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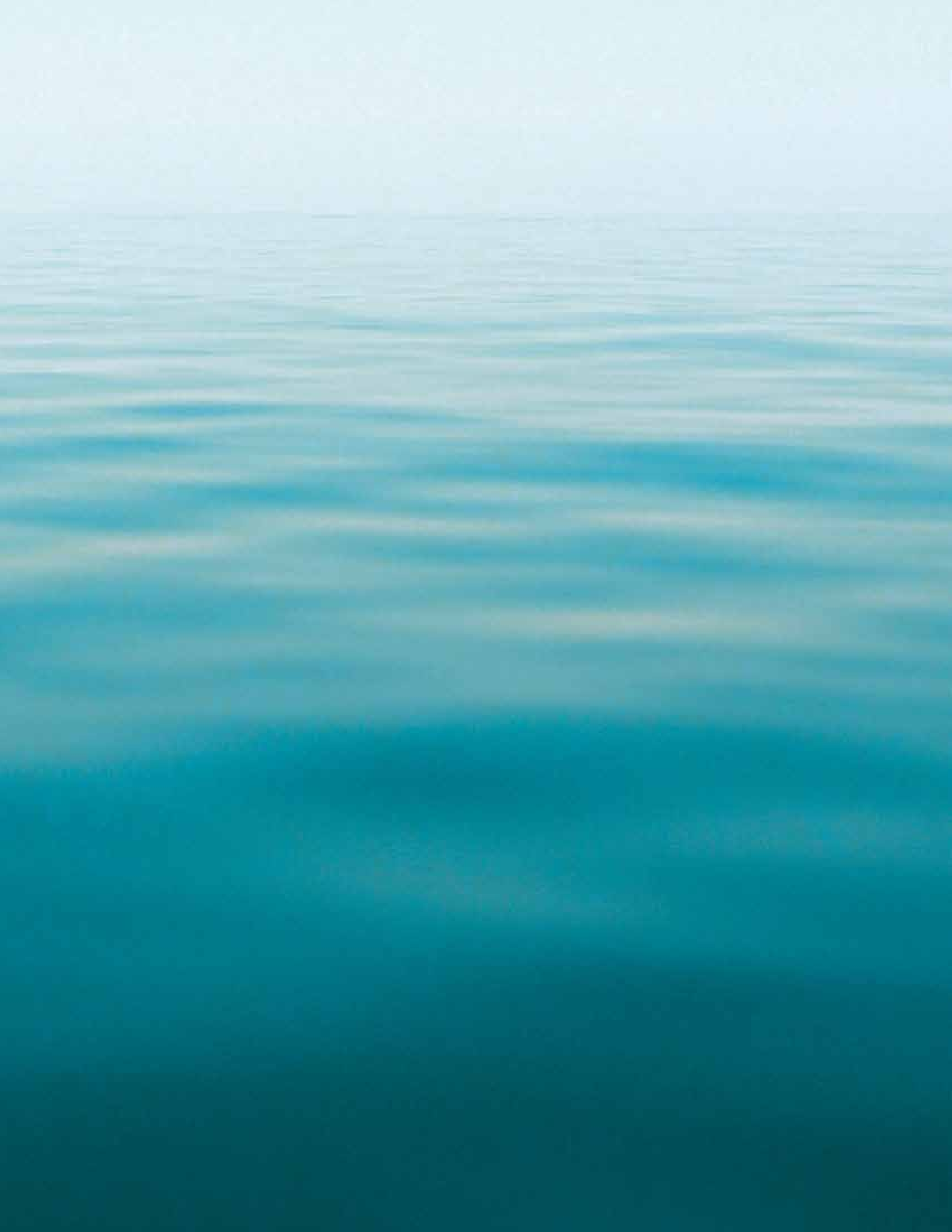
NATIONAL ROUND TABLE ON THE ENVIRONMENT AND THE ECONOMY

CHARTING A COURSE

SUSTAINABLE WATER USE BY CANADA'S NATURAL RESOURCE SECTORS

Canada



Sustainable development of our natural resources requires sustainable water use.

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ACKNOWLEDGEMENTS

The National Round Table on the Environment and the Economy (NRTEE) would like to express its sincere gratitude and appreciation to all individuals who contributed to the research of this project and completion of this report.

We wish to acknowledge and thank the many stakeholders, experts and interested Canadians who attended and contributed to our meetings and workshops across the country. Their insights and advice throughout have helped ensure that our research findings and report are grounded and relevant. In particular we would also like to thank the members of our advisory committees for their perspectives, insights and support of this research. A special thank you to the four regional watershed organizations who partnered with the NRTEE in hosting regional meetings, namely the Okanagan Basin Water Board, the North Saskatchewan Watershed Alliance, the Conseil de gouvernance de l'eau des bassins versants de la rivière Saint-François, and the Bras d'Or Lakes Collaborative Environmental Planning Initiative.

This report is also the result of the work of many consultants and experts. The NRTEE would like to thank all consultants involved in our research program, and specifically acknowledge key contributions from Steven Renzetti, Karen Bakker, Alice Cohen, Rob de Loë, Daniel Murray, Stratos Inc., M.K. Jaccard & Associates Inc., and Dave Sawyer for their analysis and advice.

NRTEE Water Sub-committee members Christopher Hilkene, Elizabeth Brubaker, Robert Slater, Richard Prokopanko, Mark Parent and Robert Kulhawy provided guidance throughout the report, as well as former NRTEE Chair, Bob Page.

Finally, thank you to the NRTEE Secretariat staff for their persistence, hard work and dedication to this program and critical area of policy research, which resulted in this, our second report of the Water Program. Denise Edwards coordinated numerous meetings and workshops. The Communications team - Marie-Josée Lapointe, Tony Bégin, Tania Tremblay, Edwin Smith and Richard Pilon - guided the report through production and design. Policy team members René Drolet, Sandeep Pandher, and former member Katherine Balpataky, all contributed to the research, analysis and writing of this report. Jill Baker was the policy lead on this project and was instrumental in delivering this report.

LETTER FROM THE VICE-CHAIR

The NRTEE believes that the opportunity is now to put Canada on a policy path to ensure sustainability of our water and natural resource sectors. *Charting a Course*, the second report by the NRTEE examining the future of Canada's water supply, is an important contribution to meeting Canada's objectives of improved water use efficiency and water conservation.

Past assumptions of water governance and management may no longer be applicable in the face of anticipated pressures on water resources. In a world of increasing competition for access to water, new pressures such as climate change are emerging that could put the long-term sustainability of our water resources at risk.

This new report shows that Canada can address some of these water challenges while maintaining a prosperous natural resources sector, by proposing several potential avenues of solutions: improved understanding of water-demand forecasts, new policy tools, information and data improvements, and more effective collaborative governance approaches.

The NRTEE recognizes ongoing efforts across the country to modernize and improve existing water policies and legislation, and hopes that the insights, conclusions and recommendations included in this report will help steer Canada on a policy path to ensure a prosperous economy through the development of our natural resource sectors while ensuring the protection and health of our ecosystems.

R.W. SLATER, CM, PH.D.
NRTEE Vice-Chair

MESSAGE FROM THE PRESIDENT AND CEO

Fewer issues bring the environment and the economy together more than water and industry. Canada's natural resources sectors are the largest water users in our country. How they use, conserve, and manage water has a real impact on ensuring sustainable water use across Canada.

In the past two years, the NRTEE has released two reports on sustainable water use by Canada's natural resources sectors. Having identified the issues in *Changing Currents*, we now outline new ways forward to value, manage, and sustain water use for industry and ecosystems in *Charting a Course*.

We set out key principles to govern sustainable water use by the natural resources sectors. We show how water conservation and efficiency can be generated through pricing and other measures. We highlight new collaborative ways to govern water use by all interests in a watershed. And we show the importance of good information and data so governments can make solid water allocation and management decisions for the future.

Charting a Course demonstrates the long-term importance of getting water sustainability right. It says all players, industry, governments, communities, have a stake and a role in both charting that course and following it through.

DAVID McLAUGHLIN
NRTEE President and CEO

NATIONAL ROUND TABLE ON THE ENVIRONMENT AND THE ECONOMY: ABOUT US

Emerging from the famous Brundtland Report, *Our Common Future*, the National Round Table on the Environment and the Economy (NRTEE or Round Table) has become a model for convening diverse and competing interests around one table to create consensus ideas and viable suggestions for sustainable development. The NRTEE focuses on sustaining Canada's prosperity without borrowing resources from future generations or compromising their ability to live securely.

The NRTEE is in the unique position of being an independent policy advisory agency that advises the federal government on sustainable development solutions. We raise awareness among Canadians and their governments about the challenges of sustainable development. We advocate for positive change. We strive to promote credible and impartial policy solutions that are in the best interest of all Canadians.

We accomplish that mission by fostering sound, well-researched reports on priority issues and by offering advice to governments on how best to reconcile and integrate the often divergent challenges of economic prosperity and environmental conservation.

The NRTEE brings together a group of distinguished sustainability leaders active in businesses, universities, environmentalism, labour, public policy, and community life from across Canada. Our members are appointed by the federal government for a mandate of up to three years. They meet in a round table format that offers a safe haven for discussion and encourages the unfettered exchange of ideas leading to consensus.

We also reach out to expert organizations, industries, and individuals to assist us in conducting our work on behalf of Canadians.

The *NRTEE* Act underlines the independent nature of the Round Table and its work. The NRTEE reports, at this time, to the Government of Canada and Parliament through the Minister of the Environment. The NRTEE maintains a secretariat, which commissions and analyzes the research required by its members in their work.

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NRTEE PRESIDENT AND CEO
David McLaughlin

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EXECUTIVE SUMMARY

Improved water-use management starts with strong principles that value water so it can be conserved and used efficiently. Sustainable water use will come from better knowledge and application of four key knowledge areas: water forecasts, water quantity data and information, policy instruments, and collaborative water governance.

EXECUTIVE SUMMARY

Water, the defining component of ecosystems across Canada, is integral to the development and prosperity of Canada's natural resource sectors.[1] Water drives the natural resource sectors' development and operations. The natural resource sectors are, and will continue to be, the most significant water users in Canada. The sustainable development of our natural resources requires careful and informed consideration of what development may mean for our water resources. It is critical that in setting the right conditions to ensure prosperous economies through development of our natural resources, we also ensure the protection and health of our aquatic ecosystems.

To understand how Canada can ensure sustainable water use by the natural resource sectors, the National Round Table on the Environment and the Economy (NRTEE) set out to explore four areas related to quantitative water use by the natural resource sectors:

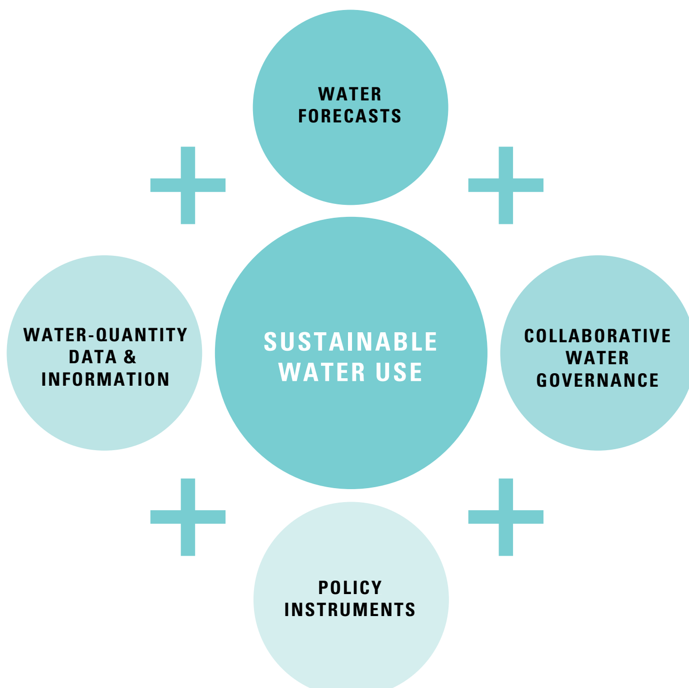
- **Water use by the natural resource sectors**: how each of the resource sectors uses water, and to what degree water use might increase in the future with rising production (water forecasts);

- **Emerging policy instruments for water management**: the potential of two emerging policy instruments — water pricing and voluntary initiatives — to improve water conservation and efficiency;

- **Water-quantity data, information, and knowledge**: how we can improve our data and information base for quantitative water use by the sectors; and

- **Collaborative water governance**: the potential use of more collaborative governance approaches to improve water allocation and management decisions.

FOUR KNOWLEDGE AREAS



Improving our understanding of these four knowledge areas will significantly contribute to an improved system of water governance and management, moving us in the direction of sustainable water use by the natural resource sectors.

The NRTEE's advice is intended to inform governments as they develop water strategies, as well as industrial and agricultural sectors in their practices and management plans. Achieving sustainable water use depends upon getting strategies and policies right. Water strategies must include the goals of water conservation and water efficiency. Together they will ensure ecosystem protection, allow jurisdictions to be better prepared in times of water shortage, provide a safety margin that may help avert water shortages, and promote best management practices to address an uncertain water future.

THE CONTEXT

The natural resource sectors use and consume more water than any other sectors in the nation, accounting for approximately 86% of Canada's water use in 2005. According to economic forecasts, the sectors are expected to experience significant growth, ranging from 23% to 58%, by 2030. Added to other stresses, like climate change and a resultant increase in the frequency of extreme weather events, the NRTEE concluded in our first report, *Changing Currents: Water Sustainability and the Future of Canada's Natural Resource Sectors,* that the long-term sustainability of our water resources may be in question. And more specifically that our governance and management structures may be not be well positioned to deal with an uncertain water future, especially with respect to water quantities in this country.

FINDINGS

Our research shows that we can address some of the water challenges associated with a prosperous resource sector by taking steps to

- better understand the future growth of the natural resource sectors and their water requirements;
- recognize the value of water, both in terms of how much it currently costs the sectors and where water pricing may be an incentive for further water efficiency and conservation;
- ensure that water strategies and policies include a suite of new policy instruments that are readily available for implementation, including water pricing and voluntary initiative options;
- develop comprehensive water data and information systems, taking stock of both water supplies and water demands, particularly in the most vulnerable watersheds in the country; and
- promote further collaborative water governance in appropriate circumstances, such as in the need for water strategy development.

CONCLUSIONS

Focusing on our four key knowledge areas, the NRTEE research led us to these conclusions.

WATER FORECASTS

Historical water use by the natural resource sectors shows improved water-use efficiency for most sectors, even in the absence of water policies to motivate such efficiency gains. These improvements may be due to the link between water use and energy, as rising energy costs cause firms to find ways to reduce their energy use, resulting perhaps in water intake reductions.

Based on past improvements demonstrated by the sectors, our research anticipates that water-use intensity will continue to decrease or at least hold steady through to 2030 for many of the natural resource sectors. Even when coupled with an expected increase in economic activity for these sectors, these historical trends of water-use intensity result in small overall increases in water use in Canada in the future.

Even though our scenario analysis reveals a potentially small overall increase in water intake on a national basis, the result masks some regional challenges. Nowhere is this more apparent than in areas with regional concentrations in oil and gas and agriculture. Further analysis on a regional and sectoral basis is required to improve our understanding of where water demands are likely to increase substantially with economic growth.

POLICY INSTRUMENTS

Economic instruments (EIs) and voluntary initiatives have real potential for contributing to the goals of improving water conservation and water efficiency.

Adopting new EIs — such as water charges or tradable water permits — would allow Canada to meet these objectives by transitioning current regulatory approaches to more efficient mechanisms. EIs provide incentives and flexibility for water users by allowing them to determine their water use and adopt water-conserving technologies. A water charge seems the most likely option of the two, at least in the shorter term, and can be viewed as a *transitional* policy option. In contrast, trading of water permits within a watershed represents a fundamental shift in water-management systems and can be seen as a *transformative* option.

Voluntary initiatives, taken on by industries in the absence of government intervention, are likely to continue their role in improving water management across many sectors. While the effectiveness of such initiatives is still in question, past experience shows promise for these approaches as they relate to measuring and reporting water use and improving transparency of industrial water management. Together, they help support industry's "social licence" to operate.

Our research shows that pricing water on a volumetric basis can help achieve water reduction objectives, with modest impacts to most sectors and the national economy. An important piece of new information, the NRTEE's original scenario analysis looks at the relationship between water demands from the natural resource sectors and industry's responsiveness to a price on water. Our analysis demonstrates that some sectors may be responsive to water pricing, and large efficiency and conservation gains could be achieved with small increases in the price of water.

WATER-USE DATA AND INFORMATION

A lack of reliable, publicly available data on water quantity has negative implications for current and future water resource management in Canada. Specifically, the lack of baseline water-use measurements hampers efforts to improve efficiency since the potential to improve can be difficult to estimate, actual improvements cannot be assessed, and incentives for reductions cannot be readily developed, implemented, or evaluated.

For the supply side of water in Canada, data about water quantity, monitoring capacity, and reporting protocols are well established. The different stakeholders have established a clear understanding of their respective roles. Although some gaps remain in the water supply-side data system, a strong foundation exists upon which to build.

Data systems for the demand-side of water quantity are at the opposite end of the spectrum of development and deployment, as they vary considerably across provincial and territorial jurisdictions. In collaboration with the natural resource sectors, governments at all levels must address significant gaps before they establish measuring, monitoring, and reporting protocols for demand-side data that are consistent across the country.

In Canada, governments at all levels lack the capacity to integrate supply-side and demand-side water-quantity data to evaluate, predict, and forecast future water availability at a watershed scale. Governments need to develop the capacity to generate integrated water-management tools that provide information at a watershed scale on a priority basis.

COLLABORATIVE WATER GOVERNANCE

Effective collaborative water governance requires the involvement of a broad range of stakeholders. To stay engaged and committed, stakeholders need incentives and solid, attainable outcomes. There is a strong desire to see alignment with other planning processes such as municipal land-use planning or forest management plans. To encourage participation in collaborative water governance, governments need to demonstrate strong leadership and act on the recommendations provided by the collaborative process.

Collaborative water governance is a tool to be selected in particular situations, not a panacea for all water governance challenges. It requires time and dedicated resources, as well as clear rules and guidance from governments. To be successful, the mandate, scope, and role of collaborative groups must be clearly stated in written documents. Successful collaborative governance requires clear objectives and accountability rules, and stakeholder or government support. Provincial and territorial governments need to be clear about the mandate, scope, and role of collaborative groups' activities as well as the role and importance of Aboriginal communities and the natural resource sectors in collaborative water governance initiatives. Furthermore, we note the need to move toward integrating land and water management in addressing many watershed challenges.

RECOMMENDATIONS

PRINCIPLES FOR WATER GOVERNANCE AND MANAGEMENT

The NRTEE recommends that federal, provincial, and territorial governments developing new water strategies should adopt the following core principles in our report:

- Water has value — in economic, environmental, and social terms — and should be managed in trust without harm to its sustainability or that of the ecosystems in which it occurs.
- Water must be conserved and used efficiently.
- Water governance and management should be adaptive.
- Water governance and management should be collaborative.

WATER FORECASTS

- The federal, provincial and territorial governments should collaborate in the development and publication of a national water-use forecast, updated on a regular basis – a Water Outlook – the first to be published within two years. This could be led by a national organization such as the Canadian Council for Ministers of the Environment.

- Governments should develop new predictive tools such as water forecasting to improve their understanding of where and when water demands might increase. The information provided by forecasts will be important to inform water allocations and management strategies in the future.

- Recognizing that accurate water forecasting requires improving how we measure and report water-quantity data, governments and industry should work collaboratively to develop appropriate measurement and reporting requirements on a sector-by-sector basis.

POLICY INSTRUMENTS

- Recognizing that water policy strategies across Canada need to be flexible and responsive to changing water realities (changing hydrological conditions and increased water demands on regional and watershed bases) to avoid potential water conflicts, governments should take a phased approach to policy change: (1) ensure that enabling conditions such as legislation and regulation are in place, and (2) stage policy options, thereby allowing for adaptation to different circumstances.

- Provincial and territorial governments should provide policy direction that is focused on more efficient water use and increased conservation, where required.

- Recognizing that further research is required on the use of economic instruments within the context of watersheds, governments intending to use EIs should evaluate their environmental, economic, and social implications, allowing for an informed discussion of trade-offs.

With respect to putting a price on water intake by the natural resource sectors:

- Governments should research the relationship between water use and pricing needs before they implement water pricing on a volumetric basis. Specifically, they need to better understand the potential implications on sectors and firms. In order to do so, data on water use needs to improve, to gain a better understanding of water intakes, recirculation, and recycling within facilities.

- The natural resource sectors should look closely at their water intake and where the costs rest within their use of water. Incorporating the "value" of water into operations may reveal opportunities for costs savings, through implementation of improved technologies or best management practices, possibly leading to overall water intake reductions.

- If a price is put on water use by the natural resource sectors, revenues should be directed to support watershed-based governance and management initiatives, rather than put into general revenue of the province or territory.

WATER-USE DATA AND INFORMATION

- Provincial and territorial governments should establish demand-side data systems that have clearly defined reporting requirements for water licence holders. These systems would have common obligations to report provisions, contain defined time periods for reporting, and introduce enforcement programs to ensure reporting of water use by water licence holders.

- The provinces and territories, in collaboration with stakeholders and partners, should develop common measurement techniques to collect water-quantity data.

- The provincial and territorial governments, in collaboration with the natural resource sectors, should research the sector-specific future water data needs of their jurisdictions. These initiatives would help jurisdictions identify and develop data-management approaches and systems that have buy-in from the natural resource sectors.

- Governments at all levels should collaborate with partners and stakeholders to develop and integrate water-quantity data for use as a water-management tool at a local watershed scale. Provinces and territories should first develop integrated water-management tools within their jurisdictions at a finer spatial resolution, as it is easier to "roll-up" small-scale assessments to larger scales rather than to disaggregate an initial assessment performed at a larger spatial scale.

- In collaboration with partners and stakeholders, governments at all levels should develop protocols for transparent access to water data. Provinces and territories should continue establishing their own water-data portals. The federal government should develop a national web-based water portal, in collaboration with the provinces and territories, which also provides access to provincial and territorial water portals.

COLLABORATIVE WATER GOVERNANCE

- Governments should affirm the legitimacy of collaborative water governance and demonstrate that collaborative governance bodies have an important role to play. If governments choose to invest in collaborative processes, they must act on the recommendations provided by the collaborative process as much as possible and commit to provide formal feedback to the group when recommendations are ignored. Otherwise, participants from the natural resource sectors will lose confidence and leave the process, given the significant time and financial commitment for them.

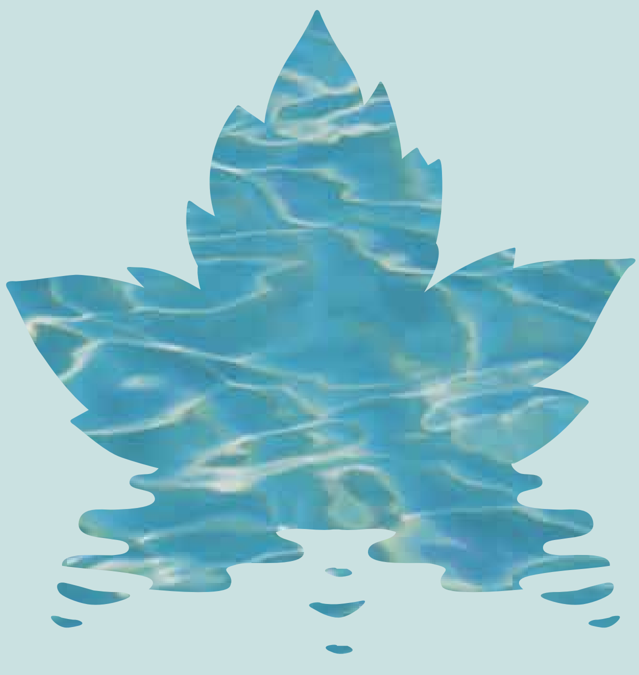
- Governments must recognize that collaborative water governance structures require clear roles and responsibilities and well-defined accountability rules. Most people and organizations involved in collaborative water governance across Canada, including the natural resource sectors, believe that there is insufficient clarity about authority and accountability for decision making within the current frameworks. As a minimum, the Terms of Reference for the collaborative processes require a written description of roles and responsibilities. A more formal document would strengthen the accountability, and in some cases, governments may want to enshrine the governance structure into a new piece of legislation.

- Collaborative water governance processes should be developed and implemented in a coordinated manner with other planning processes and policies. Water governance is not only about water and cannot take place in isolation from other planning processes affecting and involving the natural resource sectors, such as municipal land use planning or forest management plans. As these processes operate at various scales and involve several orders of governments, policy alignment will require coordination between a number of governmental and non-governmental organizations.

- Governments should provide incentives for participation. Effective collaborative water governance requires the involvement of a broad range of stakeholders, including the major water users in the natural resources sectors. For collaborative water governance processes to become operating concerns in the natural resources sectors (rather than optional activities), government must identify them as a priority. This could be done by making participation mandatory, through regulation or as a condition of water licences.

CHAPTER ONE

SUSTAINABLE WATER USE



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HIGHLIGHTS

The natural resource sectors are, and will continue to be, the most significant water users in Canada. Sustainable development of our natural resources requires sustainable water use.

Future policy strategies must include water conservation and efficiency goals together if the overall goal of reduced water use is to be achieved.

The NRTEE's advice is intended to inform governments in their development of water strategies, as well as industrial and agricultural sectors in their practices and management plans.

SUSTAINABLE WATER USE

The availability of clean, secure, and abundant water resources will be necessary to ensure the resilience of our ecosystems and economic prosperity in the 21st century. This report addresses the issues related to the industrial use of water by Canada's natural resource sectors — how much is used, and in what form. It then looks at what is necessary to ensure that future water use by these key economic sectors is sustainably managed.

Sustainable development of our natural resources requires sustainable water use. In turn, sustainable water use is based on the fundamental idea that nature has a limited carrying capacity, and that society has a responsibility to alter its behaviour in a way that maintains ecosystem services and accounts for not just current needs but those of future generations.[2]

To foster sustainable water use by the natural resource sectors, water governance and management will need to adapt and become more flexible. Past assumptions of water governance and management may no longer be applicable in the face of anticipated pressures on water resources. In a world of increasing competition for access to water, new pressures are emerging that could put the long-term sustainability of our own water resources at risk. Governance and management of water will need to evolve in order to respond to these pending risks.

In this report, the NRTEE provides information and advice to ensure the sustainable use of water by the natural resource sectors in Canada — guidance that is supportive of economic growth while at the same time ensuring the health and resilience of our ecosystems. This new report continues our research and policy advice set out in our first report on water, *Changing Currents*.[3] Our report will assist policy makers, water managers, and the sectors themselves improve water efficiency and conservation, with the goals of reducing water demands in the future, ensuring adequate flows for the environment, and thus avoiding future conflicts over water. The NRTEE recognizes ongoing efforts across the country to modernize and improve existing water policies and legislation. We hope that the insights in our report will help those making policy decisions on water management and governance for the natural resource sectors.

OUR GOALS AND PURPOSE

The NRTEE's goal is to provide information and advice that will assist in the achievement of two policy goals:

- **Improving water conservation** so we use less water to conduct the same activities, saving water. Water conservation means any beneficial reduction in water use, loss, or waste. It includes water-management practices that improve the use of water resources to benefit people or the environment.[4]

- **Improving water-use efficiency** to make more productive use of the water we have. Efficient water use includes any measure that reduces the amount of water used per unit of any given activity, without compromising water quality.[5]

Focusing on these goals, the purpose of this report is fourfold:

1. to examine quantitative water use by the natural resource sectors, now and into the future;
2. to consider the potential role of economic instruments (specifically volumetric water pricing) and voluntary initiatives to improve water use efficiency and conservation objectives;
3. to explore areas where data and information management should be improved on the quantitative aspects of water management; and
4. to consider the expanded use of collaborative approaches to water governance when appropriate.

