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EXPERTS WORKSHOP SUMMARY PAPER

**Ecological Impacts of Water Withdrawals in the Great Lakes-St. Lawrence System
November 13-14, 2001
Ann Arbor, Michigan**

Draft

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I. PREFACE

This document presents the summary proceedings of an Experts' Workshop on Ecological Impacts of Water Withdrawals in the Great Lakes-St. Lawrence River System (November 13-14, 2001 – Ann Arbor, Michigan). The workshop was sponsored by the Great Lakes Commission with support from the Great Lakes Protection Fund. The workshop was conducted as part of the Commission's ongoing project: *Development of a Water Resources Decision Support System for the Great Lakes/St. Lawrence system*.

These proceedings were prepared by Wendy M. Larson and Dr. Joseph V. DePinto of Limno-Tech, Inc. (LTI), and Dr. Michael J. Donahue of the Great Lakes Commission. The Commission (Dr. Donahue, Tom Crane, and Tom Rayburn) was also responsible for the overall design and conduct of the workshop, facilitation of workshop discussions and recording the opinions/observations of the invited experts. All workshop participants were present in their personal and professional capacities. The statements presented in the proceedings are those of the authors and contributors, and do not necessarily represent those of their agency, the Great Lakes Protection Fund, the Commission's International Study Team, or the Commission itself.

The main body of the proceedings consists of an introductory statement, background presentations including an initial list of "essential questions" for consideration by workshop participants, and a summary of the refinement of this list by workshop participants. The main body also includes information that was presented and discussed related to the incorporation of ecological impacts information into a decision support system.

The appendices include the workshop agenda, a list of participants, copies of workshop presentations, and background information including a summary of literature review on cumulative ecological impacts of water use and changes in levels and flows.

II. SUMMARY AND INTRODUCTION

Issues of water withdrawal, diversion and export are high on the agenda of public officials in the Great Lakes-St. Lawrence region. The region's governors and premiers, for example, are taking steps to establish a formal process by which such proposals can be reviewed and evaluated in a scientifically sound and rigorous manner. Toward this end, the Great Lakes Commission was asked to develop the framework for a state-of-the-art decision support system that will provide the data, information and process required to ensure timely and well informed public policy decisions concerning the use and management of ground and surface water. The Great Lakes Protection Fund is supporting this effort.

The primary objectives of the Experts' Workshop were to identify the types of "essential questions" that should be asked to evaluate the potential for ecological impacts for any given water withdrawal proposal, begin to develop an inventory of information on ecological impacts, and provide an opportunity for participants to raise issues and concerns related to this topic. Experts from a range of relevant disciplines were invited to serve on an Experts' Panel to address this objective. Panel members included individuals with expertise in fisheries biology, surface and groundwater hydrology, wetlands ecology, aquatic ecology, bird ecology, environmental engineering, and other disciplines. The Panel included workshop participants and others who were not able to attend the workshop but provided input before and after the workshop. Appendix A provides a list of the members on the Experts' Panel.

Panel members were invited to contribute to the development of an initial list of "essential questions" before the workshop. The initial list was then reviewed and refined by participants during the workshop. The outcome of the workshop was a list of "essential questions" as presented in Section IV.C of this summary paper. In addition, participants raised and discussed several other important scientific and policy-related questions related to the process of assessing ecological impacts of water withdrawals, as described in Section IV. While several issues were discussed, it was beyond the intent of the workshop to reach consensus or draw conclusions related to these issues. Rather, the workshop provided an opportunity for an "open airing" of issues and concerns related to this topic.

Workshop participants were first provided with relevant introductory information, including an overview of the Great Lakes Commission's Decision Support System project, and a definition of workshop objectives and format.

A. Project Overview: A Water Resources Decision Support System for the Great Lakes.

Tom Crane, Program Manager, Great Lakes Commission provided an overview of the Water Resources Management Decision Support System (WRMDSS) project. He explained how the WRMDSS project relates to Great Lakes water resource management activities, and described the five projects elements. A brief summary of the DSS project, which was distributed to invitees before the workshop, is attached as Appendix B. A copy of the project overview presentation is found in Appendix D.

