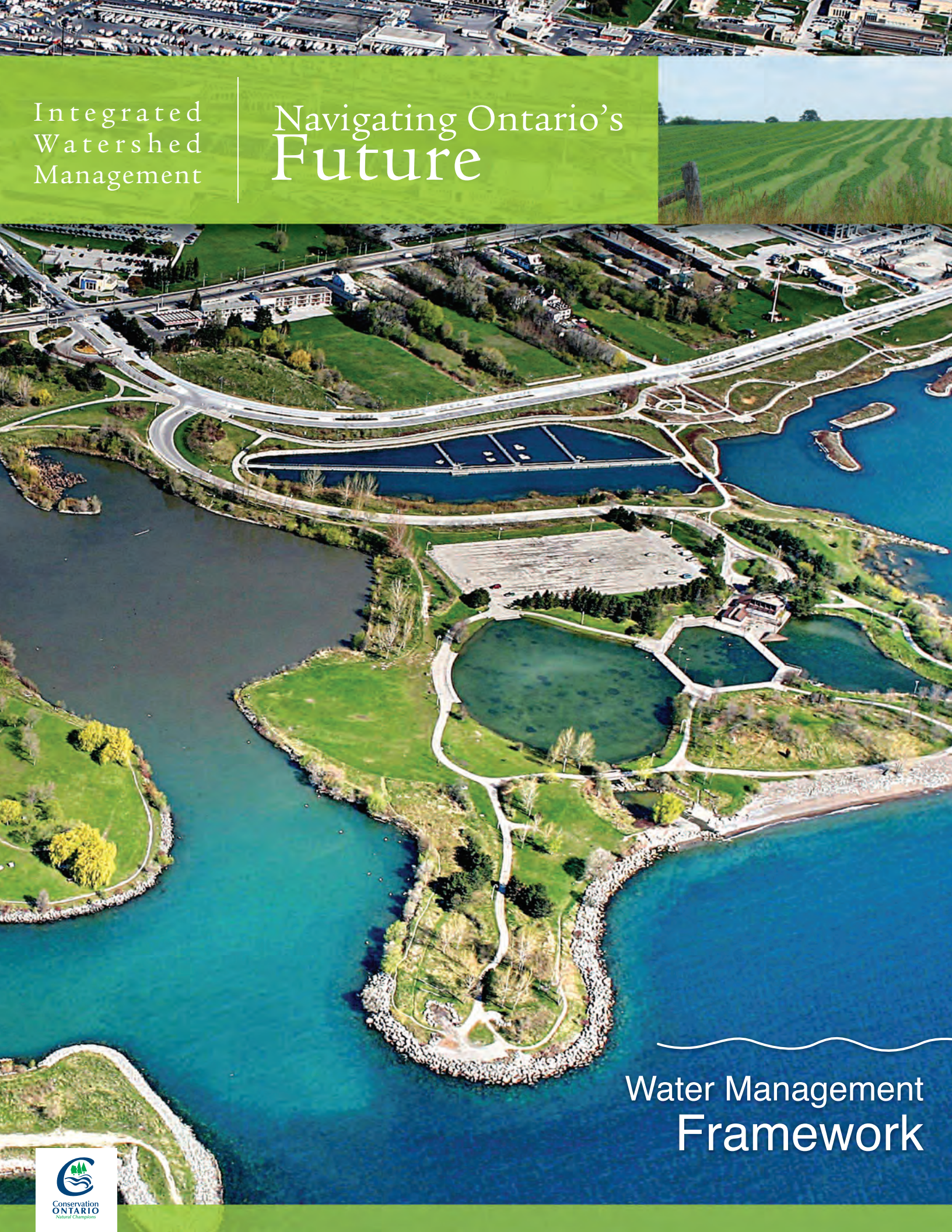

Integrated Watershed Management

Navigating Ontario's Future

Water Management Framework

Conservation ONTARIO
Natural Champions

ACKNOWLEDGEMENTS

Integral to the development of these reports were a number of individuals from various organizations who provided data, attended meetings, reviewed draft documents and provided input to the project. Significant contributions from Environmental Water Resources Group are acknowledged with regard to the Water Management Framework Report. In addition, full acknowledgement is noted with respect to the work completed by Blackport and Associates for their work on the Water Budget Synthesis Report. The facilitation of workshops and follow up summary reports provided by Kidd Consulting is also acknowledged. The work of Hazel Breton (P.Eng) on the Integrated Watershed Management Reports and overall project management of this initiative is also acknowledged.

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EXECUTIVE SUMMARY

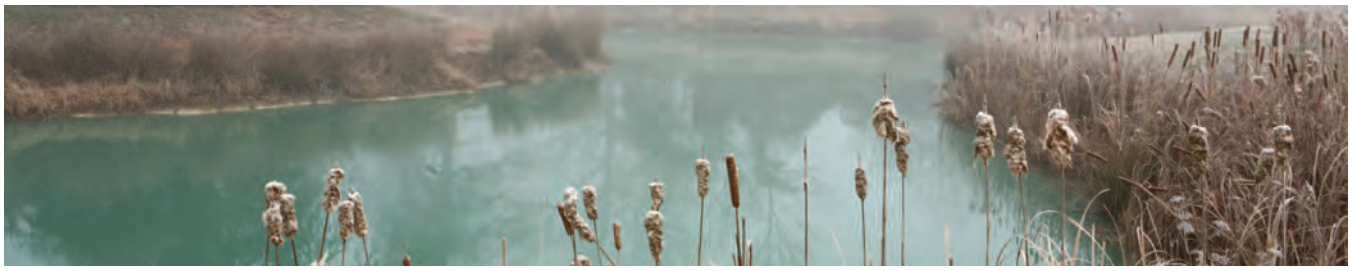
To address current and emerging issues relating to Integrated Watershed Management (IWM), Conservation Ontario in partnership with the Ministries of Environment and Natural Resources, and Fisheries and Oceans Canada launched the Integrated Watershed Management Initiative in 2008. The objective of the Initiative is to update the understanding of IWM in Ontario, assess it against IWM being conducted globally and nationally, identify gaps, and recommend strategic shifts needed to address these gaps.

As part of this Initiative, a request to explore the development of a Water Management Framework and Water Budget Overview for Ontario was made. These initiatives are discussed in separate reports. Linkages exist between these initiatives as there is a hierarchical relationship with feedback loops between them.

Water Management Issues in Ontario

Over the past ten years, we have witnessed the emergence of a number of water management issues in Ontario. While dominated by the Walkerton tragedy and the subsequent efforts to enhance the protection of drinking water, Ontario has also had to deal with significant droughts, Great Lakes issues, severe urban flooding, continuing urban development pressures and aging infrastructure. Overarching all of these are the pending implications of climate change on water resources.

The nature and scale of these issues suggest that there is both a need and an opportunity to develop a more coordinated approach to water management through a framework in the context of Integrated Watershed Management (IWM). IWM has been accepted internationally as an effective approach to managing water resources and is the cornerstone of Conservation Authority watershed-based programs.



What is a Water Management Framework?

A Water Management Framework is used to solve or address complex issues within a watershed. This tool can be equated with a blueprint or a scheme that allows us to outline a variety of functions occurring within a watershed and then analyze how they relate and impact on each other. A Water Management Framework is developed in order to address issues such as:

- Limits on surface and groundwater quantity and quality
- Many competing water users including ecosystems, municipalities, industries, etc.
- Many agencies with differing mandates

For the purposes of this report, five major water related issues were identified around our current approach to water management in Ontario and act as drivers for a water management framework. These include:

1. Gaps in research knowledge
2. Insufficient monitoring information
3. Lack of capacity (staff & funding)
4. Lack of clarity around who does what
5. Fragmented legislation

Principles

Numerous examples of water frameworks exist and in order to sort through them and assess their usefulness to Ontario, a review was carried out by a project team and input was received from a number of water experts from a wide variety of sectors and agencies. From this review, we are able to identify a number of common principles that should be considered in developing a Water Management Framework for Ontario. These principles support sustainability, use the watershed as a management unit, and consider water management against other considerations such as land, water, human uses and ecosystem requirements. As well, other principles that need to be considered include the use of Adaptive Environmental Management which ensures transparency, flexibility and stakeholder participation; use of goals and the ability to develop a unique set of solutions for different systems and places.

