended. Angular stone such as ‘rip rap’ is not ideal for facilitating terrestrial wildlife movement and would likely deter movement of target species.
- Low light and moisture conditions due to structure shading may discourage vegetation growth, thereby limiting shelter opportunities and increasing susceptibility of smaller species (i.e. amphibians and snakes) to predation. The provision of supplementary material including stumps and logs can provide cover and shelter opportunities to encourage movement by smaller wildlife species.

**MAINTENANCE IMPLICATIONS**
- Structure cleaning typically requires the removal of any debris and other materials on or under the structure as part of the periodic maintenance or prior to activities such as sand blasting and painting. Bird nest materials would require removal as part of this work. Maintenance work would be conducted in accordance with the Migratory Birds Convention Act to protect nesting birds in and around the structure.
- Design measures must be identified to ensure that any cleaning or maintenance materials are properly stored, handled and controlled to prevent substance release to aquatic or terrestrial habitat.
### Wildlife Underpass: Large Culvert

**DESCRIPTION**
- Defined as structures with a height and width of 1.5 m or greater.
- A box culvert is 4-sided and is rectangular or square-shaped. It typically has a concrete bottom, although it can also have an open bottom configuration.
- Box culverts can be arranged in series forming multiple chambers.
- Culverts may also be arch shaped with a high or low profile, with or without a bottom.
- Openness ratio (OR) is a measure of the “see-throughness” or tunnel effect of a structure. The OR has implications for wildlife use as most species are more inclined to travel through a culvert if they are able to see the light through the other end of the structure. Depending on the length of the culvert, a larger culvert tends to have a higher OR.
- Culverts that connect wetland habitats or convey a watercourse may be modified with raised ledges to facilitate terrestrial wildlife movement.

![Diagram](image)

**Openness Ratio Calculation for Culvert / Underpass**

\[
\text{Openness Ratio} = \frac{\text{Height (H) x Width (W)}}{\text{Length (L)}}
\]

For example, if H = 4 metres, W = 7 metres, L = 30 metres:

\[
\text{Openness Ratio} = \frac{28}{30} = 0.9
\]

**Concrete Box Culvert, Kitchener**

**Multi-Cell Pre-cast Open Bottom Culvert, Markham**

**TARGET WILDLIFE GROUPS**
- Depending on structure dimensions, wildlife groups ranging from small mammals, reptiles and amphibians up to ungulates can be accommodated.
- Culverts with a height of less than 2 m will typically allow passage for small and mid-size wildlife species but are generally too small for ungulates.
## Wildlife Underpass: Large Culvert

<table>
<thead>
<tr>
<th>RECOMMENDED LOCATIONS AT LONG POINT</th>
<th>C1, C2, C3, C4, C5, C6, C7, C8, C9, C10</th>
</tr>
</thead>
</table>

### APPLICATION SUITABILITY
- There are numerous examples worldwide of culverts that have been used to facilitate wildlife movement and improve habitat and landscape connectivity. In early cases culverts were installed for other reasons (e.g., drainage) and use by wildlife was secondary. In recent years, the provision of culverts specifically for wildlife use is becoming more commonplace, and is a growing expectation of the Ministry of Natural Resources, Conservation Authorities and other stakeholders on new road projects such as the Highway 404 extension (York Region), Highway 69, Highway 407 East Completion (Durham Region), Bayview Avenue Extension (York Region) and on road widening projects such as Victoria Street through the Lynde Creek Marsh Coastal Wetland (Durham Region).
- Culverts at watercourse crossings can employ open bottom design with footings or can be counter sunk with a single box or multi-cell design. With proper design the counter sunk approach can provide a low flow channel for aquatic passage as well as dry banks for terrestrial movement. The open bottom design requires special design consideration to maintain low flow channel stability coupled with terrestrial passage. Design consideration must also ensure that fish movement requirements are met.
- Large culverts can be oversized to provide opportunities for both aquatic and terrestrial wildlife passage. A multi-cell culvert will often be used to convey low flow through one cell and provide terrestrial passage through another cell. In high flow situations, multiple cells could convey flows (e.g., flood flows) through both cells. Conveyance of flood flows is not anticipated to be an issue at Long Point however, and the multi-cell culvert would provide a hydraulic connection between Big Creek Marsh and Inner Bay as well as year-round terrestrial passage.
- Jackson and Marchand (1998) tested the response of Painted Turtles to a simulated road underpass system consisting of a wooden tunnel (OR=0.20) and funnel fencing. Two thirds of the turtles that encountered the fencing were successfully guided to the tunnel, and of the turtles that reached the tunnel, all successfully passed through.
- On US Highway 441 across Paynes Prairie State Preserve, Alachua County, Florida, a concrete wall 1.1 m high with a 15.2 cm overhanging lip was constructed approximately 9.1 m from the roadway. The wall funnelled wildlife to 8 ecopassages (two 2.4m x 2.4m partially submerged box culverts, two 1.8m x 1.8m dry box culverts and four round culverts 0.9m in diameter) and was effective in reducing wildlife road mortality rates by over 90% (excluding treefrogs and birds).
- At the McKenzie Marsh, a wetland segmented by St. John’s Sideroad in Aurora, ON, a vertical wall extending approximately 2m above the water level has been effective in funneling wildlife to terrestrial (1.2m diameter) and aquatic (4m x 3m) culverts (Gartner Lee Limited 1999).
- Kaye et al. (2006) determined that a large, 6 x 6 ft box culvert was effective in providing passage for Spotted Turtles between two highly used habitats that were to be bisected by a highway in Massachusetts. In the spring and summer of 2004, post-construction monitoring documented direct evidence (thread trails, visual observation) for seven turtles, and indirect evidence (radio telemetry points on both sides of the culvert, visual observation) for 13 turtles, confirming the use of the culvert as a crossing structure.

