Environment Canada Environnement Canada

Canada Water Act

Annual Report

for April 2010 to March 2011

Canada

Canada Water Act

Annual Report

for April 2010 to March 2011

Print version
Cat. No.: En1-20/2011
ISSN 0227-4787

PDF version
Cat. No.: En1-20/2011E-PDF
ISSN 1912-2179

Website: www.ec.gc.ca/eau-water

Aussi disponible en français

Foreword

The *Canada Water Act*, proclaimed on September 30, 1970, provides the framework for cooperation with the provinces and territories in the conservation, development and use of Canada's water resources. Section 38 requires that a report on operations under the Act be laid before Parliament after the end of each fiscal year. This annual report covers progress on these activities from April 1, 2010, to March 31, 2011.

The report describes a wide range of federal activities conducted under the authority of the Act, including participation in federal–provincial/territorial agreements and undertakings, significant water research, and public information programs. A map depicting Canada's major drainage areas and drainage flows is provided in Figure 1.

Provisions of the *Canada Water Act*

The following is a summary of the major provisions of the Act:

Part I, section 4, provides for the establishment of federal–provincial arrangements for water resource matters. **Sections 5**, **6 and 8** provide the vehicle for co-operative agreements with the provinces to develop and implement plans for the management of water resources. **Section 7** enables the Minister, either directly or in co operation with any provincial government, institution or person, to conduct research, collect data and establish inventories associated with water resources.

Part II provides for federal–provincial management agreements where water quality has become a matter of urgent national concern. It permits the joint establishment and use of federal or provincial incorporated agencies to plan and implement approved water quality management programs. The application of alternative co-operative approaches and programs has resulted in **Part II** never having been used.

Part III, which provided for regulating the concentration of nutrients in cleaning agents and water conditioners, has been repealed. It was incorporated into the *Canadian Environmental Protection Act* in 1988 and later into sections 116–119 (Part VII, Division I) of the *Canadian Environmental Protection Act, 1999*, which came into force on March 31, 2000. (See the *Canadian Environmental Protection Act, 1999* annual reports to Parliament, available at www.ec.gc.ca/CEPARegistry/gene_info.)

Part IV contains provisions for the general administration of the Act, including annual reporting to Parliament. In addition, **Part IV** provides for inspection and enforcement, allows the Minister to establish advisory committees, and permits the Minister, either directly or in cooperation with any government, institution or person, to undertake public information programs.

Figure 1: Major drainage areas and drainage flows in Canada

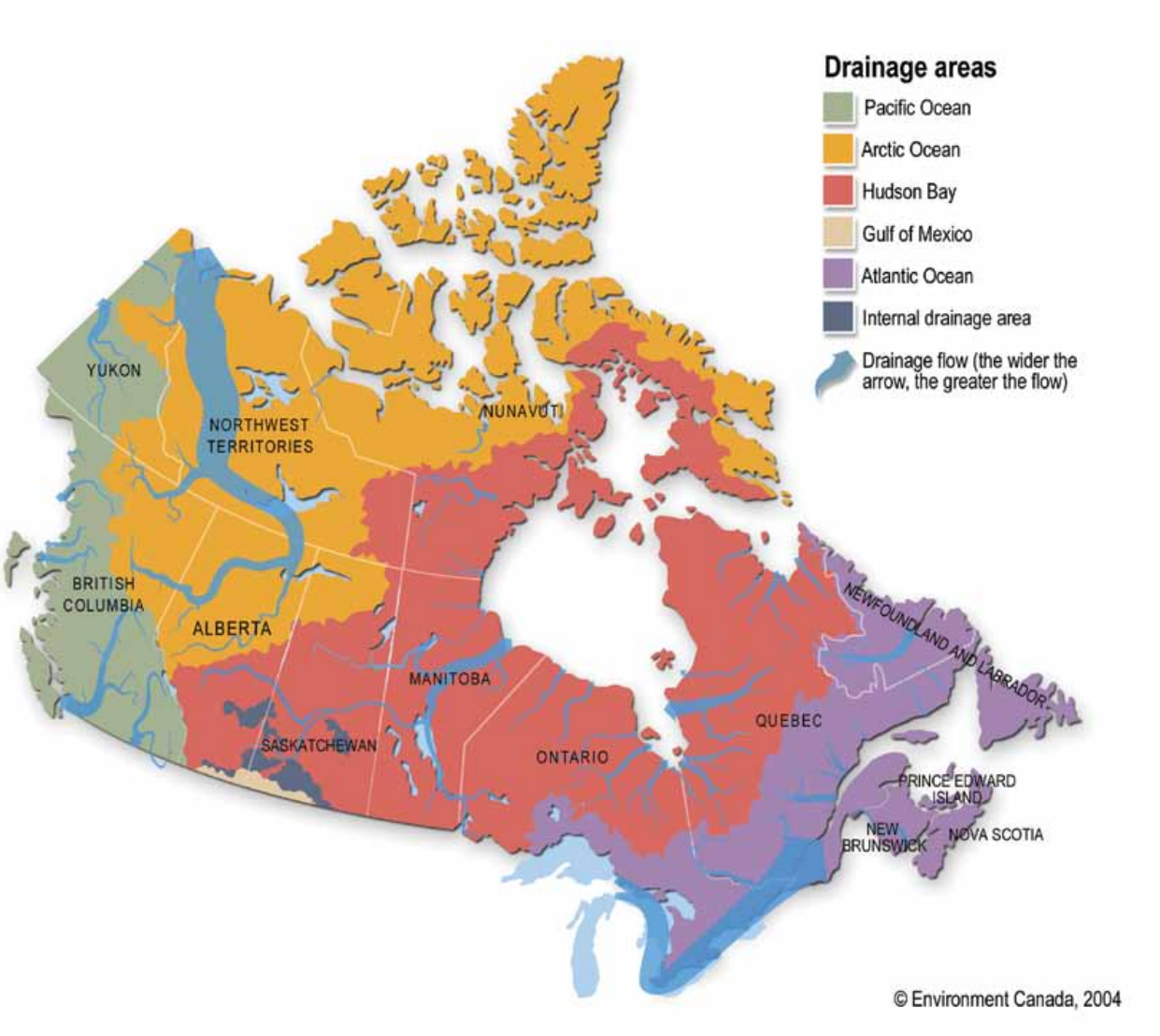


Table of Contents

Executive summary ..... **vi**

COMPREHENSIVE WATER RESOURCE MANAGEMENT
(Part I of the *Canada Water Act*) **1**

1 Federal-provincial/territorial programs **1**
1.1 Data collection and use 1
1.1.1 The National Hydrometric Program 2
1.1.2 Water use and supply 6
1.1.3 Water quality 10
1.1.4 Canadian Environmental Sustainability Indicators (CESI) 14
1.2 Inter-jurisdictional water boards 15
1.2.1 Ottawa River Regulation Planning Board 15
1.2.2 Prairie Provinces Water Board 16
1.2.3 Mackenzie River Basin Board 17
1.2.4 Lake of the Woods Control Board 18
1.3 Partnership-based ecosystem approaches 19
1.3.1 Ecosystem Initiatives 19
1.3.2 Other partnership-based ecosystem approaches and activities 30
1.3.3 Action Plan for Clean Water 32

2 Water research **35**
2.1 Wastewater 35
2.1.1 Wastewater treatment technologies 36
2.2 Pathogens and parasites 37
2.3 Algal blooms and health of the aquatic ecosystem 37
2.4 Agricultural and industrial runoff 37
2.5 Oil sands–related research 38
2.6 Northern Canada 39
2.7 Hydro-meteorological modelling and prediction 40

PUBLIC INFORMATION PROGRAM
(Part IV of the *Canada Water Act*) **42**
1 Environment Canada's Water Website 42
2 Biosphère Environment Museum 42
3 WaterSense partnership 43

Appendix A: Agreements **44**

Figure 1: Major drainage areas and drainage flows in Canada iv
Figure 2: National Hydrometric Monitoring Network 3
Figure 3: Water Availability Indicator for 2005 8
Figure 4: Water Availability Indicator for 2007 9
Figure 5: Water Availability Indicator based on the 30-year long-term yearly average water supply 9
Figure 6: CABIN network stations by year 11
Figure 7: Water quality indicator ratings by land-use category, 2006–2008 15
Figure 8: Prairie Provinces Water Board water quantity and quality monitoring stations and basins 16

Executive summary

The *Canada Water Act* provides an enabling framework for joint consultation and partnering among the federal and provincial/territorial governments in matters relating to water resources. This annual report on the *Canada Water Act* highlights Environment Canada's activities under the Act from April 1, 2010, to March 31, 2011.

The fall 2010 report of the Commissioner of the Environment and Sustainable Development (CESD) included the findings of an audit of Environment Canada's water monitoring resources. The Department has put in place an action plan to fulfill its commitment to meet the recommendations presented in the report.

Hydrometric agreements have been administered as cooperative endeavours between most provincial governments and the federal government since 1975. These agreements provide for the collection, analysis, interpretation and dissemination of water quantity data. During 2010–2011, Environment Canada's Water Survey of Canada (WSC), the federal partner in the National Hydrometric Program, continued to operate 2300 hydrometric stations in Canada, of which approximately 1000 are federal stations; the remaining stations are operated on behalf of the provincial and territorial partners. There were no significant changes to the size of the national hydrometric network, although the network did undergo some adjustments. Work also continued on outreach, technology development and maintaining the program's International Organization for Standardization (ISO) certification. Notably, the Department launched its Wateroffice website (www.wateroffice.ec.gc.ca), which provides public access to real-time hydrometric data. In 2010–2011, the WSC continued to provide assistance during flood events, many of which occurred as a result of extreme weather conditions such as heavy rains.

The Okanagan Basin Water Supply and Demand Project continued to evaluate present and future water needs and availability, which included assessing the effects of climate change impacts, population growth and water conservation measures.

The Water Availability Indicator was developed by a federal interdepartmental working group, led by Environment Canada, to describe water availability across the country. The first nationwide results of the initiative, released in 2010–2011, indicate that the overall threat to water availability is low across the country; however, in some areas, such as the Okanagan Valley, the southern Prairies and southwestern Ontario, water availability is a concern.

Environment Canada collaborated on water quality monitoring under agreements with British Columbia, Manitoba, New Brunswick, Newfoundland and Labrador, and Prince Edward Island. Cooperative water quality monitoring in Quebec is conducted through mechanisms similar to those used in the St. Lawrence Plan (terminated in March 2010, but a new plan was under negotiation as of publication of this report). In 2010–2011, measurements at numerous water quality monitoring stations for groundwater, inland freshwater and transboundary waters were used to assess and report on status and trends, and to evaluate the progress of protection and remediation programs. Benthic and aquatic habitat monitoring was also undertaken as part of the Canadian Aquatic Biomonitoring Network, which provides a nationally standardized protocol for the collection, identification and reporting of data.

Federal–provincial/territorial water quality data, as well as data from numerous other federal sites, contribute to the calculation of the Water Quality Index, which the federal government publishes as one of the Canadian Environmental Sustainability Indicators (CESI). The 2010 CESI report is based on data collected from 2006 to 2008. Freshwater quality measured at 176 river stations across Canada was rated as "good" or "excellent" at 42% of sites, "fair" at 40%, and "marginal" or "poor" at 18%.

This report includes summaries of the 2010–2011 activities of four inter-jurisdictional water boards: the Ottawa River Regulation Planning Board, the Prairie Provinces Water Board, the Mackenzie River Basin

Board, and the Lake of the Woods Control Board. These boards tailored their activities to the needs in each region. These activities address issues such as the integrated management of reservoirs, flood protection, transboundary apportionment, water quality, relations between adjoining jurisdictions and development activities.

The report also describes a variety of partnership-based, ecosystem approaches through which Environment Canada works to ensure that Canadians have access to clean, safe and healthy water, and that the country's water resources are used wisely, both economically and ecologically. These approaches include three ecosystem initiatives (Great Lakes Program, St. Lawrence Plan, and Atlantic Ecosystem Initiatives), the Action Plan for Clean Water, and the Memorandum of Understanding on Environmental Cooperation in Atlantic Canada.

In 2010–2011 the governments of Canada and Ontario extended the Canada–Ontario Agreement to June 2012, and added six new commitments to maintain momentum on the restoration, protection and conservation of the Great Lakes, while negotiations proceed between the federal governments of Canada and the United States to amend and strengthen the Great Lakes Water Quality Agreement. The Canadian Federal Great Lakes Program, a partnership of federal departments, provides the framework for working toward Canada's commitments under the Great Lakes Water Quality Agreement. Canada's activities are integrated with those of Ontario through the Canada–Ontario Agreement Respecting the Great Lakes Basin Ecosystem, which outlines how the two governments will cooperate and coordinate their efforts to restore, protect and conserve the Great Lakes Basin ecosystem. Highlights of actions in 2010–2011 include a wide range of research, monitoring and restoration projects in Great Lakes Areas of Concern through the Great Lakes Action Plan and the Cooperative Science and Monitoring Initiative; projects to reduce the amount of nutrients, solids and bacteria entering watercourses; and research in support of Canada–U.S. Lakewide Management Plans.

The St. Lawrence Plan, initiated in 1988, is a Canada–Quebec Ecosystem Initiative to protect, conserve and restore the St. Lawrence River ecosystem. The 2005–2010 Canada–Quebec Agreement on the St. Lawrence signed between the federal government and the Province of Quebec ended on March 31, 2010. The Government of Canada has since been negotiating with the Government of Quebec to define the terms of a new agreement. Although 2010–2011 was a transitional year, given that the previous agreement has expired and a new agreement is being negotiated, a network of governmental and non-governmental partners pursued various programs, such as the Priority Intervention Zone (ZIP) Program, the Community Interaction Program, and the Monitoring the State of the St. Lawrence River Program, and a number of activities such as monitoring shore erosion and invasive alien species, restoring and improving wetlands, and publishing fact sheets and reports on the health of the St. Lawrence ecosystem.

The Atlantic Ecosystem Initiatives implements an ecosystem-based approach to environmental management through internal engagement, external engagement and the Atlantic Coastal Action Program, a unique community-based partnership program between Environment Canada and 16 multi-stakeholder community organizations and four regional coalitions in the Atlantic provinces. In 2010–2011, 34 projects, representing almost 65% of all projects under the Initiatives, dealt with water issues, including restoration, enhancement and improvement of water quality and watersheds through proactive activities such as environmental education and outreach, water quality monitoring and research and data collection.

In Environment Canada's regional offices, work is under way to coordinate the Department's intervention in priority ecosystems when neither formal agreements nor ecosystem initiatives exist. In the Pacific and Yukon Region, the Ecosystem Coordination Office works with the Okanagan Basin Water Board, a water governance body tasked with identifying and resolving critical water issues at the scale of the Okanagan watershed. Funding was also provided to the Squamish First Nation for the Coast Salish Gathering, the Burrard Inlet Environmental Action Program, and the Fraser River Estuary Management Program.

The Memorandum of Understanding (MOU) on Environmental Cooperation in Atlantic Canada is a significant federal–provincial collaborative effort to preserve, protect and enhance the environment in Atlantic Canada. A Water Annex and associated work plan under the MOU were developed in 2010, and approved for implementation by the Management Steering Committee in November 2010. The purpose of the Water Annex Work Plan, which comprises 13 projects, is to facilitate increased cooperation and coordination among the parties in their efforts to understand and protect the water quality and ecological health of the Atlantic provinces, and to achieve the vision of healthy, prosperous and sustainable watersheds for present and future generations.

This report also describes Environment Canada's work under the federal government's Action Plan for Clean Water, which provides $96 million in cleanup funding to restore Lake Simcoe, Lake Winnipeg and Areas of Concern in the Great Lakes. In 2010–2011, projects funded in the Canadian Great Lakes Areas of Concern consisted of the implementation of remedial plans for contaminated sediment. The Lake Simcoe Clean-up Fund provided $8.3 million in 2010–2011 for 43 projects that focused on pollution reduction and the restoration of the lake's ecological integrity and cold-water fishery. Work under the four-year, $18-million Lake Winnipeg Basin Initiative (LWBI) in 2010–2011 included the signing of the Canada–Manitoba Memorandum of Understanding on Lake Winnipeg, initiation of several additional stewardship projects to reduce nutrients, and further implementation of research, information and monitoring activities under the LWBI science plan.

As part of its involvement in the Government of Canada's Health of the Oceans Initiative, Environment Canada received $8 million over five years (2007–2012). Of that, $0.75 million was designated to support activities aimed at maintaining and enhancing the environmental quality in the transboundary Gulf of Maine ecosystem. In 2010–2011, funding supported the Gulf of Maine Council on the Marine Environment and activities associated with its five-year action plan, which focus on protecting and restoring habitat, fostering environmental and human health, and supporting vibrant communities.

In 2010–2011, Environment Canada scientists carried out research projects on various current and emerging issues, including the following: testing new pollution-control methodologies; examining wastewater treatment technologies; assessing impacts of municipal wastewater effluents; determining factors controlling the extent of pathogens and parasites; quantifying the fate of agricultural and industrial runoff and assessing aquaculture impacts; investigating algal blooms and the health of aquatic ecosystems; examining water-related issues in northern Canada; and conducting hydro-meteorological modelling and prediction.

In response to the recommendations made by the federal Oil Sands Review Panel in its report to the Minister of the Environment in December 2010, the Government began developing a world-class environmental monitoring plan for the oil sands. The first phase of this plan was released in March 2011.

Environment Canada continued to provide water-related public information and water awareness activities through its Water website (www.ec.gc.ca/eau-water). In addition, the Biosphere Environment Museum (www.biosphere.ec.gc.ca) offered interactive exhibitions and guided activities designed to help visitors better understand major environmental issues, including those related to water. As well, Environment Canada has partnered with the U.S. Environmental Protection Agency to promote WaterSense, a voluntary, market-based partnership program that seeks to promote water efficiency and enhance the market for water-efficient products, programs and practices.

COMPREHENSIVE WATER RESOURCE MANAGEMENT

(Part I of the *Canada Water Act*)

1 Federal-provincial/ territorial programs

In Canada, each level of government has different jurisdictional roles related to the management of water resources. As well, there are many areas of shared commitment.

Canadian provinces and one of the territories (Yukon) have the primary jurisdiction over most areas of water management and protection. Most of these governments delegate some authority to municipalities, in particular drinking water treatment and distribution, and wastewater treatment operations in urban areas. They may also delegate some water resource management functions to local authorities that are responsible for a particular area or river basin.

The federal government has responsibilities for managing water on federal lands (e.g., national parks), federal facilities (e.g., office buildings, labs, penitentiaries, military bases), First Nations reserves, as well as two of Canada's three territories (Nunavut and the Northwest Territories).

The *Canada Water Act* provides an enabling framework for joint consultation among the federal and provincial/territorial governments in matters relating to water resources. Joint projects involve the regulation, apportionment, monitoring or survey of water resources, and the pre-planning, planning or implementation of sustainable water resource programs.

Agreements for specific water programs require participating governments to contribute funding, information and expertise in agreed ratios. For ongoing activities such as the water quantity survey agreements with each province, cost-sharing is in accordance with each party's need for the data. For study and planning agreements, the federal government and the specific provincial government each assume half of the costs. The planning studies encompass interprovincial, international or other water basins where federal interests are important. Implementation of planning recommendations occurs on a federal, provincial, and federal–provincial basis. Cost-sharing for the construction of works often includes a contribution from local governments. A list of current agreements can be found in Appendix A of this annual report.

This section describes federal, provincial and territorial collaboration in the following areas:

- data collection and use
- inter-jurisdictional water boards
- partnership-based ecosystem approaches

1.1 Data collection and use

On December 7, 2010, the Commissioner of the Environment and Sustainable Development (CESD) tabled his 2010 Fall Report, which included the findings of an audit of Environment Canada's water monitoring resources. Specifically, the CESD examined how the Department manages its Freshwater Quality Monitoring program and the National Hydrometric Program, and how it measures and reports on the programs' performance.