Integrated Watershed Management

The Water Management Framework would be applied as a natural subset within the Integrated Watershed Management (IWM) context. The IWM approach identifies water management and ecosystem issues which must be evaluated to determine their relative importance and to decide which issues will be addressed. IWM when broken down into its core components consist of water quantity, water quality and natural infrastructure. A Water Management Framework for Ontario focuses on water quantity and water quality with some connections to the natural infrastructure component as appropriate for water management only. The framework is intended as a practical guide to assist agencies with a mandate for water management to work together to fulfill their collective mandates to ensure a sustainable water resource for the Province of Ontario.

Developing the Framework

A Water Management Framework is being developed to promote a coordinated approach to management of water in order to maximize the resulting economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. The framework embraces an Integrated Watershed Management approach to water management planning. It should be noted that the water experts who were consulted on this work recommended to the project team that the framework which was originally referred to as the “Water Quantity Framework” should be renamed to “Water Management Framework”.

The proposed Framework outlines the planning direction for water management and intends to provide consistent direction while, at the same time, allowing for enough flexibility to address different situations. The Framework supports sustainable resource and environmental management as well as recognizes long term cumulative impacts. It is not intended to be a detailed plan, but rather it provides the general guidance for water management. The Framework should be reviewed and updated on a regular basis.

Elements of Water Management Framework

Characterization of System

Within an IWM context, this framework requires us to characterize the water system, which includes defining the forms and functions of the water system, identifying water management issues, prioritizing needs and establishing goals and objectives for water management. The availability of watershed and subwatershed plans can provide this information from a larger context and can be scaled up or down as well as augmented depending on the scale of the analysis.

Characterization also includes identifying natural features, linkages, surface and groundwater systems, plus quantifying precipitation, and assessing existing flow regimes, recharge areas, and identifying interconnections between aquatic, terrestrial and groundwater systems, buffers and linkages. It also examines constraints to flow including floodplains, steep slopes, erosion areas, wetlands, forests, habitat, corridors, buffers and wellheads.

Any goals and objectives that are established during the characterization phase must reflect that there are limits to changes that the ecosystem can withstand and that these limits should be considered before mitigation measures and developed to accommodate future changes.

Adverse effects of our activities cannot always be eliminated through mitigation. To ensure accountability and map progress, monitoring must take place within the water management framework.

Monitoring

There are two requirements to monitoring within the Water Management Framework. The first is to provide measurements of water supply and water demand. The second is to move towards performance monitoring of the implemented water management plans.

Current and Future Uses

Sustainable water and resources management must include the determination of existing and future water uses. Sustainability reflects both the demand and supply side of water and assessments are used to determine these requirements. Water budgets are one of the tools that allow us to determine the status of supply and demand within a watershed.

Assessments

Assessments are used to determine that status of water demand and water supply and include quantity and quality considerations. Status reflects whether supply is greater than, equal to, or less than demand. Any water management plan must acknowledge the status of demand and supply in order to select alternatives that in the long term are sustainable.

Managing Uncertainty

There are many uncertainties when managing water ecosystems including incomplete and insufficient data, gaps in scientific theory in models and unknown effects of cumulative and multiple stressors in large scale and long term scenarios.

Management Instruments

Each issue will require different solutions and a series of Management Instruments have been developed to solve a wide range of issues:

- Legislation
- Policies and programs
- Watershed plans
- Collaborative partnerships
- Institutional roles
- Education/stewardship
- Conflict resolution
- Economic considerations

Desired Management Approach

The desired management approach will pull together the best information, address the needs of the ecosystem, involve all stakeholders, recognize and acknowledge uncertainties, recognize cumulative effects and use Adaptive Environmental Management.

Implementation Plan

An implementation plan or water management plan is developed cooperatively to address single or a broad range of issues. These plans can recommend allocation, conservation, restoration, etc. They can include Source Protection Plans, Water Conservation Plans, Water Demand Plans, Water Efficiency Plans, Stormwater Management Plans and Nutrient Management Plans.

Water Management Plans should follow the Framework principles and include a summary of the issues, a description of the area, a summary of the data, consideration of the relationship of the Water Management Plan to regional strategies or other planning initiatives, recommended options and strategies to address the issues, and a list of performance monitoring requirements to ensure accountability. Lastly, a feedback loop to IWM is needed to ensure that the watershed plan is updated and that the actions associated with the Implementation Plan is consistent with the long-term watershed goals and objectives.

There are many uncertainties when managing water ecosystems – gaps in data, scientific theory and effects of cumulative and multiple stressors and long term scenarios.

Considerations for Next Steps

1. The Water Management Framework developed for this project should be reviewed and considered by key water management agencies in the Province of Ontario.

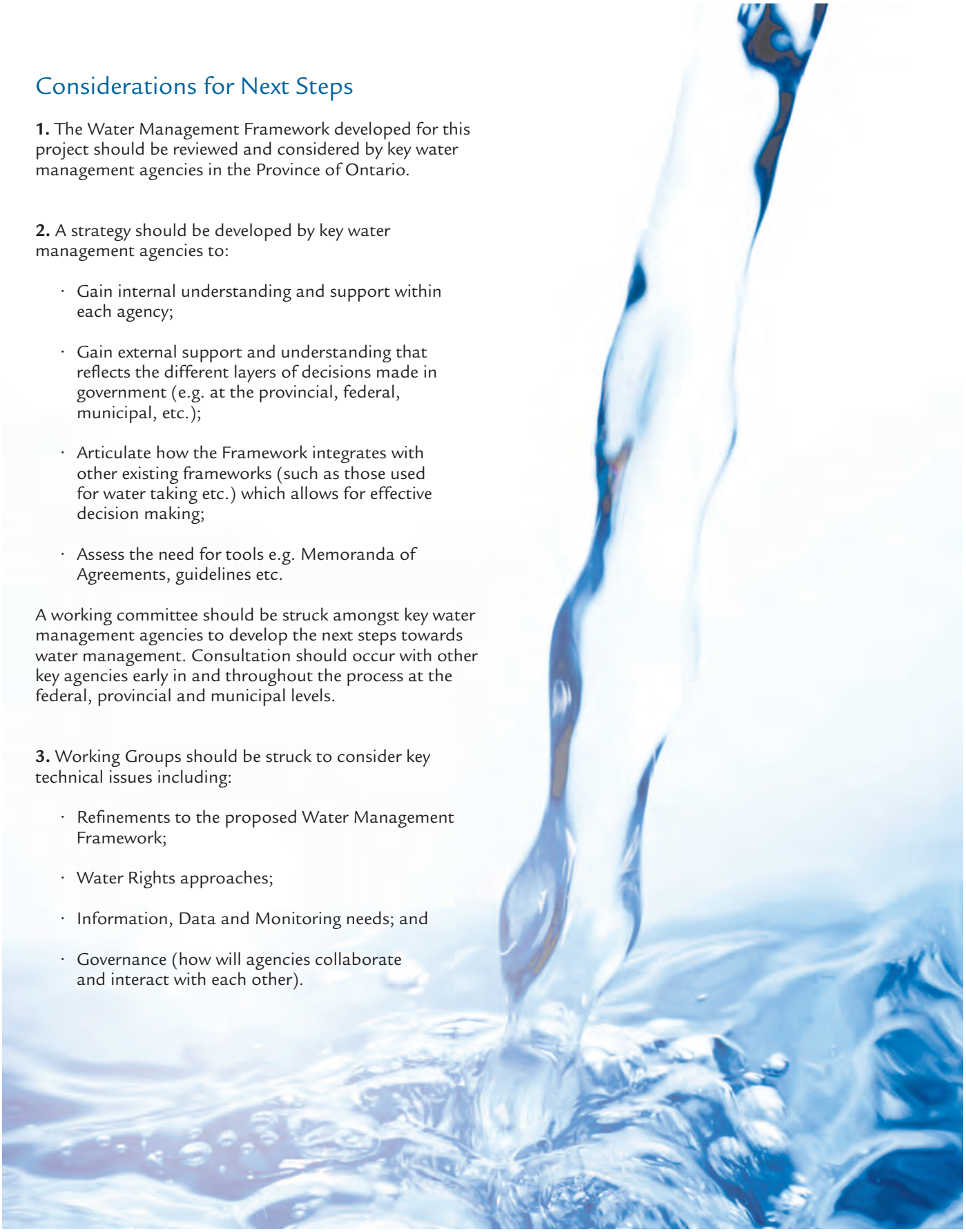
2. A strategy should be developed by key water management agencies to:

- Gain internal understanding and support within each agency;
- Gain external support and understanding that reflects the different layers of decisions made in government (e.g. at the provincial, federal, municipal, etc.);
- Articulate how the Framework integrates with other existing frameworks (such as those used for water taking etc.) which allows for effective decision making;
- Assess the need for tools e.g. Memoranda of Agreements, guidelines etc.

