March 21, 2005

Contextual Narrative

Environmental Technical Working Group (ETWG)

1. General Socioeconomic Context

(a) *Production value of the interest:*

Economic value is difficult to determine for environmental conditions, although social value may be evaluated in a qualitative sense. Replacement cost for loss of a resource (e.g., rebuilding a wetland), or possibly estimated impacts on ecotourism (including sport fishing) might be used to provide some idea of costs associated with ecosystem changes, but economic costs cannot account for impacts associated with loss of diversity or reduction in numbers of certain species, or other factors that might affect ecosystem health. Although difficult to quantify specifically for the Lake Ontario-St. Lawrence system, nationwide surveys have demonstrated strong support for a healthy and diverse environment, and the natural resources of the Great Lakes serve as a magnet for tourism in both the U.S. and Canada (NYSG 2004).

Coastal ecosystems offer diverse habitats that support a myriad of plant, fish, and wildlife species. The economy of many coastal areas is dependent on the recreational value of these habitats and the sport fishing, commercial fishing, hunting, bird-watching, and swimming and hiking activities associated with them. Expenditures by large numbers of seasonal tourists on lodging, food, sporting goods, boat and vehicle rentals, gasoline, and personal items often represent the major source of income to coastal communities. The ecosystems that supply the fish, wildlife, and recreational facilities underlying that economy have been severely impacted by many human actions. Conversion of diverse wetland habitats to vast stands of cattails clearly represents one of the greatest impacts to the Lake Ontario coastal ecosystem and has been shown to be a direct response to water-level regulation.

Societal value also is expressed through laws protecting habitat (i.e., wetlands) and specific faunal species (special interest or endangered species). The ETWG assessment of the ecosystem response to alternative plans is built on the evaluation of key indicators of overall ecosystem diversity, productivity, and sustainability (see below). Of course, species of special concern also provide thresholds beyond which regulation cannot go.

(b) *Number of stakeholders:*

Potential stakeholders include over seven million people living in the Lake Ontario basin, as well as the over four million people living in the Montréal – Quebec areas. In addition, there is a large sport fishing industry involving people traveling from outside the area.

(c) *Organizational characteristics:*

Stakeholders are relatively unevenly distributed around the shorelines of the lake and river, with several large population centers (Toronto, Montreal, Quebec City, Rochester) and a number of smaller communities. For example, the majority of the Canadian population, about 60%, is concentrated within a thin belt of land representing 2.2% of the total land between Windsor, Ontario and Quebec City. The population density in 1996 along the Canadian portion of the lower St. Lawrence River ranges from 10 persons per km^2 in the most natural areas to more than

3,800 persons per km² in the major cities (Toronto and Montréal). Much of the area bordering the water is low density residential, agricultural or natural preserve. In addition to several government agencies and departments (e.g., Department of Environmental Conservation, Environmental Protection Agency, Environment Canada), there are a number of environmentally oriented groups active in the area, including The Nature Conservancy, Ducks Unlimited, Trout Unlimited, Nature Conservancy of Canada, ZPI (Zones of Primary Intervention), Quebec Society for Wetland Conservation, Quebec Wildlife Federation, Save the River, the Thousand Islands Land Trust and other land trusts in the coastal zone of both countries, Federation of Ontario Naturalists, the charter boat sport fishing industry, and the Audubon Society. The Mohawk/St. Regis tribes also constitute a significant interest group on the upper St. Lawrence River.

(d) *Societal Values and perceptions of the environment:*

Environmental value is associated with shoreline properties, accessible and usable beaches, attractive wetlands and the fauna that they support. Many people may not fully understand the role that natural fluctuations play in determining supplies, and this may complicate the public perception of benefits and costs associated with a particular regulation plan.
The economic importance of many fish, wildfowl and furbearing animals has long been recorded and is still important. However, the perception of 'environment' is variable depending on ones ties to the watershed (i.e., by membership in naturalist groups, as an avid angler, commercial fisher, boater, one who reads about nature, etc.). First Nation and tribal peoples have historical or traditional values and perceptions about the environment that transcend economic value, although this is not to say they do not benefit economically from the environment, as they do fish in the St. Lawrence River, Lake St. Francis and Lake Ontario.