The report provides the CESD's recommendations to the Department for improving its management of these two programs, and includes Environment Canada's response to these recommendations. The report recommends that Environment Canada:

- work with other federal departments and authorities to determine where, on federal lands, water quality and quantity monitoring is needed, who will carry out the long-term monitoring at these locations, and to formalize arrangements to clarify roles and responsibilities for long-term water monitoring on federal lands;
- determine the optimum number of water monitoring stations across Canada and apply a risk-based approach to establish new monitoring stations;

- apply a quality assurance framework to assure that the data disseminated under the Freshwater Quality Monitoring program meet common quality standards across Canada and are fit for their intended uses;
- monitor a common set of core water quality parameters at each of its stations, and communicate variances from thresholds and trends so that appropriate actions can be taken in a timely manner; and
- apply a risk-based model to manage its water monitoring activities for each program by defining scope of responsibilities, identifying client needs and key risks, identifying performance gaps, establishing and ranking program priorities, and developing and implementing an action plan to close identified gaps.

Environment Canada accepted the recommendations of the report and has put in place an action plan to fulfill its commitment to meet these recommendations. The report, including the Department's responses, is available at www.oag-bvg.gc.ca/internet/English/parl_cesd_201012_e_34435.html.

1.1.1 The National Hydrometric Program

Background

Formal bilateral hydrometric agreements between most provincial/territorial governments and the federal government have been administered cooperatively since 1975. These agreements provide for the collection, analysis, interpretation and dissemination of water quantity data, to meet a wide range of needs in the hydrology community.

Under the Partnership Renewal Process initiative, government partners have been reviewing, updating and revising the 1975 bilateral agreements. New bilateral agreements have been signed between Canada and four provinces (Manitoba, Alberta, Quebec and Ontario), and by Aboriginal Affairs and Northern Development Canada on behalf of Nunavut and the Northwest Territories. Throughout 2010–2011, negotiations continued with the remaining provinces and territories, and a number of remaining bilateral agreements are expected to be signed in late 2011.

Progress to March 31, 2011

Governance

The National Hydrometric Program is co-managed by the National Administrators Table and the National Hydrometric Program Coordinators' Committee, which met regularly throughout 2010–2011 to discuss program issues. As part of their commitment to the principle of co-management under the National Hydrometric Program, a meeting was held between the two groups in September 2010 in Halifax, Nova Scotia. The National Administrators Table reviewed progress under the program's Strategic Framework, and considered the CESD's Water Monitoring Resources audit, which included a review of the National Hydrometric Program. Other agenda items included the hydrometric workstation implementation, the national costing model, and a review of hydrometric data and standards.

The Network

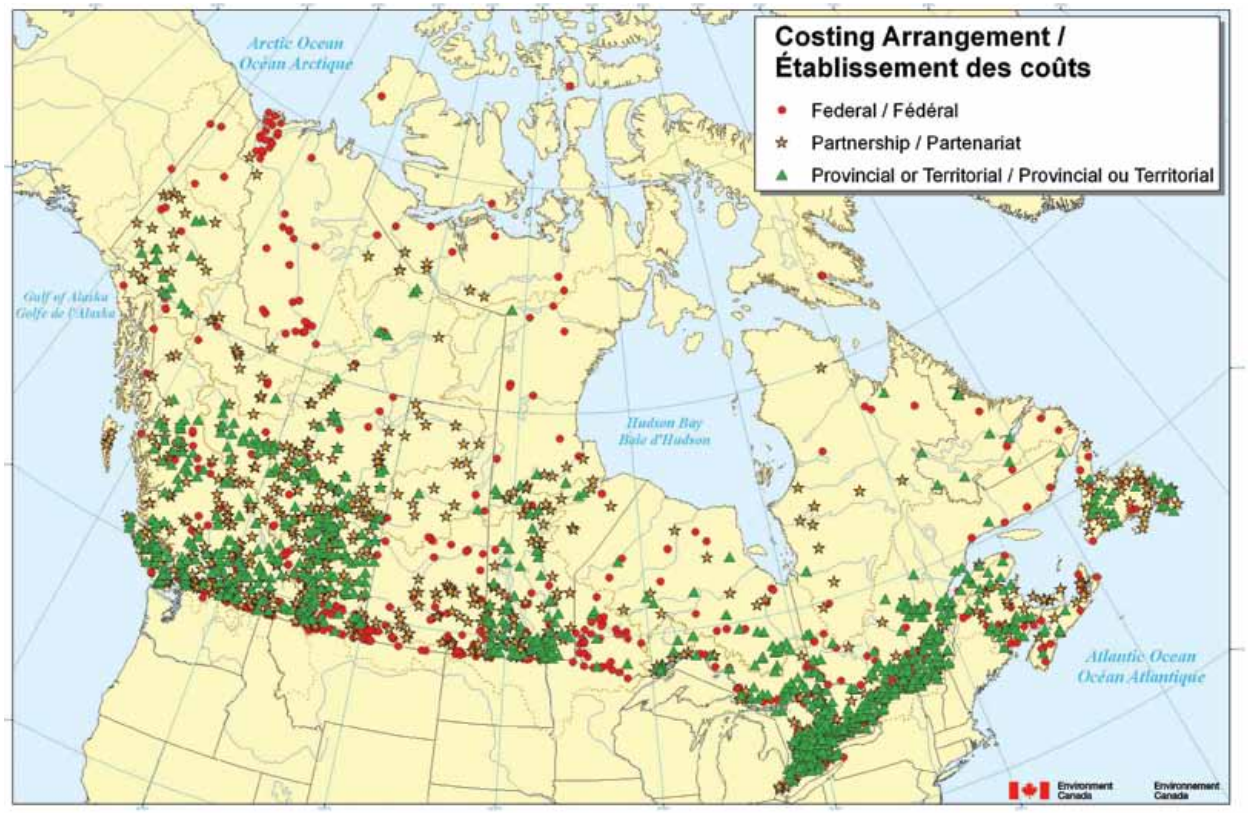
During 2010–2011, Environment Canada's Water Survey of Canada (WSC), the federal partner in the National Hydrometric Program, continued to operate 2300 hydrometric stations in Canada (see Figure 2), of which approximately 1000 are federal stations; the remaining stations are operated on behalf of the provincial and territorial partners. For the Province of Quebec, which is responsible for its own network, the ministère du Développement durable, de l'Environnement et des Parcs operated 200 hydrometric stations under the National Hydrometric Program.

In 2010–2011, there were no significant changes to the size of the national hydrometric network, although the network did undergo adjustments, including the following:

- In the Northwest Territories, four hydrometric gauging stations were constructed and activated on rivers flowing south into the East Arm of Great Slave Lake, on a full cost-recovery basis with the Northwest Territories Energy Corporation.
- In British Columbia, one station was added and seven stations were discontinued.
- In Alberta, 11 stations were discontinued, and Alberta Environment took over the operation of seven stations previously operated by the WSC on behalf of the Province.

- In Saskatchewan, three new stations were added under a service agreement with Agriculture and Agri-Food Canada, which fully funded these stations.
- In Manitoba, funding was committed in 2010–2011 for the addition of approximately 20 new stations to the network, and for the WSC to take over the operation of seven existing provincial stations. In addition, approximately 40 seasonal stations had their operational periods extended from three or four months to eight months.
- In northern Ontario, four new hydrometric stations were implemented. The Surface Water Monitoring Centre of the Ontario Ministry of Natural Resources used the network's real-time reporting hydrometric stations to track and report on water quantity conditions, including flood, high-flow and low-flow conditions.
- Also in Ontario, four new International Hydrometric Stations were implemented in cooperation with the U.S. Geological Survey, on the St. Marys River, St. Clair River, Detroit River and Niagara River. These stations provide key information on water quantity movement between the Great Lakes, and generate data that increase the accuracy of water balance calculations and hydrological modelling for Great Lakes water science, leading to improved system predictions.
- In Quebec, a hydrometric station that uses hydro-acoustic technology was deployed on the Ottawa River at Rigaud.
- Four new provincial stations were added in Newfoundland and Labrador. The stations are required by the Province to monitor the impact of new iron mining activity in the area.

Figure 2: National Hydrometric Monitoring Network



Outreach

In June 2010, the WSC participated in the annual Canadian Water Resources Association conference in Québec, to showcase the National Hydrometric Program and bring attention to its products and services. Feedback on the conference indicated that the information was well received and that participants gained a better understanding of the National Hydrometric Program and its products/services.

The WSC and science staff from Environment Canada's regional offices provided training to individuals, in a pre-conference course on the uses of specialized hydrological software developed in partnership with the Canadian Hydraulics Centre of the National Research Council. Additional training courses occurred throughout the year as part of the Department's commitment to the Improved Processes and Parameterization for Prediction in Cold Regions and International Polar Year research programs. This training involved introducing the hydrological community to Environment Canada's land-surface and hydrology coupled modelling platform. This platform is being operationalized within the context of the Meteorological Service of Canada's Numerical Weather Prediction program, and is the foundation for improved coupled atmospheric–hydrological modelling.

In 2010–2011, the WSC completed the transformation of its website (www.ec.gc.ca/rhc-wsc), and launched the WaterOffice portal (www.wateroffice.ec.gc.ca), which provides public access to real-time estimates of flow and water-level conditions at the majority of the hydrometric stations operated by the WSC.

Finally, the WSC successfully contributed to Environment Canada's Canadian Environmental Sustainability Indicators (CESI) program. A water-level indicator website was successfully launched by CESI in the summer of 2010, and flow indicators were developed and will be available on the CESI website (www.ec.gc.ca/indicateurs-indicators/default.asp) in the summer of 2011.

Technology

During 2010–2011, progress continued toward implementation of the Hydrometric Work Station, a tool that will manage the National Hydrometric Program's data production process. The customization of this software, so as to fully integrate the WSC's quality control processes, was completed, tested and evaluated. This involved consolidating the previous system of 17 national servers into two servers (Winnipeg and Toronto). This new system, which features enhanced production and enhanced real-time capability, has been designed and will be implemented to meet the National Hydrometric Program's performance and program objectives. Implementation of the Hydrometric Work Station, along with training of staff, is scheduled to begin in the spring/summer of 2011 and continue throughout the year.

The National Hydrometric Program continued to expand its installation, testing and implementation of new field technologies. The program also continued to certify field staff in the correct use of acoustic equipment, and to expand the use of this equipment for field measurements in all regions of Canada. As reported in 2009–2010, a majority of the field measurements were conducted using acoustic technologies, which provide data that are more reliable. In addition, a work group was established to implement the use of Acoustic Doppler Velocity Meter technology to measure flows. A strategy for rolling out the technology within the National Hydrometric Program will be examined.

ISO certification

The National Hydrometric Program continued to maintain its International Organization for Standardization (ISO) certification during 2010–2011, and several internal and external audits were performed at various offices throughout Canada as required under the ISO process.

Hydrological conditions and extreme events

Northwest Territories and Nunavut

For 2010, most of the Northwest Territories and Nunavut experienced the spring thaw (freshet) two to three weeks earlier than normal, followed by a summer with less than normal precipitation. Low summer precipitation was also experienced in northern British Columbia and Alberta, resulting in low flows in the Slave River, which is the major contributing inflow into Great Slave Lake. The low

inflow into Great Slave Lake resulted in low lake levels all summer, slightly above historic minimum values.

The Great Slave Lake's outflow is the Mackenzie River near Fort Providence, Northwest Territories, where a ferry crossing is the only highway link from the south to Yellowknife and other communities. As the mouth of the Mackenzie River was slightly restricted by ice and slush in November, the water levels on the Mackenzie River near Fort Providence dropped to the point where it was too shallow for the ferry to operate from November 15–28, resulting in shortages of fuel and food supplies in Yellowknife.

British Columbia

Significant precipitation in late September 2010 caused flooding of communities along the B.C. coast from northern Vancouver Island to Bella Coola. This flooding—the highest recorded, according to the 42 years of available historical data—led to the evacuation of the Aboriginal community of Kingcome Inlet (Dzaawada'enuxw First Nation) and major damage to local infrastructure. Highway 20, the main road link between Bella Coola and the B.C. interior, was also damaged, thereby isolating the community for several weeks. This flooding destroyed the Atnarko gauge and caused temporary failure of the Bella Coola gauge.

The Prairies

In mid to late June 2010, a significant rainfall occurred in southeastern Alberta, in the area east of Lethbridge to Medicine Hat and down to the Cypress Hills. Major flooding occurred in most tributaries to the Milk River and South Saskatchewan River basins, resulting in significant property damage and a temporary closure of the TransCanada highway between Medicine Hat and the Alberta–Saskatchewan border. Historical peak flows were experienced on most of the tributaries affected. Damage to WSC infrastructure during this event was minimal.

High snowfalls, combined with continuing above-normal soil moisture, produced high-flow conditions for the Red River in Manitoba and its tributaries in spring 2010 from March to late May. In the fall and winter, hydrological conditions led to significant concern in parts of the Prairies for high water and flows. The WSC began seeing significant flows, particularly along the Red and Assiniboine rivers, in early March 2011. As is always the case, the National Hydrometric Program's managers and technologists maintained close contact with and provided continuous water quantity information to the Manitoba Flood Forecast Centre during the spring period. The real-time network, which reports hourly on the hydrometric conditions for Manitoba, demonstrated the significant utility of this mode of operation for managing flood situations.

Ontario and Quebec

Diverse hydrological conditions were experienced throughout Ontario, including high-flow and low-flow conditions.

In Quebec, low amounts of snowfall, combined with relatively dry conditions in the spring in the Great Lakes Basin and the St. Lawrence River, resulted in lower than average water levels in the Montréal Archipelago, notably in the St. Lawrence River and the Milles-Îles River. High snowfall conditions in the Adirondacks during the winter of 2010 provided the conditions for exceptional flooding in the Richelieu River in the spring of 2011.

Atlantic provinces

In the Atlantic region, 2010 was a year of extreme hydrological events. For example, on August 24, the small remote community of Meat Cove in the northern Cape Breton Highlands was left stranded after a bridge on the only road reaching the community was washed away in a flash flood. A month later, on September 23, several hydrometric stations in southern and eastern Newfoundland were seriously affected by the high amount of precipitation associated with Hurricane Igor. Much of that portion of the province was flooded and several bridges and culverts were washed away, leaving many communities isolated for several days. This high-precipitation event washed out some hydrometric stations, while many others recorded record-high water levels and flows.

In early November, southwestern Nova Scotia experienced historical flooding due to another high-precipitation event. A longstanding bridge on the Tusket River washed away, and for a period of time there were concerns for a Nova Scotia Power

dam on the same river. This storm also produced record rainfalls in southeastern New Brunswick (Sussex and Fundy Park area), causing 30 roads to be closed or washed out in that region.

In mid-December, another downpour caused serious flooding in southwestern New Brunswick in the St. Croix and Magaguadavic watersheds. Several of the roads experienced washouts, and numerous homes, cottages and businesses were flooded. During this event, the WSC lost an international gauging station on a tributary of the St. Croix River (Forest City Stream), which was destroyed by a fire caused by an electrical short circuit.

1.1.2 Water use and supply

1.1.2.1 Okanagan Basin Water Supply and Demand Project

Background

Initiated in 2006, the Okanagan Basin Water Supply and Demand Project estimates present and future water needs and availability, to inform water management and planning decisions in the Okanagan Basin of British Columbia. This assessment uses available data on a multitude of relevant factors, including hydrology, climate and land use. The project also assesses the potential effects of climate change, regional growth and water conservation measures on water use and availability under different scenarios.

The Okanagan Basin Water Board currently leads the project in collaboration with British Columbia's Ministry of Environment, Ministry of Forest, Lands and Natural Resource Operations, and Ministry of Agriculture. Environment Canada, Agriculture and Agri-Food Canada, and Fisheries and Oceans Canada also participate in the project, along with the University of British Columbia (Okanagan), BC Agriculture Council, and several local and regional stakeholders.

Progress to March 31, 2011

Following completion of the Okanagan Water Supply and Demand Project Report in July 2010, the project has moved into Phase 3. This phase has thus far enabled better access to information gathered in previous phases of the project's Okanagan Basin Water Supply and Demand Study, and allowed for the continued refinement of water resource models. Additional modelling was completed on the potential effects of climate change, Mountain Pine Beetle outbreaks, water conservation, agricultural irrigation and population growth. The intention of Phase 3 is to ensure the best use of available information for planning, adaptation, education and improved water management in the Okanagan Basin. To help achieve these objectives, a public information Internet portal (Okanagan Water Supply and Demand Viewer) and a water-use reporting tool are being developed. A hydrologic connectivity study has also been undertaken to support drought planning and other water management decisions in the Okanagan Basin. Access to reports and project information is provided by the Okanagan Basin Water Board (www.obwb.ca), including a summary report of Phase 2 of the study and related water resource information.

In 2010–2011, Environment Canada began planning a field study of lake evaporation in the basin, using on-lake and shoreline meteorological studies to provide more accurate estimates of evaporative losses from the main Okanagan lakes. The Department also worked in partnership with Agriculture and Agri-Food Canada, the Okanagan Basin Water Board and the provincial government to expand groundwater monitoring in the Okanagan Basin.

1.1.2.2 Water Availability Indicator Initiative

Background

The sustainability of freshwater supplies is a growing concern worldwide. Pressures—including rapid urbanization, industrial expansion, agricultural intensification, and the impacts of climate change—stress water supply and affect the health of aquatic ecosystems. To ensure continued sustainability of freshwater for human use and ecosystem support, it is important to track the status of water availability in Canada.

Following a recommendation of the National Round Table on the Environment and the Economy,

a federal interdepartmental working group was established in 2006 in order to develop the Water Availability Indicator (WAI) to describe the availability of water across Canada. The working group, led by Environment Canada, included members from Statistics Canada, Natural Resources Canada, Fisheries and Oceans Canada, Agriculture and Agri-Food Canada, the Canadian Water Resources Association, and the International Institute for Sustainable Development.

The WAI is derived by calculating the ratio of water demand (the amount of water being used) to water availability (the volume of water in rivers) at the sub-drainage-area scale (representing 164 watersheds across Canada), on an annual basis. To calculate the ratio, a geographical information system is used to analyze water use data from several federal water use surveys and stream-flow values from the WSC's HYDAT stations. Other available sources of data are used for validation purposes.

The WAI is presented in maps and graphs to obtain a large-scale view of water availability across the country. As well, the indicator is intended to be regionally relevant. Sub-drainage areas that have existing or potential water scarcity problems, such as the southern Prairies, were the initial focus of the project. The first release of information from the WAI initiative was a case study, based on data from 2005 and 2007, in the mixed grasslands sub-drainage areas of southern Alberta and Saskatchewan, published in the *Canada Water Act Annual Report for April 2009 to March 2010*.

Progress to March 31, 2011

The first nationwide results of the initiative were released in 2010–2011. Data from the 2005 and 2007 survey years were used to produce WAIs, which were divided into four categories based on the Organisation for Economic Co-operation and Development (OECD) classification scheme:

- High (more than 40% of available water is used): severe water stress.
- Medium (between 20% and 40% of available water is used): both water supply and water demand need to be managed; conflicts among competing uses will need to be resolved.
- Moderate (between 10% and 20% of available water is used): water availability becomes a constraint on development; significant investment is needed to provide for adequate water supply.
- Low (less than 10% of available water is used): low water stress.

Northern Canada

In Northern Canada (Yukon, Northwest Territories, Nunavut, Labrador and northern parts of British Columbia, Alberta, Saskatchewan, Manitoba, Ontario and Quebec), some sub-drainage areas were merged for data analysis because of the low levels of human activity and the large surface water supply produced by the rivers. In this region, the WAI is below 10%, indicating that the threat to water availability is "low," and that there was ample water to meet needs. Because of extreme climatic conditions and the region's hydraulic regime (e.g., frozen streams), it was decided that the WAI initiative's methodology could not be applied to the extreme northern part of the country.

British Columbia

In British Columbia, the WAI is low (below 10%). The Okanagan Valley was evaluated at the sub-sub-drainage-area scale, since it is a region where water availability is a concern. The threat to water availability for this area is rated "medium" based on the OECD classification, indicating that water availability is a constraint on development, and significant investment is needed to provide adequate water supply to meet demand for the resource.