A working committee should be struck amongst key water management agencies to develop the next steps towards water management. Consultation should occur with other key agencies early in and throughout the process at the federal, provincial and municipal levels.

3. Working Groups should be struck to consider key technical issues including:

- Refinements to the proposed Water Management Framework;
- Water Rights approaches;
- Information, Data and Monitoring needs; and
- Governance (how will agencies collaborate and interact with each other).





1.0 | Introduction

To address current and emerging issues relating to Integrated Watershed Management (IWM), Conservation Ontario in partnership with the Ministry Natural Resources, and Department of Fisheries and Oceans launched the **Integrated Watershed Management - Navigating Ontario's Future** in 2008. The objective of the Initiative is to update the understanding of IWM in Ontario, assess it against IWM being conducted globally and nationally, identify gaps, and recommend strategic shifts needed to address these gaps. As part of this Initiative, a request to explore issues relating to the development of Water Quantity and Water Budget Assessment Frameworks for Ontario was made.
This report discusses the Water Quantity Framework, now referred to as the Water Management Framework. The IWM Initiative and Water Budget Initiative are discussed in separate reports. Linkages exist between these initiatives as there is a hierarchical relationship with feedback loops between them.

What is a Framework?

A framework is a basic conceptual structure used to solve or address complex issues. It can serve as a support or guide for the building of something that expands the structure into something useful.

A framework illustrates a set of functions within a system and how they interrelate; the layers of an operating system; the layers of an application subsystem, for example.
A framework is generally more comprehensive than a protocol and more prescriptive than a structure. Synonyms include: plan, base, shell, frame, scheme, skeleton, structure, blueprint and groundwork. All of the synonyms represent some kind of starting point, head start or foundation upon which to continue building in order to complete what is needed. Therefore the definition of "framework" could include: a set of tools, libraries, conventions, and best practices that attempt to abstract routine tasks into generic modules that can be reused.

Why do we need a framework for Water Management?

Water Management Frameworks developed to date have been designed as a result of:

- Limits On Water Quantity and Quality – Surface and Groundwater
- Many Competing Users – Natural Environment, Municipalities, Industries, etc.
- Many Agencies With Differing Mandates

What are the key principles underlying a water management framework?

Numerous examples of water management frameworks exist. A review of the underlying principles that were used to set up such frameworks in Canada for Alberta was performed with a view to assessing their applicability to Ontario. A number of principles that should be considered in developing a Water Management Framework for Ontario include:

- sustainability;
- the framework should be based on watershed units;
- use of an ecosystem approach that considers land, water, human uses and ecosystem requirements;
- use of Adaptive Environmental Management;
- stakeholder participation;
- consideration of issues relating to scale;
- transparent governance;
- use of a goal oriented approach; and
- use of unique solutions for different systems and places.

What are the water related issues?

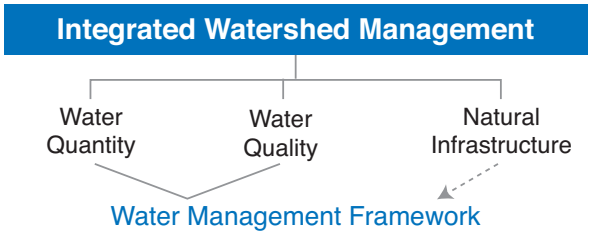
In the research that was carried out, five major issues have been identified that need to be addressed by Water Management Frameworks including:

- gaps in water research knowledge;
- insufficient monitoring information;
- capacity (lack of funding and staff);
- coordination and participation (lack of clarity with respect to roles and responsibilities); and
- fragmented legislation.

How was this work done?

Integrated Watershed Management
The Water Management Framework would be applied as a natural subset within the IWM context. The IWM approach identifies water management and ecosystem issues that must be evaluated to determine their relative importance and to decide which issues will be addressed. IWM, when broken down into its core components consists of water quantity, water quality and natural infrastructure. A Water Management Framework for Ontario focuses on water quantity and water quality with some connections to the natural infrastructure component as appropriate for water management only. Figure 1 shows a visual schematic. The framework is intended as a practical guide to assist agencies with a mandate for water management to work together to fulfill their collective mandates to ensure a sustainable water resource for the Province of Ontario.

Figure 1



The water budget work would be a subset of the water management framework and as indicated earlier is the subject of a separate report.

A project team consisting of representatives from Conservation Ontario, Environmental Water Resources Group, Blackport Hydrogeologists and Kidd Consulting was retained. A search was conducted to secure examples of water management frameworks. A number of water experts (water resources engineers, hydrologists, hydrogeologists, water quality specialist, monitoring specialists, biologists) from Ontario from various sectors (consulting, municipal, provincial, conservation authorities, academia and federal) were contacted and asked to participate in two workshops in 2009.

The first workshop was designed to explain the initiative, gain feedback on key environmental issues and challenges facing Ontario now and in the near future; assess the need for a water management framework; and discuss what the elements of such a framework might be. The second workshop was designed to obtain feedback on the proposed water management framework suggested by the project team. Appendix 1 contains the notes from each workshop. Throughout this process, numerous working sessions were held amongst project team members in order to assimilate the research conducted, assess input obtained from the Ontario water experts and bring the project team's collective professional experiences to bear before finalizing the proposed water management framework.

How is this report laid out?

Section 1 gives a brief introduction and background on the IWM Initiative and its connection to a Water Management Framework is described. A brief description of frameworks is provided along with the general principles that have been applied to Water Management Frameworks by others. Finally, the process that was followed to arrive at a Water Management Framework for Ontario is briefly described.

Section 2 builds on the work presented in Section 1 and offers an Ontario context on the question of why a Water Management Framework is needed.

Section 3 describes the recommended Water Management Framework for Ontario and provides a discussion on the component elements.

Section 4 describes how the Water Management Framework should be used in Ontario.

Section 5 offers considerations for next steps.

The Water Management Framework is intended as a practical guide to assist agencies with a mandate for water management.

2.0 | Need for a Framework

The past ten years has witnessed the emergence of a number of water management issues in Ontario. While dominated by the Walkerton tragedy and the subsequent efforts to enhance the protection of drinking water, Ontario has also had to deal with significant droughts, Great Lakes issues, severe urban flooding, continuing urban development pressures and aging infrastructure. Overarching all of these are the pending implications of climate change on water resources. The nature and scale of these issues suggest that there is both a need and an opportunity to develop a more coordinated approach to water management through a framework in the context of Integrated Watershed Management (IWM). IWM has been accepted internationally as an effective approach to managing water resources and is the cornerstone of Conservation Authority watershed-based programs.

Climate Change · Urbanization · Great Lakes Issues · Aging Infrastructure

2.1 What objectives should a water management framework have for Ontario?

Participants at the first water experts' workshop suggested that a Water Quantity Framework (subsequently renamed by the group to Water Management Framework) should aim to:

- address both excess of water and lack of water through mechanisms such as flood and drought management plans;
- address ecosystem needs (such as in-stream flow);
- protect water quality;
- consider the quality aspects of water quantity (for example, impacts on water quality from stormwater discharges or the reduction of baseflow;
- manage surface water and groundwater in an integrated fashion;
- require the use of the best information available in decision-making;
- recognize a range of possibilities, given incomplete knowledge and uncertainties including the uncertainties associated with climate change;
- assume the likelihood of higher variability (e.g., in temperatures) and use the precautionary principle (e.g., require greater setbacks);
- consider cumulative impacts;
- be flexible to address and adapt to climate change;
- address the issue of allocations and potential conflicts in water use;
- be transparent;
- be reviewed on a regular basis;
- integrate science and the needs of the community;
- move to risk based planning and decision-making; and
- address major stressors including population growth and land use changes.

