Environment and Climate Change Canada
Environnement et Changement climatique Canada
Canada

# *Canada Water Act*

## ANNUAL REPORT

FOR APRIL 2016 TO MARCH 2017

# *Canada Water Act*

## ANNUAL REPORT

FOR APRIL 2016 TO MARCH 2017

**Print version**
Cat. No.: En1-20E
ISSN 0227-4787

**PDF**
Nº de cat. : En1-20E-PDF
ISSN 1912-2179

**Web Site**
https://www.canada.ca/en/environment-climate-change/services/water-overview.html

Unless otherwise specified, you may not reproduce materials in this publication, in whole or in part, for the purposes of commercial redistribution without prior written permission from Environment Canada's copyright administrator. To obtain permission to reproduce Government of Canada materials for commercial purposes, apply for Crown Copyright Clearance by contacting:

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

*Cover Photo:* © Getty Images

© Her Majesty the Queen in Right of Canada, as represented by the Minister of Environment and Climate Change, 2018

Aussi disponible en français

# TABLE OF CONTENTS


**1 INTRODUCTION** 3

**2 DATA COLLECTION AND USE** 6

**2.1 Water quantity monitoring** 6

2.1.1 National monitoring network 6

2.1.2 Technology development 11

**2.2 Water quality monitoring** 13

2.2.1 Freshwater quality monitoring 13

2.2.2 Biological monitoring 17

2.2.3 Marine water quality monitoring 19

**2.3 Hydro-meteorological modelling and prediction** 20

**3. CANADIAN ENVIRONMENTAL SUSTAINABILITY INDICATORS** 23

**4. RESEARCH** 26

**4.1 Research on the impacts of climate change on aquatic systems** 26

**5. INTER-JURISDICTIONAL WATER BOARDS** 27

**5.1 Ottawa River Regulation Planning Board** 27

**5.2 Prairie Provinces Water Board** 28

**5.3 Mackenzie River Basin Board** 29

**5.4 Lake of the Woods Control Board** 30

**6. ECOSYSTEM-BASED APPROACHES TO WATER QUALITY MANAGEMENT** 31

**6.1 Atlantic Ecosystems Initiatives** 32

**6.2 Gulf of Maine Initiative** 33

**6.3 St. Lawrence Action Plan** 33

**6.4 Great Lakes Ecosystem Initiative** 36

**6.5 Lake Simcoe/South-eastern Georgian Bay** 38

**6.6 Lake Winnipeg Basin Initiative** 38

**7. PUBLIC INFORMATION** 39

# 1 INTRODUCTION

The *Canada Water Act* (CWA) administered by the Minister of Environment and Climate Change 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.

**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 waterquality management programs. The application of alternative cooperative approaches and programs has resulted in **Part II** never having been used.

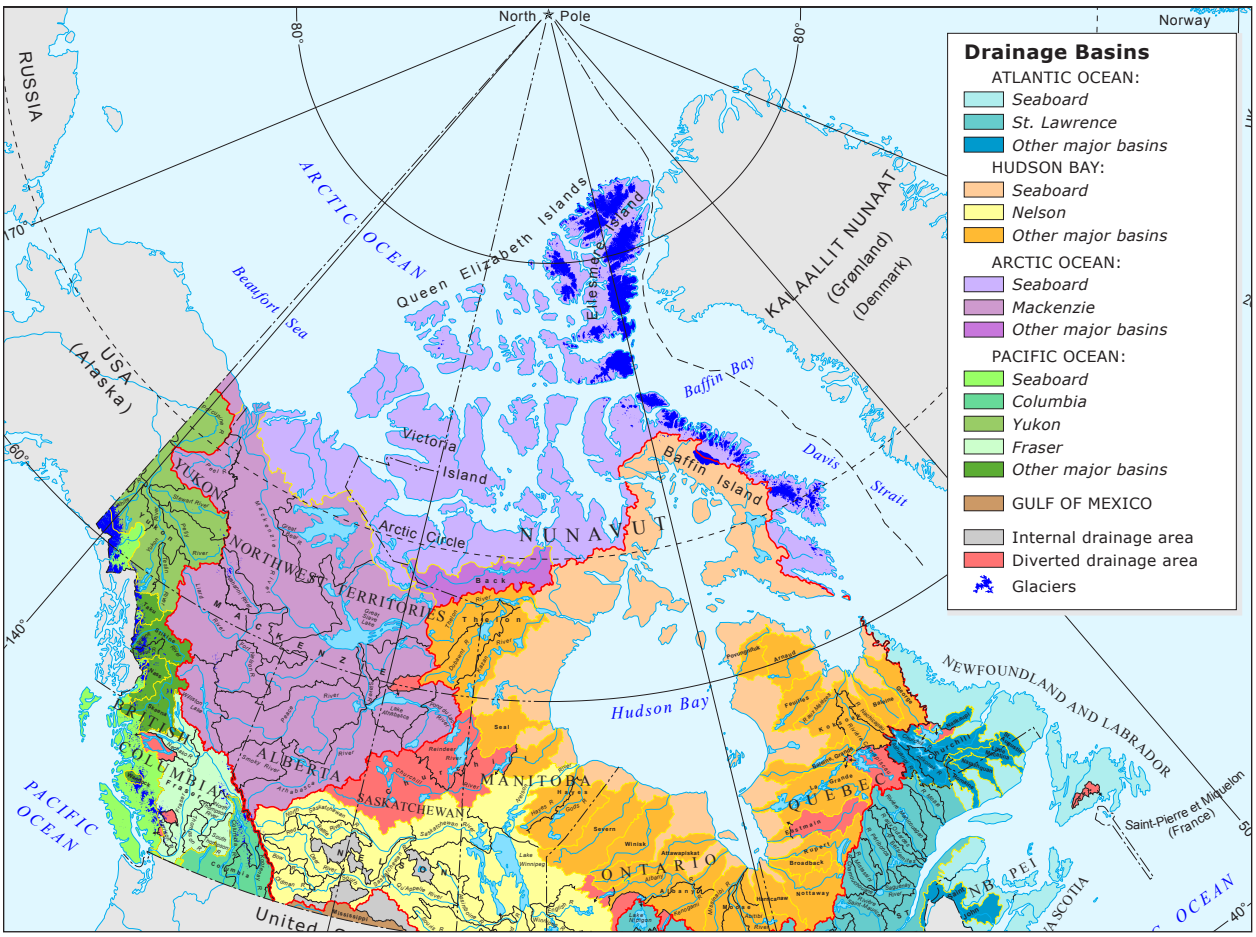
Part III, which provided for regulating the concentration of nutrients in cleaning agents and water conditioners, is now part of the *Canadian Environmental Protection Act, 1999*, (See the *Canadian Environmental Protection Act, 1999* annual reports to Parliament, available at www.ec.gc.ca/lcpe-cepa/default.asp?lang=En&n=64AAFDF1-1.)

**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.

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, 2016, to March 31, 2017.

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 monitoring and 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.

**Figure 1: Drainage areas in Canada**




© Her Majesty the Queen in Right of Canada, represented by the Minister of Natural Resources, 2007

Canadian provinces, Yukon, Nunavut 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), Indigenous lands 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.

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.

CWA agreements that were ongoing during 2016–2017, included the following:

- Agreements related to apportionment and monitoring programs
- Renewed hydrometric agreements with nine provinces, Yukon and Northwest Territories, and with Indian and Northern affairs 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.

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

- data collection and use;
- interjurisdictional water boards; and
- partnership-based ecosystem approaches.

# 2 DATA COLLECTION AND USE

## 2.1 WATER QUANTITY MONITORING

The National Hydrometric Program (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 Environment and Climate Change Canada's (ECCC) Wateroffice website at https://wateroffice.ec.gc.ca/index_e.html.

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 hydrometric monitoring agreements in each province or territory and one national administrator designated by Canada. Both groups met regularly throughout 2016–2017 to discuss program issues. 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 for the NHP.

The Water Survey of Canada which is part of ECCC's National Hydrological Service (NHS) is the federal partner and primary operator of the NHP network in Canada.

### 2.1.1 National monitoring network

During 2016–2017, the national monitoring network of the NHP in Canada consisted of 2793 hydrometric monitoring stations (see Figure 2 and Table 1). During this period, ECCC, operated 2156 of these hydrometric stations. Out of the ECCC-operated stations, 1148 were fully or partially federally funded, and the remaining were operated by ECCC on behalf of the provincial and territorial collaborators or a third-party interest, and cost-shared according to specific needs and requirements (see Table 1). In Quebec, the Ministry of Sustainable Development, Environment and the Fight against Climate Change operated 227 stations, some funded in whole or in part by the Government of Canada. ECCC disseminates the data collected from Quebec, along with data from another 409 stations operated by parties other than ECCC, across Canada.