Prairie region

The southern part of the Prairies (Alberta, Saskatchewan and Manitoba) is a dry, arid area where low precipitation leads to a smaller water supply compared with other parts of the country. In this region, the agricultural and industrial sectors are large users of surface water, and as a result the indicator shows a moderate to high threat to water availability. For the northern part of the Prairies, WAIs are below 10%, indicating a low threat to water availability.

Ontario

In Ontario, the threat to water availability is high (WAI > 40%) in the urbanized southwestern part of the province, owing to heavy industrial and municipal water use and a low inland surface water supply. According to the OECD classification scheme, this region was under water stress during 2005 and 2007. In other parts of the province, the results of the indicator calculations show a low threat to water availability.

Quebec

In Quebec, the threat to water availability is considered low in most of the province, meaning that there was ample water during 2005 and 2007 to meet users' needs. Because of the lack of available historical data, water availability was not evaluated in the northern part of the province.

Atlantic region

In Atlantic Canada, the presence of large rivers and relatively low water demand means that the threat to water availability is ranked as being low (below 10%). This region has ample water to meet the different demands placed on the resource at the sub-drainage-area level.

Historical comparison

Annually, surface water supply changes based on climatic conditions, such as temperature, precipitation and humidity. This change in supply results in variations in the ratio of water demand to water availability from year to year. To compare the 2005 and 2007 WAI results to average values over time, a historical ratio was calculated. In calculating this ratio, yearly average surface water supply is based on a 30-year period (or on as many consecutive years for which data are available). For "water use," an average value for the survey years 2005 and 2007 was employed. Based on the resulting ratio, the majority of the sub-drainage areas remain in the same category of threat to water availability as they were in the 2005 and 2007 study period (see Figure 5). There are a few exceptions—specifically, in some sub-drainage areas in the southern part of the Prairies (e.g., the sub-drainage areas known as 05B-Bow, 05J-Qu'Appelle and 05M-Assiniboine). In these areas, the historical ratios indicate a higher threat to water availability than the 2005 and 2007 ratio values. This result indicates that the water supply was above the normal values for these sub-drainage areas in 2005 and 2007.

Figure 3: Water Availability Indicator for 2005

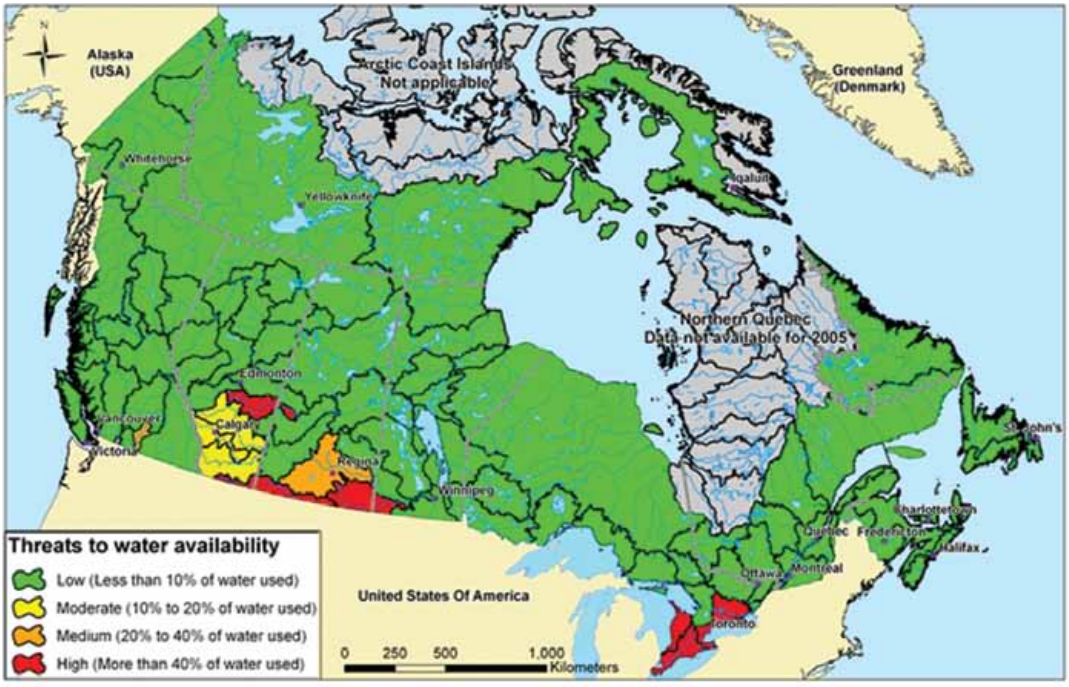


Figure 4: Water Availability Indicator for 2007

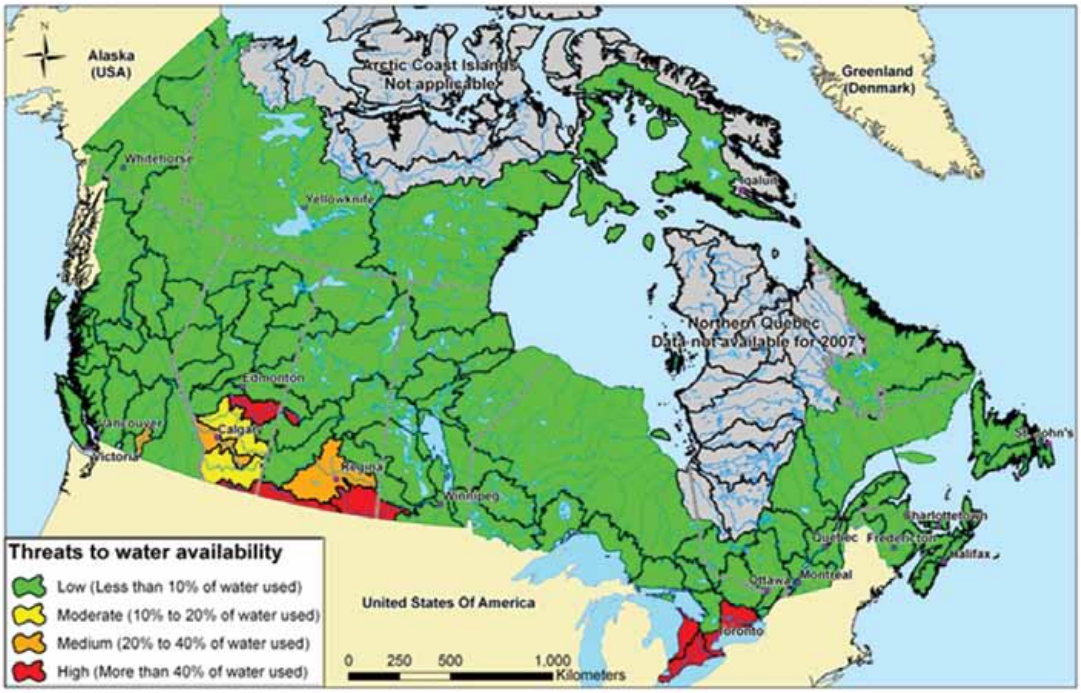
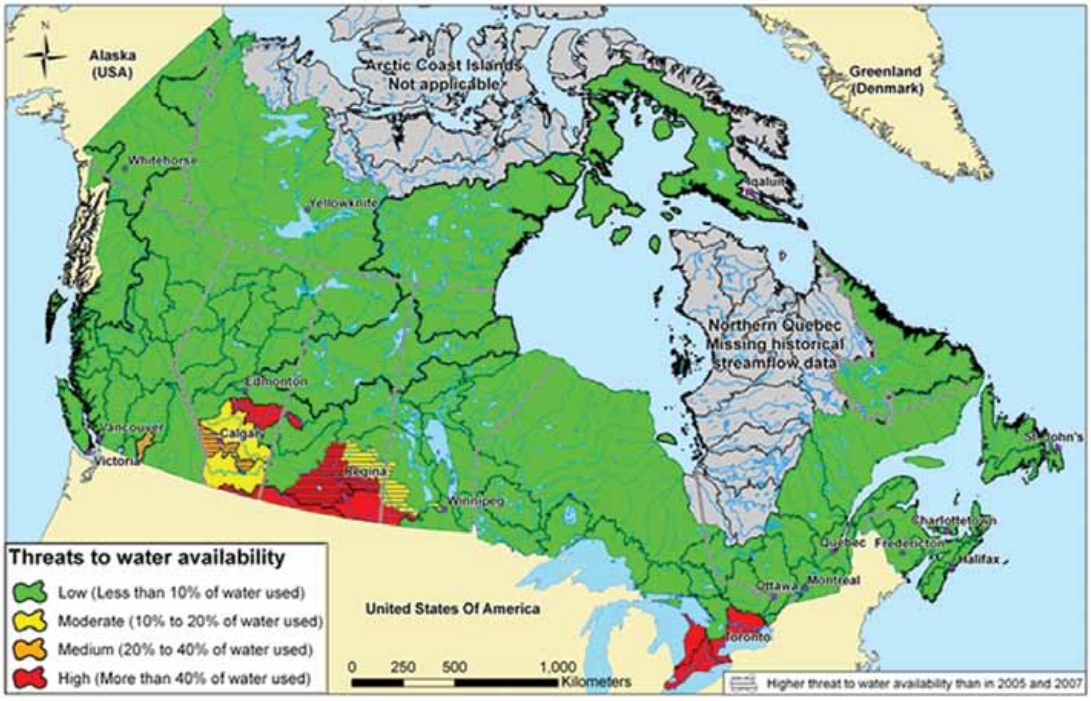


Figure 5: Water Availability Indicator based on the 30-year long-term yearly average water supply



1.1.3 Water quality

Background

Water quality monitoring has been a core program function of Environment Canada since the Department's inception in the early 1970s. The Department's activities in this area focus on the assessment and reporting on status, trends and surveillance, in fulfillment of many federal and international legislative obligations. Much of the Department's monitoring is carried out through federal-provincial agreements.

The objectives of federal-provincial water quality monitoring agreements are to achieve a long-term commitment for the acquisition of water quality data; obtain comparable, scientifically sound water quality data that are reliable for the purposes of water resource management; and disseminate timely information on water quality to the public, government agencies, industry and the scientific community. Five federal-provincial water quality monitoring agreements are currently active:

- the Canada–British Columbia Water Quality Monitoring Agreement, signed in 1985;
- the Canada–Manitoba Water Quality Monitoring Agreement, signed in 1988;
- the Canada–New Brunswick Water Quality Monitoring Agreement, signed in 1988 and harmonized in 1995;
- the Canada–Newfoundland Water Quality Monitoring Agreement, signed in 1986; and
- the Canada–Prince Edward Island Memorandum of Agreement (MOU) on Water, signed in 1989 and renewed in 2001.

Progress to March 31, 2011

National

Environment Canada's Freshwater Quality Monitoring Program (www.ec.gc.ca/eaudouce-freshwater) collected approximately 2300 samples at 343 sites, to meet the obligations outlined as part of five federal–provincial water quality agreements and the requirements of various interprovincial and international transboundary watershed boards (see section 1.2).

A national assessment of nutrient levels in Canadian watersheds conducted in 2010–2011 found that between 1990 and 2006, total phosphorus increased in 21% of sites, decreased in 31% of sites, and did not change in 48% of sites. Nearly a third of the sites had a high ratio of total dissolved phosphorus to total phosphorus, indicating that most of the phosphorus is dissolved and readily available for uptake by plants. Even though the natural levels of total phosphorus vary across the country, the impacts of excess nutrients, such as algal blooms, were apparent.

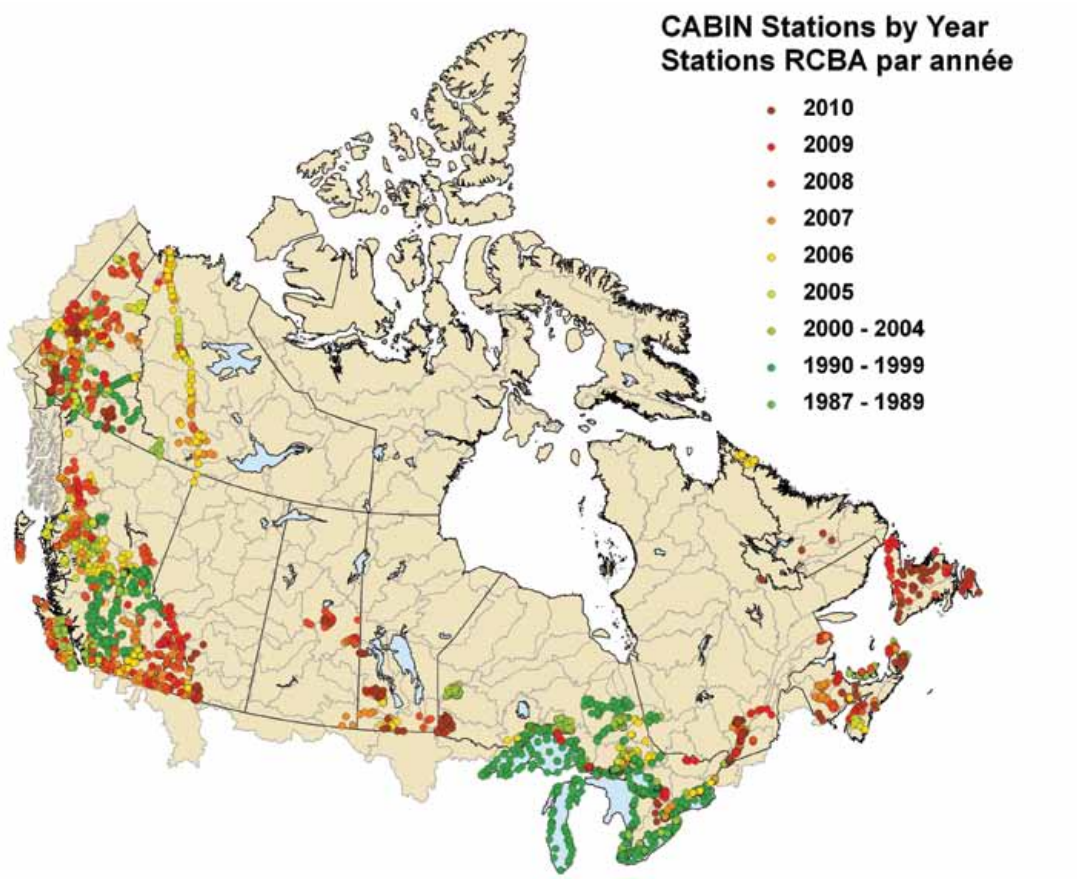
Samples of organisms from bottom sediments were collected in collaboration with provincial partners as well as federal partners such as the Parks Canada Agency, to help assess water quality status and trends. These data will enhance geographic coverage for most basins that have water-quality concerns in the Atlantic region, Yukon, British Columbia and Alberta, as well as for the Lake Winnipeg Basin and the Lake of the Woods.

CABIN

The biological health of freshwater in Canada is monitored through the Canadian Aquatic Biomonitoring Network (CABIN) (www.ec.gc.ca/rcba-cabin/), an aquatic biological monitoring program that assesses the health of freshwater ecosystems in Canada. CABIN is based on a network-of-networks approach that promotes inter-agency collaboration and data sharing to achieve consistent and comparable reporting on freshwater quality and aquatic ecosystem conditions in Canada. The program is maintained by Environment Canada to support the collection, assessment, reporting and distribution of biological monitoring information. CABIN allows partners to take their observations and make a formalized scientific assessment using nationally comparable standards. A set of national CABIN protocols is used for field collection, laboratory work and analysis of biological monitoring data. A training program is available to partners to increase bio-monitoring capacity nationally.

During 2010–2011, CABIN, in partnership with the Canadian Rivers Institute of the University of New Brunswick, continued to provide an online program that trains partners to implement the network's standardized protocol and to share resulting data within the national network. In addition, over

Figure 6: CABIN network stations by year



100 students from across the country participated in the online training course. In-person field certification courses were held in a number of cities across Canada. Additionally, the International Polar Year initiative continued to provide an opportunity to expand training in Canada's northern regions. As the number of CABIN-trained participants increases, the ability to generate new data and water quality assessments improves. In addition to sampling areas with upstream human activities, data were collected across the country at sites where anthropogenic effects are minimal, to build reference models that will be used to assess the biological health of freshwater bodies. Reference models for water quality assessment are available for Yukon, British Columbia and the Great Lakes. In 2010–2011, the Yukon River Basin model was updated (in partnership with Fisheries and Oceans Canada, the Government of Yukon, and the University of Western Ontario), the B.C. Coastal Model (in partnership with the B.C. Ministry of Environment) and the Okanagan–Columbia Basin Model (in partnership with the Parks Canada Agency and the B.C. Ministry of Environment) were completed, and the Atlantic model was initiated.

Since CABIN was implemented nationally in 2006, reference-site data have been collected in several sub-basins across the country. In 2010–2011, data were collected at 174 CABIN sites by Environment Canada and its partners (Figure 6), with the aim of building reference models and assessing water quality.

British Columbia and Yukon

Under the Canada–British Columbia Water Quality Monitoring Agreement, Environment Canada and the provincial Ministry of Environment jointly conducted water quality monitoring at 39 stream and river sites in British Columbia. As a result of cost efficiencies realized through a network review in 2009–2010, two new priority federal–provincial stations were

added to the network in March 2010. Data and information from all of these sites are available on the Freshwater Quality Monitoring section of the Environment Canada Water website. The majority of these sites are either transboundary, on significant tributaries to transboundary waterways, or important for other Environment Canada activities (e.g., United Nations Global Environmental Monitoring System [GEMS] stations, major fisheries rivers, sites on Canadian Heritage Rivers, sites monitored for pre- and post-Olympic 2010 impacts). Data from 22 of the 39 sites were included in the CESI core national network, and used to report on freshwater quality in the 2010 CESI report.

Through CABIN, biological sampling was also conducted at water quality sites partnered under the Canada–British Columbia Water Quality Monitoring Agreement. Four of the CABIN reference models referred to in the national summary are relevant to British Columbia, and are used in evaluating biological conditions at monitoring sites. Additionally, an in-depth water quality assessment report, combining physical–chemical and biological (CABIN) water quality information, was completed for 12 sites in the Georgia Basin.

Although the data generated under the Agreement are used by a range of clients and stakeholders for water resource management purposes, one particularly significant use in 2010–2011 was that of the Fraser River Basin data by the Cohen Commission (Inquiry into the Decline of Sockeye Salmon in the Fraser River; www.cohencommission.ca).

Environment Canada also operated eight long-term water quality monitoring sites in national parks, in partnership with the Parks Canada Agency (six in British Columbia and two in Yukon). These "pristine" sites provided important baseline information that is compared with data gathered at the network's "impacted" sites. Moreover, many of these "pristine" sites are in key locations for assessing climate change impacts.

An additional six stream and river sites are monitored in Yukon, primarily in collaboration with Environment Yukon. All of the sites are located on transboundary rivers or significant tributaries to transboundary waterways. Three of these sites are also part of the United Nations GEMS program, and four sites were included in the 2010 CESI report. A final draft of the Canada–Yukon Water Quality and Aquatic Ecosystem Monitoring and Reporting Memorandum of Agreement has been completed in order to formalize the Canada–Yukon monitoring partnership. The data generated under this partnership were used for the recent Yukon State of Environment Report.

Cooperative federal–provincial arrangements to test groundwater quality continued at several locations in British Columbia where groundwater monitoring wells have been installed through cost-sharing with the provincial government. A total of 12 monitoring wells are sampled on an annual basis, with 6 of these wells sampled on a monthly basis. This cooperative groundwater monitoring forms part of a larger Environment Canada groundwater monitoring network in the transboundary Abbotsford–Sumas aquifer, and supports groundwater research projects investigating the potential occurrence and persistence of nitrates, pathogenic bacteria and pesticides in groundwater. Additional cooperative groundwater monitoring is conducted on a semi-annual basis in the transboundary Osoyoos aquifer (southern Okanagan), where a combination of provincial and Environment Canada monitoring wells form the basis of the Environment Canada groundwater monitoring network for this transboundary area.

Manitoba

Water quality sampling continued at two sites identified as part of the Canada–Manitoba Water Quality Monitoring Agreement. The water quality station on the Red River at Emerson, which is located on the international boundary with the United States, supports the work of the International Red River Board. This station was upgraded to accommodate the installation of state-of-the-art automated monitoring equipment, and became fully operational in March 2011. The new structure continues to house the WSC's water-level monitoring equipment and data logger.