### ADVANTAGES
- Large culverts, coupled with an improved hydraulic connection between the marsh and Inner Bay will facilitate the movement of a broad range of terrestrial and aquatic wildlife species.
- Culverts will provide passage opportunities for the targeted species at Long Point, specifically turtles, snakes and amphibians. The effectiveness of these structures will increase with the provision of wildlife fencing to funnel species to the culverts and prevent them from crossing overland.
- Strategically placed culverts will increase the permeability of the causeway to wildlife and significantly reduce road mortality rates.
- Restores some hydraulic connection, improving water circulation and facilitating the movement of sediment between Big Creek Marsh and the Inner Bay.
### Wildlife Mitigation Approaches

#### Wildlife Underpass: Large Culvert

<table>
<thead>
<tr>
<th>DISADVANTAGES</th>
<th>IMPLEMENTATION CONSIDERATIONS</th>
</tr>
</thead>
</table>
| • Passages may be noisy, depending on traffic volume.  
• Culverts may not match the ambient temperature, moisture and light regimes preferred by the targeted wildlife groups (i.e. reptiles and amphibians).  
• Flooding and ice formation may discourage use by some animals during the winter/spring period. | • The "openness ratio" (OR) and tunnel effects were first identified in the 1970s and are being increasingly considered in current designs.  
• The maximum OR that can be achieved (taking into consideration cost and the vertical road profile) should be provided to minimize the tunnel effect and increase the likelihood of wildlife crossing through the culvert. The design OR target at Long Point is 0.25 in consideration of the target wildlife species (i.e. turtles and snakes) and based on review of current literature. The culvert openings should be clear of vegetation, as vegetation can block light from penetrating through the culvert and subsequently discourage wildlife usage of the passage. As ectotherms, reptiles are more sensitive to thermal differences between the culvert and surroundings; a larger culvert will allow for more light penetration and thus a reduced thermal gradient, and should result in higher usage. A larger culvert also accommodates natural substrates, whereas a smaller culvert may not. Some small to medium sized species will use smaller culverts (OR <0.25), however, these would not be as effective for our target species at Long Point for reasons just explained.  
• Achieving a minimum OR target of 0.25 may require adjustments in final structure dimensions depending on the final road profile and footprint requirements. Headwalls can also be considered to reduce the effective length of the structure. Final details will be developed at the detail design stage when grading and other profile information is available.  
• Culverts should be regularly spaced (ideally 100 to 300 m spacing) to maximize permeability and reduce the distance wildlife will have to travel between culverts. This is especially important for reptiles and amphibians, given that species within this group are either slow moving, are at risk of desiccation, or are at risk of predation. The risks of desiccation and predation increase the greater the distance between culverts and potentially the more time spent searching for a culvert.  
• Culverts that connect the Big Creek Marsh with the Inner Bay should have a low flow channel incorporated into their design to provide for terrestrial wildlife movement on the adjacent dry banks. This design will meet the needs of a broader array of wildlife groups than will a culvert that is only wide enough to span the wetted width of the watercourse/wetland.  
• Low light and moisture conditions can discourage usage by certain wildlife groups, specifically reptiles and amphibians. Maximizing the OR and providing wood chips within the culvert can respectively increase the amount of light and decrease the thermal and moisture gradient within the culvert, increasing the attractiveness of the culvert to the targeted wildlife species. In attempting to mitigate Garter snake traffic mortality from Narcisse snake dens in Manitoba, Roberts (2001) found layering the floor of an existing 1.3 m culvert with wood chips was effective in decreasing the thermal gradient of the culvert. The culvert was used by 1068 snakes between September 7 and October 11, 2000.  
• Supplementary material such as stumps and logs can provide cover and shelter to encourage movement of snakes and amphibians, however too much material within the culvert can also discourage its use by turtles. |
<table>
<thead>
<tr>
<th>Wildlife Underpass: Large Culvert</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MAINTENANCE IMPLICATIONS</strong></td>
</tr>
<tr>
<td>- Culverts and bridges are typically inspected for safety and maintenance purposes. Standard inspection criteria should be expanded with wildlife use in mind to include vegetation control and woody debris blockage removal in and around culvert entrances to allow for openness and accessibility.</td>
</tr>
<tr>
<td>- Maintenance is required for damage due to erosion and deposition of sediments often due to poor construction. Given the low energy environment, erosion is not anticipated to be an issue, however, ice pile up may be an issue in areas where the hydraulic connection between Big Creek Marsh and Inner Bay is restored.</td>
</tr>
<tr>
<td>- Maintenance work would be conducted in accordance with the Migratory Birds Convention Act to protect nesting birds in and around the structure.</td>
</tr>
<tr>
<td><strong>REFERENCES</strong></td>
</tr>
</tbody>
</table>
## Wildlife Underpass: Small Culvert

