Environment and Climate Change Canada
Environnement et Changement climatique Canada

Canada Water Act

ANNUAL REPORT

FOR APRIL 2015 TO MARCH 2016

Canada

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Flowtracker wading measurement in Neebing River, ON © Environment and Climate Change Canada

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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 of the Act requires that a report on operations under the Act be laid before Parliament as soon as possible after the end of each fiscal year. This annual report covers progress on these activities from April 1, 2015, to March 31, 2016.

The report describes a wide range of federal operations conducted under the authority of the *Act*, including participation in federal-provincial/territorial agreements and arrangements, significant water research, and public information programs. It also includes work done under the Act to safeguard the water quality and quantity of Canada's watersheds. 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:

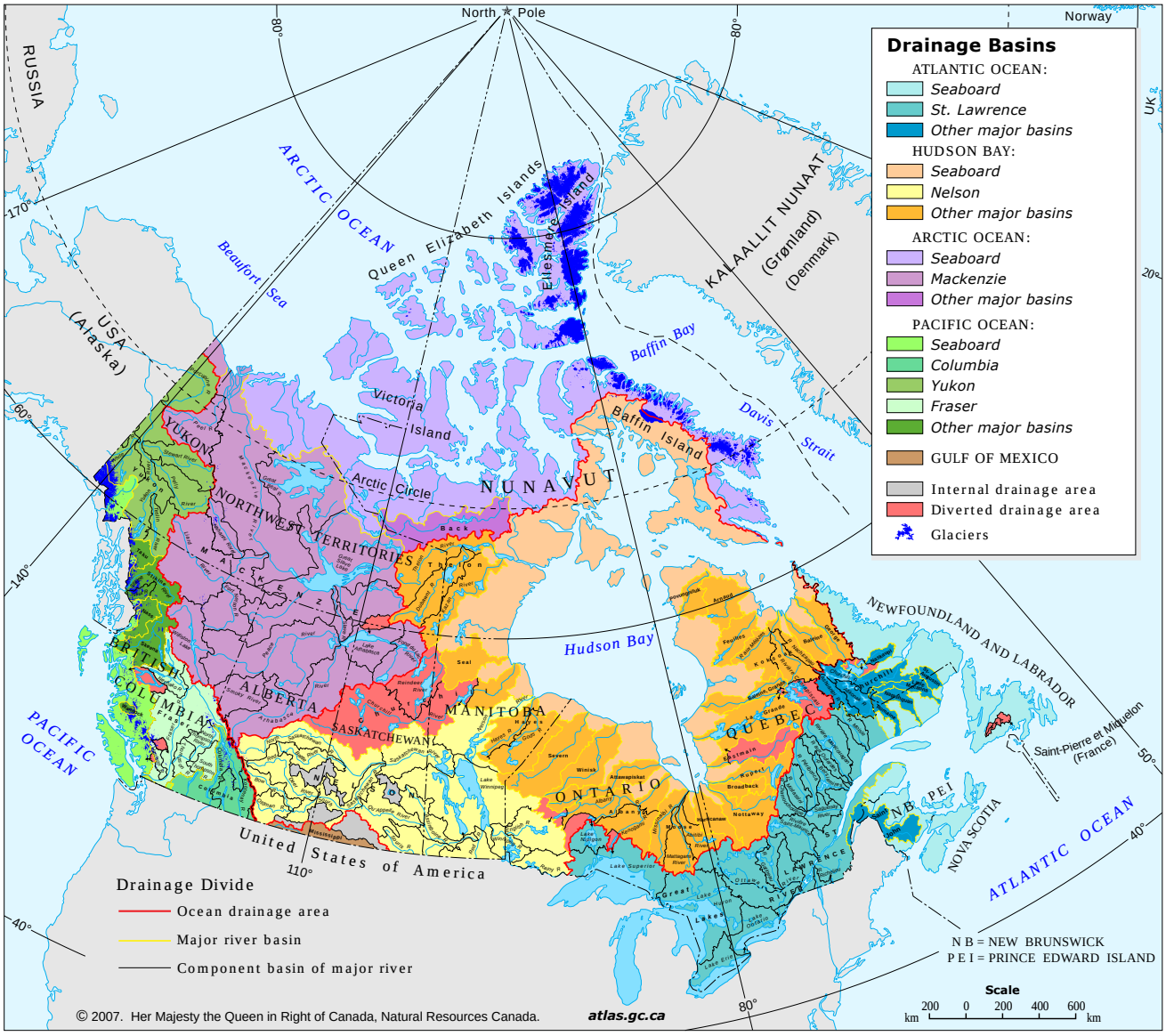
Part I, section 4, provides for the establishment of federal-provincial/territorial arrangements for the establishment of intergovernmental committees or other bodies in relation to water resource management. **Sections 5, 6 and 8** provide the vehicle for cooperative agreements with the provinces and territories to develop and implement comprehensive water resource management programs. **Section 7** enables the Minister, either directly or in cooperation with any provincial/territorial government, institution or person, to conduct research, collect data and establish inventories associated with water resources.

Part II provides authority for the establishment of federal-provincial/territorial management agreements where water quality has become a matter of urgent national concern. It also allows the Minister to name an existing corporation that is an agent of Her Majesty or that performs a function or duty on the Federal Government's behalf to plan and implement approved water quality management programs. The application of alternative cooperative 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, was 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/lcpe-cepa/default.asp?lang=En&n=64AAFDF1-1).

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: Drainage areas in Canada



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Executive summary

The *Canada Water Act* provides an enabling framework for collaboration among the federal and provincial/territorial governments in matters relating to water resources. This annual report highlights Environment and Climate Change Canada's (ECCC) operations under the Act from April 1, 2015, to March 31, 2016.

ECCC hydrometric technologist drills on the frozen McKenzie River to measure water flow under ice.
Photo: Brian Yurris © Environment and Climate Change Canada

During 2015–2016, the National Hydrometric Program (NHP) continued to provide water level and flow information to Canadians through a federal, provincial and territorial cost-shared network of approximately 2788 hydrometric stations. ECCC's Water Survey of Canada (WSC) program, the federal partner in the NHP, continued to operate approximately 2140 stations, about 1100 of which are fully or partially federally funded. Work also continued on outreach, technology development and maintaining the program's International Organization for Standardization certification.

Regarding the Joint Canada-Alberta Implementation Plan for Oil Sands Monitoring (JOSM), an external expert scientific review stated in their report that: "JOSM has made significant advances over the monitoring in place prior to 2012 by establishing more robust and comprehensive monitoring and improving the rigour, transparency and adherence to internationally recognized standards and protocols of the monitoring". The Review Panel Chair gave the monitoring a "solid B grade".

ECCC continued to lead and coordinate implementation of the 2014 Canada-Ontario Agreement on Great Lakes Quality and Ecosystem Health (COA). A joint federal-provincial assessment of progress against the 233 commitments identified in the Agreement completed in 2016, found that all COA commitments are on track to be completed by 2019. The COA Executive Committee, established to oversee the Agreement, concluded that one commitment (to develop a framework for monitoring natural recovery in Canadian Great Lakes Areas of Concern) is no longer needed as there is sufficient guidance available from the field of contaminated site management to monitor natural recovery in Areas of Concern.

Implementation of the Canada–Quebec Agreement on the St. Lawrence (2011–2026) continued, delivering 43 projects from its joint action program, along with activities under the Monitoring the State of the St. Lawrence River Program and the Numerical Environmental Prediction Program for the St. Lawrence.

In 2015–2016 the Atlantic Ecosystem Initiatives Funding Program included 14 projects relating to water quality, biodiversity and climate change. These included the enhancement and improvement of water quality and watersheds through activities such as identification and assessment of threats to water resources, water quality monitoring and research, and development of ecosystem management tools and management plans.

ECCC, through the Lake Winnipeg Basin Initiative (LWBI), continued to deliver on its mandate to reduce nutrient pollution in Lake Winnipeg and its basin through 13 scientific research projects, financial support for 31 stewardship projects and transboundary nutrient reduction activities.

I. Comprehensive Water Resource Management

The *Canada Water Act* provides an enabling framework for collaboration among the federal, provincial and territorial governments in matters relating to water resources. Each level of government has different roles related to the management of water resources. Joint projects involve the regulation, apportionment, monitoring or surveying of water resources, and the planning and implementation of programs relating to the conservation, development and utilization of water resources. As well, there are many areas of shared responsibility.

Lion's Head, Georgian Bay, ON
Photo: © Environment and Climate Change Canada

Canadian provinces, Yukon and Northwest Territories have responsibility 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 waste-water treatment operations in urban areas. In certain cases, local authorities responsible for a particular area or river basin take on some water resource management functions when requested by government.

The federal government has responsibility for managing water on federal lands (e.g., national parks), federal facilities (e.g., office buildings, laboratories, penitentiaries, military bases), First Nations reserves, and in Nunavut. The federal government also has jurisdiction to make laws in relation to fisheries, and navigation, both of which play a role in water management.

Agreements for specific water programs require participating governments to specify the amount of funding each will pay and the information and expertise they will provide, in agreed ratios. For ongoing activities such as the hydrometric monitoring agreements with each provincial and territorial government, cost-sharing is in accordance with each party's need for the data. For study and planning agreements, generally the federal government and the specific provincial or territorial 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 also occurs on a federal, provincial/territorial and federal-provincial/territorial basis. Cost-sharing for infrastructure often includes a contribution from local governments.

The following *Canada Water Act* agreements were ongoing during 2015–2016.

Agreements related to apportionment and monitoring programs

- Renewed hydrometric agreements with nine provinces, Yukon and Northwest Territories, and with Aboriginal Affairs and Northern Development Canada for Nunavut
- Master Agreement on Apportionment in the Prairie Provinces (Prairie Provinces Water Board)
- Water quality monitoring agreements with British Columbia, Newfoundland and Labrador, New Brunswick, Manitoba, and Quebec
- Canada–Prince Edward Island Memorandum of Agreement on Water
- Agreement Respecting Ottawa River Basin Regulation

Arrangements and agreements related to water management intergovernmental cooperation or programs

- Mackenzie River Basin Transboundary Waters Master Agreement
- Canada–Manitoba Memorandum of Understanding Respecting Lake Winnipeg and the Lake Winnipeg Basin

- The Canada–Ontario Agreement on Great Lakes Water Quality and Ecosystem Health, which was made pursuant to the CWA.

Other agreement related to water quality:

- The Canada–Quebec Agreement on the St. Lawrence (2011–2026), which was made pursuant to the *Department of the Environment Act* and the *Department of Fisheries and Oceans Act*

The sections below describe federal, provincial and territorial collaboration in the following areas:

1. data collection and use;
2. inter jurisdictional water boards; and
3. partnership-based ecosystem approaches.

1 Data collection and use

1.1 Water Quantity Monitoring

The NHP is responsible for providing critical hydrometric data, information, and knowledge that Canadians and their institutions need to make informed water management decisions that provide protection and careful stewardship of freshwater as a precious shared resource. This data is made available on ECCC's Wateroffice website at www.wateroffice.ec.gc.ca.

Hydrometric technologist near Thunder Bay, ON circa 1990
Photo: © Environment and Climate Change Canada

Formal bilateral hydrometric agreements between most provincial/territorial governments and the federal government provide for the collection, analysis, interpretation and dissemination of water quantity data. These agreements have been administered cooperatively since 1975.

Under the Partnership Renewal Process initiative, government partners have been reviewing, updating and revising the 1975 bilateral agreements. All agreements except those for Newfoundland, New Brunswick and Saskatchewan have been renewed since 2008. In 2015–2016, negotiations for agreements with New Brunswick and Saskatchewan continued and initial talks began with Prince Edward Island. The new agreements allow for the continued collection, processing, publication and distribution of water quantity data and information, using a common national approach and cost-share principles.

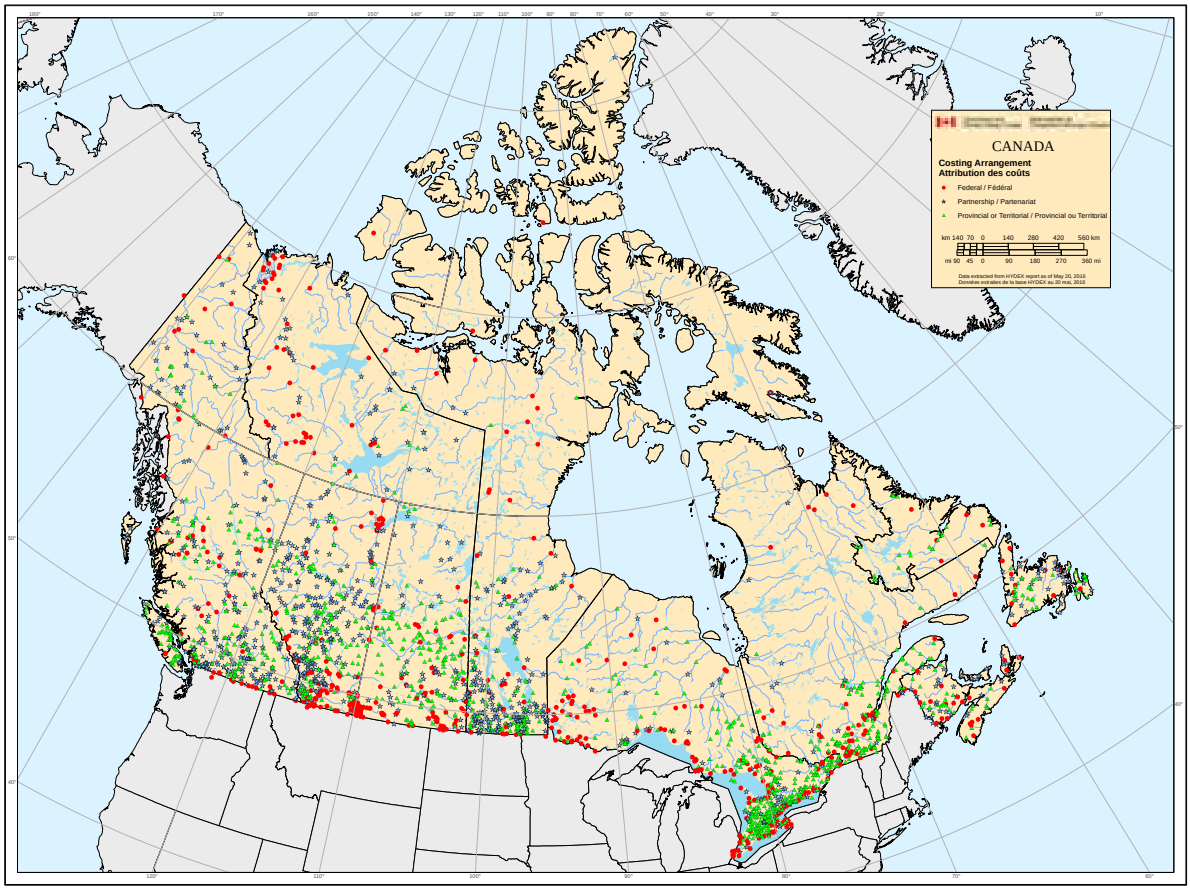
Governance

The NHP is co-managed by the National Administrators Table (NAT) and the NHP Coordinators' Committee, both consisting of members responsible for the administration of the hydrometric monitoring agreements in each jurisdiction and one national administrator designated by Canada. Both groups met regularly throughout 2015–2016 to discuss program issues. The NAT continued to support the implementation of ECCC's Datamart system by the provinces and territories. The system allows agencies to upload hydrometric data directly into their own software systems. Regular input from both groups, and an annual survey of NAT, provide valuable input on program operations, documentation and dissemination practices, and available training resources.