Associating an economic value to maintaining ones values or perceptions of the watershed is, therefore, a difficult task. The concept of value holds, but obviously values vary, for both US and Canadian citizens, as well as aboriginal peoples.

(e) *Significant statutory, regulatory and policy restrictions:*

There are 84 species of plants and animals in the Lake Ontario/Upper St. Lawrence coastal zone that are sensitive to water level fluctuations and are being tracked as species of concern by the Natural Heritage Program in New York and the Natural Heritage Information Centre in Ontario. Thirty of these species are officially designated by state, provincial, or federal authority as threatened or endangered. In the U.S., the barrier beach ecosystem of eastern Lake Ontario has been designated by the U.S. Fish and Wildlife Service as critical recovery habitat for the endangered piping plover (*Charadrius melodus*). In the lower St. Lawrence River (Québec section) there are 13 special concern, vulnerable, threatened and/or endangered species impacted by water level regulation (based on the Centre de Données sur le Patrimoine Naturel du Québec - CDPNQ), that are protected under federal or provincial laws. The Species at Risk Act (Bill C-5) is the federal legislation while the *Loi sur les espèces menacées et vulnérables* and the *Loi sur la conservation et la mise en valeur de la faune* are the provincial legislations. Laws and regulations protecting special interest species are likely to change over time, and any actions that might affect these species must be evaluated within those laws. In addition, species such as the muskrat have special significance to certain segments of the population and have taken on special

importance even though specific laws protecting them are limited to harvesting seasons. It should be noted that the IJC is not obligated to follow or abide by the laws and regulations that protect species; however, it is probably in the Commission's best interest to consider them and the impacts to species-at-risk when choosing a water level regulation plan.
Regulations protecting species or even simply the passage of fish (see section 35 Fisheries Act, Canada) may influence watershed management, as well as court decisions about aboriginal treaty rights and jurisdiction or territory.

(f) *History of environmental interest:*

Much information is available on this subject, some alluded to in responses to other questions here, but it is impractical to cover such a history in this document.

(g) *Trade flows and current market conditions:*
(This is not relevant for ETWG.)

(h) *Effect on the environment, or ecosystem during the last high or low water conditions:*

These high and low water conditions represent natural events and are important factors in maintaining wetland and biological diversity over the long term (Wilcox 1989, 1990, 1993; Wilcox et al. 1992, 1993; Wilcox and Meeker 1995).

Intensive plant community surveys within coastal wetlands representative of the study area confirm previous conclusions that the distribution of plant communities in Lake Ontario – Upper St. Lawrence River coastal wetlands is highly correlated to water-level history (Wilcox et al. 1992). The wetland plant community type observed at specific elevations was consistent among sites within and across the wetland geomorphic types. Analyses of historic aerial photographs also confirm that plant communities have responded to interannual water-level cycles, with communities shifting up- and down-slope, based upon hydrologic preferences, during high and low water-level cycles, respectively.

2. Performance Indicators

The table on the following three pages summarizes the "key" performance indicators (PIs), as well as their significance, uncertainty and sensitivity (to water level and flow regulation). This list has been distilled from an original list of over 400 PIs proposed. The process of reducing the larger list to the key PI list involved eliminating certain PIs that were determined to be either too uncertain or to be insensitive to water level variations, and grouping PIs that behaved similarly in response to water level. Thus, one key PI may in fact represent the response of many other PIs from the original list. The importance of a particular key PI in the final evaluation will depend in part on the number of other PIs it is representing. In general, the wetland vegetation PI is most closely linked to water levels and there is strong substantiation for it based on study design. Other of the key PIs also are sensitive to water levels or flows directly, or are linked to water levels through habitat responses correlated with the wetland PI. The high sensitivity indices in the table should be noted, as indication of the relative role water levels and flows have in controlling these PI responses.