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Generally defined as structures with a height and width less than 1.5 m.</td>
</tr>
<tr>
<td>• May be concrete box culverts, metal culverts (round, oval, elliptical).</td>
</tr>
<tr>
<td>• Recommended at Long Point in key locations to restore hydraulic connectivity and provide fisheries passage between Big Creek Marsh and the Inner Bay.</td>
</tr>
<tr>
<td>• Openness ratio (OR) is a measure of the “see-throughness” or tunnel effect of a structure. The OR has implications for wildlife use as most species are more inclined to travel through a culvert if they are able to see the light through the other end of the structure.</td>
</tr>
<tr>
<td>• Because the OR is proportional to the size of the opening of a culvert, a small culvert will have a smaller OR than that of a larger culvert.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TARGET WILDLIFE GROUPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Although wildlife are not specifically targeted with this culvert, aquatic species (including turtles) and terrestrial species tolerant of wet conditions may use this culvert.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RECOMMENDED LOCATIONS AT LONG POINT</th>
</tr>
</thead>
<tbody>
<tr>
<td>• C11 (Implementation is conditional upon landowner agreement to the design)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>APPLICATION SUITABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Small culverts placed north of the Big Creek Bridge and north of the Sand Boy Marina will restore some hydraulic connection, improving water circulation and facilitating the movement of sediment between Big Creek Marsh and the inner bay.</td>
</tr>
<tr>
<td>• Many small to medium-sized wildlife species will use structures with an OR ranging from 0.03 to 0.05. This includes species that are nocturnal and/or utilize tunnels or other confined spaces in their life history. Such use has been confirmed at the Bayview Avenue extension in York Region where remote camera detection systems installed by Ecoplans in 2006 in terrestrial pipe culverts (1 m – 1.2 m diameter with an average OR of 0.03) confirmed passage by a surprising diversity of species (Deer Mouse, Meadow Vole, shrew, Eastern Cottontail, Striped Skunk, Raccoon, Short-tailed Weasel, American Toad, Leopard Frog, mole salamander, Eastern Gartersnake). Nevertheless, the solitary use of culverts with an OR of 0.03 to 0.05 is not recommended for passage of the targeted species at Long Point (i.e. turtles and snakes, including large-bodied snakes).</td>
</tr>
<tr>
<td>Wildlife Underpass: Small Culvert</td>
</tr>
<tr>
<td>----------------------------------</td>
</tr>
<tr>
<td><strong>ADVANTAGES</strong></td>
</tr>
<tr>
<td>• Restores some hydraulic connection, improving water circulation and facilitating the movement of sediment between Big Creek Marsh and the inner bay.</td>
</tr>
<tr>
<td>• Can accommodate seasonal flow as required.</td>
</tr>
<tr>
<td>• May provide some passage opportunity for aquatic wildlife species, including turtles.</td>
</tr>
<tr>
<td><strong>DISADVANTAGES</strong></td>
</tr>
<tr>
<td>• Culvert sizing and OR are not optimal for passage of target species at Long Point, specifically turtles and snakes (although more aquatic turtle species may use the culvert).</td>
</tr>
<tr>
<td>• Requires periodic maintenance.</td>
</tr>
<tr>
<td>• Passages may be noisy, depending on traffic volume.</td>
</tr>
<tr>
<td>• Culverts may not match the ambient temperature, moisture and light regimes preferred by the targeted wildlife groups (i.e. reptiles and amphibians).</td>
</tr>
<tr>
<td>• Periodic flooding may discourage use by more terrestrial wildlife species, as the culvert is not wide enough to maintain a low flow channel with a terrestrial passage on the banks.</td>
</tr>
<tr>
<td><strong>IMPLEMENTATION CONSIDERATIONS</strong></td>
</tr>
<tr>
<td>• Culvert sizing will be driven by hydraulic requirements.</td>
</tr>
<tr>
<td>• This culvert is recommended for hydraulics, and therefore it is likely that it will hold water most if not all year round. Wildlife may opportunistically use this culvert during periods of low flow, however it is not designed for terrestrial wildlife use. Nevertheless wildlife fencing will be beneficial in preventing wildlife from crossing the causeway overland.</td>
</tr>
<tr>
<td><strong>MAINTENANCE IMPLICATIONS</strong></td>
</tr>
<tr>
<td>• Periodic maintenance required to address culvert blockage (debris) and any erosion.</td>
</tr>
<tr>
<td>• Vegetation at culvert opening needs to be controlled to allow for openness and accessibility, minimum vegetation needed for amphibians.</td>
</tr>
<tr>
<td>• Given the low energy environment, erosion is not anticipated to be an issue, however, ice pile up may be an issue in areas where the hydraulic connection between Big Creek Marsh and Inner Bay is restored.</td>
</tr>
<tr>
<td>• Maintenance work would be conducted in accordance with the Migratory Birds Convention Act to protect nesting birds in and around the structure.</td>
</tr>
</tbody>
</table>
## Wildlife Mitigation Approaches

