ENHANCEMENT OF WINDERMERE BASIN

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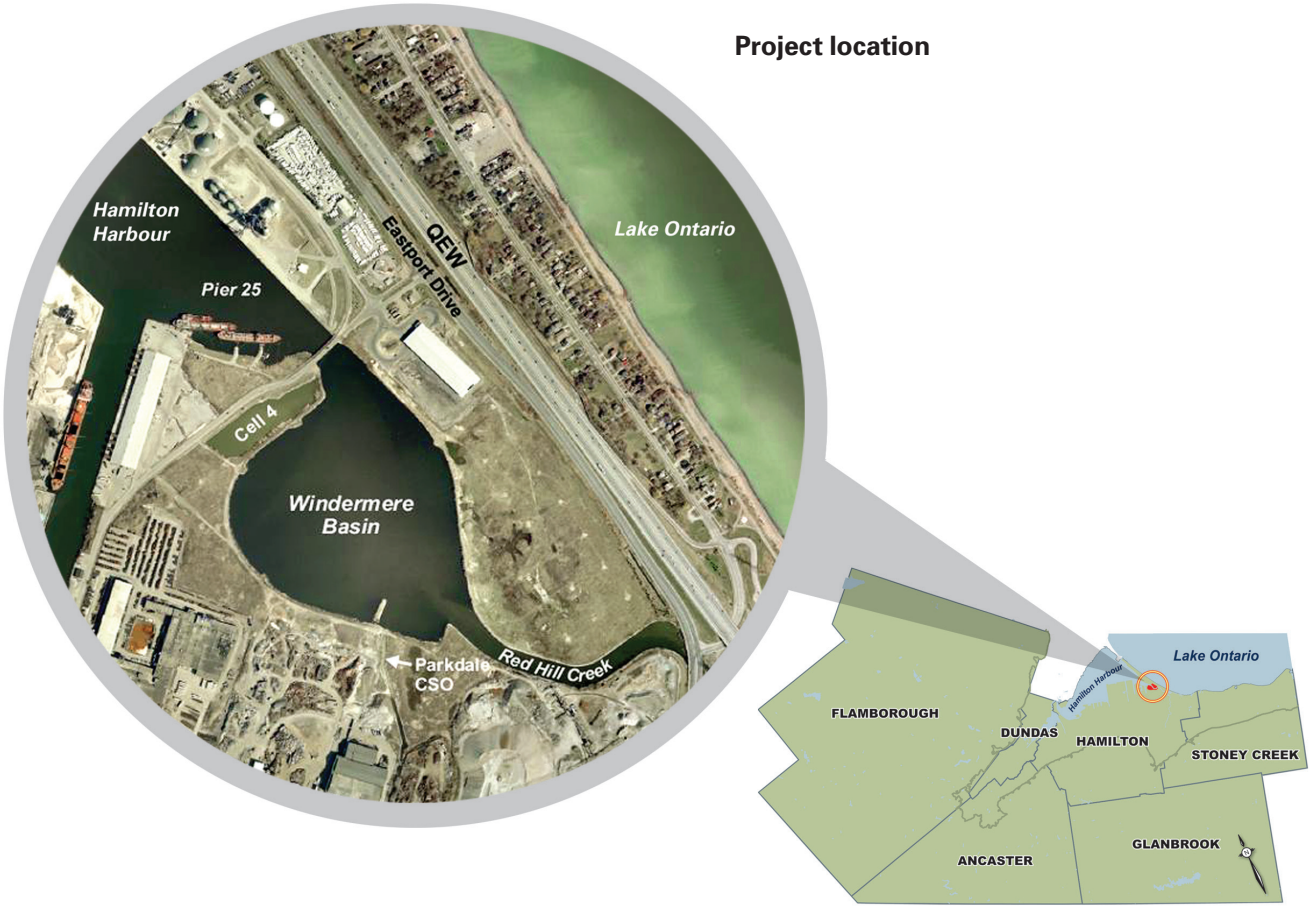
Hamilton

Enhancement of Windermere Basin
Key Features

Project location



Windermere Basin is located at the southeast corner of Hamilton Harbour, at the mouth of Red Hill Creek, and began as a pre-industrial wetland. Aerial photos of the Basin before 1950 show the area as a productive coastal wetland. However, since the 1950's, the Basin was subjected to contamination by industrial chemicals, sewage overflows, landfill leaks and eroded sediment from Red Hill Creek. Consequently, the Basin became impacted by contamination, and was environmentally degraded. In 1987, Hamilton Harbour was identified as an "Area of Concern" under the Canada-United States Great Lakes Water Quality Agreement. A Remedial Action Plan was subsequently developed, and identified that "Degradation of habitat, including the loss of 65% of Hamilton Harbour fish and wildlife habitat, has been identified as one of the causes resulting in the reduction or loss of colonial waterbirds and certain fish populations".