Figure 2: National Hydrometric Monitoring Network

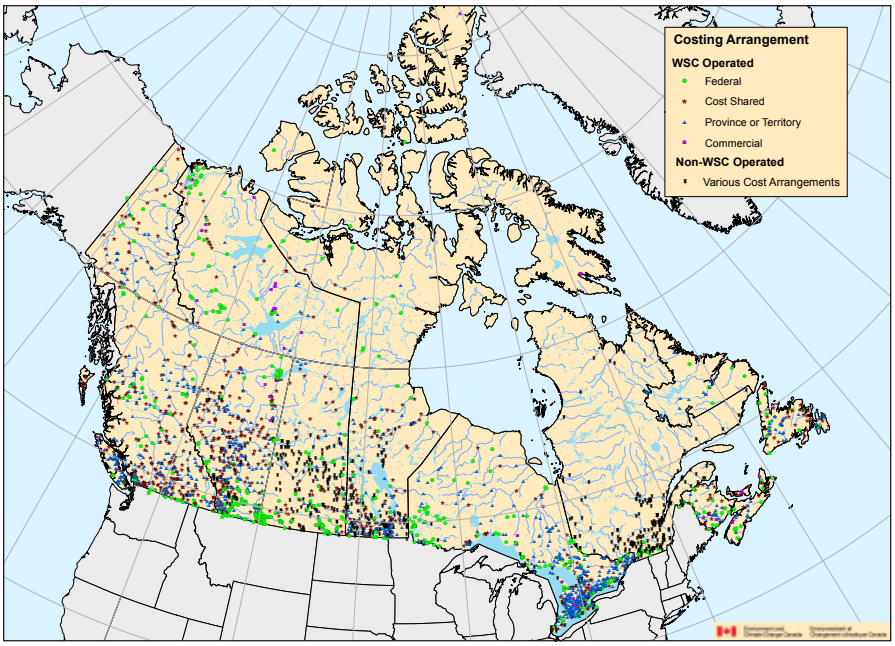



**Table 1: Stations within the National Hydrometric Monitoring Network**

| | ECCC-OPERATED (BY COST ARRANGEMENT) | | | | | |
|---|---|---|---|---|---|---|
| PROVINCE/ TERRITORY[a] | FEDERAL | COST-SHARED[b] | PROVINCE/ TERRITORY | THIRD PARTY | NON-ECCC-OPERATED (VARIOUS COST ARRANGEMENTS) | TOTAL BY PROVINCE OR TERRITORY |
| **Alta.** | 80 | 158 | 161 | 6 | 54 | 459 |
| **B.C.** | 47 | 180 | 208 | 1 | 8 | 444 |
| **Man.** | 22 | 84 | 108 | 2 | 178 | 394 |
| **N.B.** | 17 | 18 | 20 | 2 | 0 | 57 |
| **N.L.** | 16 | 32 | 60 | 0 | 0 | 108 |
| **N.S.** | 11 | 6 | 13 | 0 | 0 | 30 |
| **N.W.T.** | 46 | 23 | 13 | 10 | 0 | 92 |
| **Nun.** | 13 | 5 | 5 | 2 | 0 | 25 |
| **Ont.** | 124 | 68 | 334 | 10 | 43 | 579 |
| **P.E.I.** | 0 | 5 | 0 | 5 | 0 | 10 |
| **Que.** | 16 | 0 | 0 | 0 | 227 | 243 |
| **Sask.** | 92 | 51 | 13 | 0 | 126 | 282 |
| **Y.T.** | 10 | 25 | 35 | 0 | 0 | 70 |
| **Total** | 494 | 655 | 970 | 38 | 636 | 2793 |

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

[b] 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 CWA.

In 2016–2017, compliance with the new *Aquatic Invasive Species Regulations* made pursuant to the federal *Fisheries Act* resulted in additional 'time on site' for field technologists, restructuring of field trips/areas, as well as additional dedicated monitoring and decontamination equipment. There were no significant changes to the size of the national hydrometric network, although the network did undergo a number of adjustments, including the following:

**Yukon**

- Network expansion at previously decommissioned sites has resulted in the following stations being re-established within the operational program: Bonnet Plume River above Gillespie Creek; Ogilvie River at km 197 Dempster Highway; Big Salmon River near Carmacks; Sidney Creek at km 46 South Canol Road; Liard River above Scurvy Creek; Sister Creek at km 426 Dempster Highway; and Caribou Creek above Babbage River.
- In May 2016, a Yukon River basin experienced a geologic event - river piracy - which is rarely observed in real-time. The Slims River, which drains into Kluane Lake, had its flow diverted as a result of the retreat of the Kaskawulsh Glacier[1]. Due to this event, Kluane Lake (gauged), which is the largest lake in the Yukon Territory, experienced the lowest peak water level on record. Unfortunately, the lake outlet, Kluane River (decommissioned), is ungauged and therefore the downstream effect(s), including potential seasonal cessation of flow, are unknown.
- Two new Yukon stations were installed and are operated by Inuvik staff from NWT for operational efficiencies in 2016–2017; Babbage River below Caribou Creek; and Caribou Creek above Babbage River.

**Northwest Territories**

- Reconnaissance to establish two new stations was initiated in 2016–2017: Tazin River and Yates River.
- Four new stations were added to the NWT network in 2016–2017: Buffalo River at Highway 5; Johnny Hoe River above Lac Ste. Therese; Mountain River below Cambrian Creek; and Rat River near Fort McPherson.
- NWT staff also operates gauges in Northeastern British Columbia (Petitot River) and Northeastern Alberta (several stations within the Peace-Athabasca Delta) for operational efficiencies.
- Reconnaissance for seven new territorially-funded stations, which began in 2015, is still ongoing; funding and land tenure approval are pending.

**Nunavut**

- Twenty-five hydrometric stations were operational in 2016–2017 within Nunavut. All stations in Nunavut are operated by ECCC, in accordance with the established cost share ratio. Operational funds are split according to the specific cost share arrangement between ECCC, Indigenous and Northern Affairs Canada, Parks Canada Agency and the City of Iqaluit.
- Ruggles River at the Outlet of Lake Hazen is the northernmost hydrometric gauge in operation.

[1] The event was documented by Shugar, et.al. in the Journal of Nature Geoscience 10,370–375(2017) doi:10.1038/ngeo2932 https://www.nature.com/ngeo/journal/v10/n5/full/ngeo2932.html.

**British Columbia**

Thirty-four (34) hydrometric stations were modernized, with a focus to improve real-time reporting and update monitoring technology. A total of 381 stations (85%) of the hydrometric network now report in real-time.

**Alberta**

- One hydrometric station (Clearwater River at Draper) was destroyed by a fire in Fort McMurray and rebuilt over the summer.
- Whirling disease[2] was discovered in Banff National Park, initially affecting the Bow basin. It currently impacts two basins (Bow and Oldman), affecting 41 hydrometric stations. These require the restructuring of field circuits and dedicated equipment to follow the protocols developed to prevent the spread of this invasive disease. A decontamination facility for gear and equipment was constructed at the ECCC warehouse.
- Operations were suspended at 89 of 91 manned cableways in Alberta pending an operational review and engineering inspection. The two operational cableways are: St. Mary River at International Boundary and Berland River near the Mouth.
- Construction in Alberta has been minimal or non-existent for some time, resulting in a large backlog of projects including the decommissioning of stations, rebuilding of cableways and life cycle management.
- Five gauging shelters that still require bank operated cableways for high water measurements were constructed and added to the oil sands monitoring network as commercial stations. Sixteen stations are now operated by ECCC as part of the monitoring program in the oil sands region.

**Saskatchewan**

- One federally operated station was discontinued and replaced by another federally operated station: Moose Mountain Creek near Oxbow was replaced by Moose Mountain Creek below Alameda Reservoir.
- The operational period for the following 22 provincially operated stations was extended from 'seasonal' to 'annual': Anglin Lake Reservoir; Avonlea Reservoir near Avonlea; Boundary Reservoir near Estevan; Brightwater Reservoir at Riparian Outlet; Broderick Reservoir at West Embankment; Buffalo Pound Lake at Pumping Station; Candle Lake at Candle Lake; Codette Reservoir above the Spillway; Cookson Reservoir near Coronach; Cowan Lake near Honeymoon Point; Crooked Lake near Grayson; Cumberland Lake near Cumberland House; Echo Lake at Fish Hatchery; Fishing Lake near Wadena; Good Spirit Lake near Canora; Jackfish Lake near Cochin; Katepwa Lake at Katepwa Beach; Makwa Lake near Loon Lake; Montreal Lake near Weyakwin; Round Lake near Whitewood; South Saskatchewan River at Moon Lake; Wascana Lake at the Marina.
- Two provincially operated stations were changed from water level to flow stations: Girard Creek near Cornach and Wood River diversion to Chaplin Lake.
- All 'manned' cableways in Saskatchewan have been slated for decommissioning or converted to 'unmanned' systems.
- The following two provincially operated stations were discontinued: Iskwao Creek near Craik; and Waldsea Lake near Humboldt.

[2] Whirling disease is an infectious disease of finfish. The causal agent of whirling disease is not a risk to human health.

**Manitoba**

- Investment in new technology continues with the installation of cameras at 11 monitoring stations. The following stations are transmitting images at regularly scheduled intervals (which is increased during flooding/freshet) via satellite: Hayes River below Gods River; Dauphin River near Dauphin River; Assiniboine River near Holland; Churchill River above Redhead Rapids; Seal River below Great Island; North Saskatchewan River at Prince Albert; and Saskatchewan River below the Forks.
- The following stations are providing real-time (on demand) images using cell modems: Assiniboine River at Brandon; Assiniboine River at Headingly; Red River at Emerson; and Red River near Ste. Agathe.
- One new federally operated station was added to the network: Lake of the Prairies near Roblin.
- One federally operated station was converted from a flow station to a water level station: Bone Lake near Ninette.
- One federally operated station was converted from a 'water level' to a 'flow' station and had an Advanced Video Monitor installed: Red River at James Avenue Pumping Stations.
- Two provincially operated stations were discontinued: Souris River above Hartney Dam; and Swan Lake near Swan Lake.
- Two provincially operated stations were changed from operating year-round to seasonally, 8 months of the year: Assiniboine River at Shellmouth Bridge; and Valley River above Gilbert Plains Dam.
- All 'manned' cableways in Manitoba have been slated for decommissioning or converted to 'unmanned' systems.

**Ontario**

- One new station was installed: Mountsberg Creek near Carlisle.
- Reconnaissance for two new gauging stations in the northwest of the province was completed.
- Six gauging stations that were full discharge and water level stations were changed to water level only or seasonal discharge due to aging infrastructure, provincial road bridge re-construction, pedestrian bridge construction and aging privately-owned control infrastructure.

**Quebec**

- In Quebec, 227 stations are run by the provincial government and data are contributed to the NHP database. An additional 17 stations are run by ECCC in Quebec to address federal data needs.

**Atlantic Region**

- No major changes to the network in New Brunswick occurred in 2016–2017. Two stations are listed as "commercial" but are paid for by the New Brunswick Department of Transportation (not a NHP partner).
- In Nova Scotia, two stations that were closed during the 1990s were reopened as provincial stations: Salmon River at Murray; and North River at North River. One new provincial station was also established: Mcclures Brook at Cobequid Trail.
- In 2016–2017, there were no changes to the network in PEI.

### 2.1.2 Technology development

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, as manned cableways across the country are being decommissioned. Work continues on refining and adopting new 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 involving the in-house design and development of a stand-alone software application called electronic Hydrometric Survey Notes (eHSN), became fully operational in 2016–2017. The eHSN aims to modernize traditional Hydrometric Survey Notes from a paper-based system to a more standardized digital system. The eHSN is used operationally by field technologists to document and digitally transfer hydrometric field activities quickly and efficiently. Overall, the eHSN allows for more rapid data uploading and sharing, better data integrity and helps establish nationally consistent standards. It also better positions ECCC field data outputs towards internationally recognized data exchange formats.