In 2010–2011, Manitoba and Environment Canada conducted joint sampling at 12 sites across the province to assess the effects of inter-agency variation in sampling and analytical procedures.

Following the announcement of the Lake Winnipeg Basin Initiative in 2007 (part of the federal government's Action Plan on Clean Water), a Canada–Manitoba MOU Respecting Lake

Winnipeg was signed by the respective ministers in September 2010 (see details under Lake Winnipeg Basin Initiative in section 1.3.3). The Canada–Manitoba Water Quality Agreement is being reviewed to assess its compatibility and consistency with this new MOU.

Quebec

In 2010–2011, Environment Canada operated 11 water quality sampling stations in Quebec as part of its water quality monitoring and surveillance activities. The sampling frequency varied from one–four times per month, depending on the season or the analyses being conducted for 150 different parameters, such as metals, nutrients and pesticides. Three of these stations are located at the mouth of the Yamaska, Saint-François and Nicolet rivers south of Lake Saint-Pierre, a designated Ramsar site (under the Convention on Wetlands of International Importance). The *Pesticides at the Mouths of Lake Saint-Pierre Tributaries (2003–2008)* report, published in 2011, revealed that atrazine and metolachlor were detected at the Yamaska River station.

The agreement with la Mauricie National Park was renewed so that sampling work could continue at the mouth of the Saint-Maurice River.

Water quality monitoring on the Ottawa River at Carillon continued through a renewed agreement with the Parks Canada Agency. As the St. Lawrence's main tributary, the Ottawa River can contribute up to 50% of the river's water supply during spring freshets. It therefore has a considerable impact on water quality in the St. Lawrence. Polybrominated diphenyl ethers (PBDEs) continued to be measured and analyzed in order to monitor the status and trends of these emerging contaminants in river water and sediment.

Environment Canada and Quebec's ministère du Développement durable, de l'Environnement et des Parcs continued to work toward formalizing an agreement on implementing a joint water quality monitoring network in Quebec. This federal–provincial agreement covers watercourses of federal interest under the Department's jurisdiction, including the St. Lawrence and Ottawa rivers, and eight watercourses that cross the Canada–U.S. border. Forty-two stations operated by the ministère du Développement durable, de l'Environnement et des Parcs were selected to become part of the network. Under the agreement, test samples will be taken monthly to monitor 14 physical and chemical parameters. Over half of these stations (23) will provide data to calculate the water quality indicator presented in the CESI report.

In 2010–2011, CABIN in Quebec comprised 60 stations, located along the St. Lawrence River (including at Lake Saint-Pierre) and in the Mauricie and Forillon national parks. Work related to the CABIN program focused on developing reference models for benthic communities.

The remote sensing water quality and cyanobacteria monitoring project was in its third year in 2010–2011. The research team and monitoring team continued to share knowledge. As well, the University of Sherbrooke participated in a water sampling campaign in Missisquoi Bay. The remote sensing imagery results highlighted this method's enormous potential as a tool for monitoring water quality in large and medium-size lakes.

A wealth of information generated by the Quebec water quality monitoring and surveillance team is posted in the St. Lawrence River section of the Environment Canada Water website (www.ec.gc.ca/stl/default.asp?lang=En&n=F46CF5F8-1). For example, the Geoinformation on the Environment, Integration and Exploration application allows users to explore environmental data linked to the program through an interactive mapping interface. Users can now also obtain interactive information on the geochemical and physical quality of sediment in the St. Lawrence River via the Geoinformation on Sediment database.

Atlantic provinces

Bilateral annual meetings were held by representatives for the Canada–New Brunswick, Canada–Prince Edward Island, and Canada–Newfoundland and Labrador water quality agreements, to discuss and review the previous year's accomplishments and to plan and prioritize workloads for cost-shared and work-shared projects. Most monitoring sites were used to report on water quality on federal lands or to report on freshwater quality in the 2010 CESI report.

In New Brunswick, 5 federally designated, 10 federally-provincially designated, and 47 provincially designated surface water quality stations were monitored under the federal-provincial agreement. Fifty-seven stations were used to report on freshwater quality in the CESI report. Three real-time water quality stations were operated on international rivers: two on the St. Croix River (at Milltown and Forest City) and one on a tributary of the Saint John River (at Tracey Mills on the Big Presqu'ile Stream). Two federal automated water quality monitoring stations were operated in partnership with Fisheries and Oceans Canada and National Defence on the Nerepis and Otnabog rivers in Canadian Forces Base Gagetown. Seven sites were monitored through the CABIN program by Environment Canada.

In Prince Edward Island, 28 water quality monitoring sites were sampled, including 4 groundwater stations, 10 marine or estuarine stations, and 14 freshwater streams. Data from 10 stream stations were used to report on freshwater quality in the CESI report. As well, three real-time water quality stations were active under a federal-provincial partnership, and seven sites were sampled under the CABIN program.

In Newfoundland and Labrador, 80 water quality sites continued to be sampled 4 to 6 times per year under the federal-provincial agreement. Seventy-one stations were used to report on freshwater quality in the CESI report. Twenty-seven real-time water quality stations were actively monitored; of these, 9 were part of the federal-provincial partnership, 16 were funded through a partnership with private industry and the province, and 2 were funded by the province. Thirty-six sites were monitored through the CABIN program under the water quality agreement.

In Nova Scotia, although no official water quality agreement exists between the federal government and provincial government, a network of 24 water quality monitoring stations continued to be operated by Environment Canada throughout the province, with assistance from Nova Scotia Environment. Data from 30 stations were used to report on freshwater quality in the CESI report. Two real-time water quality stations continued to operate—one on the Little Sackville River and another on the upper reaches of the Annapolis River. Three sites were sampled by Environment Canada and 8 were sampled by other partner organizations under the CABIN program.

Ontario, Saskatchewan and Alberta

A one-year agreement, signed between Environment Canada and Saskatchewan Environment and funded by the CESI program, supported ongoing data collection and analysis as well as water quality indicator calculation for Saskatchewan's growing network of water quality monitoring sites. Resources were also used to support a water quality network optimization study.

Ontario and Alberta have no formal agreements with the federal government to monitor the quality of inland waters, and most of the surface water monitoring for inland lakes and streams is performed by the provincial governments. These provinces contribute their water quality data to the CESI report. Environment Canada's water quality monitoring in these two provinces focuses on areas of federal jurisdiction, namely, the Great Lakes and Lake of the Woods in Ontario as well as interprovincial rivers.

1.1.4 Canadian Environmental Sustainability Indicators (CESI)

Background

Since 2005, the Government of Canada has published the CESI annual report (www.ec.gc.ca/indicateurs-indicators/default.asp), which provides indicators on the state of air and water quality, and on greenhouse gas emissions. Its water quality indicator uses the Water Quality Index, endorsed by the Canadian Council of Ministers of the Environment, to summarize the status of surface freshwater quality in Canada. Quality is assessed by examining the extent to which Water Quality Guidelines for the Protection of Aquatic Life (plants, invertebrates and fish) are being met at selected lake and river monitoring sites throughout Canada.

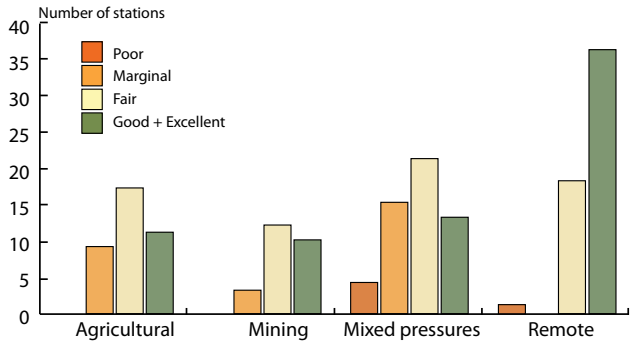
Progress to March 31, 2011

The 2010 CESI report, which was released in March 2011, is based on data collected from 2006–2008 from 348 water quality sites across Canada. For this

report, the national water quality indicator values were calculated using a core national network of 176 river stations. New river stations from the networks in Saskatchewan and Nova Scotia were incorporated this year, adding 21 stations to last year's core national network in order to enhance geographic coverage.

Water quality measured at these 176 river sites across Canada was rated "excellent" for the protection of aquatic life at 9 stations (5%), "good" at 64 stations (37%), "fair" at 71 stations (40%), "marginal" at 27 stations (15%), and "poor" at 5 stations (3%). Phosphorus levels had the greatest influence on ratings. A comparison between the freshwater quality indicators for 2005–2007 and 2006–2008 shows that 26 stations changed categories: at 15 stations, the water quality rating improved by one category; at 10 stations, the water quality rating declined by one category; and at one station, water quality declined by two categories.

Figure 7: Water quality indicator ratings by land-use category, 2006–2008



Note: Sites with more than 20% agricultural land in their upstream drainage areas are categorized as agricultural. Sites are designated as mixed pressures if they meet two or more of the following conditions: (1) population density is greater than 25 persons/km^2; (2) more than 10% is agricultural land; (3) there is at least one mine. Sites with at least one mine, and not meeting the previous population or agriculture conditions, were designated as mining. Remote sites are those with 95% undisturbed land. (Source: water quality data were assembled by Environment Canada from existing federal, provincial, territorial and joint water quality monitoring programs, and the analysis was provided by Environment Canada. Population, mining and land cover statistics for each station drainage area were provided by Statistics Canada.)

1.2 Inter-jurisdictional water boards

1.2.1 Ottawa River Regulation Planning Board

Background

In 1983, Canada, Quebec and Ontario concluded the Agreement Respecting Ottawa River Basin Regulation. Under its terms, a board was constituted to plan and recommend regulation criteria for the 13 principal reservoirs of the basin, taking into account flood protection, hydroelectric power production and other interests. Supported by a regulating committee and secretariat, the Ottawa River Regulation Planning Board endeavours to ensure that the integrated management of the reservoirs provides protection against flooding along the Ottawa River and its tributaries, and along its channels in the Montréal region.

Progress to March 31, 2011

In 2009–2010, a dry fall and a winter with less than normal snowfall and warmer temperatures than average presaged the stream flow conditions that followed during 2010.

The 2010 freshet was unique in many regards, beginning with the snow melt runoff being one of the earliest on record. The lack of winter snowfall was exacerbated by warm and windy conditions that resulted in a greater than usual amount of direct evaporation, or sublimation, from the snow on the ground. These factors resulted in runoff volumes that were 60–70% of recorded averages over the drainage basin. As a consequence, spring peak flows were much lower than average over the basin. The dry and warm meteorological conditions extended into the summer and fall of 2010, yielding close-to-record-drought conditions throughout most of the region.

The board supported a number of public information initiatives through the Ottawa River Regulation Secretariat. The secretariat, housed at Environment Canada, maintains a website (www.ottawariver.ca/emain.htm) and a recorded message on toll-free telephone services (in French and English), both of which provide information about water levels and flows at various locations in the basin.

The low water levels and the drought conditions generated a considerable amount of concern among the public, resulting in a high number of visits to the website (approximately 50 000), and approximately 1100 calls to the toll-free numbers. Secretariat personnel also participated in a number of radio and newspaper interviews.

The board met three times, in Ontario and Quebec. The agenda items and business considered by board members were standard issues, including current and planned projects along the Ottawa River, operation of the Regulating Committee and production of its annual report, secretariat operations, hydrological model review, mitigation measures that the board recommended to agencies to help alleviate the low water conditions, and correspondence and communications with organizations and the public.

1.2.2 Prairie Provinces Water Board

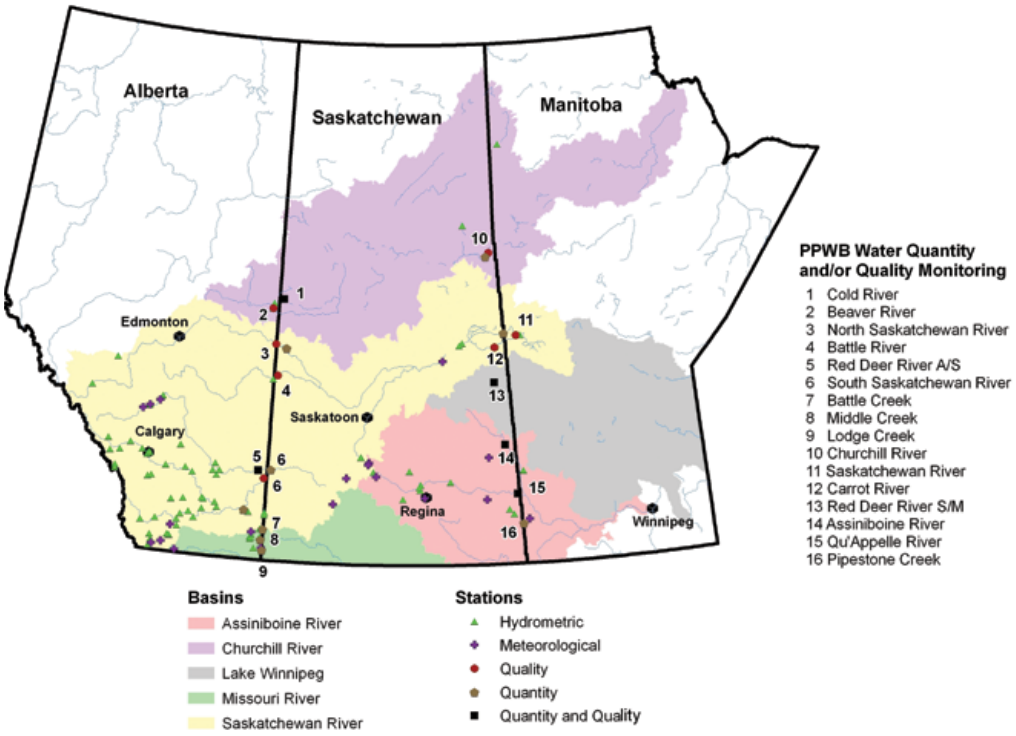
Background

In 1969, the governments of Canada, Alberta, Saskatchewan and Manitoba signed the Master Agreement on Apportionment, to facilitate the equitable apportionment and protection of eastward-flowing interprovincial rivers and streams, and groundwater, in terms of both quantity and quality of water. The agreement also fosters the cooperation of the parties in interprovincial water management (see www.ppwb.ca).

Schedules A and B to the Master Agreement provide mechanisms to apportion water, foster cooperation and resolve potential disputes between Alberta and Saskatchewan, and Saskatchewan and Manitoba, respectively. Schedule C establishes the Prairie Provinces Water Board to administer the provisions of the Master Agreement. Schedule E specifies water quality objectives in 11 river reaches along the Alberta–Saskatchewan and Saskatchewan–Manitoba boundaries, and further defines the water quality mandate of the board.

To meet the requirements of the Master Agreement, Environment Canada monitors stream flows, water quality and meteorological conditions on eastward-flowing streams on the provincial borders (see Figure 8). The board computes apportionable flows from water-use flows and meteorological information. Excursions to the Master Agreement's water quality objectives are calculated annually.

Figure 8: Prairie Provinces Water Board water quantity and quality monitoring stations and basins



Progress to March 31, 2011

Activities and accomplishments in 2010–2011 included the following:

- Apportionment requirements were met in the calendar year of 2010 on all eastward-flowing prairie streams.
- The board approved the hydrometric and meteorological monitoring station list for 2011–2012. Work continued on the modernization of the natural (apportionable) flow computation software programs. A project to review apportionment methods used in the basins on a 10-year rotational basis was initiated; review criteria are being developed using the North Saskatchewan River as a pilot.
- Work continued on the development of a groundwater schedule to the agreement. No groundwater concerns were identified by jurisdictions in 2010–2011. A database was compiled on historical water levels recorded in wells near the provincial borders.
- The board approved the 2011 water quality monitoring program and the 2010 Water Quality Excursion Report. Percent adherence to water quality objectives was very high (94%) for all rivers, such that water quality continues to be protected.
- A four-step process to review all water quality objectives for each of the 11 rivers continued, with a priority on nutrient objectives. Trend analysis was conducted for nutrients, ions and metals in all of the rivers.
- The board continued to exchange information on issues of common interest, including water quality issues related to Lake Winnipeg, Saskatchewan–Manitoba drainage issues, the Montana–Alberta St. Mary and Milk Rivers Water Management Initiative, and invasive species.
- The board published a report on irrigation return flows for the South Saskatchewan River, to assess whether irrigation monitoring stations in the Alberta Irrigation Districts could be used to compute apportionable flows. Further assessment is required.
- The board and each of its three standing committees on hydrology, water quality and groundwater held at least one meeting and additional conference calls.
- The board created a new website (www.ppwb.ca); the Secretariat responded to a number of public inquiries; and the board began updating its communications strategy.
- Member agencies were informed about board activities through distribution of minutes, quarterly reports and an annual report.

1.2.3 Mackenzie River Basin Board

Background

The governments of Canada, British Columbia, Alberta, Saskatchewan, the Northwest Territories and Yukon signed the Mackenzie River Basin Transboundary Waters Master Agreement in July 1997. The Master Agreement endorses the principle of managing water resources for future generations such that the ecological integrity of the aquatic ecosystem is maintained. It provides for early and effective consultation on potential developments and activities in the basin that could affect the integrity of the aquatic ecosystem. It also contains provisions for seven sets of bilateral agreements between adjacent jurisdictions in the basin.

The 13-member Mackenzie River Basin Board, which represents all parties to the Master Agreement, administers the provisions of the agreement. Federal members include representatives from Environment Canada, Aboriginal Affairs and Northern Development Canada, and Health Canada. The three provinces and two territories in the basin are represented by 10 members, including an appointee from provincial and territorial government water management agencies, and an Aboriginal board member nominated by Aboriginal organizations.

Under the Master Agreement, Environment Canada is responsible for managing the expenditures of the board, which are cost-shared equally by the parties. Shareable costs include the staffing and operation of the secretariat office in Yellowknife, Northwest Territories, to provide working-level support for the board. The Executive Director of the secretariat, hired by Environment Canada's Prairie and Northern Region, plans, directs and manages board operations.

Progress to March 31, 2011

Activities and accomplishments in 2010–2011 included the following:

- Board members met twice during the year and held four conference calls.
- The board developed and issued a contract for the second State of the Aquatic Ecosystem Report (SOAER 2010) to follow up on SOAER 2003. SOAERs are required every five years by the Master Agreement to evaluate the status of the basin's aquatic ecosystem. The 2010 report will focus on the impacts of oil sands, hydro power development and climate change, and on the integration of traditional knowledge and western scientific information. The report is expected to be released in the fall of 2011.
- The Mackenzie River Basin Board Technical Committee submitted its Recommendations Report to the board in December 2010. The Technical Committee found that the Mackenzie River Basin Hydrology Model can, at a basin scale, duplicate historic flows (including transboundary crossings), simulate flows where large-scale industrial water impacts were removed, evaluate the effects of past water resource developments, and predict and evaluate downstream changes in river flows due to future water management activities. The model cannot evaluate site-specific changes or impacts in small watersheds or short reaches of rivers, or evaluate water levels at specific locations in the basin. The Technical Committee recommended that further effort was required to make the model fully operational.
- Aboriginal board members reported that Aboriginal communities in the Mackenzie River Basin continue to be concerned about water quality and quantity. Most of the concerns raised by Aboriginal board members were related to the impacts of industrial oil sands mining on the lower Athabasca River, and the impacts of flow regulation by hydroelectric facilities on the Peace River.
- The Mackenzie River Basin Board Secretariat was fully staffed as of July 2010.
- The board made preparations to relocate the secretariat office from Fort Smith to Yellowknife as a cost-saving measure.
- Member jurisdictions continued to exchange information through agency reports.
- The board tracked the progress of British Columbia, Alberta, Saskatchewan, and the Northwest Territories as these jurisdictions gathered information and prepared to initiate bilateral water resource management negotiations in the Peace, Athabasca, and Slave River watersheds. The negotiations are expected to conclude by late 2012. These jurisdictions asked the secretariat to work with them to secure a facilitator in order to guide the negotiations.

