International Lake of the Woods Basin Water Quality Plan of Study

Covering the Rainy-Lake of the Woods Watershed

Draft Executive Summary and Logic Models for Public Review and Comment
July 22, 2014

Kawishiwi River (A. Mast)

Steep Rock Mine (K.Saunders)

Pine and Curry Islands (K. Saunders)

Algae, Lake of the Woods (J. Taylor)

Prepared by the Lake of the Woods Basin Water Quality Plan of Study Team

How to Provide Comments on the Draft Plan of Study

This Draft Plan of Study identifies the projects and activities needed to improve understanding of the ecosystem health of the Lake of the Woods Basin (the Basin) and support a balanced, international approach to water quality management in the Basin.

Individuals and organizations with an interest in the future of the Basin are invited to review and comment on the objectives, scope and projects presented in the draft plan. Following the 30-day public review and comment period, the Study Team will prepare a revised Plan of Study, taking into account all comments received, for approval of the International Joint Commission and submission to the governments of Canada and the United States.

Comments may be submitted to the Plan of Study Team on or before August 22, 2014 in any of the following ways:

1. *In-person*, during the public consultation meetings scheduled for:

- Warroad, MN, August 11
- International Falls, MN August 12
- Kenora, ON, August 13
- Ojibways of Onigaming First Nation, ON, August 13
- Atikokan, ON, August 14
- Red Lake, MN, August 14
- Ely, MN, August 15
- Rainy River, ON, August 15.

2. O*nline*, at the Study's website: ijc.org/en_/LWBWQPOS

3. *In writing* to the Lake of the Woods Basin Water Quality Plan of Study Team:

Canadian Section Office
International Joint Commission
234 Laurier Ave. W.
22nd Floor
Ottawa, ON
Canada K1P 6K6

United States Section Office
International Joint Commission
2000 L Street NW, Suite 615
Washington, DC
USA 20440

Executive Summary

About the Draft Plan of Study

This Draft Plan of Study identifies the projects and activities needed to improve understanding of the ecosystem health of the Lake of the Woods Basin (the Basin) and support a balanced, international approach to water quality management in the Basin.

The draft plan has been prepared by the Lake of the Woods Basin Water Quality Plan of Study Team, at the direction of the International Joint Commission (the IJC). The IJC instructed the Study Team to undertake a Plan of Study to:

- identify needed scientific research to understand the underlying causes of current water quality concerns and establish what remedial actions might be most appropriate to addressing the priority issues;
- provide an analysis of what work is being done in these areas, its timing, as well as what work is still needed;
- assess the costs of any actions and the role of governments and the public in this regard; and,
- provide a basis for the IJC to report to the governments of Canada and the United States on recommended actions.

Individuals and organizations with an interest in the future of the Basin are invited to review and comment on the objectives, scope and projects presented in the draft plan. Following the public review and comment period, the Study Team will prepare a final Plan of Study, taking into account all comments received, for approval of the IJC and submission to the governments of Canada and the United States.

The Draft Plan of Study recognizes that watershed assessment and protection is at widely varying stages throughout the Basin, and that working towards Basin-wide solutions requires common goals and a balanced, binational commitment to management. The Plan also recognizes the importance of adaptive management in an ever-changing Basin.

The Draft Plan of Study builds upon considerable cooperative work and planning that has been undertaken in the Basin in recent years. This includes the ongoing assessment and reporting work of the International Rainy-Lake of the Woods Watershed Board, and the work of the International Multi-Agency Arrangement Work Group, which works to foster trans-jurisdictional coordination and collaboration on science and management activities to enhance and restore water quality in the Lake of the Woods Watershed. In addition, the recently released *Lake of the Woods and Rainy River State of the Basin Report* provides a comprehensive review of environmental conditions and existing data for this Basin, including key ecosystem concerns, the gaps in knowledge to better understand those concerns, and recommended approaches for addressing these gaps.

The preparation of this Draft Plan of Study has involved extensive engagement with public agencies in Canada and the United States, scientific and technical experts, First Nations, Métis and Tribes, and the general public. This engagement will continue throughout the remainder of the Plan of Study process.

Addressing Priority Water Quality Concerns in the Lake of the Woods Basin

Straddling the international border between Canada and the United States, the Lake of the Woods Basin is an important natural, economic and recreational resource. Its drainage area covers about 69,750 km^2 (26,930 mi^2), with nearly 60 percent located in Ontario and Manitoba and the balance in Minnesota. The area is approximately 400 km (240 mi) east-to-west and 260km (156 mi) north-to-south.

Over the past decade, attention has increasingly focused on the ecosystem health of the Basin and on the need for cooperative, binational action to address complex water quality challenges. Three such challenges are recognized as priorities:

- nutrient enrichment and harmful algal blooms;
- aquatic invasive species; and,
- surface and groundwater contamination, including heavy metals and other contaminants.

The IJC's Terms of Reference for the Plan of Study identified two other important factors, climate change and hydrology and hydrologic regulation, and several cross-cutting areas, including consideration of current organizational and institutional arrangements and programs and the importance of incorporating traditional and indigenous knowledge into the Study's analysis.