ETWG Key PIs

Lake Ontario / Upper St. Lawrence River

Region	PI Group	PI Description	PI Units	Researchers	Significance	Uncertainty	Sensitivity
Lake Ontario	Vegetation	Wetland Meadow Marsh Community - total surface area, supply-based (Lake Ontario)	ha	Wilcox, Ingram	5	5	5
Lake Ontario	Fish	Low Veg 18C - spawning habitat supply (Lake Ontario)	ha-days	Minns, Doka, Chu, Bakelaar, Leisti	2	3	4
Lake Ontario	Fish	High Veg 24C - spawning habitat supply (Lake Ontario)	ha-days	Minns, Doka, Chu, Bakelaar, Leisti	3	3	4
Lake Ontario	Fish	Low Veg 24C - spawning habitat supply (Lake Ontario)	ha-days	Minns, Doka, Chu, Bakelaar, Leisti	2	3	4
Lake Ontario	Fish	Northern Pike - YOY recruitment index (Lake Ontario)	index	Minns, Doka	3	4	5
Lake Ontario	Fish	Largemouth Bass - YOY recruitment index (Lake Ontario)	index	Minns, Doka	3	4	4
Lake Ontario	Birds	Virginia Rail (RALI) - median reproductive index (Lake Ontario)	index	DesGranges, Ingram, Drolet	4	4	5
Lake Ontario	Species-at-Risk	Least Bittern (IXEX) - median reproductive index (Lake Ontario)	index	DesGranges, Ingram, Drolet	5	2	5
Lake Ontario	Species-at-Risk	Black Tern (CHNI) - median reproductive index (Lake Ontario)	index	DesGranges, Ingram, Drolet	5	3	5
Lake Ontario	Species-at-Risk	Yellow Rail (CONO) - preferred breeding habitat coverage (Lake Ontario)	ha	Lantry, Schiavone	2	2	5
Lake Ontario	Species-at-Risk	King Rail (RAEL) - preferred breeding habitat coverage (Lake Ontario)	ha	Lantry, Schiavone	2	2	5

Upper SL River	Fish	Low Veg 18C - spawning habitat supply (Upper St. Lawrence)	ha-days	Minns, Doka, Chu, Bakelaar, Leisti	2	3	4
Upper SL River	Fish	High Veg 24C - spawning habitat supply (Upper St. Lawrence)	ha-days	Minns, Doka, Chu, Bakelaar, Leisti	3	3	4
Upper SL River	Fish	Low Veg 24C - spawning habitat supply (Upper St. Lawrence)	ha-days	Minns, Doka, Chu, Bakelaar, Leisti	2	3	4
Upper SL River	Fish	Northern Pike - YOY recruitment index (USL)	index	Minns, Doka	3	4	5
Upper SL River	Fish	Largemouth Bass - YOY recruitment index (USL)	index	Minns, Doka	3	4	4
Upper SL River	Fish	Northern Pike - YOY net productivity (USL - Thousand Islands)	grams (wet wt.)/ha	Farrell	2	4	5
Upper SL River	Birds	Virginia Rail (RALI) - median reproductive index (Lake St. Lawrence)	index	DesGranges, Ingram, Drolet	3	3	5
Upper SL River	Mammals	Muskrat (ONZI) - house density in drowned river mouth wetlands (Thousand Islands area)	#/ha	Farrell, Toner	4	4	5

Lower St. Lawrence River

Region	PI Group	PI Description	PI Units	Researchers	Sig	Uncert	Sens
Lower SL River	Fish	Golden Shiner (NOCR) - suitable feeding habitat surface area (Lake St. Louis to Trois-Rivières)	ha	Mingelbier, Morin	4	4	5
Lower SL River	Fish	Wetlands fish - abundance index (Lower St. Lawrence)	index	de Lafontaine, Marchand	2	4	5
Lower SL River	Fish	Northern Pike (ESLU) - suitable reproductive habitat surface area (Lake St. Louis to Trois-Rivières)	ha	Mingelbier, Morin	3	4	5