THE NATURAL RESOURCE SECTORS

The NRTEE's report focuses on water use by the natural resource sectors in Canada, as these sectors collectively account for approximately 86% of total water intake in Canada. For the purposes of our report, the following natural resource sectors and subsectors are included in our research:

Energy: Oil & Gas, Thermal Power Generation
Oil and Gas includes oil sands mining, oil sands in-situ, light and heavy oil, conventional natural gas, and tight and shale gas extraction

Agriculture: crop and animal production

Mining: coal, metal ore, and non-metallic mineral mining

Manufacturing related to natural resources: pulp and paper manufacturing, primary metal manufacturing, chemical manufacturing, petroleum and coal products, food manufacturing, non-metallic production

The sectors were categorized according to the data available from Statistics Canada's Industrial and Agricultural Surveys. Due to the fact that the majority of the forest sector's water use is found in pulp and paper mills, we included this sector under the Manufacturing category (as does Statistics Canada).

PRESSURES ON WATER RESOURCES

In *Changing Currents*, the NRTEE summarized the uses and effects of water on aquatic ecosystems by Canada's natural resource sectors and explained that across Canada these sectors' reliance on water supplies will continue as long as the sectors operate and expand. Based upon the expectation that these sectors will continue to experience economic growth (output), their water intake is also expected to increase. The potential impact of this future development on water supplies is unknown, but what is certain is that implications will differ on regional and watershed bases depending on the intensity of industrial and agricultural expansion, the water supplies available, and the variability of flows. Added to this pressure are an increasing population and municipal requirements for secure, clean water supplies.

Coupled with increasing demands is the potential issue of decreasing water supplies. Decreasing water supplies in some regions and watersheds of Canada exist now, with other regions facing likely constraints in the future. Climate change brings new uncertainties also, with varying regional and local impacts. Finally, the uncertainty of future demands by the natural resource sectors is cause for concern — by governments responsible for managing water in the regions and by industry and agricultural producers looking to expand development.

THE PROBLEM STATEMENT

With a likely increase in water demands by the natural resource sectors and regional uncertainty over secure water supplies, the potential for conflicts over water exists. The NRTEE's research and consultations across Canada and with sectors and experts leads us to conclude that Canada is not as well positioned to proactively address potential short-term water shortages, as well as manage through longer-term droughts, as it could be.[6]

Canada requires more effective water governance and management to sustainably develop its natural resource sectors while maintaining the health of its aquatic ecosystems. In particular, we need to improve our knowledge in four areas:

FOUR KNOWLEDGE AREAS

- **Our understanding of the increasing demands for water by the natural resource sectors.** With an expectation of increasing economic prosperity, we need to know more about what economic development might mean for water use by the sectors.

- **Governments' ability to manage increasing water demands given supply constraints and flow variability.** Adaptive management practices, possibly using new and innovative policy instruments, will be necessary to sustainably manage water resources.

- **Our data management of actual water use.** A lack of reliable, comprehensive data and information on actual water use by the sectors; comparability of the data; and transparent sharing of this information hampers effective and efficient water use and management.

- **Our governance practices with a view to be more inclusive, engaging and collaborative.** We need to understand lessons from innovative collaborative approaches to water management, to assess how it should be supported and possibly adopted in more regions and watershed across the country.

This report provides new insights into the discussion of how best to manage and govern Canada's water resources as they relate to the natural resource sectors. Our report informs a much larger, comprehensive ongoing dialogue and debate across this country. However, the information provided here should also be taken within the broader context of integrated water resource management, providing ideas that contribute to the extensive challenge of water management and governance across all uses and regions of Canada.

APPROACH TO THE WATER REPORT

The issue, as defined here, has many components and therefore needs to be addressed with multiple solutions. The NRTEE is proposing several potential avenues of solutions: an improved understanding of water-demand forecasts, a set of new policy tools, information and data improvements, and more effective collaborative governance approaches.

This report follows a year of research by some of Canada's top experts in water issues. Much of this research was strengthened by involving and engaging many experts, industry representatives, government officials, and water managers across Canada. In total, the NRTEE held thirteen meetings over the course of 2010–2011 to assist with scoping the project, testing the research results, identifying potential solutions, and providing us with feedback on preliminary conclusions.

To begin, the NRTEE created an Expert Advisory Committee,* from which we drew both strategic guidance and technical expertise. The Committee assisted by scoping the research and reviewing some of the research findings. A few of our advisors specifically assisted us with particular pieces of research. Dr. Steven Renzetti was heavily involved in assisting with the methodology and findings of the water forecast and pricing research, and Dr. Rob de Loë conducted some of the research on collaborative water governance.

* See Appendix 1 for Expert Advisory Committee membership.

To assist us with our investigation of issues related to water data and information, the NRTEE went to those who deal with this issue on a daily basis — the provincial, territorial, and federal water managers. This group of experts from across the country came together in two workshops to collectively define the most important issues and look for potential solutions.

To better understand collaborative water governance and how it works on a watershed basis, the NRTEE convened meetings in four regions of the country — British Columbia, Alberta, Québec, and Nova Scotia — to derive learnings from the experiences of these watersheds.

Finally, at the end of our research the NRTEE held three meetings in Alberta, Ontario, and Nova Scotia to discuss some of our preliminary findings with more experts and stakeholders. This offered us an opportunity to expand our reach to hear more diverse opinions. These meetings asked participants to tell us what they thought of our research, and to specifically help us understand some of the regional realities related to our findings, as well as inform the final conclusions and recommendations.

CHAPTER TWO

GUIDING PRINCIPLES FOR WATER GOVERNANCE AND MANAGEMENT

CONTENTS

HIGHLIGHTS

The NRTEE's advice is based upon a set of principles: one central principle for broad water governance in Canada, under which a second set of three operational principles are proposed.

Central principle: Water has value — in economic, environmental, and social terms — and should be managed in trust without harm to its sustainability or that of the ecosystems in which it occurs.

Operational principles:
Water must be conserved and used efficiently.
Water governance and management should be adaptive.
Water governance and management should be collaborative.

GUIDING PRINCIPLES FOR WATER GOVERNANCE AND MANAGEMENT

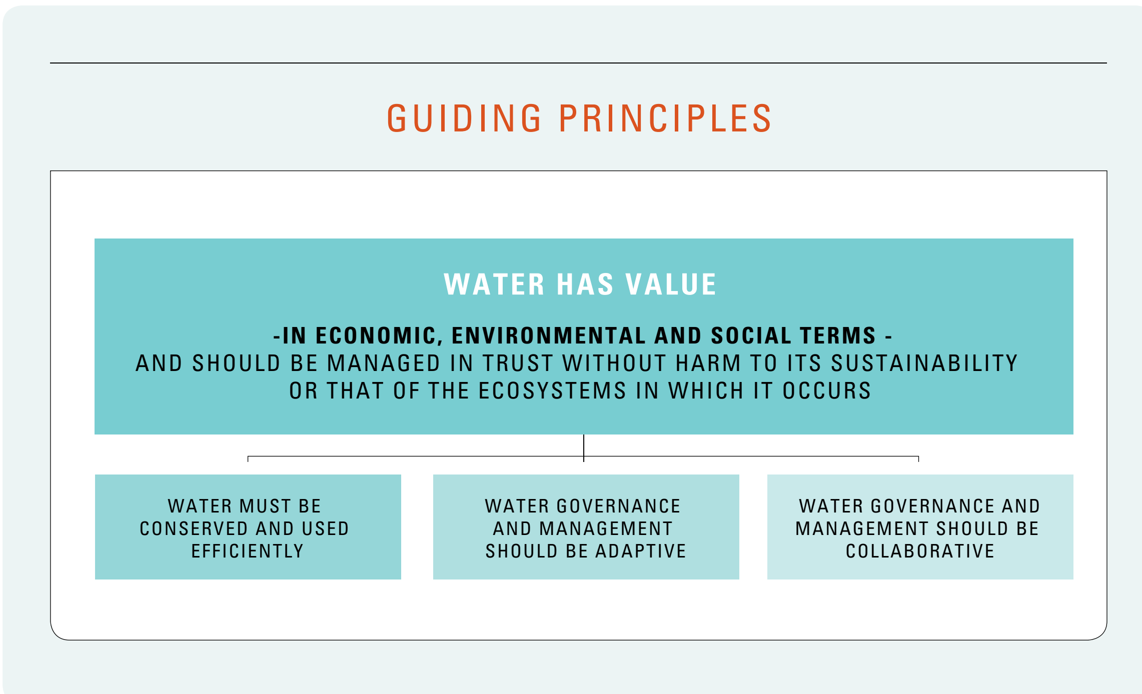
Guiding principles are often cited or proposed in water policy and strategies. Principles exist at different levels, ranging from high-level aspirations to more pragmatic, management-level or action-based objectives. In this report, we consider guiding principles as a set of statements that either reflect the values of a jurisdiction or provide guidance on best practices for governing behaviour. Consequently, guiding principles are developed to ensure that an organization's or jurisdiction's values are respected, or that best practices are incorporated when making decisions and setting policy.

The NRTEE's consultations and engagement for this report lead us to recommend that clear governing principles for water be articulated and applied. In this report we consider principles as a set of statements that provides guidance on best practices for governing behaviour and making decisions to achieve desired outcomes. Their absence will lead to uneven and fragmented water-governance approaches across our country. It will be harder to assess trade-offs and make choices on water use. Principles can rally and focus Canadians in our combined efforts to make this most critical resource sustainable for us all.

We propose a set of principles that sets the context for our research and findings, and frames our conclusions and advice. We put forward these principles to be considered in future water governance and management strategies across Canada, as they provide guiding conditions for setting down water policies in our country.

The NRTEE proposes one **central principle** to guide water governance in Canada, setting the stage under which three **operational principles** are proposed (Figure 1).*

FIGURE 1



CENTRAL PRINCIPLE

Water has value — in economic, environmental and social terms — and should be managed in trust without harm to its sustainability or that of the ecosystems in which it occurs.

The NRTEE's central principle is multi-dimensional.

The first component recognizes that **water has value** in economic, environmental, and social terms. It is a critical input to all activities in the natural resource sectors, making development and production possible. Past failures to recognize the economic value of water has led to wasteful

* These principles are based upon those found throughout water policy and management literature.

and environmentally damaging uses of our water by some industries. In recognizing that water use creates wealth, its core economic value can be revealed through a better understanding of costs and pricing. And with an understanding of this value, water will be better appreciated, more willingly conserved, and more efficiently used.

From an environmental perspective, water is vital to ecosystems, biodiversity, and human well-being. Watersheds provide critical goods and services such as keeping water clean, storing water, and providing habitats for fish and wildlife. There is a fundamental need to secure adequate minimum flows of water to maintain ecosystem services and functions, and to support basic human needs now and in the future.

Finally, water has a social value — an intrinsic non-market value that cannot be monetized but should be recognized and respected. Water policies should reflect the current social and cultural values of Canadians. Such values may differ regionally across Canada, which in turn may result in a variety of approaches to water governance and management.

The second component of our central principle recognizes that water should be managed **in trust**. Water is a public resource, requiring it to be managed for the benefit of both present and future generations and for the benefit of the natural environment. In managing our water, governments should take a preventative and precautionary approach, as prevention of harm is better than subsequent compensation or remediation.[7]

In addition, as water is a public resource, citizens have the right to know how it is used and managed. Therefore, there should be a presumption in favour of a public right to access data and information about water resources.

OPERATIONAL PRINCIPLES

With the context of the central principle, the NRTEE's conclusions and advice is based on the following three **operational principles** that can be applied to the natural resource sectors:

- Water must be conserved and used efficiently
- Water governance and management should be adaptive
- Water governance and management should be collaborative

WATER MUST BE CONSERVED AND USED EFFICIENTLY.

In areas of water scarcity, water conservation and efficiency are cornerstones of any sustainable water policy and strategy. But even in areas where water is not currently seen as being in limited supply, conservation and efficiency remain critical for guiding future water policy and management. Without currently knowing what our water supplies and demands will look like into the future, the precautionary principle of sustainable development requires us to err on the side of caution and wisely use the water we have.

Water use by the natural resource sectors creates wealth and as such it should be used to its full potential. With its economic value recognized, and further established with pricing mechanisms that increase its cost of use, the value of water will be appreciated. As a result it will be willingly conserved and efficiently utilized. This will lead to both improved economic and environmental outcomes.

WATER GOVERNANCE AND MANAGEMENT SHOULD BE ADAPTIVE.

Future water supply and demands are uncertain due to increasing pressures and climate variability. Our knowledge of current as well as future supplies and demands is limited, creating further uncertainty. Therefore we need to set up conditions that will allow us to deal with these uncertainties — conditions that will position current water-management systems to be adaptable, with a notable need to improve knowledge and information and consider additional tools to promote conservation and efficiency.

Adaptive management, the process of continually incorporating newly gained knowledge or information into decision making, can improve how we manage risk related to water uncertainty. Improved monitoring is a necessary component of adaptive management frameworks. It is important for water authorities to gather the right information and knowledge that will let them know whether actions taken to prevent or reduce negative impacts on the environment are working. Similarly, policy strategies, which include different types of policy instruments, may need to be updated allowing water managers the flexibility to react to changing circumstances and increasing knowledge bases.

WATER GOVERNANCE AND MANAGEMENT SHOULD BE COLLABORATIVE.

While jurisdictions have both differentiated and shared responsibilities for water management, watersheds can cross jurisdictions, necessitating collaborative decision making. Three concepts are embedded within this principle: watersheds as the unit of management, a participatory approach, and stewardship.

Adopting a watershed approach to management helps to keep a core focus on the resource and its ecosystems. As such, a watershed defines the unit of water management by natural boundaries instead of geopolitical boundaries. This approach requires that jurisdictions work across political boundaries, which is a challenge given different federal, provincial, territorial, and municipal perspectives on water policy and management.

This principle also recognizes the importance of taking a participatory approach to water governance and management. A participatory approach involves engaging key interests and stakeholders in planning and decision making. It means that decisions about planning and implementing water projects are taken at the most appropriate level, with the inclusive involvement of water users and those affected by the water use. Such an approach supports the idea of greater transparency and accountability. Water governance and management needs ongoing accountability to key interests and the public.

Finally, this principle recognizes the concept of stewardship. Stewardship understands that people are part of the environment and that water users and managers have a duty to ensure their actions safeguard the resource and its surrounding environment. Stewardship requires the co-operation and coordinated effort of individuals, governments, boards, organizations, communities, industry, and others to be successful.[8]

APPLYING OUR PRINCIPLES

Defining these principles first is important, as we respect these principles and demonstrate their application through our advice and recommendations in this report. These principles are used as a frame and a filter through which we reviewed our findings and conclusions. We will show they can be put into practice through new policy research and future water-management and governance practices.

CHAPTER THREE

WATER USE BY THE NATURAL RESOURCE SECTORS: PAST, PRESENT, AND FUTURE

CONTENTS

HIGHLIGHTS

The natural resource sectors have steadily decoupled their economic growth from water intake and use — in other words, despite historical economic gains by most sectors, water intake has not increased at the same rate as their economic growth.

Water forecasts to 2030, for all natural resource sectors combined on a national level, suggest minor water intake increases; however, this national perspective likely masks regional differences that may be important.

Water forecasts provide a much needed tool that allows governments and businesses to improve their understanding of where and when water demands might increase and plan water allocations and management strategies now and for the future.

WATER USE BY THE NATURAL RESOURCE SECTORS: PAST, PRESENT, AND FUTURE

With an expanding economy and a growing international demand for Canada's agricultural, energy, mining, and forest products, Canada's natural resource sectors are well positioned to prosper. Recent economic forecasts for these sectors predict they will be one and a half times larger in 2030 than they are today. This means expected water use will grow too: the question is, "How much will water use rise?" This is a difficult question to answer as no comprehensive, and useful information base linking long-term economic growth to water use in Canada currently exists.

To better understand how a growing economy might affect long-term industrial and agricultural water use, the NRTEE developed a water intake forecast to 2030.[9] This is important knowledge as future water-use demands are central to good water management. Forecasts help us understand if sustainable water-use risks might emerge. They also better inform an ongoing dialogue about water use by the sectors. Our consultations and research show that divergent views on water use exist across the country. Some believe that with economic development comes rapidly expanding water use, while others point to improvements in water-use intensity that are reducing overall water use despite increasing development.

The NRTEE research reveals that neither view is quite right. The public perception is that a significantly growing economy means that overall water use in the natural resource sector will also be significant. Industry is generally of the view that its water use intensity has improved

— that it is using less water per production unit, not more. Our research demonstrates that, in fact, industry has steadily decoupled economic expansion from water use over the years. Our forecasts indicate that, on a national scale, water intake in the natural resource sectors may increase by just 3% between now and 2030, even though economic production could increase by almost 40% overall for the sectors in this study. This of course masks some sector and regional variation, as localized demands for water use can be expected to grow over time, which may uncover significant challenges.

WATER-USE DEFINITIONS

- ***Water intake***. Water intake, also referred to in this report as water use, is the amount of water that a sector purchases from a public utility or withdraws from a natural water body.
- ***Recirculation***. Recirculation is the volume of water that the sector reuses in its processes.
- ***Gross water use.*** Gross water use is the total amount of water used by a sector: the sum of intake and recirculated water.
- ***Discharge.*** Water that is no longer required is discharged, often back into the water course where it was taken from.
- ***Consumption.*** Water consumption is the difference between the amount of water taken in and the amount of water discharged.
- ***Water-use intensity.*** Water intensity is the water intake per unit of production or per unit of economic output. To be able to compare intensities across sectors, for the purposes of this report, water-use intensity is calculated by dividing the water intake by the historical value of production in the sector.
- ***Costs of water use.*** Costs associated with acquiring water including public utility costs, operation and maintenance, as well as treatment of intake, recirculated, and discharged water.

Our forecast of water use out to 2030 is the product of two factors: first, the water-use intensity or how much water is required to produce a product; and second, how much the sector will grow, or a forecast of economic production. This chapter begins by showing historical water use by sector and province. From this we take our estimates of historical water intake and couple them with a long-term economic forecast to predict water demands out to 2030, on both national and sector bases. As this is the first time such analysis has been conducted, we set out our water forecasts in more detail and outline our methods. It is important to remember that this is one scenario, which highlights *potential* water intake trends into the future; it is meant to be illustrative, not definitive, of what might occur with water use in this country. The NRTEE recognizes that water forecasts are likely most useful on a watershed basis, but data does not exist to allow for such an analysis.

HISTORICAL WATER USE, ECONOMIC OUTPUT, AND WATER INTENSITY

Developing a water-use forecast starts with knowing the water intake of the sectors. Statistics Canada provides historical data on water use by industry from 1981 to 2005, for the agriculture, manufacturing, mining, and thermal electric power generation sectors.[*] This data is derived from five different years of surveys.[10,†] Historical water use in the agricultural sector is modelled by Statistics Canada[‡] with a recent survey in 2005. Water use in the oil and gas sector is more uncertain, with water-use data beginning in 2000 and not available for all regions of Canada.[11,§] Nevertheless, using the most recent and best available data together enables a clear picture to emerge.

Statistics Canada[12] estimates that the total water intake of Canada's residential, commercial, institutional, and industrial sectors was 42 km^3 in 2005.[¶] Of this total, water use in the agriculture, oil and gas extraction, mining, manufacturing, and thermal electric power generation sectors accounted for approximately 36 km^3, or 86%. The sectors studied in our report are the largest water users in the country. Of the water intake by the natural resource sectors, the distribution is as follows: the thermal electric power generation sector was the largest water user (77.7% of water intake), followed by manufacturing (7.8 %), pulp and paper (7.2%), agriculture (5.5%), mining (1.3%), and oil and gas (0.6 %) (Figure 2).

* Hydroelectricity is not included in this water forecast study because of the qualitatively different nature of water used for this purpose — it represents a flow-through use of water compared to the active intake, treatment, and discharge performed by other sectors.

† Industrial Water Use Survey, 1981, 1986, 1991, 1996, and 2005.

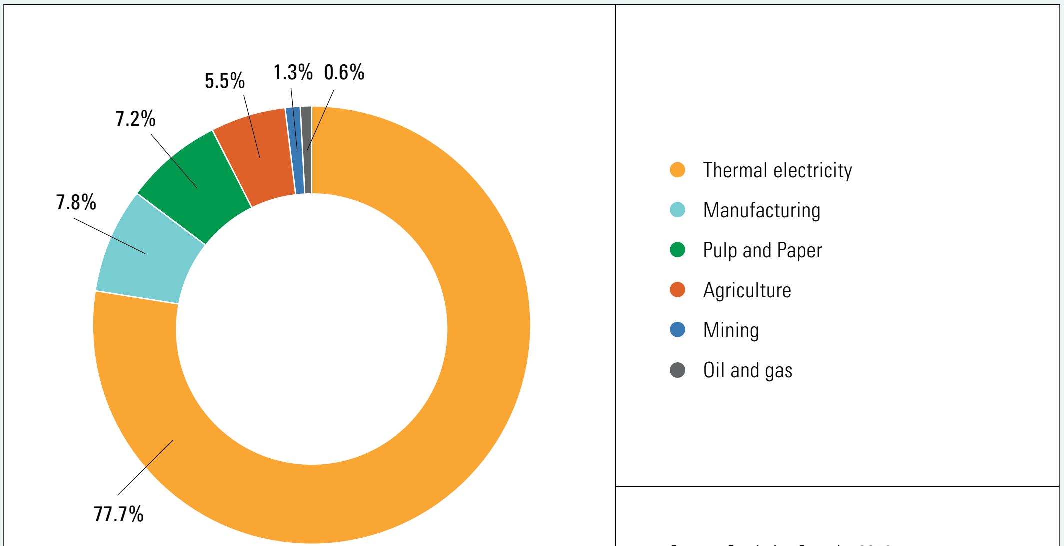
‡ 1996 from Statistics Canada (2003); 2001 from Statistics Canada 2007; and 2005 from Statistics Canada (2010a)

§ While these datasets are useful, the small number of observations makes it difficult for those interested in developing water forecasts to identify the cause of observed trends.

¶ One kilometer cubed (km^3) of water is equal to one thousand million cubic meters; in other words,1 km^3 = 1,000 Mm^3, and 1 Mm^3 = 1,000,000 m^3.

FIGURE 2

WATER USE BY THE NATURAL RESOURCE SECTORS, 2005

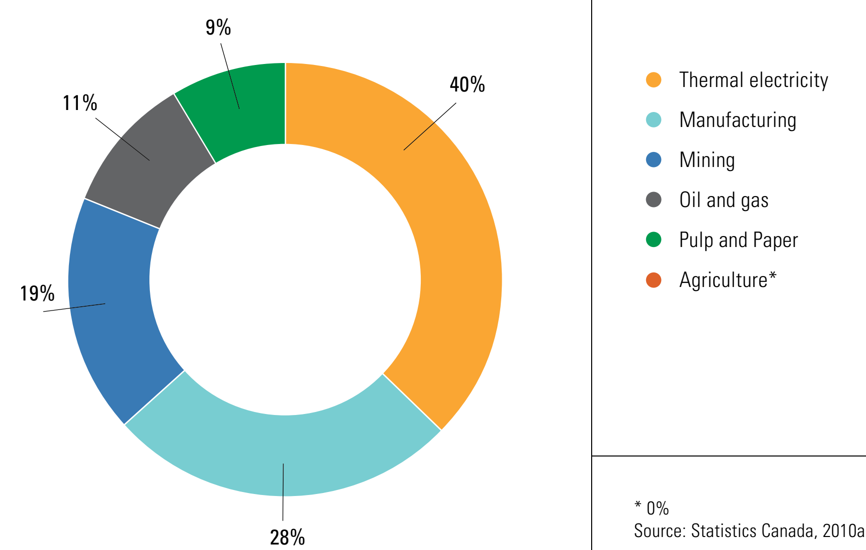


Source: Statistics Canada, 2010a.

Water recirculation is an important component of water use by many of the natural resource sectors. Recirculating water lessens overall water intake. Thermal electricity recirculates the largest share of total water on a national basis followed by the manufacturing and mining sectors (Figure 3).

FIGURE 3

WATER RECIRCULATION BY THE NATURAL RESOURCE SECTORS, 2005

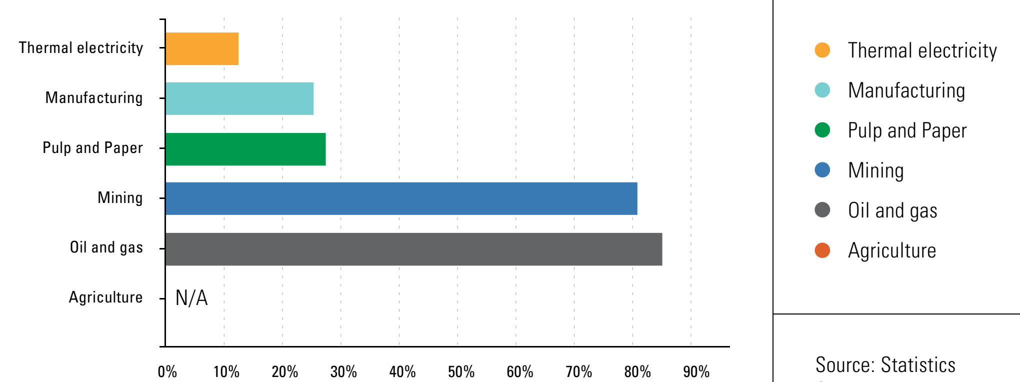


* 0%
Source: Statistics Canada, 2010a.

A different story emerges when comparing rates of recirculation across sectors – that is how much water is recirculated within a sector, when compared with other natural resource sectors' recirculation. On that basis, thermal electricity recirculates the least of all the sectors (Figure 4). This contrasts with much higher recirculation rates in oil and gas (85%) and mining (81%).

FIGURE 4

WATER RECIRCULATION RATES* WITHIN SECTORS, 2005



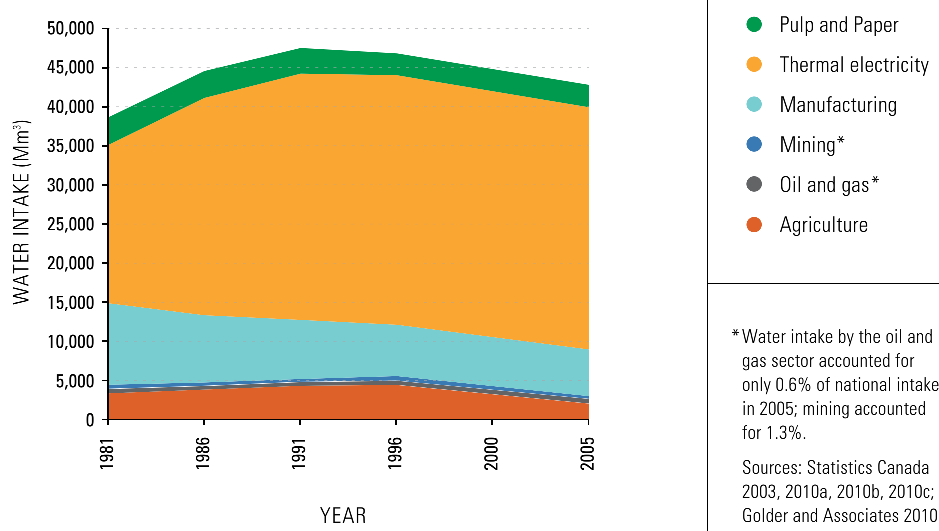
* Rates are the share of gross water use within the sector.

Source: Statistics Canada, 2010a.

Historical water intake trends between 1981 and 2005 show an overall increase of about 13% over the 24-year period. Water intake plateaus in 1991 at about 26% above 1981 levels, but then trends downward to 2005 (Figure 5). For the past 15 years water intake by many sectors has fallen, with the greatest reductions found in the agriculture and mining sectors.