The Draft Plan of Study recommends 33 projects to address these water quality and organizational challenges. Table Ex-1 lists the projects under each of the five major themes. These projects would engage researchers from public agencies in Canada and the United States, universities, the private sector, and First Nations, Métis and Tribes.

Under each recommended project, the Draft Plan of Study outlines the objectives, description of work, organization and linkages to other projects, timing considerations, and a summary of project benefits. The final Plan of Study will include information on the estimated costs of the recommended projects.

1. Foundational Projects and Activities

This set of recommended projects and activities serve the needs of all three priority water quality challenges. They would help address knowledge and data gaps and establish monitoring systems and public engagement practices to sustain assessment and interest in the water quality and ecological condition of transboundary lakes and rivers. They are organized under two key study areas:

- projects to support the development of a comprehensive monitoring and data acquisition system that would cover critical aquatic and atmospheric parameters critical for understanding processes that result in impairment of water quality; and,
- projects to inform the public and engage First Nations, Tribes and Métis to gain a complementary perspective on water quality and water resources in the Basin that can inform scientific understanding of water quality issues and enhance appreciation of the intrinsic value of rivers and lakes.

2. Nutrient Enrichment and Harmful Algal Blooms

Over the past decade, harmful algal blooms, triggered by a variety of climatic, physical, chemical and biological factors, continue to occur in the Basin, particularly in the southern basin of Lake of the Woods and in other lakes upstream from Rainy River.

Table Ex-1
Lake of the Woods Basin Water Quality Plan of Study
Recommended Projects

Challenge	Recommended Projects
1. Foundational Projects and Activities	1. Coordinated Implementation of a Tiered Monitoring Program for the Lake of the Woods Basin 2. Review of Data Collection Programs and Monitoring in the Headwaters Regions of the Basin 3. Assessment of Monitoring Networks for Meteorological Conditions and Atmospheric Deposition of Nutrients and Contaminants 4. Development of Regional Climate Models for the Basin and Improved Public Education and Engagement on the Issue of Climate Change 5. Development of a Lake of the Woods Basin Geospatial Mapping Framework 6. Collection of Ecosystem Information and Discussions of Ecosystem Health with Indigenous Communities 7. Enhancement of the IRLWWB Website as a Public Communications Tool
2. Nutrient Enrichment and Harmful Algal Blooms	8. Mass-Balance Models for Phosphorus and Nitrogen: Towards An Understanding of the Sources and Sinks of Nutrients in the Lake of the Woods Basin 9. Application of Water Quality Models at Watershed and Basin-Wide Scales to Apportion Nutrient Sources and Run Scenarios 10. Improved Understanding of Internal Loads and Hypoxia in the Lake of the Woods 11. Application of the Phosphorus-Ferrous Conceptual Model to Lake of the Woods 12. Assessment of Nutrient Subsidies from Shorelines Due to Erosion from High Water Levels in Lakes and High Flows in Rivers 13. Development of Predictive Models of Algal Blooms Based on Hydrological Forcing, Wind Dynamics and Water Circulation 14. Application of Satellite Imagery and Remote Sensing Tools to Map and Characterize Water Quality and Algal Blooms in Lake of the Woods with Application to other Transboundary Lakes in the Basin 15. Development of Aquatic Food Web Models Focusing on How Zooplankton Communities and Trophic Structure Affect Production of Harmful Algal Blooms

Challenge	Recommended Projects
	16. Taxonomic Characterization of Algal Communities and Algal Toxins 17. Public Health and Animal Welfare Risks Including Public Alerting Mechanisms
3. Aquatic Invasive Species (AIS)	18. Binational Aquatic Invasive Species Management Team for the Lake of the Woods Basin and Development of a Binational Prevention Strategy 19. Rapid Evaluation and Implementation of Options to Manage Recent Zebra Mussel Infestation in Headwaters Areas in Minnesota 20. Ecological Impact of the Spiny Waterflea in Infested Boundary Lakes 21. Develop and Implement Adaptive Control Measures for Hybrid Cattail and Rusty Crayfish. 22. Comprehensive Assessment of Potential Invasion Risks to and within the Lake of the Woods Basin 23. Water Quality Risk Assessment for Zebra Mussels and Quagga Mussels 24. Climate Risk Assessment for Aquatic Invasive Species
4. Surface and Groundwater Contamination	25. Assessment Report on Contaminants in Water, Aquatic Sediment, and Fish 26. Spatial Survey of Contaminants of Emerging Concern 27. Assess Vulnerability of Border Waters to Contamination from Mining, Agriculture and Petroleum Transport 28. Annual Mining Effects Science Workshop
5. International Water Quality Management	29. Determine the Most Appropriate Working Relationship Between the International Multi-Agency Work Group and the International Rainy-Lake of the Woods Watershed Board 30. Feasibility of Establishing a Binational Agreement on Water Quality and Ecosystem Health of the Lake of the Woods Basin 31. Pilot Project to Apply and Adapt Minnesota's Watershed Assessment Process to Ontario Waters 32. Feasibility of Establishing a Funding Program for Non-governmental Organizations to Promote Stewardship 33. Binational Water Quality Management Framework for the Lake of the Woods Basin

Harmful algal blooms can prevent recreational usage of lakes for sport-fishing, boating and swimming, alter population densities of commercial and subsistence fisheries, cause undesirable taste and odor of drinking water and compromise water treatment facilities, and sometimes release algal toxins. Toxins are of particular concern because they threaten drinking water supplies, human health and animal welfare.