In 2016–2017 there was also a dramatic increase in the use of fixed (station-based) cameras for improving field visit planning, site logistics and safety, data computations, and public/partner interest in general.

#### Hydrometric Data Systems

ECCC is working towards more fully automating data transfer so that data only has to be touched once and bringing all ECCC gauging stations to a common datum and using remote sensing to detect and measure surface water.

ECCC is also leading a height modernization[3] project, with the first pilot being undertaken in Saskatchewan. Elevation information contributes to informed decision making and impacts a wide range of important activities including mapping and charting, flood risk determination, transportation, land use and ecosystem management. This project has been advanced through partner funding and leveraging hardware and logistical coordination with Natural Resources Canada.

#### Surface Water from Space project

The Government Related Initiatives Program funded Surface Water from Space project ended in 2016. The project was successful in finding an operational means of extracting surface water from space. A peer reviewed paper was published in the open source journal "Remote Sensing" by Bolanos, S.; Stiff, D.; Brisco, B.; and Pietroniro, A. entitled "Operational Surface Water Detection and Monitoring Using Radarsat 2". This work will be leveraged in the Radarsat constellation mission Data Utilization & Application Plan project in 2017–2018 and 2019–2020.

#### Geospatial data products

In March 2017, the NHP published a set of polygons, representing the drainage areas of most active discharge stations within the national hydrometric network, through the Government of Canada's Open Maps portal. The NHS Basin Polygon dataset is a compilation of datasets collected from a number of contributing partners, including ECCC, provinces, territories and other federal government departments. The data are available as a webservice that can be accessed through any standard Geographic Information System package.

[3] Height modernization is an initiative to establish accurate, reliable heights using Global Navigation Satellite System (GNSS) technology in conjunction with traditional leveling, gravity, and modern remote sensing information.

The NHS Basin Polygon dataset will play a key role in the upcoming re-evaluation of the Reference Hydrometric Basin Network (RHBN). The RHBN is a sub-set of the national network that has been identified for use in the detection, monitoring and assessment of climate change. It is part of Canada's contribution to the Global Climate Observing System. The original network was designed in 1999 and updated periodically. NHS is working to modernize the evaluation process for identification of RHBN stations.

**Data dissemination**

The Hydrometric Data Management Integration and Renewal (HyDMIR) project has two phases. Phase 1, released on January 10, 2017, was designed to build a more efficient and robust dissemination system for real-time hydrometric data, as well as to decommission legacy infrastructure and software. Phase 2, released in March, 2017, was designed to renew the Hydex (metadata) interface and to streamline the HYDAT service to facilitate collaborators' automatic access to data. This service will replace the current web service and email service. The full transition to the new web service is scheduled for after the 2017 flooding season.

The NHP continued to maintain its International Organization for Standardization (ISO) certification during 2016–2017. Updating of ECCC's Standard Operating Procedures (SOPs) continued in 2016–2017, keeping pace with changes in technology in the operational program.

**Hydrometric science and development**

In 2016–2017, ECCC and particularly NHS staff have been heavily involved with the University of Saskatchewan, University of Waterloo, Wilfrid Laurier University and McMaster University through the Global Water Futures Program to collaborate in the important area of innovation in hydrology that would assist ECCC in its water management and hydrometric activities.

ECCC has continued collaborations with university colleagues in Quebec (L'Institut national de la recherche scientifique) in operationalizing hydro-dynamic and hydro-ecological models in rivers of federal significance and remains committed to advancements in those fields.

ECCC has embarked on a significant collaboration with the Canadian Space Agency (CSA), National Aeronautics and Space Administration (NASA), University of Sherbrooke, UCLA and other organizations in the USA on development of space-based monitoring technologies for hydrological monitoring in Canada. This includes leading the Canadian Surface Water Ocean Topograph (SWOT) hydrology mission that is scheduled for launch by NASA in 2021. SWOT aims to make the first global survey of Earth's surface water. The establishment of appropriate ground-based and aerial infrastructures in various environments worldwide will contribute towards this goal. The North Saskatchewan River would be a Tier 1 calibration/validation site for this project and funding from the CSA will be leveraged to install hardware along the site.

ECCC, in cooperation with the University of Manitoba, University of Victoria, and InnoTech Alberta, continues to support the national pilot of an operational isotope network in conjunction with the 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 (18O) and deuterium (2H) across Canada. From 2015 to 2017, a multi-year contribution from ECCC to Alberta Innovates Technology Futures made possible the collection of stable water isotopes at selected ECCC gauging stations across the country, 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[4]; and to assist in water quality, ecological studies, and net primary productivity estimation. To date a total of 3140 samples have been analyzed for 18O and 2H.

**Outreach**

The historical analysis tool was integrated into the hydrometric data (HYDAT) interface application, ECCC Data Explorer (ECDE), to allow the users to interactively compare daily time-series data over a specified period with statistically summarized historical data. A new version of ECDE was published in early 2016–2017.

## 2.2 WATER QUALITY MONITORING

### 2.2.1 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.

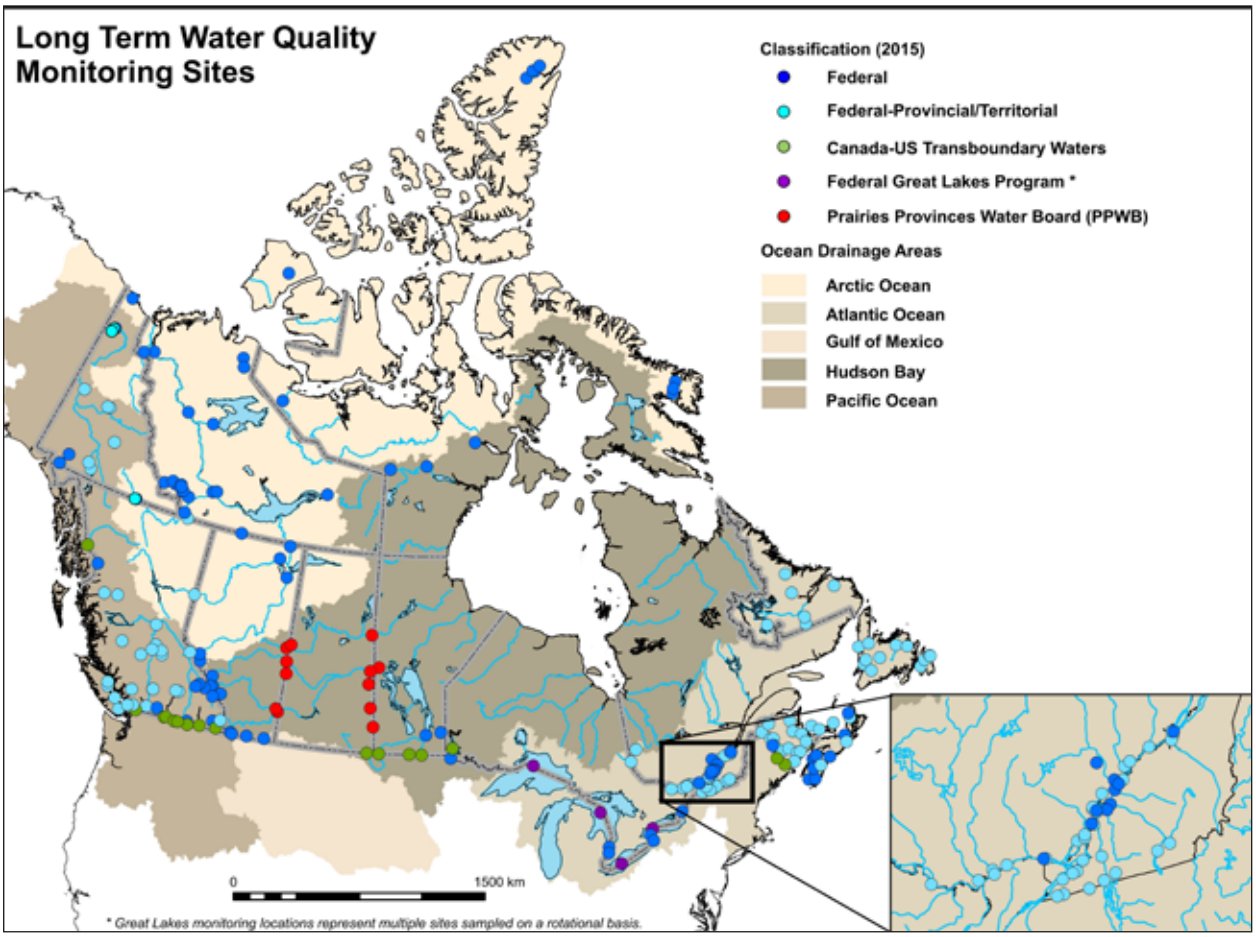
The objectives of the federal-provincial/territorial water quality monitoring agreements are to achieve a long-term commitment for the acquisition of water quality data; to obtain comparable, scientifically sound water quality data that are reliable to inform water resource management; and to disseminate timely information on water quality to the public, government agencies, industry and the scientific community. Data is also used to support the freshwater quality indicator in the Canadian Environmental Sustainability Indicators (see section 3) (access data: https://open.canada.ca/data/en/dataset/67b44816-9764-4609-ace1-68dc1764e9ea)

For more information, please consult the ECCC Fresh Water Quality Monitoring and Surveillance website at https://www.canada.ca/en/environment-climate-change/services/freshwater-quality-monitoring.html.

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.

[4] WATFLOOD is a set of computer programs for hydrological forecasting and modelling. WATFLOOD is a registered trademark

**Figure 3: Long-term water quality monitoring sites**




The ECCC's Freshwater Quality Monitoring 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.

As part of the Risk Based Adaptive Management Framework to optimize its national monitoring networks, ECCC has developed a Risk-Based Basin Analysis (RBBA), a geospatial approach to identifying relative risks and priorities in basins (sub-drainage areas) across Canada; and a Risk-Based Analysis, an approach to identifying site-specific relative risks and priorities. Key stressor variables were identified, stressor intensities calculated, and compilation of relevant geospatial layers continued. These "ever-green" analytical tools used in conjunction with statistical power analytical tools allow sampling locations and frequencies to align with risks of water quality impairment in Canadian watersheds.

In addition, to facilitate environmental information reporting consistency at the national level, work is under way to categorize sampling locations across the country based on water body characteristics (size/flow, level of risk, etc.).

