AECOM

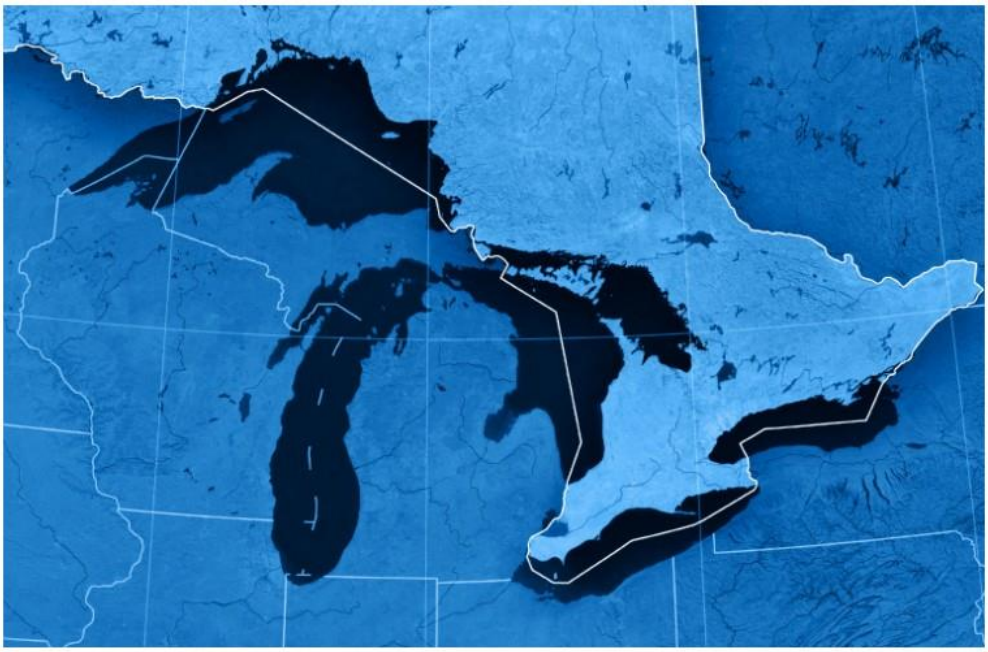
Prepared for:
Georgian Bay Forever

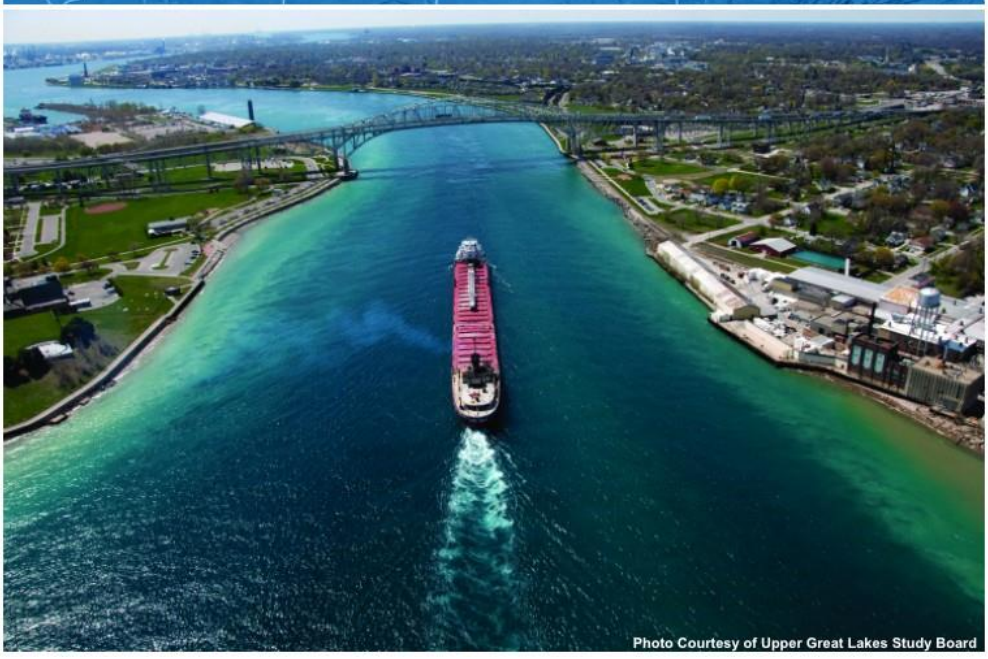
Prepared by:
AECOM Technical Services, Inc.
June 3, 2016