The Draft Plan of Study identifies a series of projects designed to improve understanding of what contributes to the occurrence of these blooms, to provide a platform by which nutrient abatement and bloom control solutions can be developed and evaluated, and to disseminate information about water quality conditions and harmful algal blooms to the public for safer use of basin waters.

3. Aquatic Invasive Species

Over the last 30 years, the Lake of the Woods Basin has been invaded by many non-native species that have disrupted communities in all trophic levels of the aquatic ecosystem, from algae up to fish. These invasive species include the hybrid cattail, spiny waterflea, rusty crayfish, and Rainbow Smelt. The spiny waterflea, an invasive predatory zooplankton, poses a particular challenge, as it preys upon other zooplankton, a common food sources for juvenile and small fish species. As well, zebra mussels have been reported in the headwater lakes of the Big Fork River, a tributary to the Rainy River.

There is considerable potential for these invasive species to expand their ranges in the Basin, carried downstream by rivers or inadvertently transported to other waterways by recreational boaters and other "human vectors." These threats require assessment, rapid response and a coordinated prevention plan.

4. Surface and Groundwater Contamination

The impacts of contaminants in the Basin have been greatly reduced through reductions of pollutant inputs into the Rainy River over the years. There are generally less contaminants entering the Basin than there would be in more densely populated and industrialized areas, such as areas in the Great Lakes watershed.

There are however, areas listed as federal contaminated sites, legacy contamination from past mining activity, atmospheric contamination of lakes and fish by mercury, and agricultural inputs in the central portions of the Basin. There also are concerns within the Basin over potential contamination from new mining activities including mining of low-grade metal sulfide ores in northeastern Minnesota, and gold mining in Canada. Finally, contaminants of emerging concern, which include personal care products, drugs, antibiotics, and other classes of synthetic organic chemicals, have been detected in lakes within Voyageurs National Park.

In response to these concerns, the Draft Plan of Study identifies the need for a more complete assessment of the various contaminant issues in the Basin. The goals are to improve the knowledge base about potential sources of contamination, assess vulnerability of water resources, and ensure protection measures are in place to minimize risks associated with contamination from various sources.

5. International Water Quality Management

Projects under this theme seek to strengthen international water quality management in the Lake of the Woods Basin in both the short-term and into the future. Existing collaborations and partnerships among agencies and organizations in Canada and the United States have done exceptional work towards

understanding and addressing the priority issues outlined in this Draft Plan of Study. The recommended projects are designed to fill existing gaps in how water is managed across the border and assess the feasibility of adopting more formal mechanisms that will accelerate resolution of transboundary water quality issues and ensure ongoing public engagement consistent with the spirit of the IJC's International Watershed Initiative. The end-goal of these projects is the development and adoption of a Basin-wide International Water Quality Management Framework aimed at restoring and protecting water quality in the Lake of the Woods Basin.

Looking Ahead

Effective management of water quality issues and their complex interactions with environmental, climatic, and human influences requires high quality information gleaned from monitoring, research, modelling, analysis, and public consultation. Furthermore, it requires an adaptive management framework where problems are addressed with the best information available and evaluated using sound science, and where approaches are adapted as new information is learned. Finally, it requires the will and the commitment of governments to dedicate the necessary short and long term funding and resources to share the responsibilities of managing water quality together across the border and to provide opportunities for public participation.

The projects and activities outlined in this Draft Plan of Study are recommended to fulfill clear objectives and direct the studies and analyses towards clear outcomes. These outcomes will be the basis for future development of international strategies to manage nutrients and reduce the severity of harmful algal blooms, prevent and control aquatic invasive species, and inventory and manage risks of possible surface and groundwater contamination. Together, these strategies will enable the development of a water quality management framework for the Lake of the Woods Basin. Working towards such a framework has many steps, starting with this Draft Plan of Study. Considerable work will need to be done to realize this long-term goal for the Basin.

Logic Models for the International Lake of the Woods Basin Water Quality Plan of Study

***** July 22, 2014 *****

For the POS projects, a series of preliminary logic models were developed to graphically depict linkages between the priority issues and cross-cutting themes as defined in the Directive to the Study Team and overall end-goals expected as a result of support for the POS. Use of logic models assisted with organization of recommended projects and outputs, identification of short-term (direct) outcomes and longer-term outcomes, and visualization of how all the pieces fit together.

This Appendix has five logic models that match the groups of projects described in the draft POS: Foundational Projects and Activities, Nutrient Enrichment and Harmful Algal Blooms (NE-HABs), Aquatic Invasive Species (AIS), Surface and Groundwater Contamination, and International Water Quality Management.