**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 with the Yukon government. In British Columbia, ECCC conducts joint monitoring with the provincial Ministry of Environment at 41 river sites (including one automated site). In the Yukon, 13 sites (including one automated site) were monitored on rivers in collaboration with Environment Yukon.

The Canada–British Columbia automated 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. In addition, ECCC in collaboration with the Department of Fisheries and Ocean, the Okanagan First Nation Alliance and the British Columbia Ministry of Environment, also deployed a real-time water quality monitoring buoy in Osoyoos Lake in 2017. Data generated from these 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 2016–2017, ECCC operated five long-term water quality monitoring sites in four national parks, in cooperation 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: 22 in the Northwest Territories, 14 in Nunavut, 2 in Yukon and 10 in northern Alberta. A majority of these sites are operated in cooperation with Parks Canada and include eight national parks (Auyittuq, Quttinirpaaq, Ukkusiksalik, Aulavik, Ivvavik, Tuktut Nogait, Nahanni and Wood Buffalo National Parks). Many of these sites are co-located with ECCC's gauge stations. In 2016–2017, a total of 213 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 Watershed section, above).

**Monitoring on the Prairies**

As part of the national long term monitoring network and 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 Program. Water quality data are routinely shared with partners and collaborators involved in the Lake Winnipeg Research Consortium, including the Province of Manitoba, other federal departments, universities and institutes working on Lake Winnipeg.

ECCC continued to work with Manitoba Sustainable Development under the Science Subsidiary Arrangement made pursuant to the Canada-Manitoba Memorandum of Understanding Respecting Lake Winnipeg and the Lake Winnipeg Basin. The agreement, signed in 2012, 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 2016–2017.

All of the transboundary rivers in the watershed are monitored regularly (8 to 12 times per year). During the 2016–2017 open water season, the Red River was monitored more intensively (biweekly to weekly) to address concerns related to increased continuing water releases from Devils Lake (North Dakota) crossing the Canadian border, and to improve the nutrient loading estimates for Lake Winnipeg. Additionally, 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. Real-time data were used to assess water quality changes due to increased Devils Lake water releases.

In 2016–2017, the Battle River near the Alberta and Saskatchewan border and the Assiniboine River and Carrot 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 (in addition to other routinely used pesticides). 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) to assess transboundary contamination.

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 ECCC to address the science needs around this issue. As part of the international effort, ECCC has intensified science and monitoring efforts in the watershed that, in addition to baseline monitoring, includes more directed research efforts on algae, nutrient mechanisms, modelling and remote sensing.

**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, under Memoranda of Understanding.

**Atlantic Watershed**

In the Atlantic Watershed, federal-provincial water quality monitoring is supported through the Canada–Quebec Water Quality Agreement, the 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 and the Canada-Ontario agreement respecting the Great Lakes as well as the Canada-US Great Lakes Water Quality Agreement.

In 2016–2017, a broad range of monitoring activities was undertaken in the Great Lakes targeting water, sediment and fish. Some of the monitoring conducted provided an assessment and

interpretation of phosphorus loading from watersheds and tributaries into the Great Lakes and enabled the assessment of performance measures which have been implemented to reduce total phosphorus loadings to the Great Lakes.

The Canada–Quebec Water Quality Monitoring Agreement renewed at the end of 2016–2017 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 2 automated) in the St. Lawrence River Basin. The sites were sampled monthly in 2016–2017 for physical parameters and nutrients, in addition to metals, pesticides and polybrominated diphenyl ethers (PBDEs) at some of them.

Under the Canada–New Brunswick Water Quality Agreement during 2016–2017, 10 federal-provincial sites were monitored. The sites are located on international and interprovincial transboundary rivers or their tributaries in the Saint John River (Wolastoq) 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 2016 Annual Report to the IJC.

In 2016-2017, eleven sites were monitored under the Canada–Prince Edward Island Memorandum of Agreement. 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 https://www.princeedwardisland.ca/. In addition, pesticide surveillance was also conducted during the growing season.

In 2016–2017, ECCC managed 13 federal sites (including 2 automated sites) in Nova Scotia in support of the Canadian Environmental Sustainability Indicator pertaining to water quality. 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, 72 sites across the major drainage areas were sampled 4–8 times in 2016–2017. Data and station information from the sites are available 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 https://www.canada.ca/en/environment-climate-change/services/freshwater-quality-monitoring.html

### 2.2.2 Biological monitoring

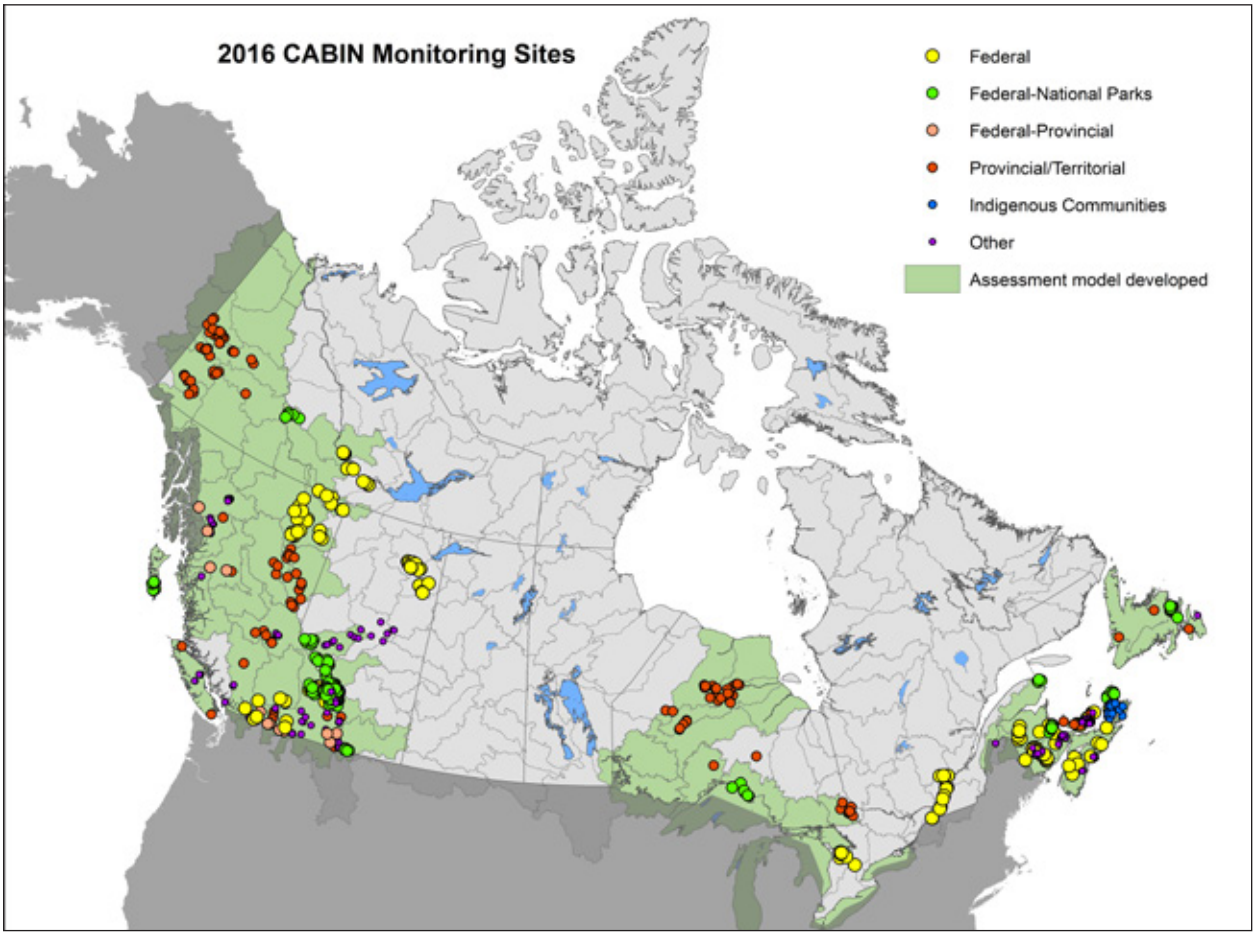
In addition to the physical-chemical water quality monitoring detailed above, ECCC also undertakes biological monitoring using benthic macroinvertebrates to assess the health of aquatic ecosystems.

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: https://www.canada.ca/en/environment-climate-change/services/canadian-aquatic-biomonitoring-network.html. This component, based on decades of research and development in many countries, has been adopted by multiple organizations across Canada. The success of CABIN results from 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.

Since the early development of the CABIN monitoring strategy in the 1980s, data has been collected in over 10,000 locations across the country. In 2016–2017, data was collected at 897 sites in several sub-basins across the country by ECCC and its collaborators (Figure 4).

**Figure 4: CABIN monitoring sites**




### 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 Environment, and Government of Yukon). Models are

available for the Yukon River Basin, Fraser River/Georgia Basin, Skagit River Basin, Okanagan Basin, B.C. Central/North Coast, Northeastern B.C. and Rocky Mountains national parks models. Preliminary models are available for B.C. south coast and Columbia. In 2016–2017, ECCC collected CABIN data from 58 stream and river sites: 41 sites for reference model maintenance and development, and 17 sites for assessment of biological condition co-located at long-term physical-chemical monitoring sites.

**Arctic/Athabasca Watershed**

In the Arctic-Athabsca watershed, a model is available in the Nahanni National Park in NWT. In the Arctic watershed in 2016-2017, ECCC revisted 11 sampling sites in the Hay River. In the Athabasca watershed, under the Joint Canada–Alberta Implementation Plan for the Oil Sands, CABIN sampling was conducted at on sites in the tributaries of the Athabasca River in 2016–2017. The program also included biomonitoring sampling in the mainstream of the Athabasca River using a modified CABIN approach for large rivers. Sampling sites in the Athabasca River and its tributaries range from within the active oil sands development area (potentially impacted sites) to outside the development area as well as beyond any natural exposures of the bituminous geologic formations in the region (reference sites).

**Hudson Bay Watershed**

In the Hudson Bay watershed in 2016-17, models were made available in CABIN for Near North Ontario and the Attawapiskat Basin. In 2016-17, ECCC revisited 5 sampling sites in southern Ontario as part of a comparative study with Ontario Ministry of Environment and Climate Change.