FIGURE 5

WATER USE IN THE NATURAL RESOURCE SECTORS, 1981–2005



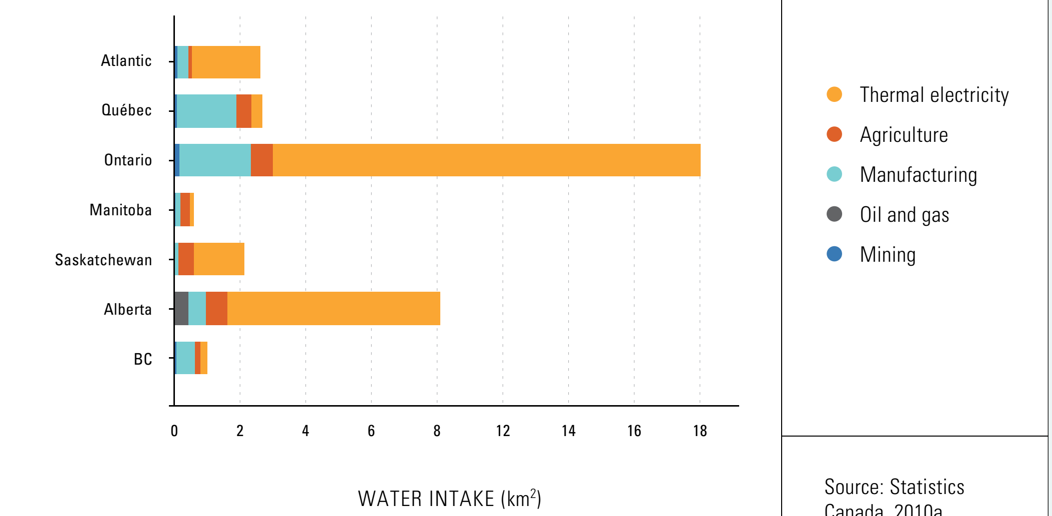
* Water intake by the oil and gas sector accounted for only 0.6% of national intake in 2005; mining accounted for 1.3%.

Sources: Statistics Canada 2003, 2010a, 2010b, 2010c; Golder and Associates 2010

Provincially, the largest water use is concentrated in Ontario and Alberta, reflecting the large share of thermal power in the provincial economies (Figure 6). Large agriculture and manufacturing water use also contribute to Ontario's high share of national water use. In Alberta, thermal electricity dominates water use, followed by agriculture and manufacturing. Oil and gas uses less than 5% of the water in Alberta. With hydroelectricity not covered in this study, manufacturing dominates intake in Québec, the third largest provincial water user as defined in our study. Thermal electricity water use predominates in Saskatchewan and Atlantic Canada, but agricultural water use is higher in Saskatchewan. British Columbia's water intake is primarily concentrated in thermal electricity and manufacturing, with each accounting for about 40% intake. Finally, in 2005, Manitoba had the lowest water intake nationally, with agriculture accounting for over 50% of total natural resource sector use within the province.

FIGURE 6

PROVINCIAL WATER USE IN THE NATURAL RESOURCE SECTORS, 2005



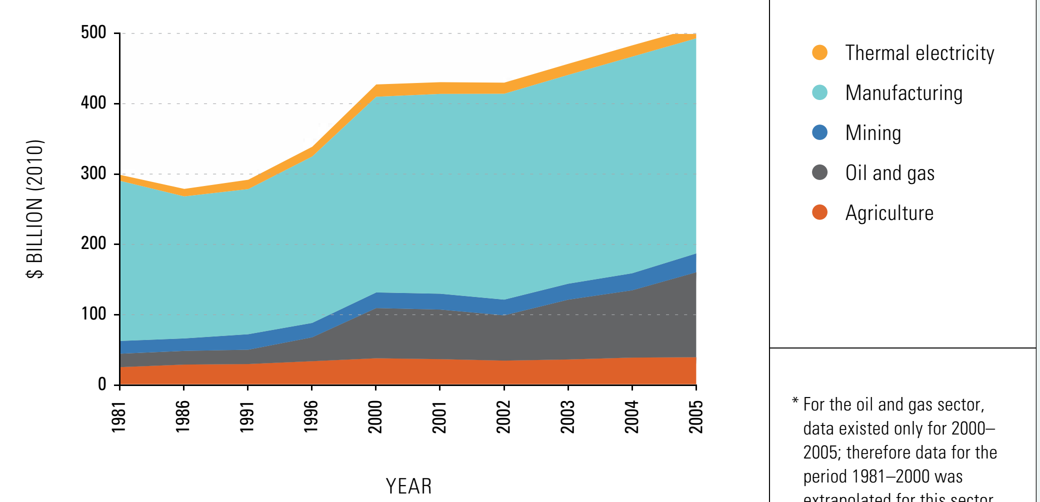
Source: Statistics Canada, 2010a.

Having identified historical trends in water intake, we can now examine water-use intensity. This requires first defining historical economic activity within the sectors. Despite an economic slowdown in the early 1980s, overall output has climbed steadily to be about to be about 70% above 1981 levels in 2005. The rate of increase in these sectors was much faster than the rate of increase of Canada's total economy, which grew by about 40% over the same period. The oil and gas sector grew even more, with an increase of greater than six times 1981 levels. Figure 7 shows the value of production for each of the sectors to the economy, as well as the increase in real terms (2010 dollars) of each from 1981 to 2005.* Manufacturing dominates the sectors accounting for 60% of all production value in this time series.

* The value of production data is taken from Statistics Canada's 2005 System of National Accounts where national and provincial output data is disaggregated by commodity, sector, and region. Disaggregated output for the electricity and oil and gas sectors was obtained from Natural Resource Canada 2011.

FIGURE 7

VALUE OF PRODUCTION FOR THE NATURAL RESOURCE SECTORS, 1981–2005



* For the oil and gas sector, data existed only for 2000–2005; therefore data for the period 1981–2000 was extrapolated for this sector.

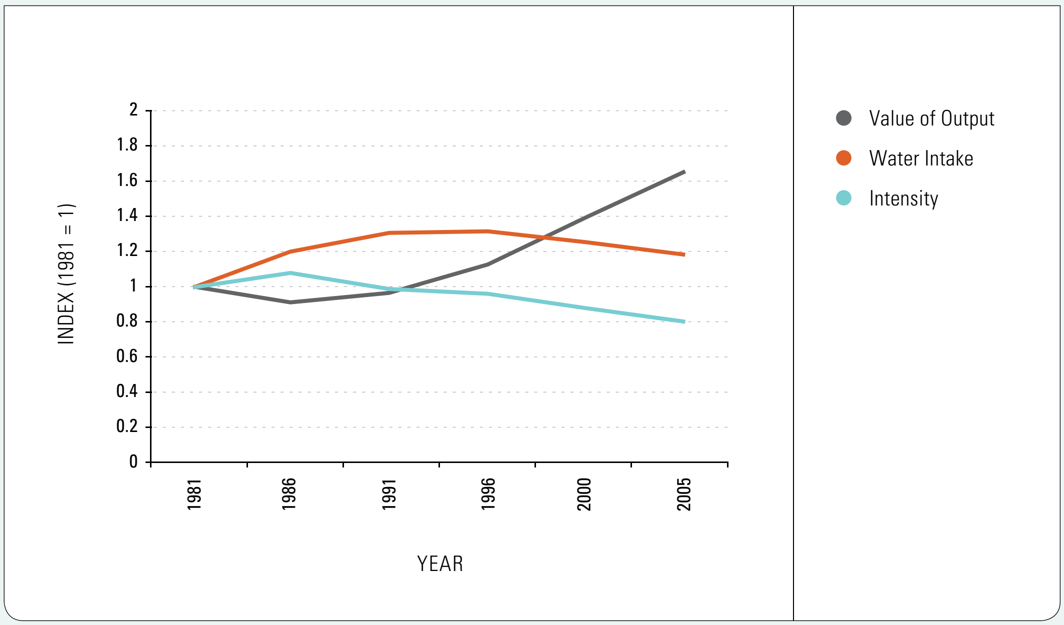
Now knowing both the historical water intake and the historical value of production, we can then calculate each sector's **water-use intensity*** — defined here as *water intake per dollar of production*. This is important to determine, as we forecast water use we need to know the change in water-use intensity over time to estimate how water intake in a growing economy changes.

With the economic activity of the natural resource sectors expanding rapidly and water intake declining over time, it is not surprising that water-use intensity has fallen. Since 1981, the natural resource sectors have steadily decoupled economic growth from water use, with a decline of about 20% for every dollar of output (Figure 8). While this is an important finding, not enough research has been completed in Canada to fully explain the decline in water-use intensity. We know, however, that important drivers include technological change, changes in the composition of industrial sectors, and changing processes for internal water recirculation.

* Using this definition of water-use intensity allows for a comparison across sectors. If defined as water intake per unit of production, a sectoral comparison would be impossible.

FIGURE 8

NATURAL RESOURCE SECTORS' WATER-USE INTENSITY, 1981–2005



Each sector's water use, including water intensity, water intake, and economic output, is discussed separately below.*

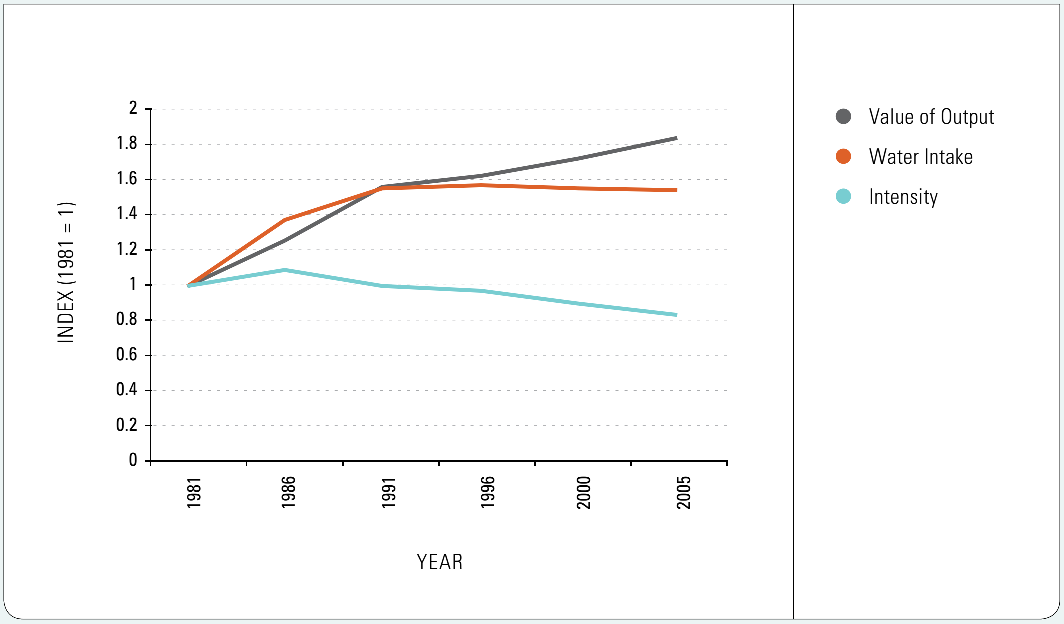
THERMAL ELECTRIC POWER GENERATION

Thermal electric power generation in Canada takes in more water than any other use, primarily from water bodies in Ontario, Alberta, and Saskatchewan. This sector accounted for 66% of the total national intake in 2005; its water use increased by about 53% from 1981 to 2005 (Figure 9). Thermal electric power generation includes conventional fossil fuel and nuclear power generation, which use approximately 140 litres and 205 litres, respectively, to produce one kilowatt-hour of electricity.[13] While a small portion of the water is converted to steam

* For ease of comparison the values of economic output, water intake, and water-use intensity are compared using an index where 1981=1, the starting point of comparison. Economic output from the oil and gas sector has grown so rapidly that it requires the index to increase to 7.

FIGURE 9

WATER INTAKE, ECONOMIC OUTPUT, AND WATER-USE INTENSITY IN THERMAL ELECTRICITY



and used to spin an electric generator, most of the water is used for cooling. This water is then either recirculated or discharged. In 2005, approximately 2.5% of this sector's water intake was consumed primarily from the loss of steam in the cooling process.

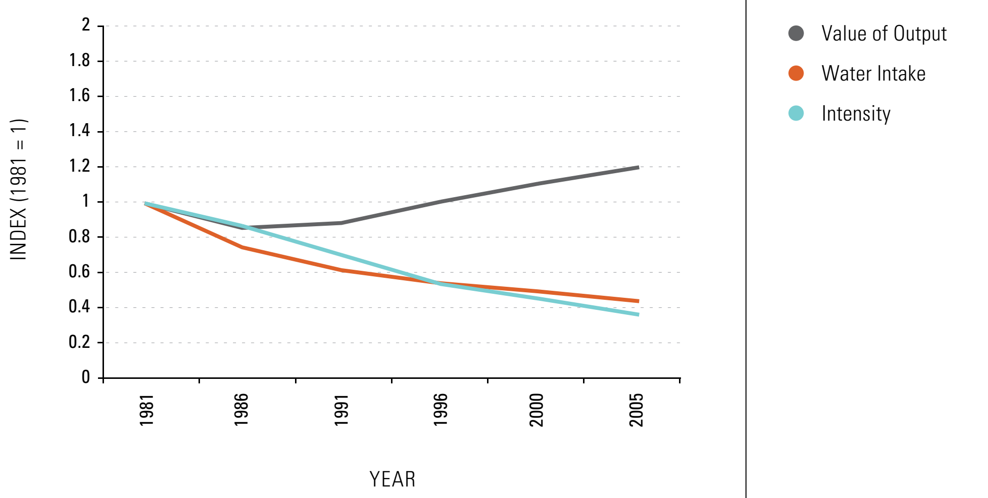
The economic value of this sector's output in 2005 was $15.6 billion, or about 80% greater than 1981. This increase in value, coupled with rising water intake (53%), results in thermal having the highest water-use intensity of any sector. In 2005 this sector had the greatest water intake in Canada but produced only 3.1% of total national economic output. As a result, water-use intensity fell by 16% from 1981 to 2005.

MANUFACTURING

Manufacturing remained the second largest water user of the natural resource sectors, accounting for almost 13% of national intake in 2005; however, this intake has fallen by half since 1981

FIGURE 10

WATER INTAKE, ECONOMIC OUTPUT, AND WATER-USE INTENSITY IN MANUFACTURING



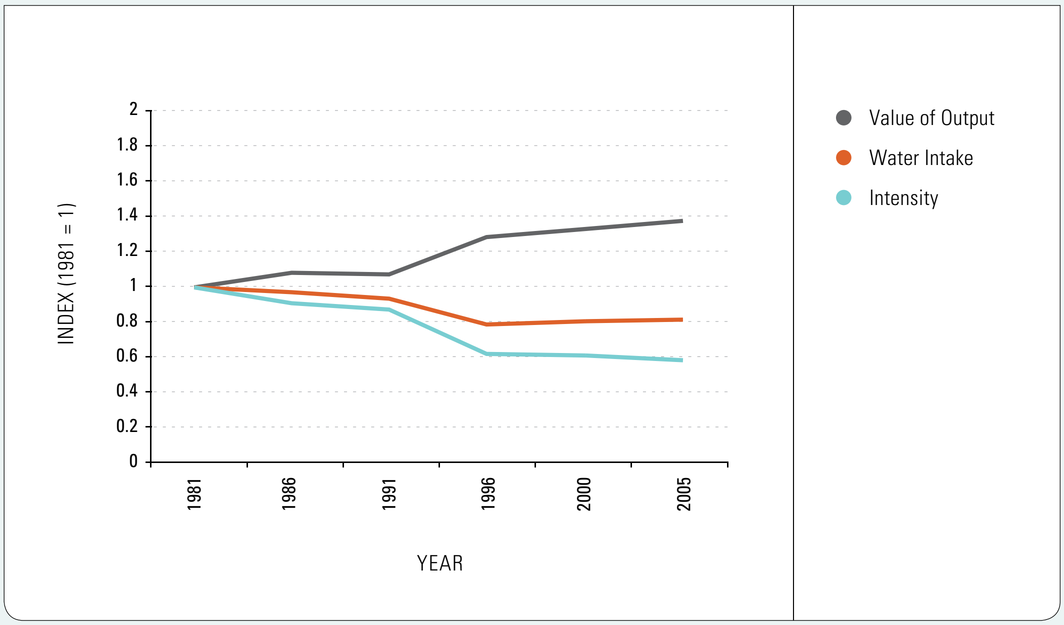
(Figure 10). In the manufacturing sector water can be used many ways — as a raw material to make pulp or beverages, a solvent for removing undesired materials, or a transport agent to move products. The largest manufacturing water users are paper and primary metal — making up 48% and 29% respectively of manufacturing water use in 2005.[14]

Despite a drop in economic output from 1981 to 1986 (due primarily to a 39% drop in output in petroleum and coal products), production in manufacturing has risen 34% since 1981. This combination of rising production and rapidly falling water intake has resulted in a dramatic reduction in water-use intensity; since 1981, the water-use intensity has fallen by more than half (Figure 10).

Given the diversity of production in manufacturing, it is not surprising that the water-use intensity of some subsectors is high while for others it is low. Those with high water-use

FIGURE 11

WATER INTAKE, ECONOMIC OUTPUT, AND WATER-USE INTENSITY IN PULP AND PAPER



intensity include pulp and paper (Figure 11), primary metal, and chemical manufacturing; those with low water-use intensity include non-metallic mineral product, petroleum and coal, and food manufacturing. Food manufacturing was the only subsector that did not reduce its water intake from 1981 to 2005. The most dramatic reduction in water intake occurred in chemical manufacturing, which reduced its water use six-fold from a share of 34% of overall manufacturing water intake to 9%.

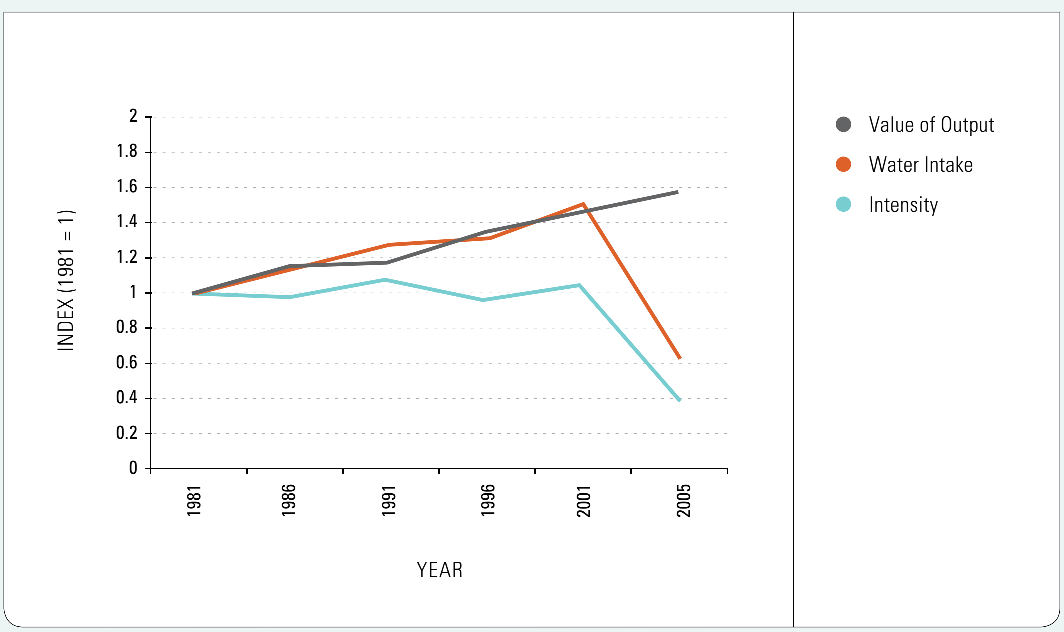
The pulp and paper subsector is considered to be part of the manufacturing sector based on Statistics Canada's data collection. Its water use represents approximately half of the manufacturing sector's total water intake, making the pulp and paper subsector one of the more water-intensive subsectors (Figure 11). From 1981 to 2005, the value of economic output in pulp and paper saw a gradual increase, in comparison with a reduction of water intake of about 20% over the same time period. As a result, the water-use intensity of the pulp and paper subsector has gradually declined by about 40% during this period.

AGRICULTURE

In 2005, water used for agriculture accounted for 5% of national intake. Included in agriculture are two subsectors: crop and animal production. Agricultural water use is primarily for irrigation (84%) and livestock watering (14%). In contrast to the industrial sectors, much of the water use in agriculture is considered *consumptive* due to evaporation, transpiration, and loss to groundwater; therefore only one-quarter of the intake water is returned to its source. Water intake in agriculture steadily increased by about 50% from 1981 to 2001, but then decreased substantially from 2001 to 2005 by 57%, resulting in about 38% below 1981 levels (Figure 12). The value of agricultural production rose steadily from \$24.5 billion in 1981 to \$38.6 billion in 2005. This, in combination with the significant drop in water intake between 2001 and 2005, had the effect of driving down water-use intensity by 60% between 1981 and 2005, with the most notable decrease occurring since 2001.

FIGURE 12

WATER INTAKE, ECONOMIC OUTPUT, AND WATER-USE INTENSITY IN AGRICULTURE



Despite being equal in the value of output to animal production historically, crop production used 95% of the water in the agriculture sector. From 1981 to 2001, water use and economic growth increased proportionally causing the water intensity of the crop production sector to remain relatively stable. However, in 2005, water use in crop production dropped to one-third of what it was reported to be in 2001. This drop in water use per unit of output was likely caused by a large decrease in the amount of water needed for crop irrigation due to higher precipitation that year. This reduction in water intake in 2005 caused the water intensity to drop by 70% of its 1981 value.

It is difficult to explain improvements to water intensity in agriculture. However, case studies of the Okanagan Valley in British Columbia, where water intensities have improved significantly, suggest possible reasons: weather and climatic conditions, adoption of newer technologies and best management practices, a change to more drought-resistance crops (less water intensive), and decommissioning of previously irrigated lands.[15]

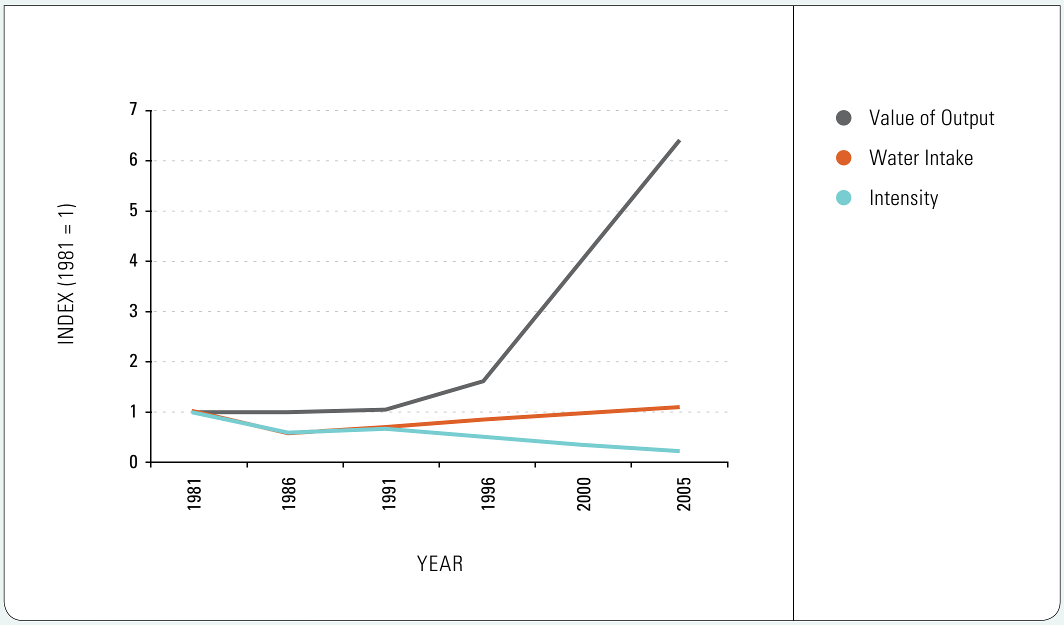
OIL AND GAS

Oil and gas extraction is a relatively small water user nationally, with the majority of current production and related water use located in Alberta. Water use is found predominantly in non-conventional oil and gas extraction, including the oil sands subsector. The overall oil and gas sector's water intake showed an uneven trend between 2001 and 2005, with both increases and decreases. Subsector variation is evident with some facing decline in the period (the water intake for conventional oil dropped 18%) and some trending up (water intake in unconventional gas rose 68%). Water-use data was only available from 2001 onward, and so water use prior to 2001 is estimated based on this data.

Overall, the water-use intensity of the oil and gas sector has been dropping over time (Figure 13). The oil and gas sector as a whole has the lowest water-use intensity of the sectors covered in this study due to its relatively large economic output (23% of output of all sectors) compared with a relatively small amount of water use (0.6% of water intake of sectors covered in this study). In 2005 the largest water user in this sector was oil sands mining, which used 66% of total water intake by the sector, but only accounted for 12% of the sector's overall economic output, resulting in the highest water-use intensity of the subsectors. In contrast, conventional oil and natural gas, which made up the majority of the economic output in this sector at 64% in 2005, was one of the lowest water users in terms of intake (27%) in 2005, resulting in the lowest water-use intensity.

FIGURE 13

WATER INTAKE, ECONOMIC OUTPUT, AND WATER-USE INTENSITY IN OIL AND GAS



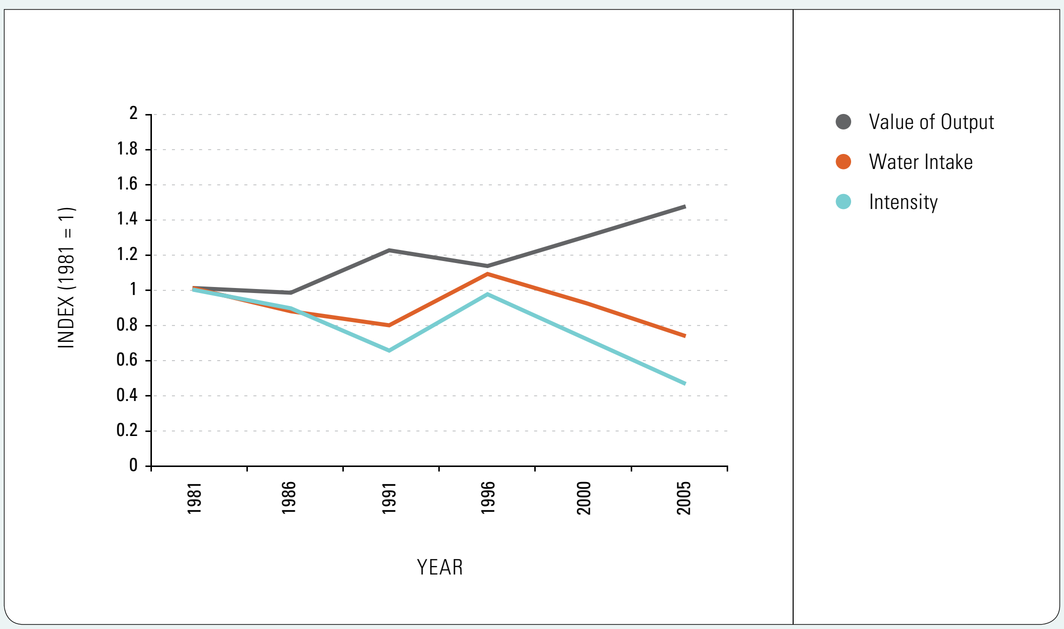
MINING

On an intake basis, the mining sector is a very small water user, accounting for just 1% of national water intake in 2005. This sector includes coal, metal ore, and non-metallic mineral mining. Water is used to cool drill bits, separate ore from the mined rock, wash the extracted ore, and remove any unwanted material. The mining sector has one of the highest recirculation rates of all sectors. Statistics Canada indicates that the mining sector actually returns more water to the environment than it extracts, due to the discharge of water that accumulates on the mine site, often due to interception of groundwater.[16]

Overall, water intake has been trending downward in mining, as the sector has steadily reduced its intake from 1981 to 2005, with the exception of an increase in 1996. However, the sector reduced its intake from 1996 to 2005 by 33%. Over the same period, the value of production rose by about 48%, which translates into a significant drop in water-use intensity for the mining sector (Figure 14). All mining subsectors show decreased water-use intensity since 1981. While the trend is down, there has been some variation such as that observed between 1996 and 2005. Economic output for all the subsectors increased from 1981 to 2005. As a result, water-use intensity fell overall from 1981 to 2005 in all subsectors despite an observed intensity increase in 1996.