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B. Workshop Objectives and Format: Ecological Impacts of Water Withdrawals.

Michael Donahue, President/CEO, Great Lakes Commission provided a brief description of the objectives and the structure for the workshop. Dr. Donahue described the objectives of the workshop as follows:

- Identify the types of questions that should be asked to evaluate the potential for ecological impacts for any given water withdrawal proposal;
- Begin to develop an inventory of information on ecological impacts; and
- Provide an opportunity for participants to raise issues and concerns related to this topic.

The charge presented to workshop participant was two-fold:

- Review and refine a listing of “essential questions” to assess ecological impacts; and
- Identify other tools (e.g., models, literature, related studies) that should be incorporated into a “decision support” system.

The workshop agenda, which describes the format for the workshop, is included as Appendix C.

III. BACKGROUND PRESENTATIONS

Session One focused on identifying the essential questions that must be asked to assess the ecological impacts of water withdrawals. Four presentations provided background information for workshop participants, as described below.

A. Literature Search Findings

Michel Slivitzky presented the findings of his literature search and analysis related to ecological impacts of current and prospective water use. He explained that most of the studies he reviewed have a site-specific, narrow focus, and he found that information related to Great Lakes systems is limited. Dr. Slivitzky also discussed challenges related to identifying significant ecological changes in the context of natural variability. The Executive Summary of the literature search report is attached as Appendix E. The full report is available on the Commission's web site at www.glc.org.

During the discussion of the literature search, it was noted that the document should be expanded to include the "grey literature", especially reports documenting reporting on case studies regarding the ecological impacts of water withdrawals.

B. Protection of Waters of the Great Lakes

Gerry Galloway, Secretary, U.S. Section, International Joint Commission (IJC) discussed the IJC's issues and concerns and ongoing activities related to protection of Great Lakes waters. The presentation described IJC recommendations related to water removals, including recommendations addressing data deficiencies. The presentation is found in Appendix D.

C. Lake Ontario-St. Lawrence River Criteria Review Study and Upper Great Lakes Plan of Study

Murray Clamen, Secretary, Canadian Section, IJC provided an overview of these studies, and highlighted the areas of overlap with the Commission's project. The presentation is found in Appendix D.

D. Canadian Water Use and Supply Project

Wendy Leger, Water Resource Project coordinator, Environment Canada provided an overview of the Canadian Water Use and Supply project, and discussed its relationship to the current effort. She described the project objectives and tasks, including an overview of the Ecosystem Requirements Work Group efforts as they relate to the workshop objectives. A copy of the presentation is attached as Appendix D. The full report of the April 2001 Workshop on Identifying Aquatic Ecosystem Indicators is included in Appendix F.

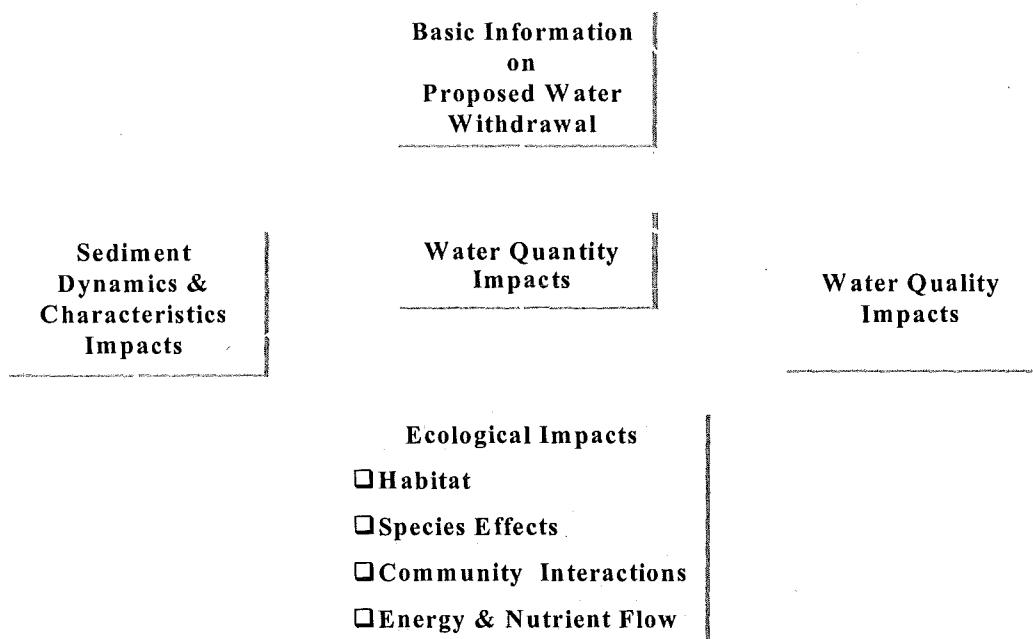
IV. IDENTIFICATION OF “ESSENTIAL QUESTIONS”