1.2.4 Lake of the Woods Control Board

Background

The Lake of the Woods Control Board (LWCB) does not fall under the *Canada Water Act*, but it is included in this report to provide a more complete picture of federal-provincial water management in Canada.

The LWCB is a Canadian board consisting of four members, each with an alternate, who represent Canada (one member), Ontario (two members) and Manitoba (one member). Appointments are made by orders in council of the appropriate government, and each appointee must be a professional engineer. The LWCB, established in 1919, is responsible for the regulation of levels in Lake of the Woods and Lac Seul, and flows in the Winnipeg and English rivers downstream from these lakes to their junction. In addition, when the level of Lac Seul exceeds certain specified levels, the LWCB controls the diversion of water from Lake St. Joseph (Albany system) into Lac Seul.

The LWCB's authority is defined by concurrent Canada–Ontario–Manitoba legislation (*The Lake of the Woods Control Board Act*; 1921, 1922, 1958) and is further mandated by a Canada–U.S. treaty (*Convention and Protocol for Regulating the Level of the Lake of the Woods, 1925*), since Lake of the Woods is an international boundary body of water. This treaty also created a second board, the International Lake of the Woods Control Board (ILWCB). Although Lake of the Woods is normally regulated solely by the LWCB, the outflow from the lake is subject to the approval of the ILWCB whenever the level of the lake rises above or falls below certain levels specified in the treaty.

The board maintains a full-time secretariat that monitors conditions in the basin, provides information

and analysis, and recommends regulating strategies or specific outflows. It also implements strategy when so directed, conducts studies, and maintains communications with basin users.

Progress to March 31, 2011

Basin conditions in 2010 were characterized by a dry winter and spring, followed by more moderate inflow conditions. Lake levels and river flows were generally somewhat above normal during the late summer and fall period. The Lake St. Joseph diversion did not come under board authority during 2010. With the moderate lake levels, Lake of the Woods levels did not reach the level at which regulation would become subject to the approval of the ILWCB.

1.3 Partnership-based ecosystem approaches

Federal and provincial governments have jointly developed and implemented basin-wide action plans in collaboration with communities and other stakeholders. These action plans are designed to help resolve complex environmental issues, particularly deteriorating water quality that threatens human and ecosystem health.

During the late 1980s, the St. Lawrence River and Great Lakes basins were the focus of the first large action plans to clean up, restore and protect ecosystems. Each of these plans involved extensive collaborative actions at the community level to prevent pollution and restore polluted ecosystems. Although each plan was designed to meet specific regional needs and priorities, all were based on an ecosystem approach, promoting partnerships that involve all sectors, encouraging community involvement, and ensuring a sound scientific basis for decision making.

Recent examples of such collaborative efforts include the Lake Winnipeg Basin Initiative and Lake Simcoe Clean-Up Fund initiated under Canada's Action Plan for Clean Water, and the MOU on Environmental Cooperation in Atlantic Canada.

This section describes a number of key partnership-based ecosystem approaches through which Environment Canada works to ensure that Canadians have access to clean, safe and healthy water, and that the country's water resources are used wisely, both economically and ecologically.

1.3.1 Ecosystem Initiatives

Environment Canada's Ecosystem Initiatives are cooperative, place-based programs designed to deliver environmental results in targeted ecosystems. The objective of Ecosystem Initiatives is to enhance or maintain ecosystem sustainability by addressing a range of local or regional environmental challenges through partnership-based work. Local activities are coordinated by Environment Canada, and undertaken in collaboration with a range of local partners and stakeholders that may include other federal departments, provinces and territories, regional, municipal and local governments, Aboriginal peoples, federal and state governments in the United States, businesses, non-governmental and community organizations, and colleges and universities.

Ecosystem Initiatives achieve their objectives by relying on measurable environmental results, aligned and coordinated efforts, collaborative governance mechanisms, integrated science and monitoring, community and stakeholder involvement, sharing of information and experiences, and informed decision making.

1.3.1.1 Great Lakes Program

Background

The Great Lakes Program is a partnership of federal departments (Agriculture and Agri-Food Canada, Environment Canada, Fisheries and Oceans Canada, Health Canada, Natural Resources Canada, Public Works and Government Services Canada, Transport Canada, and Infrastructure Canada) and one federal agency (Parks Canada), whose goals are a healthy environment, healthy citizens and sustainable communities. This program significantly bolsters Canada's efforts to protect and restore the Great Lakes Basin ecosystem (www.ec.gc.ca/grandslacs-greatlakes).

The Great Lakes Program also provides the framework for working toward Canada's commitments under the

Canada–U.S. Great Lakes Water Quality Agreement (www.ec.gc.ca/grandslacs-greatlakes/default.asp?lang=En&n=88A2F0E3-1), which is the key mechanism for protecting water quality and the health of the aquatic ecosystem in the Great Lakes. Negotiations are proceeding between the federal governments of Canada and the United States to amend and strengthen this agreement.

Federal partner departments' activities are integrated with those of Ontario through the Canada–Ontario Agreement Respecting the Great Lakes Basin Ecosystem. Federal signatories to this agreement include Agriculture and Agri-Food Canada, Environment Canada, Fisheries and Oceans Canada, Health Canada, Infrastructure Canada, Natural Resources Canada, Parks Canada, and Transport Canada. Provincial signatories include Ontario's ministries of the Environment, Natural Resources, and Agriculture, Food and Rural Affairs. The agreement outlines how the two levels of government will cooperate and coordinate their efforts to restore, protect and conserve the Great Lakes Basin ecosystem. It builds on the actions taken through previous agreements, and focuses priorities for future actions. In 2010–2011 the governments of Canada and Ontario extended the agreement to June 2012, and added six new commitments to maintain momentum on the restoration, protection and conservation of the Great Lakes (www.ec.gc.ca/lcpe-cepa/default.asp?lang=En&n=8B398B48-1).

The Canada–Ontario Agreement also contributes to meeting Canada's obligations under the Canada–U.S. Great Lakes Water Quality Agreement.

Progress to March 31, 2011

As a result of restoration work, Wheatley Harbour on Lake Erie was delisted as an Area of Concern (AOC).[1] This represents a major achievement under Annex 2 of the Canada–U.S. Great Lakes Water Quality Agreement, through which Wheatley Harbour had been identified as an AOC in 1987. The beneficial uses related to fish and wildlife populations, water quality, sediment impacts and habitat, which were originally impaired, have been restored. A community event celebrated the delisting in April 2010.

Remedial action plans

Support continued for the coordination of remedial action plan activities, which included assessing and reporting on the success of past actions, and on the status of remaining actions in Canadian AOCs. Some examples are as follows:

- All priority actions have been implemented in the St. Lawrence River (Cornwall) AOC. The Stage 3 report, describing the results of monitoring and the restoration of beneficial uses, is being produced, and a decision is expected in 2011–2012 on whether to delist the AOC or recognize it as an Area in Recovery.
- The Stage 2 Remedial Action Plan report for the Canadian portion of the Detroit River AOC was reviewed by Canadian and U.S. agencies, stakeholders and the public, and was submitted to the International Joint Commission for review and comment in December 2010 pursuant to the requirements of the Canada–U.S. Great Lakes Water Quality Agreement. This report presents an assessment of the current status of beneficial-use impairments in the AOC, an evaluation of the remedial actions to restore beneficial uses that were undertaken from 1998–2008, and recommendations regarding the remaining remedial actions, their priority, the proposed timelines, and the agency or organization that should be responsible for implementing the remedial actions.
- A Stage 2 Remedial Action Plan update report was produced for the Niagara River AOC. The report updates the recommendations and delisting criteria presented in the 1995 Stage 2 Report and 2000 Implementation Annex. The 1995 delisting criteria were updated to reflect current standards. The nine beneficial uses that were identified as being impaired for this AOC were evaluated against the updated delisting criteria using the most current data, resulting in three beneficial uses being re-designated to not impaired. Five beneficial uses continue to be impaired, and another requires further assessment.

1 An Area of Concern is a location that has experienced environmental degradation. Under Annex 2 of the Canada–United Sates Great Lakes Water Quality Agreement, 42 Areas of Concern were identified and one more (Erie, Pennsylvania) was added later. Currently there are 9 Areas of Concern in Canada, 25 Areas of Concern in the United States, and 5 additional Areas of Concern shared by both countries. For more information on AOCs, consult www.ec.gc.ca/raps-pas/default.asp?lang=En&n=A290294A-1.

- Canada and Ontario accepted the status report on the Jackfish Bay AOC prepared by Lakehead University. The report confirms that although significant improvement has occurred since the area was originally listed as an AOC, additional time is required for the ecosystem's recovery to be measurable. Three beneficial uses continue to be impaired, two require further assessment to fully ascertain their status relative to the delisting criteria, and two beneficial uses have been restored and are now considered not impaired. A long-term monitoring plan has been developed to track recovery in the Jackfish Bay Area AOC. The plan fulfills Canada's and Ontario's commitment for a long-term monitoring plan in the 2007–2012 Canada–Ontario Agreement, and responds to the recommendations from the Jackfish Bay Public Area in Recovery Review Committee. The plan, developed by Environment Canada and the Ontario ministries of the Environment and Natural Resources, is to be implemented beginning in the 2011–2012 fiscal year.

Great Lakes Sustainability Fund

In 2010–2011, Environment Canada's Great Lakes Areas of Concern program and the associated Great Lakes Action Plan ($40 million in funding from 2005–2010) continued to fund multi-stakeholder projects to restore beneficial uses in Great Lakes AOCs, through the Great Lakes Sustainability Fund.

In partnership with local and provincial stakeholders, the Great Lakes Sustainability Fund provides funds for projects in three key areas: (1) improving point and non-point source water quality; (2) rehabilitating and protecting fish habitat and wildlife habitat; and (3) characterizing contaminated sediment and developing contaminated sediment management plans in AOCs (section 1.3.3 also describes sediment remediation work being conducted in the AOCs through the Action Plan for Clean Water).

The fund supported work in the Bay of Quinte, Niagara River, St. Lawrence River (Cornwall), Hamilton Harbour, Toronto, St. Clair River and Detroit River AOCs, which aimed to develop stewardship initiatives and deliver programs that reduce nutrient inputs to watercourses from urban and rural non-point sources. Initiatives included outreach and education programs, which were directed at rural farming and non-farming landowners to encourage the adoption of best-management practices, and studies leading to improved water quality through improved management of municipal wastewater.

In the Bay of Quinte AOC, the fund continued to support the development of an integrated pollution prevention and control plan for municipalities bordering the bay, including the development and implementation of stormwater management plans for new developments.

In the Toronto Region AOC, the fund continued to support the Sustainable Technologies Evaluation Program, which evaluates the effectiveness of technologies that mitigate impacts of stormwater, promotes the adoption of low-impact development approaches and best practices, provides information on sustainable technologies to rural and urban landowners, and transfers green technologies to municipalities and the development industry.

Restoration of fish and wildlife habitat is the second focus of the Great Lakes Sustainability Fund. In 2010–2011, the fund supported a number of projects to restore habitat in AOCs, including wetlands and habitat in Cootes Paradise and Grindstone Creek in the Hamilton Harbour AOC, fish habitat on the central Windsor waterfront in the Detroit River AOC, new stream habitat and headwater wetlands in the Toronto Region AOC, and shoreline habitat in the Niagara River and St. Clair River AOCs.

Developing plans and strategies to remediate contaminated sediments is the third focus area of the Great Lakes Sustainability Fund. The following work was undertaken in 2010–2011 in support of managing contaminated sediment in Great Lakes AOCs:

- Peninsula Harbour: A field survey was conducted and an aquatic habitat map and assessment were completed, in order to support the design and implementation of the proposed project to place a thin-layer cap to manage contaminated sediment.
- Thunder Bay: Further fieldwork and analytical studies were conducted in support of the Phase II sediment management options feasibility study.

- St. Marys River: Work continued on the development of a management strategy on the ecological and human health risks of contaminated sediments in the river.
- St. Clair River: A risk assessment of the mercury-contaminated sediment in the Canadian side of the St. Clair River continued, and results were communicated to stakeholders (St. Clair Remedial Action Plan Committee, Binational Public Advisory Committee, Sarnia–Lambton Environmental Association), First Nations (Aamjiwnaang, Walpole Island) and the general public. This site is downstream of a site that was formerly the property of a chemical company, and was remediated in 2004. Additional geotechnical/geophysical studies were conducted to help delineate priority zones for cleanup. The results are to be incorporated into the draft Sediment Management Options report.

Science and monitoring

Environment Canada undertakes science and monitoring projects to support decision making in the Great Lakes AOCs in Canada and to support decision making in binational AOCs (see section 2 for additional research projects related to the Great Lakes). In 2010–2011, projects included the following:

- New monitoring projects undertaken in the Great Lakes AOCs and/or Areas in Recovery included assessing the levels of dioxins, furans and metals in Spanish River sediment. The data indicate that levels are low and emission sources no longer exist. Work in Spanish Harbour will continue in 2011 to determine whether historic levels of dioxins, furans and metal contaminants in the sediments are still a concern for the aquatic environment.
- Environment Canada, in collaboration with the Ontario Ministry of the Environment, completed an extensive sediment survey, including the collection of sediment cores and pore water sampling in the St. Marys River AOC. During 2011, the results from this study will be used to determine whether future remediation of the area is needed and the extent of remediation, if warranted.
- Through collaborative work with U.S. experts specializing in fish tumours, data from Canadian AOCs were used to assess the incidence of fish tumours as an indicator of beneficial use impairment. Data from the lower Great Lakes were used to establish a reference tumour incidence in Brown Bullhead, and this reference incidence is being used to determine beneficial use impairment within AOCs. The incidence of liver tumours in fish in the St. Lawrence AOC was compared with the reference incidence, and based on the results, the liver tumour beneficial-use impairment was removed from that AOC.

Science and monitoring programs in support of Lakewide Management Plans

Environment Canada continued to conduct world-class monitoring programs throughout the Great Lakes in support of annexes 11, 12 and 15 of the Canada–U.S. Great Lakes Water Quality Agreement and Annex 2 of the Canada–Ontario Agreement Respecting the Great Lakes Basin Ecosystem. These monitoring programs are described below.

The Great Lakes Open Lakes Surveillance program samples the offshore waters of the Great Lakes, to provide status and trends information for water quality, report on compliance with established guidelines, and identify new and emerging issues. In 2010–2011, this surveillance program included the following activities:

- Data from the U.S. and Canadian federal water quality monitoring programs were compiled to identify and assess long-term trends in the major dissolved inorganic chemical constituents in each of the Great Lakes. These data sets were then combined with historical estimates to provide an overview of the chemical makeup of the lakes over the past 150 years. When the very long residence times of these chemicals in the upper Great Lakes are taken into account, results suggest that concentrations are increasing for many ions in response to historic loads, even if those loads have since been reduced. In lakes Superior, Michigan and Huron, concentrations of chloride, sodium, sulphate and calcium have increased, while the concentrations have varied or declined (in the case of calcium) in the lower lakes. Some of the most striking trends include increases in the concentrations of nitrate and silica. In the lower Great Lakes, the invasion of

exotic mussel species is linked to changes in silica concentrations, which, in turn, are related to decreases in diatom populations. These water quality responses to the invasion of exotic species highlight the importance of systematic, long-term monitoring to inform effective management decisions. Identifying trends in major ions is essential for inferring changes to the food web that may ultimately affect the Great Lakes fishery.

- Clean sampling techniques for measuring low ambient levels of metals in water samples were implemented. These low-level measurements are important, for example, for understanding gas–water exchange of these metals. Although long-term monitoring of suspended sediments in the Niagara River indicates an approximate 30% decrease in mercury concentrations since 1986, work conducted between 2003 and 2009 within the open waters of the Great Lakes using clean sampling provides a unique perspective on water concentrations of total mercury across the lakes. Results indicate that concentrations in the offshore regions of the lakes are low and within a relatively narrow range, but much higher concentrations are observed in some nearshore areas, particularly in the western basin of Lake Erie.
- Nuisance growth of *Cladophora* algae has surged in nearshore areas of Lake Ontario and Lake Erie. In 2010–2011 Environment Canada reported on current efforts to improve our understanding of changing nutrient dynamics in the Great Lakes. In collaboration with scientists from the University of Waterloo, nutrients were measured at two areas along the north shore of Lake Ontario, and these measurements were compared with nearshore and offshore water quality measurements. Over the past 30 years, significant declines in phosphorus concentrations have occurred in north coastal waters, concurrent with offshore declines. Nutrient loadings from tributaries to the northshore study areas have also declined over time. The evidence indicates that nutrient cycling may have shifted in favour of nuisance algae; this finding is consistent with the "nearshore shunt hypothesis," according to which the presence of invasive mussels maintains soluble nutrients in the nearshore area, where they fuel the resurgent *Cladophora* growth. The results of work imply that further management of nutrient loadings may not be successful in reducing nuisance algae growth. Work is ongoing to further support the science in order to inform management decisions.

The Great Lakes Fish Contaminants Surveillance Program measures and reports on the status and trends of legacy and emerging contaminants in top predator and forage fish species, and maintains an archive of historical fish samples to allow retrospective analyses in support of an early warning system for contaminants entering waters. In 2010–2011, this surveillance program included the following activities:

- A number of initiatives have curtailed anthropogenic mercury emissions in North America over the last two decades. However, various factors, including long-range transport of global emissions, may complicate the response of fish mercury levels to remedial actions. As the Great Lakes make up the largest surface freshwater body in the world and are under the influence of many complicating factors, trends in fish from the Great Lakes can reflect the overall impact of mercury management actions at local, regional and global scales. In 2010–2011, Environment Canada worked with the Ontario Ministry of the Environment to present a comprehensive view of mercury trends in Canadian Great Lakes fish using two large (5807 samples), different (fillet and whole fish), long-term (1970s–2007) monitoring data sets. Mercury levels in Lake Trout and Walleye during this period generally varied by a factor of two to three among the lakes, with lakes Erie and Superior having the lowest and highest concentrations, respectively. These spatial (i.e., among the lakes) differences have diminished in recent years (2000–2007). Overall, mercury concentrations in fish have generally declined over the past three decades (mid-1970s–2007); however, in recent years, the concentrations have been stable in Lake Ontario Walleye, while they appear to be increasing in Lake Erie Walleye. In Lake Ontario, Lake Trout and Walleye showed mismatched temporal trends, demonstrating the importance of considering more than one fish species for proper spatial/temporal trend assessments.

- Environment Canada produced a report on the current status of the Department's world-class specimen banks (www.ec.gc.ca/scitech/default.asp?lang=En&n=4B40916E-1&xsl=privateArticles2,viewfull&po=E99DF305). The specimen banks originated in the 1960s and 1970s at a time of emerging concern over persistent toxic substances in the environment. The National Aquatic Biological Specimen Bank contains mostly fish tissues collected as part of Environment Canada's Fish Contaminants Monitoring Program, while the holdings of the National Wildlife Specimen Bank are primarily bird tissues collected for the Herring Gull Egg Monitoring Program and specimens contributed by individual researchers across Canada. The specimen banks are integral components of Environment Canada's science and monitoring activities, by providing tissues for assessing the health of fish and wildlife populations in Canada, investigating the fate and behaviour of contaminants in the environment, and providing retrospective analyses of chemicals of emerging concern. The specimen banks have been operating for over 30 years and currently contain more then 250 000 sub-samples. They are the largest repositories of frozen environmental specimens in Canada and are among the longest-running formal environmental specimen banking programs in the world.