2.2 Key Themes for a 'Made-in-Ontario' Water Management Framework

In a discussion that followed after raising the above points, the water experts made a strong recommendation to the project team that the framework should be renamed from the original "Water Quantity Framework" to "Water Management Framework".

In synthesizing the above discussion, key themes for the objectives of a made-in-Ontario framework are:

- **Communication:** There is a need to better communicate both the rationale for improved water quantity management in Ontario (including dispelling the "myth of abundance") and the benefits (including economic) of better managing our water.

- **Precautionary Approach:** Given the lack of complete knowledge and the looming specter of climate change, decision-makers should recognize a range of possibilities, assume the likelihood of higher variability in the future (e.g., in terms of temperature and rainfall) and use the precautionary principle.

- **Adaptive Approach:** It is critical to manage water quantity using an Adaptive Environmental Approach which integrates monitoring, adaptation and periodic review.

- **Data and Information Support:** Decision-makers need to understand the fundamental importance of data and information in the management of water quantity, and need to increase the funding available to fill key environmental monitoring and science needs. Key science needs include the collection of data on evapotranspiration, stream flow and instream needs.

- **Information-Based Decision-making:** Decision-makers should use all available and relevant information (e.g., when deciding whether or not to issue a Permit to Take Water).

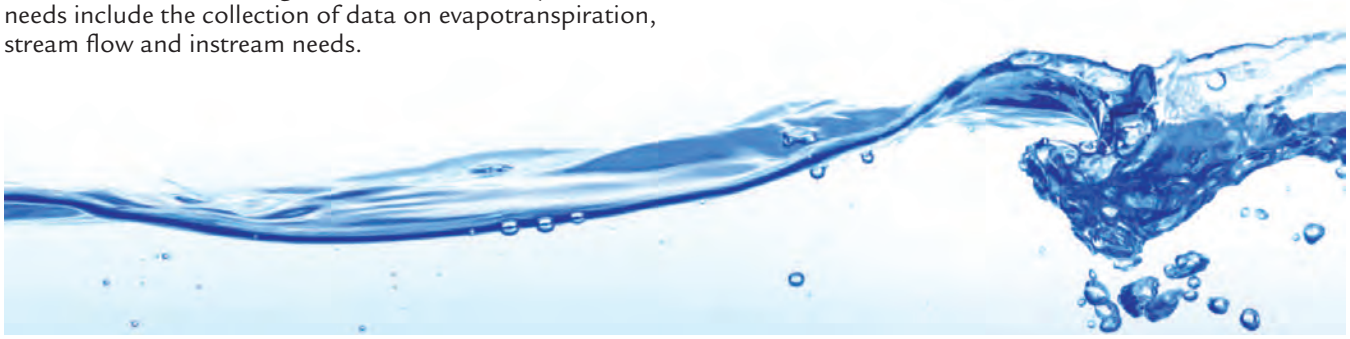
- **Provincial Direction:** The Province should provide stronger policy direction with respect to water management, through a revised Provincial Policy Statement under the *Planning Act*, or through other means.

- **Flexibility:** Despite the need for stronger Provincial direction, the policy framework for water management should respect and allow for innovation and flexibility in order to meet local needs and conditions.

- **Tools:** There is a need for better tools to help improve water management. This includes improved guidance for how and when to carry out water budgeting, sharing of models, improved regional information on aquifers, and systems to allow and encourage the sharing of data.

- **Coordination:** To improve water management, agencies and municipalities need to communicate with each other better and work better together.

- **Consideration of Ecosystem Needs:** It is critical that more consideration be paid to ecosystem needs in decision-making.



2.3 What are the key environmental and related issues/challenges/barriers facing Ontario?

A wide range of feedback was received at the workshop. This ranged from "high level" commentary on the lack of a cohesive approach to managing water to detailed comments on the need to develop criteria to expedite data sharing. The project team synthesized the feedback as follows:

- Move to a more rigid regulatory process stymies innovative designs and approaches (examples were provided where existing regulations have been quoted as the reason for not taking alternative innovative approaches).
- Need to consider ecosystem needs in decision-making (e.g., in-stream flow).
- Need to protect funding for science and monitoring as past and current trends have been to decrease funding.
- Need to identify the risks of taking no action (or insufficient action) to protect the environment.
- Address the lack of consideration of economics in planning and decision-making.
- Places to Grow allocates growth without considering implications on the environment and infrastructure.
- Need for a framework for community-based local solutions in order to improve our engagement of all stakeholders when making decisions on a local basis.
- Need to better engage municipalities in protecting the environment.
- Need to address municipal request for proposals that are overly rigid e.g. master planning contracts (i.e., that don't allow flexibility).
- Need to better understand how municipal infrastructure integrates with natural infrastructure.
- Need to address climate change and the issues of flooding and drought brought on by changes in hydrologic conditions.
- Need to evolve from deterministic target-driven regulations to risk-based approaches
- Need to address the lack of a vision for water sharing.
- Need to dispel the myth of water abundance that is shown to be the case in recent surveys of the attitudes of Canadians to water.
- Decision-making sometimes doesn't reflect the best knowledge available (e.g. getting agencies to accept the results from watershed studies).
- Need to educate legislators and users as to how regulations and policies interrelate across the Province.
- Need to use plain language in regulations.
- There is a lack of common understanding of how groundwater divides should be treated when they don't match up with surface watersheds.
- Address reductions in monitoring surface water that have been declining over the years (e.g. reduction in parameters and numbers of stations for the water quality network).
- Need to look at the potential for storage of water on the landscape to provide a supply of water during droughts.
- There is a lack of integration of information on watersheds (e.g., information obtained through the Source Water Protection process not being accepted by some agencies).
- Good science can be diluted by politics.
- Need to consider water quantity in concert with water quality (including temperature).

2.4 What are the gaps in the current approach to water management in Ontario?

The issue of water governance in Ontario has been the subject of many discussions over the years. A provincial strategy to identify who does what and how a cohesive approach can be developed to meet the imminent water challenges that Ontario must face is needed. In addition, a provincial policy statement on water management is necessary to provide direction to decision makers.

Consensus was achieved by the water experts consulted as well as the project team that a Water Management Framework should be developed that includes reviewing existing regulations, policies and programs and linking them together, as a start, within the existing system. It was agreed that for this to be achieved, provincial agencies must first agree on the recommendations for a Water Management Framework.

3.0 | Developing the Water Management Framework

The public wants a safe, secure supply of drinking water with healthy aquatic ecosystems for a sustainable economy. To fully guarantee safe drinking water, the source of water (i.e., groundwater, lakes, and rivers) must also be protected in terms of quantity and quality. Water management is complex, multi-disciplinary and is inseparable from issues of values, equity, and social justice thus, requiring a participatory approach to management.

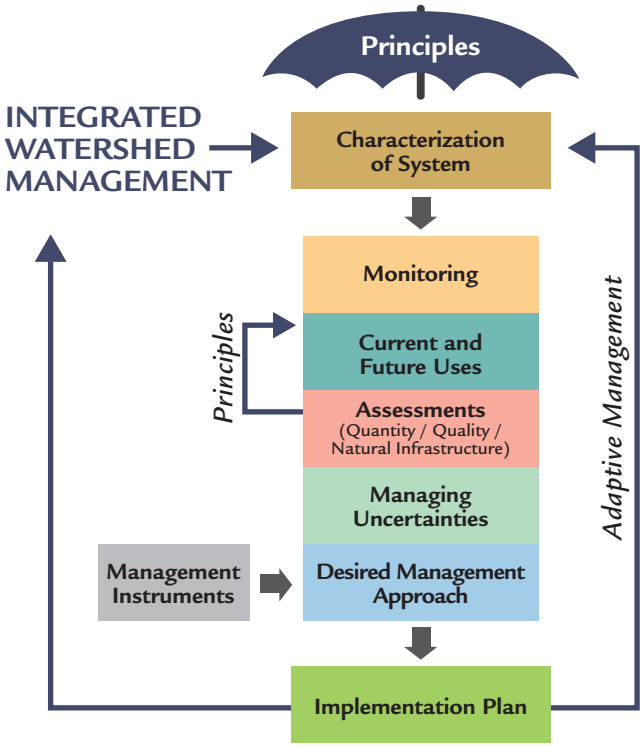
A Water Management Framework is proposed to promote a coordinated approach to management of water, land and related resources in order to maximize the resulting economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. The framework embraces an Integrated Watershed Management approach to water management planning.