A. Draft List of “Essential Questions” for Consideration.

Joseph DePinto, Senior Scientist, Limno-Tech, Inc. provided some background information, including the following guidance on the essential questions:

- Questions will be focused on scientific issues and not on regulatory or socio-economic issues (although the final Decision Support System will do so);
- Questions may be posed to either regulated or regulator parties;
- Localized as well as regional and cumulative impacts should be considered;
- Human health impacts should be considered.

Dr. DePinto also presented the categories of water use and some relevant definitions. A proposed framework for assessment was also presented in the figure shown below:



Each box in the framework represents a category of essential questions, and the arrows indicate how these impacts interact.

Dr. DePinto then introduced an initial list of “essential questions” for consideration. He described how these questions were developed from experience and knowledge based on past studies (including literature review), and incorporated input solicited and received from invited experts before the workshop. He also explained that this initial list of questions was prepared for the workshop participants to react to and refine during the workshop. He pointed out that in developing this list, there was recognition that there are multiple levels of questions that relate to different levels of authority, and this list does not address all levels of detail. The full presentation, which includes the background material and the initial list of essential questions, is found in Appendix D.

B. Refinement of “Essential Questions”

The initial list of questions was refined by workshop participants during three sessions:

1. Break Out sessions;
2. Experts Roundtable; and
3. Open Discussion.

1. Summary Response to Key Questions in Break Out Sessions

A nominal group process was used during the breakout session group discussions. This process involved a silent generation of issues and ideas by each person, a round-robin recording of ideas, a serial discussion for clarification, a group ranking of priorities, and finally a group summary. This process is described in the Group Discussion Instructions, which are attached as Appendix G.

During the breakout sessions, workshop participants were asked to respond to two key questions:

- 1. From the previous presentation on key issue areas and critical questions to be asked to discern the ecological impacts of Great Lakes water withdrawals, what questions/information needs to be added, deleted or revised to make this list complete?**
- 2. In addition to the key questions and applicable computer models, what other tools, existing studies and other techniques might be useful to inform the process for evaluating ecological impacts associated with Great Lakes withdrawals?**

Responses to Question #1: From the previous presentation on key issue areas and critical questions to be asked to discern the ecological impacts of Great Lakes water withdrawals, what questions/information needs to be added, deleted or revised to make this list complete?

Responses to this question fell into 3 general categories:

1. Specific responses (refinement of specific questions, or additional essential questions);
2. Other scientific questions; and
3. Policy-related questions.

Specific responses have been incorporated into the refined list of essential questions, presented below in Section IV.C. The other scientific and policy issues and questions that were raised and discussed relate to the larger assessment process, and do not lend themselves to being incorporated into the refined list of questions. These issues were discussed during the workshop, but it was not the intent of the workshop to reach consensus on these issues, or draw conclusions. These issues and questions are summarized below.

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Summary of scientific issues:

How does one characterize the baseline ecological condition? Do current conditions define the baseline? How do existing criteria or indices relate to the baseline condition? What is the time scale (geological?) A consensus on the definition of Great Lakes ecology is needed.

How does one detect the *health and integrity* of an ecosystem that has already been compromised?

How is “*essential habitat*” (quality and quantity components) identified?

How does one quantify *ecologically significant change*, given natural variability (“stochastic nature of ecosystems”)? How does one identify and/or differentiate between human-related and natural-cyclic impacts and/or fluctuations?