Lower SL River	Birds	Migratory wildfowl - floodplain habitat surface area (Lake St. Louis to to Trois-Rivières)	ha	Lehoux, Dauphin, Champoux, Morin	3	4	5
Lower SL River	Birds	Virginia Rail (RALI) - reproductive index (Lake St. Louis to Trois-Rivières)	index	DesGranges, Ingram, Drolet	4	4	5
Lower SL River	Birds	Migratory wildfowl - productivity (Lake St. Louis to to Trois-Rivières)	# juveniles	Lehoux	3	4	5
Lower SL River	Birds	Black Tern (CHNI) - reproductive index (Lake St. Louis to Trois-Rivières)	index	DesGranges, Ingram, Drolet	5	4	5
Lower SL River	Herptiles	Frog sp. - reproductive habitat surface area (Lake St. Louis to Trois-Rivières)	ha	Armellin, Champoux, Morin, Rioux	3	2	5
Lower SL River	Mammals	Muskrat (ONZI) - surviving houses (Lake St. Louis to Trois-Rivières)	# of houses	Ouellet, Morin	4	2	5
Lower SL River	Species-at-Risk	Least Bittern (IXEX) - reproductive index (Lake St. Louis to Trois-Rivières)	index	DesGranges, Ingram, Drolet	5	2	5
Lower SL River	Species-at-Risk	Eastern Sand Darter (AMPE) - reproductive habitat surface area (Lake St. Louis to Trois-Rivières)	ha	Giguère, Laporte, Morin	4	1	5
Lower SL River	Species-at-Risk	Spiny Softshell Turtle (APSP) - reproductive habitat surface area (Lake St. Louis to Trois-Rivières)	ha	Giguère, Laporte, Morin	4	2	5
Lower SL River	Species-at-Risk	Bridle Shiner (NOBI) - reproductive habitat surface area (Lake St. Louis to Trois-Rivières)	ha	Giguère, Laporte, Morin	4	2	5

3. Potentially Significant Benefit Categories not Addressed by the Current Performance Indicators (secondary impacts)

Secondary impacts on ecotourism, including such activities as bird-watching, fishing and hunting, are not directly incorporated in the current PIs (also see response to 1a above).

4. Key Baseline Conditions

Identify any socio-economic conditions for the environment that if altered, could impact our analysis of regulation plans

In terms of general ecosystem response, the main baseline condition is the pre-regulation, or "natural" state, which represents the best condition for the ecosystem (see also response for #5 Key Trends). The other baseline used by ETWG for comparison purposes is the current regulation plan, which is considered a reference condition against which changes in PIs for alternative plans are to be evaluated. The main goal of the ETWG is to determine a regulation plan that improves ecosystem response, relative to the current plan, and at worst causes no degradation of environmental response. The main tool used to assess different plans within the ETWG is the Integrated Ecological Response Model (IERM), which is designed to facilitate comparisons between plans.

5. Key Trends

Looking back 10 – 15 years and using a 5 – 10 year horizon, identify possible trends in baseline conditions

Possible changes in temperature and/or climate in general, and water supply specifically, would affect the environmental response. In addition, issues such as invasive species, changes in fisheries management, pollution and population changes (in numbers and/or distribution), or changes in use of the resource may also impact the environment. Thirty-year cycles in water levels, embedded within 150-year cycles, have been documented for Lake Michigan by Baedke and Thompson (2000), and 15-30 year cycles can be seen in the hydrographs for all the lakes, including Lake Ontario prior to regulation. Thus, the baseline condition is not static, rather, it is controlled by the natural cycles of variation. If "baseline" is taken to mean pre-project conditions, then it should be recognized that Plan 58D was implemented at a time of low supplies, which then rose over the following three decades to historic highs. These natural variations in supply are difficult to predict, though they obviously have impact on the environmental response. It might also be noted that various climate change scenarios predict generally drier conditions, with corresponding lower supplies. The IERM is not designed as a full ecosystem response model, since it does not take into account the above issues that certainly affect the ecology of the system. In keeping with the constraints of the present study, the IERM (and the PIs defined by ETWG researchers) focuses on those changes to the ecosystem that are related to water level and flow variations.