**Atlantic Watershed**

In the Atlantic Watershed, 191 stream and river sites were monitored by ECCC and its certified partners in 2016–2017 (170 in the Atlantic provinces and 21 in Quebec), using CABIN sampling protocols. This work supported federal-provincial water quality monitoring agreements with New Brunswick, Newfoundland and Labrador, and Prince Edward Island. Monitoring data collected also informed the Canadian Environmental Sustainability Indicators and research in the use of new techniques for assessing the suitability of aquatic habitat to support aquatic life, based on DNA collection. The monitoring allowed partners to conduct assessments in transboundary watersheds (Saint John/Wolastoq 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.

### 2.2.3 Marine water quality monitoring

The Canadian Shellfish Sanitation Program (CSSP) is a federal program which is administered jointly pursuant to a Memorandum of Understanding (MOU) between the Canadian Food Inspection Agency, ECCC and the Department of Fisheries and Oceans.

The CSSP objective is to provide reasonable assurance that molluscan shellfish are safe for consumption, by controlling the harvesting of all molluscs (e.g., oysters, mussels, clams, scallops) within the tidal waters of Canada. The mutual concerns of Canada and the United States to protect the public from the consumption of contaminated bivalve molluscs led to the Canada-US Bilateral Agreement on Shellfish Sanitation on April 30, 1948 dealing with sanitary practices in the shellfish industries of both countries. This Agreement remains in effect and to maintain open trade, Canada is subject to periodic audits by the US Food and Drug Administration.

In 2016–2017, 524 shellfish growing areas were monitored in Canada (Atlantic: 247, BC: 140, QC: 137). Marine water sampling was achieved through a combination of delivery methods in different

portions of each province, including internal ECCC resources, outsourcing to private-sector contractors federal-provincial water monitoring agreements and, to a lesser extent, voluntary agreements with First Nations and stakeholders. Analyses for fecal coliform and salinity content determination were performed in ISO 17025- accredited laboratories. Across Canada, 31,099 marine water samples (Atlantic: 18,930, BC: 6,669, QC: 5,500) were collected at 7,336 stations (Atlantic: 3,730, BC: 2,106, QC: 1500).

In addition to marine water quality determinations, sanitary shoreline investigations of point and non-point pollution sources were performed in 230 shellfish growing areas (Atlantic: 71, BC: 111, QC: 48). Related to waste water treatment plant assessments, 22 wastewater systems were evaluated or re-evaluated. Finally, 2916 environmental emergency events were reviewed and significant incidents were assessed to determine the need for emergency harvest area closures.

For more information about Shellfish Areas closure, please consult the DFO website at: https://inter-w01.dfo-mpo.gc.ca/Geocortex/Essentials/Viewer/Index.html?viewer=CSSP_Public_En_Site.

## 2.3 HYDRO-METEOROLOGICAL MODELLING AND PREDICTION

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. ECCC participated in the 15th Session of the Commission for Hydrology (CHy-15) of the World Meteorological Organization was held in Rome, Italy from December 7-13, 2016. Forty-six (46) countries were represented by 103 delegates.

The Department continues to lead the Arctic Hydrological Cycle Observing System initiative, which focuses on assessing freshwater fluxes into the Arctic Ocean. In 2016–2017, it was agreed to add extended metadata to the database of water level and flow data (available online via the Global Runoff Data Centre: https://www.bafg.de/GRDC/EN/Home/homepage_node.html) and began work to create international standards for collection of lake and river ice and water temperature observations.

### Great Lakes

In 2016–2017, 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 collaborating 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. In particular, starting in 2016–2017, estimates from the various agencies of the components of the water balance are now compiled monthly and compared. Under the 'Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data', flow measurements and computation techniques for the St. Clair and Detroit Rivers were also updated to improve water balance accounting.

Hydrological and modelling experts in ECCC continue to develop models to estimate possible scenarios of river flow through ensemble flow forecasting. The operational forecast model was expanded to 72 hours in 2016–2017. 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.

**St. Lawrence River**

Activities under the St. Lawrence Action Plan's numerical environmental predictions working group continued in 2016–2017. 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;
- two-dimensional 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 impacts of climate change on water levels.

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

**Lake of the Woods**

The Lake of the Woods Control Board is a Canadian board which regulates the water levels of Lake of the Woods and Lac Seul, and the flows in the Winnipeg and English Rivers downstream of these lakes to their junction, for the benefit of all users and interests

In 2016, Lake of the Woods Control Board staff collected field data to improve its Winnipeg River basin hydrological forecasting model. The board also joined the national FloodNET initiative, working with University of Waterloo to improve model calibration.

More information on the work of the LWCB can be found at www.lwcb.ca.

**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 one-dimensional 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. Exploratory work is being undertaken to transfer the modelling technology to provincial river forecasting agencies.

**Other activities**

ECCC provides support to many International Joint Commission (IJC) water boards, committees and special studies in 2016–2017. This included 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. Following 15 years of binational study and development and with ECCC support, in 2016–2017, the IJC implemented a new regulation plan known as Plan 2014. Plan 2014 is designed to provide for more natural variations of water levels of Lake Ontario and the St. Lawrence River that are needed to restore ecosystem health.

ECCC also played a lead role in the development of a work plan for the Lake Champlain-Richelieu Reference Study examining the cause of and possible solutions to flooding issues in that basin.

ECCC, in collaboration with U.S. Army Corps of Engineers, Detroit District, is building an Integrated Ecosystem Response Model for the St. Mary's River rapids. The bi-dimensional Ecohydraulic model will determine the best configuration for the different gates opening for improving the spawning success of several fish species that uses the swift water of the rapids for reproduction. This prototype will eventually extend to the entire St. Mary's River and will consider vegetation and several faunal indicators.

# 3. CANADIAN ENVIRONMENTAL SUSTAINABILITY INDICATORS

The Canadian Environmental Sustainability Indicators (CESI) program reports on the status and trends of key environmental issues (canada.ca/environmental-indicators). Indicators cover air quality, climate change, water quality and quantity, and wildlife and habitat.

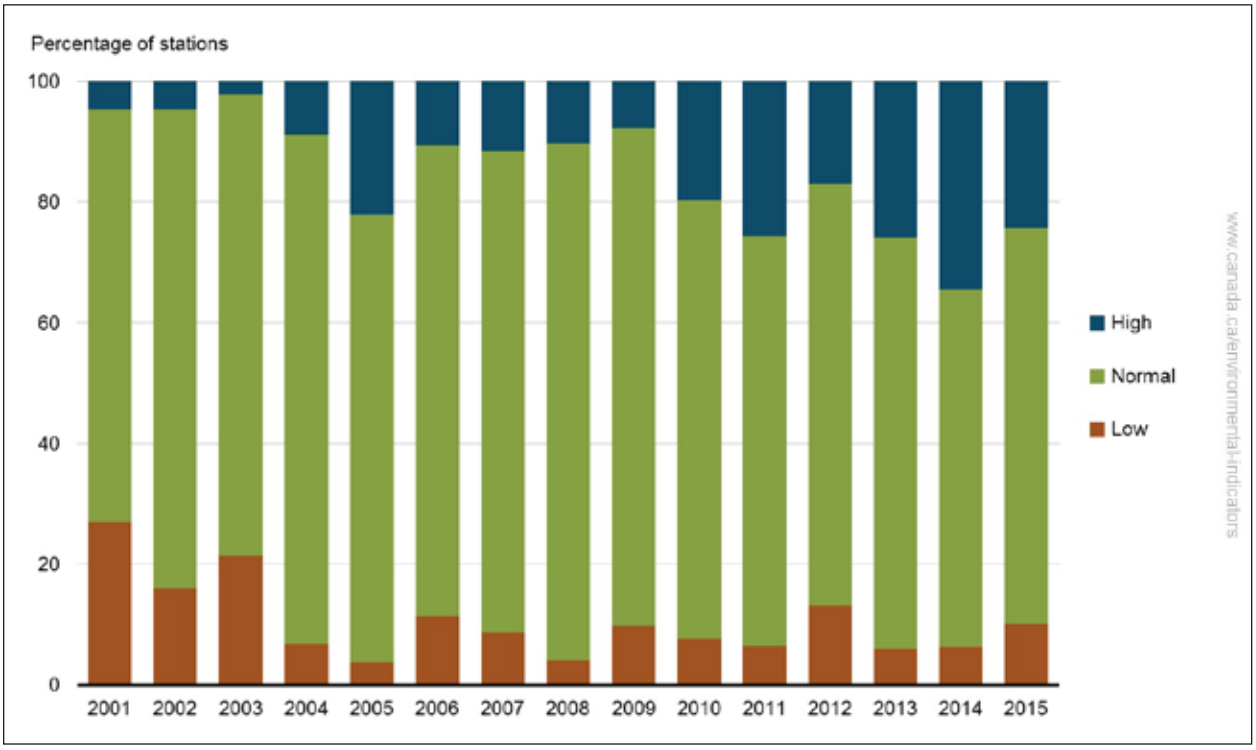
**Water quantity**

The national water quantity indicator provides a summary of trends in water quantity in rivers across Canada from 2001 to 2015 (Figure 5). At the drainage and monitoring station level, the indicators provide an illustration of whether water flows were normal, low or high from 2001 to 2015.

**National key results**

- From 2001 to 2015, most Canadian rivers had normal water quantity.
- Since 2010, there has been an increase in sites with a higher-than-normal quantity.
- The percentage of stations with a lower-than-normal quantity has declined since 2001.

**Figure 5: Water quantity at monitoring stations, Canada, 2001 to 2015**



**Water quality**

The program's water quality indicator provides an overall measure of the ability of rivers to support aquatic life (plants, invertebrates and fish) at selected monitoring sites across Canada. 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. Water quality at a monitoring station is considered excellent when substances in a river are very rarely measured above their guidelines. Conversely, water quality is rated poor when measurements are usually above their guidelines, sometimes by a wide margin.

**WATER QUALITY CATEGORIES**

Excellent = Water quality is protected with a virtual absence of threat of impairment; conditions are very close to natural or pristine levels.

Good = Water quality is protected with only a minor degree of threat or impairment; conditions rarely depart from natural or desirable levels.

Fair = Water quality is usually protected but occasionally threatened or impaired; conditions sometimes depart from natural or desirable levels.