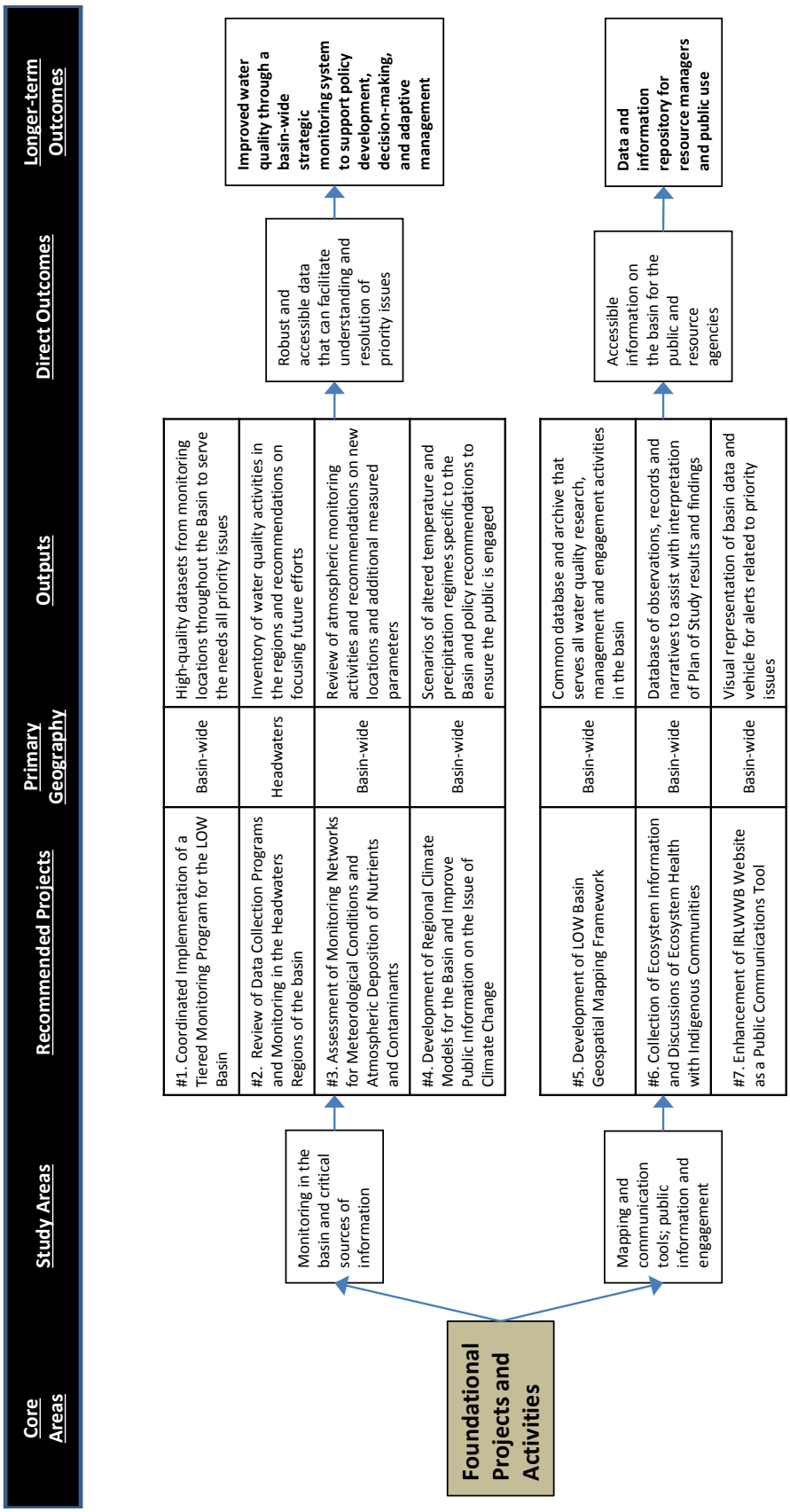
Within each logic model, the same headings are used:

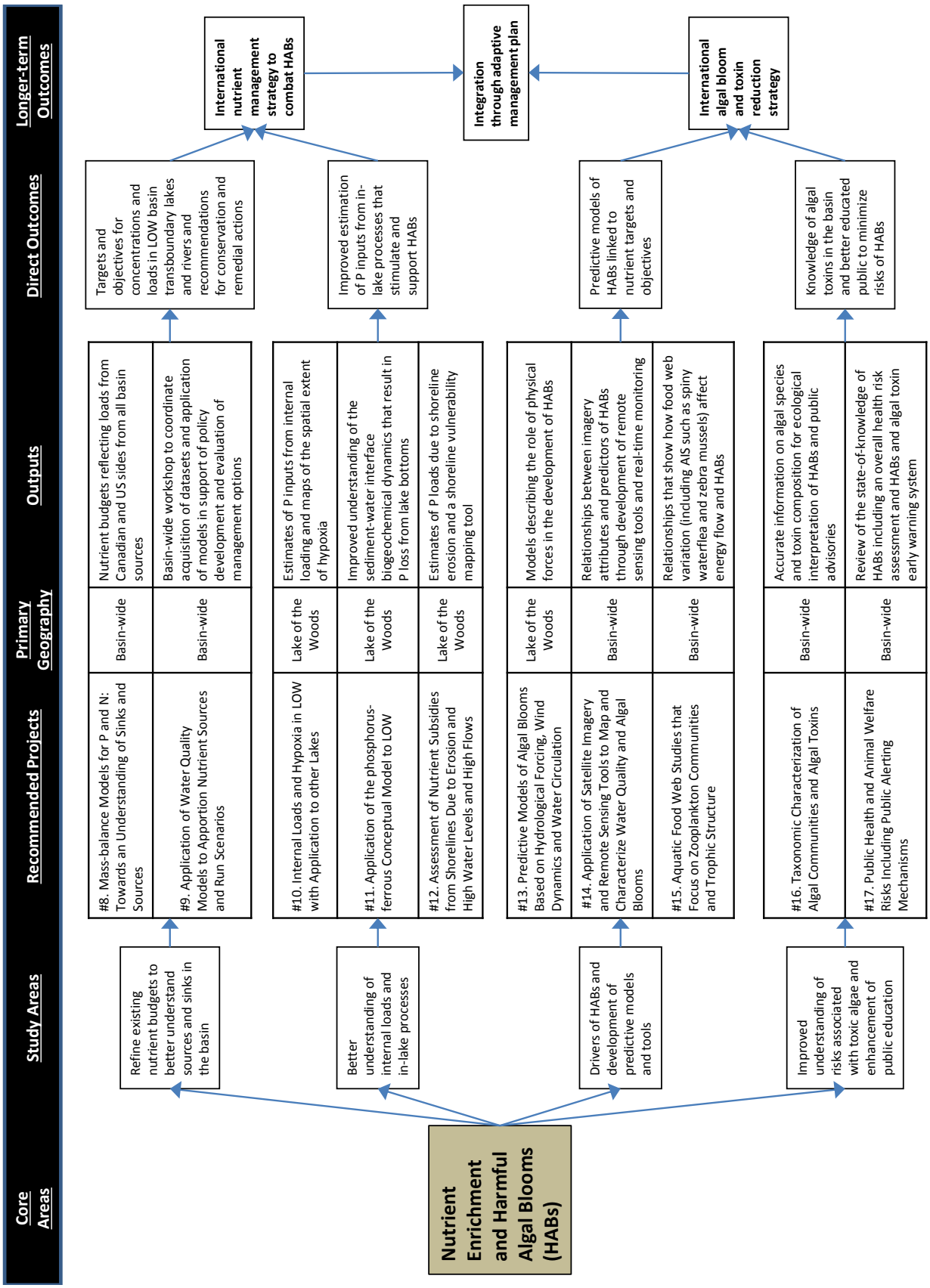
- Study Areas, which break down the high-level aggregation of projects under major headings into small groups of projects that address the same study area
- Recommended Projects and Outputs, which show the titles of each project and their specific outputs
- Primary geography, which indicates the geographic focus of the project (Basin-wide, Lake of the Woods or Headwaters)
- Direct Outcomes, which expresses the benefit of a project or projects in addressing a particular study area, and
- Longer-term Outcomes, which identify big picture goals of the POS.