### Permanent Wildlife Fencing and Funneling Measures

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>TARGET WILDLIFE GROUPS</th>
</tr>
</thead>
</table>
| - An important component of an “ecopassage system”. Research indicates that wildlife ecopassages are most effective when coupled with a measure to funnel wildlife to the crossing structures while preventing them from accessing the road. The fencing ideally runs parallel to the highway for the length of the habitat associated with the target wildlife species.  
- Wildlife diversion fences vary in height and materials depending on application.  
- Fences may be constructed of wire, woven wire, chain link, rail, sheet piling or concrete walls. Where applicable, the bottom end of the fencing may be a finer mesh or covered with another type of barrier to prevent entry by small mammals.  
- Bank slopes and culvert approaches can be treated with rip rap or other non-wildlife friendly material to deter wildlife movement up an embankment and funnel wildlife species to a culvert. | - Can be designed for and applied to most wildlife groups, including reptiles and amphibians. |

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**Wildlife Fencing with Arch Culvert, New Brunswick**

**Sheet Piling**

**Concrete Wall with Lip, Paynes Prairie, Florida**

**Amphibian Tunnel Funnel Fencing, York Region** (interlocking retaining wall material)
| APPLICATION SUITABILITY | • Fencing has been widely utilized alone or in combination with various other mitigation structures.  
• On US Highway 441 across Paynes Prairie State Preserve, Alachua County, Florida, a concrete wall 1.1 m high with a 15.2 cm overhanging lip was constructed approximately 9.1 m from the roadway. The wall funneled wildlife to 8 ecopassages (two 2.4m x 2.4m partially submerged box culverts, two 1.8m x 1.8m dry box culverts and four round culverts 0.9m in diameter) and was effective in reducing wildlife road mortality rates by over 90% (excluding treefrogs and birds) (Barichivich and Dodd 2002).  
• At the McKenzie Marsh, a wetland segmented by St. John’s Sideroad in Aurora, ON, a vertical wall extending approximately 2m above the water level has been effective in funnelling wildlife to terrestrial (1.2m diameter) and aquatic (4m x 3m) culverts (Gartner Lee Limited 1999).  
• Recent research in Massachusetts (Kaye et al. 2006) has indicated that treating a steep slope with rip rap and large boulders is effective in deterring Spotted Turtle movement up an embankment and across a highway. The turtles were funnelled to a 6 by 6 foot (1.8 by 1.8 m with an OR of 0.8) box culvert that was frequently used by radio-tagged individuals. It is important to note however that there are concerns with snakes using riprap as habitat and turtles getting caught in areas treated with rip rap. Areas treated with rip rap should be monitored to determine their effectiveness.  
• One way gates and ramps are not recommended given that the wildlife groups targeted are reptiles and amphibians. |
| ADVANTAGES | • Can serve to keep wildlife away from transportation routes and to funnel wildlife towards crossing corridors.  
• Broad applicability.  
• Considered by most researchers to increase likelihood of structure use by wildlife.  
• Raising the vertical profile of the causeway to provide a wall with a height that is level with the road will preclude wildlife from becoming trapped on the road (i.e. road profile is raised compared to the surrounding landscape). Any wildlife that does manage to enter the roadway and cross to the other side can simply walk over the edge of the fence onto the ground below. |
| DISADVANTAGES | • Can require a high level of maintenance (clearing of vegetation around permanent or temporary fences, etc.).  
• If the vertical road profile is not raised, fencing may cause wildlife to become trapped on road. |
## Wildlife Mitigation Approaches

### Permanent Wildlife Fencing and Funneling Measures

#### IMPLEMENTATION CONSIDERATIONS
- Must be coupled with crossing structures to retain landscape and population linkages.
- Many researchers conclude that structures are most effective if funnel fencing is provided, particularly for reptiles and amphibians where trends in crossing zones are not apparent.
- The fence should be durable and able to withstand temperature extremes, erosion/water forces, and winter maintenance. If solid, wall materials should be as smooth as possible to reduce the ability of wildlife to crawl up the wall. If using some form of mesh material, the fence should be durable and requires additional smaller mesh (or other material) on the lower section near the ground to deter passage by smaller species.
- Funnel fencing should be at least 1.0 m high to prevent Leopard Frogs from jumping over the fence.
- Burying the fence to a depth of a minimum of 20 cm could significantly decrease access to the roadway by burrowing wildlife. Due to the sandy substrates and concerns of erosion in many areas along the Causeway the fence should be buried to the maximum feasible depth.
- The design of the fence should include a cap or lip (10 to 15 cm) to deter wildlife, particularly Fox Snakes and treefrogs, from climbing over the fence onto the causeway. If concrete is employed it should be as smooth as possible to deter wildlife from scaling the fence.
- Walls should be flush to the ecopassages to avoid having small animals move through gaps and onto the road.
- The wall terminus should ideally curl back in a 120 degree curve away from the roadway rather than end abruptly. The wall should extend back for no less than 20 ft, if possible. The intent is to reduce the risk of wildlife reaching the end of a wall and then abruptly moving onto the causeway.