FIGURE 14

WATER INTAKE, ECONOMIC OUTPUT, AND WATER-USE INTENSITY IN MINING



WATER FORECASTS FOR THE NATURAL RESOURCE SECTORS

The 2030 forecast of water intake requires first, a forecast of water-use intensity and second, a forecast of economic growth. Each of these is discussed below.

WATER-USE INTENSITY FORECASTS

In order to forecast water use, it was necessary to first estimate what each sector's water-use intensity might be out to 2030. We did so by using the historical water-use intensity trends presented in the previous section for each sector and subsector. There are some important assumptions used in these intensity forecasts, and some important aspects of the forecasts worth noting:

- **Agriculture**. The overall historical water-use intensity of the agriculture sector improved between 1981 and 2005 with a significant reduction in intensity of about 60%. However, with the importance of irrigation to water intake, and with the relatively stable historical water-use intensity in the crop production sector, the 2005 water-use intensity is used as the future water-use intensity through to 2030.

- **Oil and Gas Extraction**. The water-use intensity for the oil and gas sector overall is predicted to improve by 43%; however, there is substantial variation between the subsectors. This forecast assumption flows from the following explanation:

    - Based on the historical trend, conventional, oil sands mining and oil sand in situ production are forecast to continue improving their water-use intensity. The in situ oil subsector is forecasted to have the largest improvement in fresh water-use intensity, based upon a significant improvement in efficiency by 2015[17], after which we assume that water-use intensity remains to 2030.

    - Due to a lack of data on water use in the different types of natural gas production, the water-use intensity of all natural gas production is forecast to increase by 1.6% per year from 2005 to 2030 — a reduction in the growth of 2.2% annually from 2000 to 2005. This increase in water intensity may be due to the transition from conventional gas production to tight and shale gas resources that are anticipated to require significant water quantities.

Therefore, despite falling or stable water-use intensities for each individual oil and gas sector, overall water-use intensity is forecast to increase 52% by 2030 in our scenarios, due to an increase in the output of the oil sectors compared to natural gas. From 2005 to 2030, the share of output will shift from 52% oil and 48% natural gas to 74% oil and 26% natural gas. Since the water-use intensity of oil production is much higher than natural gas production, the overall water-use intensity of the oil and gas sector increases by 52%.

- **Manufacturing**. Water-use intensity declined for all the manufacturing subsectors to 2005, and is forecast to continue to decline to 2030. Water intensity in the pulp and paper subsector declined significantly between 1981 and 1996 but then remained stable thereafter to 2005. We extrapolate a somewhat flat water-use forecast for the manufacturing sector as a whole to 2030.

- **Mining**. Given the general decline in water-use intensity overall in the mining sector, the water-use intensity is assumed to continue to decrease out to 2030; however, notable differences exist at the subsector level.

- **Thermal Electric Power.** Based on historical data, the water-use intensity for thermal electric power generation is forecast to continue to decline by 20% by 2030.

An important caveat to note is that the water-use intensity for each sector and some subsectors can vary substantially from region to region; as such, the NRTEE recognizes that the use of one value for water-use intensity in our future scenario is not representative of regional differences that likely exist.

Table 1 provides subsector details for the water-use intensity forecasts. Further explanation of the calculation of the water-use intensities is provided in Appendix 3.

TABLE 1

FORECAST OF WATER-USE INTENSITY (1,000 m^3 PER $ MILLION OUTPUT)

SECTOR	INTAKE INTENSITY				CHANGE †		TOTAL PER CENT CHANGE	
	1981	2000	2005	2030	1981* to 2005	2005 to 2030	1981* to 2005	2005 to 2030
Agriculture	**140.6**	**x**	**55.6**	**54.2**	**-84.9**	**-1.4**	**-60%**	**-2%**
Crop production	276.2	x	93.0	93.0	-183.2	0.0	-66%	0%
Animal production	16.3	x	18.3	18.1	2.0	-0.2	12%	-1%
Oil and Gas	**x**	**1.9**	**1.9**	**2.9**	**0.0**	**1.0**	**-2%**	**52%**
Oil sands mining	x	12.5	10.2	8.3	-2.3	-1.9	-18%	-18%
Oil sands in-situ	x	1.5	1.4	0.8	-0.2	-0.5	-10%	-39%
Oil light medium	x	1.6	1.5	1.1	-0.2	-0.4	-10%	-24%
Oil heavy	x	1.6	1.5	1.1	-0.2	-0.3	-9%	-23%
Conventional natural gas	x	0.2	0.1	0.2	0.0	0.1	-21%	40%
Tight natural gas	x	0.2	0.1	0.2	0.0	0.1	-21%	40%
Shale natural gas	x	0.0	0.0	0.2	-	0.2	-	-
Mining	**37.8**	**x**	**18.7**	**15.0**	**-19.2**	**-3.7**	**-51%**	**-20%**
Coal mining	22.2	x	7.3	6.1	-14.9	-1.2	-67%	-16%
Metal ore mining	50.4	x	25.6	22.9	-24.8	-2.7	-49%	-11%
Non-metallic mineral mining	17.1	x	11.1	7.6	-6.0	-3.5	-35%	-32%
Manufacturing	**45.1**	**x**	**19.2**	**14.7**	**-25.9**	**-4.5**	**-57%**	**-23%**
Paper manufacturing	130.8	x	76.9	73.1	-53.9	-3.8	-41%	-5%
Primary metal manufacturing	61.3	x	32.3	25.3	-29.0	-7.0	-47%	-22%
Chemical manufacturing	102.9	x	9.2	7.5	-93.7	-1.7	-91%	-19%
Petroleum and coal products	8.9	x	6.0	5.1	-2.9	-0.9	-32%	-16%
Food manufacturing	6.1	x	4.2	3.3	-1.8	-1.0	-30%	-23%
Non-metallic mineral product	10.3	x	4.7	3.5	-5.6	-1.2	-54%	-25%
Thermal electricity	**2,348**	**x**	**1,965**	**1,564**	**-382**	**-401**	**-16%**	**-20%**

"x" indicates data that was unavailable

"-" As there was no shale gas water use data available in 1981 and no intake intensity in 2005, the 'change' and 'per cent change' is not quantified.

* period of change for oil and gas sector starts in 2000 † 'changes' have been rounded to nearest decimal point.

ECONOMIC GROWTH FORECAST

The forecast of economic growth out to 2030 is determined by obtaining forecasts of growth rates for the subsectors and applying these growth rates to the 2005 base year economic data that is nationally available.[18] For most sectors, growth projections out to 2030 are from Informetrica.[19] A disaggregated forecast for the oil and gas sector was derived from the Canadian Association of Petroleum Producers[20] and the National Energy Board.[21] A forecast of growth in the electricity sector was derived from original modelling.*

Most sectors are expected to increase their gross output by 2030. While the oil sands in-situ and oil sands mining sectors are forecast to grow the fastest of any subsector of the economy, the forecast reduction in conventional oil and gas production will limit the increase in the overall oil and gas sector to that of 37% by 2030. Next to oil sands, animal production is forecast to grow the fastest at 64%, followed by chemical manufacturing, petroleum and coal product manufacturing, and crop production. Shale gas is expected to grow its share of natural gas output from 0% in 2005 to 18% by 2030. The mining and manufacturing sectors were the hardest hit by the recent economic downturn, both showing a decline in output from 2005 to 2010. However, both sectors are anticipated to increase production past 2005 levels by 2015. Table 2 provides further details of the subsector economic output forecasts to 2030.

* The CIMS model is a technologically explicit representation of the Canadian energy–economy system. The forecast of output for the electricity generation sector is based on the calculated demand from the Canadian economy.

TABLE 2

FORECAST OF ECONOMIC GROWTH (GROSS OUTPUT), 2005 TO 2030 (2010$ BILLIONS)

SECTOR	2005	2010	2015	2020	2025	2030	CHANGE, 2005 TO 2030
Agriculture	**38.6**	**39.2**	**46.6**	**50.9**	**55.4**	**61.2**	**58%**
Crop production	19.3	19.2	22.1	24.2	26.6	29.5	53%
Animal production	19.3	20.0	24.5	26.7	28.8	31.7	64%
Oil and Gas	**117.4**	**117.2**	**133.7**	**151.4**	**159.2**	**160.3**	**37%**
Oil sands mining	14.3	20.6	28.4	33.0	41.1	43.2	201%
Oil sands in-situ	11.5	18.7	28.9	42.8	50.4	57.6	402%
Oil light medium	21.8	20.5	18.4	15.9	14.0	11.9	-45%
Oil heavy	13.6	10.7	8.9	7.6	6.6	5.5	-60%
Conventional natural gas	40.1	27.4	22.0	22.8	17.8	12.8	-68%
Tight natural gas extraction	16.1	18.8	24.3	24.7	23.2	21.8	35%
Shale natural gas extraction	-	0.6	2.8	4.5	6.1	7.6	-
Mining	**26.9**	**22.3**	**29.9**	**32.4**	**33.8**	**35.1**	**31%**
Coal mining	3.3	3.2	4.7	4.7	4.7	4.5	38%
Metal ore mining	14.9	10.1	14.4	16.0	16.8	17.4	17%
Non-metallic mineral mining	8.7	8.9	10.9	11.7	12.3	13.2	51%
Manufacturing	**307.1**	**284.6**	**331.0**	**365.1**	**393.9**	**429.1**	**40%**
Paper manufacturing	36.7	28.3	33.5	36.8	39.6	42.7	16%
Primary metal manufacturing	54.0	42.8	50.6	56.8	58.3	60.8	13%
Chemical manufacturing	59.4	49.1	62.1	73.0	83.3	96.5	62%
Petroleum and coal products	65.1	72.5	80.7	87.9	94.5	101.7	56%
Food manufacturing	77.0	77.8	87.3	92.6	99.0	106.8	39%
Non-metallic mineral product	14.9	14.0	16.7	18.0	19.2	20.7	39%
Thermal electricity	**15.6**	**16.0**	**16.2**	**16.9**	**18.0**	**19.1**	**23%**

WATER INTAKE FORECASTS

By combining the forecast of water-use intensity and economic forecasts for the sectors, we estimate that overall water intake will rise by about 3% on a national basis, from 35,799 Mm^3 in 2005 to 36,787 Mm^3 in 2030. This overall increase is largely due to intake increases by agriculture and oil and gas (Table 3).

TABLE 3

OVERVIEW OF WATER INTAKE FORECASTS TO 2030, BY SECTOR (Mm^3)

SECTOR	WATER INTAKE 2005	WATER INTAKE 2030	SECTOR CHANGE 2005 TO 2030	SHARE OF TOTAL NR INTAKE, 2005	SHARE OF TOTAL NR INTAKE, 2030
Oil and Gas	203	396	96%	0.6%	1.1%
Mining	456	478	5%	1.3%	1.3%
Agriculture	1,953	3,017	54%	5.5%	8.2%
Manufacturing	5,362	5,744	7%	15.0%	15.6%
Thermal electric	27,825	27,151	-2%	77.7%	73.8%
Total	**35,799**	**36,787**	**3%**	**100%**	**100%**

Source: Statistics Canada (2010b), CAPP (2010); Forecast from MKJA (2011).

Due to the relatively small improvement forecasted for water-use intensity from 2015 to 2030 in agriculture and oil and gas (specifically oil sands mining and oil sand in-situ), the water intake increases with the high economic growth rates forecast in these sectors. Keep in mind, however, that these forecast water intakes for the two sectors, relative to the total intake by the natural resource sectors, are somewhat modest. For example, while the oil and gas sector's water intake is forecast to increase by 107% by 2030, the sector's water intake will still only account for about 1% of the national water intake by all natural resource sectors combined. However, this represents a larger share of water intake in the regional watersheds.

While most sectors' water intake is forecast to increase by 2030, some subsectors are expected to reduce their water intake. Conventional oil and gas production are expected to reduce their water intake due primarily to a reduction in the economic output of these sectors. Primary metal manufacturing and thermal electric power generation are expected to experience a decline in water intake due to decreasing water use intensities.

Table 4 shows the details of the water-intake forecasts by sector and subsector. This table also shows water intake compared to the historical trend.

TABLE 4

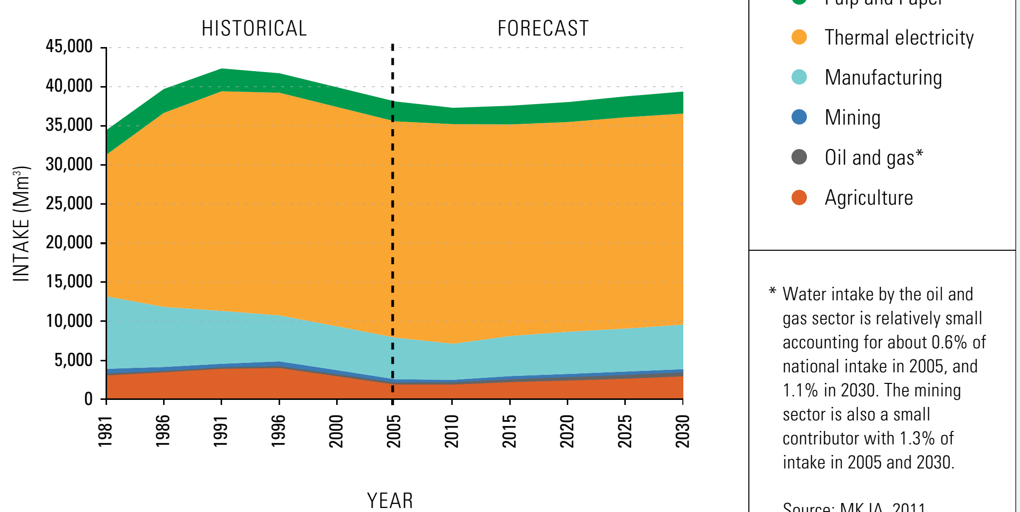
FORECAST OF WATER INTAKE, 2005 TO 2030 (Mm³)

SECTOR	2005	2010	2015	2020	2025	2030	CHANGE, 2005 to 2030
Agriculture	**1,953**	**1,950**	**2,266**	**2,481**	**2,722**	**3,017**	**54%**
Crop production	1,632	1,627	1,869	2,045	2,251	2,496	53%
Animal production	321	324	397	436	472	521	62%
Oil and Gas	**203**	**232**	**285**	**323**	**382**	**396**	**96%**
Oil sands mining	133	164	220	252	312	326	146%
Oil sands in-situ	15	18	22	33	39	44	205%
Oil light medium	29	27	23	19	15	12	-58%
Oil heavy	18	14	11	9	7	6	-69%
Conventional natural gas	5	5	4	4	3	2	-55%
Tight natural gas extraction	2	4	5	5	4	4	89%
Shale natural gas extraction	0	0	1	1	1	1	-
Mining	**456**	**345**	**449**	**473**	**476**	**478**	**5%**
Coal mining	22	22	30	29	27	25	16%
Metal ore mining	346	248	334	357	361	363	5%
Non-metallic mineral mining	88	74	85	87	88	91	3%
Manufacturing	**5,362**	**4,638**	**5,154**	**5,423**	**5,545**	**5,744**	**7%**
Paper manufacturing	2,565	2,100	2,410	2,571	2,696	2,835	11%
Primary metal manufacturing	1,583	1,283	1,400	1,464	1,415	1,398	-12%
Chemical manufacturing	497	513	560	587	611	657	32%
Petroleum and coal products	357	397	418	435	451	470	32%
Food manufacturing	298	290	305	304	308	317	7%
Non-metallic mineral product	64	54	60	62	63	66	5%
Thermal electric power	**27,825**	**28,273**	**27,237**	**26,999**	**27,185**	**27,151**	**-2%**
Total	**35,799**	**35,437**	**35,392**	**35,698**	**36,310**	**36,787**	**3%**

The increasing economic activity is predicted to exceed the rate of improvement of water-use intensity and result in an increase in water intake in all sectors, except thermal electric power generation from 2005 to 2030. Subsector variation exists within these sector averages (Table 4). Thermal electric power generation remains the largest water user in Canada, followed by manufacturing and agriculture in 2030 (Figure 15). However, thermal power's water intake is forecast to decline by about 2%, resulting in a national overall increase of 3%.

FIGURE 15

WATER INTAKE, HISTORICAL AND FORECAST, BY SECTOR



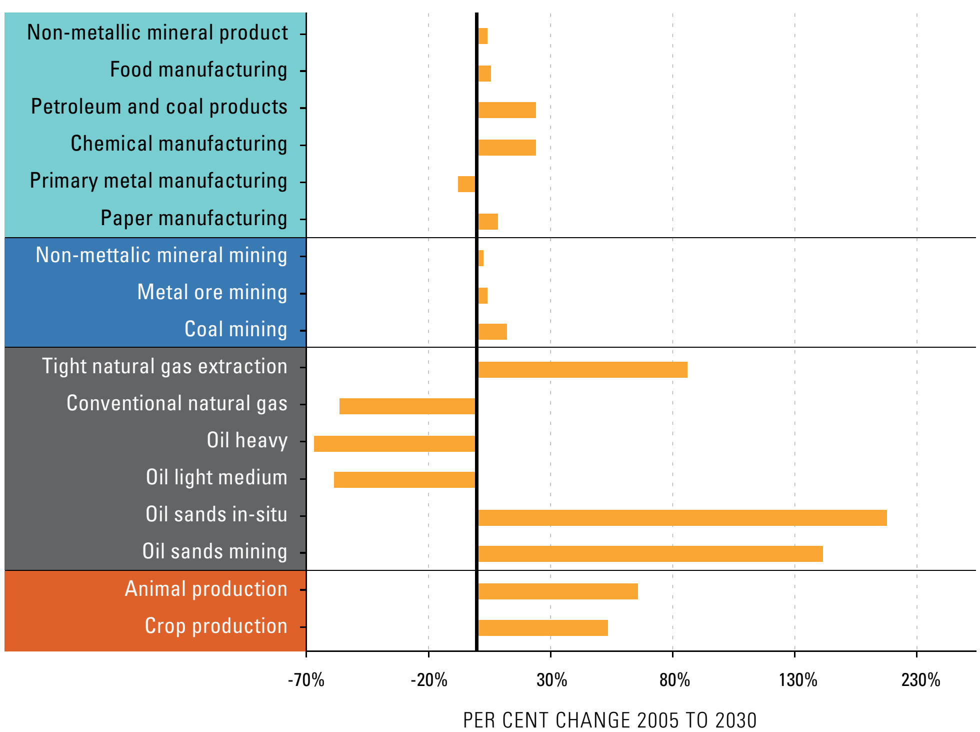
* Water intake by the oil and gas sector is relatively small accounting for about 0.6% of national intake in 2005, and 1.1% in 2030. The mining sector is also a small contributor with 1.3% of intake in 2005 and 2030.

Source: MKJA, 2011.

Although our forecasts predict that overall national water use remains fairly constant from now until 2030, subsector variations of water-use intake may be significant (Figure 16). The water-use intake for some subsectors declines, including conventional oil and gas and thermal electricity, while the water-use intake for others, including the non-conventional oil and gas subsectors, grows significantly. Oil and gas is regionally concentrated, implying perhaps localized water-use pressures. Agricultural water intake is likely to increase, and being geographically dispersed, the sector could also face increased water pressure over time. Thus the small overall forecast increase in water use may mask some significant sector and regional variation.

FIGURE 16

FORECAST CHANGE IN WATER INTAKE BY SUBSECTOR (PER CENT CHANGE 2005-2030)



SUMMARY

Our analysis reveals that the natural resource sectors have steadily decoupled their economic growth from water intake and use. Despite historical economic gains by most sectors, water intake has not increased at the same rate as their economic growth resulting in improvements of their water-use intensity.

Water forecasts to 2030, for all natural resource sectors combined on a national level, suggest minor water intake increases. However this national picture likely masks regional and sectoral differences that may exist, and must be further investigated in a regional context.

We presented our forecasts to industry representatives to test their validity and conducted technology reviews to look for future improvements in water technologies. Despite this, our forecasts have some limitations, primarily because the future trends were derived from historical water use. Any number of future drivers could alter these forecasts, notably step changes in improved water use through technology deployment. Future work on forecasting at a provincial, as well as watershed basis, would be even more insightful. Adopting a watershed approach to management makes more sense when addressing supply and demand issues. Securing reliable data at that level will provide a clearer, more detailed picture of water-use trends and pressures and assist private and public water managers make decisions.

CHAPTER FOUR

EMERGING POLICY INSTRUMENTS FOR WATER MANAGEMENT

CONTENTS

HIGHLIGHTS

Water charges that put a price on the volumes used could send a strong signal that water is valuable and must be efficiently used and conserved.

Trading water permits represents a fundamental shift in water-management systems, requiring existing legal, institutional, and administrative frameworks to be reassessed before proceeding.

Voluntary initiatives have a role in improving water management across all sectors, showing promise as they relate to measuring and reporting water use and improving transparency of sectoral water management.

EMERGING POLICY INSTRUMENTS FOR WATER MANAGEMENT

Numerous policy instruments and approaches exist for water management. Some of these include command-and-control types of regulation, water pricing, tradable water permits, standards, and voluntary approaches such as education and reporting programs. Within this suite of policy instruments, the NRTEE explored the potential use of two emerging and promising policy approaches — economic instruments (EIs) and voluntary initiatives — as complementary policy tools to existing policy approaches within Canada. The NRTEE examined each of these to determine if and how they might improve water efficiency and promote conservation by the natural resource sectors.

Emphasis was placed on EIs and voluntary approaches because they have been identified, both within Canada and abroad, as emerging approaches that have real potential for future water strategies. Yet, as our analysis reveals, practical experience with both types of instruments remains limited. We drew upon recent research into policy instruments, conducted our own assessment,[22] and drew upon observations and lessons learned from Canadian and international experience. There are many varied and diverse approaches to water management. The NRTEE's advice is meant to complement and improve upon existing systems in the short term, with a longer view that more substantial transformative changes may be needed in the future.

Our review of policy approaches across the provinces and territories in Canada points to a good foundation in current water management practices, and some interesting recent trends toward the inclusion of EIs and voluntary initiatives that show promise for improving how water is managed. While current water-management approaches function well with water abundance, longer-term risks may not be as manageable with increasing pressures on water demands and possible water restrictions. These risks can be viewed as both environmental and economic.

Environmental risks stem from a lack of information for decision making, which becomes magnified as scarcity and water competition become acute. Essentially, insufficient information creates a risk of potential over-allocation, which could have a negative impact on the aquatic environment.

Economic risks result from the difficulty of reallocating water among users. For example, in years of water restrictions it may not be possible for governments to efficiently or effectively reallocate water, thus putting some water users (i.e., those with a lower priority licence) in jeopardy. Current water allocation systems tie water rights to one set of users, making it difficult to reallocate water to other uses.[23]

These two key risks limit the ability of current water-management practices to be flexible in the face of future uncertainty. Expanding Canada's policy toolbox could make management more resilient and adaptive to circumstances of changing water supplies and demands.

CURRENT POLICY AND MANAGEMENT APPROACHES

The provinces and territories manage water in their respective jurisdictions and determine policy for water allocation and use. Many existing approaches manage and set water policy with a supply-oriented focus, ensuring that there is enough water for all users. Recent trends in the last decade are moving away from this approach to *demand-side* management, with the knowledge that the assumption of unlimited supplies of water no longer holds true. Another driver for change to demand-side management is the knowledge of and warnings from the scientific community that a changing climate will likely affect the predictability of water supply and variability of flows in much of Canada.[24]

All provinces and territories possess the legal and administrative capacity to license and therefore permit or restrict the use of water, to charge for licences, to charge for usage (on a volumetric basis), to monitor water flows, and to require reporting from water users. All provinces and territories have some form of licensing and permitting system in place, and all charge fees whether they are usage fees, licence fees, or both.

Licences can be issued for long terms of up to 20 or 50 years, but typically cover 5–10 year periods; some licences or permits may be issued for short-term uses lasting only a few weeks or months. It is important to note that the province or territory always retains the right to withdraw a licence or amend the terms and conditions attached to the licence if there is a need to introduce conservation measures, impose low-flow requirements, address violations, or serve some other public interest. Most licence and usage fees appear to charge for cost-recovery purposes of administrative costs, and some of these are used to support maintenance and improvement of water and wastewater infrastructure in municipal settings. This raises a key point — fees are set very low and do not reflect the full cost or the full value of water.

The licensing schemes and specific rates for usage fees vary considerably across the country and across sectors. This variability is expected given the number of provincial authorities, the wide range of water demands, and the range in costs for infrastructure and other factors related to delivery of water services in different parts of the country. Variation in rate schemes includes fixed rate, flat rate, and increasing block rate. Fixed rates do not vary according to volume, and flat rates imply one rate charged for every volumetric unit regardless of the volume that is consumed. For increasing block rate structures, the thresholds for blocks also differ across the country and across sectors. Many places have not established volumetric rates. The increasing block rate is more common among large-scale users with higher volumetric rate charges, such as mining and energy sector users.

ECONOMIC INSTRUMENTS FOR WATER MANAGEMENT

Economic instruments (EIs) are market-based instruments that either generate prices for water or alter the cost to change user behaviour. In the case of water this behavioural change is reflected in the quantity of water used and/or the quality of water when it is returned to the environment after its use. EIs can take several forms; our research focused on *water charges* on a volumetric basis and *tradable water permits* for the purpose of managing water quantities.

In theory, there are four advantages to using EIs to manage the quantity of water used:

- They provide incentives for behavioural change.
- They generate revenue for financing environmental initiatives.
- They promote technological innovation.
- They reduce wasteful water usage at the lowest cost to society.

EIs are designed to leverage the economic interest of individuals, corporations, or communities to protect ecosystems and the services they provide. In the case of water, EIs are designed to correct market failures, also known as *externalities*, which occur when the human impacts on water create costs that are not reflected in market prices. In this manner, EIs are structured to more fully incorporate the value of the environment to society in market prices. In other words, environmental and social opportunity costs (opportunity costs of future uses) can be incorporated into water prices, which then send signals to users or consumers to reduce inefficient and wasteful use of water resources. Well-designed EIs can help entice more innovation at a lower cost than can relying solely on command-and-control approaches or voluntary measures. EIs have the potential to be more efficient than traditional command-and-control policy approaches as users are given more flexibility in the way they achieve environmental targets.

The approaches currently used to allocate Canada's water do little to promote conservation and provide limited flexibility for reallocation of water to more efficient uses. The legal basis of these allocation schemes is entrenched in history and complexities of legal rights. Therefore, realistically in the short term, significant changes to the allocation approaches are unlikely. However, the EIs discussed here may be implemented within some of the existing management systems in the country, but should be done so cautiously, with due consideration of the potential impacts to sectors and the economy.

WATER CHARGES

Water charges can promote economic efficiency and greater fairness because they help ensure that the users shoulder the costs of their actions. Setting the appropriate price allows other environmental objectives to be achieved. For example, if it is more expensive to use water, firms will reduce their use and seek alternatives. In essence, water charges affect costs, and firms and consumers will adjust their water use in response to the price change. Of course, not every firm is able to change its behaviour, and some sectors may be limited in their ability to reduce water intake. Similarly, some sectors are likely to pass any increasing costs along to consumers, again resulting in no water-intake reductions. Where water charges are applied, government will acquire the revenues. Water charges should be designed to be revenue neutral, whereby the revenue is directed at reducing other taxes or finance subsidies or initiatives that help further conservation and efficiency objectives.

