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SUPPORTING WATER, ECOLOGICAL, AND TRANSPORTATION SYSTEMS IN THE GREAT LAKES BASIN ECOSYSTEM

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Abstract: The North American Great Lakes Basin ecosystem is globally significant. A unique, bi-national Great Lakes Water Quality Agreement (GLWQA) between Canada and the United States is the backbone for cooperative efforts within the Basin. The Agreement establishes a basis for implementing a systems approach “to restore and maintain the physical, chemical and biological integrity of the waters of the Great Lakes Basin Ecosystem,”... as... “the interacting components of air, land, water and living organisms, including humans, within the drainage basin” (GLWQA 1987). This paper introduces the interacting systems of the Great Lakes Basin ecosystem. Lessons learned and the shortfalls of approaches that divide an ecosystem into individualized compartments are also summarized. Discussion includes advancements in practices and partnerships to improve ecosystem health. The purpose of this paper is to highlight activities within the Great Lakes Basin and to discuss a systems approach to sustaining multiple economic, community, and environmental benefits.

Introduction

The Great Lakes Water Quality Agreement can be viewed as a model of international management and protection for a shared natural resource. A process for implementation of the Agreement includes periodic public reviews and revisions. Amendments to the 1972 Agreement in 1978, 1983, and 1987 provided several advancements that are discussed in this paper. Currently, public review of the Agreement is underway. The purpose of the review is to identify if any changes are needed to help ensure that the Agreement can continue to serve as a bi-national, visionary document that drives cooperative efforts for emerging, new, and long-standing Great Lakes priorities.

Activities to implement the Great Lakes Water Quality Agreement include cooperative efforts between an International Joint Commission (IJC) as a single entity representing Canada and the United States, the two governments of Canada and the United States, eight states within the U.S. (Illinois, Indiana, Michigan, Minnesota, Ohio, New York, Pennsylvania, and Wisconsin), and the Canadian Province of Ontario. Participation extends to federal, Tribal, regional, state, county, and local levels of government and agencies and the private sector, including private citizens. Partnering toward shared goals and objectives is an ongoing process for the Great Lakes. Other examples of activities and cooperative efforts underway at a national level and for the Great Lakes region are discussed in this paper.

Several United States environmental and transportation laws, requirements, and initiatives are complementary to the activities discussed in this paper. A few examples include the National Environmental Policy Act, the Clean Water Act, the National Historic Preservation Act, and the Endangered Species Act. Other examples exist at the national, Tribal, regional, state, and local levels. Transportation legislation and regulations support interdisciplinary approaches to transportation decision-making for planning and project delivery. As one example, the 2005 transportation legislation more fully links together environmental and transportation practitioners to accomplish long-range transportation planning. Provisions for environmental reviews and project level requirements are also included. The 2005 transportation legislation is the Safe Accountable Flexible Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU 2005). Many complimentary efforts are also underway in Ontario, Canada.

Several existing reports and references are available as summaries about the systems and the cooperative efforts within the Great Lakes Basin ecosystem. One example of a compilation of materials and web links is supported by the U.S. Environmental Protection Agency, Great Lakes National Program Office (USEPA GLNPO) at: <http://www.epa.gov/glnpo/>. Further details are available from this source as well as other sources. An overview of the Great Lakes Basin ecosystem and a systems approach to ecosystem management is provided below.

Overview: Systems and Benefits of the Great Lakes Basin Ecosystem

The water system of the Great Lakes Basin is a source of drinking water for more than 40 million people in Canada and the United States (IJC 2005). Drinking water is provided by both surface water and ground water. The Great Lakes contain 18 percent of the fresh surface water in the entire world (Canada and USEPA, GLNPO 1995). The Basin is a broad landscape of 290,000 square miles (750,000 square kilometers) (TNC 2000). This expansive watershed has a diversity of climate, soils, ecology, hydrology, topography, and cultures. The Great Lakes Basin ecosystem is a diversity of prairies, savannahs, fens, bogs, forests, alvars, dunes, beaches, streams, shorelines, and lakes with an abundance of flora and fauna and various rural and urban land uses. More than 30 unique natural communities that occur within the Basin are rarely found on earth and might not exist in any other locations (TNC 1997).

The Great Lakes Basin extends across the international boundary of the United States and Canada encompassing 2 provinces and 8 states “and includes the lakes, connecting channels, tributaries, and groundwater that drain through the international section of the Saint Lawrence River” (IJC 2000). Glacial and natural processes shaped the drainage

patterns and the landscape of the Basin after the retreat of the last glacier 10,000 years ago (Canada and USEPA, GLNPO 1995). The maps in figure 1 show the natural watershed boundary that shapes the Basin and its position in North America. The 5 Great Lakes of Superior, Michigan, Huron, Erie, and Ontario are also shown.

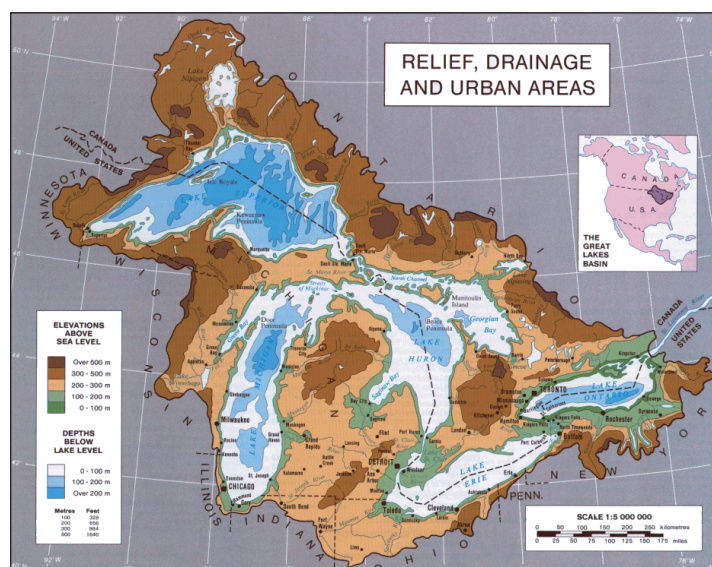


Figure 1. Great Lakes Atlas: Relief, Drainage, and Urban Areas, showing the natural watershed boundary of the Basin. (Source: Canada and USEPA, GLNPO 1995).