#### MONITORING CONSIDERATIONS
- A monitoring plan should be implemented to determine the efficacy of the ecopassage and wildlife funnel fence designs. The use of remote camera detection systems is a good tool to record wildlife use of any tunnels (one measure of success).
- The monitoring plan should take into account time required for wildlife to adapt to a funnel fence and ecopassage system.

#### MAINTENANCE IMPLICATIONS
- Fencing in association with wildlife structures is effective, but it does require a long-term maintenance commitment that must be considered in maintenance budgets.
- Depending on the material used, fences can be damaged by falling trees, vehicle accidents, and unauthorized cutting by ATV and snowmobile operators. In addition, fence poles can shift due to frost heave. All of these issues require maintenance review and periodic repair.
- Vegetation hanging over the wall and growing up from the base of the wall must be cleared at regular intervals to prevent animals from using it to climb over the fence and onto the causeway.

#### REFERENCES
## Temporary Wildlife Fencing and Funneling Measures

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>• Temporary fences can be constructed of silt fencing, a temporary sediment barrier composed of woven, synthetic filtration fabric supported by wooden or steel posts.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TARGET WILDLIFE GROUPS</strong></td>
<td>• Can be designed for and applied to most wildlife groups, including reptiles and amphibians.</td>
</tr>
</tbody>
</table>
| **APPLICATION SUITABILITY** | • Fencing has been widely used alone or in combination with other mitigation structures.  
  • Along a low density cottage road in Parry Sound, a proposed wildlife fence designed by MTO with input and approval from MNR consists of geotextile material (safety cover mesh “Black” with all edges hemmed) reinforced by a series of 2 x 4 stakes separated by a maximum distance of 2.3 m. The fence is to be buried a minimum of 6 inches to prevent turtles digging beneath the wall in order to access the highway. The geotextile consists of a swimming pool cover material that is slippery and will deter snakes and frogs from scaling the fence and accessing the road.  
  • The Lake Jackson Ecopassage Feasibility Study (Kimley-Horn and Associates Inc. 2005) was undertaken to address a high rate of turtle road mortality on U.S. Highway 27 in Tallahassee, Florida. The highway bisects a wetland with resultant detrimental effects on populations of herpetofauna. The study area includes a ¾ mile stretch of US 27 located between Lake Jackson and Little Lake Jackson, traveled by more than 23,000 vehicles each day. As a component of the study, silt fencing was installed along the length of the highway to act as a temporary means of reducing wildlife mortality until a permanent ecopassage system is constructed. Intensive, 2-4 times daily monitoring was carried out to check on the safety of the turtles and determine the effectiveness of the silt fencing (Aresco 2005). The installation of silt fencing was demonstrated to be an effective temporary means of reducing wildlife mortality. This option was not expensive to install, however it required intensive (daily) monitoring and maintenance. Furthermore, animals were still able to climb over the temporary fence or were able to enter the road through holes or breaches in the fabric. |
| **ADVANTAGES** | • Can serve to keep wildlife off the causeway as an interim measure until a permanent ecopassage system is implemented.  
  • Encourages community involvement in the project.  
  • Can provide valuable baseline information on crossing trends (with proper monitoring).  
  • If temporary fencing is successful in keeping wildlife off the road, it can reinforce the urgency and need for a permanent ecopassage system. |
Wildlife Mitigation Approaches

### Temporary Wildlife Fencing and Funneling Measures

<table>
<thead>
<tr>
<th>DISADVANTAGES</th>
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</table>
| • Is not durable and may not be able to withstand temperature extremes, erosion/water forces, and winter maintenance, especially in the Long Point setting.  
• Requires a high level of maintenance and monitoring (e.g. fence repair/replacement might be required annually, regular clearing of vegetation, etc.).  
• Fencing may cause wildlife to become trapped on road (particularly if there is movement of wildlife from the Sandboy Marina west to the Big Creek Marsh).  
• Does not retain landscape and population linkages without an ecopassage system in place.  
• Without a cap or lip, some species of wildlife (i.e. Fox Snakes and treefrogs) may be able to scale or climb the fence and access the causeway. |

<table>
<thead>
<tr>
<th>IMPLEMENTATION CONSIDERATIONS</th>
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</table>
| • Fence material should be selected with a tight enough weave to prevent wildlife passage.  
• Funnel fencing should be at least 1.0 m high to prevent Leopard Frogs from jumping over the fence.  
• Burying the fence to a depth of a minimum of 20 cm could significantly decrease access to the roadway by burrowing wildlife. Due to the sandy substrates and concerns of erosion in many areas along the causeway the fence should be buried to the maximum feasible depth.  
• The fence terminus should ideally curl back in a 120 degree curve away from the roadway rather than end abruptly. The fence should extend back for no less than 6 m, if possible. The intent is to reduce the risk of wildlife reaching the end of the fence and then abruptly moving onto the causeway.  
• In 2003 the MNR Parry Sound issued a Conservation Advisory indicating that heavy duty silt fence used in construction projects may cause mortality in large-bodied snake species. This type of silt fence is constructed of nylon mesh netting that reinforces the regular woven plastic strand material. The nylon mesh is about one inch square. Large-bodied snakes become entangled in the mesh and frequently die. Susceptible species include the Lake Erie Watersnake as well as other SAR snakes (Eastern Foxsnake, Eastern Hog-nosed Snake, Black Ratsnake, Eastern Milksnake). Snakes may encounter this silt fencing where it has been erected across or along a movement zone. Possible attraction to the thermal properties of the fencing material for body temperature regulation has also been speculated by MNR. |