Providing Structural Solutions for Adaptive Management in the Great Lakes

Creating Climate Resilience

Executive Summary





Managing Water Levels in the Great Lakes: The Search for New Solutions

Study Background:

Georgian Bay Forever (GBF), a nonprofit organization dedicated to scientific research and public education, has had a long-standing concern over the adverse impacts of pronounced water level fluctuations on Georgian Bay, Lake Huron and, more generally, the Great Lakes-St. Lawrence River System. An economic impact assessment released in 2014 by The Council of the Great Lakes Region, for example, found that plausible future declining water levels in the system will result in $18.82B in economic loss over the next 35 years if structural interventions do not take place.

Building on that work, GBF commissioned an internationally recognized water resources planning and engineering consultancy, AECOM Technical Services, Inc. (AECOM) to prepare a study to "provide viable structural options for the long-term climate resilient protection of water levels in the upper Great Lakes." The study addressed an unmet need acknowledged by the International Joint Commission (IJC) when releasing the 2012 International Upper Great Lakes Study (IUGLS): the need for a detailed examination of additional lake level control structures.

Study Process:

The study entailed the examination of over a dozen structural alternatives for lake level control within the Great Lakes-St. Lawrence River System. The alternatives are categorized as: *Compensatory Structures* (i.e., submerged sills, weirs, jetties, river training walls, wing dikes); *Power Generating Structures* (i.e., conventional hydroelectric dams, In-stream turbines); *Adaptive Management Structures* (i.e., inflatable flap gates, inflatable dams, control/sector gates); and *"Other" Structures* (i.e., ice booms, landfill and control gate structures). They include well-established, extensively researched structures, emerging technologies, and new ideas developed specifically to address lake level controls within the Great Lakes-St. Lawrence River System.

These various alternatives were examined in light of existing data and information, and subsequently evaluated on the basis of seven criteria that include performance, implementation feasibility, cost, regulatory requirements, climate resiliency, environmental impacts, and social/cultural considerations. The evaluation culminated in the selection of three alternatives for additional analysis and "concept level" development. These included:

- **In-stream Turbines** to be installed on the river bed of the Upper St. Clair River by the Blue Water Bridge, as well as upstream of the St. Mary's River Compensation Works. By reducing river flow when in operating mode, the turbines impact river hydrodynamics, increasing water levels upstream and decreasing levels downstream, as needs dictate. Power generation is a significant ancillary benefit.

- **Inflatable Dams** to be installed in the St. Clair River at Stag and/or Fawn Islands. When the inflated dams are operational, river flow is reduced with a resultant increase in upstream water levels. During higher than desired levels, the dams are deflated to allow for increased river flow.

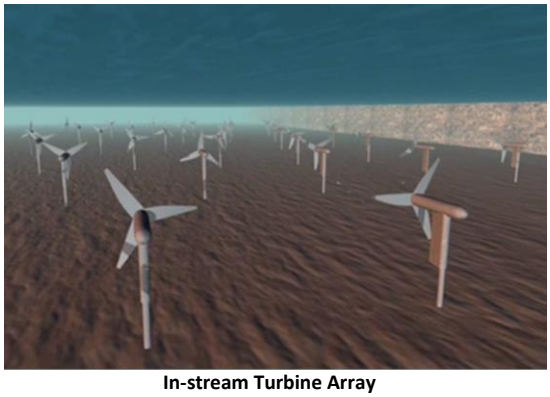
- **A Park Fill/Control Gates System** to be constructed at the mouth of St. Clair River. The proposed structure is composed of two new islands (involving stone revetment, sand fill, topsoil and landscaping) and two flood control gates that will be adjusted, as needed, to reduce river flow and increase upstream water levels. The gates can be opened to allow for increased river flow when water levels are higher than desired. An important ancillary benefit is the creation of a park offering the public many opportunities for water-based recreational activities.

The analysis of these alternatives was complemented by conversations with various interested parties to gain perspectives on the notion of additional structural controls for Georgian Bay and Lake Huron.