A basin/watershed can be described as a region or area from which water drains into a single stream, lake, water body, or ocean. Topography and terrain are the foundation for natural drainage patterns and natural watershed/basin and sub-watershed/sub-basin boundaries. The Great Lakes Basin boundary defines a natural geographic area that is used as a focus for bi-national, ecosystem-based management (Canada and USEPA, GLNPO 1995).

An ecosystem is comprised of interacting systems. Figure 2 illustrates this concept. A balance within and between systems is ideal for sustaining multiple benefits through time.

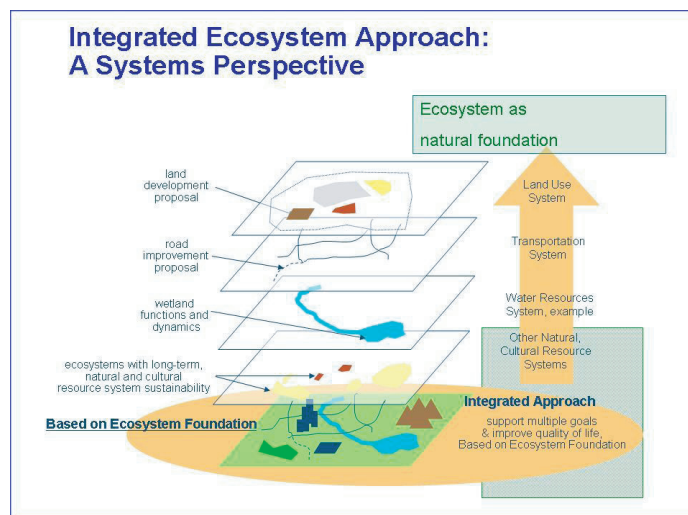


Figure 2. An ecosystem foundation can provide multiple benefits sustained by an effective interaction between systems, independent of jurisdiction or political boundaries (Source: Available within the public domain).

The integrated systems shown at the bottom of figure 2 is the foundation of a systems approach. An understanding of systems and their interactions has advanced over many years. With changes to systems, natural processes occur in response as homeostasis. A few highlights about systems within the Great Lakes Basin ecosystem are discussed below.

Interacting Systems Within the Great Lakes Basin Ecosystem

A systems approach for the Great Lakes Basin ecosystem is cooperatively agreed upon within the bi-national Great Lakes Water Quality Agreement for “the interacting components of air, land, water and living organisms, including humans, within the drainage basin of the St. Lawrence River at or upstream from the point at which this river becomes the international boundary between Canada and the United States” (GLWQA 1987).

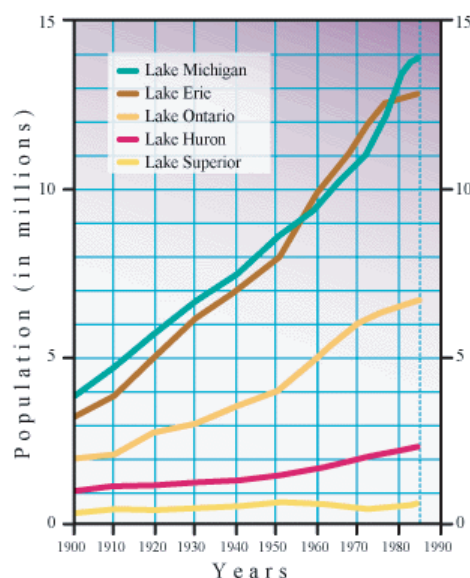


Figure 4. Human population in the Great Lakes Basin 1900 to 1990 by sub-basin for each of the Great Lakes. (Source: Canada and USEPA, GLNPO 1995).

Today, the largest population centers in the Basin are along the shorelines of the Great Lakes as Chicago, Illinois; Detroit, Michigan; and the city of Toronto in Ontario, Canada. Currently, the Great Lakes Basin supports more than 10 percent of the United States population and 25 percent of the Canadian population as a total of more than 37 million people (Canada and USEPA, GLNPO 1995; IJC 2005).

Through settlement, original wetlands, prairies, savannas, and forests were converted to other land uses and purposes. Natural landscapes were converted to production agriculture, forest industry, and rural and urban uses. Waters were fished commercially. These changes altered the ecosystem and its balance (Canada and USEPA, GLNPO 1995). Currently, land uses are distributed in the Basin as shown in the map in figure 5. Changes in commercial fisheries are also shown. An estimated 7 percent of agricultural production in the United States and almost 25 percent of agricultural production in Canada is supported within the Great Lakes Basin (Canada and USEPA, GLNPO 1995).

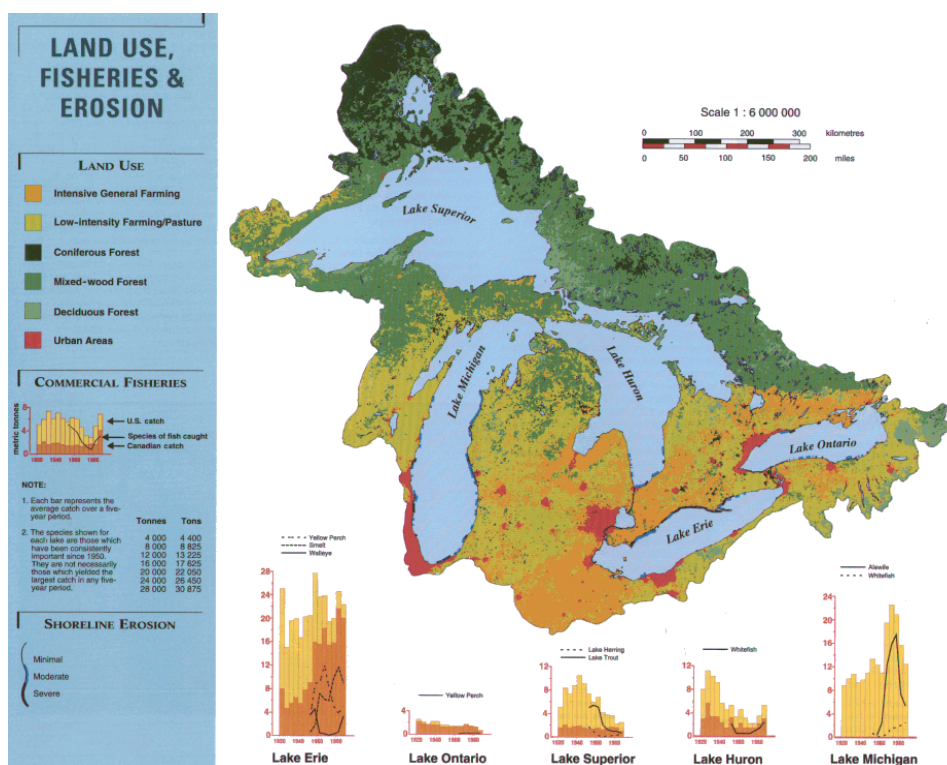


Figure 5. Land uses for agricultural, forest, rural, and urban purposes; and changes in commercial fisheries catch and shoreline erosion in the Great Lakes Basin (Source: Canada and USEPA, GLNPO 1995).