<table>
<thead>
<tr>
<th>MONITORING CONSIDERATIONS</th>
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<tbody>
<tr>
<td>• An intensive, daily (or daily, multiple frequency) monitoring plan should be implemented to determine the effectiveness of the temporary funnel fence design. This plan will provide baseline data detailing trends in wildlife movement.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>MAINTENANCE IMPLICATIONS</th>
<th></th>
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</thead>
</table>
| • Fencing in association with wildlife structures is effective, but it does require a long-term maintenance commitment that must be considered in maintenance budgets.  
• Fences can be damaged by falling trees, vehicle accidents, and unauthorized cutting by ATV and snowmobile operators. In addition, fence poles can shift due to frost heave. All of these issues require maintenance review and periodic repair.  
• Vegetation hanging over the fencing and growing up from the base of the fencing must be cleared at regular intervals to prevent animals from using it to climb over the fence and onto the causeway. |

<table>
<thead>
<tr>
<th>REFERENCE</th>
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</table>
| RATIONALE | The Long Point Causeway bisects wetland that provides critical habitat for a number of turtles, including Species-at-Risk (SAR). Turtles cross the Long Point causeway through random wandering (particularly with Blanding’s Turtles), or direct, intentional movement either towards critical habitat (nesting, foraging or over-wintering habitat) or in search of a mate. Turtles are attracted to the loose, gravelly substrates and open canopy conditions of the road shoulder for nesting, putting both nesting females and emerging hatchlings at risk of road mortality.

The creation and/or enhancement of turtle nesting sites within the Big Creek Marsh can indirectly reduce road mortality by providing species with access to a mosaic of habitat that is not fragmented by the causeway. Long Point is one of the most important areas for reptiles in all of Canada, and may provide the only viable populations of SAR reptiles in the near future (S. Gillingwater 2008; personal communication). Providing turtles with nesting habitat while taking measures to reduce road mortality is critical to the conservation of turtles at Long Point. |

| View of artificial turtle nesting beds at the RBG | Creation of turtle nesting habitat |
| Photo: M. Pomfret | Photo: S. Gillingwater |

| Nesting Midland Painted Turtle | Hatchling Snapping Turtles |
| Photo: S. Gillingwater | Photo: S. Gillingwater |
### Construction of Turtle Nesting Habitat

<table>
<thead>
<tr>
<th>APPLICATION SUITABILITY</th>
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<tbody>
<tr>
<td>In addition to recommending a network of ecopassages coupled with a wildlife exclusion wall system, the creation and/or enhancement of turtle nesting sites can indirectly reduce road mortality by providing turtles with access to a mosaic of habitat that is not fragmented by the causeway.</td>
</tr>
<tr>
<td>Because of certain life history traits of turtles (i.e. late age of maturity and nesting site fidelity), it can take years for the nesting sites to be used. Nevertheless the provision of nesting habitat is critical to the conservation of turtles, and offering individuals a variety of suitable nesting sites can only increase hatching success.</td>
</tr>
<tr>
<td>Turtle nesting habitat projects have been initiated throughout North America:</td>
</tr>
<tr>
<td>In 1996 the New York State Department of Environmental Conservation constructed an artificial 8 x 11m sand-based turtle nesting mound. From 1996 to 2006, over 3000 ha</td>
</tr>
<tr>
<td>In an effort to reduce vehicle-related mortality, the Royal Botanical Gardens (RBG) created artificial turtle nesting beds away from any roads. In 2003 two experimental nest sites were created along the top edge of a south-facing slope using gravel material donated by Dundas Quarries (LaFarge, Canada). The dimensions of the beds were based on those of natural nests dug by Snapping Turtles on RBG property, measuring 2.7m X 4.9m and 0.35m deep, and 4.3m X 11m and 0.4m deep. Although the nest sites have not yet been used by nesting turtles, the RBG continues to monitor these sites (K. Spence-Diermair 2007 and 2008; personal communication).</td>
</tr>
<tr>
<td>In 1998 the Columbia Basin Fish and Wildlife Compensation Program began a nest site enhancement and monitoring project at the Red Devil Hill nest site at Revelstoke, B.C., to determine the feasibility of creating alternative nest sites to keep Painted Turtles away from the road. After 3 years of monitoring, evidence suggests that turtles still have a very high preference for the existing nest site over the enhancement sites (Maltby 2000).</td>
</tr>
<tr>
<td>The selection of successful turtle nesting habitat locations requires knowledge of trends in local population movement and ground truthing to ensure key criteria are met. Where possible nesting habitat should be created in proximity to existing, confirmed nesting sites to increase the likelihood of the nesting sites being used (MA Division of Fisheries and Wildlife 2007). Nesting site locations for Blanding’s Turtle and Snapping Turtle should be selected within 300 m of the wetland (MA Division of Fisheries and Wildlife 2007).</td>
</tr>
<tr>
<td>There have been reports of turtles nesting in piles of soil and sandy loam created inadvertently by local residents (e.g. through the preparation of garden beds, etc.) in the Long Point area each year (R. Levick 2008; personal communication). Although there are concerns with the suitability of these sites in successfully hatching turtle eggs, it nevertheless indicates that turtles in the Long Point area are selecting to nest in “artificially” created sites.</td>
</tr>
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<table>
<thead>
<tr>
<th>MOISTURE</th>
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<tr>
<td>Turtle egg shells are porous and exchange water with the environment inside their nests. The availability of water during incubation influences incubation time, hatchling size, locomotion speed and body composition (Johnson 2007).</td>
</tr>
<tr>
<td>With suitable temperatures, nest cavity moisture can affect hatching fitness. Bobyn and Brooks (1994) found that higher moisture levels in warm nests (above 25.3°C) produced larger hatchlings that grew faster after emergence.</td>
</tr>
<tr>
<td>There is a discrepancy regarding the advantages of higher moisture nests over low moisture nests. Nests with higher moisture contents produce larger hatchlings that have an immediate advantage over smaller hatchlings (in terms of predation and conspecific competition). Hatchlings from drier nest sites are smaller. However they have a greater yolk sac mass the first week post-hatching and a greater triglyceride content at all intervals, suggesting that they have greater energy reserves during the first winter (Finkler et al. 2002).</td>
</tr>
</tbody>
</table>
### Construction of Turtle Nesting Habitat