The Connecting Channels Monitoring programs in the St. Clair, Niagara and St. Lawrence rivers measure and report on trends in inputs/outputs from the connecting channels to the lakes, and measure the success of remedial measures in these binational AOCs. In 2010–2011, this surveillance program included the following activities:

- Environment Canada reported on the concentration loads and trends of contaminants in the Niagara River from 1986–2005. This report was unique because it provided the first look at contaminant trends over both long and short time spans while assessing the source of the contaminant. The results indicate that while there has been much progress during the monitoring period, with a decreasing trend for many contaminants, a number of contaminants have levelled off. Notably, the polycyclic aromatic hydrocarbons (PAHs) class of contaminants, known for their carcinogenic properties, is showing an increase in concentration.
- In collaboration with the U.S. Geological Survey, Environment Canada undertook an exercise to fingerprint (i.e., identify) the source of PAHs in the Niagara River. Initial results from this screening implicate coal-tar-based asphalt sealers as a significant source of PAHs in the watershed. Further work is required to confirm this assessment.
- Environment Canada undertook a formal review of the St. Clair monitoring program. This review was conducted to consider modifications to the current program. Recommendations have been implemented to reduce the scale of monitoring for the legacy contaminants while implementing monitoring for mercury, which was identified as a data gap for the corridor.
- The utility of the connecting channels monitoring stations was demonstrated through the confirmation of nutrient (phosphorus) trends in the Great Lakes. Scientific literature has reported a dramatic rise in phosphorus concentrations, which is confirmed by data from the St. Lawrence and Niagara River stations but not from the St. Clair stations. This finding is important, as it indicates that the upper Great Lakes are not the source of the phosphorus, and it will also help guide potential management strategies being developed to address the problem.

The Great Lakes Surveillance program samples the nearshore and within the watershed, to provide status information on threats to water quality, report on compliance with established guidelines, and identify new and emerging issues. Activities in 2010–2011 included the following:

- Environment Canada reported on a study investigating enzyme-linked immunosorbent assay (ELISA) as a cost-effective, high through-put method for measuring pesticide concentrations in surface waters. Some 739 samples from 158 locations throughout Ontario were analyzed for atrazine and metolachlor from April–October 2007. Concentrations ranged from < 0.1 to 3.91 nanograms per litre (ng/L) for atrazine, and from <0.1 to 1.83 ng/L for metolachlor. Peak concentrations occurred in late spring / early summer and in rural agricultural locations, and decreased over the remainder of the

growing season for both herbicides. Atrazine data suggest that ELISA may be used with traditional techniques in order to enhance the spatial and temporal resolution of a water quality monitoring study. ELISA may be used to detect atrazine and metolachlor in surface water samples, but it is not recommended as a quantitative replacement for traditional analytical methods.

- The Department also reported on the concentrations of atrazine and metolachlor in 101 surface water samples collected from the five Laurentian Great Lakes in 2005–2006. Concentrations of atrazine ranged from 5.5–61 ng/L; levels were highest in lakes Ontario, Michigan and Erie, intermediate in Lake Huron, and lowest in Lake Superior. Metolachlor concentrations ranged from 0.28–14 ng/L and showed similar trends among the lakes.
- Concentrations of mecoprop, dichlorprop and metolachlor in Ontario streams in 2006–2007 were compared with concentrations measured in 2003–2004. Median concentrations of dichlorprop and metolachlor were not significantly different between the two sampling periods, but mecoprop was higher in 2006–2007. Concentrations of mecoprop and dichlorprop in Lake Ontario surface water were one to two orders of magnitude lower than average concentrations in streams. In 2003–2004, 1.2% of the samples exceeded the Canadian Council of Ministers of the Environment's (CCME's) Water Quality Guideline (WQG) for mecoprop, but metolachlor did not exceed the CCME WQG. In 2006–2007, all samples were below the CCME WQG for mecoprop and metolachlor.

The Integrated Atmospheric Deposition Network, a binational program involving Environment Canada and the U.S. Environmental Protection Agency, reports on spatial and temporal trends in concentrations and loadings of priority toxic chemicals in the Great Lakes. In 2010–2011, Environment Canada continued to measure priority toxic substances, conduct data analysis, and develop and refine methods (more information on the program and results for 2010–2011 can be found in the *Canadian Environmental Protection Act, 1999 Annual Report for April 2010 to March 2011*).

Great Lakes and Regional Environmental Quality Monitoring and Surveillance Program

The binational Cooperative Science and Monitoring Initiative is a five-year rotational program that coordinates research and monitoring, from planning through to data synthesis and reporting. Coordinated field activities occur on each lake once every five years. The complete cycle for each lake involves two years of planning, one year of field activity and two years for analysis, synthesis and reporting. Starting with Lake Huron in 2012, issues affecting the connecting channels will be included in the assessment of the downstream lakes to the extent that these issues affect the downstream lake.

A special session on Lake Ontario (field year 2008) was held at the 2010 conference of the International Association for Great Lakes Research. The focus of the Lake Ontario program included understanding nearshore–offshore nutrient transport; the status of the offshore lower food web; a lakewide fishery assessment; and the use of biomarkers to identify food-web changes.

The 2009 intensive field year for Lake Erie was extended into 2010 to assess the impact of invasive species on nutrient transport from nearshore to offshore in the central and eastern basins of the lake.

Planning continued for Lake Superior (field year 2011). Priority research subjects include the status of chemicals of concern and chemicals of immediate concern in Lake Superior's ecosystem, the status of the lower food web, the early detection of aquatic invasive species, and a study of native fish species in the lake, including a lakewide juvenile Lake Sturgeon index survey.

Lake Huron (field year 2012) is in the issue-identification year. A binational planning workshop was held in Tobermory, Ontario, in October 2010, with a follow-up Canadian workshop held in Burlington, Ontario, in November 2010. The identified science priorities will be sent to the Lakewide Management Plan Management Committee for vetting and prioritization.

Canada–U.S. cooperation

The Great Lakes Binational Toxics Strategy is an innovative, collaborative arrangement between Environment Canada, the U.S. Environmental

Protection Agency and many Great Lakes stakeholders. Under the strategy, work continued toward reducing emissions and releases to the Great Lakes environment of 12 Level 1 persistent toxic substances, such as mercury, polychlorinated biphenyls (PCBs), dioxins and furans, hexachlorobenzene and benzo(a)pyrene.

In collaboration with the United States, Canada released the strategy's 2008–2009 Biennial Progress Report, which documents progress achieved and actions taken to reduce the use and release of Great Lakes Binational Toxics Strategy Level 1 substances, highlights the activities of a new group focused on emerging substances of concern, and presents environmental trend data of strategy substances collected by Great Lakes monitoring and surveillance programs.

In 2010, Canada amended the *PCB Regulations*, published in 2008 under CEPA, 1999 (SOR/2008-273, September 5, 2008), to accelerate the elimination of PCBs in use and storage. Preliminary data indicate that Canada's goal of a 90% reduction of high-level PCBs in service, from a 1993 baseline, has now been met. Canada also continued to monitor levels of dioxins in the environment, maintained its release inventory, collaborated with the United States to reduce uncontrolled combustion sources such as burn barrels, and is nearing completion of a national modelling study to better understand the transboundary impacts associated with releases of dioxins and furans from North American and global sources.

Canada made further progress on the development of a Canadian framework to identify and prioritize substances of emerging concern in the Great Lakes Basin.

A national wastewater monitoring program initiated in 2009–2010 in support of Canada's Chemicals Management Plan continued in 2010–2011. The program, which contributes to meeting objectives under the strategy, aims to improve our understanding and prediction of the occurrence and fate of emerging contaminants in Canadian municipal wastewater and solids treatment processes, and to determine whether control measures are needed to prevent these substances from entering the municipal wastewater system. This monitoring program includes five wastewater treatment plants that discharge into the Great Lakes or a tributary of the Great Lakes. PBDEs, bisphenol A, perfluorinated compounds, selected metals, selected phenols and acidic pharmaceuticals were monitored in wastewater and solids. This work will lead to a greater understanding of the extent to which these substances are entering the Great Lakes from municipal wastewater treatment facilities. As the understanding of the sources and extent of the problem deepens, different approaches, such as increased awareness through education, can be developed to address this issue.

With financial contributions from the Ontario Ministry of the Environment and Environment Canada, EcoSuperior continued to distribute information about safe disposal of medicines to four Lake Superior Basin communities (Nipigon, Terrace Bay, Marathon and Wawa), and to residents of Thunder Bay.

Environment Canada has been involved with the International Joint Commission Multi-Board Work Group on Chemicals of Emerging Concern (CECs). The CECs work group is focusing on two priorities from 2009–2011: the assessment of the performance of wastewater treatment plants in the removal of CECs, and the assessment of human and ecosystem health effects from exposure to CECs. In 2010–2011, literature reviews were conducted in support of both topics, and an expert consultation will be undertaken for the latter.

Environment Canada, in collaboration with the U.S. Environmental Protection Agency, regularly reports on the ecological health of the Great Lakes ecosystem. In 2010–2011, a review of the Great Lakes indicator suite was completed. The review included input from an independent panel of experts and contributions by staff from over 30 organizations, and resulted in a new organizational framework for the indicators and new indicator categories. Planning for the October 2011 State of the Great Lakes Ecosystem Conference continued.

Environment Canada, in cooperation with the U.S. Environmental Protection Agency, co-chairs binational Lakewide Management Plans under the Canada–U.S. Great Lakes Water Quality Agreement. The plans identify binational ecological objectives and management strategies, including science priorities for data collection to fill knowledge gaps

in ecosystem status and trends. In 2010–2011, a number of Lakewide Management Plan reports and activities were undertaken:

- The first annual Lakewide Management Plan reports were published for each of the Great Lakes.
- The draft Lake Superior Aquatic Invasive Species Complete Prevention Plan was revised following public workshops that were held throughout the basin to promote the plan and gather input. The plan's purpose is to prevent new aquatic invasive species from entering and becoming established in Lake Superior.
- The International Biodiversity Conservation Strategy for Lake Huron was finalized following a two-year conservation action planning process that engaged more than 100 agencies and organizations. The strategy identifies conservation features that are representative of the biodiversity of Lake Huron, ranks critical threats, and recommends strategies and opportunities for implementation.
- The final draft of the Lake Erie Binational Nutrient Management Strategy was completed. The strategy defines goals, objectives, targets, indicators, and priority watersheds, and identifies monitoring and research needed to limit further eutrophication and improve current conditions in Lake Erie.
- Environment Canada continued to participate in a number of key Canadian watershed and coastal initiatives, including the Lake Huron Southeast Shore and Southern Georgian Bay Coastal initiatives, and the Grand River Water Management Plan. These initiatives seek to develop mechanisms for the protection and restoration of Lake Huron and Lake Erie, respectively.

1.3.1.2 St. Lawrence Plan

Background

Launched in 1988, the St. Lawrence Plan (www.planstlaurent.qc.ca) is a collaborative initiative of the federal and Quebec governments to protect, conserve and enhance the St. Lawrence ecosystem. This five-year program, which has been renewed three times since it was first signed in 1988, has produced concrete results through the concerted efforts of both governments. Their initiatives have benefited from participation by the private sector, universities, research centres, committees on priority intervention zones (know as ZIP committees), non-governmental organizations and shoreline communities. The program focuses on the St. Lawrence and the mouth of its main tributaries, from Lake Saint-François on the Quebec–Ontario border to the eastern reaches of the Gulf of St. Lawrence. The 2005–2010 agreement, signed in November 2005, ended on March 31, 2010. Since then, the Government of Canada has been negotiating with the Government of Quebec to define the terms of a new agreement. Public consultations on its possible directions were conducted in the fall of 2010, and the input received was considered in the development of the next agreement, which should be announced in 2011–2012.

Progress to March 31, 2011

The year 2010–2011 was a transitional period, during which the renewal of the Canada–Quebec agreement (St. Lawrence Plan) took shape while some key programs were maintained to bridge the period between the expiration of the previous agreement and the signing of the new agreement. Also during this period, various programs and working groups, including the Monitoring the State of the St. Lawrence River Program Working Group and the community involvement programs, reviewed ongoing activities and resource allocations. As well, Environment Canada managers and scientists participated in committees involved in developing the next phase of the plan, in order to identify the activities to be undertaken with partners. These activities included value-added projects involving water quality improvement, biodiversity conservation and sustainable use of resources.

Community involvement and awareness

Stratégies Saint-Laurent and its members—the 14 ZIP committees—continued to work with local communities to protect, conserve and enhance the St. Lawrence ecosystem. Projects carried out in 2010–2011 included the launch of a new community web portal on the St. Lawrence and

the issues affecting the river, the management of watercourses to promote fish habitat conservation, the monitoring of invasive alien species and erosion, activities that protect and raise awareness about threatened species, the characterization of watercourses and riparian areas, and the enhancement of the natural environment.

The Community Interaction Program continued to support non-governmental organizations that conduct projects benefitting the St. Lawrence. In 2010–2011, 16 projects were implemented under this program, including a wetland restoration and improvement program involving the Cacouna–île Verte coastal corridor along the Lower St. Lawrence. This project will solve the problem of water depletion in a marsh of great ecological value. In addition, floating structures installed on adjacent ponds will provide resting places for birds. Twelve other projects have been approved and will be carried out in 2011–2012. These projects are the result of initiatives undertaken by shoreline communities that seek to stimulate interest in their activities and broaden their scope by focusing on the St. Lawrence Plan's priorities.

Monitoring the State of the St. Lawrence River Program

The network of governmental and non-governmental partners and collaborators continued to conduct scientific activities and disseminate information under the Monitoring the State of the St. Lawrence River Program. The information disseminated in 2010–2011 included three new fact sheets based on environmental indicators, published by Environment Canada (posted on the St. Lawrence Plan website):

- Temporal Changes in Toxic Contamination at the Carillon Sampling Station reveals that, in 2004–2005, water quality at the Carillon station located at the mouth of the Ottawa River was comparable to environments deemed to be free or nearly free of metal contaminants such as copper, mercury and nickel.
- Shoreline Erosion in Freshwater Areas reveals that, in 2006–2007, the 120 monitoring stations along the river section recorded, on average, the greatest amount of shoreline recession since 1998.
- Land Cover along the Great Lakes and the St. Lawrence River, an analysis of changes detected by remote sensing, shows that agricultural and urban areas have increased at the expense of woodlands and wetlands since the mid-1970s.

A scientific report on the dynamics and geochemistry of sediments in Lake Saint-Louis was also published. The work focused on 82 sampling sites and the tests performed on more than 100 parameters in 2003. The results revealed high concentrations of mercury, PAHs, PCBs, and dioxins and furans.

The scientists presented their findings at events held last year, such as the Forum sur l'état de l'écosystème du lac Saint-Pierre, the International Conference on Diffuse Pollution and Eutrophication, the Association québécoise pour l'évaluation d'impacts, a meeting of the Society of Environmental Toxicology and Chemistry, and the Aquatic Toxicity Workshop.

While pursuing their scientific activities and dissemination initiatives, riverside communities continued to participate in the Monitoring the State of the St. Lawrence River Program. Environment Canada provided assistance to and trained five groups (the Société d'aménagement de la Baie Lavallière, and the Lake Saint-Pierre, Haut-Saint-Laurent, Les deux rives and Jacques-Cartier ZIP committees) to help monitor invasive plant species in St. Lawrence wetlands. The data collected to complete a three-year cycle in Lake Saint-Pierre, and the results analysis, showed that several open, high marshes disturbed by agricultural activities were colonized by Reed Canary Grass, and that there were large colonies of Common Water Reed throughout the Lake Saint-Pierre archipelago.

1.3.1.3 Atlantic Ecosystem Initiatives

Background

The Atlantic Ecosystem Initiatives implements an ecosystem-based approach to environmental management through internal engagement, external engagement and the Atlantic Coastal Action Program (ACAP), a community-based partnership program between Environment Canada and

16 multi-stakeholder community organizations and four regional coalitions in the Atlantic provinces. The work of these partners has a positive impact on the health of watershed ecosystems across the region, and on larger ecosystems in the Gulf of Maine, the southern Gulf of St. Lawrence and the Bay of Fundy. Initiatives that receive support through ACAP use local and regional expertise, and support people who work in their own communities and regions, in order to help build a better environment for Canadians.

Environment Canada contributes funding, technical and scientific expertise, and direct staff support with respect to four broad categories of projects relevant to the *Canada Water Act*: clean water, pollution sources, toxics and natural habitat.

Progress to March 31, 2011

In 2010–2011, the Atlantic Ecosystem Initiatives Inter-Branch Team was established. The team, a forum for sharing information about activities taking place in the Atlantic region, works collaboratively to support the implementation of an ecosystem-based approach to environmental management in the region, and to identify gaps and opportunities to better coordinate and/or align Environment Canada programs, services and interventions addressing three environmental priorities, including nearshore water quality.

The Atlantic Ecosystem Initiatives is now also strongly linked with the Water Annex Work Plan under the MOU on Environmental Cooperation in Atlantic Canada (signed in 2008; see section 1.3.2.2). The Atlantic Ecosystem Initiatives supports two projects in the Water Annex Work Plan: Community Funding Programs Optimization (Water Related) and Regional Vulnerability Assessment.

Through ACAP, 34 projects (representing almost 65% of all projects) dealt with water issues. The bulk of project activities involved restoration, enhancement and improvement of water quality and watersheds, through proactive activities such as environmental education and outreach, water quality monitoring, and research and data collection.

Restoration and enhancement of watersheds remain a high priority for many organizations working within Atlantic Canada.

In Nova Scotia, the Clean Annapolis River Project continued to work on its Building Aquatic Science Knowledge of the Annapolis Watershed project. The goal of this science project is to gain an improved understanding of the status of and threats to the aquatic ecosystems of the Annapolis watershed, which will lead to the development of successful mitigation measures. Although previous work made important contributions to understanding the chemical status of the Annapolis watershed, two significant areas had not been examined: suspended particulate levels and the status of aquatic biological communities. The outcome of this work enables the use of tools such as the Water Quality Index in the assessment and communication of the status of the watershed, which in turn will facilitate greater engagement of community members in the protection of the watershed.

Project activities included determining baseline conditions for suspended particulate matter and establishing the relationship between turbidity and total suspended solids. This information facilitates improved assessments of stressors to the aquatic system, and helps the public gain a better understanding of water quality results.

In northeastern New Brunswick, the Miramichi River Environmental Assessment Committee (MREAC) partnered with Environment Canada scientists to gather important water quality data. With volunteer support from New Brunswick Community College (NBCC)–Miramichi Environmental Technology, a Chemicals Management Plan station was installed, monitored and maintained, and the data generated by the station were analyzed. The Napan River was selected as the location for this monitoring station, because it is the most impaired tributary of the Miramichi River (due to industrial, municipal and rural land uses). One very elevated measurement of bisphenol A in July 2009 prompted renewed concern about this site, and additional sediment sampling was conducted further upstream. This spike has not been repeated. The additional water quality parameters collected continuously by real-time monitoring contribute significant insights into the results observed at this sampling station.

This Chemicals Management Plan station will generate data that are useful not only to Environment Canada but also to the MREAC

and its partners, as well as to NBCC–Miramichi Environmental Technology students, who gained experience in real-time monitoring.

Cyanobacteria blooms were a concern in Newfoundland and Labrador. Northeast Avalon ACAP (NAACAP) is researching the factors that led to the first recorded cyanobacteria blue-green algae bloom in the province. In 2010–2011, NAACAP and Memorial University's Department of Environmental Engineering designed and delivered a water system modelling activity to simulate the transport and fate of nutrients in two pond systems based on an inventory of upstream land uses. This model estimates the losses to nearby water bodies, helps to understand the impact of watershed land-use practices on water quality, and may assist in predicting future blooms. The sources of nutrients and the effects of various land uses and of existing watershed management practices will be researched. The work undertaken by NAACAP and Memorial University will integrate the new modelling approach with impact assessment, climate change scenarios, and the preferred methods of land-use development by stakeholders, in order to support sustainable watershed management.

Gulfwatch, a long-term chemical-contaminants monitoring program, is organized and administered by the Gulf of Maine Council on the Marine Environment (see also Health of the Oceans Initiative under section 1.3.3). Since 1993, this program has used Blue Mussels as a sentinel species to determine and track habitat exposure to organic and inorganic contaminants in coastal waters of the Gulf of Maine. In 2010–2011, the program facilitated the collection of mussel samples at 23 sites throughout the Gulf of Maine and completed data reports for a 2009 mussel sample analysis, in order to augment the longer-term Gulfwatch data set. Gulfwatch data spreadsheets from 1992–2008 were also finalized, so that they could be published online. Making these data accessible to decision makers helps them to make informed decisions that prevent contaminants from entering the Gulf of Maine watersheds and the Gulf of Maine itself, thereby contributing to improved water quality in the region.