Changes in land use were observed to cause runoff of water and erosion from land surfaces including transport of dissolved chemicals and nutrients and sediment as water flowed across the landscape and drained to lower elevations and water bodies. Based on these observations, in 1972, the IJC was asked to investigate pollution from land use activities. New studies investigated both urban and rural land uses and interactions between systems. The original focus on point sources of pollution was expanded to include pollution from non-point sources. For example, key non-point urban sources were identified and categorized as nutrients, toxic substances, pathogens, and sediments within runoff (GLSAB 2000).

Priorities for improved ecosystem management for land and water interactions and point and non-point sources of pollution were identified and promoted for these types of practices (FHWA 1996a, FHWA 1996b, FHWA 2006, GLSAB 2000, GLWQA 1987, Grannemman 2004):

- Watershed planning and approaches
- Control and treatment of runoff from land surfaces
- Land use planning and evaluations
- Land management and conservation
- Conservation tillage for agriculture
- Stream and wetland vegetative buffers
- Site selection and design
- Prevention of soil erosion and displacement
- Control of sediment deposition
- Management of non-stormwater sources (e.g. septic systems)
- Control and management of combined and sanitary sewer systems and overflows
- Methods that include changes in impervious surfaces and development in analyses
- Evaluations of alterations in hydrology and corresponding impacts
- Incorporating chemical and pollutant and sediment loading into methods
- Virtual elimination and zero discharge of persistent toxic substances into the Great Lakes
- Stormwater best management practices (BMPs)
- Use of education programs

The benefits of land use planning and selection of land use practices and infrastructure development to match landscape and site conditions became apparent. Examples of methods for selecting land uses based on soil characteristics and economic analyses have been developed for the Great Lakes region (Campbell and Majerus 1986). Conservation tillage on agricultural lands has reduced soil erosion and sediment loading into wetlands and waterways.

For transportation, highway hydrology methods can incorporate knowledge of how land use changes affect watershed changes. “Deforestation and urbanization change the runoff processes that control watershed response to rainfall” (FHWA 1996a). Systems planning for highway drainage systems can integrate hydrology, land use, soil types, topography, and watershed characteristics and size as well as the “expected level of development in the upstream watershed over the anticipated life of the facility” (FHWA 1996b). Advancements in understanding and improved practices toward integrated approaches continue to be applied to managing the systems within the Great Lakes Basin (GLSAB 2000).

Changes in land use systems and the needs of a growing population also affected changes in transportation systems. For the Great Lakes region, the water system is essential within the transportation system as an intermodal system that links together rail, air, transit, road/highway, bicycle, pedestrian, and marine/water transportation. As a broad overview of transportation in the Basin, figure 6 depicts waterborne commerce for major commodities and figure 7 shows other transportation modes and major types of infrastructure. It is important to recognize that the waterborne transportation in the Great Lakes is taking place in the drinking water source.

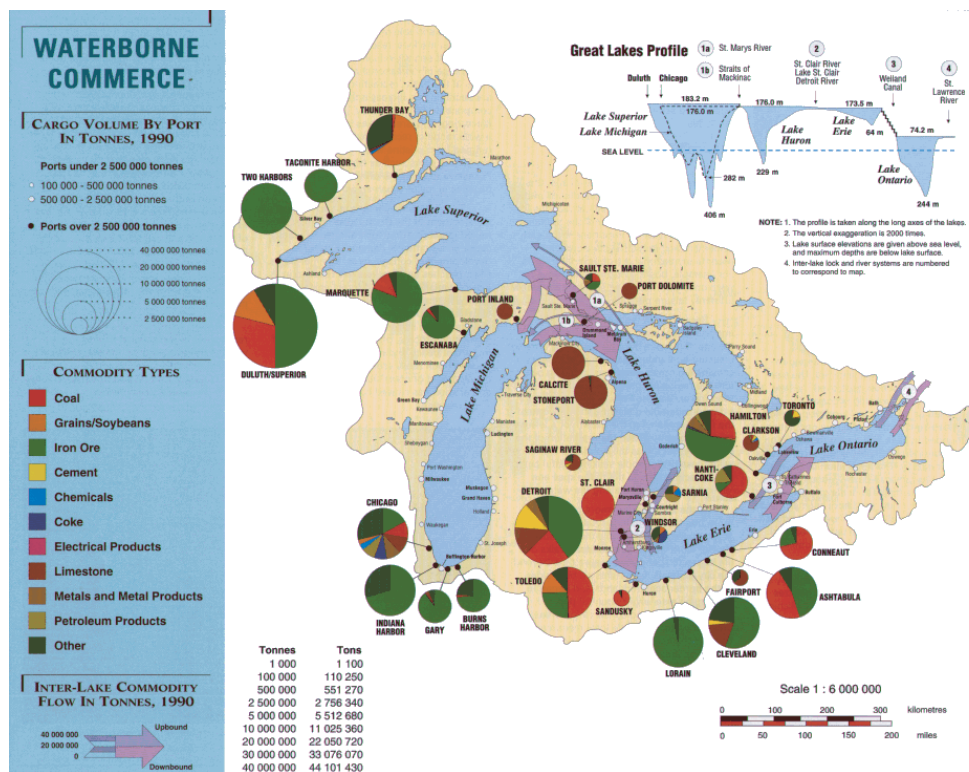


Figure 6. Waterborne commerce in the Great Lakes Basin ecosystem as of 1990. (Source: Canada and USEPA, GLNPO 1995).