| SUBSTRATES | • Blanding’s Turtle, Map Turtle, Snapping Turtle and Painted Turtle prefer to nest on well drained, loose, soil, sand or gravel. Substrates that have been salvaged and brought in from other locations should be washed to minimize translocation of weeds or invasive plant species and impede rapid growth of vegetation (MA Division of Fisheries and Wildlife 2007).  
• Most turtle species in the area have been confirmed nesting along man-made berms, with some species also utilizing muskrat lodges and large grass tussocks (S. Gillingwater 2007; personal communication).  
• Substrates for artificially created sites should be selected carefully, and should mimic substrate composition of nearby successful sites as much as possible. |
| --- | --- |
| TEMPERATURE, SUN EXPOSURE, AND CANOPY COVER | • Incubation success is temperature dependent. Turtles have a range of temperature tolerance, outside of which they experience abnormalities or mortality (Johnson 2007).  
• Temperature influences both the duration of incubation and the sex of the hatchlings (note: all Ontario turtles exhibit temperature dependent sex determination except for Wood Turtle and Eastern Spiny Softshell Turtle). Generally higher temperatures result in shorter incubation periods and female clutches, while low temperatures produce males over a longer incubation period. The exception to this is with Snapping Turtles; females are produced at extreme high and low temperatures while males are produced at intermediate temperatures.  
• Female Blanding’s Turtles select nest sites in relatively open areas or disturbed habitats, including roadways (Congdon et al. 2000). The selection of a site with an open canopy ensures maximum sun exposure, increasing the mean temperature in the nest cavity and subsequently the likelihood of a successful nest (COSEWIC Status Report on the Blanding’s Turtle 2005).  
• Blanding’s Turtle eggs have a high critical thermal minimum for the completion of development (Gutzke and Packard 1987), making the selection of suitable nesting conditions critical to the reproductive success of this species. Sites with an open east to west canopy cover are preferable to those with an open north to south canopy cover as this ensures maximum sun exposure throughout the majority of the day. |
| GROUND COVER | • Nest design is specific to different species of turtles. While some species prefer areas with no vegetation, other species select sites with vegetation (S. Gillingwater 2008; personal communication). Nevertheless vegetation growth should be monitored and maintained to prevent excessive growth, as vegetation cover can decrease incubation temperatures, roots can pierce turtle egg shells and above ground vegetation growth can impede hatchling emergence from the nest (Maltby 2000).  
• Data collected by Maltby (2000) suggests that selection for vegetated areas as a defensive cover from human disturbance may negatively affect population recruitment from the Red Devil Hill nest site. Hatchling fitness may also be reduced in heavily vegetated nest sites.  
• Landscape fabric can be placed beneath the substrates (approximately 0.5 m beneath the ground surface) to prevent or delay the growth of vegetation at the nest site.  
• Non aggressive, native shrubs can be planted nearby to provide cover for the gravid females and newly emerged hatchlings (MA Division of Fisheries and Wildlife 2007). |
| NESTING DEPTH | • The temperature of the nest (and consequently the development of the eggs) is determined in part by the depth of the nest. A shallower nest with a higher temperature typically results in a shorter incubation period and a higher percent viability, however shallow nests are more vulnerable to surface disturbances that may harm or destroy eggs or hatchlings (Maltby 2000). |
**RISK OF PREDATION**