1.3.2 Other partnership-based ecosystem approaches and activities

1.3.2.1 Pacific and Yukon Region's Ecosystem Coordination Office

Environment Canada's regional offices coordinate the Department's interventions in identified priority ecosystems where a formal Ecosystem Initiative is not established. In the Pacific and Yukon Region, the Ecosystem Coordination Office works with the Okanagan Basin Water Board, a water governance body tasked with identifying and resolving critical water issues at the scale of the Okanagan watershed. Its 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 (a multi-stakeholder group established by the board to provide independent science-based advice on water issues). The overall objective of the Okanagan Basin Water Board is to undertake strategic projects and programs at the basin scale that meet the collective needs of Okanagan citizens for long-term sustainable water supplies, while supporting the capacity of member jurisdictions to meet their own water management goals. Funding was provided to the board to help enhance decision and reporting tools for water purveyors, undertake a second round of scenario developments for the Water Supply and Demand Project (see section 1.1.2.1), and develop additional map layers identifying sensitive and riparian habitat areas for a web-based atlas.

Funding was also provided to the Squamish First Nation for the Coast Salish Gathering (www.coastsalishgathering.com), an annual meeting convening First Nation Chiefs, U.S. Tribal leaders, the U.S. Environmental Protection Agency and Environment Canada to share information and address environmental issues facing the Salish Sea transboundary ecosystem. A component of the funding included support for the Coast Salish Water Quality Project, a joint initiative (between the Coast Salish First Nations from the Canadian and U.S. sides of this shared ecosystem and the U.S. Geological Survey) to measure and report on water quality in Puget Sound and the Strait of Georgia.

The Ecosystem Coordination Office also continued to support the Burrard Inlet Environmental Action Program and the Fraser River Estuary Management Program, which are key governance mechanisms that bring together federal departments (Environment Canada, Fisheries and Oceans Canada, and Transport Canada), Port Metro Vancouver, Metro Vancouver, the British Columbia Ministry of Environment and various municipalities to discuss and act upon environmental management issues of the Burrard Inlet and Fraser River Estuary.

1.3.2.2 Memorandum of Understanding on Environmental Cooperation in Atlantic Canada

Background

The MOU on Environmental Cooperation in Atlantic Canada (signed in 2008) is a significant federal-provincial collaborative effort to preserve, protect and enhance the environment in Atlantic Canada. This MOU outlines broad principles of environmental cooperation, indicates that annexes will be developed, and establishes a Management Steering Committee to oversee its governance. The committee consists of the Regional Director General of Environment Canada's Atlantic Region and the deputy ministers of the environment from the four Atlantic provinces.

The MOU has created opportunities for closer intergovernmental collaboration on several Environment Canada priorities, including water, and has been instrumental in fostering stronger federal-provincial relations in Atlantic Canada. Environment Canada contributes technical and scientific expertise, and direct staff support, for this MOU and its annexes.

Progress to March 31, 2011

A Water Annex and Water Annex Work Plan under the MOU were developed in 2010, and approved for implementation by the Management Steering Committee in November 2010.

Under the Water Annex, the parties recognize the value of water resource management involving federal and provincial agencies, and propose to promote a regionally and nationally consistent level of environmental quality, operational advantages, cost efficiencies and service to Canadians. The annex indicates that the parties will work toward establishing arrangements and understandings for water quantity monitoring and prediction, water quality monitoring and surveillance, and sustainable water management. To facilitate these efforts, the parties developed a Water Annex Work Plan for 2010–2012.

The purpose of the work plan is to facilitate increased cooperation and coordination among the parties in their efforts to understand and protect the water quality and ecological health of the Atlantic provinces, and to achieve the vision of healthy, prosperous and sustainable watersheds for present and future generations.

There are 13 projects under the work plan: community funding programs optimization (water-related), regional vulnerability assessment, water availability assessment protocol, water management and use, implementing the WaterSense program in Atlantic Canada, Atlantic Canada water monitoring network assessment and optimization, hydrometric bilateral agreements, water quality agreements, climate change impacts and adaptation, climate change prediction modelling, a federal-provincial Atlantic water workshop and exchange forum, CESI (water), and the WAI.

These 13 projects have been categorized under the five water goals outlined in the CCME's Setting Strategic Directions for Water vision document. The parties have agreed that these goals reflect commonalities found in federal and provincial policies and programs. However, adoption of these goals under the work plan does not obligate its signatories to the CCME's Strategic Directions for Water Three Year Action Plan, nor does it obligate the CCME to the Water Annex and its work plan. The goals are as follows:

1. Aquatic ecosystems are protected on a sustainable watershed basis.
2. The conservation and wise use of water is promoted.
3. Water quality and quantity management is improved, benefiting human and ecosystem health.

4. Climate change impacts are reduced through adaptive strategies.
5. Knowledge about the state of Canada's water is developed and shared.

The initiatives under the Water Annex Work Plan have been under way since December 2010, and are being worked on collaboratively by Environment Canada, Fisheries and Oceans Canada, the Atlantic Canada Opportunities Agency, and the four provincial partners. The first progress update to the Management Steering Committee is to be prepared in the spring of 2011.

1.3.3 Action Plan for Clean Water

Background

Environment Canada is carrying out its work under the Government of Canada's Action Plan for Clean Water, through $96 million in cleanup funding to restore Lake Simcoe and Lake Winnipeg and to implement remediation plans for contaminated sediment in eight Canadian AOCs in the Great Lakes.

The Action Plan for Clean Water also encompasses the Health of the Oceans Initiatives (HOTO). HOTO provides five years of funding to support various programs and activities that protect fragile marine environments, counter pollution and strengthen preventive measures. Although Fisheries and Oceans Canada is the formal federal lead for HOTO, five federal departments and agencies, including Environment Canada, receive funding to advance the goals and objectives of this initiative.

Progress to March 31, 2011

Great Lakes Areas of Concern

The Government of Canada's Action Plan for Clean Water is providing $48.9 million to implement contaminated sediment management projects in eight AOCs: Detroit River, Bay of Quinte, Niagara River, Peninsula Harbour, St. Marys River, Thunder Bay, St. Clair River (by 2012), and Hamilton Harbour (by 2016). The Action Plan funds project implementation, while the planning and design of the sediment remediation projects are funded by the Great Lakes Action Plan (GLAP). The 2010–2011 status of sediment remediation work at each of the sites is as follows:

- The third year of a four-year sediment transport monitoring study in the Trent River (which flows into the Bay of Quinte) was completed. Monitored natural recovery was selected as the preferred sediment management option by the Trent River Mouth Investigation Steering Committee, because the risk to humans and wildlife was found to be minimal. An administrative controls protocol (to restrict development of activity that might disturb sediments in the river) was developed with provincial and local agencies, and is to be implemented in 2011.
- In the Niagara River AOC, the preferred option of monitored natural recovery was implemented in 2010, and an administrative controls protocol is to be adopted in 2011. A baseline monitoring study was completed in 2010.
- In Peninsula Harbour, the proposed sediment remediation option is thin-layer capping. Development of the project design and environmental assessment continued in 2010–2011 (supported by GLAP funds), and was scheduled to be completed in the spring of 2011. Project implementation, using Action Plan funds, is scheduled for the spring of 2012.
- In the St. Clair River AOC, sediment management options are currently being evaluated by Environment Canada in partnership with the Ontario Ministry of the Environment and the St. Clair Region Conservation Authority. The assessment of sediments is taking longer than expected, and two years of field studies (2010–2011 and 2011–2012) are being conducted to fill unforeseen data gaps. The sediment options study, funded through GLAP, is expected to be completed in 2013–2014.
- In the Thunder Bay AOC, investigations have revealed that the mass of contaminated sediment in the north harbour is much larger than originally thought, with characteristics that will potentially make the sediments more difficult and expensive to manage. The development and evaluation of sediment management options continued in 2010–2011, using GLAP funds.
- In the St. Marys River AOC, the investigation of the magnitude and extent of sediment

contamination continued in 2010–2011, using GLAP funds. The assessment of sediments has taken longer than anticipated due to the discovery of two depositional areas downstream of Bellevue Marine Park in Sault Ste. Marie. The volumes of sediment requiring management action are potentially much larger than originally anticipated. A determination will be made by the spring of 2012 about whether sediment remediation is required.

- In the Hamilton Harbour AOC, the proposed sediment remediation option, which was developed through a community stakeholder advisory group, is to contain the sediments in a facility to be constructed within Hamilton Harbour. The project design and environmental assessment were completed in 2010–2011, using GLAP funds, and an independent peer review of the design is to be completed by September 2011. Public Works and Government Services Canada could be engaged as early as 2012, using Action Plan funds, to begin project implementation.

Lake Simcoe

Environment Canada's Lake Simcoe Clean-up Fund (www.ec.gc.ca/doc/eau-water/simcoe_e.html#a1), launched in 2008, is expected to improve water quality for recreational use, reduce phosphorus loads, and advance the restoration of a sustainable coldwater fishery and the ecological integrity of Lake Simcoe. The fund is administered by the Department in consultation with Fisheries and Oceans Canada, Agriculture and Agri-Food Canada, the Province of Ontario, the Lake Simcoe Region Conservation Authority, and other key stakeholders. The Department is assisted by the Technical Review Committee, and the Protect and Preserve the Environment of Lake Simcoe Committee, which advises on priority actions and funding recommendations.

The Lake Simcoe Clean-up Fund provided $8.3 million in 2010–2011 for 43 projects that focused on pollution reduction and the restoration of the lake's ecological integrity and coldwater fishery.

The Lake Winnipeg Basin Initiative

Work continued throughout 2010–2011 on Environment Canada's four-year, $18-million Lake Winnipeg Basin Initiative (www.ec.gc.ca/doc/eauwater/winnipeg_e.html), intended to help restore the ecological integrity of Canada's sixth-largest lake. Lake Winnipeg is recognized as one of Canada's most eutrophic lakes, with algal blooms that are widespread and recurrent. In addition, the lake has a highly complex and fragmented transboundary watershed spanning almost one million square kilometres. This initiative focuses on three areas: facilitating governance throughout the watershed; the administration of the Lake Winnipeg Basin Stewardship Fund to support projects that reduce nutrient levels in the lake; and a science program encompassing research, monitoring and information management.

A progress report was published in 2010–2011, documenting the activities undertaken during the first two years of the initiative. Work also continued with Manitoba on a report describing Lake Winnipeg's physical, chemical and biological characteristics from 1999–2007. The report is anticipated to be released in 2011, and will provide a baseline for scientific information and investigations on the lake.

In September 2010, Environment Canada and the Province of Manitoba signed a five-year, Canada–Manitoba MOU Respecting Lake Winnipeg and the Lake Winnipeg Basin under section 4 of the *Canada Water Act*, providing for a long-term collaborative and coordinated approach between the two governments. A steering committee, with representatives from key federal and provincial departments, was established to provide oversight for the MOU. Work was also initiated to develop a science subsidiary arrangement under the MOU, in order to coordinate federal-provincial scientific monitoring and research.

Round 4 of the Lake Winnipeg Basin Stewardship Fund was implemented in 2010–2011. Since its inception, the fund has provided over $2.1 million in federal funding for 33 projects throughout the watershed. Projects encompass agricultural beneficial management practices, wetland and riparian restoration, and demonstration projects related to nutrient abatement.

Research, information and monitoring activities continued in 2010–2011 on Lake Winnipeg and major sub-basins, in support of Environment

Canada's Lake Winnipeg Basin Initiative science plan. The science plan's goal is to understand the gaps related to ecology and nutrient cycling, and the sources and transport mechanisms for nutrients, in order to provide a basis for establishing nutrient objectives and performance indicators for the lake.

Examples of the science work under way include the following:

- assays of major nutrients, particulate organic matter and dissolved oxygen in Lake Winnipeg—one of the first rigorous studies of dissolved oxygen in the lake;
- hydrodynamic and water quality models for Lake Winnipeg and Lake of the Woods;
- analysis and validation of remote-sensing aquatic colour data for Lake Winnipeg and Lake of the Woods;
- continued assessment of major nutrient inputs, their transfer and bioavailability to plankton, and their potential role in the development of noxious blooms;
- assessment of sediment mass and nutrient loading to Lake Winnipeg from external (tributary) and internal (re-suspended) sources, and their potential effects on water quality and algal bloom development;
- use of non-point-source water quality models to evaluate a suite of best management practices developed (in collaboration with scientists from Agriculture and Agri-Food Canada) to reduce the loadings of nutrients from agricultural lands in the Assiniboine and Red River watersheds;
- monitoring of the distribution, biomass, species composition and toxin content of harmful blooms of cyanobacteria in Lake Winnipeg and Lake of the Woods;
- analysis of sediment cores from Lake Winnipeg to assess long-term trends in sediment deposition, nutrients, and planktonic algal and zooplankton species composition and productivity;
- assessment of water quality, dissolved oxygen, nutrients and the planktonic food web in Lake of the Woods;
- research on nutrient sequestration in lakes and reservoirs;
- field studies and modelling to quantify the sources, transport and fate of nutrients from agriculturally dominated watersheds through tributaries of the Red and Assiniboine rivers; and
- analysis of the nature and variability of hydrologic inputs to Lake Winnipeg and the possible impacts of climate change on water cycle variation, with implications for nutrient transport.

Further refinements and data acquisition were undertaken for the online Lake Winnipeg Basin Initiative Information Portal. The portal compiles and promotes data sharing with key partners and ensures consistent, relevant and reliable access to information about the Lake Winnipeg Basin.

Strategic capacity development was carried out on the information portal for partners in government (federal, provincial and municipal) and non-governmental stakeholder organizations, resulting in long-term information sharing and use capacity for the portal. Ongoing capacity-building exercises will continue throughout the project duration.

Decision makers in the Lake Winnipeg watershed require information on the costs and benefits of measures to reduce excess nutrients and improve water quality. Under the Lake Winnipeg Basin Initiative, Environment Canada is applying an analytical framework for ecological goods and services, to assess three different types of possible measures to reduce nutrient loading: agricultural beneficial management practices, wetlands restoration, and infrastructure investments in wastewater treatment. This study will estimate the benefits of ecological goods and services, including market and non-market values. The analysis includes the co-benefits that occur in addition to nutrient reductions, such as habitat provision and carbon storage. This will be the first step toward developing a model that would allow the benefits of each measure to be compared with the costs involved, in order to determine which provides the best results for a given investment.

Health of the Oceans Initiatives (HOTO)

As part of its involvement in HOTO, Environment Canada received $8 million over five years (2007–2012). Of that, $0.75 million was designated to support activities in the Gulf of Maine, a transboundary watershed and marine ecosystem of the coast of New Brunswick and Nova Scotia. This funding, administered by the Atlantic Ecosystem Initiatives, provides support to the Gulf of Maine

Council on the Marine Environment (GOMC; see www.gulfofmaine.org/default.asp). The GOMC is a Canada–United States partnership of governmental and non-governmental organizations working to maintain and enhance environmental quality in the Gulf of Maine in order to allow for sustainable resource use by existing and future generations, through the implementation of a five-year action plan. In particular, HOTO supports GOMC activities associated with the Climate Change Network, the GOMC's Gulfwatch chemical contaminants monitoring program, the Ecosystem Indicator Partnership (ESIP) (a committee of the GOMC), and the GOMC's education and outreach program.

In 2010–2011, Environment Canada's HOTO support for the Gulf of Maine focused primarily on Gulfwatch and ESIP. Support for Gulfwatch enabled continuation of its sampling and analysis activities, and contributed to its long-term tracking of the status and spatial and temporal trends of select contaminants within the transboundary region. ESIP continued the identification and development of ecosystem indicators to monitor and track ecosystem health within the Gulf of Maine for six theme areas: fisheries/aquaculture, contaminants, climate change, coastal development, eutrophication, and aquatic habitats. ESIP also pursued the development and population of an online indicator reporting tool to disseminate indicator information to stakeholders throughout the region.

2 Water research

This section describes research activities conducted by Environment Canada's Water Science and Technology Directorate in support of *Canada Water Act* activities. Environment Canada water scientists conduct an array of research across Canada, including on wastewater and wastewater technologies, pathogens and parasites, algal blooms, and the health of the aquatic ecosystem; the impacts of agricultural and industrial runoff; oil sands related water research; water issues specific to the North; and hydro-meteorological modelling and prediction.

2.1 Wastewater

Activities related to the research of wastewater included treatment technologies and the effects of wastewater effluent on aquatic organisms. A collaborative study with the French Le Centre d'étude du Machinisme Agricole du Génie Rural des Eaux et Forêts provided evidence that chloride had an effect on organisms living on the bottom of water bodies (i.e., benthic communities) during winter and spring, and that benthic communities recovered during summer and fall. This work and the development of a modified benthic invertebrate index provides an indicator of water quality, and may determine the health and recovery potential of shallow urban pond systems important in urban stormwater and wastewater systems. Over 16 000 samples have been identified for this project. The results span a wide range of ecosystem conditions, and work continued in partnership with Trent University on identifying the watershed and pond features that determine water quality conditions in stormwater ponds.

The performance of stormwater ponds in the removal of contaminated solids from urban stormwater was studied, as solids removal efficiency is one of the parameters that provides the best indication of a pond's effectiveness at controlling pollution and improving water quality. Designers of stormwater ponds face a number of challenges, including short settling times, which result from small pond sizes and which can limit the removal of solids; and re-suspension and washout of bottom sediments, which cause downstream pollution when high flows pass through shallow ponds. During 2010–2011, a new concept consisting of placing a porous bed structure (lattice) on the bottom of the pond to overcome the aforementioned challenges was proposed and studied in the laboratory. Preliminary results indicate that, for various flows and under the conditions tested, the particle removal rates increased by 14–35%, and the sediment retention rate improved from 20% to 80%.

An ongoing study of urban groundwater in Canada focused on assessing the occurrence and distribution of groundwater contaminants discharging to streams, and the effects of the seepage of contaminated groundwater on aquatic

ecosystems. Analysis of data compiled and interpreted in 2010–2011 demonstrated that, based on the results of field investigations, artificial sweeteners (such as those used in foods) are useful as indicators of groundwater contaminated by urban wastewater sources.

2.1.1 Wastewater treatment technologies

Research continued into methods for removing antibiotics from wastewater, and focused on the development of new filtration treatment technologies such as micellar-enhanced ultrafiltration techniques. It was shown that partitioning the antibiotics into aggregates (micelles) enhanced the removal of contaminants from wastewater streams. In 2010, the research was extended to improve understanding of the binding process with micelles and sediments.

Environment Canada entered into a multi-year grant and contribution agreement with Queen's University to further research micellar-enhanced ultrafiltration wastewater treatment technologies.

Ultraviolet (UV) disinfection of wastewater is widely used for reducing the risk of waterborne diseases. However, biological aggregates found in wastewater protect pathogens from UV light, thus increasing the required UV dose. This increases the size of the UV system, its energy usage, and greenhouse gas emissions. Biological aggregates can be removed by filtration or membrane separation, but these technologies require significant capital investments. Research has confirmed that suspended aggregates can be effectively disrupted by liquids in motion (i.e., hydrodynamic stress), rendering them less resistant to UV disinfection. A key outcome of this research is the development of a novel treatment system in which hydrodynamic particle disruption is integrated with existing UV technology. In 2010–2011, research was also carried out to investigate the application of ultrasound techniques as an alternative for disrupting biological aggregates in wastewater. Although it is generally recognized that ultrasound techniques can be used for particle disruption, the focus of this research is to assess various means of reducing the energy consumption, such as through the use of additives.

Pilot-scale research was conducted to develop a new technology to treat municipal wastewater using an anaerobic (i.e., without oxygen) membrane bioreactor. The objective of this research is to investigate the performance of a pilot-scale anaerobic membrane bioreactor treating municipal wastewater under various reactor and membrane operating conditions. Preliminary results have indicated that the bioreactor's efficiency at removing organic contaminants was comparable to that of conventional wastewater treatment technologies. Furthermore, valuable nutrients such as ammonium and phosphorus can be recovered from the system.

Research was also conducted on novel gas-permeable membrane bioreactor technology that holds the promise of being one of the next-generation sustainable wastewater treatment technologies that are energy efficient and have superior contaminant removal capability, particularly for the removal of ammonia (a toxic substance under the *Canadian Environmental Protection Act, 1999*). Modelling was carried out to assist future, larger-scale application of this technology.