The proposed Water Management Framework (Figure 3 - 1) outlines the planning direction for water management. The Framework is intended to provide consistent direction, while at the same time allowing for enough flexibility to address different situations. The Framework supports sustainable resource and environmental management, and recognizes long term cumulative impacts. The Framework applies to streams, rivers, lakes, aquifers and wetlands. The Framework is not intended to be a detailed plan rather it provides general guidance for water management. There is a constant need to re-evaluate the Framework and modify it where necessary.

The remainder of Section 3 describes each of the elements or boxes shown on Figure 2.

What follows is an outline for a structure that conforms to the definition of a framework for water management.

Figure 2: Water Management Framework



3.1 Principles

The principles discussed in this section recognize the following:

- There are limits to the available water supply. Water must be managed to meet current and future needs. A clean, abundant supply of water is necessary for uses such as human well being, drinking, swimming, irrigation, industrial processes, and the generation of electricity.
- Healthy aquatic ecosystems are vital to a prosperous economy and balanced economic development. Water is a vital component of the aquatic ecosystem, including the diversity of aquatic life.
- There is an interdependence of water quality, water quantity, and natural resources.
- There are many stakeholders when it comes to water management.

The following principles permeate through all elements in the Water Management Framework shown in Figure 2:

- Must be sustainable
- Based On Watershed Units
- Uses An Ecosystem Approach
- Based on Adaptive Environmental Management
- Provides Transparent Governance
- Considers Different Scales
- Is Goal Oriented
- Allows for Flexibility & Innovation
- Provides for Multiple Outcomes/Unique Solutions
- Uses a Long Term Time Frame

Water must be managed to meet current AND future needs.

3.1.1 Must be Sustainable

Any Water Management Framework must be premised on the concept of a sustainable, safe secure water supply. Water is vital to the survival of the natural ecosystem of which humans are a part. Failure of the ecosystem has dire consequences from an economic and social perspective.

3.1.2 Uses an Ecosystem Approach

A Water Management Framework must consider the full range of environmental, social, health and economic uses. It must be comprehensive and integrated. An ecosystem approach must be one of the core principles of any Water Management Framework.

The ecosystem approach is one of the most important principles of the water management framework. It requires taking into consideration the effects of actions on every element of an ecosystem, based on the recognition that all elements are linked. Within the Framework, ecological goals must be treated equally with economic and social goals.

The ecosystem consists of air, land, water and living organisms (including people) and the interactions among them. A water ecosystem includes all water, whether flowing or standing, the processes, factors and natural cycles which affect it and the organisms that live in the water. Sustainable water management requires that adverse impacts be prevented or minimized over the long term to ensure the water ecosystem's overall integrity. Ecosystems have limits to the stress that must be realized before the ecosystems are irreversibly degraded or destroyed.

Instream flow need is a scientifically determined amount of water, flow rate or water level that is required in a water body to sustain a healthy ecosystem. Included are human needs such as recreation, tourism, transportation, navigation, hydro power, waste assimilation, and aesthetics.

3.1.3 Based on Watershed Units

Water management is most effective when based on watersheds rather than political boundaries such as towns, municipalities and cities. Development activities have an impact on water and the rate flow at downstream locations. Water management can address water quantity, community and habitat issues beyond the scope of single jurisdictions like towns and municipalities. Therefore, watersheds are logically the most appropriate units for managing water. Watersheds form a natural unit that provides a hierarchy to examine cumulative impacts over time and space. Watersheds integrate physical, chemical, and biological processes of an ecosystem.

A watershed may drain to a lake, wetland, creek or river. Major river basins are made up of smaller watersheds. Water management in a smaller watershed must consider implications to the major river basin.

The province of Ontario, through their support of Conservation Authorities, has practiced water management on a watershed basis for several decades. Some municipalities have also recognized the need to evaluate land use development within a watershed.

3.1.4 Based on Adaptive Management

Current knowledge on ecosystem management is fraught with uncertainty. A Water Management Framework must recognize this and be responsive and flexible. The Framework must respond to new scientific information, shifts in social preference, and be adaptable to technological innovations, and new situations.

Adaptive management is a cyclical decision making process that improves practices and policies from previous outcomes. Adaptive management is about learning. The process is proactive in dealing with uncertainty. Water management deals specifically with the protection and conservation of water and aquatic ecosystems that are fraught with uncertainty.

Adaptive management traditionally has the following six steps :

1. Identify and assess any water management issues;
2. Examine alternatives and select a plan to mitigate the issues;
3. Implement the plan by working with the appropriate agencies, individuals, organizations;
4. Monitor and analyze the plan;
5. Evaluate the monitored data; and
6. Adjust the plan thereby completing adaptive management cycle.

3.1.5 Provides Transparence Governance

In the Province of Ontario each landowner whose property abuts a natural watercourse has the right to the non-consumptive use of water. In addition, there are several Ministries involved in regulating the use of that water. However, there are limits to quantity of water available within Ontario. Several municipalities have already reached those limits in Southern Ontario. If water supplies are limited then it can be envisioned that water allotment will sooner or later be implemented. Given Ontario's historical perception of abundant water supplies it is important that any Water Management Framework provide the following elements of governance:

Collaborative - those persons affected by decisions should be consulted before action is taken;

Fair and Transparent - decision-making processes will be fair and will provide those affected with access to the relevant information;

Understandable - decisions and processes will be straightforward, and not open to a wide range of interpretation; and

Accountable - lines of accountability for developing and implementing water management plans must be clear. Decision-makers must be accountable for their actions.

3.1.6 Considers Different Scales

The Water Management Framework must be able to cross the many ecological and social scales that exist for any water management issue. Issues can exist at groundwater shed, watershed, subwatershed, and 'reach' levels. In addition, issues can exist at the international, national, provincial, county, and municipal levels. In addition, management issues may develop between regulators, corporations, and the many property owners.

For success, the Water Management Framework must have cross scale collaboration to solve the many water management issues.

3.1.7 Goal Oriented

The Water Management Framework requires that the implementation plan be goal oriented. The implementation plan is monitored in order to determine if the goals are being met. Goals could include public health, ecosystem sustainability, and economic efficiency.

3.1.8 Allows for Flexibility and Innovation

Lack of understanding of ecosystem needs, and gaps in scientific knowledge require the integrated framework be flexible and innovative. In times of droughts, useful tools include water sharing agreements, voluntary restrictions, modified dam operations, and revised irrigation schedules to name a few.

3.1.9 Provides For Multiple Outcomes and Unique Solutions

Water Management Frameworks must lead to solutions that are unique and responsive to many different issues. As a result, the Framework should be designed to accommodate multiple possible outcomes and solutions.

3.1.10 Uses a Long Time Frame

Solutions for water issues will not be solved in relatively short time frames and this require long term planning. The lack of understanding on ecological issues and water management requires a long term time frame to allow for the ecosystem to react to changes as well as allowing for implementation of adaptive management measures.

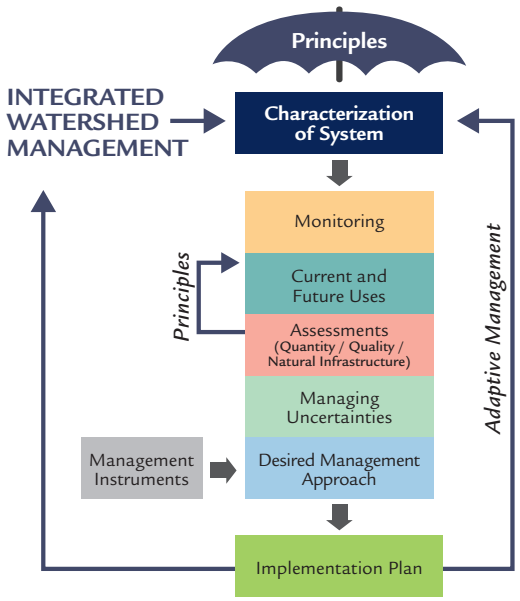


Figure 2 - 1: Characterization of System

3.2 Characterization of the System

Characterization is an important step in managing water and the associated ecosystems. Characterization includes the following:

- Describing the Form (e.g. features such as springs), Function (e.g. connection of springs providing cold water to a nearby stream) and Linkages (e.g. spring provides a cold temperature environment for a coldwater fishery in that nearby stream) of the Water System;
- Identifying Water Management Issues;
- Prioritizing Needs; and
- Establishing Goals and Objectives for Water Management.