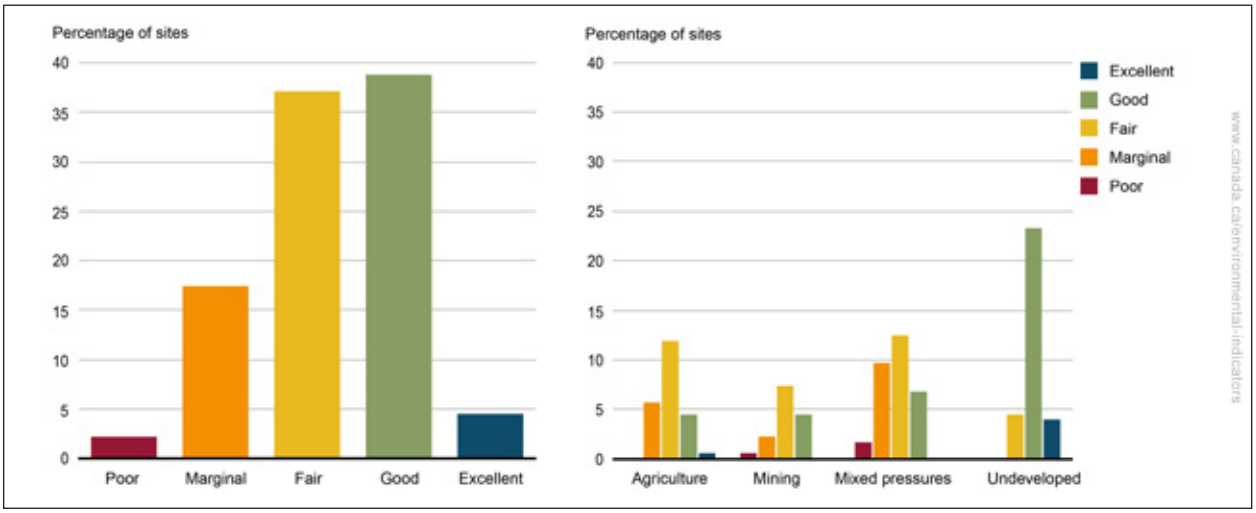
Marginal = Water quality is frequently threatened or impaired; conditions often depart from natural or desirable levels.

Poor = Water quality is almost always threatened or impaired; conditions usually depart from natural or desired levels.

The latest water quality indicator is based on data collected from 2002 to 2016 at 322 water monitoring stations across Canada and reflecting the diversity of watersheds in the country. The data were assembled from 21 federal, provincial, territorial and joint water quality monitoring programs. The national water quality indicator was calculated using a core national network of 178 river sites, selected to be representative of surface freshwater quality across southern Canada where human pressure is most intense (Figure 6a).

Water quality measured at these river sites across Canada was rated as poor at 4 sites, marginal at 28 sites, fair at 74 stations, good at 63 stations, and excellent at 9 sites. Water quality tends to be worse where there is agriculture, mining, or a combination of these with cities (mixed pressures) (Figure 6b).

**Figures 6a and 6b: National freshwater quality indicator for the 2014–2015 period, Canada**




Note: Water quality was evaluated at 178 sites across southern Canada using the Canadian Council of Ministers of the Environment's Water Quality Index. Two sites have not had their land use categorized because they are close to the Canada-United States border or the ocean. They have not been included in the land use indicator. Percentages may not add up to 100 due to rounding.

Source: Data assembled by ECCC from federal, provincial, territorial and joint water quality monitoring programs. Population, mining and land cover statistics for each site's drainage area were provided by Statistics Canada.

Overall, water quality has not changed at a majority of sites across southern Canada between 2002 and 2016. Out of the 178 core sites, there was improvement in water quality at 10% of sites and deterioration at 9% (Figure 7).

**Figure 7: Trends in National water quality indicator change from 2002–2015, Canada**

Note: The trend in water quality between the first year that data were reported for each site and 2015 was calculated at 178 sites across southern Canada. A uniform set of water quality guidelines and parameters were used through time at each site for the trend analysis. Changes in water quality from the first year of data collected at the site to 2015 are evaluated by dividing the concentration of each water quality parameter at a site by its guideline for each sampling date. These ratios are averaged annually to obtain the deviation ratio at a site. A Mann-Kendall test was used to assess whether there was a statistically-significant increasing or decreasing trend in the annual guideline deviation ratios at a site.

Source: Data assembled by Environment and Climate Change Canada from federal, provincial and joint water quality monitoring programs.

Other water indicators can be found online at https://www.canada.ca/en/environment-climate-change/services/environmental-indicators.html

# 4. RESEARCH

## 4.1 RESEARCH ON THE IMPACTS OF CLIMATE CHANGE ON AQUATIC SYSTEMS

In 2016–2017, 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:

- identification of catchments and field sites in the North to provide testbed data and locations for process research to assist in the development of next generation climate-permafrost-hydrology models;
- initiation of studies in collaboration with universities and provincial and territorial agencies to achieve a pan-Canadian network capable of determining the impacts of permafrost thawing on water resources;
- examination the effects of permafrost degradation on fluvial sediment dynamics;
- examination of the linkage between terrestrial flow pathways and sediment sources with changes in moisture content/condition (permafrost thaw, rainfall);
- maintenance of energy flux sites at fixed locations and with partners by enhanced mobile platforms with new mounted observation systems;
- quantifying the impacts on river and lake ice phenology[5] in northern regions;
- 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 of historical and projected future hydro-climatic variability and extremes over southern watersheds in the Canadian Prairies;
- analysis of the impact of projected climate on water availability over western Canada in terms of precipitation, temperature and the Standard Precipitation Evapotranspiration Index was finalized using Coupled Model Intercomparison Project Phase 5[6] climate scenario data;
- assessment of climate variability and change on prairie wetlands and hydrology; and
- research on the vulnerability of those regions of western Canada reliant on water from mountain headwaters to increasing drought risk and diminishing snow packs in collaboration with international and national academic organizations.

[5] Phenology: the study of cyclic and seasonal natural phenomena, especially in relation to climate and plant and animal life.
[6] CMIP5 is meant to provide a framework for coordinated climate change experiments.

# 5. 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 2016–2017 activities of each are described below. There are also many international transboundary and inter-jurisdictional water boards in which Canada participates, most of which are led by the IJC. IJC work is not covered under the CWA; ECCC's progress towards work plans is reported internally under the Environment and Climate Change Canada–International Joint Commission Memorandum of Understanding.

## 5.1 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 Montreal region.

The 2016 spring freshet was notable for its duration and volumes. The freshet started extremely early in the southern basins and ended unusually late in the northern basins. The amount of water in the snowpack was above average for the northern part of the basin and normal in the southern part. This amount of snow, combined with heavy precipitation received in March, led to a sharp increase in flows in mid-March. Fortunately, a lack of rain during the snowmelt period limited the severity of flooding. Considering the 1963–2015 historic record at the Carillon dam, the 2016 freshet flood peak was exceeded in 22% of cases. However, the freshet volume at Carillon from March 15 to May 31, 2016, was exceeded in only 9% of cases.

Through the integrated management of the principal reservoirs, flooding along the Ottawa River in areas that are regularly affected by high water was minimized all through the freshet. Given the high freshet volume, the use of flood reserves was necessary for the management of Rivière-des-Mille-Îles.

Total energy production on the Ottawa and Gatineau Rivers for Hydro-Quebec was 9% above average while energy production for Ontario Power Generation (OPG) was slightly 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 2016, the Secretariat recorded 56,100 page views on its website during the freshet period (March-June), which is higher than the previous year. The total number of unique users of the site was 9790. This increase is primarily due to the unusual formation of frazil[7] ice experienced in January and the significant water volume of the freshet.

[7] Frazil ice is a collection of loose, randomly oriented needle-shaped ice crystals in water. It sporadically forms in open, turbulent, supercooled water, which means that it usually forms in rivers, lakes and oceans, on clear nights when the weather is colder, and air temperature reaches −6 °C or lower.

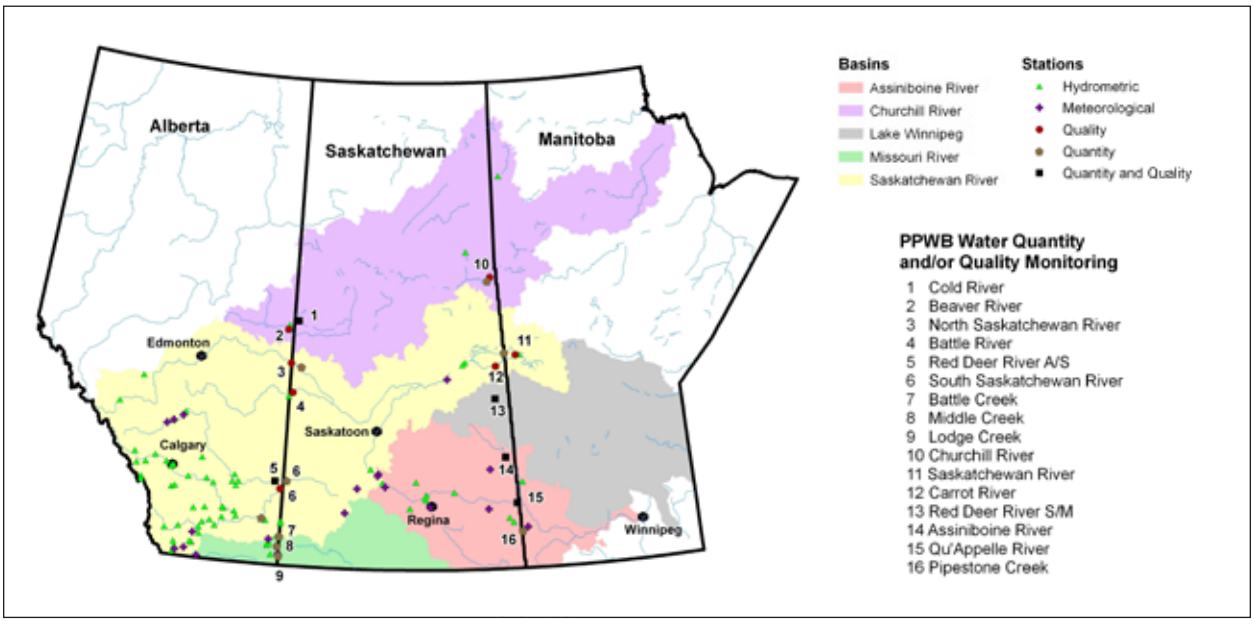
## 5.2 PRAIRIE PROVINCES WATER BOARD

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 among 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 and meteorological conditions on eastward-flowing streams and water quality at the provincial borders (see Figure 8). The PPWB computes apportionable flows on a river as though that river had never been affected by the activities of people. The PPWB also calculates excursions or exceedances and adherence to the MAA water quality objectives annually.