The Network

During 2015–2016, the national monitoring network of the NHP in Canada consisted of 2788 hydrometric monitoring stations (see Figure 2 and Table 1). During this period, ECCC's WSC, the federal partner in the NHP, operated 2140 of these hydrometric stations. Out of the ECCC-operated stations, 1146 were fully or partially federally funded, and the remaining were operated by ECCC on behalf of the provincial and territorial partners or a third-party interest, and cost-shared according to specific needs and requirements (see Table 1). In Quebec, the ministère du Développement durable,

Figure 2: National Hydrometric Monitoring Network



de l'Environnement, et de la Lutte contre les changements climatiques operated 228 stations, some funded in whole or in part by the Government of Canada. ECCC disseminates the Quebec-collected data, along with data from another 420 stations operated by parties other than ECCC across Canada. Note that the increase in contributed stations since 2014–2015 is in part due to the inclusion of 84 stations run by Manitoba Hydro that were not counted last year but are not a new addition to the network.

In 2015–2016, there were no significant changes to the size of the national hydrometric network, although the network did undergo some adjustments, including the following:

Yukon

- In addition to five hydrometric stations that were re-established in 2014–2015 at former ECCC sites previously decommissioned in the 1990s, a sixth site was re-established in 2015–2016.
- Several stations located in British Columbia and Nunavut continue to be operated by the ECCC Yukon office and some paid for by Yukon Energy.
- Eight new territorial hydrometric stations began operating in 2015–2016, as part of an ongoing multi-year network expansion.

1. Takhini River above Kusawa Lake
2. South MacMillan River at Km 407 Canol Road
3. Hess River above Emerald Creek
4. Little South Klondike River below Ross Creek
5. Whitestone River near the Mouth
6. Hyland River at km 108.5 Nahanni Range
7. Babbage River below Caribou Creek
8. Caribou River near the Babbage Confluence

Nunavut:

- One station in Nunavut: Contwoyto Lake at Lupin Mine switched from a Federal-Territorial cost share arrangement to now being funded by the Territorial government.

- All stations in Nunavut are operated by the ECCC, and funded by a combination of ECCC, Parks Canada, Indigenous and Northern Affairs Canada (INAC) and the City of Iqaluit.

Northwest Territories

- Two new commercial stations were installed in the Northwest Territories in 2015–2016: Mackenzie River near Fort Providence and Yellowknife River above Quyta Lake.
- Mountain River below Cambrian Creek and Buffalo River at Highway #5 and four other territorially-funded station are being prepared for re-installation next year.
- A few commercial stations were taken over by federal and territorial governments: La Martre River below outlet of Lac La Martre is now funded federally and Hoarfrost River near the mouth, Tazin River near the mouth and Kakisa River at Outlet of Kakisa Lake are now funded by the Territory. Territorial station Baker Creek at Outlet of Lower Martin Lake is now cost-shared between INAC and the Territory.
- Reconnaissance for seven new territorially-funded stations began in 2015.

British Columbia

- Two provincially-funded stations were added at Carbon Creek near the mouth and Lillooet River at Tenas Narrows, and five provincial and commercial stations (Tsolum River below Murex Creek, Trepanier Creek Near Peachland, Compass Creek Near Kispiox, Five Mile Creek Above City Intake And Camp Creek Near The Mouth) were removed from the network, resulting in a net loss of three stations to the network.
- 34 hydrometric stations were upgraded to real-time. A total of 372 stations (84%) of the hydrometric network report in real-time.

Alberta

- Temporary gauges installed in 2015 are still being used to monitor the flow at stations that were destroyed by a flooding event in June 2013, although one such station is still not operational. Cableways damaged during the 2013 flood have not yet been repaired.
- Recently 89 of 91 staffed cableways in Alberta are still suspended from operation pending an operational review and engineering inspection.
- The annual operation of 12 stations operated by the ECCC continued as part of a network of approximately 50 stations in the oil sands region. In addition, ECCC completed a report assessing the state of the hydrometric network operated by contractors in the region, and provided estimates as to the costs necessary to bring the entire oil sands hydrometric network in line with ECCC operation.
- Four water quality sensors were connected to ECCC loggers to allow real time information for Alberta Environment at JOSMP sites.

Manitoba and Saskatchewan

- Monitoring continues to move towards safer alternatives, reduced infrastructure and operational efficiencies by investing in bank-operated cableways, remote control boats and tilting mast stations.
- In two jointly-funded (Fed/Prov) stations ceased operations as replacement stations in new locations were established and became operational within the same year.
- Two Federal stations were discontinued in August 2015, after they were deemed to be not required at the International Joint Commission - St. Mary's/Milk Rivers Eastern Tributary meeting. One station funded by Parks Canada was also discontinued in August.
- Two stations were extended from a seasonal operational period to continuous, and one station that currently provides continuous water levels is being investigated for conversion to a flow station by the addition of an Acoustic Velocity Meter.
- Work is continuing with the Canada-Manitoba Lake Winnipeg MOU steering Committee, by providing regular updates on activities relevant to watershed health of Lake Winnipeg.
- Note that the increase in "contributed" stations since 2014–2015 is in part due to the inclusion of 84 stations run by Manitoba Hydro that were not counted last year but are not a new addition to the network.

Ontario

- To support the Ontario Ministry of the Environment study of small basins and contaminants (Southern Ontario Multi-Watershed Study), six additional stations were installed and

instrumented in 2015–2016 in southern Ontario, bringing the total to ten stations

- One new discharge gauge was installed at the request of the City of Hamilton, to fulfill their mandate for source water protection understanding.
- One gauge at a minor outlet of the Lake of the Woods (known as Mink Creek) was discontinued, as discharge computations were taken over by the Lake of the Woods Control Board.
- One gauge in the Greater Toronto-Hamilton Area was discontinued due to a decade of excessive sediment load downstream of the Niagara escarpment.
- A permanent location for the jointly-funded Turkey Creek gauge was located and installed. The previous site was successfully decommissioned, with soil testing by the Contaminated Sites Group showing complete remediation in relation to previous mercury manometer operations.
- Temporary gauge installations were used at various times throughout the year at 3 locations
- Five stations were improved with new or re-installed station infrastructure for bank stabilization, more sustainable look-in installations, and ground screws for stabilization of very shallow well installations.
- Two control structures in the Greater Toronto-Hamilton Area were improved/repaired to increase predictability in the stage-discharge relationship during low-medium water levels and repair erosion resultant from extreme high water events.
- Two stations were relocated to improve safety and reliability of access year-round and to increase data quality.
- Two bank operated cableways were inspected and support structures were load-tested. The use of load-failure devices is recommended and will be implemented prior to further use.
- Four northern remote locations were enhanced with satellite transmission cameras at the request of the Ministry of Natural Resources and Forestry.
- A provincial effort, supported by the Minister of Natural Resources and Forestry, continues to increase the number of stations using satellite telemetry to transmit real-time data and increase the number of stations using solar power.

Quebec

- In Quebec, 228 stations (3 less than in 2014–2015) are run by the province and data are contributed to the NHP database. An additional 17 stations (one more than in 2014–2015) are run by the ECCC in Quebec to address federal data needs.
- Four stations previously provincially funded are now federally funded (but still operated by Quebec) and 3 are now funded by a Federal-Provincial cost share. Conversely, 3 previously federally-funded stations are now paid for by the Province.

Atlantic Region

- No major changes to the network in New Brunswick occurred in 2015–2016. Two stations are listed as "commercial" but are paid for the New Brunswick Department of Transportation (not a NHP partner).
- In Newfoundland one new provincial station was established (Steady Brook above confluence to Humber River).
- As of April 1, 2015, a Nova Scotia station, Tusket River at Wilson's Bridge, changed from being requested by Nova Scotia Power (commercial) for dam management, to being paid for by the province at the request of Environment NS.
- In PEI, one additional commercially-funded station was operated by ECCC in 2015–2016 compared to the year before.

Outreach

In addition to its contribution to the Canadian Environmental Sustainability Indicators program (see section 1.3), the NHP has integrated the water quantity indicator calculator into its HYDAT interface application, the ECCC Data Explorer (ECDE), thereby making it publicly available in both official languages. The new version of ECDE was delivered internally near the end of 2015–2016 and is expected to be published in early 2016–2017.

Technology

The NHP continued its investment in new field technologies, including hydroacoustic equipment and advanced deployment platforms, such as remote bank operated cableway systems and remote control boats, in part to deal with the challenge of

Table 1: Stations within the National Hydrometric Monitoring Network

	WSC-operated (by cost arrangement)					
Province/ Territory*	**Federal**	**Cost-shared****	**Province/ Territory**	**Third party**	**Non-WSC-operated (various cost arrangements)**	**Total by province or territory**
Alta.	78	158	161	1	55	453
B.C.	50	180	203	0	7	440
Man.	25	83	107	0	179	394
N.B.	14	21	20	2	0	57
N.L.	16	32	61	0	0	109
N.S.	10	6	9	2	0	27
N.W.T.	41	24	13	14	0	92
Nun.	13	4	5	3	0	25
Ont.	124	67	330	9	44	574
P.E.I.	0	5	0	5	0	10
Que.	17	0	0	0	228	245
Sask.	95	51	14	0	135	295
Y.T.	9	23	34	`	0	67
Total	**492**	**654**	**957**	**37**	**648**	**2788**

* Hydrometric monitoring stations located within the boundaries of each province, no matter which office operates them.

** Cost-shared stations are those that are partially funded by the federal and the provincial/territorial governments. The cost-share ratio varies by station.

Note: The network also includes a small number of designated International Gauging Stations located in the United States that are not included here as they support International Joint Commission activities not covered under the *Canada Water Act*.

decommissioning hundreds of manned cableways across the country. Work continues to refine standard operating procedures and methods to ensure these advanced measurement techniques provide accurate and reliable data, while maintaining and improving safe work practices.

An innovative project began in 2015 involving the in-house design and development of electronic Hydrometric Survey Notes, which aim to modernize how ECCC documents hydrometric field activities, going from a paper-based system to a more standardized digital system.

As part of ongoing efforts to improve the reliability of real-time data collected at hydrometric gauges, the National Hydrological Service began installation of remote surveillance cameras at select locations in the hydrometric network in 2015–2016. The cameras provide near real-time information on current conditions (e.g. ice, flood) which aid in interpretation of hydraulic conditions affecting the observed gauge record. Pictures from the cameras are also proving valuable to assess local site conditions which may impact access to the site due to weather or flood.

Data dissemination

The Hydrometric Data Management Integration and Renewal (HyDMIR) project is well underway to integrate real-time hydrometric data into the ECCC Meteorological Service of Canada data management system. This project aims to build a more efficient, robust dissemination system and to decommission legacy infrastructure and software. Phase 1 and 2 of the project are ongoing and expected to be completed in 2016–2017.

The national WaterOffice web site (www.wateroffice.ec.gc.ca) is being converted to a new web format. The development is near completion, with a final test to be conducted in early 2016–2017. The release of the new site will be coincident with the HyDMIR

project release as HyDMIR provides the data source for the new development platform.

The bulk downloading of archive hydrometric data is now available in a higher quality format (.sqlite3), released quarterly with the HYDAT database file.

The North American Water Watch (NAWW) Web page (http://watermonitor.gov/naww/en/index.php) was enhanced with some new features: downloadable Google Earth (KML) format was added; Canadian basins are available in the drop down list; multiple regions can be displayed simultaneously on the map; when a region is selected, a direct switch between the English and French versions is now available; and pop-up messages were added on the main page.

International Organization for Standardization certification and audits

The NHP continued to maintain its International Organization for Standardization (ISO) certification during 2015–2016. Six internal Quality Assessment Program office and field audits were performed at various ECCC WSC offices throughout Canada, as required under the ISO process. The results of the audits were positive and resulted in very few calls for corrective actions and/or opportunities for improvement within the program.

ISO-9000-2008 continued to be the quality management standard to which ECCC operates, although work commenced toward adopting the new ISO-9000-2015 standard, which will be implemented over the next 3 years (target date of 2018 for organizational compliance).

Updating of ECCC's WSC Standard Operating Procedures (SOPs) continued in 2015–2016, keeping pace with changes in technology in the operational program, and changes to the computational environment with the adoption of the hydrometric workstation over the past several years. A new SOP for rating curve development, a key stage in the data acquisition and approvals process, was adopted by the program in March 2015.