3.2.1 Integrated Watershed Management

Characterizing the water system will include defining the form, function and linkages of the natural ecosystem. Watershed/subwatershed plans can provide this information from a larger context and can be scaled down or up and augmented depending on the scale of analysis. This step includes the identification of natural features, linkages, surface and groundwater systems. Identification will include aquatic and terrestrial habitats and the quantity of surface and groundwater resources, relationships, and water related dependencies.

Characterization will include quantifying precipitation (rainfall and snowfall) groundwater, and surface water. Identification will include existing flow regimes (peak flow volume and rates), existing water balance (recharge areas, rates and sensitivity), features and functions of the natural heritage system (interconnections between and among aquatic, terrestrial and groundwater systems, buffers and linkages), and constraints (floodplains, steep slopes, erosion areas, wetlands, forests, habitat, corridors, buffers, wellheads).

3.2.2 Water Management Issues

Integrated Watershed Management can identify water management and ecosystem issues through watershed/subwatershed plans. The identified issues must be evaluated to determine their relative importance and prioritized.

Water management issues can be categorized in terms of the need for preservation, protection, enhancement, and rehabilitation. All stakeholder issues must be identified at an early stage. Main issues may include the following:

- Downstream flooding and erosion
- Fisheries and habitat destruction
- Recreation opportunities
- Water-takings, water uses, and water conservation
- Ground water recharge / discharge and baseflows
- Municipal servicing needs

3.2.3 Prioritization of Needs

Usually, there are many issues to be resolved during the development and implementation of any water management plan. There will be a need for the prioritization of issues in order to effectively manage resources.

3.2.4 Goals & Objectives for Water Management

Goals and objectives should be established during the Characterization phase. These goals and objectives may be refined at a later stage. Preliminary goals should determine what resources are to be preserved, protected, enhanced, or rehabilitated.

The goals and objectives must reflect that there are limits to changes that the ecosystem can withstand and that these limits should be considered before compensation measures are developed to accommodate future changes. Adverse effects of human activity cannot always be eliminated through compensation measures and such measures cannot replace good planning.

The establishment of goals and objectives must adhere to the principles of Integrated Watershed Management as manifested in watershed/subwatershed plans as well as those that are developed for a Water Management Framework.

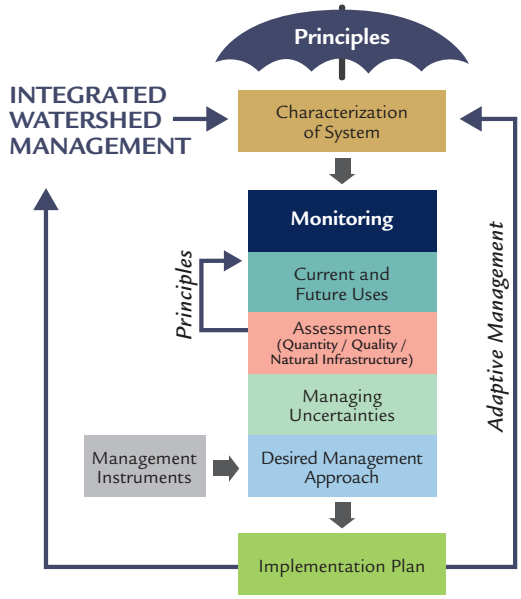


Figure 2 - 2: Monitoring

3.3 Monitoring

There two requirements to monitoring within the Water Management Framework. The first is to provide measurements of water supply and water demand. The second is towards performance monitoring of the implemented water management plans.

3.3.1 Water Measurement

Water measurement includes all the components of a data measurement system. It includes the design of the measurement system, data retrieval, data storage, analysis and synthesis of the data, dissemination of the data, and compatibility with other data systems.

Water measurement can include all of the components of the hydrologic cycle. The term includes climatological measurements as well as water quantity and quality measurements. It can include groundwater quantities, surface water quantities, flow rates, and includes the withdrawal and discharge of water for human uses.

Our ability to make sound decisions on the management of water is dependent on our understanding of the quantity and quality of water that is available for ecosystem needs. The accuracy of the quantity and quality of water for human uses is probably high in comparison of the accuracy of groundwater and surface water supply quantity and quality. It can probably be said by the many water managers that we will never have enough accurate information with regard to quantity and quality of water supply and water demand. Therefore, it is imperative that water measurement is an integral component of a Water Management Framework.

3.3.2 Performance Monitoring

The implementation of a water management plan resulting from the application of a Water Management Framework and targets set within that plan may take years to achieve. Monitoring allows water managers to assess performance of the plan components and to adapt to unexpected results. As part of the adaptive management process performance monitoring is critical to success.

The performance monitoring includes developing indicators to be used to measure the success of the implementation plan, the target values, and knowing the variability of these indicators. The proponents of water management plans are responsible for monitoring and reporting.

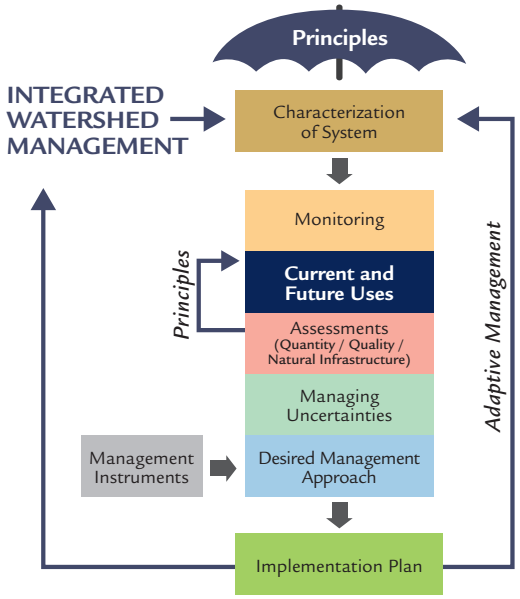


Figure 2 - 3: Current and Future Uses

3.4 Current and Future Uses

Sustainable water management must include the determination of existing and future water uses. Sustainability reflects both the demand and supply side of water. Water management plans will require the determination of the balance or status of water supply and water demand within a watershed. In order for sustainability to be achieved demand must be less than supply. Before future issues can be resolved it is important to determine if current demand is greater than supply.

Current water use quantities or demand include both the temporal and spatial needs within a watershed. Current water use reflects demand from human needs as well as needs from other ecosystem users.

Water uses include the following:

Anthropogenic

- Drinking Water Supply
- Wastewater Assimilation
- Hydro/Dams
- Shipping
- Irrigation
- Stormwater
- Industrial Uses
- Recreation

Other Ecosystem Needs

- Aquatic
- Riparian
- Terrestrial

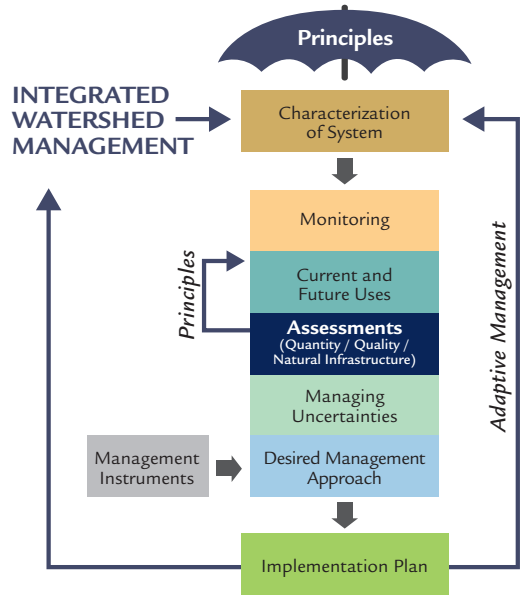


Figure 2 - 4: Assessments

3.5 Assessments

Assessments are a critical part of water management. Assessments are used to determine that status of water demand and water supply and include quantity and quality considerations. Status reflects whether supply is greater than, equal to, or less than demand. Any water management plan must acknowledge the status of demand and supply in order to select alternatives that in the long term are sustainable. In addition, the degree of supply greater than demand will allow the determination of future water uses.