Historically, water charges or fees have largely been associated with the cost of providing the water — that is, building and maintaining the infrastructure necessary to treat and deliver water to users. In the context of this report, we are exploring the possible use of water charges on a volumetric basis, actually paying for the water itself. In Canada, this is a rarity, and has had limited implementation (see text box on Volumetric Pricing in Québec).

VOLUMETRIC WATER PRICING IN QUÉBEC

Québec's regulation respecting the charges payable for the use of water came into effect on January 1, 2011.[25] Charges payable for the use of water apply to all industries that withdraw or use 75 m^3 or more of water per day, whether it is self-supplied from surface or groundwater or it is taken through a distribution system. An initial rate of $70 per million litres of water (or $0.07 per m^3) withdrawn has been set for industries in the following categories: bottled water, juice and beverages, non-metallic mineral products, agricultural products (pesticides and fertilizers), inorganic chemical products, and oil and gas extraction. A lower rate of $2.50 per million litres of water ($0.0025/$m^3$) has been set for all other targeted sectors. Funds collected through these charges will go to the Green Fund to support a number of government commitments in the areas of integrated water resource management and knowledge acquisition.

A key challenge for water charges is to find the right price: high enough to achieve the desired environmental objective, but not so high as to trigger significant competitiveness issues for firms or industrial sectors. In addition, political acceptability continues to be an important potential barrier to the adoption of water charges. However the ground may be shifting on public opinion of water charges, as indicated by the recent poll conducted by the Canada West Foundation whereby western Canadians are seen as supportive of a water charge that contributes to conservation goals, whether paid by individuals or industrial users.[26]

Licensing and water rental fees currently exist in all provinces and territories. This provides a solid foundation from which to move from a fee structure that is fiscally oriented, aimed at recovering administrative costs (but providing little incentive to conserve water), to one that is more incentive-based, where water charges send a signal that water is valuable and should be willingly conserved. Opportunities exist either to continuously improve established management systems by implementing volumetric water pricing, or where pricing is already in place, to increase the price to achieve environmental and economic objectives.

TRADABLE WATER PERMITS

The trading of water permits essentially allows for permanent or temporary reallocation of water quantities from licence holders with a surplus of water to those in need. Water-management systems that enable trading of water permits or allocations have, in practice, delivered both environmental and economic benefits, albeit with varied experiences. In Canada, water trading exists in Alberta at a very limited scale. Internationally, Australia, western United States, Chile, and Spain have all instituted water trading with variable degrees of success.[27] It is fair to say that trading has largely been used in situations of extreme water scarcity, where allocations are no longer available.

Trading systems work by setting quantities through caps on withdrawals, and firms adjust (or create) prices in response. Firms that are able to reduce their water use by over-achieving their targets contribute to a healthier environment *and* gain financially by selling excess credits to firms that need the water rights. Another advantage is that the system leaves the choice of technology up to the firm, allowing companies to cost-effectively customize their own solutions in their own time frames. However, it is important to acknowledge the perception or concern that water trading could lead to increasing prices or a situation in which industrial developers have an opportunity to take up significant water allocations.[28] Given very limited experience with trading water rights in Canada, there are calls for caution in future implementation.[29, 30]

Trading water rights within a watershed represents a fundamental shift in water-management systems and so represents a real challenge. With water trading, regulators must become market designers and enforcers while remaining focused on managing water supply constraints. Existing legal, institutional, and administrative frameworks need to be assessed and reoriented to detach historical or riparian water rights and allow them to be reallocated through market trading. Finally, political barriers can be significant, with concerns about stripping away long-standing rights, commoditizing water, and concentrating water rights. Real or perceived, these outcomes can be a barrier to implementation.

Water markets in other countries have experienced both successes and failures. Water experts in Canada note that before moving toward this policy option, we need to continue a dialogue to better understand the level of acceptance for and potential implications of water trading, and implement institutional and legal safeguards.[31,32]

VOLUNTARY INITIATIVES

A wide range of voluntary initiatives has evolved to serve different purposes or functions. These include codes of conduct, codes of practice, guidelines, standards, certification schemes or programs, and non-regulatory agreements. The initiation and development of voluntary initiatives or programs may result from a variety of external or internal factors:

- Responding to market and customer expectations or requirements (including those influenced by consumers or non-government organizations);
- Maintaining a social licence to operate and community support;
- Providing an alternative to government regulation;
- Enabling internal management and performance improvement;
- Demonstrating public accountability; or
- Addressing gaps in knowledge.

Voluntary initiatives related to water use will likely play a role in improving water efficiency and conservation, but the extent of their influence remains uncertain as it is difficult to predict their potential uptake across and within the natural resource sectors in Canada. However, the experience of similar programs shows that voluntary initiatives can lead to performance improvements.[*]

Voluntary initiatives are guided by a shared commitment among participating organizations to achieve a desired outcome. They are intended to influence, shape, control, or benchmark internal performance, external stakeholder understanding and perception, or customer and consumer behaviour in the marketplace. By definition, voluntary initiatives are non-mandatory; they are meant to encourage responsible behaviour that considers the needs of both companies and society at large. However, some voluntary initiatives include requirements for participation, for example, as a condition of membership in industry associations or to gain product or practice certification. Voluntary initiatives can also set de facto standards or benchmarks for industry performance that can be recognized by regulators or by the courts.

Voluntary initiatives exist across a range of industries, products, and services and address a range of environmental, social, and economic issues. Although voluntary initiatives can take many shapes and forms, they are often used to promote public disclosure and/or improve or standardize management practices and performance. Voluntary initiatives also have the potential to gain regulatory recognition.

* For example, the Chemistry Industry Association of Canada's Responsible Care program has led to improvements in reducing emissions from toxic chemicals.

CATEGORIZATION AND POTENTIAL OF VOLUNTARY INITIATIVES

In a scan of voluntary initiatives for improving water efficiency and conservation, the NRTEE identified a range of initiatives or programs relevant to water management and defined them here according to the their purposes. In addition, we briefly touch on the future policy roles these voluntary initiatives could play in improving water efficiency and conservation and in forming part of a suite of policy instruments on water management.

INDUSTRY-DRIVEN PERFORMANCE INITIATIVES

These initiatives are often introduced and governed by companies or associations in a single sector to demonstrate or improve performance on key issues. Industry associations often develop these programs to maintain their licence to operate, offer an alternative to regulation, or respond to market requirements. Industry-driven programs are developed with different degrees of rigour and can include a variety of elements such as guiding principles, management practice guidelines, performance standards, reporting requirements and indicators, and accountability mechanisms. Examples of these kinds of initiatives include the Oil Sands Leadership Initiative, the Global Social Compliance Program, and water-management tools developed by the International Council on Mining and Metals.

Well-designed and properly implemented, industry-driven performance and practice initiatives could move a sector or group of firms toward improved water efficiency and conservation. Key factors for success include the following:

- The initiative is a condition of industry association membership, or peer pressure in the industry exists to ensure uptake.
- There are clear drivers for improving water management such as the licence to operate, response to broader stakeholder pressure, market or customer demands and recognition for improved management, and reduced or more enabling regulation.
- The initiative covers water efficiency and conservation through a consistent performance standard. For example the performance indicators are consistent from one year to the next to allow performance tracking over time.
- The sector is already actively monitoring, analyzing, benchmarking, and targeting improvement.
- Accountability is already established. The sector reports both internally across participating firms and publicly on the industry, at the company and/or facility-level.

STANDARD AND CERTIFICATION PROGRAMS

Standard and certification initiatives can be led by industry associations, multi-stakeholder bodies, or external third parties. These initiatives are usually developed and adopted to improve environmental and social management practices and performance, to promote brand or product recognition, or to demonstrate a standard of performance and management practice to the market. However, unlike industry-driven performance and practice initiatives, they are usually governed by more than one interest, such as industry and government, or industry and non-government organizations. These kinds of initiatives can be market-facing, such as product or responsible-use certification programs, or they can be internal-facing to promote the development of effective management systems. These initiatives can be sector specific (e.g., Global G.A.P. in the agriculture sector) or applicable to a wide range of sectors or companies (e.g., Alliance for Water Stewardship and ISO 14046).

Standards and certifications can help create the conditions and the capacity for improved performance. In the forestry sector, for example, the Forestry Stewardship Council (FSC) and the Canadian Standards Association Sustainable Forest Management Certification System have helped improve forestry management practices, which have enabled companies to reap strong market recognition and rewards.

The effectiveness of standard and certification programs in contributing to water efficiency and conservation is highly dependent on the presence of clear drivers to encourage uptake. Examples include the need to improve stakeholder or community relations to maintain a licence to operate or strong market pressure to meet customer expectations. The design and rigour of these programs are also essential in driving performance improvements. As most water-related standard and certification programs are currently under development, it is too early to speculate on their future role in the Canadian context.

INTERNATIONAL REPORTING INITIATIVES

International reporting initiatives are often developed by non-industry organizations to encourage company transparency and accountability to stakeholders on key issues facing businesses. These initiatives promote standardized practices and approaches and are often developed through multi-stakeholder processes. The use of international reporting initiatives by companies can improve the public's access to information and may serve as incentives for companies to improve their performance over time. Examples of these kinds of initiatives include the Global Reporting Initiative, the Carbon Disclosure Project — Water Disclosure, and the Stewardship Index for Specialty Crops.

International reporting initiatives help focus attention on material issues, including water, causing companies to prioritize and address them. By increasing the awareness of both companies and stakeholders on water issues, and by encouraging the development of management processes related to water management, international reporting initiatives have the potential to lead to improved water efficiency and conservation. However, there must be sufficient data quality and stakeholder interest in place for reporting initiatives to drive improved performance. Reporting initiatives can also be an important source of information for policy makers, as individual countries' data and knowledge bases are often limited and insufficient.

ACCOUNTING AND MANAGEMENT INITIATIVES

These initiatives are often developed through partnerships within industry or between industry and other interests such as NGOs or professional organizations. They are designed to develop standard approaches and practices where gaps exist in knowledge and guidance. Natural resource sector companies participate in these initiatives to improve management practices by identifying risks and areas for performance improvement, and to demonstrate corporate social responsibility by communicating their participation and results to stakeholders. Examples of these kinds of initiatives include the WBCSD Global Water Tool, the Global Environmental Management Initiative (GEMI) – Collecting the Drops: A Water Sustainability Planner Tool, and the Sustainability Agricultural Initiative Platform.

As with industry-driven and reporting initiatives, accounting and management initiatives can certainly help companies or producers improve water efficiency and conservation. Having the ability to measure water use and its impact is often a precursor to successfully managing the resource.

SUMMARY

Expanding the use of EIs in regions experiencing or at risk of water restrictions may prove helpful in achieving both environmental and economic outcomes. As the next chapter shows, water pricing can lead to reduced water intake by industry. However, our review of EIs supports and reinforces what others before us have noted — that specific water pricing options need careful consideration before being implemented within a watershed.[33,34] Before implementing either water charges or water trading, a robust policy evaluation should be undertaken to understand environmental, economic, equity, administrative, and governance issues.*

* The NRTEE research conducted such an analysis at a national level for the natural resource sectors, providing us with general insights. However sector-specific case studies, such as that by Adamowicz (2007) on oil sands, should be conducted.

With respect to voluntary initiatives, traditional thinking suggests that such approaches are most effective when used in tandem with other forms of regulation. Regulation provides a backstop for management or performance requirements, particularly in ensuring that companies not participating in voluntary initiatives meet a minimum standard. Voluntary initiatives are designed to go beyond compliance. When they function well within a robust program design and implementation plan and have strong company uptake, these initiatives can lead to performance improvements. Further, voluntary initiatives can operate as catalysts to raise standards in a sector by informing the content of regulations, either through formal regulatory recognition, by being referenced into regulations, or by serving as a basis to reward good behaviour. Given the uncertainty related to the effects of voluntary initiatives on water efficiency and conservation improvements, their value may well lie, at this point in time, in the secondary benefits that are associated with their uptake. These include increased awareness of water issues inside companies and among their stakeholders and enhanced company capacity to manage water use and impacts. Over time, such initiatives have the potential to improve water-use efficiency and conservation in natural resource sectors, and to inform the design and implementation of complementary economic and regulatory policy instruments.

CHAPTER FIVE

A PRICE ON WATER USE BY THE NATURAL RESOURCE SECTORS

CONTENTS

HIGHLIGHTS

Large efficiency and conservation gains may be achieved with modest increases in the price of water intake.

Overall, the economic impacts of water pricing are modest but may be more pronounced on a firm or sector basis.

Further research into the relationship between water use and pricing is required however before water pricing is implemented on a volumetric basis.

A PRICE ON WATER USE BY THE NATURAL RESOURCE SECTORS

The previous chapter discusses the potential of EIs and voluntary initiatives to move industrial and agricultural water users toward greater efficiency and conservation. In researching these policy tools, the NRTEE identified a lack of information on water pricing in Canada, specifically on the potential for volumetric water pricing. We therefore conducted new and innovative research to determine the potential of water pricing to deliver on our two goals of improved water efficiency and improved water conservation. [35]

We find that water pricing applied to the intake of self-supplied water in the natural resource sector may deliver water-use reductions thorough efficiency and conservation gains at costs that may be minimal. Water prices afford a significant opportunity to reinforce water-efficiency gains observed in Chapter 3. Of course, there will be cost impacts on industry, ranging from small to large depending on the sector. But for all sectors, costs rise quickly as greater water-use reductions are sought. In this chapter we present the approach and methods used to reach these conclusions, as well as detailed modelling results.

To explain our findings we start with a discussion of the price currently paid by industry for water intake and follow it by examining potential water-use reductions that could be realized from pricing water. We then look at related cost implications to sectors and the economy.

THE CURRENT PRICE OF WATER

A key starting point for assessing the potential of water pricing is to determine the costs that industry currently pays for water intake and use. Outside of industry there is a perception that water is free. In reality, the use of water has costs associated with it, which vary across the country and between sectors. The total cost of using water includes components of what is paid in licensing fees to provincial governments as well as intake, recirculation, and discharge costs that require energy, labour, and capital.

Statistics Canada's Industrial Water Survey collects water-cost data from the thermal electric power generation, mining, and manufacturing sectors. Water intake, recirculation, and operation and maintenance costs for pumping and treating intake, recirculation, and discharge water in 2005 are all publicly available. But some limitations exist that we needed to address, notably a lack of cost information for the agriculture and oil and gas sectors. Discussions with the agriculture sector confirmed that the costs for treating intake, recirculation, or discharge water were zero, with only pumping having applicable costs. For oil and gas, we used a simplified assumption based on the average cost to the mining and manufacturing sectors, but appropriately scaled to production. Table 5 presents the Statistics Canada water-cost data, where the average cost of gross water use is about \$0.13 per m^3 across all natural resource sectors. This average cost of *self-supply* is 75% lower than the cost paid by some industries for water from public utilities — \$0.53 per m^3 versus self-supplied water at \$0.13 per m^3.

One factor missing in the Statistics Canada data is that of capital costs, or the cost to buy and upgrade equipment necessary for treating and pumping water. Table 5 therefore represents an underestimation of the costs paid by industry for water use. To address this omission we conducted research to fill the gap and added capital costs to Statistics Canada data of the operational costs of water[*] and incorporated this into the model.

It is important to look at water-use costs by sub-sector of an industry. Current water-use costs vary significantly by subsector (Figure 17) with costs ranging from a low of \$0.05 in animal and crop production to a high of approximately \$0.60 in food manufacturing. Typically water intake costs are a small share of total water-use costs, with recirculation driving a large share of costs. In some industries like food manufacturing, the need for clean water and effluent-quality requirements drives up intake and discharge costs.[†]

* See MKJA, 2011 for full explanation.

† Data limitation and confidentiality requirements did not allow for a regional disaggregation of the data by sector, which we expect varies significantly.

TABLE 5

WATER COST DATA, 2005 (CENTS PER m^3)

SECTOR	Operation and maintenance (excluding treatment)	Licence fees	Intake treatment	Recircu-lation	Discharge treatment	Gross water use*
Thermal electric power generation	0.1	-	0.1	0.1	0.1	0.3
Mining	9.8	0.2	5.0	3.4	7.7	7.5
Manufacturing	3.2	-	5.2	7.8	10.6	14.4
Agriculture	3.7	0.1	NA	NA	NA	3.7
Oil and gas	3.7	0.1	5.2	6.2	10.2	6.6

* Gross water use is the total amount of water used by a sector — the sum of intake and re-circulated water. "NA" indicates that these prices were not applicable.

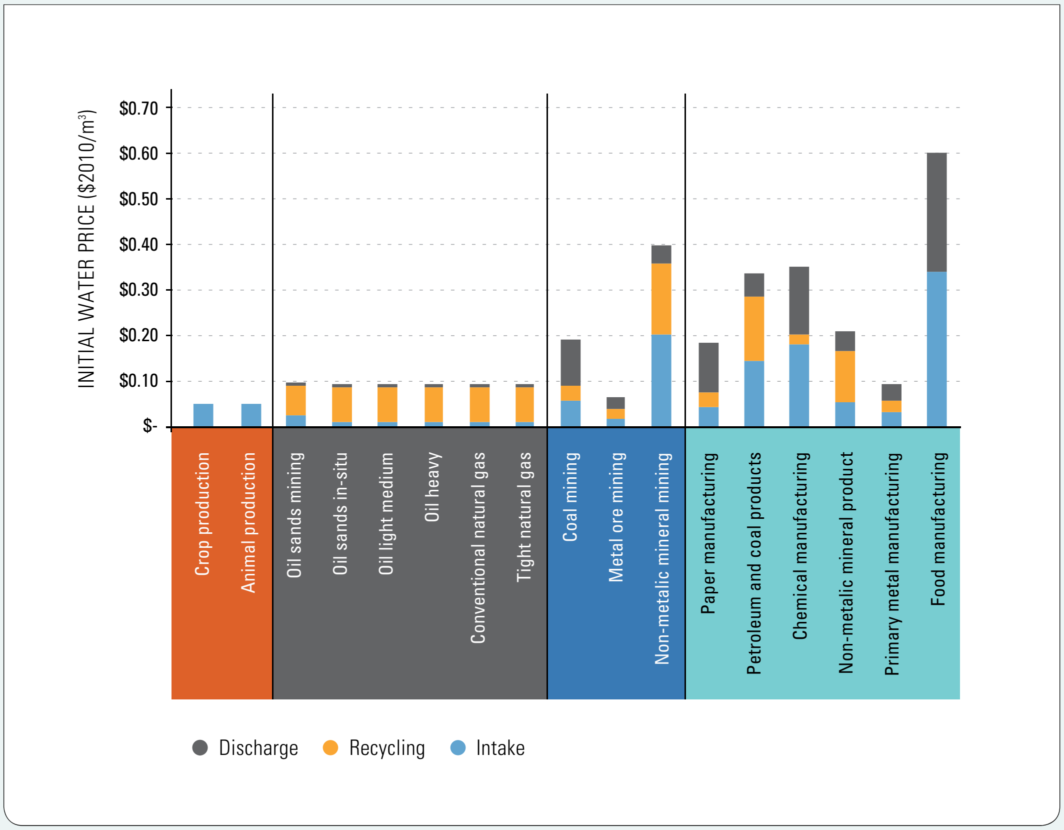
Source: Statistics Canada 2010b

This data highlights that industry does indeed pay to use water: it is not a free commodity. While water-licensing fees account for less than 1% of the total cost, water use represents a real operational cost to industry. Evidence that industry faces water costs likely explains why we have seen improved water efficiency trends of the level presented in Chapter 3.

Having established the base cost of water across sectors, the next section discusses our modelling to assess the potential of water pricing to improve efficiency and conservation.

FIGURE 17

WATER COSTS FOR NATURAL RESOURCE SUBSECTORS, 2005



THE POTENTIAL OF WATER PRICING TO IMPROVE EFFICIENCY AND CONSERVATION

The NRTEE used a macroeconomic model of the Canadian economy to assess the potential of water pricing to improve water-use efficiency and conservation and to estimate the impact of the pricing on industry.* In the model, we focus on 2030 as the forecast year, growing the structure of the Canadian economy in 2005 by the same long-term economic forecast used in Chapter 3.† The water-use intensities discussed in Chapter 3 are also added to the model to

* See Appendix 3 for explanation of the CGE model.

† The data underlying the model are derived primarily from the Statistics Canada System of National Accounts (2005) while the forecast is from Informetrica (2011), CAPP's (2010) production data for oil and gas production, and CIMS energy economy model for electricity production (MKJA, 2011).

develop the 2030 water use in each sector. The cost imposed on a sector by a policy such as water pricing depends on the ability of the processes and technology to adapt to this policy. Estimates were acquired and used in the model to assess the percentage change in water demand associated with water-price increases.

WATER INTAKE REDUCTIONS

With the model populated with economic and water-use data in 2030, as well as an understanding of how water-use demand responds to water pricing, water-pricing scenarios were applied to see what potential water-intake reductions could be achieved. A series of volumetric charges based on *per metre cubed of intake water* were imposed on self-supplied water in the natural resource sectors to deliver a reduction in water intake of 10%, 20%, 30%, 40% and 50% in each province. The pricing scheme is applied at the provincial level, and does not equilibrate prices between different provinces. As a result, we allow the water price in one province to deviate from that in another. This pricing regime was chosen because water use is a regional issue more than a national one. The volumetric charges are incremental to the baseline water costs already facing industry, as presented in Table 5.

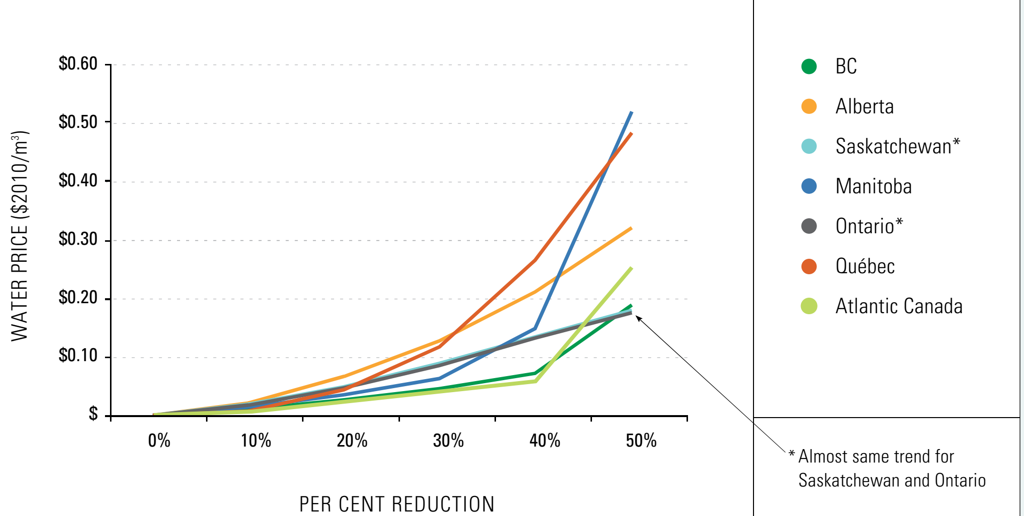
Figure 18 indicates that, in most provinces, a 20% reduction in water intake results from an average price increase of about \$0.05 per m^3. A 40% reduction in water intake is achieved through the application of a water-intake price averaging \$0.14 per m^3 with a range from \$0.07 to \$0.26 per m^3.

Two variables affect the response of a sector and province to a water price: the initial cost and the ease at which production can be altered in response to cost increases. Sectors with lower starting water prices and a greater ability to change production techniques can reduce their water use at a lower cost than sectors with higher prices or less of an ability to alter production. For example, prices in Québec and Manitoba must rise much more to reach equivalent water-intake goals in comparison with the other provinces, due to the relative shares of their sectors. In Québec the price is higher due in large part to a large manufacturing sector, dominated by pulp and paper that has a low ability to alter water use at a low cost. The manufacturing sector generally has a higher water cost, making reductions in water use more costly. In Manitoba, approximately 75% of water use is in sectors that have a limited ability to alter production — agriculture and thermal electric power generation — which also makes reducing water use more costly. Similarly, 85% of water use in Alberta is attributed to thermal electricity. Although the price of water in the electricity sector is very low, there is a limited ability to use less water.

Because of the insensitivity of thermal electricity use to water pricing and its dominance in total water use, a series of scenarios were developed that remove thermal electricity generation from

FIGURE 18

PROVINCIAL WATER INTAKE REDUCTIONS IN RESPONSE TO WATER PRICING, 2030



* Almost same trend for Saskatchewan and Ontario

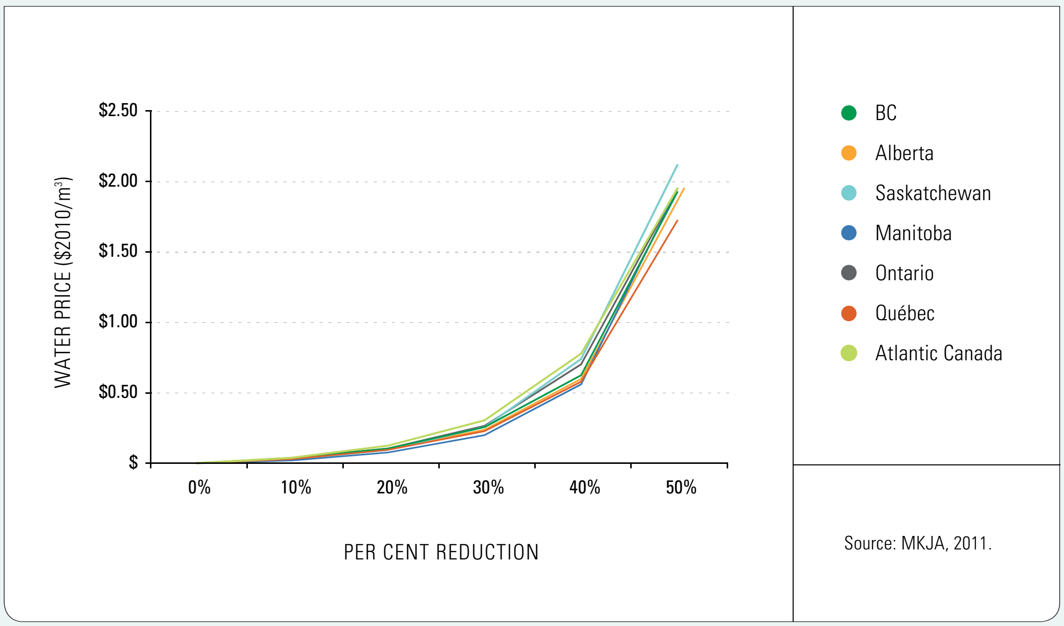
Source: MKJA, 2011.

the calculations. When thermal electricity is removed from the analysis, the overall cost per unit to firms of self-supplied water use — before adding a commodity price — rises from $0.05 to $0.15 per gross m^3 (Figure 19). Without the thermal electricity sector included, cost curves for all provinces are quite similar, and the response of each province to water pricing is more uniform. To achieve a 20% reduction in water intake requires an increase in price of $0.09 per m^3. To achieve a 40% reduction in water intake requires an increase in price ranging from $0.50 to $0.70 per m^3 by province, with an average of $0.55 per m^3.

For the remainder of this report, we focus on pricing scenarios that exclude the thermal electricity generation sector because of uncertainty (resulting from lack of empirical studies) of how the sector responds to changes in the price of water.