Given *uncertainties* related to weather variability/climate change, is it possible to determine whether or not a use will affect the system? The degree of uncertainty will need to be stated.

How does one separate *cause-and-effect* related to water withdrawals, given other major changes that may be occurring?

How does one determine if a proposed action affects or limits the *functionality* of ecosystems?

How are *effects on ecosystem services* measured, and how does one determine which services are impacted?

How should essential questions address the question of how, where, and to what extent the project constitutes an *improvement* to the waters and water-dependent resources of the Great Lakes-St. Lawrence Basin? How does one measure “improvement”?

How does one actually measure changes? How are cumulative impacts measured? Will monitoring be required? What should be monitored? What are the requirements related to quality of information (QAQC, standardized, consistent protocols, etc.)

How much of a change is acceptable from a scientific perspective? How will the significance of effects be judged? Will we need to incorporate risk into the process.

How does one distinguish *habitat loss* from *habitat change*?

Effects on biodiversity should be accounted for in this framework...How?

Perhaps there is a need for a *process analogous to TMDLs* for each watershed, that includes allocations and accounts for future growth.

Summary of policy-related issues:

How much a change is acceptable from a policy perspective? How will the significance of effects be judged? Will need to incorporate risk in the process.

How does one understand and assess *cumulative impacts*, accounting for future uses and effects of features that modify the impacts? Should an adaptive resource management approach be employed given uncertainties?

Management objectives: In order for this process to work, it is essential to first determine what it is you are trying to protect, and what are your objectives.

How will the definition of *public lands* change with lower water levels?

How will *conservation measures* be taken into consideration?

Navigational dredging can lower water levels, and therefore should be considered a withdrawal. The effects can be significant, as evidenced by permanent lowering of Lake Michigan and Lake Huron water levels over past century due to connecting channel dredging.

Should look at *impacts of dredging on land* in addition to water impacts.

How will current and future water withdrawals *impact the public*?

Should *mitigation* be considered in this framework?

Assessment must be made on a *watershed scale* to account for the cumulative effects of all water withdrawals in the watershed.

Issues related to *boundaries and jurisdictions*

- Must consider effect of legal precedence in one jurisdiction on decisions in another.
- Question is still open on who has jurisdiction within watersheds that span political boundaries.

Who sets *management objectives* on which decisions are based and how are they determined?

There is a need for a *decision framework*, and then scientists can act on the framework. The framework needs to be in place before one can decide which myriad of questions to pursue. It must be a framework that is useable by managers, with local applicability. As part of this framework, management objectives must be identified first. The framework should address any ecological disturbance, including water withdrawals.

The use of an "*adaptive management approach*" in the assessment of water withdrawals should be considered, due to the many unanswered questions and large uncertainties.

Responses to Question 2: In addition to the key questions and applicable computer models, what other tools, existing studies and other techniques might be useful to inform the process for evaluating ecological impacts associated with Great Lakes withdrawals?

The following existing tools and studies were mentioned:

- Ecological indicators identified through SOLEC process
- Impingement/entrainment studies and models (including power plant intake studies related to zebra mussels)
- Parallel studies (Environment Canada, International Joint Commission Lake Ontario Study)
- Lakewide Management Plans (sources and loads)
- Land use change models
- Sediment quality assessment tools and models
- Federal Energy Dam Relicensing (FERC) program
- U.S. National Assessment
- Ecological indicators
- Ongoing monitoring efforts
- Canada Country study
- Great Lakes Islands and Lake Sturgeon Decision Support Systems (DSS)
- Climate change models
- Paleolimnology (water level fluctuation)
- GIS mapping layers
- CEAA process (for effluent discharges) as an example framework
- Trading protocols
- GAP analysis
- AEAM approach

With respect to modeling tools, some participants cautioned against using the types of simple models that are used in TMDL (Total Maximum Daily Load) analyses. Others noted that models must be verified before use, and uncertainties must be quantified.