Water budgets are one of the tools that allow us to determine the status of demand and supply within a watershed. Water budgets involve the determination of quantities and rates of water movement throughout the watershed. Water budgets determine the rates of groundwater recharge / discharge, the rate of streamflow at both a temporal and spatial scale. Water budgets should be completed for all watersheds and fed into all types of water management plans. They can be cursory or detailed in nature. Water budgets are more fully discussed in a separate document entitled **A Water Budget Overview for Ontario**. Other examples of tools that allow for establishing the status of demand and supply include assimilative capacity assessments, determination of instream flow needs etc.

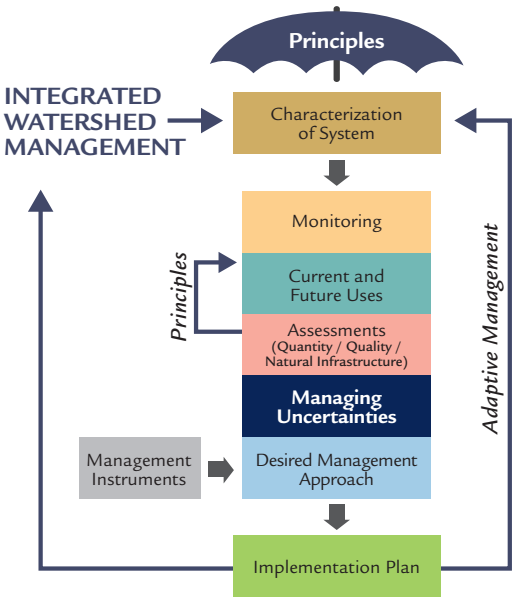


Figure 2 - 5: Managing Uncertainties

3.6 Managing Uncertainties

There are many uncertainties when managing water and the ecosystem. Included are the following:

- Incomplete and insufficient data;
- Gaps in scientific theory and in models used to bridge information gaps. Models are used to predict potential impacts and are only as good as the information used to build the models; and
- Unknown effects of cumulative stressors in large scale and long term scenarios.

Many uncertainties can be reduced while others may be of such a magnitude and variety that they may never be significantly reduced. The Precautionary Principle can be applied to water management where the exact nature of the impact on human health and the ecosystem is uncertain or potentially irreversible.

The Precautionary Principle includes an implicit ethical responsibility towards maintaining the integrity of natural systems (including humans), and acknowledges uncertainties in the understanding of natural systems.

A precautionary approach to water management and public health includes the following components:

- Taking precautionary action before scientific certainty of cause and effect;
- Planning should be based on well-defined goals (as determined when the characterization of the system was performed and by the needs and issues raised by stakeholders) rather than on future scenarios and risk calculations that may be plagued by error and bias;
- Seeking out and evaluating alternatives rather than asking what levels are safe or economically optimal; and
- Shifting burdens of proof to proponents that their activity will not cause undue harm to human health or ecosystems.

The process of applying the Precautionary Principle must be transparent and include all potentially affected parties. The process must involve an examination of the full range of alternatives, including no action.

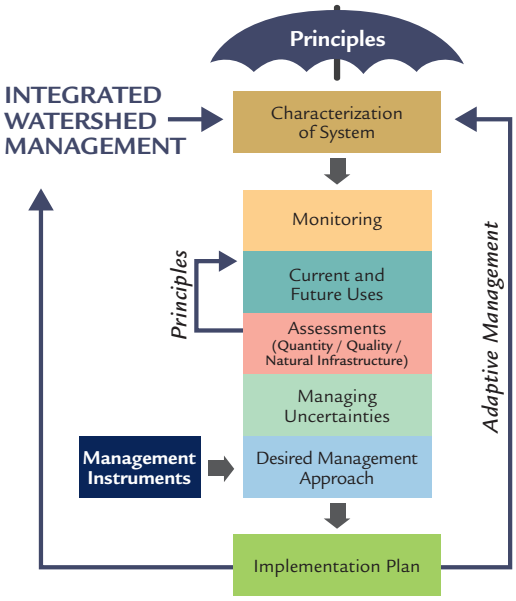


Figure 2 - 6: Management Instruments

3.7 Management Instruments

Each issue will require different solutions. It is important to have management solutions in place when a solution is needed. The following management instruments will be required to solve a wide range of issues:

- Legislation
- Policies / Programs
- Plans (i.e. watershed, conservation, etc.)
- Collaborative Partnerships
- Institutional Roles
- Education / Stewardship
- Information Management
- Conflict Resolution
- Economic Considerations

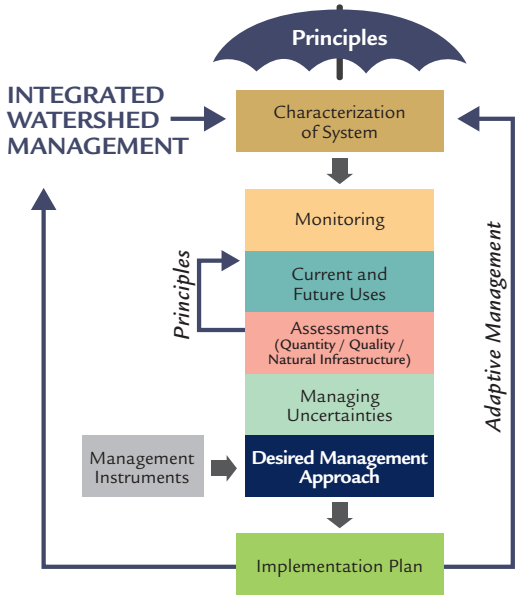


Figure 2 - 7: Desired Management Approach

3.8 Desired Management Approach

The desired management approach will include the following elements:

- Use best information
- Address the needs of ecosystem
- Involve all stakeholders
- Recognize uncertainties
- Recognize cumulative effects
- Use Adaptive Environmental Management

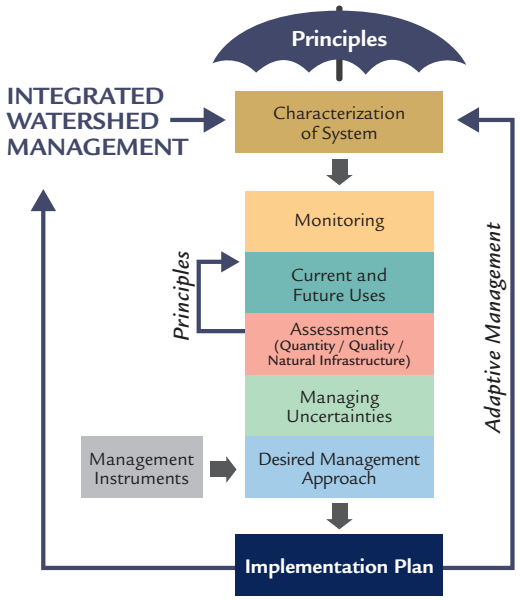


Figure 2 - 8: Implementation Plan

3.9 Implementation Plan

An implementation plan or a water management plan is developed cooperatively to address single or a broad range of multiple water issues. The plans can recommend allocation, conservation, stream rehabilitation, reservoir operation plans, etc. Implementation plans can include the following:

- Drinking Water Source Protection Plans
- Water Conservation Plans
- Water Demand Management Plans
- Water Efficiency Plans
- Storm Water Management Plans
- Nutrient Management Plans
- Water Management Plans for Hydropower

Water management plans should follow the Framework described in Section 3.2.

The plan should at a minimum include the following:

- a summary of all issues considered;
- a description of the area in which the Water Management Plan applies;
- a summary of the information assembled as part of the planning process;
- the relationship of the Water Management Plan to regional strategies, watershed/subwatershed plans or other planning initiatives;
- the recommended options and strategies to address the issues; and
- a list of performance monitoring requirements.