FIGURE 19

PROVINCIAL WATER INTAKE REDUCTIONS IN RESPONSE TO WATER PRICING, 2030
(EXCLUDING THERMAL ELECTRICITY GENERATION)

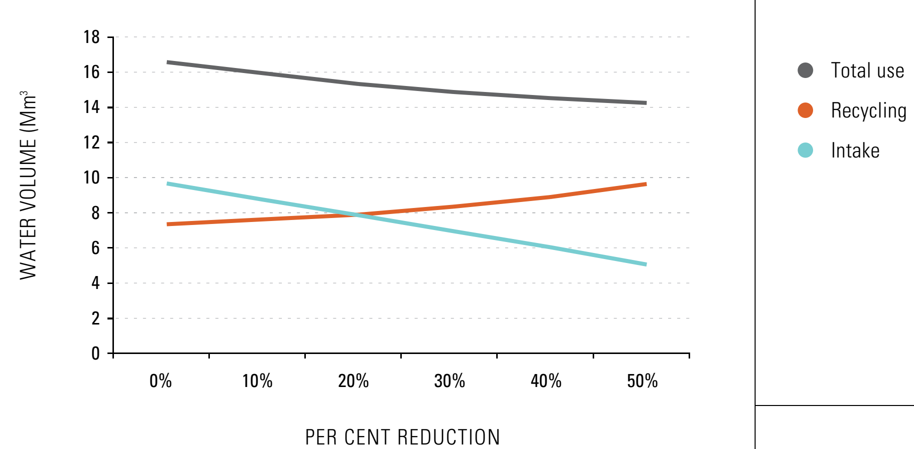


Source: MKJA, 2011.

In our assessment we found evidence of both conservation and efficiency in response to water pricing. Because the model allows for substitution between water intake and recirculation, our findings show that with pricing, water intake falls while recirculation increases (Figure 20). However, the increase in recirculation only partially makes up for the fall in intake, such that total water use falls in the pricing scenarios.

FIGURE 20

NATURAL RESOURCE SECTORS' WATER INTAKE, RECIRCULATION AND TOTAL USE, BY PER CENT REDUCTION, 2030



Source: MKJA, 2011.

INNOVATIVE RECYCLING OF WASTEWATER

In 2010, Shell Canada and the City of Dawson Creek, B.C., came up with an innovative solution to the city's water shortage. Due to water shortages, the city was forced to restrict water availability — creating a problem for Shell, a company that used upward of 25% of the community's potable water. To ease pressures on the city's water supply, Shell invested in a new wastewater treatment plant that will produce reclaimed water, supplying Shell and other industries with the water they need. This will allow the municipality's potable water supply to be available for public needs and will discontinue sales of potable water for industrial purposes. The reclaimed water will cost industries less than potable water supplies.

With thermal electricity generation removed, we estimate that

- An increase of price of \$0.09 per m^3 will reduce water intake by 20% and gross water use by 8%, and
- An increase of price of \$0.55 per m^3 will reduce water intake by 40% and gross water use by 14%.

Overall, the reduction in gross water use with water pricing translates into an increase in the efficiency of gross water use by 8% with an increase in water price of \$0.09 per m^3 and 14% with an increase of \$0.55 per m^3. This means that conservation contributes an important part of the fall in total intake. A key finding is that industry is responsive to the price of water, and efficiency and conservation gains can be expected with small increases in the price of water.

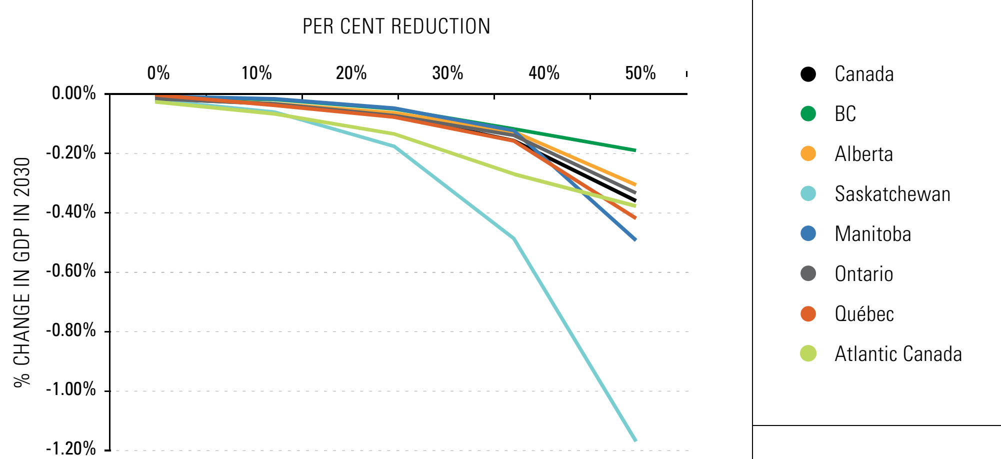
ECONOMIC IMPACTS

The NRTEE assessed both environmental and economic trade-offs, and as such the water pricing analysis identified economic impacts. A first area of focus is on how gross domestic product (GDP) is affected by water pricing. Overall, economic impacts on Canada resulting from even substantial increases in water prices are likely to be very small. The model suggests a 0.03% reduction in the level (not to be confused with the growth rate) of GDP in 2030 associated with a 20% reduction in water intake in each of the provinces; and a 0.16% reduction in the level of GDP associated with a 40% reduction in water intake. This means that even with the 40% water intake reduction, the economy will continue to grow, and will still be approximately one and a half times larger in 2030. The economic effects of modest increases in the price paid for water appear to be small, affording an opportunity for water users to compensate Canadians for the use of this public resource.

Most provinces do not deviate substantially from the national pattern, although Saskatchewan's gross domestic product is projected to drop more with large reductions in water use. For a 40% reduction in water use, we project a 0.6% reduction in the level of 2030 gross domestic product in Saskatchewan (Figure 21). This results primarily from the pattern of trade in Saskatchewan, especially for non-metal mineral products (potash and uranium). These products constitute a substantial portion of Saskatchewan's economic output, and all production is exported such that the demand curve facing Saskatchewan producers of non-metal minerals is essentially flat. When production costs increase with water production, the entire incidence of the policy is borne by producers, resulting in a cut in production. This is in contrast to most goods, for which at least a proportion of production is devoted to local consumption where consumers bear a portion of the burden on the policy in the form of higher consumer prices.

FIGURE 21

IMPACTS OF WATER PRICING ON GDP, 2030, RELATIVE TO BUSINESS-AS-USUAL

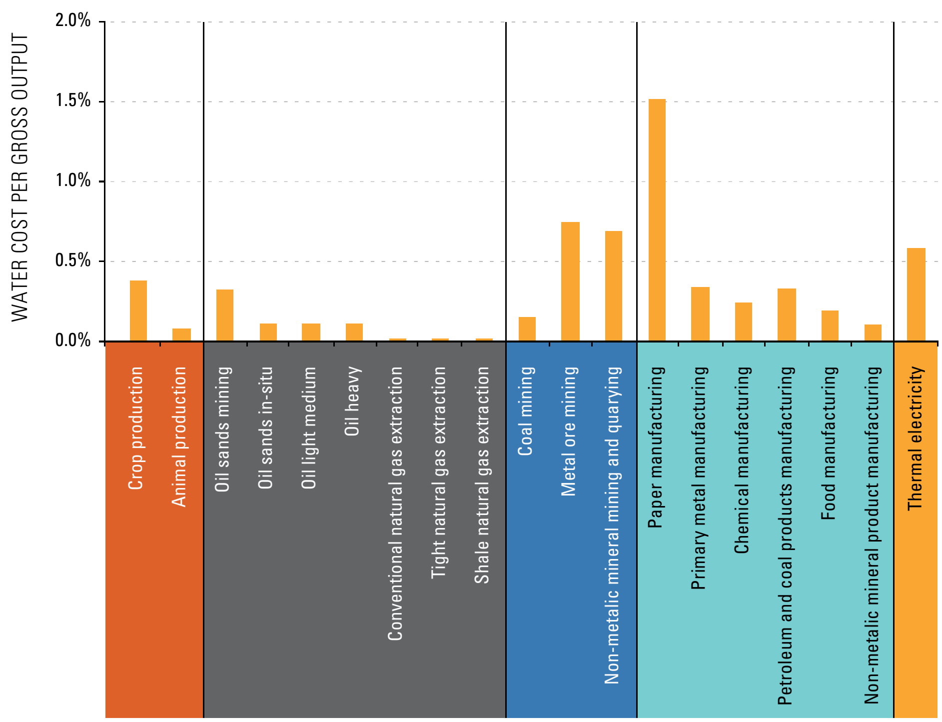


Source: MKJA, 2011.

The second area we investigated was the potential impact that pricing would have on the natural resource sectors. One factor that contributes to the impact is the cost of water per unit of output. Figure 22 shows the cost to firms of self-supplied water (including capital, labour, energy, and material costs) for each sector as a percentage of its gross output. However, while the natural gas sectors have the lowest cost per unit of gross output, the cost of water to most sectors is less than 0.5% of their overall gross output. In comparison, the sectors included in this study will pay 15% of their output for energy and 44% for other intermediate inputs. The cost of water makes up more than 0.5% in just four sectors: paper manufacturing (1.9%), metal ore mining (0.9%), non-metallic mineral mining (0.9%), and thermal electric power generation (0.7%). This indicates a risk that water pricing could lead to adverse competitiveness impacts for some, but not all, sectors.

FIGURE 22

SUBSECTOR WATER COST AS A PERCENTAGE OF GROSS OUTPUT



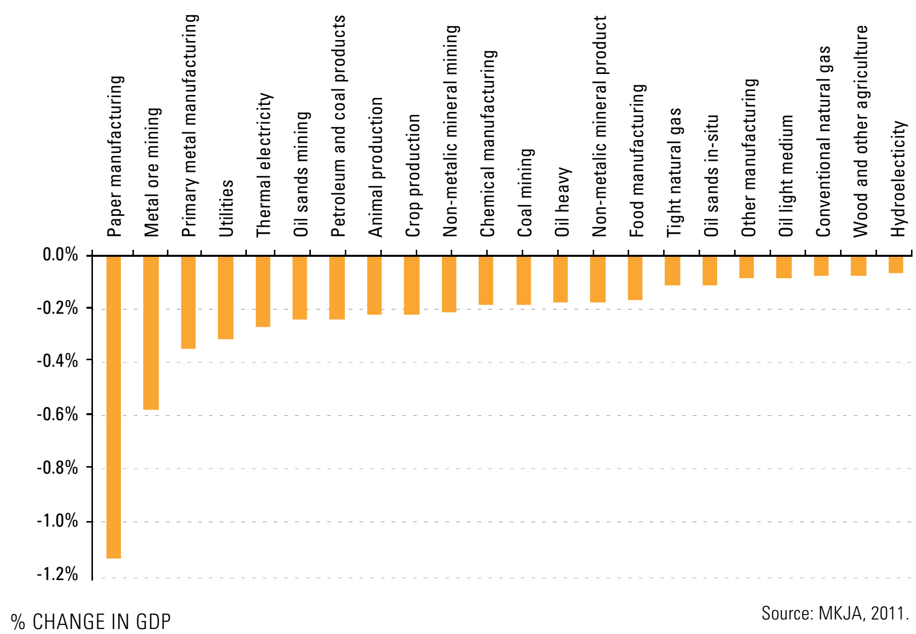
Source: MKJA, 2011.

Economic impacts are subsector specific. For example, paper manufacturing, metal ore mining, and non-metallic mineral mining would likely see larger impacts than sectors such as oil and gas. Figure 23 and Figure 24 show changes in gross domestic product by sector (at basic prices*) resulting from water commodity prices.

* Basic prices include all of the costs of capital, labour, and any taxes and subsidies on production. This is consistent with the manner in which Statistics Canada reports on GDP.

FIGURE 23

CHANGE IN SUBSECTOR GDP FROM WATER PRICING, 20% WATER INTAKE REDUCTION, 2030

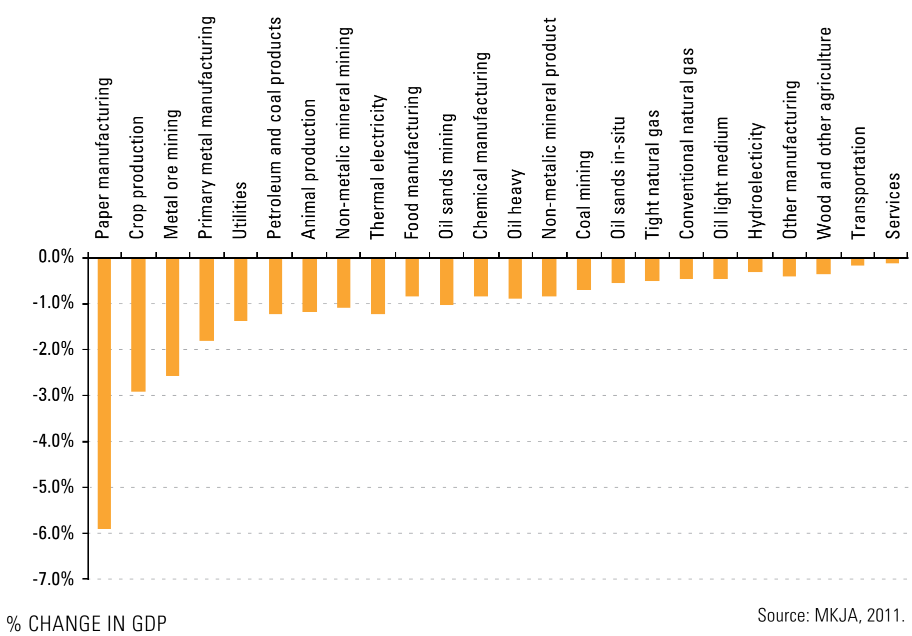


Source: MKJA, 2011.

Figure 23 shows changes associated with a 20% reduction in water intake. Several subsectors, including the paper manufacturing, metal ore mining, and primary metal manufacturing sectors experience modest reductions in output due to water pricing. However, in all cases except paper, output losses are less than 0.6% relative to the reference case scenario. In total, as stated above, Canadian gross domestic product is relatively unaffected in this scenario — it is about 0.03% lower than in the reference case.

FIGURE 24

CHANGE IN SUBSECTOR GDP FROM WATER PRICING, 40% WATER INTAKE REDUCTION, 2030



Source: MKJA, 2011.

Figure 24 shows the same information for the scenario where water intake is reduced by 40%. In this case, some subsectors experience a more pronounced contraction in output. In particular, the paper manufacturing, crop production, and metal ore mining sectors all experience a loss of at least 2% in gross domestic product relative to the case without additional water charges.

SUMMARY

Our research reveals that the natural resource sectors currently do pay for water use, largely through costs associated with water infrastructure (treatment, movement, and discharge). Our findings show the potential effects of pricing water on achievement of environmental water reduction objectives, with perhaps minimal economic impacts to most sectors and the national economy. A price on water reduces intake by industry resulting in more conservation and better water-use efficiency.

Some industries may be responsive to the price of water, and large efficiency and conservation gains may be achieved with modest increases in the price of water intake. Water recirculation currently plays an important role in water use by many of the industrial sectors, and it appears that water recirculation may have a significant role in future water reductions, as a price on water pushes industries to find innovative ways of using recycled water.

CHAPTER SIX

WATER-QUANTITY DATA, INFORMATION AND KNOWLEDGE

CONTENTS

HIGHLIGHTS

Future water-management tools such as forecasting and pricing depend upon the availability of robust data on water quantity.

Demand-side water quantity data lacks consistent and common practices necessary to monitor, collect, measure, report, and communicate data and information.

Governments need better data and information than is currently available to effectively manage water resources.

WATER-QUANTITY DATA, INFORMATION, AND KNOWLEDGE

Good policy development and solid management decisions require sound evidence and information. Information is derived from data, and in the context of water quantities in Canada, this data is not as comprehensive or as readily available as it should be. To effectively implement water policies and management strategies we need to improve our understanding of both water *supplies* and water *demands*. With increasing competition for water resources, governments need better data, not just to make sound allocation decisions today, but also to ensure there is enough water for the future. Accurate, complete, and current water-quantity data is a critical building block in establishing water-management systems in which water is effectively allocated and efficiently used.

Specifically, improved water data and information systems can

- better inform decision making about water allocation, especially in areas where water availability is limited or constrained, thereby reducing both environmental and economic risks;
- enable governments to use economic instruments as policy options to achieve water conservation and efficiency goals more effectively; and
- allow for more informed dialogue with the public regarding water-use decisions, thereby gaining the public licence to operate.

Improving data and information is not just about collecting better data. It is equally important to communicate this information clearly and use the data effectively when making decisions.

Conservation and efficiency are core policy and management objectives within many provincial and territorial water strategies. In order to achieve these objectives, current water-quantity data systems must be improved. Canada has dated and inconsistent systems for collecting and measuring data, reporting these measurements, and communicating water quantities. These data systems can be developed as stand-alones within their own vertical silos; however, we propose here that a more effective approach is to assess these concepts from a horizontal perspective, as their interconnectivity contributes immensely to the success of future water-quantity data networks. In the federal government alone, 20 departments and agencies are involved in some aspect of freshwater management. Improved approaches to coordinated and collaborative data collection and monitoring are necessary to successfully establish common approaches to measurement and reporting practices. In turn, this could result in integrated data and analysis that facilitates transparent communication of water data and information. Managing water-quantity data effectively will result in efficient and integrated decision making on policy issues involving water management, across different government departments at all levels (municipal, provincial and federal).[36]

The NRTEE's research on water-quantity data and information focuses on improving our understanding of the two core components of the natural resource sectors' water use — supply and demand. For the purposes of this report, data for the supply side of water quantity *(supply data)* refers to the data measuring water levels and water flows in existing surface water resources across Canada. Data for the demand-side of water quantity *(demand data)* refers to the data measuring water withdrawals by the natural resource sectors to meet their operational needs. Water supply and demand data are independent in nature; as such they can be collected, coordinated, and managed on their own. However, having a combination of the supply and demand data provides decision makers with a more comprehensive, informed, and integrated understanding of water balances. It enables them to evaluate the status, as well as forecast long-term trends associated with quantity of freshwater resources at multiple scales — locally at the watershed level, regionally at the provincial, territorial levels, and interprovincial levels, and nationally.

To get a better understanding of the current data systems for water quantity across the country, the NRTEE explored existing systems with a view to providing recommendations to improve them. This chapter provides input on further steps needed to strengthen and integrate the water-quantity data systems so that they will meet the data needs of different end-user groups. These include federal departments and agencies, provincial and territorial governments, researchers and academia, the natural resource sectors, environmental non-governmental organizations, and watershed authorities. The research related to water-quantity data was informed by a series of meetings the NRTEE held with water experts and water managers from across the country, and also by new research commissioned by the NRTEE.[37]

This report is limited to its consideration of surface water resources and as such groundwater resources are not included in the water-supply component; however, we recognize the critical importance of groundwater in many regions of the country. Data and information on groundwater supplies is also largely absent and necessary for sustainable management of our water resources.[38]

THE IMPORTANCE OF ASSESSING WATER-QUANTITY DATA

Throughout this report we emphasize the important reliance of the natural resource sectors on access to sustainable supplies of clean water. Regional water scarcity issues are emerging due to a combination of factors such as economic development, population growth, and climate change. Looking ahead as far as 2030, we need to develop improved predictive capabilities that will allow us to understand better where regional water pressures may arise. While our water forecasts show modest national increases of water intake, we note that this result likely masks potentially significant increases at regional and watershed levels. Therefore decision makers need access to adequate water-quantity data to better forecast any increased pressures on water resources. In areas where water risks emerge, governments may turn to the use of economic instruments, such as water pricing, to achieve more efficient use of water and reduce water intake. In these circumstances, more accurate and reliable water data will be necessary before such options can be implemented.

The distribution of jurisdictional powers under the Canadian constitution gives the federal, provincial, and territorial governments shared responsibility for freshwater management.[*] The federal government has jurisdictional responsibilities for fisheries, navigation, transboundary waters shared with the United States, and federal lands. As such, the federal government, in collaboration with the provinces and territories, has historically contributed to establishing data systems that measure stream flow and water-level information in all major surface water bodies across the country. This has allowed the governments to establish a consistent and robust national system that tracks the water supplies through the Water Survey of Canada.

* The NRTEE recognizes that municipal governments have an important role in freshwater management however, due to the scope limitations within this study the focus is on provincial and federal governments.

Provinces and territories ultimately have the authority over all aspects of water supply and use related to pollution control, energy development, irrigation, and industrial and economic development within their jurisdictions.[39] They control all water allocations, licences, permits, and any reporting requirements for water uses by the natural resource sectors. Each province and territory has the jurisdictional power to develop its own water-quantity data systems within its own borders. As we will show in this chapter, the current demand-data systems are inconsistent across provincial and territorial jurisdictions, and are at varying stages of development.

WATER-SUPPLY DATA

As previously noted, federal, provincial, and territorial governments currently share the responsibility for managing surface water resources. The federal government collaboratively works with the provinces to establish a system for measuring and accounting for surface water supplies. The federal government, through the National Hydrometric Program (NHP), monitors the quantity of surface water resources at more than 2,500 sites across the country. The program has been operating continuously since 1908 under the auspices of the Water Survey of Canada. The program collects, interprets, and disseminates surface water-quantity data and information. It is the primary source of water-supply data for water managers and Canadian institutions to make water-management decisions.[40] The NHP, through formalized monitoring arrangements, has been successful in establishing clear monitoring responsibilities to address international boundary and territorial/interprovincial requirements. Environment Canada as the lead federal department has successfully established cost-sharing agreements between the federal and provincial governments, as well as with Indian and Northern Affairs Canada (INAC) to carry out monitoring activities in the territories.

According to a recent report from the Commissioner of the Environment and Sustainable Development (CESD),[41] the NHP received $20.9 million in federal funding. From 2006/07 to 2009/10 the NHP has seen an increase in the program budget by more than 50%, which has been allocated to increasing investments in monitoring technologies. Through the various cost-sharing programs with provincial governments, federal departments, and the private sector, the NHP was able to realize an additional $13.9 million, for a total investment of almost $45 million in 2009/10. The NHP has been reasonably successful in accounting for water supplies within the provinces and territories, but the same cannot be said for federal lands such as First Nations reserves, national parks, national wildlife areas, and Canadian forces bases, which lack monitoring capacity.

The CESD report also indicated an absence of a strategic long-term plan within the NHP to establish new surface-water monitoring capacity to identify, assess, and monitor future risks to water supplies. The NHP program lacks a long-term vision to establish new monitoring stations, long-term monitoring strategies, and priorities to adapt to water-quantity threats such as climate change. Developing a strategic approach is an essential step for the NHP to establish new monitoring capacity in regions that face increased water-quantity risks. However, the financial constraints facing all levels of government limit their capacity to establish monitoring initiatives.

The extent to which water-quantity data and information is fit and reliable for use is driven by the quality assurance and quality control components attached to the data. Unreliable water-supply data can result in inappropriate decisions attached to natural resource development and water allocations. Validation procedures attached to data are important in assessing the accuracy of data prior to dissemination. The NHP has successfully established national-level quality assurance protocols to validate its data prior to dissemination using a centralized national database — HYDAT. The NHP has also developed consistency and auditing specifications to ensure provincial and private-sector data collection is done to national standards.[42] Due to the maturity of supply-side data systems in Canada, there is a significant level of confidence related to our knowledge of surface-water resources.

It is important that data produced under the NHP addresses the needs of the end users of the data. The NHP has convened a national Administrators Table with federal, provincial, and territorial partners to provide a forum for discussion to address issues related to surface-water accounting. The NHP also has an established process to assess client needs and identify program gaps. In practice however, the NHP has not used its own established processes and forums to evaluate future program needs; it lacks a plan to address future program gaps.[43] As such, even though the Program is well positioned to provide water-supply data today, it is not well positioned to address future water-management risks due to a lack of strategic planning.

WATER-DEMAND DATA

Surface water and natural resource development are unevenly distributed across Canada. In regions experiencing a high level of water demand associated with natural resource development, there could be limitations to the future availability of water resources, especially where competition for water resources arise.[44] Data about water demands becomes an important component of conducting comprehensive assessments of future water scenarios in some regions.

In such conditions it is important for water managers to have reliable data on existing water demand before approving any new water allocations and adding additional pressures on the water resources.

The sound administrative foundation underpinning water-supply data does not exist in a parallel form for water-demand data. For one, the federal government does not have any long-term programs akin to the NHP to support water-quantity data collection by and with the natural resource sector. Secondly, the provinces and territories are responsible for managing their own water resources and natural resource development; water-demand data has a stronger jurisdictional and economic relevance for them. Finally, water-demand data is heavily reliant on the private sector for development as custom business-data needs reflect the different water-resource needs of each of the natural resource sectors.

At present, knowledge of water demands is based largely on water-allocation permits — that is, provinces and territories know how much water is allocated through the permitting system but most of them do not know what quantities are actually taken (or returned) to water bodies. Added to this, there is an important void of information about the timing and seasonality of withdrawals. This information is, and will be increasingly, critical for managing water allocations in years of water constraint.

The future development of the natural resource sectors in all provinces and territories depends on stable energy sources. In Canada, thermal energy production is the primary means of meeting the energy needs for the three largest natural-resource-dependent provinces. In excess of 75 % of energy production in Ontario, Alberta, and Saskatchewan comes from thermal electricity sources.[45] Future economic growth related to natural resource development in these provinces will require the additional development of energy sources. There is anticipation that the energy mix in Ontario will change in coming years: however, it still remains to be seen how it will be accomplished. Two needs must be fulfilled: to replace existing generation capacity created by retiring old generation facilities, and to create new generation capacity to meet increased energy demands. Due to technological constraints in the short term, thermal energy electricity generation is the only viable approach to meeting increased energy demands over the next 10 years. As such, and despite technological advancements, future thermal energy development will likely impose an increased pressure on water resources in these provinces.[46] In watersheds of these provinces, where water scarcity issues are emerging, it will be important for decision makers to have reliable water-demand data to support economic development related to natural resources.

FEDERAL ROLE IN WATER-DEMAND DATA

Currently Statistics Canada gathers information from the natural resource sectors in Canada through the Industrial Water Use Survey and Agricultural Water Use Survey. The Industrial Water Use Survey is a biennial survey that provides data on gross water use (intake, recycle, and discharge) by the manufacturing, mining, and thermal electricity generation sectors.[47] The Agricultural Water Use Survey collects water-demand data in two main categories: crop production related information and livestock related information.[48]

Water managers and Canadian institutions rely on these surveys and data sets to assess the natural resource sectors' water demands. As one of the few sources of water-demand data produced by the federal government, the data produced under these programs have a high level of credibility. Data are differentiated by the method of data collection and analysis. In undertaking this research, five tiers or types of data have been identified — Primary, Proxy, Modelled, Analyzed, and Hybrid. Due to the nature of analysis associated with each type of data, the accuracy and reliability of each data set varies. Primary data is more reliable and accurate than other sources, proxy data is next, and modelled data is the least reliable and accurate of the three water-use data. Analyzed and hybrid data sources can only be as accurate and reliable as their inputs (i.e., the primary, proxy, or modelled data inputs).[49]

Both the Industrial and Agricultural Water Use surveys are conducted in a manner to ensure that errors associated with these methods are incorporated into the final data. However, as both surveys depend on the accuracy attached to the data inputs or coefficients used for calculation, the level of accuracy has limitations. In future it remains important for Statistic Canada to assess approaches that encourage water users to provide accurate and reliable input data in response to the surveys.

PROVINCIAL ROLE IN WATER-DEMAND DATA

The legislative authority for developing and managing natural resources rests with the provincial and territorial governments. As such, all water allocations, licensing, and permitting attached to water uses in the natural resource sectors are provincial and territorial responsibilities. The development of water-demand data is therefore fully dependent on the provinces and territories. They have the sole responsibility to establish data collection, measuring, and reporting requirements for the natural resource sectors, including setting standards for the frequency and format of the reports. Presently only eight of the 13 provinces and territories have mandatory reporting requirements.

Provinces and territories define the criteria that trigger the need for users in the natural resource sectors to acquire a water licence (for example, in Ontario water users diverting more than 50,000 L a day re quire a water licence), the conditions, and the monitoring and reporting requirements attached to a licence. Water users that do not surpass the volumetric threshold, but remain just below it, are not captured by the current water licensing systems. As such, an Ontario water user withdrawing 49,000 L per day is not captured by the current licensing requirement despite the fact it is still a significant user. There could be multiple unaccounted water users withdrawing significant water resources but not being captured under the licensing requirements — leading to a significant cumulative impact. In the future, provincial and territorial governments need to assess the cumulative impact of water users that are not being regulated but could still be adding pressure to existing water scarcity issues if left unchecked.