Windermere Basin was an example of degraded habitat within Hamilton Harbour. In addition to historic contamination, the Basin had been significantly altered through dredging in 1990 to act as a sediment trap to protect shipping routes. The trap was to prevent sediments conveyed by Red Hill Creek from entering the Harbour immediately downstream of the Basin at Piers 24 and 25, where significant shipping activity occurs under the control of the Hamilton Port Authority. In October 2000, the City of Hamilton and the Hamilton Port Authority (HPA) (formerly the Hamilton Harbour Commissioners) entered into an agreement which transferred ownership of the Basin and surrounding lands to the City. As part of this agreement, the City assumed responsibility for maintenance dredging of the Basin, to be undertaken in a timely matter to ensure that the build up of sediment would not impinge upon the shipping and navigation needs of the Harbour.

INTRODUCTION TO PROJECT CONT'D

Through undertaking bathymetric surveys, it was discovered that the Basin had reached capacity and was no longer effective. It was also determined that the accumulated sediments within the Basin were contaminated, and would be expensive to dredge and dispose of off-site. The City undertook several studies to determine the best course of action to deal with its obligations to the HPA and how to best manage the Basin property. It was determined that sediments within the Basin should remain, dredging be completed at Pier 25, and that the Basin be restored to a more natural condition.

The City retained Cole Engineering as lead engineering consultants to assist in the completion of the Enhancement of Windermere Basin project, including:

- Municipal Class Environmental Assessment;
- Canadian Environmental Assessment Act screening; and,
- Preliminary design, detailed design and contract administration services.

Upon completion of the environmental assessment processes, it was determined that the preferred solution was to construct a watercourse to direct sediment to Hamilton Harbour and create a wetland aquatic habitat within the remainder of the Basin. It was also identified through the environmental assessment that the existing Basin was a highly desirable nesting area for the Common Tern, which was identified as an important species to the success of the project. This species nests in colonies in a relatively small number of locations in the lower Great Lakes. When construction commenced, the Spur Dyke within the Basin was the only remaining Common Tern colony in Hamilton Harbour. Aspects of the Remedial Action Plan for Hamilton Harbour indicated that permanent nesting habitat is to be created. The result of the environmental assessment, and subsequent detailed design, was a restoration and remediation project that was inline with the goals of the Remedial Action Plan.

INNOVATION

The Enhancement of Windermere Basin project was particularly innovative because a solution was developed that fulfilled the client's goals while minimizing capital cost. The primary goal of the project was to transform the existing Basin, an unproductive body of water with limited fish & wildlife diversity, into a healthy coastal wetland supporting a diverse range of plants and wildlife. This goal is inline with the objective of the Hamilton Harbour Remedial Action Plan. An additional goal was to provide more efficient sediment management, and minimize long-term dredging costs for the downstream shipping routes. Effective sediment management design and customized water balance modeling drove successful completion of the goals.

Sediment Management

An initial environmental investigation was completed to assist in the development of a preferred solution. It was found that the accumulated sediments were impacted, with the following characteristics:

- High total phosphorus concentrations, often exceeding the Ministry of Environment (MOE) severe effect level;
- High metal concentrations, with Cr, Cu, Fe , and Zn exceeding the MOE severe effect level in Basin sediments;
- High PAH and total PCB concentrations, often exceeding the MOE low effect level; and,
- Very limited benthic invertebrate populations.

The results of the investigation indicated that the sediment was contaminated to an unacceptable level for wetland health. Human health and ecological risk assessments were undertaken, which recommended that that the sediments could remain on site with minimal risk if covered with a 0.5 m thick cap. By implementing the recommendations of the risk assessment, project goals could be achieved through a solution of channelizing Red Hill Creek through the Basin and creating a wetland. This alternative keeps the accumulated 270,000 m^3 of impacted sediment on site and permits more efficient future dredging operation downstream instead of within the Basin.