2. Summary Response to Key Questions in Experts Roundtable and Open Discussion:

During the Experts Roundtable, participants were asked to respond to 3 key questions:

- 1. Which “essential questions” should be of highest priority?**
- 2. To what extent can existing data, information and models respond to the “essential questions” for any given water withdrawal proposal?**
- 3. Where are the primary data/information gaps and how can they be addressed?**

The Roundtable was followed by an Open Discussion, which also focused on these three questions. The main points raised during these sessions are summarized below.

Question #1: Which “essential questions” should be of highest priority?

The magnitude of the water withdrawal in the context of total system flows was considered by some to be a high priority question. Participants also noted several high priority scientific and policy questions, as summarized below:

- What are the “critical thresholds”? At what point does a system become stressed? How does one determine the point at which “if go any further”, will lose species, etc. There is a critical need to define “habitat opportunity” before addressing this (e.g., minimum flow required for salmon spawning).
- It will be important to determine how much change occurs compared to what is there now, and what it means (how does one define acceptable levels of change?). Changes may be positive or negative. It was also noted that quantity changes may be easier to measure than quality changes.
- It was noted that organisms may adapt better to quantity changes (flow, level) than to quality changes. However, changes in water level and flow can allow for exotic species invasions.
- What components of the system have the potential to be the most severely impacted?
- How is ecosystem function measured? What is the “currency” of function?
- How is the resiliency of the Great Lakes ecosystem assessed?
- How does one assess quantitative and qualitative shifts and appropriate measurements for monitoring?
- It is important to understand how water withdrawal fits into the framework of what has occurred to date and anticipated future changes.
- In terms of cumulative effects, it was noted that sentinel changes in Lake St. Clair or the Niagara River might be seen before the effects are seen on the Great Lakes themselves.
- Concerns were raised about legal precedent; specifically, the implications of allowing a diversion and then turning down a future applicant because of cumulative impacts.

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Question #2: To what extent can existing data, information and models respond to the “essential questions” for any given water withdrawal proposal?

Participants discussed the limitations of existing information, and cited the following potentially applicable resources:

- Forestry management planning may provide a good conceptual model.
- Data on biotic changes through cycle of water levels changes on the Great Lakes should be studied and incorporated.
- The observed effects of the Welland diversion on Lake Erie should be reviewed.
- Experiences related to the CALW (California) and Colorado river systems may be applicable.

It was also noted that it is important to move forward even without all the desired data.

Question #3: Where are the primary data/information gaps and how can they be addressed?

The following data gaps were noted by participants:

- The lack of knowledge and data related to groundwater/surface water interactions within the Great Lakes-St. Lawrence River Basin;
- Lack of good mapping of groundwater data;
- Long-term studies on ecological response to natural variability;
- Consistent protocols between jurisdictions;
- Temporal datasets to understand response to variability;
- Data and research on open waters and nearshore areas of Great Lakes;
- Models that link groundwater and surface water to ecological impacts;
- Synthesis of existing data is needed, and computer models can assist with this
- Better communication between groups;
- Baseline ecological data (regional data, hydrological data);
- Data and information related to consumptive losses due to evaporation (e.g., is water evaporated from cooling ponds a consumptive loss or does it return to the basin?); and
- Socioeconomic concerns.

The need for a “meeting of the minds” that would define the baseline properties of the Great Lakes Basin was also recognized.

C. Refined List of “Essential Questions”

The refined list of essential questions is organized into 5 categories. The questions relate to:

1. Basic information;
2. Water quantity;
3. Sediment dynamics and characteristics;
4. Water quality; and
5. Ecological impacts.

The questions are presented below.

Category 1: Basic Information on Water Withdrawal

The first category of questions covers basic information on the water withdrawal, such as the characteristics of the source and return water bodies, the proposed use of the water, and information related to the structure and operation. These questions also address alternatives to the proposed withdrawal, and the associated impacts.

1. Where is the proposed water withdrawal?

If water withdrawal is from a Great Lake, St. Lawrence River, or Connecting Channel:

What is the specific location and depth of withdrawal?

What are the relevant hydrology, geometry, hydrodynamics, and water quality in the vicinity of the withdrawal?

If water withdrawal is from a river:

Where is it located on the river?