**Figure 8: PPWB water quantity and quality monitoring stations and basins for 2016**




Activities and accomplishments of the PPWB in 2016–2017 included the following:

- The PPWB approved the 2015 Water Quality Excursion Report. The overall adherence to Interprovincial Water Quality Objectives was very high with an average of 96.5% in 2015, such that water quality continues to be protected. The adherence rate was based on the comparison of 4674 water quality results to water quality objectives.

- Apportionment requirements were reviewed and determined to have been met in the calendar year of 2015 on all eastward-flowing prairie streams. Interim flows indicate that 2016 apportionment requirements were met on the South Saskatchewan River. It is anticipated that once computations are completed, they will demonstrate that there were not any problems in meeting apportionment for 2016 on any transboundary stream.
- A project to review apportionment methods is continuing. 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 early 2017 while the Qu'Appelle River Basin review is expected to be completed at the end of the 2017–2018 fiscal year.
- Work continued on the development of a proposed schedule to the MAA related to transboundary aquifers. A groundwater schedule was drafted and continues to undergo an internal review by the members of the PPWB. 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 held their first water quality workshop in Regina, Saskatchewan on October 4-5, 2016, focusing specifically on nutrients and current and emerging water quality issues in prairie water management. It provided an orientation and networking opportunity for approximately 50 water quality specialists and managers from participating jurisdictions.
- In November 2016, the PPWB approved the hydrometric and meteorological monitoring station list for 2017. There were no proposed changes from 2016 to 2017.
- Also in November 2016, the PPWB approved the 2017 water quality monitoring program. After a review of pesticide data from all 12 transboundary rivers, acid herbicides were added as part of the annual monitoring program to six of the transboundary rivers including: the Battle River, South Saskatchewan River, North Saskatchewan River, Red Deer River (Alberta-Saskatchewan boundary), Saskatchewan River, and the Qu'Appelle River.

### 5.3 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. 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 Master Agreement. Federal members include representatives from ECCC and Indigenous and Northern Affairs Canada. Health Canada also participates, providing support and expertise on human health issues. The three provinces and two territories in the basin are represented by 10 members, including an appointee from each provincial and territorial government water management agencies, and an Indigenous board member representing Indigenous peoples in each of the five provinces and territories in the basin.

Under the Master Agreement, ECCC is responsible for managing the expenditures of the MRBB, which are cost-shared equally by the parties. Cost-shared expenditures include the staffing and operation of the Secretariat office in Yellowknife, Northwest Territories, to provide working-level support for the Board. The Secretariat is made up of an executive director, who is hired by ECCC and is responsible for planning, directing and managing Board operations.

Key activities and accomplishments included the following:

- A British Columbia-Yukon Bilateral Water Management Agreement was concluded on March 30, 2017 to establish and implement a framework for cooperating to achieve the principles of the Master Agreement.
- The MRBB tracked the progress of bilateral water management negotiations between British Columbia and Alberta, and Alberta and Saskatchewan.
- The MRBB tracked the implementation of bilateral water management agreements between Alberta and the Northwest Territories, and British Columbia and the Northwest Territories.
- The MRBB published the Mackenzie River Basin Board Report to Ministers 2015–2016. The report describes the activities of the Board during this period and 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 with bodies of water on other continents, specifically the Amazon Basin in South America and the Mekong Basin in Asia.
- Some MRBB members participated in the *Tracking Change – Local and Traditional Knowledge in Watershed Governance* Youth Knowledge Fair, which was held in Edmonton in May 2016. Students from across the Mackenzie River Basin came together to present and share information about water issues.
- MRBB Indigenous Board members participated in the *Tracking Change – Local and Traditional Knowledge in Watershed Governance* Global Knowledge Symposium, held in Ubon Ratchathani, Thailand in February 2017.

### 5.4 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 2016, conditions in the Winnipeg River basin allowed the LWCB to maintain Lake of the Woods and Lac Seul within their normal operating ranges, balancing lake levels with flow conditions on the Winnipeg and English Rivers. The lakes under the LWCB's authority were maintained within the water level limits established under the Canada-United States treaty and federal and provincial legislation.

In 2016, 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.

The LWCB continued its normal engagement activities, hosting a booth at the Lake of the Woods District Property Owners Association's annual Cottage Show in Winnipeg in May, visiting Shoal Lake to examine the City of Winnipeg's water intake and aqueduct facility, and holding an open house in Kenora in June. Other outreach activities included media interviews, phone calls and email interaction with the public. The 2015 LWCB Annual Report was published in June 2016.

## 6. ECOSYSTEM-BASED APPROACHES TO WATER QUALITY MANAGEMENT

This section describes a number of key cooperation-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, Indigenous peoples, federal and state governments in the United States, businesses, non-governmental and community organizations, and colleges and universities.

### 6.1 ATLANTIC ECOSYSTEMS INITIATIVES

The Atlantic Ecosystems Initiatives program provides grants and contributions 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 and include broad collaborations and cooperative 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 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 2016–2017, seven projects addressed water issues quality, habitat and biodiversity, and impacts of climate change. ECCC committed over $568,000 for these projects. The following examples demonstrate the type of projects that were funded:

- In Nova Scotia, the Confederacy of Mainland Mi'kmaq partnered with the Fort Folly Habitat Recovery Program in New Brunswick to conduct comprehensive ecosystem assessments in two watersheds surrounded by heavy agricultural land use. By conducting surface water quality and CABIN monitoring, pesticide contamination in species testing, and runoff modelling, the group will identify potential stressors on surface water quality, habitat quality, and contamination of riparian and freshwater organisms. A 'Two-Eyed Seeing' approach[8] is being used to integrate Mi'kmaw traditional knowledge with western science to identify the full impacts of agriculture on Mi'kmaw communities.
- In Newfoundland and Labrador, C-Core developed a framework for wetland mapping and monitoring for the province and produced wetland inventory maps of the Avalon Peninsula using remote sensing technologies. As the transition zone between terrestrial and aquatic ecosystems, wetlands serve vital hydrological, ecological, habitat and biodiversity function, making it important to complete the wetland inventory for the province of Newfoundland, which has not been done previously. The completed wetland inventory provides comparative data across Atlantic Canada to allow for a region-wide approach to land use planning and conservation activities.
- In two watersheds, one in New Brunswick and one in Nova Scotia, Dalhousie University collected baseline water quality data with a focus on nutrient inputs from different sources such as municipal wastewater effluent, septic systems, wetlands and storm water runoff. One watershed is predominantly used for agriculture, while the other primarily supplies residential development. The data collected is being used to calibrate nutrient loading models to assess the potential impacts to water quality due to anticipated climate change stressors in the two watersheds with very different types of land uses.

[8] A 'Two-Eyed Seeing' approach embodies both Indigenous and Western world views, acknowledging that no single perspective is better. This framework originated with Mi'kmaq Elders Albert and Murdena Marshall.

### 6.2 GULF OF MAINE INITIATIVE

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 (GMI) 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.

ECCC contributed funding, technical and scientific expertise, and direct staff support for water quality projects. These contributions are improving assessment, monitoring, and modeling of the area and will lead to the mitigation of multiple stressors and their cumulative effects on water quality in the Gulf of Maine ecosystem.

In 2016–2017, all four multi-year projects address water quality issues in the Gulf of Maine ecosystem:

- Building upon data from two previous projects, the Gulf of Maine Council are creating data-based action plans for six Bay of Fundy estuaries. The action plans will provide local watershed organizations a basis to create targeted environmental management strategies. This ensures that there is a cohesive, science-based strategy for environmental management at the watershed level.
- The Nature Conservancy of Canada is classifying the biological and ecological diversity within watersheds by developing a seamless aquatic ecosystem classification and stress index across the Canadian portion of the Gulf of Maine and prioritizing watersheds and stressors within watersheds for conservation and restoration.
- Eastern Charlotte Waterways Inc. in partnership with Dalhousie University are completing a baseline assessment of pH in the estuarine environments of the Bay of Fundy.
- The University of New Brunswick will quantify impacts of salmon aquaculture on invertebrate and fish communities of shallow coastal habitats of the Canadian Gulf of Maine and provide recommendations to reduce the associated impacts on water quality.

In addition to the grants and contributions funded projects, in 2016–2017, ECCC worked in collaboration with Fisheries and Oceans Canada (DFO), Natural Resources Canada, and the provinces of Nova Scotia and New Brunswick to share data and information to develop an estuary characterization framework, and to draft preliminary profiles of key estuaries within the Bay of Fundy portion of the Gulf of Maine. ECCC also collaborated with DFO, the United States Environmental Protection Agency and other organizations through the Gulf of Maine Council on the Maine Environment to produce a State of the Gulf of Maine – Watershed Status report.

### 6.3 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 five 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.

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

For the year 2016–2017, the second phase work plan (2016–2021) was launched, which included 37 projects from the joint action program for which a number of research projects, fieldwork activities, and decision-making tools are being developed, including:

- The identification of important fish and interconnected habitat for protection and restoration.
- An Integrated Biodiversity Conservation Plan for the Lowlands and Coastal Areas of the Estuary and Gulf of St. Lawrence.
- A study of the potential for reestablishing the functional connectivity of biodiversity hotspots in the St. Lawrence lowlands, including tools for knowledge transfer;
- Wetland rehabilitation guidance for the St. Lawrence.
- The integration of wildlife and habitat issues with the potential for marine transportation development.
- The promotion of recreational fishing along the St. Lawrence, including the implementation of an incentive program.
- The establishment of a committee to promote and better integrate climate change issues.
- The quantification of the contribution of dissolved and particulate organic matter to hypoxia and the acidification of the deep waters of the St. Lawrence estuary;
- A study of the impacts of hydrocarbons and dispersants on aquatic freshwater organisms.
- A study of the use of retention ponds to capture pesticides and nutrients in surface water and agricultural runoff in the Lake Saint-Pierre area.
- A study of the current state and evolution of the weed beds and plant ecosystems of Lake Saint-Pierre, including the impacts of algal blooms and the presence of cyanotoxins.
- A study of the ecotoxicological effects of sewage discharge from the city of Montreal after its disinfection treatment by ozonation (tertiairy waste water treatment).
- A study of the risk associated with the presence of the cytostatics (new pharmaceutical products/anti-cancer substances) in the St. Lawrence.