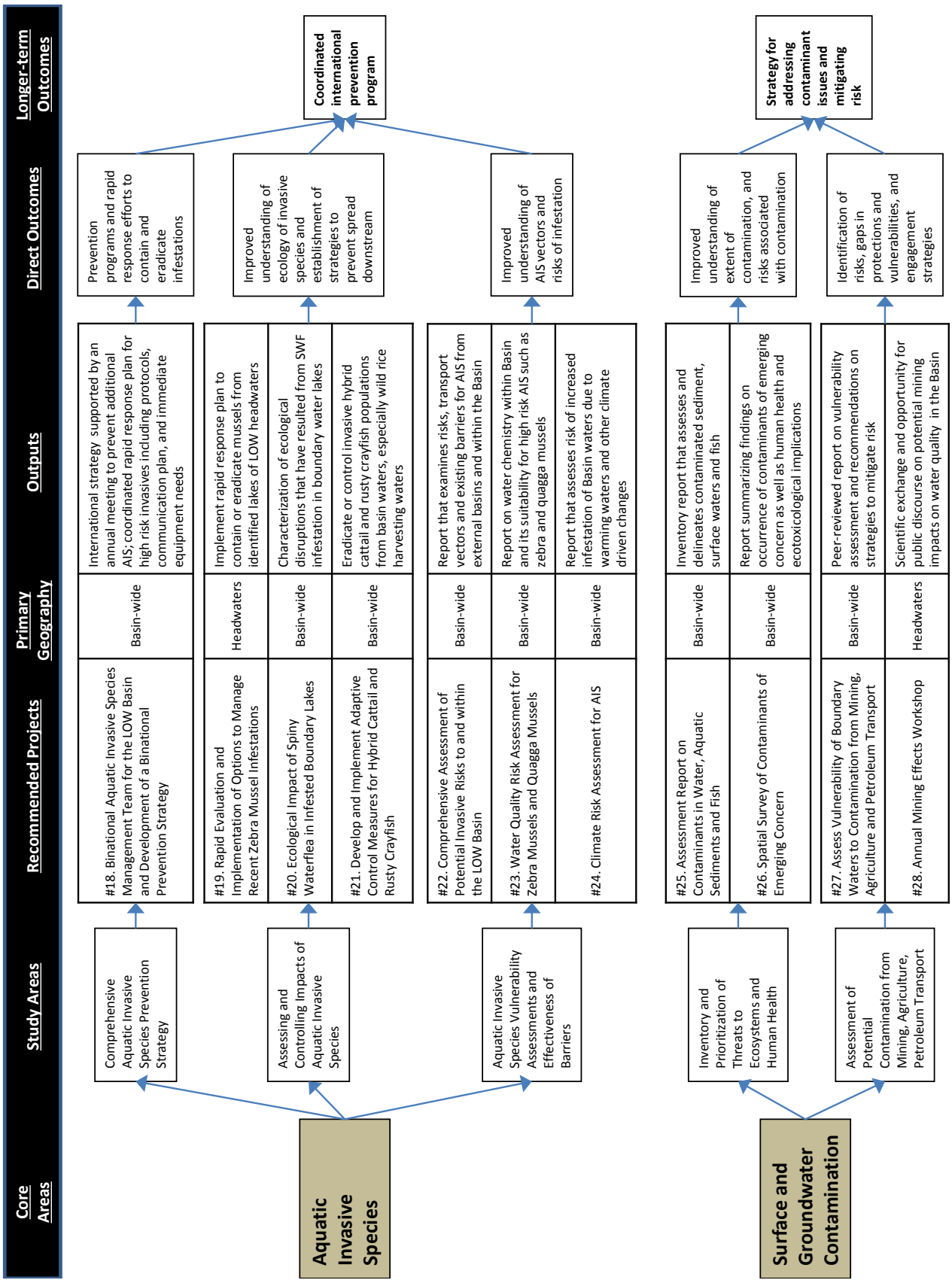
Using these logic models, there are currently 33 recommended projects. The POS team invites comments on the application of the logic model approach and on the contents of any of the components of the logic models.

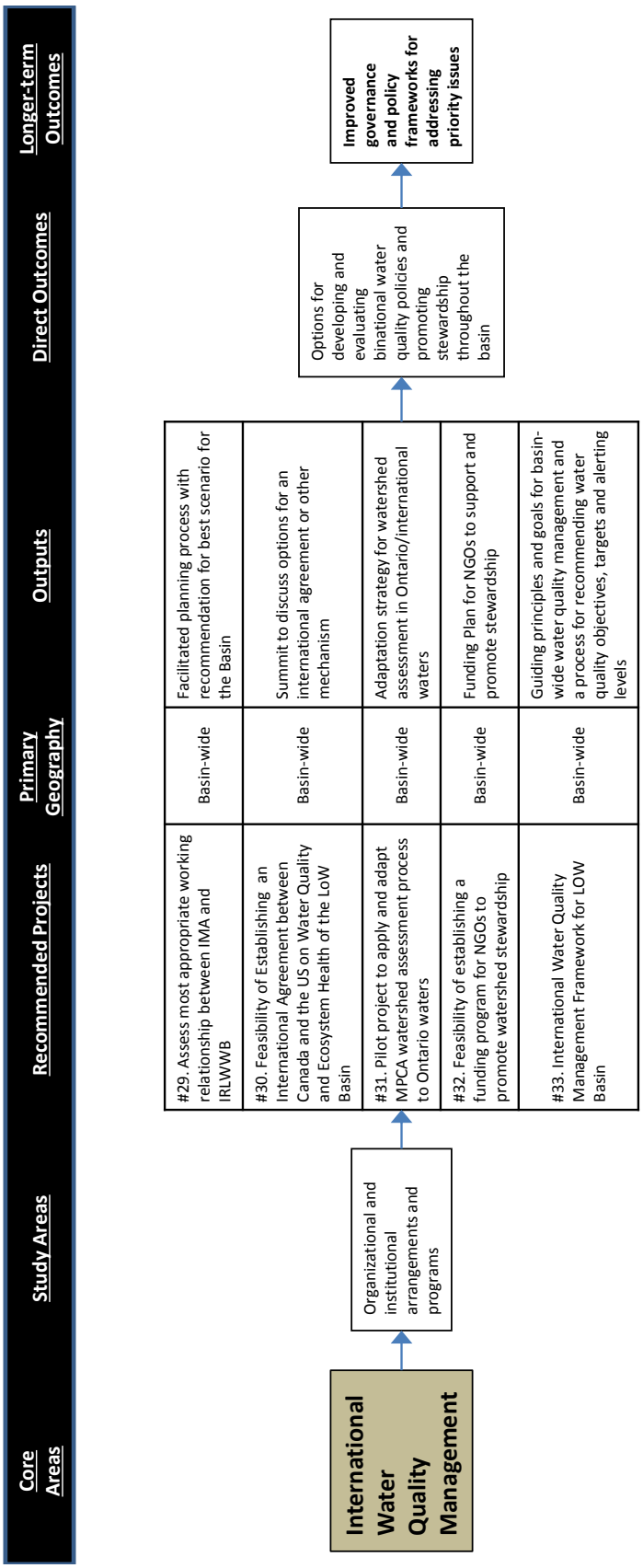
Table A1. Lake of the Woods Basin Plan of Study Preliminary Logic Models.