What are the statistics on flow regime (average flow, 7Q10, 100 year flow)?

What are the key characteristics of the river and watershed? Characterize sub-watersheds by land use types.

If water withdrawal is from an inland lake:

What are the inflows and outflows?

What is the lake geometry?

What is range of water levels?

What is hydraulic retention time?

If water withdrawal is from a groundwater source:

What is the elevation of the water table?

What is the size of the aquifer?

What is the general characterization of the aquifer?

What is the estimated sustained yield of the aquifer?

How does this aquifer relate to the surface waters of the Great Lakes basin?

2. What is the existing quality of the source water and sediments?

Temperature

Dissolved oxygen

BOD

Total dissolved solids

Pathogens

Dissolved organic carbon

Nutrients

Nitrates

Buffering capacity

Salinity

Sulfur

Water conductivity

Persistent Toxic Substances

3. Describe the current assimilative capacity of the source and return water.

Category 1: Basic Information on Water Withdrawal

- 4. Describe the key habitat characteristics for habitats associated with the source or receiving water (i.e., quality, access, resilience)**
 - Are there endangered or threatened species or fragile habitats associated with the source water?
 - If so, list and describe.
 - Does the area of influence contain a significant amount of seasonal/semipermanent wetlands, bogs or fens that are directly linked to the water table?
 - If so, describe.
- 5. What components of the system are most sensitive to withdrawals? Which of these will most likely improve?**
- 6. What are the existing uses (e.g., drinking water), of the source water body?**
- 7. Is there a watershed management plan or objective for the area where the withdrawal is proposed to be made? For the source water? If so, provide details.**
 - What are the existing water quality standards for the source water?
 - For the return water?
- 8. What is the proposed use of the withdrawn water?**
 - What are the water use processes?
 - Will its water quality be altered by this use? If so, explain.
 - Will the use be consumptive? If yes, what fraction of withdrawn water is consumed?
 - What is the potential for future changes in the proposed use?
- 9. What is the proposed rate of withdrawal?**
 - Will there be seasonal or diurnal variations in withdrawal rate? If so, describe.
 - What is the anticipated duration of this withdrawal?
 - Will the diversion be essentially irreversible?
 - Is an increase in water withdrawal anticipated in the future?
- 10. Where is the unconsumed water proposed to be returned?**
 - Will the water be impounded before being returned? If so, describe.
 - Will it be treated before it is returned? If so, describe treatment.
 - If in same water body, where is return located with respect to withdrawal?
 - If different water body, what is the location of the water return?
 - What is the quality of the receiving water for the return?
 - Are there endangered or threatened species or fragile habitats associated with the receiving water? If so, describe.
 - What are the existing uses of the receiving water for the return?

Category 1: Basic Information on Water Withdrawal
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<p>11. What will be the structure and operation of the proposed water withdrawal and return? Describe in detail.</p>

<p>Will there be any physical, chemical, or biological impacts due to the withdrawal operation? Describe in detail and include entrainment or impingement effects.</p>
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<p>12. Are other options to this proposed withdrawal available? Can the location of the proposed withdrawal be changed to minimize the impact?</p>

<p>If so, describe the impacts that are associated with these alternatives.</p>

Category 2: Water Quantity

Questions in this category relate to flows, water levels, groundwater yields, and other information about water quantity in the source and the receiving water.

- 1. For the source water, receiving water for returns, and any other impacted waterbodies (including bypassed reaches, downstream waterbodies and impacted wetlands), does the withdrawal affect:**
 - Baseflow?
 - Range and timing of water levels or water table elevation fluctuations (including seasonal ranges or fluctuations)?
 - Flows and flow variability?
 - High water mark?
 - Stream status (permanent or intermittent)?
 - Index?
 - Recession (rate of recharge?

If yes to any of the questions above, describe the impacts.
- 2. How large is the proposed water withdrawal in the context of total system flows in the source water and the receiving water?**
- 3. If there are impoundments, will there be a reduction in peak flows?**
 - Will there be a loss in variation of water levels?
 - If yes, describe the impacts.
- 4. For groundwater withdrawals:**

How important is groundwater seepage in the overall water budget and water characteristics of hydrologically-connected surface waterbodies (e.g., baseflows, water temperature)?