To ensure accurate measurement of water being used, all water licence holders must report their water use. As noted, current provincial and territorial reporting requirements do not allow for a comparison between actual water use and the amount allocated on the licence. Establishing actual water use is a prerequisite to establishing efficient allocation regimes. Only then can allocations be diverted from licences not using their full allotment to licences that need increased allocation.

As the driver for water-use-related measurement practices, the provinces and territories can leverage their reporting requirements to work toward conserving and effectively managing water resources. A consistent measure of actual water use is important to ensuring sustainable water management in the future. Constant monitoring helps with leak detection and influences reduced consumption. Moreover it gives a comprehensive picture of water usage across time scales: diurnal, weekly, monthly, and seasonal.

NATURAL RESOURCE SECTOR WATER-DEMAND DATA

The natural resource sectors vary in their end use of the water; this in turn creates a basis for the different sectors having different parameters attached to water monitoring, measurement, and reporting. Due to the unique nature of sector-specific uses, it may be important for provincial and territorial governments to develop sector-specific approaches for data and information systems. The natural resource sectors are currently responding by establishing water efficiency and conservation programs to meet their business needs in the form of voluntary, industry-driven water-management initiatives.

Many industry- and sector-driven voluntary water-management initiatives are being used by natural resource companies in jurisdictions across Canada. All these private sector initiatives have a water-demand data component. As discussed in Chapter 4, voluntary initiatives are driven by the need to promote public disclosure in response to broad stakeholder pressure and the increasing need for corporations to have a social licence to operate. It helps natural resource sectors improve their image with the public and at the same time establish common management practices to measure corporate performance on water use.

Most voluntary initiatives are relatively new or under development, hence the associated demand data is limited. Data gathered through voluntary initiatives has the potential to improve water-use efficiency and conservation in the natural resource sectors. However, the public does not trust data produced exclusively by industry, and as such, provinces and territories are reluctant to use voluntary information. However, if the natural resource sectors were to include independent third-party audit and verification of the data gathered through voluntary programs, it would be viewed as being more reliable and would benefit from added public confidence. It could also provide provincial jurisdictions with critical information they need to assess future water-quantity trends when designing and implementing viable economic and regulatory policy.

INTEGRATING DATA TO PRODUCE LOCALIZED DECISION-MAKING TOOLS

Water management is inherently local. This is why it is important to be able to assess water needs at the watershed scale, as compared to a national scale. The real potential of water supply-and-demand data is currently constrained due to the nature in which the data is collected, with efforts largely focused on one or the other and not in an integrated manner. Independently the data on supplies and demands are useful to regulators and water users to assess information at a macro scale. To be able to address and understand some of the localized and regional water-management challenges at the watershed level, decision makers and the public need access to integrated water-management tools such as water-quantity indicators, water yield models, and water budgets. These tools consolidate the water supply-and-demand data to provide comprehensive water assessments that can forecast long-term trends.

In Canada, multiple stakeholders develop the indicators for measuring the state of water quantity. There are approximately 80 indicators for water-quantity measuring and reporting on different variables. The indicators tend to evaluate data in silos and provide information in terms of either demand or supply. More indicators that collectively evaluate impacts based on both demand and supply need to be developed.[50] The present state of water-quantity data requires time and financial investment to develop both the supply-side and demand-side data systems independently; as such the development of integrated water-management tools is a long-term aspirational goal to address future needs. At the federal level, two integrated water-management tools have been developed: the Water Availability Indicators (WAI) and the Water Yield Model.

Environment Canada developed the WAI initiative to provide an important addition to the assessment capacity of water resources in Canada. It is geared to address the needs of the public, policy analysts, and decision makers, providing information on the ratio of water demand to water availability at the sub-drainage area scale (representing 164 watersheds across Canada).

Statistics Canada has developed a new integrated water-management tool — the Water Yield Model — which provides a national estimate of renewable water and allows for a national measure of the supply and demand of water when coupled with results from the water-use surveys. Since the original methodology document was produced, Statistics Canada has validated an additional 350+ basins. In future, Statistics Canada intends to provide access to updated water yield data on its online database.

At the provincial and territorial level there is limited development of integrated water-management tools. An example of a tool that exists at this level is the Prairie Provinces Water Board (PPWB), a collaborative water resource management entity between Alberta, Manitoba, Saskatchewan, and the federal government. The PPWB was established to ensure equal access to water for all users across the three provincial jurisdictions.[51] To carry out its duties PPWB developed an integrated water-management tool — the "Composite Index of Vulnerability of Prairies Resources" — that evaluates both water-supply and water-demand data in Alberta, Saskatchewan, and Manitoba for management decisions.

Water budgets — which here refers to modelling future water needs and impacts based on available data — show promise as another integrated water-management tool that could have significant impact at the watershed scale. Water budgets enable decision makers to assess water scenarios at local watershed scales rather than having to rely on a larger scale. The scale of the assessment is important because the more the spatial scale of assessment increases, the more small-scale impacts or stresses tend to be masked or hidden. In other words, it is likely that significant local impacts would not be detected using a relatively large, lumped assessment of overall water supply and demand at the larger regional or national scales.

WATER-QUANTITY DATA TO ADDRESS DIFFERENT COMMUNICATION NEEDS

As water is a public resource, there is an inherent expectation that data on water use by the natural resource sectors should be made available to technical experts, decision makers, and the public. These three constituencies require information for different purposes and with different levels of complexity and detail. Governments at all levels need to collaborate to ensure water data is made available to serve the different information needs of the public, technical experts, and decision makers. At the core of improving access to data is the need for governments at all levels to conduct a strategic analysis of end uses for water data. Governments need to assess what aspects of the data are appropriate for public dissemination. If the data is to be made available to the public, then having a screen for sensitive water-quantity data may be important for competitive reasons. At the same time raw water-quantity data has to be accessible to technical and scientific experts.

The sensitivity associated with publicly sharing water data from the natural resource sectors comes from the water use associated with the internal processes used in product processing and manufacture. Currently there is limited information about firm-level water use, largely due to this sensitivity. Some sectors report their water use publicly through either industry association sector-level reporting or individually through their sustainability reports; but for the most part, firms and producers do not report publicly on their water use. It is necessary to recognize that industries may need to protect information that may be inferred from inflow and outflow measurements. At the same time, it is important for regulators to know the water usage for predicting impacts on the ecosystems (i.e., outflows and amount consumed in any facility).

While transparency to the public is important, data should not stand alone as it is easily subject to misinterpretation without context. It is essential to include context when presenting water data and information to the public (i.e., water use relative to average natural flow in a given basin, percentage of total water use in basin by sector). It would likely be acceptable to provide aggregate data by natural resource sectors or on a watershed basis. Data could be rolled up by sector and region; showing usage by company or by small area when there are only a few users should be avoided where possible.

SUMMARY

This chapter evaluates water-quantity data systems in Canada looking at the demand and supply aspects of water balances. In Canada the supply side of water-quantity data has dedicated financial resources and cost-sharing agreements in place to develop and deploy a reliable pan-Canadian water-quantity data system. The supply-side monitoring capacity and reporting protocols are well established. The different stakeholders have a clear understanding of their respective roles. Gaps remain in the water-supply data system, but the system has a strong foundation to build upon as it improves and addresses those gaps. The demand-side water-quantity data systems are very much on the opposite end of the spectrum of development and deployment, as water-demand data systems vary across provincial and territorial jurisdictions. Significant gaps need to be addressed by governments at all levels in collaboration with natural resource sectors to establish measuring, monitoring, and reporting protocols for demand-side data that are consistent across the country.

In Canada, governments at all levels lack the capacity to integrate supply-side and demand-side water-quantity data to evaluate, predict, and forecast future water availability at a localized watershed scale. Governments need to develop the intellectual capacity to generate integrated water-management tools that provide information at a watershed scale on a priority basis. Finally water-quantity data is used by a multitude of end-users who have different needs for the information. Moving forward, governments need to assess, through transparent processes, the different end-user profiles for water-quantity data. Based on these strategic assessments it is important to design intelligent water-quantity data systems that not only respond to present water-quantity data needs but also foresee future water-quantity data trends.

CHAPTER SEVEN

COLLABORATIVE WATER GOVERNANCE

CONTENTS

HIGHLIGHTS

Successful collaborative governance requires ongoing support from higher orders of government with clear rules and guidance, as well as incentives for participation.

Although focused on the watershed, collaborative water governance should be coordinated with other planning processes, and if possible, integrated with them.

Collaborative governance is a tool to be selected in particular situations, not a panacea for all water governance challenges.

COLLABORATIVE WATER GOVERNANCE

Water **governance** refers to the processes and institutions through which decisions are made about water. This includes the range of political, organizational, and administrative processes used to make and implement decisions, as well as how decision makers are held accountable. This is different from water **management**, which refers to the operational, on-the-ground activity to regulate the water resource and the conditions of its use.[52]

The NRTEE set out to explore the potential of collaborative water governance approaches and how they might assist in achieving sustainable water use by the natural resources sectors. Our research provides insights into three areas:

1. the benefits and challenges of current collaborative water governance approaches;
2. governments' and industries' changing roles in water governance and management, and how a collaborative governance process might deal with these changes; and
3. circumstances under which collaborative water governance might be appropriate in the future.

COLLABORATIVE WATER GOVERNANCE MODELS IN CANADA

The emergence of collaborative water governance models provides an opportunity to improve the way we manage water in Canada and brings the flexibility required for addressing regional and local particularities. It allows for a more localized planning process, which promotes better-informed, place-based decisions and facilitates the involvement of a wider range of stakeholders. Collaborative water governance structures are often associated with watershed management, as the watershed offers a relevant scale for the involvement of local and regional stakeholders. A number of Canadian jurisdictions have recently developed province- or territory-wide water strategies including Québec (2002)[53], Alberta (2003)[54], Manitoba (2003)[55], British Columbia (2008)[56], and, most recently, Nova Scotia[57] and the Northwest Territories (2010)[58]. Many of these strategies include collaborative water governance initiatives, often involving the creation of watershed-based organizations.

While provinces have some type of watershed-based organizations, the role and responsibilities of these groups varies from place to place. In Alberta, for example, the Watershed Planning and Advisory Councils (WPACs) are recognized in the province's water strategy and work toward watershed management plans that may eventually be legislated. In contrast, British Columbia's watershed-scale organizations operate independently from one another without a common policy basis. Some, like the Okanagan Basin Water Board, are enshrined in provincial legislation and have taxation powers, while others in the province are purely voluntary. Provinces with a formal, jurisdiction-wide watershed governance process include Alberta, Saskatchewan, Manitoba, Ontario, Québec, and New Brunswick. Often, the shift toward watershed-scale decision making also includes a change from top-down "command and control" types of governance structures to bottom-up, collaborative governance structures.

Provinces that have mandated participation or specified which categories of stakeholders should participate in water governance include Alberta, Saskatchewan, Manitoba, and Québec. Other provinces strongly encourage watershed groups to include a variety of stakeholders, but this inclusion is not mandated, nor are the categories of stakeholders specified.

COLLABORATIVE WATER GOVERNANCE DEFINED

Collaborative water governance can take on many forms and functions, differentiated primarily by two key characteristics:

1. the degree of non-governmental participation, and
2. the degree of delegation of decision-making power.

Figure 25 illustrates the range of potential governance models that are possible based on these two factors, from which four models are defined:

A. **Traditional governance** exists where government controls all decision making. Non-government participants are involved on a limited basis, typically by invitation only, and often with a high proportion of technical experts. The governance process is usually time-limited, with a very specific and often narrow mandate. Most governments in Canada have moved away from this model.

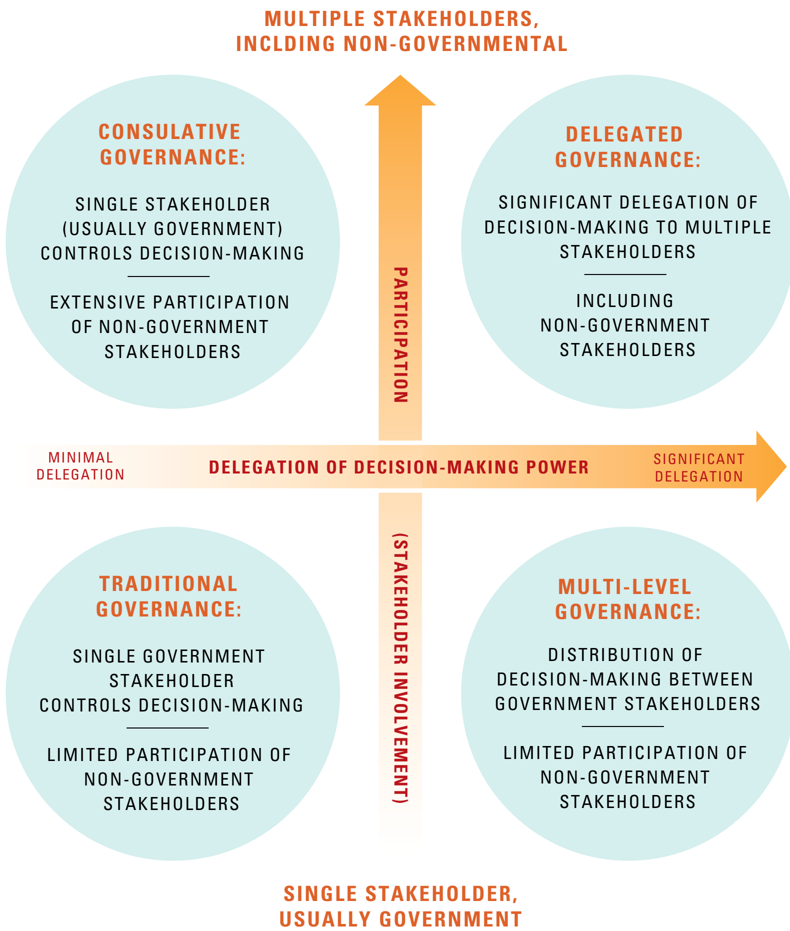
B. **Multi-level collaborative governance** involves many orders of government, with a broader goal of improving water-management outcomes. Typically this involves collaboration between a range of governmental — and sometimes non-governmental — stakeholders over a relatively long time period. Usually a forum is created in which information is shared and management actions are discussed and negotiated, but formal government agencies retain decision-making power. Existing government partners act under their respective jurisdictions and legislative mandates and appoint representatives to the collaborative process. Examples include the Fraser Basin Council in British Columbia and the Collaborative Environmental Planning Initiative for the Bras d'Or Lakes in Nova Scotia.

C. **Consultative governance**, which covers problem-focused governmental initiatives, is intended to provide specific inputs for policy reform. The primary goal is extensive consultation with a wide range of stakeholders, where governments consult with stakeholders, but do not share decision-making power. Typically of limited duration, the mandate of these initiatives is normally constrained. There is generally no legislative basis for any organization formed under a consultative governance approach. An example is New Brunswick's Watershed Groups, which carry out extensive work to classify streams in their watershed but have no formal or regulatory role.

D. **Delegated governance** involves formalized, autonomous bodies with implementation power for water-management decisions, often with larger budgets than the other types of collaborative water governance. A range of governmental and private stakeholders groups is typically represented. Unlike other collaborative governance arrangements, these bodies are formal governmental agencies, often mandated by specific legislation. The Okanagan Basin Water Board provides an example of such a model.

FIGURE 25

APPROACHES TO COLLABORATIVE WATER GOVERNANCE



Source: adapted from Nowlan & Bakker, 2007[59]

These categories are illustrative only, as it is often difficult to assign a specific governance model to one of the four categories. For example, Québec's Watershed Organizations fall somewhere in the midst of multi-level governance, the consultative governance, and the delegated governance categories. In addition, governance models may fall within the same broad category, but still be different in their level of delegation or participation.

EXPLORING COLLABORATIVE WATER GOVERNANCE IN CANADA

The NRTEE, in collaboration with four watershed organizations, explored how collaborative water governance might assist in achieving more sustainable water use by the natural resource sectors. Our research was informed by a series of watershed-based workshops held in Alberta (North Saskatchewan River Watershed), British Columbia (Okanagan Basin), Nova Scotia (Bras d'Or Lakes), and Québec (Saint-François River Watershed). We convened a broad range of stakeholders involved in collaborative water governance initiatives, including governments of all levels, non-governmental organizations, natural resources sectors, and other interested citizens. These workshops allowed the NRTEE to go beyond the theory and learn from hands-on experiences across the country.

The findings from the four watershed-based workshops were consistently similar. Despite some regional differences — mainly expressed through the different nature of the socio-economic reality in each watershed — the key issues and concepts identified in Alberta, British Columbia, Nova Scotia, and Québec were often the same. Our report therefore builds on this national consistency and does not describe regional differences. More information on the detailed findings of each workshop can be found in an internal report commissioned by the NRTEE.[60]

Our research also included an online expert panel consultation. In this exercise, representatives from the natural resource sectors provided input on specific questions similar to those discussed during the watershed-specific workshops. The purpose of assembling this panel of industry experts was to build on their practical experience and better understand the views and opinions of the natural resource sectors on collaborative water governance in Canada.

Finally, our research was informed by the outcomes of a national workshop held in February 2010 that explored the role of the natural resource sectors in collaborative water governance. The remainder of this chapter describes our key findings from this comprehensive consultation and engagement process on collaborative water governance. More than 140 stakeholders from all regions of Canada participated and provided input throughout this process.

FOUR CASE STUDIES OF COLLABORATIVE WATER GOVERNANCE

This chapter reports our findings from a series of workshops held in Penticton (B.C.), Edmonton (Alberta), Sydney (Nova Scotia), and Sherbrooke (Québec), in collaboration with local watershed organizations.

OKANAGAN BASIN

Located in central British Columbia, the Okanagan is a semi-arid, snow-dependent watershed that faces extremes of water abundance and scarcity. Irrigation of various forms accounts for 86% of water consumption, with the agriculture sector being the largest single consumer (55%), followed by domestic outdoor irrigation (24%). The *Okanagan Basin Water Board* was initiated in 1968 and mandated with the tasks of identifying and resolving critical water issues. The Board of Directors includes representatives from the three Okanagan regional districts, the Okanagan Nation Alliance, the Water Supply Association of BC and the Okanagan Water Stewardship Council.

NORTH SASKATCHEWAN RIVER WATERSHED

The North Saskatchewan River watershed is one of the major drainage basins in Alberta. Its total drainage area is about 57,000 km^2. Originating in the ice fields of Banff National Park, it flows easterly through Alberta to join the South Saskatchewan River in Saskatchewan. It is home to about one-third of Alberta's population and runs through 86 municipalities. It contributes to about 60% of the province's energy generation including two major hydroelectric reservoirs and three coal-fired electricity generating plants, alongside large forestry, agricultural, petrochemical, and oil and gas sectors. The *North Saskatchewan Watershed Alliance* was incorporated as a non-profit society in 2000. It was designated the official Watershed Planning and Advisory Council (WPAC) for the North Saskatchewan watershed in 2005 and is mandated under Alberta's "Water for Life" Policy to formulate watershed management plans.

BRAS D'OR LAKES

The Bras d'Or Lakes is an estuarine environment. The 3,500-km^2 watershed includes parts of the Cape Breton Highlands at hundreds of metres elevation, down to sea-level salt marshes and barrachois (a coastal lagoon that is separated from the ocean by a sand bar).

Human activity within this area is diverse, and includes mining, farming, fishing, tourism, hunting, arts and crafts, and wind farms. The *Bras d'Or Lakes Collaborative Environmental Planning Initiative (CEPI)* was initiated in 2003 by a group made up of representatives from federal and provincial governments, First Nations, community groups, academics, and residents. CEPI is unique in that it incorporates expertise from both western science and First Nations knowledge, an approach referred to as "two-eyed seeing."

SAINT-FRANÇOIS RIVER WATERSHED

This watershed is located in southeastern Québec and covers 10,499 km^2, 14% of which is located in the United States. The Saint-François River originates from Lac Saint-François and flows northward to empty into the Saint-Lawrence River. The basin includes 102 municipalities but the main land uses in the basin are forest (66%) and agriculture (23%). The *Conseil de gouvernance de l'eau des bassins versants de la rivière Saint-François* (COGESAF)'s mandate is framed by the province's 2002 *Politique nationale de l'eau* and the subsequent 2009 *Loi affirmant le caractère collectif des ressources en eau et visant à renforcer leur protection.* Together, these provincial-scale initiatives established 33 (now 40) priority basins in the province, of which the Saint-François River Basin is one. Although COGESAF's plans are developed at the basin scale, the organization also oversees and coordinates planning and management at the sub-basin scale.

BENEFITS AND CHALLENGES OF COLLABORATIVE WATER GOVERNANCE

BENEFITS

Collaborative water governance can help to build trust, increase understanding, and prevent or reduce conflict. Collaborative governance builds friendships, alliances, and understanding between diverse groups. In turn, developing relationships leads to reduced conflict. This is, in part, predicated on the potential for learning afforded by the collaborative water governance process, which provides an opportunity for diverse stakeholders to work toward common visions, goals, and mutual understanding. Those involved learn to better appreciate the specific challenges other individuals and organizations have to face. Innovation also arises from the cross-pollination of ideas and mutual education.

Collaborative processes can help improve decision making and long-term planning at the watershed level. They provide for a more informed governing body that is better equipped to plan for the future and address upcoming challenges. Collaborative water governance can be a crucially important mechanism for setting priorities at the watershed level and offering a mechanism for allocating financial and human resources to address water-management issues. Collaborative water governance is seen as a central mechanism for integrated land and water management, from which to address the interrelationship between issues (e.g., food security and water security), resolve problems, and integrate water management within a broader framework of ecological management and action.

For firms in the natural resource sectors, uncertainty about the future direction of regulatory frameworks presents challenges, as strategic planning requires knowledge of the regulatory environment for many years into the future. Collaborative approaches can provide insights into future regulatory direction if the process has clearly established roles and connects to broader, strategic policy-making processes.

CHALLENGES

Challenges of collaborative water governance include changing membership over time (both in number and in representation); lack of data; fragmentation of data; uneven stakeholder representation; jurisdictional fragmentation; and tensions between the perceived advantages of autonomy and decision-making authority, and the desirability of oversight, direction, and support from the province.

Fair representation is often noted as a challenge. For example, there are challenges associated with working with small municipalities who have jurisdiction over a small area of land within a watershed, but who have much greater authority in terms of land-use planning and water regulation. Similarly, larger municipalities present a challenge in that they may dominate a particular basin demographically and economically, yet still only have a single seat at the table — creating an artificial equality.

The consensus-driven approach can be a strength but it can also be a weakness. On the one hand, this approach leads to more buy-in, learning, and trust. On the other hand, the approach is at times slow, cumbersome, and expensive.

Similarly, the lack of mandated authority has two edges. Because it has little vested authority, a watershed organization is usually respected as a neutral convener. However, the lack of mandated authority means that it cannot always act on issues that the public perceives to be within its area of responsibility. Moreover, the lack of vested authority implies that the governing body can do little to help with one of the major governance challenges identified in various watersheds: the lack of coordination and synchronization between water-related policies and planning processes of different government agencies.

Engaging in collaborative processes is seen as a resource-intensive investment for the participating industries. Multiple regional and local processes, often across a wide geographical area, require staff time, information and research, and travel investments. For firms operating in many provinces this can represent a particularly large investment. To continue their participation in the long term, firms need to see a clear return on this investment, particularly as they engage in collaborative processes in parallel to fulfilling regulatory requirements applied to their industry. Clearly defined objectives, outcomes, and results from collaborative approaches, and clearer understanding of how these processes fit within existing regulatory frameworks can help address this concern, and keep industries engaged in collaborative governance initiatives.

Finally, there are specific instances when trust could be diminished within a collaborative governance process, particularly when rules governing accountability and roles are unclear. Designing the right governance "rules of engagement" is as important as bringing the right people to the table.

GOVERNMENTS' AND INDUSTRIES' CHANGING ROLES

ROLES OF GOVERNMENTS

Despite the fact that provincial governments have been investing in collaborative governance processes, participants in such arrangements often express frustration at the perceived lack of ongoing provincial guidance. Issues of transparency and accessibility surrounding the process — particularly roles and responsibility of government — are always raised as conducive to success.

MAKING COLLABORATIVE WATER GOVERNANCE WORK

Collaborative water governance is appropriate when

- input from multiple stakeholders into decision making on "big picture" or strategic issues is required;
- long-term commitment from multiple stakeholders is required;
- policy frameworks are being developed; or
- watershed plans are being developed.

Collaborative water governance works when

- rights, responsibilities, mandates, and rules are clear;
- relationships are emphasized over hierarchies;
- common objectives and benefits can be defined;
- participants recognize the need to make decisions at a specific scale;
- stable funding is available to support the collaborative process; and
- participants share a commitment to sustainable water governance.

Collaborative water governance may not work or be appropriate when

- not all participants are willing to come to the table;
- the process is used by certain groups to delay action or hinder policy processes;
- no processes exist for conflict resolution;
- power imbalances exist;
- clarity is lacking about authority for decision making;
- federal and provincial policy is not aligned with municipal or watershed organizations' objectives;
- a crisis situation requires immediate action; or
- there is a well-defined problem that can be easily dealt with by a government department.

The following suggestions to help improve future collaborative processes – for both provincial and federal governments — were developed from input the NRTEE received at its watershed workshops.

For provincial governments:
- clarifying collaborative governance processes in legislation, including accountability guidelines;
- providing stable funding for collaborative water governance initiatives; and
- reforming water allocation licences.

For the federal government, future roles could focus on
- improving data collection, monitoring, and analyses;
- harmonizing water quality and water availability assessment tools across Canada (where possible); and
- placing a greater emphasis on public education.

First Nations governments and peoples play an increasingly important role in collaborative water governance in Canada. Although First Nations' water rights — including rights of governance and control — are still being interpreted and defined in negotiations and by the legal system, it is clear that new duties apply to governments with respect to First Nations and water. Any activity that could potentially infringe on these rights requires consultations with the rights holders, and this includes water-management decision-making processes. In many regions across Canada, First Nations are engaging directly in water governance, working with or encouraging collaboration with other governments and partners through watershed planning, water-source protection planning, and water-management initiatives.

First Nations' cultural and spiritual values make them excellent contributors to collaborative water governance processes seeking to reconcile the needs of various users with the needs of the ecosystems, for the present and the future. First Nations and Indigenous knowledge could contribute substantively to
- our understanding of the health and functioning of the watershed;
- our approaches for effective collaboration;
- the identification of values and priorities; and,
- the successful and co-operative implementation of actions and solutions.

Their participation in collaborative water governance is therefore essential for success.

ROLES OF THE NATURAL RESOURCE SECTORS

The natural resource sectors have been involved in collaborative processes for a long time and see the value of such processes as being dependent on various factors. They believe that the benefits of collaboration need to be clearly demonstrated. They also emphasize the critical need to provide contextually appropriate incentives for industry participation in water governance processes. Similarly to other stakeholders, firms in the natural resources sectors require greater clarity with respect to expectations and roles and responsibilities in water governance.

Industry's participation in collaborative water governance forums is not guaranteed and may remain limited until governments mandate such processes. Several issues can explain such limited participation. One important factor is that for some industry sectors, the benefits of participation seem both limited and unclear. Corporations respond strongly to signals from governments and regulatory mechanisms. If they believe that water governance is not a government priority, then they will not consider it a priority and will likely not participate.

Another issue is the amount of time and resources required to participate in those processes, which often leads to "volunteer burnout" in the non-governmental stakeholders. This has implications, as companies will be reluctant to invest time and money in a process that does not have a good chance of success. Incentives are required to ensure participation from all relevant natural resources sectors in order to improve involvement in, and acceptance of, the collaborative water governance process.