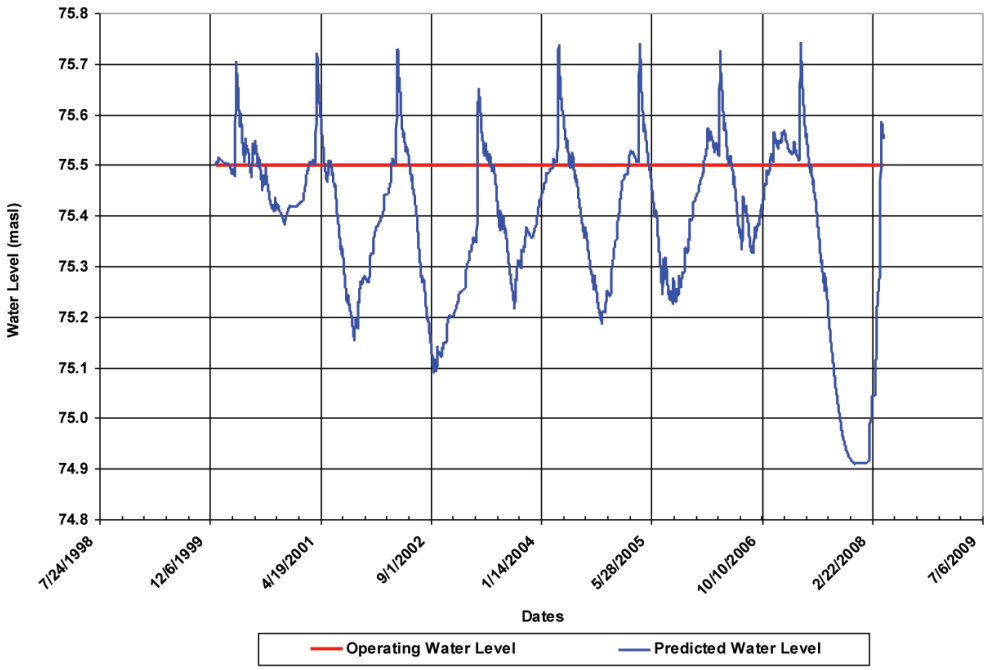
Existing ecological conditions were recognized and desired ecological design concepts were used to develop the proposed design. Both invasive species and water quality were identified as key concerns during initial phases of the project. To exclude carp and to regulate water quality within the wetland, the wetland was isolated from Red Hill Creek by the construction of an earth dyke. Using additional dykes, the wetland was separated into three zones of different water depths to create habitat for a diverse range of vegetation and wildlife species. Final elevations of each zone were determined using an iterative process, with the goal of achieving a cut/fill balance across the site.

During the design phase, it was expected that there would be a small surplus of material, requiring disposal off-site. However, efficiencies realized during construction resulted in a net shortfall of material, requiring import of additional fill which was used to assist in capping the sediment, resulting in a net decreased cost to the project. The project team decided that the additional fill could be used to divide the area to be capped through the construction of internal access routes. This situation allowed for the use of additional capping techniques and reduced potential schedule risk to the project.

Water Balance

Water levels in the pre-construction Basin were governed by both Red Hill Creek and Lake Ontario water levels; however, in the post-construction condition, the Basin is isolated from these water sources by a new semi-impermeable dyke. As it was desired to promote fish passage into and out of the wetland through a fishway structure during the spring months, a water balance model was developed to predict long-term water levels. The goal of the water balance exercise was to maintain operation of the fishway during the warmwater fisheries window of April 1 to June 30 of each year in order to allow for potential movement of warmwater species into the wetland. The daily water balance included potential water inputs from precipitation and pumping, and losses such as discharge through the fishway and evapotranspiration from the wetland. Several model runs were completed using different operating rules and configurations before the final water levels and v-notch weirs were determined.

Typical engineering procedure would have been to develop a water level management strategy where water levels are maintained at a relatively constant elevation from year to year, preferably through an automated control system. While this approach would have been easier to implement and require less human input for long-term operations, it would not be beneficial to the long-term wetland ecosystem. Having a consistent water level regime typically results in the development of a low-diversity wetland, which is not in line with the Remedial Action Plan. Therefore, completion of the water balance model was innovative as it considered that a fluctuating water level from year to year was desirable, within certain limits. This strategy was consistent with the long-term adaptive management approach proposed for the project.