Will there be a reduction in the amount of groundwater seepage in the river? Or timing of? Explain.

Will there be an effect on any drinking water wells? If yes, explain.

Category 3: Sediment Dynamics and Characteristics

Questions in Category 3 relate to potential changes in sediment suspension and distribution, or sediment characteristics as a result of the water withdrawal.

- 1. Will there be a change in sediment transport and distribution (i.e., erosion, accretion/deposition, turbidity) in the source water or the return water?**
 - What is the anticipated magnitude and extent of this impact?
 - Will this alter the shoreline geomorphic features or the location and area of shallow water zones? In what way?
 - Will this change result in the need for increased dredging? Explain.
 - If there are impoundments, will there be a reduction in total sediment delivery? Explain.
 - Will there be significant effects on dynamic beach/coastal processes? Explain.
- 2. Will the water withdrawal affect wave energy dynamics and their impact? If yes, describe the effects.**
- 3. Will there be a change in sediment characteristics in the source water or the return water?**
 - Will there be an increased sediment contamination by persistent toxic substances?
 - Will there be a change in the properties of suspended or bedded sediments?
 - Will there be an alteration of the organic carbon content of sediments?
 - Will there be an increased sediment oxygen demand?

Category 4: Water Quality

The following questions relate to the quality of the source and receiving water, including any potential impacts related to invasive species.

1. How will the withdrawal alter the water quality of the source water and the return water? Address changes in:

- Temperature
- Dissolved oxygen
- BOD
- Total dissolved solids
- Pathogens
- Dissolved organic carbon
- Nutrients
- Nitrates
- Buffering capacity
- Salinity
- Sulfur
- Water conductivity
- Persistent Toxic Substances

2. Are there invasive species in the source water or return water? Please list.

How are invasive species in the source water affected (negative and positive impacts)?

What pathways, if any, will be created by the withdrawal/diversion that would allow invasive species to spread?

3. Will the water use (e.g., irrigation) lead to degradation of unrelated water supplies (e.g., groundwater)? Explain.

4. Will there be alteration of the thermal profile in the source or receiving water? Explain.

If there are impoundments, will there be an increase in water temperature? Explain.

Category 5: Ecological Impacts

Questions in Category 5 relate to potential impacts on habitats, structure and function of the ecosystem, and any ecological benefits that may occur as a result of the proposed activity.

- 1. For the source and return systems, will the changes in water quantity, sediment dynamics, and/or water quality:**
 - affect aquatic or terrestrial habitats ?
 - Will there be habitat loss or gain?
 - Which species habitats are impacted (fish, benthos, birds, amphibians, reptiles, mammals, invertebrates)? Will any sensitive species such as piping plover be impacted?
 - What are the habitat attributes that are impacted? For example, for migratory species, will access or connectivity be affected? Will resiliency of the habitat be affected?
 - affect production or diversity of flora (including phytoplankton, periphyton, and macrophytes)?
 - cause acute or chronic toxicity to any species?
 - affect population levels or growth rates of any species in impacted system?
 - affect hyporheic zone and subsequently affect surface aquatic systems?
 - have an ecological impact on assemblages of endangered/threatened species?
 - Describe any changes in detail. Include consideration of any seasonal pattern of withdrawals, and the related effects on impacted species (e.g., access to fish spawning areas in the spring).
- 2. For the source and return systems, will the changes in water quantity, sediment dynamics, and/or water quality:**
 - affect predator-prey relationships or food web structure and/or function in the impacted system?
 - If yes, which species are impacted?
 - If yes, how will the whole community structure and function be impacted?
 - cause a change in the energy flow or nutrient cycling through the ecosystem?
 - cause an increased bioaccumulation of contaminants in the food web? Lead to human health impacts through increased contaminant levels in fish or other pathways?
 - Describe any changes in detail.
- 3. What ecological benefits, if any, will accrue from the proposed water withdrawal or diversion?**
- 4. Will the withdrawal change the amount or the functioning of riparian land? Describe any changes.**

Category 6: Cumulative Impacts

The questions in Category 6 address the potential for cumulative impacts as a result of the proposed use and other existing and future uses of the water. Questions also address whether there are any features (such as land use) that may alter the impact of the proposed activity.