Research

ECCC, in cooperation with the University of Manitoba, University of Victoria, and Alberta Innovates Technology Futures, continues to support the national pilot of an operational isotope network in conjunction with their hydrometric network, similar to the existing isotope-hydrometric network in the United States. The goal is to demonstrate the value in systematic collection of river discharge in tandem with analysis for oxygen-18 and deuterium across Canada.

A multi-year contribution from ECCC to AITF made possible the collection of stable water isotopes at selected ECCC gauging stations across the country during 2015–2017, to gain insight into the sources of streamflow (rain, snow, groundwater, wetlands, glaciers etc.) and their spatio-temporal variability, to characterize open-water evaporation losses and to partition evapotranspiration, to assist in parameterization of isotope-capable hydrological models such as WATFLOOD, and to assist in water quality, ecological studies, and net primary productivity estimation.

1.2 Water quality monitoring

1.2.1. Freshwater Quality Monitoring

Freshwater quality monitoring has been a core program function of ECCC since the Department's inception in the early 1970s. The Department's monitoring and surveillance activities are critical for assessing and reporting on water quality status and trends, and for fulfilling many federal domestic and international commitments and legislative obligations. Much of the Department's monitoring is carried out through federal-provincial/territorial agreements, ensuring cost-effective and non-duplicative program delivery.

ECCC scientists in the field at Richardson River, AB

Photo: © Environment and Climate Change Canada

The objectives of the federal-provincial/territorial water quality monitoring agreements are to achieve a long-term commitment for the acquisition of water quality data; to obtain comparable, scientifically sound water quality data that are reliable to inform water resource management; and to disseminate timely information on water quality to the public, government agencies, industry and the scientific community. Data are also used to support the freshwater quality indicator in the Canadian Environmental Sustainability Indicators (see section 1.3). Five federal-provincial water quality monitoring agreements are active.

For more information, please consult the ECCC Fresh Water Quality Monitoring and Surveillance website at www.ec.gc.ca/eaudouce-freshwater/Default.asp?lang=En&n=6F77A064-1.

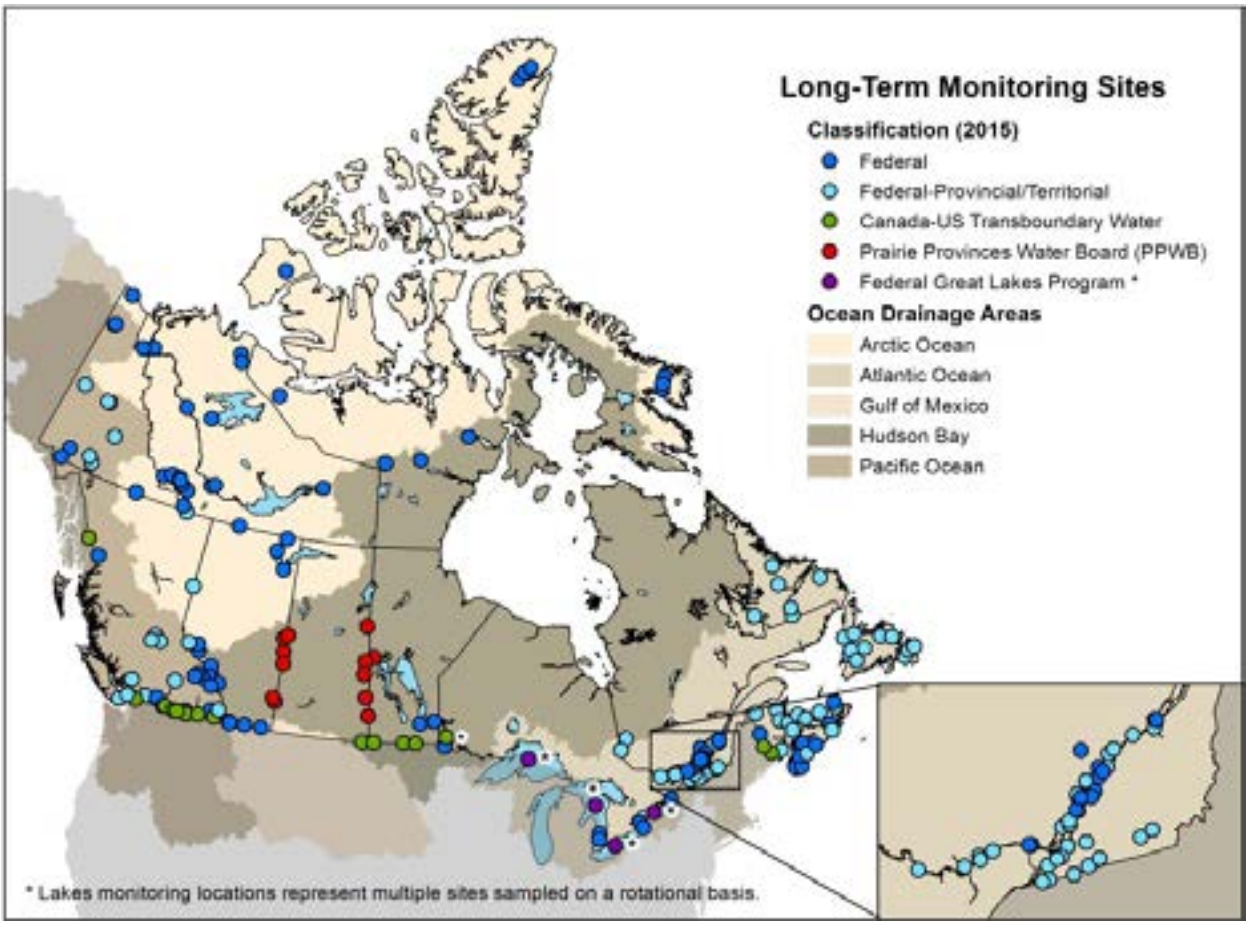
The long-term freshwater quality monitoring network consists of federal, federal-provincial and federal-territorial sampling sites across Canada (see Figure 3).

Water quality samples are collected routinely at these sites for physical and chemical water quality parameters such as temperature, pH, alkalinity, turbidity, major ions, nutrients and metals. Pesticides and additional parameters of concern are also monitored where site-specific water quality issues exist.

The Freshwater Quality Monitoring (FWQM) Program is aligned with Canada's major watersheds (Pacific, Arctic/Athabasca, Hudson Bay and Atlantic watersheds). This program promotes robust water resource management across Canada.

The FWQM Program has developed a Risk-Based Basin Analysis (RBBA), a geospatial approach to identifying relative risks and priorities in basins (sub-drainage areas) across Canada. Key stressor variables were identified, stressor intensities calculated, and compilation of relevant geospatial layers continued. The RBBA is an "ever-green" analytical tool that is intended to be used in conjunction with statistical power analytical tools

Figure 3: Long-term water quality monitoring sites



to optimize the national monitoring networks such that sampling locations and frequencies are aligned with risks of water quality impairment in Canadian watersheds.

In addition, work is under way to categorize sampling locations by type of water body in order to facilitate the reporting of environmental information across the country.

Pacific Watershed

In the Pacific Watershed (which includes parts of British Columbia and Yukon), monitoring is conducted under the Canada–British Columbia (BC) Water Quality Monitoring Agreement and under operational schedules agreed to with the Yukon government. In British Columbia, under the Canada-BC Agreement, originally signed in 1985, ECCC conducts joint monitoring with the provincial Ministry of Environment at 39 river sites (including 1 automated site). In the Yukon, 11 sites (including 1 automated site) were monitored on rivers in collaboration with Environment Yukon.

One of the Canada–British Columbia monitoring sites located in the Fraser River Estuary is a monitoring buoy platform. This automated site provides real-time water quality, meteorological, and grab-sample data to the public on ECCC's Fresh Water Quality Monitoring and Surveillance website. Quality assurance testing procedures for of the automated sampling equipment were developed in 2015. ECCC, in collaboration with the Department of Fisheries and Ocean and the British Columbia Ministry of Environment, also deployed two real-time water quality monitoring buoys in Osoyoos Lake in 2015. Data generated from automated sites are used to identify important trends and emerging water quality issues from urban, agricultural and industrial activities in the lower Fraser and Okanagan Basins.

In 2015–2016, ECCC operated five long-term water quality monitoring sites in four national parks, in partnership with the Parks Canada Agency (Glacier, Yoho and Kootenay National Parks in British Columbia and Kluane National Park in Yukon). The sites are relatively pristine and provide important reference information for comparison with sites influenced by human activities. Many of these sites are also located in key areas for assessing climate change.

Arctic/Athabasca Watershed

ECCC undertakes monitoring at 48 sites within the Arctic Watershed and across the North: 24 in Northwest Territories, 10 in Nunavut, 2 in Yukon and 12 in northern Alberta. A majority of these sites are operated in cooperation with Parks Canada and include 8 national parks (Auyittuq, Quttinirpaaq, Ukkusiksalik, Aulavik, Ivvavik, Tuktut Nogait, Nahanni and Wood Buffalo National Parks). Many of these sites are co-located with Water Survey of Canada gauge stations. In 2015–2016, a total of 147 sampling trips were completed.

Many of the high-Arctic sites are considered relatively pristine and, over time, provide an important baseline and reference for comparison with respect to long-range transport of atmospheric pollutants to high-latitude areas, as well as for any potential future influences from human activities in the North. ECCC also operates water quality sites on major rivers in the North, some of which are associated with transboundary basins (e.g., Mackenzie River, Slave River, Liard River) or are significant northern watersheds (e.g., Coppermine River, Thelon River, Great Bear Lake/River). Additional northern rivers are also monitored in Yukon (see Pacific Ocean Watershed section, above).

Hudson Bay Watershed

In the Hudson Bay Watershed, ECCC conducts water quality monitoring at key interprovincial and international transboundary sites as well as in certain national parks. ECCC also assists the Ministry of the Environment and Climate Change (Ontario) Water Quality sampling efforts in the far north by collecting samples for analysis - targeting 5 sites, 3 times per year - in the general area of the Ring of Fire.

Monitoring on the Prairies

In support of the Prairie Provinces Water Board Master Agreement on Apportionment, ECCC monitors 12 sites along the main rivers crossing between the Alberta, Saskatchewan and Manitoba provincial boundaries. This work supports annual reporting on water quality objectives for nutrient, metal, major ion and pesticide parameters established by Canada, Alberta, Saskatchewan and Manitoba. The water quality data and information obtained is also used to support the Lake Winnipeg Basin Initiative. Water

quality data are routinely shared with partners involved in the Lake Winnipeg Research Consortium, including the Province of Manitoba, federal departments, universities and institutes working on Lake Winnipeg.

ECCC continued to work with Manitoba Conservation and Water Stewardship under the Canada-Manitoba Lake Winnipeg Memorandum of Understanding and its Science Subsidiary Arrangement. The MOU, renewed in 2015, supports the development of science-related data, indicators and nutrient targets.

Other key transboundary monitoring sites are located on the Red, Pembina, Winnipeg and Souris rivers and on the Milk River–St. Mary River system. The Red and Souris rivers, in particular, have encountered many water quality issues over time (nutrients, metals, pesticides, salinity). Water quality and water quantity issues on these rivers are addressed formally through the International Red River Board and International Souris River Board under the International Joint Commission (IJC). Regular monitoring updates were provided to these boards and to a number of institutional partners in 2015–2016.

All of the transboundary rivers in the watershed are monitored regularly (8 to 12 times per year). During the 2015–2016 open water season, the Red River was monitored more intensively (biweekly to weekly) to address continuing concerns related to increased water releases from Devils Lake (North Dakota) crossing the Canadian border, and to improve the nutrient loading estimates for Lake Winnipeg. ECCC also operates an automated station on the Red River at Emerson, Manitoba, as a real-time alert system in the context of transboundary flooding and water quality monitoring. In July 2015, ECCC participated in an international interagency cooperative effort to collect biological data on the Red River that will be used to inform nutrient guideline development for the Red River at the international border.

In 2015–2016, the Red Deer and Battle Rivers near the Alberta and Saskatchewan border and the Assiniboine River near the Saskatchewan and Manitoba border in the Prairies were monitored for neonicotinoids, a class of pesticide that has seen increased use and received significant global attention. Transboundary contamination in the Red River, a key international transboundary waterway, was also monitored for a suite of current use pesticides, including neonicotinoids, carbamates (fungicide) and sulfonyl urea (herbicide).

As an international and interprovincial transboundary waterway, Lake of the Woods is relatively unique in the number of jurisdictions and international organizations, such as the IJC, that have a role to play for successful environmental management. Local and national concerns with noxious and potentially toxic cyanobacteria (blue-green algae) blooms and declining water quality in Lake of the Woods prompted the formation of ECCC's Lake of the Woods Science Initiative as part of a larger program to assess and remediate deteriorating water quality in Lake Winnipeg. In 2015–2016, as part of the international effort, ECCC conducted an annual monitoring cruise on the lake. This effort is unique because it provides a whole-lake snapshot bi-annually, allowing scientists to assess the spatial inter-lake water quality relationships, an important part of tracking changes in the hydrological system. In addition, the Rainy River, an international boundary river and the major tributary to the lake, was monitored regularly for nutrients and trace metals at several key points along the river.

Atlantic Watershed

In the Atlantic Watershed, federal-provincial water quality monitoring is supported through the Canada-US Great Lakes Water Quality Agreement, Canada–Quebec Water Quality Agreement, Canada–New Brunswick Water Quality Monitoring Agreement, the Canada–Newfoundland and Labrador Water Quality Monitoring Agreement, as well as the Canada–Prince Edward Island Memorandum of Agreement on Water.

In 2015–2016, a broad range of monitoring activities was undertaken in the Great Lakes targeting water, sediment and fish. The impacts of the 1978 Canada-US Great Lakes Water Quality Agreement phosphorus controls and the introduction and explosive spread of non-native mussels are evident in the long-term monitoring record for the Great Lakes. Monitoring results demonstrated which waters have phosphorus concentrations below established targets and which areas may require further nutrient action or controls. Other work in the Great Lakes included monitoring a number of chemical pollutants, as well as the first basin-wide monitoring of flame retardants.