6. Expected Consequences of Changes

Based on key baseline conditions and trends, summarize the expected consequences of these changes in terms of: (*i*) *adoption of substitute goods and services and averting behavior change*;

(*ii*) *winners/losers from changes, including regional distribution; an*d (*iii*) *sensitivity of the environment to changes and ability to adapt to changes through mitigation*
The worst consequence would be the elimination of a species, particularly one that might be endangered or of special interest. In Canada there is a "no net loss" principal for wetlands (and fish habitat in general), so any deliberate change in water regulation would have to consider possible mitigation actions, such as wetland or shoreline habitat restoration. In general, changes in water regulation are expected to have an impact on distribution and abundance of different wetland types, thus affecting habitat suitability and eventually the populations of different indicator species.
Study results indicate that moderation of water-level fluctuations under water regulation has significantly restricted the long-term hydrologic environment important to the maintenance of coastal wetland meadow marsh communities. Moderation of long-term water-level fluctuations also has created hydrologic conditions that have supported the expansion of aggressive, dominant emergent and submergent plant species, resulting in a reduction of plant species richness and emergent marsh habitat quality. It is likely that the reduction in habitat quality also has been influenced and magnified in wetlands that have been impacted by increased nutrient and sediment inputs due to surrounding land uses. However, intensive surveys and historic aerial photo evaluations provide very similar results across all of the study sites, including sites with largely natural (forested) watersheds. The consistency in study results support the conclusion that water-level moderation due to water regulation is having a major impact on coastal wetland habitat quality.

7. Adaptive Behaviors

The adaptive behaviors underlying a performance indicator should be described. The description of adaptive behaviors should provide insight as to why a particular adaptive behavior was chosen from among alternative possible behaviors. What is the likely adaptive behavior of the recreational boating sector to an extended low water period? How likely is it that the sector will adapt?
"Adaptive behaviors" as defined here is not relevant for ETWG, since it is the ecosystem that will change in response to changes in water levels and flows. Such behavior is already incorporated in PI responses in the IERM.

8. Risk Assessment/Sensitivity Analysis

Identify the likelihood of a major shift in the sector any thresholds that if crossed could result in a major dislocation of environmental interests; characterize the confidence associated with the baseline conditions, trends and risk assessment
Information serving as the basis for the IERM and SVM algorithms used to assess the environmental response to hydrologic change has been gathered largely through field studies and literature reviews. The field studies have a duration of two or three years at most, although several studies were designed to evaluate the response to lake-level changes dating to pre-regulation, and there is uncertainty in extrapolating the environmental response to a 50 or 100 year hydrologic sequence. In addition, the environmental response is sensitive to longer term sequences in the hydrologic record (i.e., not just what is happening in one particular year or season), and those kinds of relationships are more difficult to incorporate into the SVM

framework. As previously mentioned, the current evaluation framework does not account for factors external to the study, such as changes in water quality, global warming, invasive species, land use, fisheries management practices, etc, that might impact the environment. Recognizing that uncertainty about outcomes is a constant feature of the management of complex and dynamic ecosystems such as Lake Ontario/St. Lawrence, and also that the mathematical relationships used by the IERM and SVM to predict outcomes are hypotheses based on a limited period (several years) of research, it has been proposed that a new management plan be adaptive in its implementation. Such an adaptive management approach brings a systematic process for continually improving management – for all the interests – by learning from the outcomes of operational actions.
Extensive evaluations of sensitivity of PIs to water level and flow regulation have been carried out, and results are summarized in the key PI table above. As previously noted, one of the criteria used to determine the key PI list was sensitivity, and although many of the initially defined PIs were not as sensitive, all the key PIs have a sensitivity ranking of 4 or 5 (on a 5 point scale). Details of these rankings may be found in the individual PI descriptions included in the IERM documentation (LTI 2005).

9. Sources

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10. Review Process

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