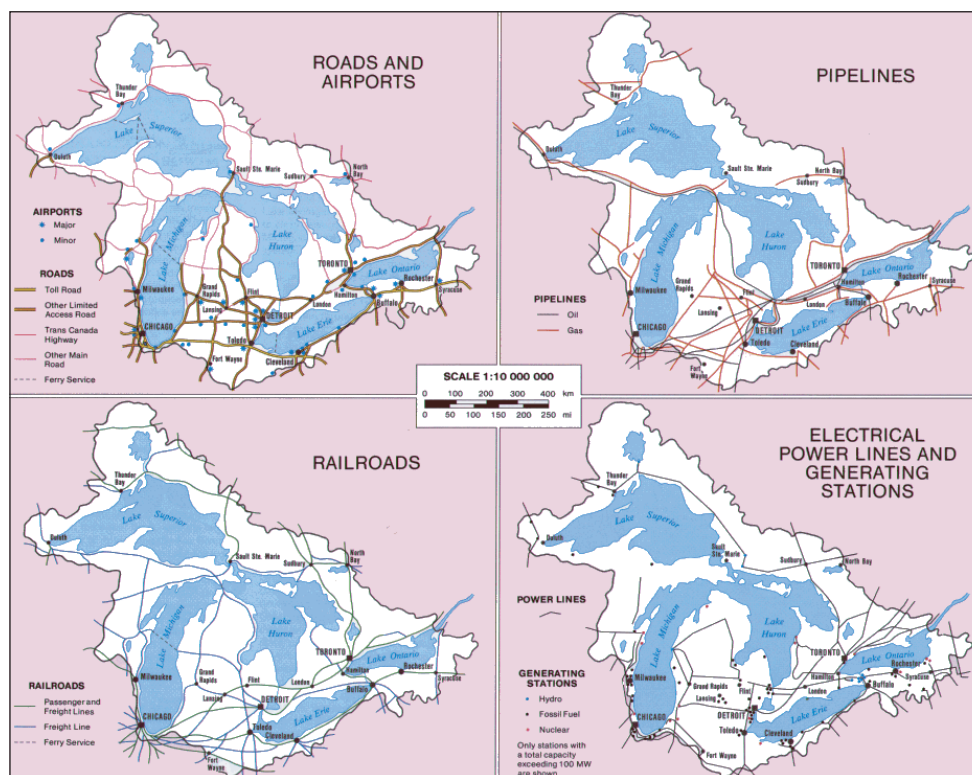


Figure 7. Transportation systems and major infrastructure in the Great Lakes Basin ecosystem (Source: Canada and USEPA, GLNPO 1995).

The transportation system expanded to support international enterprises and trade. Some ecosystem changes happened unknowingly and the implications only became understood later with observation and monitoring through time. One example occurred with the movement of transoceanic ships into the Great Lakes water system. More than 20 years ago, discharges of ballast water from transoceanic ships introduced a new, non-native species into the Great Lakes system, the zebra mussel (*Dreissena polymorpha*). The zebra mussel expanded in numbers in the freshwater habitat of the Great Lakes. In 20 years, the location of zebra mussels extended and “invaded” into the freshwaters of the Great Lakes, as well as the Ohio River Basin and the Mississippi River Basin as shown in the map in figure 8.

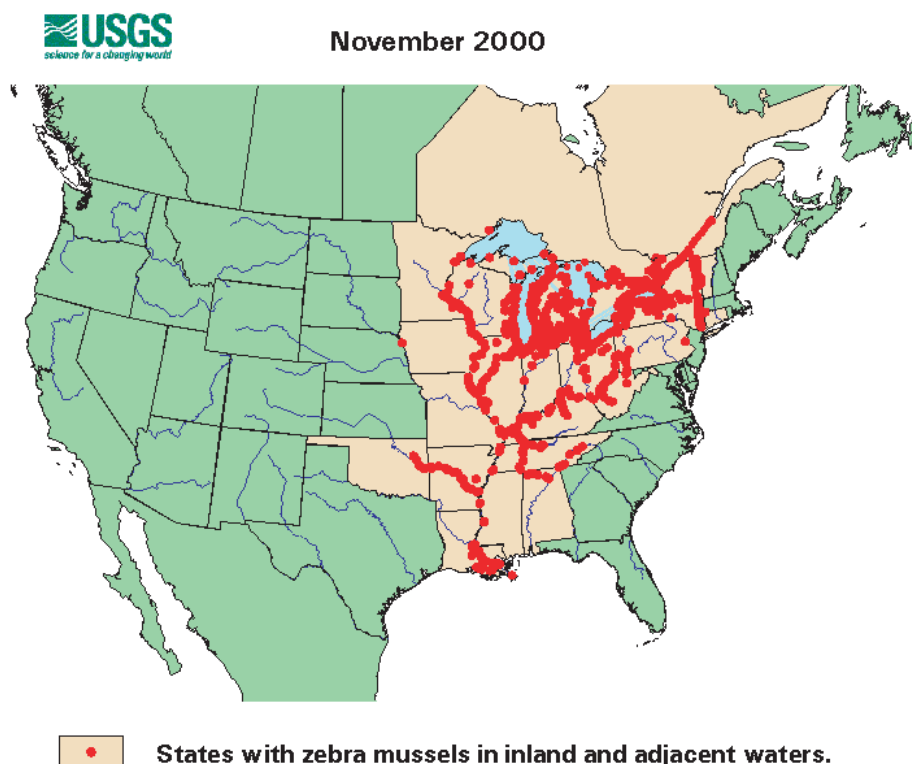


Figure 8. Extent of location of zebra mussels in the U.S. water systems 20 years after their initial introduction into the Great Lakes (Source: USGS 2000). The zebra mussel is considered an “invasive” species.

The arrival of the zebra mussel and its effect on the Great Lakes ecosystem emerged as a prime example of the interdependencies between biological, chemical, and physical processes. Zebra mussels impacted Great Lakes biological integrity by disrupting the established food web. They impacted the chemical integrity by clearing the water as filter feeders. Changes in water clarity allowed sunlight to reach further into the depths of the lakes and promoted the growth of plants and algae. Zebra mussels also impacted physical integrity by clogging water intake pipes and as a source of mounds of shells on the shoreline beaches. Research also seems to indicate the potential that zebra mussel fecal matter can act as fertilizer, contributing nutrients to the lake chemistry. This nutrient control problem of the 1960s and 1970s was thought by many to have been solved but has recently returned to areas near the shorelines. As filter feeders, zebra mussels build up toxins in their tissues. This causes bioaccumulation of toxins because zebra mussels are a food source for higher trophic levels in the food web. This toxicity alters chemical processes (Beck 2007).

There are many other examples of how the introduction of non-native species into the Great Lakes Basin can trigger disruption in the health of the ecosystem. Control of invasive species and prevention of their introduction into the ecosystem remain as ongoing challenges. In concert with ecosystem management, there are ongoing priorities to nurture and sustain species native to the Basin, such as native mussels. Priorities also include sustaining water quality and quantity for the long-term.