ECCC also conducted water and sediment monitoring in Hamilton Harbour to establish a baseline condition

that will be used to measure the effectiveness of scheduled sediment remediation activities at Randle Reef.

The Canada–Quebec Water Quality Monitoring Agreement signed at the end of 2012–2013 comprises 39 sites in the transboundary St. Lawrence River and its tributaries. In addition to the sites covered by this agreement, ECCC operated 10 additional federal sites (including 6 automated) in the St. Lawrence River Basin. The sites were sampled monthly in 2015–2016 for physicals, nutrients, metals, pesticides and polybrominated diphenyl ethers (PBDEs).

The Canada–New Brunswick Water Quality Agreement was signed in 1988 and updated in 1995. During 2015–2016, 10 federal-provincial sites were monitored under the Agreement. The sites are located on international and interprovincial transboundary rivers or their tributaries in the Saint John River and Restigouche River watersheds. Two real-time (automated) sites were also maintained by ECCC at the borders of the transboundary Big Presque Isle Stream and Meduxnekeag River.

The International St. Croix River Watershed Board, under the IJC, plays an important role in managing water levels, water quality and fisheries between Maine and New Brunswick. The Board works collaboratively with stakeholders within the watershed by preventing and resolving disputes. ECCC monitored water levels at seven stations in the watershed and real-time (automated) water quality at two stations and provided input to the Board's 2015 Annual Report to the IJC.

The Canada–Prince Edward Island Memorandum of Agreement on Water was originally signed in 1989 and renewed in 2001. Eleven sites were monitored under the agreement in 2015–2016. One real-time (automated) site was operated on the Wilmot River. The sites are distributed across the province, with data available on the Government of Prince Edward Island's website at http://www.gov.pe.ca/environment/index.php3?number=1043751&lang=E.

In 2015–2016, ECCC managed 13 federal sites (including 2 automated sites) in Nova Scotia in support of the Canadian Environmental Sustainability Indicators. Nova Scotia Environment provided support on data collection. The sites are located across the province and cover major watersheds within the Maritime Major Drainage Area, including those flowing into the Bay of Fundy.

In Newfoundland and Labrador, 79 sites across the major drainage areas were sampled 4–8 times in 2015–2016. Data and station information from the sites is available on the Department's website at http://genie.qc.ec.gc.ca/wqmsd_en.aspx, as well as on the Newfoundland and Labrador Water Resources website at http://maps.gov.nl.ca/water/.

For more information, please consult the ECCC Fresh Water Quality Monitoring and Surveillance website at www.ec.gc.ca/eaudouce-freshwater/Default.asp?lang=En&n=6F77A064-1.

1.2.2. Biological Monitoring

In addition to the physical-chemical water quality monitoring detailed above, ECCC also undertakes biological monitoring using benthic macroinvertebrates to assess the health of aquatic ecosystems.

The Canadian Aquatic Biomonitoring Network (CABIN) is a component of the Freshwater Quality Monitoring (FWQM) program for assessing the biological condition of freshwater ecosystems in Canada using standardized data collection and analysis methods (www.ec.gc.ca/rcba-cabin). This component, based on decades of research and development in many countries, has been adopted by multiple agencies and organizations across Canada. The success of CABIN results from interagency collaboration and data sharing. It is led by ECCC's National CABIN Team, which provides online data management, assessment tools and models, field and laboratory analysis protocols, certification and training, and ecological research and development. Network partners share their observations within the national database. CABIN partners include federal, provincial and territorial government departments, industry, academia, Indigenous communities, and non-governmental organizations such as community watershed groups. A CABIN Science Team, consisting of ECCC and external scientists with expertise in large-scale ecological monitoring, provides science advice and recommendations for the CABIN component of the FWQM program.

Currently, there are 13 reference models available to assess the biological health of freshwater bodies in Yukon, British Columbia, Nahanni National Park,

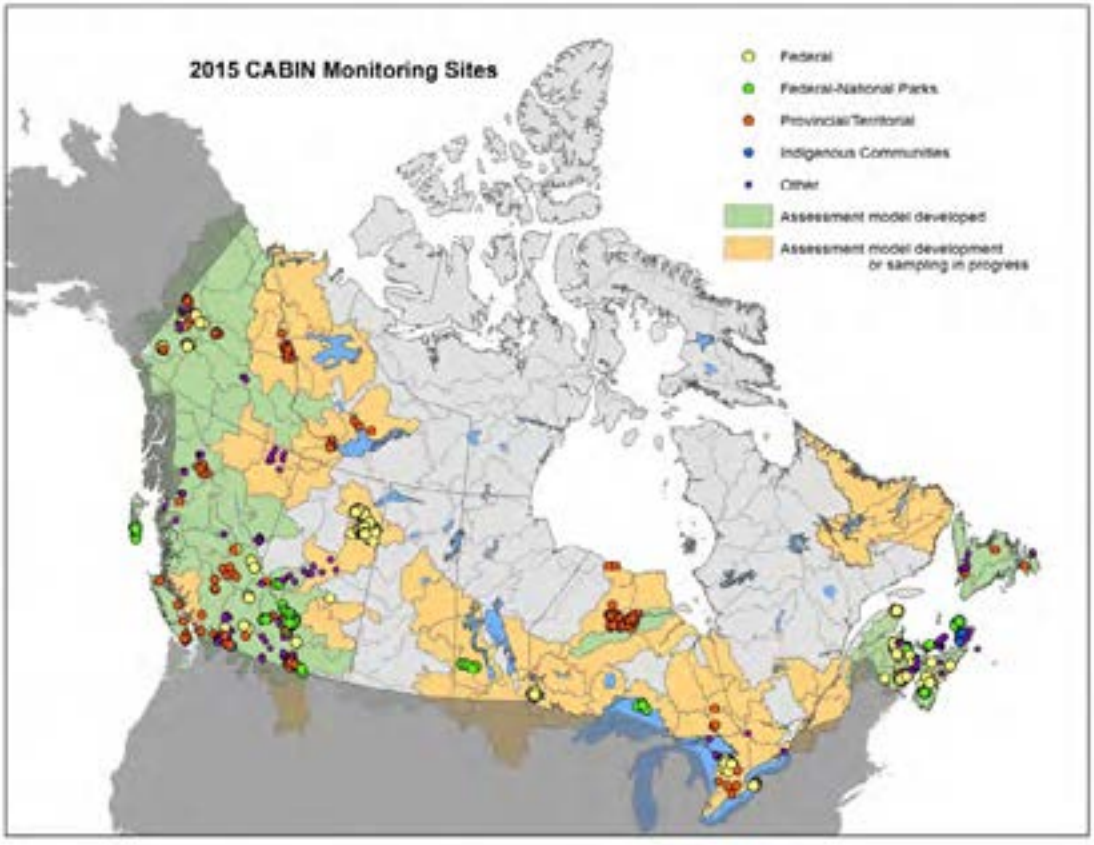
Rocky Mountains national parks, the Atlantic provinces and the Great Lakes. Two new models were finalized and made available to users in 2015: BC Central-North Coast and Attawapiskat Basin in Northern Ontario. Two additional models are currently being finalized: a preliminary northeastern British Columbia model and a Near-North Ontario model. Quality control evaluations for laboratory processing and taxonomy were published in 2015. Quality assurance evaluations for national program processes and program data were finalized in early 2016.

Since the early development of the CABIN monitoring strategy in the 1980s, data have been collected in over 8070 locations across the country. In 2015–2016, data were collected at 1,108 sites in several sub-basins across the country by ECCC and its partners (Figure 4). The development of a national training program in 2008, in partnership with the Canadian Rivers Institute of the University of New Brunswick, provided a means of promoting the use of national protocols, and expanding data collection and knowledge of biological conditions across the country. In 2015–2016, participation in the online modules included 164 participants. Program trainer capacity was also expanded with five new trainers certified through the CABIN Train-the-Trainer program and three ready for certification in 2016. As the number of CABIN-trained participants increases, the ability to generate new data across the country and assess water quality improves for ECCC and all network partners.

Pacific Watershed

In British Columbia, CABIN monitoring is jointly conducted under the Canada–British Columbia Water Quality Monitoring Agreement. Under this agreement, ECCC and the provincial Ministry of Environment collaborate on data collection for reference model maintenance and development and site assessment. Eleven reference models are available to all CABIN users to conduct biological assessments in watersheds in British Columbia and Yukon that were developed collaboratively by federal, provincial and territorial agencies (i.e., Department of Fisheries, Oceans and the Canadian Coast Guard, Parks Canada, BC Ministry of

Figure 4: CABIN monitoring sites



Environment, and Government of Yukon). Models are available for the Yukon River Basin, Fraser River/Georgia Basin, Skagit River Basin, Columbia/Okanagan Basin, B.C. Coastal, Skeena Region and Rocky Mountains national parks models. In 2015–2016, ECCC collected CABIN data from 25 stream and river sites: 11 sites for reference model maintenance and development, and 14 sites for assessment of biological condition co-located at long-term physical-chemical monitoring sites. The Fraser River/Georgia Basin and Yukon Territory reference condition bioassessment models were revised and made available through the CABIN website.

Arctic/Athabasca Watershed

CABIN activity in the Arctic Ocean Watershed has been focused in the Athabasca Basin. Under the Joint Canada–Alberta Implementation Plan for the Oil Sands, CABIN protocols have been applied in the tributaries of the Athabasca River as per recommendations in Phase 2 of the Integrated Monitoring Plan, with a total of 53 sites visited in 2015–2016. The program also included biomonitoring sampling in the mainstem of the Athabasca River, with 11 monitoring reaches along the Athabasca River and multiple stations within each reach representing 110 sampling sites. The sampling sites range from within the active oil sands development area to outside the development area as well as beyond any natural exposures of the bituminous geologic formations in the region. In addition to understanding potential impacts from active bitumen mining, the JOSM freshwater program aims to understand how natural exposure to bitumen shapes biological communities. A reference condition model is currently being developed for the Athabasca Oil Sands Region.

Further details can be found in section 1.2.2 and on the Canada–Alberta Oil Sands Environmental Information Portal at www.jointoilsandsmonitoring.ca/pages/home.aspx?lang=en.

Hudson Bay Watershed

CABIN sampling has been focused on the Lake of the Woods, conducted as part of the Lake of the Woods Science Initiative. A preliminary reference model for the lake was developed and will be revised in two years based on additional data collected. Located at the corner of Ontario, Manitoba and Minnesota, Lake of the Woods is the largest lake in the drainage basin upstream of Lake Winnipeg, contributing approximately 6% of the total phosphorus load to Lake Winnipeg via the Winnipeg River.

Atlantic Watershed

In the Atlantic Watershed, 210 stream and river sites were monitored by ECCC and its provincial partners 2015–2016 (193 in the Atlantic provinces, and 17 in Quebec), using CABIN sampling protocols. This work supported federal-provincial water quality monitoring agreements with New Brunswick, Nova Scotia, Newfoundland and Labrador, and Prince Edward Island. Monitoring data collected also informed the, Canadian Environmental Sustainability Indicators. The monitoring allowed partners to conduct assessments in transboundary watersheds (Saint John River, St. Lawrence River) and federal lands (i.e., national parks, Indigenous communities, and the Meaford and Gagetown Canadian Forces Bases). CABIN sampling using lake protocols was also conducted in the Great Lakes.

1.2.3. Freshwater Quality Monitoring Marine Water Quality Monitoring

In 2015–2016, ECCC conducted fecal coliform monitoring in 1369 bivalve molluscan shellfish harvesting areas on the Atlantic and Pacific coasts to assess the natural and human-induced sanitary contamination of these areas. This work was carried out as part of ECCC's responsibilities under the Canadian Shellfish Sanitation Program (CSSP), a federal food safety program jointly administered by the Canadian Food Inspection Agency (CFIA), Fisheries and Oceans Canada (DFO) and ECCC. The goal of the program is to protect Canadians from the health risks associated with the consumption of contaminated bivalve molluscan shellfish (for example, mussels, oysters and clams) through controls to verify that only shellfish that meet food safety and quality standards reach domestic and international markets.

1.2.4. Freshwater Quality Monitoring Marine Water Quality Monitoring Water Monitoring in the Oil Sands

In February 2012, the federal and provincial environment ministers announced the Joint Canada-Alberta Implementation Plan for Oil Sands Monitoring ("Implementation Plan"), committing the two governments to implementing a scientifically rigorous, comprehensive, integrated and transparent environmental monitoring program for the region. The Implementation Plan described a phased implementation of enhanced monitoring activities over three years (2012–2015), and the rationalization and integration of current monitoring activities into a single, government-led program under the joint management of the two governments.

The three-year Implementation Plan sought to make monitoring of the changes due to oil sands development on the ambient environment more comprehensive, with more compounds sampled at more sites with greater frequency, using established scientific standards and protocols. The results are intended to help us better understand the condition of the environment in the oil sands area, and cumulative environmental effects caused by oil sands development activities.

The Implementation Plan called for the monitoring system to undergo external expert peer review after year three, to ensure that scientific integrity is maintained. In accordance, an independent, external review panel of six internationally recognized scientific experts was established in 2015. In February 2016, the external expert scientific review stated in their report that: "JOSM has made significant advances over the monitoring in place prior to 2012 by establishing more robust and comprehensive monitoring and improving the rigour, transparency and adherence to internationally recognized standards and protocols of the monitoring". Progress, the report concluded, had been made since implementation began, with the Review Panel Chair giving the jointly delivered monitoring a "solid B grade".

ECCC is working with the Government of Alberta on a long-term agreement to continue oil sands monitoring. ECCC continues to monitor the oil sands and is committed to reporting on scientifically rigorous, comprehensive and integrated environmental monitoring of oil sands development. Reporting on the scientific results supports ECCC's mandate of making science "fully open and available publically" and to the government's commitment of scientific transparency.