COMPLEXITY

Materials

Design and construction of the project was challenging due to large volumes of material and difficult geotechnical conditions in the Basin. The cap and dykes were constructed using over 628,000 tonnes of clay fill, which was required to meet stringent guidelines for unconfined lake fill material.

Once the proper material was selected, construction of the project was challenging itself. The existing sediments in the Basin are saturated, soft, and not capable of supporting loads, which created challenges in dyke construction and the handling and placement of the cap.

Dykes were constructed by advancing clay material using bulldozers, excavators and trucks. In most areas, imported and compacted clay material would displace the in-situ soft sediments. However, geotechnical investigations undertaken during the design phase indicated that significant depths of peat material were present in some areas where new dykes were proposed. The geotechnical behaviour of peat is highly unpredictable, but it was expected that peat would not displace, but would slowly compress over time. It was anticipated that dykes built over significant depths of peat would experience long-term settlement, and therefore peat was dredged in advance of dyke construction for areas where settlement could not be tolerated, or where settlement was expected to be excessive.

The large area of sediment to be capped was divided into smaller areas through the advancement of internal dykes composed of shale, ideally spaced so that long-reach excavators could place material in between the dykes. Compounding the problem of capping the sediments was the unseasonably warm winter of 2012. The original plan to cap the sediments was to place the capping material over frozen sediments; however, insufficient frost was generated and the cap could not be placed in the winter of 2012. Instead, a series of capping trials were completed, where different capping methodologies were attempted. It was found that the use of a layer of woven geotextile directly over the sediments worked most effectively for maintaining the cap. Where access onto the cap was required, bi-axial geogrid was used to provide additional strength. By use of these innovative methods, the cap was successfully completed in the spring/summer conditions, which allowed the project to be completed on schedule.

COMPLEXITY CONT'D

Schedule

A construction completion deadline of September 2012 was associated with Canadian Strategic Infrastructure Funding. The project schedule was highly constrained by various environmental and weather related factors, including fisheries timing windows, migratory bird breeding seasons and management of dewatering schedules to minimize disruption to amphibians.

The City, Cole Engineering and the Contractor worked together to develop a rigorous construction schedule. The schedule was a living document, and was updated monthly during construction. Detailed two-week 'look ahead' schedules were also maintained in order to efficiently schedule site personnel. As potential delays were encountered, they were flagged immediately to the project team and resolved quickly to minimize schedule disruptions.

SOCIAL AND ECONOMIC BENEFITS

Based on the remedial works and habitat enhancements, the Basin project provides substantial societal benefits to the City and its residents. Economic benefits will also be realized through providing additional tourism opportunities. Hamilton Harbour is a well known birding area, with the existing Basin being a prime location to observe a number of species. The enhanced Basin, with the new diversity of habitat conditions, will offer further opportunities to see an increased variety of birds and wildlife and will become a destination for bird watchers. While the wetland itself is not accessible by the public, an elevated viewing area was constructed on the east side of the Basin. This area is publicly accessible and offers excellent sight lines over the wetland. Interpretative signage, explaining the history of the site along with the recent enhancements, will be installed at the viewing area. The project will assist in creating a natural eastern gateway to the City and a significant positive public profile will be generated through the project.

Construction of the Basin enhancement provides economic benefit to the City by allowing an ongoing dredging program with a manageable cost, in comparison to dredging the entire Basin. The capital cost to remove the accumulated 270,000 m^3 of sediment accumulated in the Basin since 1990 conditions was estimated at $34 million. By enhancing the Basin with a capital cost of $18 million, the City saved $16 million in capital costs.

In terms of long-term costs, the estimated net present value of periodically dredging the Basin was $59.4 to $79.4 million over 50 years. This estimate is significantly higher than the net present value of enhancing the Basin and dredging at Pier 25, which is estimated between $19.1 and $40.3 million over 50 years.

Habitat Improvements

The local environment has been drastically improved over the previous conditions by restoring approximately 15.4 ha of the Basin property. The project provided the opportunity to re-create an 11 ha historic Great Lakes coastal wetland area to counter-balance the loss of natural wetlands in southern Ontario. The new wetland is sustainable with only native plantings and minimal operational requirements.