- To reduce the risk of human disturbance to the site and poaching of turtle eggs and/or hatchlings, nest site locations should be selected away from commonly used areas and trails (S. Gillingwater 2008; personal communication). Tall vegetation (e.g. shrubs and grasses) can also be planted to block nesting site locations from public view, however careful attention must be paid to ensure that this vegetation does not block exposure to the sun.
- Predation of turtle nests is generally quite high. At Long Point the most common predators of turtle nests are skunk, raccoon, mink, opossum, coyote and red fox. To minimize the effects of predation it is recommended that multiple nesting sites be created in a mosaic of locations.
- To avoid leading predators to nests, sites should be constructed in a non-linear, non-uniform distribution (B. Johnson 2007; personal communication).
- Confirmed nest sites can be protected from predation with a wire metal cage. Since turtles nests are at greatest risk of predation within the first 48 hours of the eggs being laid (Minnesota Department of Natural Resources 2001), the cage can be removed well before the hatching period to ensure that hatchlings are not trapped. If the cage is left on for the duration of the incubation period, sites require intensive monitoring to ensure that hatchlings do not become trapped in the nest.

**MONITORING**

- The site should be monitored regularly to determine the success of the nesting site and whether maintenance is required.
- Since nests are most commonly predated within the first 48 hours of nesting activity, nest site locations should be monitored intensively during nesting season in order to protect nests with wire metal cages.
- As previously noted, nests that have been protected with a wire metal cage need to be monitored intensively during the hatching period to ensure that hatchlings are not trapped.

**MAINTENANCE**

- Herbaceous and woody vegetation should be manually removed if the total cover exceeds 10%, and the area raked to ensure that the substrates are loose and not compacted.
- Hartwig et al. (2008) determined that Blanding's Turtles in Southeastern New York were more likely to use nest sites that had been tilled than nest sites that had been hand weeded or mowed.

**CONSTRUCTION COSTS AND CONSIDERATIONS**

- Backhoe, cat rental--$275 per day
- Landscape filter cloth--$12 per 3’x50’ roll
- Pea gravel--$35 per cu.yd.
- Granular ‘A’ Gravel--$32 per cu.yd.
- Mulch--$40-55 per cu.yd.
- Landscape soil (topsoil/sand)--$20 per cu.yd.
- Sand--$20 per cu.yd.
- Topsoil--$20-30 per cu.yd.

(Source: Johnson 2007)
## Construction of Turtle Nesting Habitat

- Johnson, B. 2007. Personal communication with Bob Johnson, Curator of Reptiles and Amphibians, Toronto Zoo. 416.392.5968
- Minnesota Department of Natural Resources Natural Heritage and Nongame Research Program. 2001. *Environmental Review Fact Sheet Series—Blanding’s Turtle (Emydoidea blandingii)*.
# Wildlife Mitigation Approaches

## Wildlife Warning Signs

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
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| - Widely used to alert drivers of potential wildlife crossings.  
  - Traditional warning signs are diamond shaped with a yellow background and black silhouettes of animals or potential dangers illustrated in the foreground.  
  - Other diverse signs have also been used. |

<table>
<thead>
<tr>
<th>TARGET WILDLIFE GROUPS</th>
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<tbody>
<tr>
<td>- Can be utilized for all wildlife groups with ungulates being the most typical group. Crossing signs have also been developed for amphibians (including toads), waterfowl, turtles, and snakes.</td>
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<table>
<thead>
<tr>
<th>APPLICATION SUITABILITY</th>
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</table>
| - Easy to install and maintain.  
  - Can be installed at the north and south ends of the Causeway, warning drivers of the possibility of encountering wildlife. |

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
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</thead>
</table>
| - May accommodate a broad range of wildlife species.  
  - Economical in comparison to crossing structures.  
  - Can be modified to enhance their visibility such as with flashing lights.  
  - Can be used seasonally during greatest wildlife road crossing times. |

<table>
<thead>
<tr>
<th>DISADVANTAGES</th>
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</table>
| - Effectiveness of measures have not been conclusively evaluated and are generally assumed to be variable, if not neutral.  
  - Drivers become habituated to static signs and are less likely to respond to the warning by reducing speed or increasing alertness, unless they have had a previous wildlife collision experience (or close call).  
  - Novel signs can be prone to theft as souvenirs. |
<table>
<thead>
<tr>
<th>Wildlife Mitigation Approaches</th>
<th>Wildlife Crossing Warning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wildlife Warning Signs</strong></td>
<td></td>
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</tbody>
</table>
| **IMPLEMENTATION CONSIDERATIONS** | - MTO has received input from MNR on sign type and placement based on their knowledge of wildlife species and the local area.  
- Seasonal message signs, particularly with digital message providing warning command for motorists, may be more effective, particularly at high profile locations where wildlife mortality is a major concern.  
- The option of welding or including a locking mechanism for the bolts will reduce the risk or signs being stolen. |
| **MAINTENANCE IMPLICATIONS**   | - Easily accessible for maintenance.  
- May need to be replaced or repaired due to deterioration, vandalism or theft. |