1.3 Canadian Environmental Sustainability Indicators

For several years, researchers and scientists at ECCC and many partner organizations 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.

ECCC continued to contribute internationally through its leadership as the Canadian hydrological advisor to the World Meteorological Organization's Commission for Hydrology. This entails providing input and advice to the commission on all matters related to hydrometric monitoring and hydro-meteorology. Specifically, the Department contributed expertise toward the development of techniques for uncertainty analysis in hydrometric measurements and on basic systems. The Department continues to lead the Arctic Hydrological Cycle Observing System initiative, which focuses on freshwater assessment into the Arctic Ocean. In 2015–2016, ECCC organized and chaired the third steering committee meeting held in May 2016 with representatives from hydrological services in the eight Arctic Council nations. The completed year-one deliverables were discussed, and next year's work plan drafted towards the goal of ensuring data on freshwater fluxes to the Arctic Ocean are made available in a timely fashion.

ECCC continued to play an active role working with universities on water-quality-related research through support of the Natural Sciences and Engineering Research Council research initiative, including the Canadian Cold Regions Network led by the University of Saskatchewan, and the FloodNet Canadian Strategic Network led by McMaster University.

Great Lakes

In 2015–2016, ECCC 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 in the region. ECCC is partnering with the U.S. Army Corps of Engineers, the National Oceanographic and Atmospheric Administration in the U.S., and the U.S. Geological Survey to operationalize various modelling systems for historical analysis of the water balance in the upper Great Lakes. Under the 'Coordinating Committee on Great Lakes Basic Hydraulic and Hydrology', hydraulic numerical modeling of the interconnecting channels are being updated with bathymetry and fine-tuned calibration. Products developed in this modelling system are being analyzed and used to assist in understanding recent and future changes in water levels in the Great Lakes.

Hydrological and modelling experts in ECCC's Meteorological Service of Canada and the Science and Technology Branch are continuing to develop models to estimate possible scenarios of river flow up to 10 days out through ensemble flow forecasting. A 48-hour forecast model was developed in 2015–2016. This capability is of particular use to the provincial flood forecasting agencies. Initial testing of the model in the Great Lakes continues as researchers strive for a 10-day model.

A satellite image shows the Great Lakes from space.
Photo: © NASA and GeoEye

St. Lawrence River

Activities under the St. Lawrence Action Plan's numerical environmental predictions working group continued in 2015–2016. The main activities of the group are:

- modelling and assimilation of surface data covering the watersheds of St. Lawrence River tributaries;
- hydrological modelling and routing of waters entering via the watersheds of St. Lawrence tributaries;
- 2D hydrodynamic modelling of the St. Lawrence River, Lac des Deux-Montagnes, Lac Saint-Louis, the LaPrairie Basin, Rivière des Mille-Îles, Rivière des Prairies, and the Sainte-Anne and Vaudreuil channels;
- modelling of the dynamics of the major St. Lawrence River ecosystems; and
- modelling of ocean ice in the St. Lawrence Estuary and the Gulf of St. Lawrence.

These activities are done through the collaboration of federal and provincial partners under the St. Lawrence Action Plan, and they support the main priorities of the plan (biodiversity, water quality and uses).

The hydrodynamic model of the St. Lawrence River between the Port of Montréal and Trois-Rivières has been operating in "experimental mode" at the Canadian Meteorological Centre for more than a year. At present, one simulation per day (nowcasting) is produced automatically. The results are made available online (http://collaboration.cmc.ec.gc.ca/cmc/cmoi/SHOP) and will eventually be published on ECCC's Wateroffice website. The performance of the system has been assessed, and the development of the model downstream of Trois-Rivières to Baie Saint-Paul and upstream of Montreal continues with calibrations and activities and optimization for operational use.

Lake of the Woods

In 2015–2016 the Winnipeg River basin hydrological forecasting model was further developed to include better land classes and calibration parameters, increasing its value for low flow conditions.

Prairies

Ongoing studies have focused on improved 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. Research collaboration continued on the development of models for large-scale simulation of the Saskatchewan River and Mackenzie River basins with the Global Institute for Water Security at the University of Saskatchewan. Recent progress includes linking hydrological models with water management models and 1-D hydraulic models, making use of satellite technology to improve predictive ability, evaluating various precipitation estimation tools for the region, improving the representation of physical processes in the models, and exploring new methods of blending modelled and observed streamflow to improve predictive abilities. Progress has also been made in predicting streamflow using the land surface component of ECCC's weather model.

Other activities

ECCC also provided support to many IJC water boards, committees and special studies in 2015–2016. This support includes establishing plans for special studies and development, testing and implementation of hydrologic and ecosystem models, and the initiation and implementation of an adaptive management framework for the on-going review of lake regulation plans. IJC work is not covered under the *Canada Water Act*; ECCC's progress towards work plans is reported internally under the Environment and Climate Change Canada–IJC Memorandum of Understanding.

2 Canadian Environmental Sustainability Indicators

The Canadian Environmental Sustainability Indicators (CESI) program reports on the status and trends of key environmental issues (www.ec.gc.ca/indicateurs-indicators/default.asp). Indicators cover air quality, greenhouse gas emissions, water quality and quantity, and protecting nature.

The program's freshwater quality indicator provides an overall measure of the ability of freshwater bodies to support aquatic life (plants, invertebrates and fish) at selected monitoring sites across Canada. The freshwater quality indicator is calculated using the water quality index, endorsed by the Canadian Council of Ministers of the Environment, to summarize the status of surface freshwater quality in Canada. This indicator reflects the extent to which water quality guidelines for the protection of aquatic life are being met at selected river monitoring sites throughout Canada. When water quality is rated poor, water quality measurements usually exceed the guideline, and the exceedances may be large. Water quality at a monitoring station is considered excellent when ambient water quality does not exceed guidelines at any time for any selected parameter.

Freshwater Quality Categories

Excellent = measurements *never or very rarely* exceed water quality guidelines

Good = measurements *rarely* exceed water quality guideline

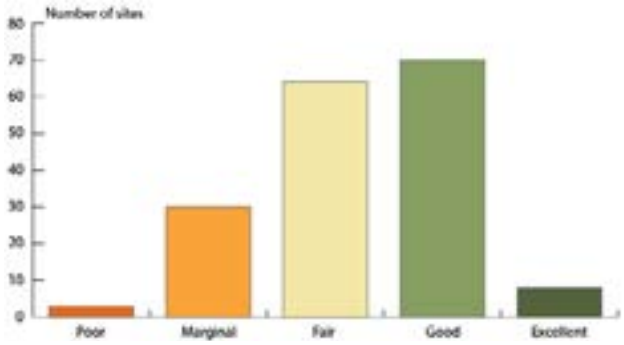
Fair = measurements sometimes exceed water quality guidelines *and, possibly, by a wide margin*.

Marginal = measurements often exceed water quality guidelines *and/or by a considerable margin*.

Poor = measurement usually exceed water quality guidelines *and/or by a considerable margin*.

Freshwater quality measured at these 175 river sites across Canada was rated poor at 3 stations, marginal at 30 stations, fair at 64 stations, good at 70 stations, and excellent for the protection of aquatic life at 8 stations. Overall, there has been little change in the national freshwater quality indicator between 2003–2005 and 2012–2014 at the 97 stations for which there are data for that entire period. During this period, no change was detected in the freshwater quality indicator rankings for 81 stations, while the ranking has significantly improved for 10 stations and declined for 6 stations (Figure 6).

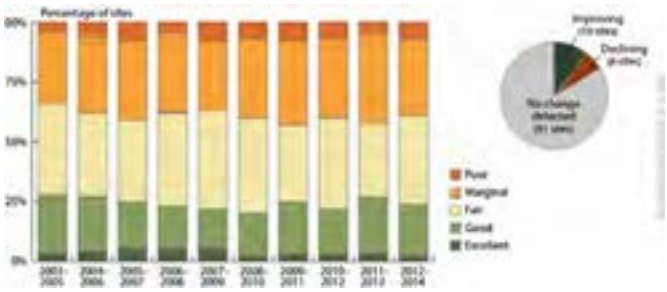
Figure 5: National freshwater quality indicator for the 2012–2014 period, Canada



Note: Freshwater quality was assessed at 175 stations throughout Canada's 16 drainage regions where human activity is most intensive, using the Canadian Council of Ministers of the Environment's Water Quality Index.

Source: Data assembled by ECCC from federal, provincial, territorial and joint water quality monitoring programs.

Figure 6: National freshwater quality indicator change from 2003–2005 to 2012–2014, Canada



Note: Change in the indicator between the 2003–2005 and 2012–2014 periods was assessed at 97 stations in 16 drainage regions across Canada where historical data were available. For each station, change in the indicator was assessed using a consistent set of water quality guidelines and parameters through time.

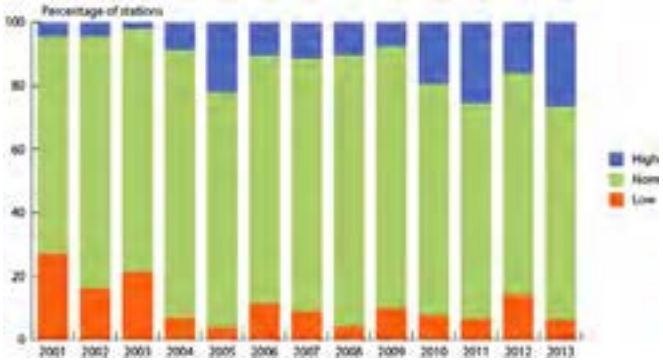
Source: Data assembled by ECCC from federal, provincial, territorial and joint water quality monitoring programs.

The water quantity in Canadian rivers indicator summarizes annual trends in the hydrometric data at the national scale. Water quantity at a station is judged by comparing daily water flow data to the amount of water observed at water quantity monitoring stations from 1981–2010. Daily data are rolled up to annual patterns for a station, which are summarized nationally.

The latest water quantity in Canadian rivers indicator was released in April 2016 and uses 2013 data for 866 hydrometric stations across Canada rolled up nationally.

In 2013, 27% of 866 water quantity stations were classified as having higher-than-normal quantity, 6% had lower-than-normal quantity and 67% had normal quantity. From 2001 to 2013, Canada's rivers typically had normal water quantity with an increasing tendency for higher-than-normal quantity starting in 2010. The percentage of stations with lower-than-normal quantity has declined since 2001.

Figure 7: National freshwater quality indicator change from 2003–2005 to 2012–2014, Canada



Note: The water quantity classification for a station is based on a comparison of the most frequently observed flow condition in a given year with typical water quantity at that station between 1981 and 2010. The normal period for the Northern Quebec drainage region was 1971–2000, instead of 1981–2010, because of a data gap in the drainage region. The 2013 data has fewer stations contributing to the results because of delays getting data into the HYDAT database. Normal water quantities are specific to each region and do not refer to the same amount of water in each drainage region (e.g., normal water quantity in the Prairies is different from normal water quantity in the Maritimes).

Source: Water Survey of Canada, Environment and Climate Change Canada (2015) HYDAT Database.

Other water indicators can be found online at www.ec.gc.ca/indicateurs-indicators.

3 Research

3.1.1. Freshwater Quality Monitoring Marine Water Quality Monitoring Water Monitoring in the Oil Sands Research on the Impacts of Climate Change on Aquatic Systems.

In 2015–2016, ECCC undertook a number of activities to quantify and predict local, regional and national sensitivities of hydrological regimes and aquatic ecosystems to climate change, including:

- Cataloguing freshwater biodiversity water sources across Canada's North;

- A study of the effects of permafrost thaw on tundra lakes, particularly the water chemistry response, and subsequent impacts on benthic invertebrate communities;
- Establishing the impact of warming air temperatures, wetter precipitation regimes and thawing permafrost on predominant hydrological and ecological processes and regimes in Canada's permafrost regions;
- A project to quantify the impacts on river and lake ice phenology in northern regions;
- Continued research evaluating changes in peak runoff events to the Arctic Ocean;
- Ongoing research at the Baker Creek Research Catchment in order to obtain information on how baseline runoff and water chemistry regimes are changing so as to properly evaluate responsible resource development in the subarctic Canadian Shield;
- Continued research assessing past and future climatic impacts on western Canadian water resources has quantified the large to synoptic-scale atmospheric circulation patterns responsible for observed hydro-climatic extremes and variability within key watersheds. Future work will involve determining changes to future atmospheric circulation patterns and resultant impacts on water resources within the region;
- Assessment of climate variability and change on prairie wetlands and hydrology;
- In collaboration with international and national academic partners, research on the vulnerability of those regions of western Canada reliant on water from mountain headwaters to increasing drought risk and diminishing snowpacks;
- The establishment of the Great Lakes Evaporation Network that manages observation platforms to evaluate ice-lake temperature-evaporation-water level feedbacks and improve analytical tools to understand and predict the impacts, risks to, and vulnerabilities of the quality of the waters of the Great Lakes from anticipated climate change impacts; and
- The development of a methodology to quantify the cumulative effects of climate and regulation on the frequency of ice-jam flooding in rivers that are harnessed for hydro-power generation. Its general applicability represents a significant advancement in our understanding of climate-hydrology interactions in regulated rivers.

3.1.2. Agricultural and Industrial Runoff.

Research efforts continued throughout 2015–2016, between ECCC and Agriculture and Agri-Food Canada (AAFC), in collaboration with academic research partners from the University of Calgary.

The collaborative research focuses on the mitigation of agricultural impacts on groundwater quality in the transboundary Abbotsford-Sumas aquifer. The Abbotsford-Sumas aquifer straddles the Canada–U.S. border and is a valuable source of fresh water for communities on both sides of the border. ECCC manages a network of monitoring wells on the Canadian side of the aquifer that are focused on the agricultural area where high nitrate levels have been observed in groundwater. Continuous groundwater monitoring in this portion of the aquifer has shown 70% sample exceedance relative to the Canadian Drinking Water Quality Guidelines (CDWQG) for nitrate since 1992. The CDWQG suggest the maximum acceptable concentration for nitrate is 10 mg/L Nitrate-N), while the average concentration, from 1990 through 2015, in the study area is about 14.4 mg/L Nitrate-N. In March 2015, nitrate values ranged as high as 51.8 mg/L Nitrate-N. The high average nitrate concentration, above the CDWQG levels, represents an ongoing concern for groundwater users on the US side of the international border, due to the southward direction of groundwater flow. Results of collaborative research on the water quality effects of current agricultural practices over this aquifer were published in the Winter 2015 issue of the Journal of Groundwater Monitoring and Remediation (Volume 35(1), pages 82-96).