Lastly, a feedback loop is needed to ensure that the watershed plan is updated and that the actions associated with the Implementation Plan is consistent with the longterm watershed goals and objectives.

4.0 | How Should the Framework Be Used in Ontario?

4.1 Introduction

As stated earlier, the issue of water governance in Ontario has been the subject of many discussions over the years. A Strategy for Collaboration to identify who does what and how a cohesive approach can be developed to meet the imminent water challenges that Ontario must face is imperative. In addition, a provincial policy statement on water management will provide direction to decision makers at all levels of government.

4.2 A Strategy for Collaboration

Developing a strategy is beyond the intent of this project. However, when considering change, answers to the following questions can be used as a guide in developing a strategy:

1. What is the desired change and why is it needed?
2. What are the benefits of change, and how will these benefits be distributed?
3. What will be the costs, and who will bear them?
4. Which groups or proponents are likely to oppose the change? Who has a vested interest in maintaining the status quo?
5. Which proponents (or coalition of proponents) will push forward and implement the change?
6. What can realistically be done to address constraining conditions and create an enabling environment for institutional transformation?
7. How can knowledge producers and processors such as academics, consultants, and practitioners play a more effective role in supporting change processes?
8. How can lessons learned during the course of implementing the strategy feedback into and used to guide the process?

5.0 | Considerations for Next Steps

The following considerations for next steps were synthesized from the collective knowledge and experience of the project team, comprised of a collection of Ontario water experts, in addition to the results of research carried out on other jurisdictions.

1. The Water Management Framework developed for this project should be reviewed and considered by key water management agencies in the Province of Ontario.

2. A strategy should be developed by key water management agencies like MNR, MOE and Conservation Ontario to:

- Gain internal understanding and support within each agency;
- Gain external support and understanding that reflects the different layers of decisions made in government (e.g. at the provincial, federal, municipal, etc.);
- Articulate how the Framework integrates with other existing frameworks (such as those used for water taking etc.) which allows for effective decision making;
- Assess the need for tools e.g. Memoranda of Agreements, guidelines etc.

A working committee should be struck amongst key water management agencies to develop the next steps towards water management . Consultation should occur with other key agencies early in and throughout the process at the federal, provincial and municipal levels.

3. Working Groups should be struck to consider key technical issues including:

- Refinements to the proposed Water Management Framework;
- Water Rights approaches;
- Information, Data and Monitoring needs; and
- Governance (how will agencies collaborate and interact with each other).

APPENDICES

Appendix 1: Notes from workshops
- IWM Water Quantity and Water Budget Frameworks, January 19, 2009
- IWM Workshop on Water Quantity Framework, March 31, 2009

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DEFINITIONS

Aquatic Ecosystem: An aquatic ecosystem refers to a community of organisms (bugs, plants, wildlife, surroundings) that live in water and are dependent on each other for survival.

Aquifer: An underground layer of permeable rock, sediment (usually sand or gravel), or soil where groundwater is stored. Aquifers are connected to other aquifers and surface water bodies and can occur at various depths.

Biodiversity: Refers to the uniqueness and variability of all life with particular emphasis on genes, species, landscapes or ecosystems.

Ecosystem: A dynamic complex of organisms and their associated non-living environment, interacting as an ecological unit composed of primary producers, consumers and decomposers.

Elasticity: Refers to the ability of an ecosystem to accommodate change while maintaining its structure and function.

Ecological resilience refers to the capacity of natural ecosystems, social resilience to the capacity of human communities to cope with change.

The term **ENVIRONMENT** as used in this document refers to the natural components of aquatic ecosystems, the flora and fauna, and the natural ecological processes that take place between individual plants and animals, their surroundings, and between each other. The maintenance of species biodiversity, community structure and functioning and natural ecological processes are important elements (and indicators) of the maintenance of overall environmental integrity.

Ecological Values are defined as the natural ecological processes occurring within water dependent ecosystems and the biodiversity of these systems.

Environmental Water Requirements are descriptions of the water regimes needed to sustain the ecological values of aquatic ecosystems at a low level of risk. These descriptions are developed through the application of scientific methods and techniques or through the application of local knowledge based on many years of observation.

Environmental Water Provisions are that part of environmental water requirements that can be met.

Environmental Water Provisions may refer to:

- unregulated flows in rivers and water in wetlands and aquifers;
- specific volumetric allocations and/or releases from storages;
- water levels maintained in wetlands; and
- water in transit for other users, the pattern of flow of which may be defined to meet an environmental need.

Complexity: A feature of systems that comprise diverse components among which there are many interactions, the resulting implications of which are often unpredictable.

Cumulative Impact: The incremental impact of an action on the environment when the impacts are combined with those from other past, existing and future actions.

Driver: Any natural or anthropogenic factor that causes change within a system, whether through direct or indirect means, regardless of whether it is internal or external to the system.

Erosion: The wearing away, by water, of the banks or bed of a stream or of the materials used in any works.

Green Infrastructure: An interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations.

Impact: Any aspect of an action that may cause an effect; for example, land clearing during construction is an impact, while a possible effect is loss and fragmentation of wildlife habitat.

Impact Model: A formal description of a cause-effect relationship that allows the assessing of various components of that relationship through the use of an Impact Statement, a Pathways Diagram, and the validation of linkages and pathways.

Indicator: Anything that is used to measure the condition of something of interest. Indicators are often used as variables in the modeling of changes in complex environmental systems.

Infrastructure: An underlying base or foundation especially for an organization or system. The basic facilities, services, and installations needed for the functioning of a community or society, such as transportation and communications systems, water and power lines, and public institutions including schools, post offices, and prisons.

Integrated Management: An approach to management through which multiple actors collaborate and share risk in defining, analyzing, and resolving social ecological challenges for the common good. This approach moves beyond conventional single-species management to consider the implications of, species interactions, habitat and ecosystem linkages, and cumulative effects.

Mitigation: In the context of climate change, a human intervention to reduce the sources or enhance the sinks of greenhouse gases. Examples include: using fossil fuels more efficiently for industrial processes or electricity generation, switching from oil to natural gas as a heating fuel, improving the insulation of buildings, and expanding forests and other "sinks" to remove greater amounts of carbon dioxide from the atmosphere.

Precautionary Principle: See the report, Integrated Watershed Management in Ontario (Phases I-III), Appendix 4.

Resilience: Refers to the capacity of an ecological or social system to accommodate change, stress and variability without altering its structure and function.

Riparian Zone: The riparian zone is the area between the land and a surface water body. Plants alongside the banks of the water body are called riparian vegetation and are important for the health of the stream and to stop bank erosion.

Robust Management: Management that is designed to ensure an acceptable level of performance despite conditions of elevated scientific uncertainty and limited control over exploitation.

Social Capital: The social norms, networks of reciprocity and exchange, and relationships of trust that enable people to act collectively.

Social Learning: The collaborative or mutual development and sharing of knowledge by multiple stakeholders through learning-by-doing.

Stakeholders: Individuals or groups (including government and non-government institutions, communities, research institutions, development agencies, etc.) with an interest or claim.

Surface Water: Surface water is the water that runs over or sits on the land. This includes lakes, rivers, streams, creeks and ponds. It is usually fresh water and it is not stored in the ground.

Threshold: The critical boundary (e.g. spatial or temporal) where the attraction of a system to a new equilibrium or configuration supersedes the system's attractions to its current state.

Watershed: The region or area of land that drains into a river, river system, or other body of water. Watersheds are divided by mountains or hill ridges.

Water Dependent Ecosystems: Those parts of the environment, the species composition and natural ecological processes of which are determined by the permanent or temporary presence of flowing or standing water. The instream areas of rivers, riparian vegetation, springs, wetlands, floodplains and estuaries are all water dependent ecosystems.

Water Flow Requirement: Water flow requirement refers to the amount of water that nature (fish, wildlife, streams) needs in a water body so that it can function properly. Water flow requirement needs relate to adequate water flow, water quality, riparian margins and water temperature.

Wetland: Wetlands refer to a body of land saturated by water and include swamps, marshes and bogs. Wetlands are the interface between land and aquatic ecosystems and usually support diverse forms of life and provide significant benefits to the environment.

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