Changes in population and land use also triggered changes in the use and consumption of water. The IJC states that “water uses” ... can be... “presented in two categories: (1) consumptive uses estimated from water withdrawal data and (2) removals. Close to 90 percent of withdrawals are taken from the lakes themselves, with the remaining 10 percent coming from tributary streams and groundwater sources.” The IJC summarized consumptive use in the Great Lakes Basin by type of water use as: “irrigation, 29 percent; public water supply, 28 percent; industrial use, 24 percent; fossil fuel thermoelectric and nuclear uses, 6 percent each; self-supplied domestic, 4 percent; and livestock watering, 3 percent,” based on 1993 data (IJC 2000).

The International Joint Commission also presented the following discussion of water use to support the economy and land uses within the Basin (IJC 2000):

“The Commission has developed insights into trends in water use and their impact on potential future water demands. These insights were derived from a simple extension of trends established over the previous decade. ... All predictions are heavily dependent on the assumptions underlying them and on an accurate understanding of the present starting point. Factors such as climate change could encourage the increased use of water for irrigation and other purposes. On the other hand, continued improvement in water demand management as well as in water conservation might help to slow any increase in withdrawals for consumptive use within the Basin. Because population will increase, there is a greater probability of increasing use in the future than there is of decreasing use. Projections presented below extend to 2020. The Commission believes that water use is likely to increase modestly by 2020 and that projections beyond this point should be considered highly speculative.

Thermoelectric Power Use. At thermoelectric power plants, water is used principally for condenser and reactor cooling. In the United States, thermoelectric withdrawals have remained relatively constant since 1985 and are expected to remain near their current levels for the next few decades. In Canada, modest increases are expected to continue along with population and economic growth.

Industrial and Commercial Use. In the United States, industrial and commercial water use has declined in response to environmental pollution legislation, technological advances, and a change in the industrial mix from heavy metal production to more service-oriented sectors. A similar trend is evident in Ontario, so combined use is expected to gradually decline through 2020.

Domestic and Public Use. In the United States, water use for domestic and public purposes in the Great Lakes Basin generally increased from 1960 to 1995 and is expected to climb gradually through 2020. In Ontario, however, the modest downward trend established in recent years because water conservation efforts is expected to continue.

Agriculture. In the United States, water use for agriculture in the Great Lakes region increased fairly steadily from 1960 to 1995 and is expected to continue to grow. In Canada, the rate of increase was somewhat greater, so that combined projections indicate a significant increase by 2020...

Total Water Use. There is agreement that water withdrawal will increase in the future, although it is impossible to say with confidence just how much the increase will be. There is, however, no such agreement on consumptive use...

... The above figures” ... “represent a range of possibilities. What is clear is that water managers will need to manage the resource carefully”

This information supports decision-making for water demand management and water conservation and the use of advisories and restrictions on water withdrawals and consumption, water diversion, uses of water, swimming, and fish consumption.

Additional efforts for water management were launched in December 2005 when the Great Lakes Governor’s and Premiers signed an agreement that will provide protection for the Great Lakes-St. Lawrence River basin. This agreement will have to be approved by the state legislatures in order to be implemented. The agreement bans new diversions with limited exceptions based on a consistent standard for review. The agreement also provides for data collection and sharing, development of water conservation goals, and efficiency measures. The agreement recognizes that the waters of the basin are a shared public treasure and includes a strong commitment to continued public involvement in the implementation of the agreement. Information is available at: <http://www.cglg.org/projects/water/annex2001Implementing.asp> (Council of Great Lakes Governors 2005).

Studies of water and hydrology can provide baseline information for existing conditions and monitoring changes through time to assess impacts to water quantity and quality and ecosystem response. The previous diagram shown in Figure 3 includes approximations of quantities for some of the water inputs and outputs for the Great Lakes water system (Canada and USEPA, GLNPO 1995). The groundwater system connects to streams that flow into the Great Lakes so that “groundwater indirectly contributes more than 50 percent of the stream discharge to the Great Lakes” (Granneman et al. 2000). These approximations provide an example of the types of water supply studies that are conducted within the Basin.

Systems respond to changes and stressors through homeostasis as ongoing natural processes. However, it is now known that thresholds and limits exist in system capabilities to respond to changes to regain ecosystem health and it is possible that ecosystem balance could collapse. For the Basin, it was “later in time, when the watershed was more intensively settled...,” that it was ... “learned that abuse of the waters and the basin could result in great damage to the entire system” (Canada and USEPA, GLNPO 1995). Monitoring showed the existence of problems and sometimes pointed out unexpected interactions.

For example, contaminated groundwater was discovered to be a source of pollutants for the Great Lakes. The deposition of toxic chemicals from the air was also found to be detrimental to the waters of the Great Lakes. Deposition of contaminated sediments also influenced the ecosystem. Through time, it was also found that ...“in spite of their large size, the Great Lakes are sensitive to the effects of a wide range of pollutants. The sources of pollution include “... the runoff” that transports soil particles “... and farm chemicals from agricultural lands, the waste from cities, discharges from industrial areas and leachate from disposal sites. The large surface area of the lakes also makes them vulnerable to direct atmospheric pollutants that fall with rain or snow and as dust on the lake surface.” ... “Outflows from the Great Lakes are relatively small (less than 1 percent per year) in comparison with the total volume of water. Pollutants that enter the lakes - whether by direct discharge along the shores, through tributaries, from land use or from the atmosphere - are retained in the system and become more concentrated with time. Also, pollutants remain in the system because of resuspension (or mixing back into the water) of sediment and cycling through biological food chains.” (Canada and USEPA, GLNPO 1995). This knowledge and the results of monitoring were applied to advancements in partnering and management efforts for the Great Lakes Basin.

Bi-National Partnerships and Agreements for the Great Lakes

Canada and the United States formalized a bi-national partnership to define and implement priorities for the Basin. Specifically, the 1909 Boundary Waters Treaty created the International Joint Commission as a single body to act in concert toward shared benefits for Canada and the United States. In addition, “the Treaty created a unique process for cooperation in the use of all the waterways that cross the border between the two nations, including the Great Lakes” (Canada and USEPA, GLNPO 1995). Under the Boundary Waters Treaty of 1909, the Great Lakes Water Quality Agreement was created in 1972 and modified in 1978, 1983, and 1987. The Great Lakes Water Quality Agreement became a bi-national agreement and in many ways can be considered a model for addressing environmental priorities and resources across an international boundary (IJC 2006). The content of the bi-national agreement as of 1987 serves as the foundation to implement activities “to restore and maintain the physical, chemical and biological integrity of the waters of the Great Lakes Basin Ecosystem,” ... as” the interacting components of air, land, water and living organisms, including humans, within the drainage basin” (GLWQA 1987).