A second component of this collaborative research effort is taking place on Prince Edward Island, where researchers from ECCC and AAFC collaborate with academic research partners (University of Calgary, University of Guelph, University of New Brunswick and University of Prince Edward Island) to study the effects of intensive agriculture practices on the quantity and quality of groundwater, and consequently on aquatic ecosystems. On Prince Edward Island, the unconfined aquifer set in fractured sandstone constitutes a valuable public

resource as it is the only source of drinking water for the province. Over the last several decades, nitrate concentrations in both streams and groundwater show an upward trend, resulting in more frequent algal blooms and anoxic events experienced by several estuaries in the recent past. The research effort attempts to test the effects of novel crop production systems on the quality of the receiving waters and to understand the nutrient cycling in the soil zone as well as the transport of fertilizers through the shallow geological strata. Results of this collaborative research were published in the Journal of Groundwater Monitoring and Remediation, 2015 (Volume 53(1), pages 30-42).

4 Inter-jurisdictional water boards

Inter-jurisdictional water boards have been established to focus on specific water issues that have implications for more than one province or territory. Domestic inter-jurisdictional boards include the Ottawa River Regulation Planning Board (ORRPB), Prairie Provinces Water Board (PPWB), Mackenzie River Basin Board (MRBB), and the Lake of the Woods Control Board (LWCB). The 2015–2016 activities of each are described below. There are also many international trans-boundary and inter-jurisdictional water boards in which Canada participates, most of which are led by the International Joint Commission (IJC). IJC work is not covered under the *Canada Water Act*; ECCC's progress towards work plans is reported internally under the Environment and Climate Change Canada–IJC Memorandum of Understanding.

4.1 Ottawa River Regulation Planning Board

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.

The 2015 freshet in the Ottawa River was quick and very low in the south of the basin, whereas in the north it was relatively normal. The cumulative volume of the 2015 freshet was in fact one of the lowest of the last 15 years (2001–2015), even lower than that of 2010 in the extreme south. This is due to several factors, including a very harsh winter, deeper over-winter snow cover in the north of the basin and a normal snowpack in the south, and delayed snowmelt followed by a precipitation deficit in April and May in the south, compared to normal precipitation in the north of the basin in the same period.

Given the low volume of the freshet, no problems with flooding were reported along the Ottawa River in areas that are regularly affected by high water, and the use of flood reserves was unnecessary for the management of Rivière des Mille Îles.

Total energy production on the Ottawa and Gatineau Rivers for Hydro-Québec (HQ) was 9% above average while energy production for Ontario Power Generation (OPG) was above average on the Ottawa River and below average on the Madawaska River for the given period.

The Board supported a number of public information initiatives through the Ottawa River Regulation Secretariat. The Secretariat, which is housed at ECCC, maintains a website and a recorded message on toll-free telephone services in English and French, both of which provide information about water levels and flows at various locations in the basin. In 2015 the Secretariat recorded 38,758 pageviews on its website during the freshet period (March-June), significantly lower than the previous year. The total number of unique users of the site numbered 8,050. This decrease is primarily due to the smaller volume of this year's freshet.

4.2 Prairie Provinces Water Board

Recognizing that water use within one province may impact another province, and because federal and provincial governments have shared responsibility

for water, the governments of Canada, Alberta, Saskatchewan and Manitoba signed the Master Agreement on Apportionment (MAA) in October 1969. The purpose of this agreement is to apportion water between the provinces of Alberta, Saskatchewan and Manitoba, and to protect surface water quality and transboundary aquifers. The MAA also provides for cooperation between governments with respect to transboundary water management, and for the establishment of the Prairie Provinces Water Board (PPWB) to administer the MAA.

The overarching deliverable for the PPWB is to report on the achievement of the terms of the MAA. The MAA provides for an equitable sharing of available waters for all eastward-flowing streams, including transboundary lakes that cross provincial boundaries. The schedules to the Agreement describe the role of the Board and stipulate the amount and quality of water that shall pass from Alberta to Saskatchewan and from Saskatchewan to Manitoba.

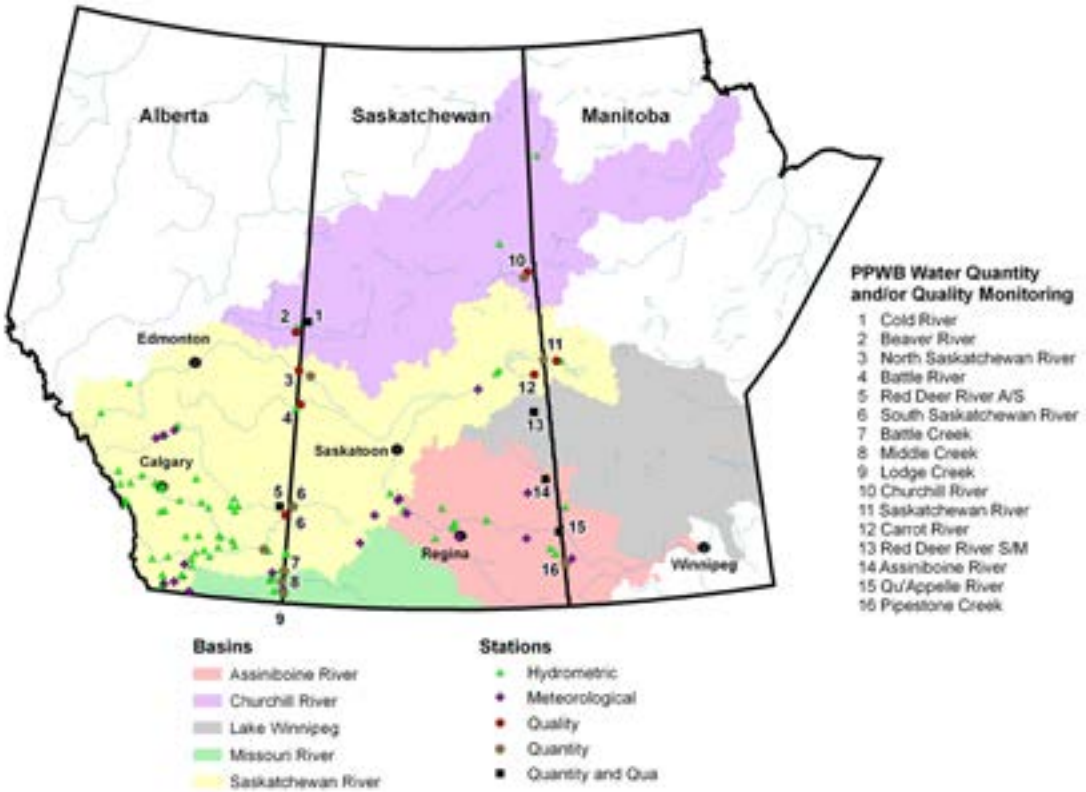
In support of the MAA, ECCC monitors stream flows, water quality and meteorological conditions on eastward-flowing streams on the provincial borders (see Figure 8). The PPWB computes apportionable flows based on the natural flow on a river if that river had never been affected by the activities of people. Excursions to the MAA water quality objectives are also calculated annually.

Under the MAA, ECCC is responsible for managing the expenditures of the PPWB, which are cost-shared with Canada providing ½ and each province 1/6 of the funds. The secretariat consists of 5 professionals, who are hired by ECCC and are responsible for planning, directing and managing the operations of the board and its technical committees.

Activities and accomplishments of the PPWB in 2015–2016 included the following:

- Apportionment requirements were reviewed and determined to have been met in the calendar year of 2014 on all eastward-flowing prairie streams. Interim flows indicated that 2015 apportionment requirements were likely met on the South Saskatchewan River. It is anticipated that there will not be any problems meeting apportionment for 2015 on any transboundary stream.

Figure 8: PPWB water quantity and quality monitoring stations and basins for 2015



- In February 2016, the PPWB approved the hydrometric and meteorological monitoring station list for 2016–2017. Important changes to note are the addition of five new meteorological stations for a total of 25 stations along the North Saskatchewan River.
- A project to review apportionment methods resulted in the completion of reviews of the North Saskatchewan River Basin and of Cold Basin, which were published as PPWB technical reports. The Saskatchewan River Basin and the Qu'Appelle River Basin, both at the Saskatchewan/Manitoba boundary, are undergoing reviews. The Saskatchewan River Basin review is expected to be completed in 2016–2017. The Qu'Appelle River Basin review is in its preliminary phase.
- A proposed schedule to the MAA related to transboundary aquifers is under development. The objective of the schedule will be to establish a cooperative framework for effective and efficient management and sustainable use of groundwater and aquifer systems by the Parties of the MAA.
- The PPWB approved the 2014 Water Quality Excursion Report. The overall adherence to Interprovincial Water Quality Objectives was very high with an average of 95% in 2014, resulting in the continued protection of water quality.
- On June 22, 2015, Ministers Leona Aglukkaq, Steve Ashton, Thomas Nevakshonoff, Herb Cox and Shannon Phillips approved the 2015 Water Quality Objectives. The new 2015 Water Quality Objectives came into effect on July 8, 2015. There are now 71 transboundary water quality objectives, on 12 transboundary river reaches. In February 2016, the PPWB approved the 2016-17 water quality monitoring program based on these new objectives.
- The new PPWB Committee on Flow Forecasting, formed in 2015, will investigate, oversee, review, report and improve the accuracy of flow forecasting at the interprovincial boundaries. This Committee will also provide recommendations on matters pertaining to streamflow forecasting of interprovincial basins.
- The PPWB also produced annual reports to ministers which are available on the website (www.ppwb.ca).

4.3 Mackenzie River Basin Board

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 in another jurisdiction. It also contains provisions for seven sets of bilateral agreements between adjacent jurisdictions in the basin.

The Mackenzie River Basin Board (MRBB) represents all parties to the Master Agreement and administers the provisions of the Agreement. Federal members include representatives from ECCC and Indigenous and Northern Affairs Canada. Health Canada provides support and expertise on human health issues. The 3 provinces and 2 territories in the basin are represented by 13 members, including an appointee from each provincial and territorial government water management agencies, and an Indigenous board member nominated by Indigenous organizations within each jurisdiction.

Under the Master Agreement, ECCC is responsible for managing the expenditures of the MRBB, which are cost-shared equally by the parties. The secretariat consists of the executive director, who is hired by ECCC and is responsible for planning, directing and managing board operations.

Key activities and accomplishments of the MRBB in 2015-2016 include:

- The governments of British Columbia and the Northwest Territories signed a bilateral water management agreement on October 15, 2015, to establish and implement a framework for cooperating to achieve the principles of the Master Agreement.
- The MRBB tracked the progress of ongoing bilateral water management negotiations between British Columbia and Alberta; Alberta and Saskatchewan; and British Columbia and Yukon.
- The MRBB monitored the implementation of bilateral water management agreements between

Alberta and the Northwest Territories, and the newly signed agreement between British Columbia and the Northwest Territories.

- The MRBB published the *Mackenzie River Basin Board Report to Ministers 2014–2015*, which is available on the MRBB website (www.mrbb.ca).
- The MRBB Traditional Knowledge and Strengthening Partnerships Steering Committee partnered with the University of Alberta, other national and international academics, and the Government of the Northwest Territories to gather and communicate water-related Traditional and Local Knowledge from around the Mackenzie River Basin. The project, titled *Tracking Change – Local and Traditional Knowledge in Watershed Governance* will also provide the MRBB with the opportunity to learn from indigenous experiences in the Amazon and Mekong Basins.

4.4 Lake of the Woods Control Board

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 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 (*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 LWCB 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 the LWCB's operating strategy, conducts studies and maintains communications with basin users.

In 2015, conditions in the Winnipeg River basin allowed the LWCB to maintain Lake of the Woods at a relatively low level through the summer, following the historic high flows experienced throughout the Winnipeg River basin in 2014. Low summer levels allowed for greater access for property owners to undertake projects to repair shoreline structures and address areas vulnerable to erosion. Stable, low summer levels also helped provide one of the best wild rice crops in years.

During 2015, the lakes under the LWCB's authority were maintained within the water level limits established under treaty and legislation.

In 2015, the LWCB held three regulation meetings with resource advisors and special interest group representatives in Kenora, Ontario. These meetings resulted in the adoption of seasonal operating strategies employed by the LWCB Secretariat in daily operations.

Due to the extreme conditions, during 2015 the LWCB continued its normal engagement activities, visiting the Lake of the Woods District Property Owners Association's annual Cottage Show in Winnipeg in May, a south shore resort on Lake of the Woods to see the impacts of the 2014 high water, and held a public open house in Kenora in June. Other outreach activities included twenty-two media interviews, phone calls and email interaction with the wider public, and the popular web site. The LWCB published the 2015 LWCB Annual Report in early 2016.

5. Ecosystem initiatives and ecosystem-based 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.

This section describes a number of key partnership-based ecosystem approaches through which ECCC 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.

ECCC's Ecosystem Initiatives are cooperative, place-based programs designed to deliver environmental results in targeted ecosystems. The objective of the 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 ECCC 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.

5.1. Great Lakes Ecosystem Initiative

The Great Lakes Ecosystem Initiative is a partnership of federal departments (Agriculture and Agri-Food Canada, ECCC, Fisheries and Oceans, Health Canada, Natural Resources Canada, Public Works and Government Services Canada, Transport Canada, and Infrastructure Canada) and one federal agency (the Parks Canada Agency) (www.ec.gc.ca/grandslacs-greatlakes).