Plan of Study Components	Number of Projects
Foundational Projects and Activities	7
Priority Issue: Nutrient Enrichment and Harmful Algal Blooms	10
Priority Issue: Aquatic Invasive Species	7
Priority Issue: Surface and Groundwater Contamination	4
International Water Quality Management	5
Total Number of Projects	***33***


Core Areas
Study Areas
Recommended Projects
Primary Geography
Outputs
Direct Outcomes
Longer-term Outcomes
Foundational Projects and Activities
Monitoring in the basin and critical sources of information
Mapping and communication tools; public information and engagement
#1. Coordinated Implementation of a Tiered Monitoring Program for the LOW Basin
Basin-wide
High-quality datasets from monitoring locations throughout the Basin to serve the needs all priority issues
#2. Review of Data Collection Programs and Monitoring in the Headwaters Regions of the basin
Headwaters
Inventory of water quality activities in the regions and recommendations on focusing future efforts
#3. Assessment of Monitoring Networks for Meteorological Conditions and Atmospheric Deposition of Nutrients and Contaminants
Basin-wide
Review of atmospheric monitoring activities and recommendations on new locations and additional measured parameters
#4. Development of Regional Climate Models for the Basin and Improve Public Information on the Issue of Climate Change
Basin-wide
Scenarios of altered temperature and precipitation regimes specific to the Basin and policy recommendations to ensure the public is engaged
Robust and accessible data that can facilitate understanding and resolution of priority issues
Improved water quality through a basin-wide strategic monitoring system to support policy development, decision-making, and adaptive management
#5. Development of LOW Basin Geospatial Mapping Framework
Basin-wide
Common database and archive that serves all water quality research, management and engagement activities in the basin
#6. Collection of Ecosystem Information and Discussions of Ecosystem Health with Indigenous Communities
Basin-wide
Database of observations, records and narratives to assist with interpretation of Plan of Study results and findings
#7. Enhancement of IRLWWB Website as a Public Communications Tool
Basin-wide
Visual representation of basin data and vehicle for alerts related to priority issues
Accessible information on the basin for the public and resource agencies
Data and information repository for resource managers and public use


Core Areas
Study Areas
Recommended Projects
Primary Geography
Outputs
Direct Outcomes
Longer-term Outcomes
Nutrient Enrichment and Harmful Algal Blooms (HABs)
Refine existing nutrient budgets to better understand sources and sinks in the basin
Better understanding of internal loads and in-lake processes
Drivers of HABs and development of predictive models and tools
Improved understanding of risks associated with toxic algae and enhancement of public education
#8. Mass-balance Models for P and N: Towards an Understanding of Sinks and Sources
#9. Application of Water Quality Models to Apportion Nutrient Sources and Run Scenarios
#10. Internal Loads and Hypoxia in LOW with Application to other Lakes
#11. Application of the phosphorus-ferrous Conceptual Model to LOW
#12. Assessment of Nutrient Subsidies from Shorelines Due to Erosion and High Water Levels and High Flows
#13. Predictive Models of Algal Blooms Based on Hydrological Forcing, Wind Dynamics and Water Circulation
#14. Application of Satellite Imagery and Remote Sensing Tools to Map and Characterize Water Quality and Algal Blooms
#15. Aquatic Food Web Studies that Focus on Zooplankton Communities and Trophic Structure
#16. Taxonomic Characterization of Algal Communities and Algal Toxins
#17. Public Health and Animal Welfare Risks Including Public Alerting Mechanisms
Basin-wide
Basin-wide
Lake of the Woods
Lake of the Woods
Lake of the Woods
Lake of the Woods
Basin-wide
Basin-wide
Basin-wide
Basin-wide
Nutrient budgets reflecting loads from Canadian and US sides from all basin sources
Basin-wide workshop to coordinate acquisition of datasets and application of models in support of policy development and evaluation of management options
Estimates of P inputs from internal loading and maps of the spatial extent of hypoxia
Improved understanding of the sediment-water interface biogeochemical dynamics that result in P loss from lake bottoms
Estimates of P loads due to shoreline erosion and a shoreline vulnerability mapping tool
Models describing the role of physical forces in the development of HABs
Relationships between imagery attributes and predictors of HABs through development of remote sensing tools and real-time monitoring
Relationships that show how food web variation (including AIS such as spiny waterflea and zebra mussels) affect energy flow and HABs
Accurate information on algal species and toxin composition for ecological interpretation of HABs and public advisories
Review of the state-of-knowledge of HABs including an overall health risk assessment and HABs and algal toxin early warning system
Targets and objectives for concentrations and loads in LOW basin transboundary lakes and rivers and recommendations for conservation and remedial actions
Improved estimation of P inputs from in-lake processes that stimulate and support HABs
Predictive models of HABs linked to nutrient targets and objectives
Knowledge of algal toxins in the basin and better educated public to minimize risks of HABs
International nutrient management strategy to combat HABs
Integration through adaptive management plan
International algal bloom and toxin reduction strategy