The NRTEE partnered with the Water Policy and Governance Group (WPGG) at the University of Waterloo to examine the explicit implications of collaborative approaches to water governance for firms in the natural resource sectors and the implications of their involvement for collaborative processes. The research contributes to the NRTEE's research, as well as to that of the WPGG's on-going study of *Governance for Source Water Protection in Canada.*

Twenty-one participants from across Canada representing natural resource sector firms in the mining, oil and gas, forestry and electricity generation sectors are taking part in an online multi-round "Policy Delphi" forum. Using a web-based survey, panel members interact anonymously with each other, allowing for a more thorough and open examination of key questions and concerns. This research design helps to tease out areas of agreement and disagreement between participants. Preliminary results illustrate the complex relationship that firms in the natural resource sectors have with collaborative approaches to water governance. Collaborative approaches offer many opportunities, but do not come without costs as evidenced by key themes emerging from the research:

- The two-way dialogue that collaborative processes permit offers opportunities to exchange information, perceptions, and ideas. This allows firms to engage with stakeholders, build relationships, dispel false perceptions, and advance their perspective. It also provides opportunities to listen and learn from the experience of others.

- Collaborative processes allow firms to engage in decision-making processes from the beginning, permitting them to shape the perceptions of other engaged stakeholders and to ensure that their position, perspective, expertise, experience, and information are incorporated throughout the decision-making process.

- Natural resource sector firms identified one of their biggest challenges as the uncertainty about the future direction of regulatory frameworks, noting that strategic planning requires knowledge of the regulatory environment for many years in the future. Collaborative approaches can provide a key insight into the future regulatory direction, but only if the process has clearly established roles and connections to broader policy-making processes.

- Engaging in collaborative processes is a resource-heavy investment for firms in the natural resource sectors. Multiple regional and local processes across a wide geographical area require staff time, information and research, and travel investments. For firms operating in more than one province or watershed, this can represent a particularly large investment. Participating over the long term requires a clear return on this investment, particularly as firms engage in collaborative processes in parallel to fulfilling the regulatory requirements applied to their industry. Clearly defined objectives, outcomes, and results from collaborative approaches, and clearer understanding of how these processes fit within existing regulatory frameworks can help address this concern.

- Natural resource sector firms acknowledge that decision making through collaborative processes has its limitations. Such processes may not work well when parties are not willing to come to an agreement or consensus. In this instance, government may still have a responsibility to act.

- On the following two pages is a summary of the "key elements of successful collaborative governance for sustainable development", prepared by the NRTEE and the Public Policy Forum. It has relevance and applicability to collaborative water governance.

ELEMENTS OF SUCCESSFUL COLLABORATIVE GOVERNANCE FOR SUSTAINABLE DEVELOPMENT

1) FOCUS ON CLEAR OUTCOMES

Collaborative processes must be focused on clear, measurable outcomes. Collaboration for collaboration's sake leads nowhere. Citizens will commit to a process that is expected to yield clear, real results.

2) FIND THE RIGHT CONVENOR

Collaborative processes need a convenor that is credible, neutral, and trustworthy. The convenor must be able to bring the right players to the table and establish a process that will enable progress. Governments are often best placed to convene, but not always; sometimes others are better positioned to convene collaborative processes.

3) BRING THE RIGHT PEOPLE TOGETHER

Collaborative processes must have the right players at the table. The process does not have to include every possible relevant stakeholder, but the process will not generate solutions that are successful in the long term if it excludes key interests.

4) ENSURE REAL COMMITMENT

Every participant must commit fully to the collaborative process. This means a commitment from all participants to see the process through, to act on the results, and to find solutions together through the collaborative process.

5) CREATE CLEAR RULES AND SCOPE

Collaboration depends on clearly defined and agreed upon goals, rules, and scope. Success requires clarity on the goals; it requires clarity on timelines, so that discussions are not open-ended; it requires clarity on roles and responsibilities, so that participants understand what is expected of them; and it requires clarity on the rules of the process, so that participants can police each others' actions and avoid conflict.

6) FOSTER SHARED OWNERSHIP AND ACCOUNTABILITY

Collaborative processes must develop a shared ownership and accountability for the process and the resulting policy solutions. Collaboration means that the participants are taking responsibility as a group for solving their problems together.

7) BUILD LEGITIMACY

Collaborative initiatives must be — and must be seen as being — legitimate processes. Success depends on developing two forms of legitimacy. Internal legitimacy derives from having the right participants and good processes with clear, transparent, and fair rules. External legitimacy is gained through some level of recognition and backing from established democratic institutions.

8) ESTABLISH ONGOING DIALOGUE

Collaborative processes should establish ongoing dialogue and engagement. Ongoing processes create trust and build on past success. They enable evaluation and continuous learning from the successes and shortcomings of the past.

Source: NRTEE. 2010b. *Progress Through Process: Achieving Sustainable Development Together.*

SUMMARY

Effective collaborative water governance requires involvement from a broad range of stakeholders whose participation is not always guaranteed. As for other stakeholders, representatives from the natural resource sectors need some incentives to remain committed to such processes. They want to see alignment with other planning processes such as municipal land use planning or forest management plans. To encourage participation in collaborative water governance, governments need to demonstrate strong leadership and act on the recommendations provided by the collaborative process.

Collaborative water governance is a tool to be selected in particular situations, not a panacea for all water governance challenges. It requires time and dedicated resources, as well as clear rules and guidance from governments. To be successful, the mandate, scope, and role of collaborative groups must be clearly stated in written documents. Collaborative governance in name only — without clear objectives and accountability rules, without stakeholder or government support, in a conflict-ridden situation, and without a spirit of collaboration — has the potential to make things worse, not better. But future water-management challenges require consideration of more inclusive decision-making processes as a means to identify shared problems and potential solutions. Collaborative governance approaches for water management need to be considered.

CHAPTER EIGHT

CONCLUSIONS AND RECOMMENDATIONS

CONTENTS

CONCLUSIONS AND RECOMMENDATIONS

To achieve the policy outcomes of water conservation and efficient use of water by the natural resource sectors, we need in Canada — across all provinces and territories — a more comprehensive and innovative approach to water governance and management. Such an approach must incorporate strategies to improve our knowledge of how and what water is being used by the sectors, when it is required or will be required in the future, what policy instruments can more efficiently and effectively manage water allocations, and the state of water supplies and demands in the most at-risk regions and watersheds of Canada.

A comprehensive approach should be principles-based, and we recommend inclusion of the following principles to guide water governance and management:

- Water has value — in economic, environmental and social terms — and should be managed in trust without harm to its sustainability or that of the ecosystems in which it occurs.
- Water must be conserved and used efficiently.
- Water governance and management should be adaptive.
- Water governance and management should be collaborative.

GUIDING PRINCIPLES

WATER HAS VALUE

-IN ECONOMIC, ENVIRONMENTAL AND SOCIAL TERMS -
AND SHOULD BE MANAGED IN TRUST WITHOUT HARM TO ITS SUSTAINABILITY OR THAT OF THE ECOSYSTEMS IN WHICH IT OCCURS

WATER MUST BE CONSERVED AND USED EFFICIENTLY	WATER GOVERNANCE AND MANAGEMENT SHOULD BE ADAPTIVE	WATER GOVERNANCE AND MANAGEMENT SHOULD BE COLLABORATIVE

The NRTEE's research and discussions with experts and stakeholders have resulted in new insights and many conclusions. These conclusions have led us to provide a number of recommendations in the realms of water forecasting, policy instruments including water pricing, water-use data and information, and collaborative water governance. Our conclusions and recommendations were developed to help decision makers design the best policies and programs for water management and governance for the natural resource sectors. And ultimately, they are intended to help achieve the outcomes of better water conservation and efficient water use.

WATER FORECASTS

CONCLUSIONS

A comprehensive and useful information base linking long-term economic growth to water use in Canada does not, for the most part, exist. This presents a significant gap in our knowledge of how water resources and economic development are linked. Without this knowledge, it is difficult to strategically plan for sustainable development of our natural resources.

Historical water use by the natural resource sectors demonstrates an improvement in water efficiency for most sectors, even in the absence of water policies to entice such efficiency gains. Water use requires energy — to pump, circulate, treat, and discharge it. Because of rising energy costs over the last decade, and through discussions with sector experts, we know that the natural resource sectors have found ways to reduce their energy costs, and in doing so, improve their water-use intensities. However we need to better understand the reasons for these improvements on a sector basis. This information is important in two respects: it will improve future water forecasts, which will in turn inform water allocation and management strategies; and it will inform how the natural resource sectors use policy instruments to reduce future water demands.

While most sectors currently pay very little to governments for the water they use, they nevertheless are incurring costs that drive water efficiency and conservation now. And while increased economic activity is causing increased water use in the natural resource sectors overall, historical trends of decoupling water use from economic growth are anticipated to continue, resulting in small overall increases in water use in Canada.

Even though the results of our scenario analysis reveal a potentially small overall increase in water intake on a national average, this result likely masks some regional challenges, in particular in oil and gas and agriculture. Further analysis on a regional basis is required to improve our understanding of where water demands are likely to increase substantially with economic growth.

RECOMMENDATIONS

- The federal, provincial and territorial governments should collaborate in the development and publication of a national water-use forecast, updated on a regular basis – a Water Outlook – the first to be published within two years. This could be led by a national organization such as the Canadian Council for Ministers of the Environment.

- Governments should develop new predictive tools, such as water forecasting, to improve their understanding of where and when water demands might increase. The information provided by forecasts will be important to inform water allocations and management strategies in the future.

- Recognizing that accurate water forecasting requires improving how we measure and report water-quantity data, governments and industry should work collaboratively to develop appropriate measurement and reporting requirements on a sector-by-sector basis.

POLICY INSTRUMENTS

CONCLUSIONS

Economic instruments (EIs) — either water charges or tradable water permits — allow the economic value of water to be revealed. They offer the opportunity to meet conservation and water-efficiency targets by transitioning current regulatory approaches toward instruments that are more efficient: water pricing or water trading. EIs have the potential to provide incentives and flexibility for water users by allowing them to determine their water use and adopt water-conserving technologies.

The use of a water charge seems the most likely option of the two, at least in the shorter term, and can be viewed as a *transitional* policy option. Licensing and water rental fees exist in all provinces and territories. This provides a solid foundation from which to move from a fee structure that is fiscally oriented, aimed at recovering administrative costs but providing little incentive to conserve water, to one that is incentive-based, where water charges send a signal that water is valuable and should be efficiently used and conserved. There are opportunities here to work within established management systems.

Trading water within watersheds represents a fundamental shift in water-management systems, and can be seen as a *transformative* option. With water trading, regulators must become market designers and enforcers while remaining focused on water-supply constraints. Existing legal, institutional, and administrative frameworks need to be assessed and reoriented to detach historical or riparian water rights, therefore allowing water to be reallocated through market trading. Political barriers can be significant when it comes to trading water rights. Real or perceived, concerns about stripping away long-standing rights, commoditizing water, and concentrating water rights in the hands of wealthier firms or sectors can be a barrier to trading.

Water charges and water trading both face formidable challenges associated with their design and implementation. For water charges, the complexity of determining the value of water to society can make it very difficult to design and manage simple, transparent, efficient, and equitable pricing rules. A market for water trading requires a higher level of governance, increased capacity, and more knowledge. Therefore, water trading would likely be a more costly option to design and implement.

In the absence of government intervention, voluntary initiatives are likely to continue playing a role in improving water management across all sectors. While the effectiveness of such initiatives is still in question, past experience shows the promise of these approaches as they relate to measuring and reporting water use, and improving the transparency of industrial water management. Together, they help support industry's "social licence" to operate. The sectors may therefore continue to generate interest in voluntary initiatives, as the financial community and customers are looking for more information on aspects of corporate social responsibility, including water management.

RECOMMENDATIONS

- Recognizing that water policy strategies across Canada need to be flexible and responsive to changing water realities (changing hydrological conditions and increased water demands on regional and watershed bases) to avoid potential water conflicts, governments should take a phased approach to policy change:

    1. **Ensure that enabling conditions such as legislation and regulation are in place.** Because it takes years to develop and enact the legislation and regulation necessary for new economic instruments, jurisdictions that have not already done so should begin reviewing and working on the necessary legislative/regulatory and policy changes today if they want to strategically manage their water sustainability.

    2. **Stage policy options, thereby allowing for adaptation to different circumstances.** A comprehensive evaluation of economic and environmental conditions within a watershed must take place before determining which policy instruments are the most appropriate and the most likely to address water-allocation issues. Only then will governments be in a position to implement policy options appropriate to the situation within the watershed. Staging of options should be based on the existing or expected water constraints within a watershed. For example, watersheds experiencing existing or growing pressures on their water resources should take more aggressive policy approaches.

- Provincial and territorial governments should provide policy direction that is focused on more efficient water use and increased conservation, where required. To do so, jurisdictions should

  - set conservation targets based on in-stream flow needs to ensure healthy aquatic ecosystems;
  - set efficiency targets for the natural resource sectors to achieve;
  - allow industry to demonstrate how they could achieve the efficiency targets on a voluntary basis first; and
  - where necessary, send a long-term signal that water has an economic value by setting a volumetric price on water intake, in situations where water scarcity is or could be a real risk.

- Recognizing that further research is required on the use of economic instruments within the context of watersheds, governments intending to use EIs should evaluate their environmental, economic, and social implications, allowing for an informed discussion of trade-offs.

PRICING WATER

CONCLUSIONS

The NRTEE research shows the potential that putting a price on water has on achieving water reduction objectives, with modest impacts to most sectors and the national economy. Our scenario analysis, while preliminary in its development, is an important piece of new information looking at the relationship between water demands of the natural resource sectors and industry's responsiveness to a price on water. Our analysis demonstrates that some sectors may be responsive to water pricing, and large efficiency and conservation gains could be achieved with small increases in the price of water. However, this research needs to be taken further, with better data sources, and discussed with the sectors to better understand the opportunities to change their water use in response to water prices. Specifically, we note that future analysis would be strengthened with additional sector and regionally-specific data that would allow for an assessment of the responsiveness on a price per unit of production basis.

RECOMMENDATIONS

- Governments should research the relationship between water use and pricing needs before they implement water pricing on a volumetric basis. Specifically, they need to better understand the potential implications on sectors and firms. In order to do so, data on water use needs to improve, to gain a better understanding of water intakes, recirculation, and recycling within facilities.

- The natural resource sectors should look closely at their water intake and where the costs rest within their use of water. Incorporating the "value" of water into operations may reveal opportunities for costs savings, through implementation of improved technologies or best management practices, possibly leading to overall water intake reductions.

- If a price is put on water use by the natural resource sectors, revenues should be directed to support watershed-based governance and management initiatives, rather than put into general revenue of the province or territory.

WATER-USE DATA AND INFORMATION

CONCLUSIONS

A lack of publicly available, reliable water-quantity data has negative implications for current and future water-resource management in Canada. Specifically, the lack of baseline water-use measurements hampers efforts to improve efficiency since improvement potential is difficult to estimate, actual improvements cannot be assessed, and incentives for reductions cannot be readily developed, implemented, or evaluated. Adequate water-quantity data would be required if jurisdictions opt to recover the costs of administrating water policy and water-efficiency programs and maintaining water-use databases. All provinces and territories would benefit from developing a "toolkit" of common water-quantity measurement techniques that could measure and quantify actual water intake and discharge volumes. Mapping information through an interactive media, similar to the National Atlas, is one possible tool, which could allow policy makers, technical experts, and the public to better understand and identify the geographic areas facing water resource concerns.

RECOMMENDATIONS

- Provincial and territorial governments should establish demand-side data systems that have clearly defined reporting requirements for water licence holders. These systems would have common obligations to report provisions, contain defined time periods for reporting, and introduce enforcement programs to ensure reporting of water use by water licence holders.

- The provinces and territories, in collaboration with stakeholders and partners, should develop common measurement techniques to collect water-quantity data.

- The provincial and territorial governments, in collaboration with the natural resource sectors, should research the sector-specific future water data needs of their jurisdictions. These initiatives would help jurisdictions identify and develop data-management approaches and systems that have buy-in from the natural resource sectors.

- Governments at all levels should collaborate with partners and stakeholders to develop and integrate water-quantity data for use as a water-management tool at a local watershed scale. Provinces and territories should first develop integrated water-management tools within their jurisdictions at a finer spatial resolution, as it is easier to "roll-up" small-scale assessments to larger scales rather than to disaggregate an initial assessment performed at a larger spatial scale.[61]

- In collaboration with partners and stakeholders, governments at all levels, should develop protocols for transparent access to water data. Provinces and territories should continue establishing their own water-data portals. The federal government should develop a national web-based water portal, in collaboration with the provinces and territories, which also provides access to provincial and territorial water portals.

COLLABORATIVE WATER GOVERNANCE

CONCLUSIONS

Provincial governments need to clearly define the mandate, scope of activities, and role of collaborative groups as well as the role and importance of First Nations and the natural resource sectors in collaborative water governance initiatives. We also note the need to move toward the integration of land and water management in addressing many connected watershed challenges.

Three crosscutting themes arise from the research:

THE CONTINUED IMPORTANCE OF HIGHER ORDERS OF GOVERNMENT

Successful collaborative governance depends on strategic support from higher orders of government. The NRTEE notes that stakeholders often perceive a lack of guidance and/or support from governments. This is particularly interesting given the high degree of variability with respect to provincial/federal involvement, financial support, and oversight across the country. A central theme is the alignment (or lack thereof) of municipal, regional, and provincial governments, collaborative watershed groups, and the public. Although focused on the watershed, collaborative water governance touches land use and other key planning processes, and cannot be conducted in isolation from them. When creating collaborative water governance partnerships, government agencies should remember that they must continue to play a key ongoing role.

THE IMPORTANCE OF RELATIONSHIPS

Building relationships and trust is central to the success of collaborative governance processes. Collaborative governance initiatives are both a space to build relationships, and entities dependent on these relationships. Their value is seen as being both formal (e.g., sharing data or holding regularly scheduled meetings) and informal (e.g., building friendships and understanding, knowing who to call with a question). This, in turn, highlights an important element of successful collaborative governance: sufficient time devoted to the process.

THE NEED FOR CAREFUL DESIGN OF COLLABORATIVE GOVERNANCE PROCESSES

Collaborative governance is a tool to be selected in particular situations, not a panacea for all water governance challenges. It is an excellent tool for conducting public outreach and education, for preventing potential conflict, and for bringing stakeholders together. On the other hand, collaborative governance initiatives need clear rules, guidance, and support from their respective provincial governments in order to "do their jobs well," and they are not a replacement for strong provincial leadership. In fact, collaborative governance "badly done" — i.e., without stakeholder or government support, in a conflict-ridden situation, or not in the "true spirit" of collaboration — has the potential to make things worse, not better.

RECOMMENDATIONS

- Governments should affirm the legitimacy of collaborative water governance and demonstrate that collaborative governance bodies have an important role to play. If governments choose to invest in collaborative processes, they must act on the recommendations provided by the collaborative process as much as possible and commit to provide formal feedback to the group when recommendations are ignored. Otherwise, participants from the natural resource sectors will lose confidence and leave the process, given the significant time and financial commitment for them.

- Governments must recognize that collaborative water governance structures require clear roles and responsibilities and well-defined accountability rules. Most people and organizations involved in collaborative water governance across Canada, including the natural resource sectors, believe that there is insufficient clarity about authority and accountability for decision making within the current frameworks. As a minimum, the Terms of Reference for the collaborative processes require a written description of roles and responsibilities. A more formal document would strengthen the accountability, and in some cases, governments may want to enshrine the governance structure into a new piece of legislation.

- Collaborative water governance processes should be developed and implemented in a coordinated manner with other planning processes and policies. Water governance is not only about water and cannot take place in isolation from other planning processes affecting and involving the natural resource sectors, such as municipal land use planning or forest management plans. As these processes operate at various scales and involve several orders of governments, policy alignment will require coordination between a number of governmental and non-governmental organizations.

- Governments should provide incentives for participation. Effective collaborative water governance requires the involvement of a broad range of stakeholders, including the major water users in the natural resources sectors. For collaborative water governance processes to become operating concerns in the natural resources sectors (rather than optional activities), government must identify them as a priority. This could be done by making participation mandatory, through regulation or as a condition of water licences.

FUTURE AREAS OF POLICY RESEARCH

In conducting our research, experts and stakeholders brought forward many issues related to water use by the natural resource sectors, of both a quantitative and qualitative nature. It is worth noting some of these issues, and pointing out that the NRTEE recommends that they should be further investigated as Canada continues to develop its natural resource sectors.

EFFECTS ON WATER QUALITY AS A RESULT OF NATURAL RESOURCE DEVELOPMENT

Most, if not all, of the natural resource sectors have some potential effect on the quality of the water they use in their production and operational activities. While some of these effects are well understood, emerging sectors, such as shale gas, are not well understood in the Canadian context and need to be assessed further.

UNDERSTANDING OUR GROUNDWATER

While the NRTEE's research focused on surface water resources, we recognize the inherent link between many of Canada's surface waters and groundwater. Our recommendations regarding the need for improved data and information of surface water extends to that of our groundwater resources. The NRTEE recommends that governments continue to prioritize the mapping of Canada's aquifers in an attempt to better understand the groundwater supplies and the withdrawals that are taken from these sources.

WATER-ENERGY NEXUS

Through our investigation of water use by the natural resource sectors, it has become apparent that the relationship between water and energy is very important. As we noted in our first report *Changing Currents*, this linkage warrants further detailed analysis in Canada, especially as policies are developed for energy, water, and greenhouse gas reductions. A better understanding of these linkages will lead to more effective policy development.

CHAPTER NINE

APPENDICES

CONTENTS

APPENDIX 1: NRTEE EXPERT ADVISORY COMMITTEE MEMBERS

ACADEMIC

Zafar Adeel
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GOVERNMENT

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Michael Keenan
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John MacQuarrie
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Prince Edward Island Ministry of the Environment, Energy, and Forestry

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INDUSTRY

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NON-GOVERNMENT ORGANIZATIONS

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Polis Project on Ecological Governance

David Brooks
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Polis Project on Ecological Governance

Mike Kelly
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Chair, Bow River Basin Council

David Marshall
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Bob Sandford
Chair, Canadian Partnership Initiative, United Nations, Water for Life Decade; Director, Western Watersheds Climate Research Collaborative

APPENDIX 2: GLOSSARY

ADAPTIVE MANAGEMENT	The process of continually incorporating newly gained knowledge or information into decision making.[62]
COLLABORATIVE WATER GOVERNANCE	The involvement of non-state actors in decision-making for water management.[63]
RECIRCULATED WATER = WATER RECIRCULATION OR RECYCLING	Water that is used more than once, often for different processes. Recirculated water can also refer to water that leaves a particular process and then re-enters that same process, including water that is discharged to a cooling pond and is later reused. Water recirculation and total water intake form the gross water use of an establishment.
WATER AVAILABILITY	The volume of water in the rivers and water bodies that can be accessed for use.
WATER CONSERVATION	Any beneficial reduction in water use, loss, or waste. Often includes water-management practices that improve the use of water resources to benefit people or the environment.[64]
WATER CONSUMPTION	The water lost in the production process. In other words, consumed water is not returned to its original source. Water is consumed via evaporation (escaped steam in industry or evapotranspiration in agriculture) or when it is incorporated into a product.
WATER DISCHARGE = WASTEWATER, EFFLUENT	The water returned to the environment in liquid form, usually close to the point of use. Total water intake is equal to the sum of its consumption and discharge.
WATER EFFICIENCY	The amount of water used per unit of any given activity.
WATER GOVERNANCE	The processes and institutions through which decisions are made about water.[65]
WATER INTAKE	The total amount of water extracted for use in an establishment or industry. The water may come from natural systems or from municipal or other sources.
WATER MANAGEMENT	The operational, on-the-ground activity to regulate the water resource and the conditions of its use.[66]
WATER-USE INTENSITY	Water intake per dollar of production.

APPENDIX 3: THE MODEL AND ASSUMPTIONS

THE MODEL: CIMS

The NRTEE uses a macroeconomic model of the Canadian economy to assess the potential of water pricing to improve efficiency and conservation and to estimate the impact of the pricing on industry. This model balances supply and demand for commodities and services in all markets, ensures that no sectors make excess profits, and balances incomes and expenditures of all "agents" in the economy by solving for a combination of prices and activity levels that are consistent with this equilibrium. The model contains the economies of British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Québec, Atlantic Canada, and the United States as separate regions, and each of these regions interact through trade of commodities and services. Commodities can be sold to other producers (as intermediate inputs), to final consumers, or to other regions and the rest of the world as exports. Commodities can also be imported from other regions or the rest of the world.

The water-use intensities discussed in Chapter 3 are also added to the model to develop the 2030 water use in each sector. Each of the sectors represented in the model uses different processes and technologies to combine a unique set of inputs into a unique set of outputs, contained in the integrated set of economic and physical (water, GHGs, etc.) accounts.

The cost imposed on a sector by a policy such as water pricing depends on the ability of the processes and technology to adapt to this policy. Economists represent the technology that a firm uses to transform inputs (like capital, labour, energy, and water) into output by a production function. A production function captures the relative amounts of all inputs that are required to make a unit of output, and also captures the substitutability (e.g., water intake for recirculation) or complementarity (energy and water intake) between pairs of inputs. Understanding these relationships in the case of water has proven challenging with relatively few studies that estimate production functions including water as a separate input. Still, workable estimates were acquired and used in the model to construct production functions for the sectors to assess the percentage change in water demand associated with water price increases.

FORECAST ASSUMPTIONS, CAVEATS, AND FUTURE RESEARCH

The NRTEE water forecasts and water pricing are firsts for Canada. Being on the forefront of water-policy analysis necessarily means there are caveats worth noting. While we have used high-quality data from Statistics Canada on both water use in the industrial sector and the structure of the Canadian economy, data limitations remain. Similarly, the economic model we used is based on sound economic theory and accepted in policy circles across Canada, but there are limitations.

Several limitations of this new field of research are noted here, mostly related to availability of data. Further study in the following areas would improve the state of knowledge in this relatively uncharted field of research:

- **Water-use intensity growth rates were estimated based on historical trends.** Historical trends may not necessarily hold in the future. Input from industry representatives or the linking of these trends to the factors causing them may make these forecasts more accurate.

- **National water-use data were used in this study.** Water-use and water-cost data for Canada's natural resource sectors was only available at a national level. To produce regional water-use estimates, the national data was disaggregated using regional output. This disaggregation implies that the structure of water use in each sector is the same across Canada. Using water-use data for each sector and region would more accurately represent water use and the impact that placing a price on water would have on each region of Canada.

- **Cost data was not available for all sectors.** Statistic's Canada's *Industrial Water Use Survey* collects data for several sectors including mining, manufacturing, and oil and gas, which was used in this study. However, we were unable to obtain data on the cost of water in the agriculture and oil and gas sectors. Therefore, we assume that the average cost of operation and maintenance as well as intake, recirculation, and discharge treatment are similar in the agriculture and oil and gas sectors (where applicable) to the average of the mining and manufacturing sectors.

- **Data on the elasticity of water demand was derived mainly from the manufacturing sector.** Most of the data on the elasticity of water use was limited to the manufacturing sector. Based on this limited data set, we assumed an average demand elasticity of -0.45 for the manufacturing, mining, and oil and gas sectors. We also assumed a fixed coefficient for the animal production and thermal electric power generation. In particular, further research should be performed on the thermal electric power generation because, due to its high water use and low water, water-use reductions appear to be less expensive than they likely are.

- **Cost data was disaggregated into capital, labour, energy, and materials costs.** The cost information derived from Statistic's Canada's *Industrial Water Use Survey* did not break down the cost into labour, energy, or material costs and did not include the capital cost of equipment required to pump water. Therefore, a capital cost was added to Statistics Canada's estimates and assumed the following breakdown of costs for water use (based on the average input structure of Canadian industrial sectors): capital is 25% of inputs, labour is 26%, energy in 5%, and material inputs make up 44% of the cost for pumping and treating water.

- **In the model we assume that all revenues generated from a commodity price on water are returned to the government.** Further modelling could be undertaken to assess the impact that different revenue recycling schemes may have on each sector's gross domestic product and the Canadian economy.

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