The Great Lakes Ecosystem Initiative coordinates actions towards meeting Canada's commitments under the 2012 Canada–U.S. Great Lakes Water Quality Agreement (GLWQA), and the 2014 Canada–Ontario Agreement on Great Lakes Water Quality and Ecosystem Health (COA). The GLWQA establishes broad, long-term objectives for Canada and the United States for restoring and protecting the Great Lakes, while the COA provides a short-term (five-year) plan for achieving Canada's GLWQA commitments.

Areas of Concern

Areas of Concern (AOCs) are specific locations, such as harbours and embayments, where water quality and ecosystem health have been severely degraded by human activity at the local level. In 1987, Canada and the United States together designated 43 AOCs, 12 of which are in Canada, and 5 that are shared between Canada and the United States. In 2015–2016, coordination of Remedial Action Plan (RAP) activities in Great Lakes AOCs continued, including assessing and reporting on the success of past actions and on the status of remaining actions. Some examples of these activities are as follows:

- The decision on whether to delist the St. Lawrence River (Cornwall) AOC or to recognize it as an Area of Concern in Recovery is still pending. The St. Lawrence River Institute for Environmental Studies continued the study to assess shoreline sediment mercury concentrations which is expected to result in an updated contaminated sediment management plan for the river. The St. Lawrence River Restoration Council agreed to a review of the AOC delisting criteria to ensure that they are reasonable and achievable.
- The Bay of Quinte Remedial Action Plan (RAP) initiated assessments of the status of the degradation of fish and wildlife populations and degradation of fish and wildlife habitat beneficial uses. The RAP also finalized a Natural Heritage Strategy for the AOC and began to engage municipalities on its implementation.
- A significant milestone was achieved in the Toronto Region AOC with the re-designation of the Restrictions on Dredging Activities and Degradation of Benthos beneficial uses from "impaired" to "not impaired" status. This brings the total number of impaired beneficial uses in the AOC to six, down from ten five years ago.

- In the Hamilton Harbour AOC, work began on the Randle Reef Contaminated Sediment Remediation Project. This $138.9 million project is the largest contaminated sediment remediation project ever undertaken in a Canadian AOC. The project involves the construction of a 6.2 hectare, double walled, containment facility which, when it is complete in 2022, will manage approximately 695,000 m3 of polycyclic aromatic hydrocarbon contaminated sediments and is the last remaining large-scale project for the eventual delisting of the AOC.
- For the Canadian Niagara River AOC, initiated a bi-national study of fish populations in the river which is the first step towards the development of fish community objectives for the river.
- The Canadian St. Clair River AOC achieved a significant milestone with the re-designation of the Degradation of Aesthetics beneficial use from impaired to "not impaired". This brings the total number of impaired beneficial uses to six, a reduction of three in the past five years.
- The Detroit River Canadian Cleanup also celebrated a significant milestone in 2015–2016 with the re-designation of the Degradation of Aesthetics and Beach Closings beneficial uses from "impaired" to "not impaired". This brings the total number of impaired beneficial uses in the Canadian portion of the Detroit River AOC to seven, five fewer than in 2011.
- The Nipigon Bay RAP finalized the Remedial Action Plan Completion Report with the incorporation of a long-term post delisting environmental monitoring plan.
- In the Jackfish Bay AOC in Recovery, an ecological risk assessment was completed. The assessment is intended to help understand the natural recovery in the ecosystem and determine whether existing levels of contaminants pose a threat to fish and wildlife. The results of the assessment are expected to help guide future management decisions in the AOC in Recovery.
- In the St. Mary's River AOC, it was previously unknown whether there was an increased incidence of bird deformities or reproductive problems. A report documenting the assessment of the status of the "Bird or Animal Deformities of Reproductive Problems" beneficial use confirmed that it is "not impaired."

In 2015–2016, ECCC continued to fund multi-stakeholder projects to clean up and restore the Great Lakes AOCs through the Great Lakes Sustainability Fund, which is part of the Great Lakes Action Plan.

In partnership with local and provincial stakeholders, the Great Lakes Sustainability Fund (GLSF) provides funds for projects in three key areas: (1) improving point source 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.

The GLSF continued to support work to improve point source and non-point-source water quality, and to develop and implement stewardship initiatives and deliver programs that reduce nutrient inputs to watercourses from urban and rural non-point sources in the Bay of Quinte, Niagara River, Hamilton Harbour, Toronto and Region, Thunder Bay, Nipigon Bay, St. Mary's River, and Detroit River AOCs. Initiatives included outreach and education programs to encourage rural farming and non-farming landowners to adopt best management practices, and studies leading to improved water quality through improved management of municipal waste water.

In 2015–2016, the GLSF supported projects to restore fish and wildlife habitat in AOCs, including projects to implement habitat management plans in the Bay of Quinte AOC; habitat and wetland restoration projects along the Detroit River, the Niagara River, the St. Clair River, and in McVicar Creek and in the McIntyre River in the Thunder Bay AOC, and six projects in the St. Clair River AOC; and several projects to restore fish and wildlife habitat and populations in the Toronto and Region AOC.

- In 2015–2016, the GLSF continued to support advance plans and strategies to management and remediate contaminated sediments in AOCs including a project to survey and map contaminated sediments in the nearshore areas of the Canadian St. Lawrence AOC.

Science and monitoring

ECCC undertakes science and monitoring projects to support decision making in the Great Lakes AOCs in Canada and in binational AOCs.

As part of the Great Lakes Nutrients Initiative, all priority Canadian tributaries to Lake Erie were monitored in a systematic way to track and assess nutrient loadings both year-round and at a basin-wide scale. The research included determining relative contributions of nitrogen and phosphorus from municipal sewage versus agricultural lands and the effects of these added nutrients on harmful algal blooms in Lake Erie.

In addition, modelling efforts continued to develop suitable models to assess water quality and evaluate nutrient targets on main Canadian tributaries and into selected nearshore zones of Lake Erie. In these nearshore zones, work continued to characterize and quantify the sources of phosphorus associated with nuisance, Cladophora, and the nutrient and hydrodynamic conditions near the bottom above dreissenid mussel beds.

Canada–Ontario and Canada–U.S. cooperation

The current COA entered into force on December 18, 2014. The COA outlines how the governments of Canada and Ontario will cooperate and coordinate their efforts to restore, protect and conserve the Great Lakes basin ecosystem.

Commitments by Canada and Ontario include:

- taking action to address algal blooms, including blue-green algae;
- completing actions to clean up historical AOCs including the Niagara River, Nipigon Bay, Peninsula Harbour, the Bay of Quinte and the St. Lawrence River (Cornwall);
- helping to prevent aquatic invasive species, such as zebra mussels, from entering the lakes;
- protecting the lakes from harmful pollutants;
- conserving important fish and wildlife habitats; and
- strengthening collaboration with the Great Lakes community.

In 2015–2016, the Department continued its long-standing collaboration with the U.S. and Ontario to restore and protect the Great Lakes. ECCC continued to lead implementation of the Canada–U.S. GLWQA, 2012 and through the Great Lakes Executive Committee; the Department contributed in key areas, such as:

- Nutrients – Proposed binational phosphorus targets for the western and central basins of Lake Erie were adopted by the Government of Canada and the United States in February 2016 to combat algal blooms. The reduction target calls for a 40 percent reduction in phosphorus loads compared to a 2008 baseline.
    - Work continued to develop targets for east basin Lake Erie to minimize Cladophora blooms.
    - In 2015–2016, a new Nearshore Framework and baseline assessment approach were drafted. This work was undertaken through the Great Lakes Nutrient Initiative and coordinated under the Canada–U.S. GLWQA.
- Lakewide Management – published a 2015 Lakewide Action and Management Plan (LAMP) Annual Report for each Great Lake; drafted the Lake Superior LAMP and initiated development of the Lake Huron LAMP; undertook outreach and engagement activities with Great Lakes stakeholders, First Nations and Metis communities
- Science – drafted Great Lakes indicator reports and draft assessments for indicator categories and general objectives in preparation for State of the Great Lakes reporting in Fall 2016
- Areas of Concern – re-designated five impaired beneficial uses from impaired status to not impaired status in the St. Clair River, Detroit River and Toronto Region AOCs

Areas of Concern -- Initiated the largest contaminated sediment remediation project ever undertaken on the Canadian side of the Great Lakes with the start of the $138.9 million Randle Reef Contaminated Sediment Remediation Project in the Hamilton Harbour Area of Concern. This seven year project will manage 695,000 cubic metres of polycyclic Aromatic Hydrocarbon contaminated sediments from historical industrial and urban activities.

Lake Simcoe/South-eastern Georgian Bay

In 2015–2016, the Government of Canada committed $3.63 million, leveraging $5.14 million, to 34 community-based projects through Lake Simcoe/South-eastern Georgian Bay Clean-Up Fund. These projects included activities to reduce phosphorus inputs to the watersheds from urban and rural point and non-point sources, restore and create aquatic habitat, and support innovation and advance research into the water quality issues of Lake Simcoe/South-eastern Georgian Bay.

Also in 2015–2016, studies started during the previous two reporting years continued on sediment characterization; nutrient source tracking; surface water quality and associated harmful algal blooms; and groundwater quality and its role in nutrient loading. Preliminary modelling of phosphorus loads was also undertaken and nearshore autonomous underwater vehicle deployments were carried out on the Nottawasage River to Nottawasaga Bay. In addition, projects were undertaken to examine methods for increasing the removal of phosphorus from stormwater and agricultural land runoff. Stewardship programs targeting rural, shoreline, and agricultural landowners residing in high restoration priority locations were supported. These programs encouraged environment improvements that benefited the overall quality of the aquatic habitats and educated the community.

5.2. St. Lawrence Action Plan

The St. Lawrence Action Plan (http://planstlaurent.qc.ca/en/home.html) is a collaborative effort between the Canadian and Quebec governments to protect, conserve, and enhance the St. Lawrence ecosystem. This multi-year program, which has been renewed four times since it was first signed in 1988, has helped produce concrete results through the cooperative efforts of the two governments. Their efforts have benefited from participation by the private sector, universities, research centres, Areas of Prime Concern committees (zone d'intervention prioritaire, known as ZIP committees), non-governmental organizations and riverside communities. The program focuses on all of the St. Lawrence River's ecosystems and on the mouths of its main tributaries, from Lake Saint-François, straddling the border between Quebec and Ontario, to the eastern reaches of the Gulf of St. Lawrence.

St. Lawrence River
Photo: © Environment and Climate Change Canada

The Canada–Quebec Agreement on the St. Lawrence, also known as the St. Lawrence Action Plan 2011–2026, covers a span of 15 years, with 5-year planning cycles.

For the year 2015–2016, which was the end of the five-year planning cycle for 2015–2016, 43 projects of the joint action program were completed, for which a number of research projects, fieldwork activities, and decision-making tools were developed and completed, including:

- An Integrated Biodiversity Conservation Plan for the Lowlands and Coastal Areas of the Estuary and Gulf of St. Lawrence;
- a study on the impact of climate change on water levels
- a campaign to develop agricultural watercourses in the floodplain of Lac Saint-Pierre to reduce the spread of pollution from agricultural sources;
- identification of the effects of diffuse pollution from agricultural sources on the aquatic ecosystems of the St. Lawrence River;
- a study to document the presence of pharmaceuticals in municipal effluents in the Montréal area and to assess their effects on wild aquatic species
- development of a decision-making framework for the assessment of contaminated sediments and their impact on the quality of the water and the general environment of the St. Lawrence River;

- development of a guide for the ecotoxicological risk assessment and for the health of contaminated sediments sites in the St. Lawrence River;
- identification of key environmental issues related to the presence of contaminated sediments in several areas of the St. Lawrence River in order to obtain a more complete and coherent picture of contaminated sediment sites.

Community involvement and awareness

The ZIP Program supports Stratégies Saint-Laurent and its members (the 12 Areas of Prime Concern committees) in their efforts to mobilize and coordinate the various parties involved in issues affecting the St. Lawrence, and to foster their commitment to improving the quality of the environment. In 2015–2016, the activities included collaboration with local authorities to highlight local environmental issues linked to the St. Lawrence River, consultation on emerging issues (hydrocarbon transport on the river, port development, management of invasive species), participation in information activities related to shoreline erosion, sustainable development of coastal environments and preservation of different uses (bathing, access), as well as habitat conservation and Improvement of natural environments. In addition, the ZIP committees have made a significant contribution to the integrated management approach of the St. Lawrence River at the local level, in particular through their commitments to the establishment of 6 Regional Tables on priority regional issues.

Under the St. Lawrence Action Plan 2011–2026, ECCC and Quebec's ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques are also implementing the Community Interaction Program (CIP), which supports non-governmental organizations that implement projects that benefit the St. Lawrence. In 2015–2016, ECCC funded 21 projects for a total of $552,555 in contributions; these were carried out throughout the program area, from Cornwall to Gaspé, including the Magdalen Islands, and on the north shore, from Carillon to Blanc-Sablon, including the Anticosti and Saguenay regions. These projects involved key players from riverside communities, including municipalities, First Nations, academia, industry and agriculture, local communities, and relevant provincial and federal departments. Specifically, the projects funded in 2015–2016 were intended to give rise to voluntary change in salmon fishing practices in the Innu community of Natashquan; to contribute to the recovery of the American eel through the evaluation of its habitat and the production of a feasibility study for the installation of fish passages in the Saint-Charles River in Quebec City; to manage yellow perch habitats in the river area of the Bécancour sector; and to restore coastal habitats in the Matane region. In addition, 33 new project proposals were submitted to the CIP in 2015–2016 for activities beginning in 2016–2017. Finally, the fifth edition of the Forum Saint-Laurent, on the theme of improving water quality, was held in Quebec City in November 2015. This forum for discussion and dialogue among the parties concerned by issues related to the water in the St. Lawrence River provided an opportunity to identify common directions relating to this theme.