Advancements in Bi-National Agreements and Approaches

An understanding of inter-dependencies and ecosystem changes can be viewed as the basis for changes in the Great Lakes Water Quality Agreement from 1972 to 1987. These changes can be highlighted as the following advancements.

- Broadening of the original focus on the Great Lakes as individual water bodies, toward a Great Lakes water system, and then toward a definition of the Great Lakes Basin ecosystem as “the interacting components of air, land, water and living organisms, including humans, within the drainage basin of the St. Lawrence River at or upstream from the point at which this river becomes the international boundary between Canada and the United States” (Canada and USEPA, GLNPO 1995; GLWQA 1978).
- Chemical water quality objectives were expanded to more comprehensive goals that seek “to restore and sustain the chemical, physical, and biological integrity of the waters of Great Lakes Basin Ecosystem” (GLWQA 1987).
- Inclusion of ecosystem objectives and indicators to complement the chemical objectives already mentioned in the Agreement (Canada and USEPA, GLNPO 1995).
- Approaches based on an understanding that watersheds, basins, and drainage areas occur within and are part of ecosystems (Canada and USEPA, GLNPO 1995).
- Activities for monitoring as “a scientifically designed system of continuing standardized measurements and observations and the evaluation thereof...” (GLWQA 1987).
- Implementation of continued monitoring as a basis for improved management practices (Canada and USEPA, GLNPO 1995).
- Use of indicators within monitoring methods. An indicator has been defined as a measurable feature, or one derivable from measurements, which singly or in combination provides managerially and scientifically useful evidence of ecosystem integrity, or reliable evidence of progress toward one or more ecosystem objective (DePinto 2005).
- Advancements from an early focus on point source pollution to include both point and non-point sources of pollution (GLWQA 1987).
- Strengthened management provisions to achieve defined and desired future conditions (GLWQA 1987).
- Application of new knowledge to solutions that embrace relationships of water systems to land systems to atmospheric systems, specific to impacts of deposition of airborne toxic substances into waters, contaminated sediments, and pollution from contaminated groundwater and both point and non-point sources of pollution (Canada and USEPA, GLNPO; GLWQA 1987).
- Creation of specific water quality planning and restoration programs, such as Remedial Action Plans (RAPs) for geographically defined Areas of Concern (AOCs) and Lakewide Management Plans (LaMPs) for critical pollut-

ants and goals to improve the health of the Great Lakes ecosystem. (Finger Lakes-Lake Ontario Watershed Protection Alliance 2000, Lake Michigan LaMP 2000).

- Implementation of Lakewide Area Management Plans using adaptive management approaches including the identification and use of biological, chemical, and physical indicators to monitor the health and response of the ecosystem to changes and management efforts (Lake MI LaMP 2000).
- Identification of 14 impairments to beneficial uses for the Great Lakes, as defined by the International Joint Commission (GLWQA 1987).
- Creation and participation of Great Lakes Advisory Boards to include a variety of expertise and scientific approaches. For example, one advisory board will "... consist of managers of Great Lakes research programs and recognized experts on Great Lakes water quality problems and related fields..." (GLWQA 1987).

Further details are provided below.

Specifically, the Great Lakes Water Quality Agreement advanced to establish an expanded advisory committee structure for the International Joint Commission that brings together experts in the Water Quality Board, Air Quality Board and the Science Advisory Board. The parties to the agreement, the United States and Canada, work jointly through the Bi-national Executive Committee (BEC). The following efforts report to the BEC: Lakewide Management Plans (LaMPs), Area of Concern Remedial Action Plans, State of the Lakes Ecosystem Conference and the Bi-national Toxic Strategy. All of the efforts produce plans and reports for the public, hold conferences, and support on-going public stakeholder groups. The Lakewide Area Management Plans are developed collaboratively and focus on the sub-basin/sub-watershed of each of the Great Lakes.

Another aspect of the implementation process for the Great Lakes Water Quality Agreement is periodic public reviews. The IJC conducted public hearings and public reviews during 2005 and 2006 (IJC 2006). Many of the changes suggested in review comments support the concepts of systems alignment now underway in various Great Lakes efforts. The review process is still underway.

Regarding this review of the Agreement, the International Joint Commission offered the following advice to the Governments of Canada and the United States as they undertake their review of the Agreement (IJC 2006):

"Since 1972, the Great Lakes Water Quality Agreement between Canada and the United States ... has provided a vital framework for bi-national cooperation, consultation and action to restore and maintain Great Lakes water quality and the ecological health of the Great Lakes basin. Much has worked well over the past three decades and there have been many achievements. Threats to water quality persist, however, and new ones have emerged. Scientific advances have yielded new understandings of problems which, in turn, point to different solutions than in the past. What once was judged far-sighted and robust enough to protect vulnerable populations of humans, fish and wildlife is no longer sufficient. ... Key principles and concepts from the current Agreement, such as virtual elimination and zero discharge of persistent toxic substances, should be retained." ... Changes to the agreement to include "other concepts that could underpin and strengthen the Agreement, such as the ecosystem approach," and "adaptive management" ... "should also be clearly enunciated in the new Agreement"

Ecosystem Approach and Collaborative Implementation

An ecosystem approach for the Great Lakes "is a departure from an earlier focus on localized pollution" ... and from ... "management of separate components of the ecosystem in isolation" ... and it ... "assumes a more comprehensive and interdisciplinary attitude..." (Canada and USEPA, GLNPO 1995). "This approach calls for creative partnerships that look at natural boundaries... as the unit of management" (GLIN 2006). The State of the Lakes Ecosystem Conference (SOLEC) 2006 discussed the ecosystem management concepts illustrated in figure 8.

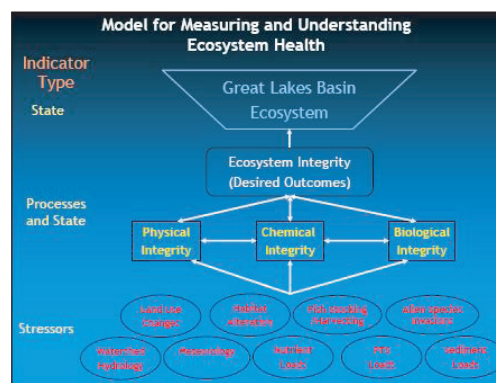


Figure 8. Model for ecosystem health, including physical, chemical, and biological integrity; indicators; and monitoring of ecosystem integrity and outcomes. (Source: DePinto 2005)

Examples for implementation include the Lakewide Management Plans that have been developed for each Great Lake sub-basin/sub-watershed. Participation includes an array of federal, Tribal, regional, local, state and provincial agencies and stakeholders to develop and implement the management plan.