Core Areas
Study Areas
Recommended Projects
Primary Geography
Outputs
Direct Outcomes
Longer-term Outcomes
Aquatic Invasive Species
Comprehensive Aquatic Invasive Species Prevention Strategy
#18. Binational Aquatic Invasive Species Management Team for the LOW Basin and Development of a Binational Prevention Strategy
Basin-wide
International strategy supported by an annual meeting to prevent additional AIS; coordinated rapid response plan for high risk invasives including protocols, communication plan, and immediate equipment needs
Prevention programs and rapid response efforts to contain and eradicate infestations
Assessing and Controlling Impacts of Aquatic Invasive Species
#19. Rapid Evaluation and Implementation of Options to Manage Recent Zebra Mussel Infestations
Headwaters
Implement rapid response plan to contain or eradicate mussels from identified lakes of LOW headwaters
#20. Ecological Impact of Spiny Waterflea in Infested Boundary Lakes
Basin-wide
Characterization of ecological disruptions that have resulted from SWF infestation in boundary water lakes
Improved understanding of ecology of invasive species and establishment of strategies to prevent spread downstream
Coordinated international prevention program
#21. Develop and Implement Adaptive Control Measures for Hybrid Cattail and Rusty Crayfish
Basin-wide
Eradicate or control invasive hybrid cattail and rusty crayfish populations from basin waters, especially wild rice harvesting waters
Aquatic Invasive Species Vulnerability Assessments and Effectiveness of Barriers
#22. Comprehensive Assessment of Potential Invasive Risks to and within the LOW Basin
Basin-wide
Report that examines risks, transport vectors and existing barriers for AIS from external basins and within the Basin
#23. Water Quality Risk Assessment for Zebra Mussels and Quagga Mussels
Basin-wide
Report on water chemistry within Basin and its suitability for high risk AIS such as zebra and quagga mussels
Improved understanding of AIS vectors and risks of infestation
#24. Climate Risk Assessment for AIS
Basin-wide
Report that assesses risk of increased infestation of Basin waters due to warming waters and other climate driven changes
Surface and Groundwater Contamination
Inventory and Prioritization of Threats to Ecosystems and Human Health
#25. Assessment Report on Contaminants in Water, Aquatic Sediments and Fish
Basin-wide
Inventory report that assesses and delineates contaminated sediment, surface waters and fish
Improved understanding of extent of contamination, and risks associated with contamination
Strategy for addressing contaminant issues and mitigating risk
#26. Spatial Survey of Contaminants of Emerging Concern
Basin-wide
Report summarizing findings on occurrence of contaminants of emerging concern as well as human health and ecotoxicological implications
Assessment of Potential Contamination from Mining, Agriculture, Petroleum Transport
#27. Assess Vulnerability of Boundary Waters to Contamination from Mining, Agriculture and Petroleum Transport
Basin-wide
Peer-reviewed report on vulnerability assessment and recommendations on strategies to mitigate risk
Identification of risks, gaps in protections and vulnerabilities, and engagement strategies
#28. Annual Mining Effects Workshop
Headwaters
Scientific exchange and opportunity for public discourse on potential mining impacts on water quality in the Basin


Core Areas
Study Areas
Recommended Projects
Primary Geography
Outputs
Direct Outcomes
Longer-term Outcomes
International Water Quality Management
Organizational and institutional arrangements and programs
#29. Assess most appropriate working relationship between IMA and IRLWWB
Basin-wide
Facilitated planning process with recommendation for best scenario for the Basin
#30. Feasibility of Establishing an International Agreement between Canada and the US on Water Quality and Ecosystem Health of the LoW Basin
Basin-wide
Summit to discuss options for an international agreement or other mechanism
#31. Pilot project to apply and adapt MPCA watershed assessment process to Ontario waters
Basin-wide
Adaptation strategy for watershed assessment in Ontario/international waters
#32. Feasibility of establishing a funding program for NGOs to promote watershed stewardship
Basin-wide
Funding Plan for NGOs to support and promote stewardship
#33. International Water Quality Management Framework for LOW Basin
Basin-wide
Guiding principles and goals for basin-wide water quality management and a process for recommending water quality objectives, targets and alerting levels
Options for developing and evaluating binational water quality policies and promoting stewardship throughout the basin
Improved governance and policy frameworks for addressing priority issues