The State of the St. Lawrence River Monitoring Program

A network of governmental and non-governmental partners and collaborators continued to conduct sampling campaigns required to obtain scientific data through the State of the St. Lawrence River Monitoring Program. ECCC collected data on water levels and flow rates; the fluvial transport of contaminants; water and sediment quality; land cover; benthic communities at Lake Saint-Pierre; seabird populations, in particular the Great Blue Heron; and shellfish water quality.

During 2015–2016, ECCC published seven new fact sheets on environmental indicators online. Each fact sheet contributes to our understanding of the state of the St. Lawrence River. They deal with oceanographic processes in the estuary and Gulf of St. Lawrence, the surface areas of freshwater wetlands, contamination of sediments by toxins (butyltins), the Northern gannet and seabirds, and shellfish water quality.

The Working Group on the State of the St. Lawrence River published the Overview of the State of the St. Lawrence River 2014, and started to prepare the next *Rendez-vous Saint-Laurent 2016* to be held in Québec city in October 2016. This overview, which is released every five years, aims to inform decision-

makers and riverside communities by giving them an analysis of the river's condition and evolution, while also addressing global environmental issues and future perspectives.

Numerical Environmental Prediction Program

The Numerical Environmental Prediction Program for the St. Lawrence is a program to aid decision making and water management planning for the St. Lawrence and its watershed. It simulates the evolution of physical, biological or chemical processes in the St. Lawrence and its watershed to predict the state of the corresponding terrestrial and aquatic environment. The program aims in particular to improve our understanding of the St. Lawrence ecosystem as a whole and to provide a tool to support decisions about its integrated management. The program is being carried out by a working group whose activities in 2015–2016 made significant progress, notably through four projects that dealt with the coupling of the hydrological models of the St. Lawrence watershed, the integration of hydrodynamic modelling tools into the Montréal archipelago, and hydrological and hydraulic modelling of the Richelieu River watershed. The group also supported various activities under the St. Lawrence Action Plan's three main issues, which are conservation of biodiversity, sustainability of uses and water quality improvement.

Another notable result was the introduction of an attempt at quantifying some of the uncertainties associated with delineation of flood maps. The maps show shades of blue to indicate the depths of inundation expected under each scenarios, and yellow bands on each side of the delineated flood zone that represent the uncertainty of +/- 20 cm in determining what areas would flood under the chosen scenario. This is calculated based on the slope of the land – when there slope is low (i.e. fields), the error band is wide, and where the land is steep, the error band, and therefore the uncertainty, is smaller. This simple uncertainty estimation was accomplished by subtracting the surface elevation provided by a 2D hydraulic model from a Digital Elevation Model (DEM) based on LiDAR data.

The International Lake Champlain-Richelieu River Technical Working Group presented their final report and technical reports to the International Joint Commission on November 30, 2015. The International Joint Commission presented their final report, built on the work of the International Lake Champlain-Richelieu River Technical Working Group, to the governments of Canada and the United States in December 2015.

Case Study:

Static flood inundation mapping for Lake Champlain and Richelieu River

The International Lake Champlain-Richelieu River Technical Working Group was established by the International Joint Commission (IJC) to carry out two components related to its 2013 Plan of Study on flooding in the Lake Champlain Richelieu River basin:

9. collecting and harmonizing data on the topography, bathymetry, aquatic vegetation, soil texture and other features of the Lake Champlain-Richelieu River watershed; and
10. creating static flood-inundation maps showing those areas, where data are available, that would be affected at different water levels on Lake Champlain and the Richelieu River.

From October 1, 2014 to September 30, 2015 a number of federal and state/provincial agencies worked together to enhance flood preparedness and warnings for Lake Champlain and the Richelieu River (LCRR). The one-year case study yielded impressive results that were well received by the IJC and are now being tested by the Quebec government. Results included the development of a new method for flood plain mapping and associated static flood inundation maps for a variety of flooding scenarios (Scenario #7 being the closes to the severe flood the region experienced in 2011) and preparatory work for a future dynamic flood forecasting system.

5.3. Atlantic Ecosystem Initiatives

The Atlantic Ecosystems Initiatives program provides funding for projects that improve the health, productivity, and long-term sustainability of ecosystems in Atlantic Canada. The program supports projects that use an ecosystem-based approach that include broad partnerships and collaborative action resulting in positive environmental impacts throughout Atlantic Canada. The program funds Atlantic Canadian organizations, including non-government organizations, coalitions and networks of organizations, research and

academic institutions, and Indigenous governments and organizations to deliver projects that address one or more of the three program priority issues of water quality, habitat and biodiversity, and the impacts of climate change.

ECCC contributed funding, technical and scientific expertise, and direct staff support, for water quality projects relevant to the *Canada Water Act* that will improve the assessment, monitoring, modeling, and mitigation of multiple stressors and their cumulative effects on water quality in Atlantic Canada from headwaters to estuaries.

In 2015–2016, 6 projects (representing 43% of all projects funded by the Atlantic Ecosystems Initiatives program) addressed water issues related to water quality, habitat and biodiversity, and impacts of climate change. ECCC committed over $920,000 for these projects. The following examples demonstrate the type of projects that were funded:

- In Nova Scotia, the Clean Foundation is bringing together experts and stakeholders throughout Atlantic Canada to address stormwater-related impacts of climate change through the adoption of Low Impact Development (LID) systems. The goal is to better manage water quantity and flow, while mitigating the associated impacts to water quality and habitat and biodiversity.
- In Newfoundland and Labrador, C-Core is developing a framework for wetland mapping and monitoring for the province, as well as producing wetland inventory maps of the Avalon Peninsula using remote sensing technologies and implementing the developed framework.
- In New Brunswick, the Association of Canadian Delegates to the Gulf of Maine Council on the Marine Environment is managing a project that supports climate change risk preparedness in Atlantic Canada by providing a web-based tool which will improve access to Intensity/Duration/Frequency (IDF) extreme rainfall data. Access to this data will enhance the technical capacity to predict flooding and other impacts associated with extreme precipitation events and help to better prepare for climate change impacts.

5.4. Gulf of Maine

ECCC is working collaboratively with other federal departments, provincial governments, U.S. governments, and community groups to help advance efforts that enhance conservation and promote responsible development in the Gulf of Maine transboundary ecosystem, which includes watersheds and coastline in New Brunswick and Nova Scotia.

The focus of the Gulf of Maine Initiative is enhancing collaborative efforts to build knowledge of the ecosystem—watershed and coast—to better understand its current condition and identify stressors and threats to help inform decisions.

2015–2016 saw the continuation of seven multi-year projects (87% of the Gulf of Maine Initiative projects) that address water quality issues in the Gulf of Maine ecosystem. Some examples of the projects include:

- Researchers from Dalhousie University are investigating the threat that ocean acidification imposes on ecosystem health and will integrate their results with U.S. initiatives to generate a comprehensive view of the entire Gulf of Maine ecosystem.
- The World Wildlife Fund Canada is conducting a Freshwater Health Assessment and a Freshwater Threats Assessment throughout the entire Canadian portion of the Gulf of Maine ecosystem to quantify the top threats to the Gulf of Maine and identify the key drivers behind them.

Other Gulf of Maine Initiative grants and contribution (G&C) project activities included collecting and making accessible information on eutrophication and contaminants, applying the Ocean Health Index to assess the health of the Gulf of Maine, identifying linkages between environmental stressors and upstream land use activities in the Annapolis watershed (Nova Scotia), and the development of a strategic framework to understand, monitor and manage the cumulative effects from multiple stressors in Saint John Harbour (New Brunswick).

In addition to the G&C projects, the Gulf of Maine Initiative supported a collaborative ECCC and

Fisheries and Oceans Canada project that will enhance regional storm surge flood modelling and forecasting to better inform development decisions by coastal communities and resource users. In an effort to build a better collective understanding of the Gulf of Maine ecosystem, the Gulf of Maine Initiative is helping to facilitate on-going dialogue on regional coastal mapping activities and sharing of existing data, as well as opportunities to coordinate resources for new mapping and data acquisition activities.

5.5. Lake Winnipeg Basin Initiative

The Lake Winnipeg Basin Initiative (LWBI) is the Government of Canada's response to address the water quality issues in Lake Winnipeg. The LWBI aims to engage citizens, scientists, and domestic and international partners in actions to restore the ecological health of Lake Winnipeg, reduce nutrient pollution and improve water quality.

Phase II of the LWBI ($18 million, 2012–2017) continues. This phase increases focus on stakeholder stewardship actions that measurably reduce nutrient loading and improve Lake Winnipeg's water quality.

Some key highlights from 2015–2016 include:

- The Lake Winnipeg Basin Stewardship Fund (LWBSF) provided financial support for 31 stewardship projects valued at $1.2 million;
- The Lake Winnipeg Basin Office (LWBO) hosted the 2nd Annual LWBSF Symposium on March 7, 2016 in Winnipeg. The Symposium recognized and highlighted the important work, collaboration and contributions made by LWBSF recipients to reduce nutrients in Lake Winnipeg and the basin;
- The Nutrients in Lake Winnipeg Indicators report was published in February 2016. This report forms part of the Canadian Environmental Sustainability Indicators (CESI), which provides data and information to track Canada's performance on key environmental sustainability issues;
- The Canada-MB MOU Respecting Lake Winnipeg and the Lake Winnipeg Basin was extended to September 2020. The MOU facilitates a cooperative and coordinated approach in efforts to understand and protect the water quality and ecological health of Lake Winnipeg and its basin.

The Government of Canada continued to provide support for stakeholder-driven projects through the LWBSF. In 2015–2016, ECCC approved over $317,000 for 13 new LWBSF projects aimed at reducing nutrient loading in the Lake Winnipeg Basin. Since its inception in 2008, the LWBSF has provided over $6.7 million in federal funding for 88 stakeholder-driven projects ranging from wetland restoration to innovative waste-water treatment, and beneficial agricultural practices to cutting-edge scientific research. For every dollar provided by the fund, approximately $2.63 in additional partner funds and in-kind contributions were generated. In total, stakeholder-driven projects valued at over $23 million have benefitted the Lake Winnipeg Basin.

The LWBI continued to provide annual funding support to the Lake Winnipeg Research Consortium, which operates the *MV Namao* and *MV Fylgja*, two research and monitoring vessels. In addition, annual funding support was provided to the University of Manitoba for the Lake Winnipeg Basin Information Network, a web-based information portal for exchange of scientific information generated in the Lake Winnipeg Basin.

The LWBI emphasizes collaborative work with other governments (provincial, state, federal) and organizations within the Lake Winnipeg transboundary watershed. Domestic and international water management boards play a key role in managing nutrients in the Lake Winnipeg Basin. ECCC participates in a number of water science and water management boards to facilitate coordination of efforts across the watershed and to help address nutrient loading originating from outside of Manitoba's jurisdiction.

Research, modelling and monitoring activities in 2015–2016 included the ongoing implementation of 13 scientific research projects in Lake Winnipeg and its watershed focusing on the identification of the sources and impacts of nutrient loadings to Lake Winnipeg. Work is well under way in a number of areas, including water quality monitoring of key transboundary sites and related main rivers.

Projects in 2015–2016 focused on:

- addressing knowledge gaps related to the impacts of human activity (particularly land use) on nutrients in Lake Winnipeg tributaries.
- addressing critical knowledge gaps in lake nutrient dynamics relative to changes in nutrient loads to Lake Winnipeg, by evaluating the spatial and temporal flux of nutrients from the watershed to Lake Winnipeg and evaluating the fate of these nutrients once in the lake, particularly in relation to internal nutrient recycling from sediments and the factors driving harmful algal blooms; and
- developing predictive models in support of nutrient management in the Lake Winnipeg Basin.

5.6. Pacific and Yukon Region

During 2015–2016, ECCC committed close to $200,000 to support projects across British Columbia and Yukon, including in the Okanagan Basin. These projects advanced the development and implementation of water balance models and ecosystem health indicators to support informed decision making, as well as to protect habitat and biodiversity.

In the Okanagan, ECCC supported the development of a protocol to determine water levels that are needed by fish in major tributary streams. This work will inform the actions and decisions of governments, and lead to higher fish survival and less conflict between water users. ECCC also supported the implementation of the Biodiversity Conservation Strategy for the Okanagan Region (2014) by providing funding to identify habitat connectivity corridors, mechanisms for conservation across all land uses and tenures, and parkland acquisition priorities in North Okanagan. This work will inform actions and decisions of governments, business and individuals that share in the responsibility of conserving biodiversity in the region.

In the Yukon, ECCC supported a collaborative project with the Arctic Borderlands Ecological Knowledge Society to increase the capacity of the Society and its partners to use and integrate both science and traditional knowledge within their decision-making framework. This will form the basis for integrating new traditional and local knowledge indicators within an ecosystem management framework, as well as helping to increase the number of communities that contribute ecological knowledge to the community-based monitoring network coordinated by the Society.

II. Public information

There are a number of ways in which ECCC and its partners provide information on the use and conservation of water. Many of these activities are discussed throughout this report, including in the section on ecosystem initiatives.

ECCC's Water website (www.ec.gc.ca/eau-water) provides general information on a wide range of water-related topics, comprehensive educational materials (such as *A Primer on Fresh Water*) and the full text of key water publications (such as the *Canada Water Act* Annual Report, and the Federal Water Policy). In addition, the site provides content on ECCC's water-related activities and program areas.

ECCC's Wateroffice (www.wateroffice.ec.gc.ca) provides public access to real-time and archived hydrometric data collected in Canada. In 2014–2015, the Wateroffice website received over 62 million hits (approximately 1.2 M visits).

Real-time hydrometric data is also now available on ECCC's Datamart (http://dd.meteo.gc.ca/about_dd_apropos.txt), for partners to directly upload data into their own software systems.

Additional information can be obtained at:

Environment and Climate Change Canada
Public Inquiries Centre
7th Floor, Fontaine Building
200 Sacré-Coeur Boulevard
Gatineau QC K1A 0H3
Telephone: 1-800-668-6767 (in Canada only) or 819-997-2800
Email: ec.enviroinfo.ec@canada.ca