As a specific example, the Lake Michigan Lakewide Management Plan (LaMP) seeks multiple benefits for people and communities as (Lake MI LaMP 2000):

- *“Moderating natural events and human activities.* Healthy landscapes can make communities safer and more livable by tempering the effects of natural events and human activity. For example, wetland systems can absorb and store storm waters and thereby aid in flood control and ensure more routine flows and water levels in streams.
- *Enhancing social well-being.* Healthy landscapes provide services that make communities more enjoyable and rewarding. For example, they provide opportunities for outdoor recreation. To many, they also serve as a source of civic pride and personal and spiritual well-being.
- *Supporting local economies.* In sustainable landscapes, people meet the needs of the present without compromising the ability of future generations to meet their needs”

The Lake Michigan LaMP 2000 incorporates 3 components of ecosystem sustainability including: environmental integrity, economic vitality, and socio-cultural well being. A shift in focus from resource programs to resource systems is considered necessary. Humans and communities are considered part of an ecosystem and its management and are affected by ecosystem health (Lake MI LaMP 2000).

Regarding an example approach to adaptive management, the Lake Michigan LaMP 2000 quotes the Keystone Report of 1996 which states, “adaptive management encourages active participation by all stakeholders in the planning, implementation, monitoring, and redirection of ecosystem management initiatives. Social and economic values and expectations are routinely considered, along with ecological objectives, in continually correcting the course of management. Results from the monitoring of ecological, economic, and social variables are used to track management outcomes” (Keystone Report 1996).

In addition to the Great Lakes Water Quality Agreement and the International Joint Commission, several other partnerships and multi-agency initiatives are moving forward to support ecosystem approaches to sustain multiple benefits across systems, including transportation and infrastructure. A few examples of these supporting partnerships and initiatives are discussed below.

Executive Order Expands Collaboration for the Great Lakes

In 2004, the collaboration for the Great Lakes took another major step. “In May 2004, President Bush signed Executive Order 13340 creating a cabinet-level Task Force to bring an unprecedented level of collaboration and coordination to accelerate protection and restoration of this national and internationally significant resource. Recognizing that efforts to protect and enhance the ecosystem must go beyond the federal government, the Executive Order” ... calls for ... “the convening of a Regional Collaboration of National Significance to facilitate collaboration among the federal government, the Great Lakes states, local communities, Tribes, and other interests in the Great Lakes region as well as Canada” (GLRC 2004). The title of this Executive Order is: Establishment of a Great Lakes Interagency Task Force and Promotion of a Regional Collaboration of National Significance for the Great Lakes (EO 13340 2004).

This Executive Order set up a Federal Interagency Task Force and a Regional Working Group for the Great Lakes. Several efforts are related to this Executive Order. One example is a U.S. Department of Transportation (USDOT)/FHWA Great Lakes stormwater workshop that brought together representatives from 8 Great Lakes states including state transportation agencies, FHWA headquarters, FHWA state Division Offices, and the USEPA Region 5 office. Participants included transportation and environmental professionals involved with stormwater management in the Great Lakes region (FHWA 2006).

The USDOT/FHWA workshop presentations and discussions included several topics such as the Clean Water Act (Sections 401 and 402), the National Pollutant Discharge Elimination System (NPDES) and permitting, prevention of soil erosion, control of sediment, pollution prevention plans (PPPs), drainage studies and drainage plans, and use of stormwater Best Management Practices as part of transportation project delivery. FHWA distributed a written summary of various resources and sources of information on stormwater that is included in the final workshop report (FHWA 2006).

The workshop discussions highlighted examples from a cooperative effort that is a compilation of information and a database and website for stormwater BMPs. The overall purpose of the cooperative effort is to provide scientifically sound information to improve the design, selection and performance of BMPs. This “International Stormwater Best Management Practices” (BMPs) website is located at: <http://www.bmpdatabase.org/> (International Stormwater BMPs 2007). Adoption and use of stormwater BMPs is one example of how to improve practices for transportation within the Great Lakes Basin.

Another partnership is underway within a nationwide, multi-agency initiative for integrated and ecosystem approaches to developing infrastructure. This initiative can be implemented in the Great Lakes region as well as through local, state, regional, Tribal, and national level efforts. A summary is provided below.

Multi-Agency Initiative – Eco-Logical: An Ecosystem Approach to Developing Infrastructure Projects

Eco-Logical is a multi-agency initiative and guide that encourages federal, Tribal, state, and local partners to integrate environmental solutions and goals into planning and delivery of infrastructure projects. *Eco-Logical* offers a conceptual framework for integrating environmental and transportation plans and projects across agency and geographical boundaries, and endorses ecosystem-based mitigation approaches to compensate for unavoidable impacts caused by infrastructure projects. The framework is useful for practitioners in both the public and private sectors. *Eco-Logical* meets all existing U.S. regulatory requirements while offering improved practices within an ecosystem approach (Eco-Logical 2006). *Eco-Logical* also supports the requirements of U.S. transportation legislation, the Safe Accountable Flexible Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU 2005).

The *Eco-Logical* approach shifts the U.S. federal government's traditional focus from individual jurisdictions and actions to a larger focus across multiple agencies within a larger natural ecosystem. An *Eco-Logical* guide was developed as a multi-agency, collaborative effort and was agreed upon and signed by the headquarters offices of 8 U.S. federal agencies including:

- Federal Highway Administration, U.S. Department of Transportation
- U.S. Environmental Protection Agency, (Office of Federal Activities)
- U.S. Environmental Protection Agency, (Office of Wetlands, Oceans, and Watersheds)
- U.S. Fish and Wildlife Service, U.S. Department of Interior
- U.S. Forest Service, U.S. Department of Agriculture
- Bureau of Land Management, U.S. Department of Interior
- U.S. Department of the Army; Department of Defense
- National Park Service, Department of Interior
- National Marine Fisheries Service, National Oceanic and Atmospheric Administration

Participants on the multi-agency *Eco-Logical* Steering Team also included two state transportation agencies and a toll highway authority (Eco-Logical 2006).