1. **From a lake-wide, river, connecting channel, and/or system-wide basis, how will this withdrawal (and return flow if applicable) affect:**
 - water levels and flows?
 - water quality and ecological health of the source water?
 - water quality and ecological health of the receiving water for the return?
2. **Will this withdrawal (and return flow if applicable), when combined with ongoing and anticipated future withdrawals, cause a deviation from the hydrology/hydraulics of the system that is required to maintain the health and integrity of the ecosystem? In what way?**
3. **Will changes in the hydrology/hydraulics of the Great Lakes-St. Lawrence system that may result from global climate changes alter the impact of the water withdrawal? In what way?**
4. **Can further impacts be anticipated in the long-term on such things as land-use or population, as a result of the project?**
5. **Are there any existing or potential features that would alter the impact of the water withdrawal (channel/lake structures, channel lake substrate, existing land use, water control structures, conservation)? If so, describe.**

V. INCORPORATING ECOLOGICAL IMPACTS INFORMATION INTO A DECISION SUPPORT SYSTEM

While the primary focus of the Experts' Workshop was to identify the "essential questions," a panel session was included that addressed how ecological impact information might be incorporated into a decision support system. Three presenters shared their thoughts on this topic, as described below:

A. What Resource Managers Need: Ideas on a "User Friendly" Decision Support System

Richard Bartz, Assistant Chief, Division of Water, Ohio Department of Natural Resources, discussed needs and concerns relating to the DSS from the perspective of water resource managers and the regulated community. He discussed how the DSS needs to incorporate criteria for water projects (such as "reasonable use") into regulatory frameworks. He also expressed the need for clear definitions of terms such as "significant" and "adverse" in annex 2001. The concerns of the regulated community were highlighted, including the application process and data requirements, timely processing, the criteria for assessment and the need for a consistent application of criteria. The presentation is included in Appendix D.

B. Options for an Online Decision Support System

Tom Rayburn, Project Manager, Great Lakes Commission, presented options for an online DSS. Mr. Rayburn provided a conceptual framework for how an online system could be structured. He described how the system would provide links to available online resources, including flow statistics and GIS data. The presentation is included in Appendix D.

C. Ensuring Access to the Latest Data, Information and Modeling: Keeping the Decision Support System Updated

The presentation of Roger Gauthier, U.S. Army Corps of Engineers, is found in Appendix D.

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VI. DISCUSSION OF NEXT STEPS

This draft document provides a summary of the proceedings of a two-day Experts' Workshop on ecological impacts of water withdrawals on the Great Lakes-St. Lawrence Basin. A list of essential questions that must be asked to assess impacts, as refined by workshop participants, is presented. In addition, other scientific and policy issues that were raised during the workshop are listed. While some issues were discussed during the workshop, it was not the intent of the workshop to reach consensus or draw conclusions during the discussions. Rather, the workshop provided participants with an opportunity for a "public airing" of issues and concerns.

Members of the Experts' Panel will have the opportunity to review this draft document for accuracy and completeness. This summary paper will then be revised to reflect any comments. The revised document will then be presented to the Project Management Team (PMT) for final approval.

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APPENDIX A
WORKSHOP PARTICIPANTS AND CONTRIBUTORS

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APPENDIX B

SUMMARY SHEET: DEVELOPING A WATER RESOURCES MANAGEMENT DECISION SUPPORT SYSTEM FOR THE GREAT LAKES

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APPENDIX C
WORKSHOP AGENDA

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APPENDIX E

LITERATURE REVIEW ON CUMULATIVE ECOLOGICAL IMPACTS OF WATER USE AND CHANGES IN LEVELS AND FLOWS EXECUTIVE SUMMARY

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APPENDIX F

**REPORT OF APRIL 2001 WORKSHOP ON IDENTIFYING
AQUATIC ECOSYSTEM INDICATORS**

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APPENDIX G
GROUP DISCUSSION INSTRUCTIONS