Research was conducted to integrate external hollow-fibre and tubular membranes with anaerobic digesters in order to concurrently thicken and efficiently digest sludge. The use of membranes allowed the reactor size to be decreased by up to 75% while maintaining treatment efficiency. This research was expanded in 2010–2011 to determine the effect of longer solids-retention times and temperature on the removal of emerging contaminants.

Several pilot-scale wastewater treatment trains have been set up to assess how various types of treatment processes alter the adverse effects (i.e., toxicology) of the effluent. A unique strength of this pilot study is the use, for biological testing, of Canadian aquatic species that are directly relevant to the country's diverse environments. In 2010–2011, a model was developed and populated with the study results for prediction of effects under various treatment scenarios.

Environment Canada scientists partnered on several research studies to assess the effects of municipal wastewater effluents in wild fish and mussels and in laboratory fish. Chemical characterization of the effluents was researched to assess levels of pharmaceuticals, personal care products, and conventional toxicants such as ammonia, metals

and hydrocarbons. One such study, in partnership with the Ontario Ministry of the Environment, assessed the measurement of pharmaceuticals and personal care products in municipal wastewater effluents. Results of this research will assist in the development of models that aim to better predict environmental exposure and provide information to enable environmental risk assessment activities.

2.2 Pathogens and parasites

Environment Canada scientists researched a variety of water-borne pathogens and parasites that have a detrimental impact on Canadians' quality of life and economic well-being. For example, partnering with the Niagara Region municipal government and McMaster University, Environment Canada conducted research on microbial source tracking. Over 2000 water samples were analyzed across 15 Lake Ontario and Lake Erie beaches to investigate the sources of fecal pollution responsible for beach closures. Results of this research will guide future beach cleanup efforts.

Additionally, collaboration and partnering with the U.S. Environmental Protection Agency resulted in development of a new DNA marker for seagulls, which will assist in understanding the prevalence of impacts from seagull fecal droppings in major Canadian urban beaches and stormwater outfalls.

2.3 Algal blooms and health of the aquatic ecosystem

Environment Canada has an extensive history of partnering on research into algal blooms, and is engaged in highly targeted work to characterize the key mechanisms that control the severity, toxicity and harmful impacts of algae in freshwaters. The work is aimed at the development of sustainable risk management and long-term mitigation and management in partnership with local, municipal, provincial, national and international governments, and private and academic sectors. Studies of selected lakes (Great Lakes, Lake of the Woods, Lake Winnipeg) using satellite imagery have enabled frequent, large-scale views of these lake processes, allowing analysis of the evolution of water quality issues over time, the detection of lakewide changes over time, and the identification of areas of persistent or recurring water quality concern. Research conducted in 2010–2011 aimed to further unravel the remote sensing signal in order to provide additional information on the composition of algal blooms, with an emphasis on distinguishing potentially harmful cyanobacteria.

During 2010–2011, Environment Canada partnered with the multi-disciplinary Microbial Ecology of the Lake Erie Ecosystem (MELEE) research group, which has been studying various aspects of this ecosystem's microbial ecology. This important work will help to further the understanding of chemical, biological and physical controls that influence the cycling of carbon, nitrogen, phosphorus and trace metals in the Lake Erie water column, which, in turn, affect aquatic ecosystem health.

A modelling study during 2010–2011 estimated source contributions of nitrogen and phosphorus to the Saint John River and Bay of Fundy. Results suggested that dispersed pollution (often from runoff from fields) was three times higher than that of point sources (often from cities and towns). This study has led to further partnering and engagement on watershed research with the International Joint Commission and GOMC.

Environment Canada scientists continue their efforts to research the health of the aquatic ecosystem, including the biological effects of contaminated groundwater, impacts of and recovery from acid rain, and the impact of pollution on the proliferation of invasive species.

2.4 Agricultural and industrial runoff

Environment Canada, Agriculture and Agri-Food Canada, and academic research partners from the University of Calgary and University of Waterloo continued, through a four-year study, to collaboratively research agricultural impacts on groundwater quality in the transboundary Abbotsford–Sumas aquifer (the study area is located on the Canadian side of the aquifer, in British Columbia's Lower Fraser Valley). This study, initiated in 2009, evaluates factors that bring about rapid nitrate leaching from the soil zone to the aquifer. Ongoing Environment Canada groundwater monitoring shows long-term nitrate contamination of groundwater in the study area.

The study includes soil-water and groundwater sampling, and assessment of groundwater quality data in relation to seasonal factors, fertilizer and manure application practices, and other agricultural management practices. The Department also collected groundwater samples bi-monthly to study potential influences of and seasonal variations in different sources of nitrate contamination that could be affecting groundwater quality in the aquifer.

In another groundwater study, Environment Canada has partnered with the Canada–Manitoba Crop Diversification Centre and the University of Manitoba to evaluate the vulnerability of the Assiniboine Delta aquifer to contamination by pesticides, and to develop a risk assessment model. The Assiniboine Delta aquifer, which underlies an area of approximately 4000 km^2 near Carberry, Manitoba, is a valuable source of high-quality water for drinking, industrial uses and irrigation. Pesticide usage data analyzed in 2009–2010 were used to design a program for monitoring key active ingredients in strategically located groundwater wells. In 2010–2011, the only detections were of three herbicides, two herbicide metabolites and a fungicide, all at levels below CCME Canadian Water Quality Guidelines.

Environment Canada continued to partner on studies assessing the impacts of agricultural management practices on water resources. In collaboration with researchers from Agriculture and Agri-Food Canada, the University of Saskatchewan and University of Manitoba, and provincial agencies, the effectiveness of several agricultural best management practices are being evaluated at the edge-of-field and small-watershed scales. Conservation tillage, small water-retention ponds, conversion of cropland to forage, and use of extensive beef cattle overwintering sites were among the practices studied in 2010–2011. Although conservation tillage was effective in reducing particulate nutrient loading in runoff, it led to accumulation of phosphorus and increased the transport of dissolved phosphorus in snowmelt runoff. Positive results were obtained for small dams, which were shown to be effective in reducing peak flows and the transport of total and dissolved nutrients. Evaluation of the other practices is ongoing.

Surface waters located in agricultural watersheds may be subject to surface runoff, the deposition of spray drift, and occasional over-spray of herbicides. A surveillance research project of sulfonylurea herbicides has been under way since 2009 in the watershed of the Saint-François Bay (Lake St-Pierre), at the outflow of the Yamaska River, which drains a large agricultural watershed. The project aims to improve knowledge about the presence, sources, transfer and fate of sulfonylurea herbicides in air, precipitation and water. The results will identify agricultural practices that can minimize the environmental risks associated with the use of new pesticides. Preliminary results indicate the presence of a short life cycle (< 5 days) of these herbicides in surface waters, but not in air or precipitation, which suggests a quick transfer between the field and river.

In partnership with industry and academia, Environment Canada is investigating the causes of and solutions to pulp and paper effluent's impact on aquatic life and water quality. One such study is assessing the reproductive effects in fish downstream of pulp and paper mill effluents at the L'Etang estuary of the Bay of Fundy at St. George.

In the aquaculture industry, antibiotics (including oxytetracycline and florfenicol) are used to control and prevent disease. Drugs such as emamectin benzoate and teflubenzuron are used for the prevention of sea lice in salmon. There is evidence that use of such antibiotics may create localized antibiotic resistance. An ongoing study on the possible environmental impacts of land-based aquaculture facilities (hatcheries and land-based grow-out sites) continued in 2010–2011. Twelve water samples and five sediment samples were collected at six facilities in Nova Scotia and New Brunswick. This study will continue in 2011–2012 with the addition of new sites for water quality testing.

2.5 Oil sands–related research

In 2010–2011, work focused on responding to recommendations made by the Federal Oil Sands Advisory Panel in its report to the Minister in December of 2010 (www.ec.gc.ca/pollution/default.asp?lang=En&n=E9ABC93B-1). The panel identified a need for independent scientific oversight to ensure adaptability and continuous improvement

of monitoring activities, better integration between environmental media, a robust science-based approach that has rigour and statistical power, and improved transparency regarding reporting, data access and quality control. The panel also noted that Environment Canada has a trusted and recognized scientific capacity that could be applied to oil sands monitoring.

In response to the Government acceptance of the panel's recommendations, Environment Canada coordinated, with Alberta, other federal, provincial and territorial departments and agencies, and academia, the development of a Preliminary Water Quality Monitoring Plan for the Lower Athabasca River and its tributaries. Released in March 2011, the first phase of the plan covers surface water quality and quantity, groundwater quality (riverine interactions and seepage from tailings ponds), and local atmospheric deposition as it relates to direct and indirect stack emission impacts on water quality. Plans are being developed for a second phase in which monitoring of aquatic biota (including fish), terrestrial biota, acid-sensitive lakes and regional air quality / atmospheric deposition are being added, and the geographic extent is being expanded to include areas upstream and/or outside of oil sands development (primarily for reference information) and downstream of oil sands developments (potential contaminant-receiving environments), including the Peace–Athabasca Delta, Slave River and Slave River Delta.

The Department's primary 2010–2011 research and monitoring activities in the oil sands region continued in eight key areas:

1. Chemical profiling – fingerprinting
2. Toxicity and effects
3. Groundwater surveillance
4. Atmospheric deposition
5. Water quantity monitoring (hydrometric and ecological flow needs)
6. Water quality monitoring
7. Biodiversity
8. Environmental effects monitoring

2.6 Northern Canada

A study to assess the performance of wastewater treatment systems in Canada's Arctic began in 2009. Field research is being conducted to develop an inventory of wastewater system facilities and their current treatment capabilities. The majority of Arctic communities use lagoons for wastewater treatment, and in some of these communities the lagoon effluent is discharged into a wetland for further treatment. In 2010–2011, work was initiated on developing a computer model for simulating wastewater treatment in northern lagoons and to provide a tool for theoretical optimization of these systems. Results from the field research and model, coupled with associated risk assessment input, will be used to formulate discharge standards for the Arctic Component of the Canada-Wide Strategy for the Management of Municipal Wastewater Effluent, which, in turn, will be incorporated as an amendment in the *Wastewater Systems Effluent Regulations*, currently under development by Environment Canada. Preliminary data suggest that lagoon effluent in the Arctic has consistently exceeded the CCME's proposed standards for carbonaceous biochemical oxygen demand and total suspended solids. Partial results show seasonal variation in effluent quality. Other factors that affect wastewater treatment, such as retention time, loading, dissolved oxygen concentrations and sludge volume in the lagoon, will continue to be identified and evaluated. In addition, parallel fieldwork has been conducted on northern wetlands. Preliminary work has also shown that wetlands can provide additional wastewater treatment, though their role needs to be better understood from scientific and regulatory perspectives.

During 2010–2011, a team of international authors led by a Canadian produced a chapter of the Arctic Monitoring and Assessment Program's report *Changing Lake and River Ice Regimes: trends, effects, and implications*. Results of the chapter were presented at an international meeting in Copenhagen in June 2011, and the final report is scheduled for publication in late 2011.

Field research on stream-flow generation in the discontinuous drainage systems of the Subarctic Canadian Shield continued in partnership with Aboriginal Affairs and Northern Development Canada. Research conducted during 2010–2011 on relationships between frozen ground, surface soil moisture and runoff led to the development of a new runoff routing parameterization for

Environment Canada's land surface scheme. Changing precipitation patterns in northern Canada are producing larger winter stream-flow across much of the region. In 2010–2011, scientists investigating the magnitude of these changes at sites near Yellowknife found that longer periods of ground freeze-back in the fall due to wetter conditions are changing water pathways through the soil and, in turn, changing water chemistry in headwater basins. Growing uncertainty in aquatic chemistry regimes may have implications for regulating sustainable economic development in the North.

2.7 Hydro-meteorological modelling and prediction

For several years, researchers and scientists at Environment Canada and many partner agencies have used atmospheric and weather data as input for day-to-day operational forecasting models, and hydrologic data collected under the hydrometric agreements as input for hydrologic models. These models demonstrate how regional hydro-meteorological modelling can help improve water resources management.

Environment Canada scientists and regional hydrologists completed their involvement in programs funded by the Canadian Foundation for Climate and Atmospheric Sciences (CFCAS), including the Improved Processes and Parameterization for Prediction in Cold Regions program and the Drought Research Initiative. In particular, they made significant contributions toward the main objective of the Drought Research Initiative, which was to better understand the causes and impacts of major hydro-climatologic extremes over Canada, with a focus on the severe 1999–2005 drought that affected the Canadian Prairies. Specific contributions from Department scientists include research toward acquiring a better understanding of past variability and projected future occurrences of extreme droughts on the Prairies, and of groundwater variability associated with extreme Prairie drought events. Work is under way to establish a permanent archive of the data and findings for these CFCAS studies.

Throughout 2010–2011, the WSC contributed internationally through its leadership as the Canadian hydrological advisor to the World Meteorological Organization (WMO). This entails providing input and advice to the WMO on all matters related to hydrometric monitoring and hydro-meteorology. Specifically, it included the contribution of departmental expertise toward the development of a new WMO publication on stream-flow monitoring, published last year. As well, the Department continued its engagement in the Arctic Hydrological Cycle Observing System (HYCOS) initiative, which focuses on stream-flow assessment in the Arctic Ocean. Canada co-leads the Arctic HYCOS program with the Russian Federation.

Environment Canada scientists initiated a research study in 2009 to improve understanding of water availability and sustainability of stream-flow in the Athabasca River Basin, which is experiencing multiple stressors from climate change/variability and various water uses (e.g., water extraction for oil sands processing). Historical stream flow trends and variability for 33 hydro-ecologically relevant indicators of alteration on the Athabasca River main stem and tributaries continued in 2010–2011.

In 2010–2011, Environment Canada's atmospheric researchers continued to improve methods for coupled hydro-meteorological modelling and prediction under an expanded environmental prediction framework. The model enables an improved understanding of interactions between the atmosphere and land surface, and supports improved water management using the Modélisation environnementale de surface et hydrologie (MESH) system and the international Hydrologic Ensemble Prediction Experiment. Partnering with the U.S. Army Corps of Engineers, Environment Canada operationalized the MESH modelling system for historical analysis of the water balance in the upper Great lakes. The model will also help with understanding the water levels of the Great Lakes, which are of significant economic importance to Canada and the United States.

Ongoing studies have focused on improving our understanding of water availability in Canada through the development of new methods for modelling the hydrological cycle at a variety of scales, from small basins to large rivers. In 2010–2011, research continued on developing physically based models for frozen soils

parameterization and large-scale simulation of the Saskatchewan River Basin.

The development and implementation of Environment Canada's eco-hydraulic modelling system for major portions of the St. Lawrence River continued during 2010–2011, including work toward the operationalization of hydrodynamic models.

The Department continued to develop water supply indicators in support of the National Water Atlas project, and contributed to ecosystem trends studies that focused on the availability of water resources.

PUBLIC INFORMATION PROGRAM

(Part IV of the *Canada Water Act*)

Responsible decision making and widespread engagement of the public are critical to successful water resource management. Education and outreach are complementary instruments that are used to encourage water conservation and water quality protection measures. Informational and educational materials can promote responsible behaviour and inform Canadians about the status of our water resources and the health of aquatic ecosystems. Public awareness campaigns, comprehensive websites, information workshops, dissemination of educational programming and materials, and a wide range of field activities are among the many ways in which Canadians and their communities receive information and learn how to act on it. This section describes some of the ways through which Environment Canada and its partners engage Canadians to learn more about the country's water resources and provide information on its sustainable use and conservation at a national level. Public information campaigns are also undertaken at the project level and within specific regions. These activities are discussed throughout the annual report, including in the section on the ecosystem initiatives.

1 Environment Canada's Water Website

Environment Canada's Water website (www.ec.gc.ca/eau-water) continued to provide general information on a wide range of water-related topics, comprehensive educational materials (such as *A Primer on FreshWater* and various fact sheets), and the full text of key water publications (such as the *Canada Water Act Annual Report*, the Federal Water Policy, and reports on municipal water use and pricing). In addition, the site provides content on Environment Canada's water-related activities and program areas. During the reporting period, the addition of an extensive "Links" page to each subject area rendered the site a portal to other water-related websites in Canada and across the world.

Environment Canada's Water website was visited almost 419 000 times in 2010–2011, an average of 33 670 visits per month.

2 Biosphere Environment Museum

The only environment museum of its kind in North America, the Montréal-based Biosphere offers enjoyable, educational exhibitions and guided activities to help visitors better understand major environmental issues and learn about living a green lifestyle, whether they live in an urban or rural area. The museum covers areas such as water, air, biodiversity, climate change, transportation, responsible consumption and sustainable development, among others.

In 2010–2011, more than 100 000 people toured the museum's exhibits and/or took part in its off-site activities.

The Biosphere's regular programming includes a number of water-related activities:

- Drop by Drop, an interactive video conference aimed at high schools across Canada, focusing on water chemistry, pollution, the water cycle and ideas on how to conserve water.
- Evening seminars on water-related issues, presented free of charge at the Biosphere on World Water Day, in cooperation with the Canadian Museum of Nature.
- Adopt-a-River, an awareness-raising program for youth aged 11 to 18, coordinated by the Education and Water Monitoring Action Group and supported by the Biosphere and a broad network of coordinators in five provinces. The program celebrated its 10th anniversary in 2010.

- Sur la piste de l'eau, a guided tour on the St. Lawrence River for 10- and 11-year-olds.
- All the Water in the World, a scientific activity on the world's water resources.
- Two exhibitions: Water Wonders and Blue-green Algae.

3 WaterSense partnership

WaterSense is a voluntary, market-based partnership program sponsored by the U.S. Environmental Protection Agency. It works to promote water efficiency and enhance the market for water-efficient products, programs and practices, by helping consumers identify products and programs that meet certain water efficiency and performance criteria.

In January 2011, Environment Canada signed a Promotional Partnership Agreement with the Agency that identifies the roles and responsibilities of each jurisdiction in promoting WaterSense in Canada. Primarily the agreement opens the door for other levels of government in Canada (provincial-territorial and municipal) and other Canadian organizations (trade associations and non-governmental organizations) to secure individual partnership agreements with the Agency, in order to promote WaterSense in their jurisdictions and to their clients. Interested Canadian partners will form a consortium, the primary role of which will be to share information, minimize duplication and develop synergies. Environment Canada will be an active member of the consortium's steering committee, and will provide in-kind services that support the translation and metrification of the promotional information that will be distributed to Canadians online and in print.

Appendix A: Agreements

The following *Canada Water Act* agreements[2] were ongoing during 2010–2011:

Apportionment and monitoring programs

- Agreements on water quantity surveys with all provinces, and with Aboriginal Affairs and Northern Development Canada for the territories
- Canada–Quebec Protocol on Administrative Arrangements under the Canada–Quebec Agreement on Hydrometric and Sedimentological Networks in Quebec
- Master Agreement on Apportionment in the Prairie Provinces (Prairie Provinces Water Board)
- Water quality monitoring agreements with British Columbia, Newfoundland and Labrador, New Brunswick and Manitoba
- Canada–Prince Edward Island Memorandum of Agreement on Water
- Agreement Respecting Ottawa River Basin Regulation

On behalf of the federal government, the 2007 Canada–Ontario Agreement Respecting the Great Lakes Basin Ecosystem was made pursuant to the *Canadian Environmental Protection Act, 1999*, and the Canada–Quebec Agreement pertaining to the St. Lawrence (2005–2010) was made pursuant to the *Department of the Environment Act* and the *Department of Fisheries and Oceans Act*.

Water management programs

- Mackenzie River Basin Transboundary Waters Master Agreement

[2] For which *Canada Water Act* authority exists (in most cases, by Order in Council).

www.**ec.gc.ca**

Additional information can be obtained at:

Environment Canada
Inquiry Centre
10 Wellington Street, 23rd Floor
Gatineau QC K1A 0H3
Telephone: 1-800-668-6767 (in Canada only) or 819-997-2800
Fax: 819-994-1412
TTY: 819-994-0736
Email: enviroinfo@ec.gc.ca