The *Eco-Logical* framework includes an agreed upon definition of an ecosystem as: “an interconnected community of living things and the physical environment they depend upon (humans included)” (Eco-Logical Guide 2006). *Eco-Logical* recommends a non-prescriptive framework for ecosystem-based mitigation and sequencing to avoid adverse impacts, then minimize impacts, and then compensate for unavoidable adverse impacts. The overall goals of the ecosystem approach to mitigation and *Eco-Logical* are: conserve larger, scarce, multi-resource ecosystems; increase habitat and system connectivity; improve predictability in environmental review and regulatory processes; provide better public involvement to improve transparency and establish greater credibility; and streamline infrastructure planning and project delivery (Eco-Logical 2006).

The *Eco-Logical* framework can facilitate ongoing future refinements in planning and project delivery using the elements shown in figure 9. It is important to recognize that any part of the *Eco-Logical* cycle of elements shown in Figure 9 can be implemented at any stage during planning and project delivery.

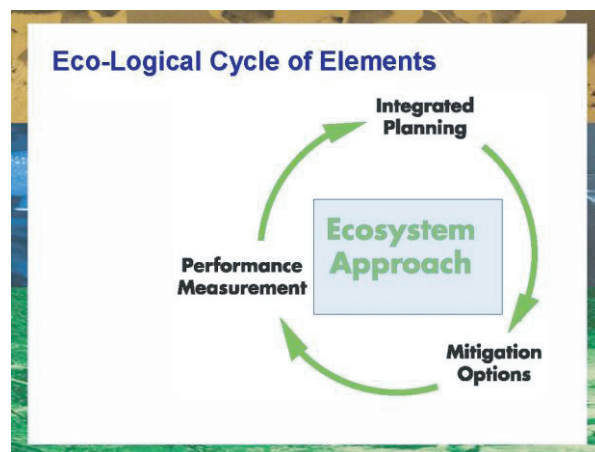


Figure 9. Elements within the *Eco-Logical* framework (Source: Eco-Logical 2006).

Details are provided in the multi-agency guide available as “Eco-Logical: An Ecosystem Approach to Developing Infrastructure Projects,” downloadable at: http://www.environment.fhwa.dot.gov/ecological/eco_index.asp (Eco-Logical 2006).

Implementation of *Eco-Logical* via Funding and an FHWA Grant Solicitation

Across the United States, several efforts that implement Eco-Logical are already underway within long-range planning, mid-range planning, and project delivery. To further advance implementation of Eco-Logical, the Federal Highway Administration (FHWA) is providing funding and currently soliciting grant applications. Eligible applicants can be from all levels of the U.S. government, Tribes, non-profit organizations, colleges/universities, and private entities. Information about the U.S. Eco-Logical grant solicitation is posted at: <http://www.grants.gov/search.do?oppld=13223&mode=VIEW>

Eco-Logical supports several initiatives and U.S. Executive Orders such as: Cooperative Conservation, Integrated Planning, and Environmental Streamlining and Stewardship for Transportation. *Eco-Logical* also supports existing agreements and Executive Order 13340 for the Great Lakes. Within the *Eco-Logical* ecosystem approach, infrastructure and environmental planning and project delivery can be integrated to support economic, environmental, and social needs and achieve multi-purpose goals and community benefits.

Recommendations and Future Activities

This paper has highlighted findings and activities that can be applied to sustain ecosystem health for multiple benefits. Based on this discussion, the following recommendations are offered for planning and project delivery and activities at the international, national, provincial, state, regional, and local levels.

- Implement and promote the *Eco-Logical* multi-agency initiative and guide (Eco-Logical 2006).
- Participate in the FHWA *Eco-Logical* grant solicitation underway (Integrating Transportation and Resource Planning to Develop Ecosystem Based Infrastructure Projects) as posted at: <http://www.grants.gov/search/search.do?oppld=13223&mode=VIEW>.
- Utilize a systems approach rather than compartmentalizing systems and efforts into separate, individual pieces.
- Pursue and use best available science and technology and expertise and interdisciplinary approaches.
- Implement ecosystem-based approaches with a focus on natural boundaries rather than jurisdictional or political boundaries.
- Use adaptive management and methods that measure and monitor results and outcomes as a basis for adapting and refining plans and activities.
- Recognizing that land use can affect either a positive or a negative response within an ecosystem, implement practices for land use planning and land management that help sustain ecosystem health.
- Coordinate and develop partnerships with the public and private sectors, as relevant.
- Coordinate with relevant activities of the International Joint Commission within the transboundary watershed area shared by Canada and the U.S. extending from the west to east coasts of North America.
- Participate in the public review of the Great Lakes Water Quality Agreement currently underway.

The following section provides a brief biography for each author.

Biographical Sketch: Judy Beck has managed the Lake Michigan team in the Great Lakes National Program Office of USEPA since 1995. Prior to this position, she served as State Relations Manager in the USEPA Region 5 Regional Administrator's Office. She began her career at EPA working in what was then the “new” Superfund Program. Judy Beck has also held non-partisan public office in Illinois, being re-elected 5 times as Commissioner of the Glenview Park District. She has also served as President of the Illinois Association of Park Districts and represents them on the Northeastern Illinois Planning Commission (NIPC). Judy graduated from Old Dominion University and did graduate work at George Washington University.

Sherry Kamke is an Environmental Specialist with the USEPA, Region 5 office. Sherry's responsibilities include implementation of the National Environmental Policy Act (NEPA). Sherry conducts environmental reviews for proposed infrastructure and transportation projects. Some of these projects involve a level of NEPA processing as environmental assessment and environmental impact statements. Sherry has also supported long-range transportation and regional planning. Sherry has a B.S. degree in Chemistry from Saint Xavier University and a M.S. in Environmental Engineering from the Illinois Institute of Technology.

Kimberly Majerus is a natural resource and GIS analyst with the Environmental Team of the FHWA-Resource Center in Olympia Fields, IL. She supports FHWA Divisions and Headquarters to deliver technical assistance and customized sessions to transportation and environmental practitioners nationwide. A 20 year career includes the Illinois Department of Transportation and Corps of Engineers and University of Illinois as project manager, environmental unit head, and GIS lab coordinator as well as President of the Illinois Environmental Council (IEC). As a Project Manager, Kimberly has implemented projects through all stages from planning to design, to construction, operations, and maintenance. Kimberly's experience includes participation in nationwide, multi-agency programs and projects. Her B.S. and M.S. degrees were earned at the University of Illinois at Urbana-Champaign.

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