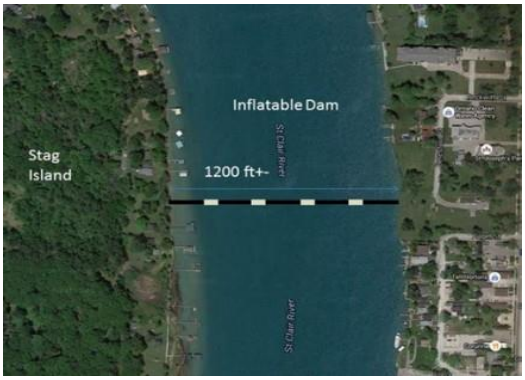
Study Outcome:

Based on previous modeling work, evaluation outcomes and "concept level" analyses, it was found that these three structural alternatives (In-stream Turbines, Inflatable Dams, Park Fill and Control Gate System) have potential merit as additional lake level control mechanisms. Their individual benefits are substantial and, if implemented collectively, will be even more pronounced. Singly or in combination, they address the GBF goal for the "long-term climate resilient protection of the water levels of the upper Great Lakes." For example:

Deploying an array of large **In-stream Turbines** (56 in total) in the St. Clair River near the Blue Water Bridge will raise water levels by as much as 9 cm (3.5 inches) under average flow conditions, according to a study by the National Research Council (2001). If the number of turbines totaled 151 in that general location, upstream water levels will increase by 19 cm (7.5 in). Power production is estimated at 1.3 MW for the former and 2.5 MW for the latter. Additionally, an in-stream turbine array upstream of the St. Mary's River Compensation Works would complement the St. Clair River array in terms of both lake level control capability and power generation capacity. This emerging technology has been applied in multiple locations in the United States and overseas. Primary applications to date are for "clean" power generation, but modeling exercises have also demonstrated applicability for water level control purposes.



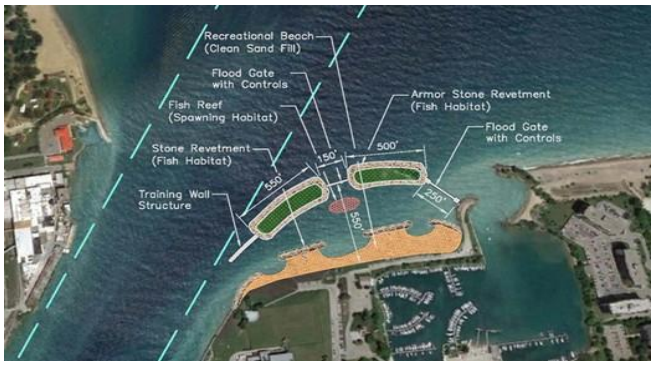
In-stream Turbine Array
(courtesy Verdant Technologies)



Inflatable Dam - Stag Island, St. Clair River
(aerial courtesy Google Maps)

Installing **Inflatable Dams** at Stag and Fawn Islands in the St. Clair River will raise upstream water levels by an estimated 21 cm (8.3 in). This increasingly popular semi- adjustable technology has been successfully installed in multiple states as well as overseas. Composed of a highly durable membrane and permanent sill, this structure is known to perform well in extreme weather conditions. It features automated control system technology as well as remote monitoring and controls to facilitate inflation/ deflation according to water level variations.

Constructing a **Park Fill and Control Gate System** at the mouth of the St. Clair River would raise upstream water levels by as much as 19 cm (7.5 in). This alternative has additional benefits, as it entails the construction of two islands that also provide upland habitat, fish spawning structure and water-based recreational opportunities. Control gates are readily adjustable based upon water level variations.



Park Fill and Control Gate System- Mouth of St. Clair River (aerial courtesy Google Maps)

Individually and collectively, these structural alternatives have the potential to provide significant relief to pronounced fluctuations in water levels. They are proven technologies readily adaptable to changing conditions: each can be quickly activated or de-activated based upon current and anticipated water levels.

Next Steps:

All three of these structural alternatives have significant strengths: they are proven technologies in freshwater systems, are adaptable to changing climate and water level conditions and, compared to other alternatives investigated, have favourable environmental and socio-economic characteristics.

Although these technologies are promising, they have only been examined at the conceptual level based on existing data and information. Data gaps and information needs must be fully addressed to ascertain, in detail, their potential applicability to the Great Lakes. This includes additional research and modeling to determine, with a degree of precision, factors such as their individual and collective water level control capabilities, desired engineering and design features, installation and operational costs, regulatory considerations, and perspectives of affected parties.

Recommendation:

It is recommended that the International Joint Commission and the two federal governments support detailed design work on these alternatives to better understand their potential to augment existing lake level control plans, procedures and structures.

For Further Information:
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