The first step to improving to the local environment was to improve the water and sediment quality by isolating the Basin from the Parkdale Combined Sewer Outfall (CSO) and Red Hill Creek, both sources of high levels of nutrients and contaminants. This was completed through the construction of new dykes made of material meeting MOE's guidelines for unconfined lake fill. Impacted sediments were then moved around the Basin to desired grades. Both hydraulic and mechanical dredging was utilized depending on site conditions.

As recommended by the human health and ecological risk assessments conducted as part of the project, construction included capping of existing exposed contaminated sediment with 0.5 m thick clean fill. Once capped, the wetland could be restored and enhanced. Key features of the natural environment design included;

- Development of three (3) distinct wetland zones that created a wide variety of wetland communities suited to each zone's water depth;
- Planting a variety of native upland, emergent and submergent species, including big bluestem, little bluestem, sweet flag, softstem bulrush, water lilies, and tape-grass;
- Protection of the active Common Tern colony and enhancement of additional tern habitat;
- Installation of terrestrial and aquatic habitat structures to promote usage of the Basin by desirable wildlife;
- Installation of a fishway structure to provide access to the wetland during the majority of the warm-water timing window for desirable fish species such as northern pike, large mouth bass, and white sucker, while excluding Common Carp;
- Protection of wetland water quality by isolating the wetland from the Parkdale CSO and Red Hill Creek; and,
- Utilization of a new pump chamber to augment water levels in the wetland in order to assist in promotion of desirable wetland communities and fish accessibility.

Final substrate grading and isolation dykes were designed to create and sustain a unique range in depth of standing water within each zone. The variations in depth were created by a variable bottom elevation and not by water level control of each zone. The water elevation throughout the wetland is uniform. These factors allow unique vegetation communities to become established in each zone and attract potential wildlife including: Marsh breeding birds (e.g., Common Yellowthroat, Swamp Sparrow, rails, Red-winged Blackbird, Pied-billed Grebe, Marsh Wren, etc.), herons, wetland invertebrates, Muskrat, breeding amphibians, over–wintering amphibians, Turtles, and fish species. The improvement in habitat conditions will contribute to the delisting of Hamilton Harbour as an Area of Concern for the Great Lakes Water Quality Agreement.

MEETING CLIENTS NEEDS

The client's main goal for the project was to develop a restored site that would contribute to the delisting of Hamilton Harbour as an Area of Concern for the Great Lakes Water Quality Agreement, while minimizing both capital costs and ongoing costs related to meeting its dredging obligations to the Hamilton Port Authority. An additional need for the project was to meet deadlines associated with funding. The City had partnered with the Federal and Provincial Governments to provide funding for this project through the Canada Strategic Infrastructure Fund (CSIF) for improvements to assist in the cleanup of Hamilton Harbour in support of the Remedial Action Plan. According to the funding agreement, the project had to be substantially performed by September 2012.

Due to the nature and complexity of the project, diligent coordination with the Department of Fisheries and Oceans, Transport Canada, Hamilton Region Conservation Authority, Ministry of Environment, Electrical Safety Authority and Horizon Utilities were required to expedite the construction process. Most agencies were involved during the environmental assessment phase, and all agencies were supportive of this project, which assisted in acquiring quick approvals. The following approvals were acquired in support of the project:

- Fisheries Act Authorization;
- Navigable Waters Protection Act Permit;
- Hamilton Region Conservation Authority, O.Reg. 161/06 under O.Reg. 97/04;
- Permit to Take Water; and,
- Electrical Safety Authority.

The project was successfully delivered on time and under budget and achieved the client's goals. The project represented a cost savings for the City of Hamilton in terms of meeting its agreement with the HPA. The capital cost for the City to dredge the Basin to its 1990 conditions was estimated at $34 million. By restoring a Great Lakes coastal wetland at a capital cost of $18 million, the City realized a significant capital cost savings of approximately $16 million along with achieving a design that permitted more efficient dredging operations downstream of the Basin. Environmental enhancements, such as Common Tern nesting islands, native plantings and fish passage structure, will contribute to meeting the goals of the Hamilton Harbour Remedial Action Plan, and assist in the future delisting of Hamilton Harbour as an Area of Concern under the Great Lakes Water Quality Agreement.