**Community involvement and awareness**

Under the St. Lawrence Action Plan, ECCC and Quebec's Ministry of Sustainable Development, Environment and Fight Against Climate Change are implementing the Community Interaction Program (CIP), which supports non-governmental organizations to pursue and implement projects that benefit the St. Lawrence ecosystem. In 2016–2017, ECCC funded 22 projects for a total of $556,000 in contributions. These were carried out throughout the program area. 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 2016–2017 were intended to restore priority sites with high bulrush marsh in the Montmagny region; 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 fishways in the watersheds of the Ha! Ha! and Petit Saguenay, as well as the watersheds of the Portneuf and Jacques-Cartier Rivers; and to restore coastal habitats in the Matane region. In addition, 30 new project proposals were submitted to the CIP in 2016–2017 for activities beginning in 2017–2018.

**The State of the St. Lawrence River Monitoring Program**

A network of governmental and non-governmental 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 quality; benthic communities in Lake Saint-Pierre and Northern Gannet populations. The interpretation of water quality, sediment contamination, land cover and benthic communities' data was performed and fact sheets were written in 2016–2017. Those fact sheets will be released in 2017–2018.

The Working Group on the State of the St. Lawrence River organized the *Rendez-vous Saint-Laurent 2016*, which was held in Quebec City in October 2016. This event brought together experts and spokespersons from communities, non-governmental organizations, industry, academia, municipalities and governments. It was an opportunity for participants and collaborators to present the latest results from environmental indicators documented under the State of the St. Lawrence Monitoring Program and to explore possible options for improving the Program.

**Enhanced use of precipitation observations in the St. Lawrence watershed**

Precipitation and snow-on-ground observations are important inputs for the environmental prediction system along with hydrological forecasting. A number of federal, provincial and municipal agencies operate their own precipitation measurement programs and provide data from several sources: measurements made by observers, ground observations obtained with automated equipment, and remote sensing. This collaborative research project aims to compare the different sensors and methods used to measure solid precipitation. This involves taking measurements at an experimental site, the Montmorency Forest, which is located north of Quebec City and belongs to Laval University. In keeping with the scientific objectives, measurements are taken at the site in order to compare the solid precipitation data obtained manually and with various automated systems. Comparisons will be made with the protocols developed by ECCC and Department of Sustainable Development, Environment and the Fight Against Climate Change. The measurements obtained in winter 2015–2016 serve as a baseline and will be used by the different research teams in the development of the numerical environmental prediction system.

**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 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 2016–2017 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 Montreal 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.

## 6.4 GREAT LAKES ECOSYSTEM INITIATIVE

Environment and Climate Change Canada (ECCC) works in collaboration with the government of the United States, other Canadian federal departments, the Ontario provincial government, Indigenous Peoples and many other organizations, groups and individuals on water management, restoration and protection efforts in the Great Lakes. (https://www.canada.ca/en/environment-climate-change/services/great-lakes-protection.html)

ECCC leads and coordinates the implementation of 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.

In 2016-2017, Canada and the U.S. released the first Progress Report of the Parties. The report documents the binational and domestic actions taken since the GLWQA took effect in February 2013.

Key actions completed for the reporting period include:

- Pursuant to the GLWQA, the Governments of Canada and the United States finalized a Nearshore Framework, which is a systematic, integrated and collective approach for assessing the nearshore health of the Great Lakes and identifying and communicating cumulative impacts and stresses. Through implementation of the Nearshore Framework, the Governments will provide the first comprehensive assessment of nearshore waters of the Great Lakes; share the information from the assessment; identify areas that would benefit from protection, restoration or prevention activities; and identify causes of impairment and threats. A pilot project was undertaken in 2016–2017 to test the nearshore framework approach in Lake Erie.
- The Governments of Canada and the U.S. completed development of the Lakewide Action and Management Plan (LAMP) for Lake Superior. The LAMP provides an assessment of the state of the lake and priorities for action.
- To address the problem of toxic and nuisance algae in Lake Erie, a draft Canada-Ontario Action Plan for achieving phosphorus reductions from Canadian sources was prepared and released for public comment in March 2016. The draft Plan presented Canada and Ontario's proposed actions in support of binational targets and commitments under the Canada-U.S. Great Lakes Water Quality Agreement, 2012 and the Canada-Ontario Agreement on Great Lakes Water Quality and Ecosystem Health, 2014, and invited Canadians to contribute their ideas and actions for inclusion in the Action Plan. The Canada-Ontario Action Plan will be finalized in 2018.

### 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 2016–2017, coordination of Remedial Action Plan 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 noted below:

- 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 Bay of Quinte Remedial Action Plan completed an assessment of the incidence of fish tumours and other deformities and concluded that this beneficial use, which, up until now, was considered to require further assessment, is not impaired.
- A significant milestone was achieved in the Toronto Region AOC with the release of their report *Within Reach: 2015 Toronto and Region Remedial Action Plan Progress Report* which highlights the progress that has been made over the past five years and identifies remedial Action Plan priorities for the next five years.
- In the Hamilton Harbour AOC a major milestone was achieved with the upgrading of the Skyway Waste Water Treatment Plant to tertiary treatment. Work continued 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, addressing 695,000 $m^3$ of polycyclic aromatic hydrocarbon contaminated sediments.

**Science and Monitoring**

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

In 2016–2017, a broad range of monitoring activities targeting water, sediment and aquatic biota, was undertaken. Science-related work included ongoing monitoring surveys on the Great Lakes, the review and update of Lake Management Plans and ongoing data collection to support Great Lakes environmental indicator reporting.

Monitoring was conducted on tributaries flowing to Lake Erie to assess tributary load targets, in-stream processes and to support the development of domestic action plans for achieving phosphorous reductions in Lake Erie. In addition, monitoring continued in the nearshore of East Basin Lake Erie to assess nearshore water quality and ecosystem health. Monitoring results demonstrated which waters have phosphorus concentrations at established targets and which areas may require further nutrient action or controls.

Research activities under the Great Lakes Nutrients Initiative included determining the relationship between human activity and nutrient concentrations, thereby better informing nutrient source identification and nutrient criteria development. In addition various beneficial management practice scenarios were simulated to assess the impact on nutrients, sediment and flow for the Grand River watershed.

Additional research efforts demonstrated that *Cladophora*, a species of algae that thrives in Great Lakes nearshore waters, can develop into nuisance blooms when exposed to elevated levels of phosphorus, especially in its dissolved form, soluble reactive phosphorus (SRP). A high resolution model implemented for eastern Lake Erie described how dissolved phosphorus coming from land-based local sources and offshore waters drive *Cladophora* growth. Significant progress to date showed that the supply of phosphorus from the lake's offshore waters can significantly contribute to localized nearshore *Cladophora* growth. Therefore, efforts to manage nearshore nuisance blooms in Lake Erie will also have to account for the offshore phosphorus supply.

## 6.5 LAKE SIMCOE/SOUTH-EASTERN GEORGIAN BAY

In 2016–2017, the Government of Canada committed $1.77 million to 17 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 2016–2017, multi-year studies on sediment characterization; nutrient source tracking; surface water quality and associated harmful algal blooms; and groundwater quality and its role in nutrient loading were completed. Research projects advanced understanding of the sources, transport and fate of phosphorus in the Nottawasaga River watershed, Nottawasaga Bay and Georgian Bay embayments. They contributed to an improved understanding of the factors influencing water levels in Georgian Bay and its embayments and provided new information on water quality in less studied waters in the south-eastern Georgian Bay geographic region. The research and monitoring has resulted in new management tools and information/data to support these tools. 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.

## 6.6 LAKE WINNIPEG BASIN INITIATIVE

The Lake Winnipeg Basin Initiative (LWBI) was the Government of Canada's response to addressing water quality issues in Lake Winnipeg. The LWBI aimed 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), which ended on March 31, 2017, increased focus on stakeholder stewardship actions that measurably reduced nutrient loading and improved Lake Winnipeg's water quality.

Some key highlights from 2016–2017 include:

- The Lake Winnipeg Basin Stewardship Fund (LWBSF) provided financial support for 16 stewardship projects valued at $690,000; and 14 projects to reduce nutrient loading in the Lake Winnipeg Basin;
- The Lake Winnipeg Basin Office (LWBO) launched its webinar series on February 28, 2017 with a webinar presentation by Dr. Caren Binding, Water Science and Technology Directorate, ECCC titled "Remote sensing indicators for enhanced monitoring of algal bloom conditions on Lake Winnipeg".
- The Reducing Phosphorus Loads to Lake Winnipeg indicator in the Nutrients in Lake Winnipeg Indicators report, first published in February 2016, was updated in August 2016.
- The Canada-Manitoba Memorandum of Understanding Respecting Lake Winnipeg and the Lake Winnipeg Basin (MOU) 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.

- Since its inception in 2008, the LWBSF 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. Every dollar provided by the fund generated approximately $2.63 in additional funds and in-kind contributions from collaborators. In total, stakeholder-driven projects valued at over $23 million have benefitted the Lake Winnipeg Basin.

Scientific projects in 2016–2017 focused on:

- addressing knowledge gaps related to the impacts of human activity (particularly land use) on nutrients in Lake Winnipeg tributaries;
- undertaking water quality and biotic monitoring to track spatial and temporal flux of nutrients transported from the watershed to the lake;
- addressing critical knowledge gaps in lake nutrient dynamics relative to changes in nutrient loads to Lake Winnipeg;
- developing predictive models in support of nutrient management in the Lake Winnipeg Basin; and
- developing satellite earth observation tools for detecting and reporting on the extent and severity of algal blooms on Lake Winnipeg.

# 7. PUBLIC INFORMATION

There are a number of ways in which ECCC and its many collaborators 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.

The Government of Canada's Water website (https://www.canada.ca/en/environment-climate-change/services/water-overview.html) provides content on ECCC's water-related activities and program areas as well as general information on a wide range of water-related topics and the full text of key water publications (such as the *Great Lakes–St. Lawrence River water levels*). In addition, the site provides links to laws and regulations.

ECCC's Wateroffice (https://wateroffice.ec.gc.ca) provides public access to real-time and archived hydrometric data collected in Canada. In 2016–2017, the Wateroffice website received over 54 million hits (approximately 1.6 M visits).

Real time hydrometric data is also now available on ECCC's Datamart (https://wateroffice.ec.gc.ca), for partners to directly upload data into their own software systems.