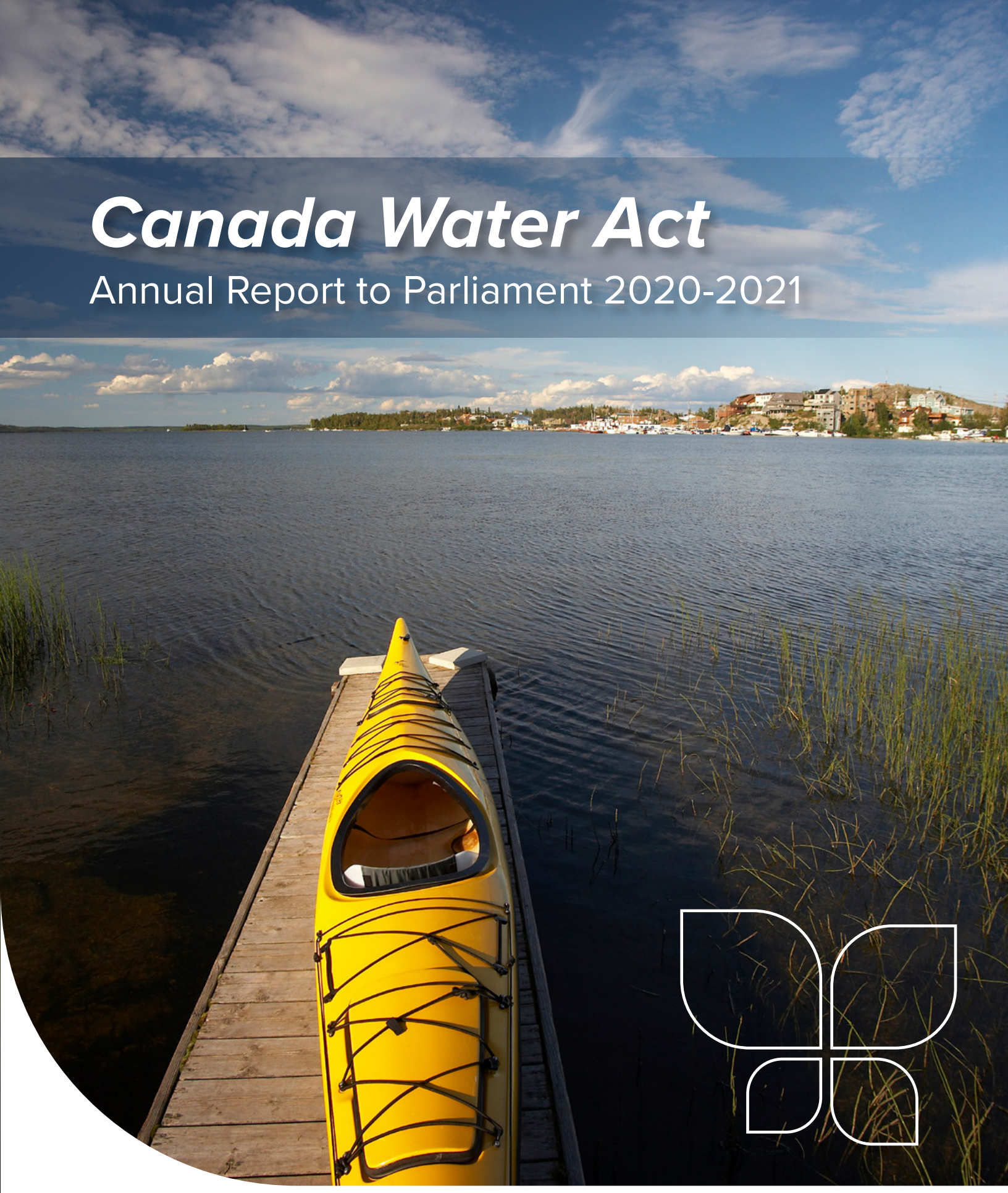
Canada Water Act

Annual Report to Parliament 2020-2021



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Lake Louise, Alberta

1 Introduction

The *Canada Water Act* (CWA), which is administered by the Minister of Environment and Climate Change, enables a framework for collaboration among federal, provincial and territorial governments in matters relating to water resources. Each level of government has a different role related to the management of water resources and there are many areas of shared responsibility. 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.

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, 2020 to March 31, 2021.

This 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.

Freshwater management in Canada is a responsibility shared between federal, provincial, territorial, and Indigenous governments. The federal government is involved in freshwater-related areas such as fisheries, pollution prevention, shipping and navigation, international relations, domestic transboundary waters, and the creation and management of protected areas. The federal government is also responsible for management of freshwater on federal lands.

Provincial and territorial governments play major roles in the management of freshwater. They are generally involved in freshwater-related areas such as providing the authorization for water use within their borders, responsibility for drinking water, as well as managing inland fisheries, aquatic species at risk, and invasive species.

Canadian provinces and territories have significant responsibility over areas of water management and protection within their borders, including water allocation and use, drinking water and wastewater services, source water protection, and thermal and hydroelectric power development. Most of these governments delegate some authority to municipalities, in particular in relation to drinking water treatment and distribution, and wastewater 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.

Under many historic and modern treaties, and self-government agreements, Indigenous Peoples have fresh-water-related rights. Indigenous Peoples are also involved in transboundary freshwater management, including through water management boards.

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

- freshwater monitoring
- water quality and quantity indicators
- shellfish water classification program
- interjurisdictional water boards
- ecosystem-based approaches to water quality management
- research and development

2 Highlights

- In 2020-2021, there was a suspension of Environment and Climate Change Canada's (ECCC) in-person research and monitoring field and lab operations activities due to the COVID-19 pandemic. Continuity in monitoring was facilitated, in part, through partnerships with provinces and territories.
- The uploading process of hydrometric data was automated to retrieve approved daily data from the data production system and upload them into the National Archive database. This new process enabled the data uploading on a daily basis and greatly improved the efficiency of data publishing.
- Hydrometric Needs Index (HNI) maps were developed as a graphical representation of monitoring needs for the hydrometric network. The index is based on user requirements and partner mandates, and is generated by processing open source geospatial data.
- Thirty-five new hydrometric test stations across 7 provinces were established in 2020-2021. These new stations will be used to test a variety of new sensors and monitoring techniques to assess their performance and ability to improve the accuracy, reliability and timeliness of the hydrometric data.
- In 2020-2021, snowpack in the western portion of the Northwest Territories and the southern portion of the Yukon were well above normal (188% in southern Yukon). Water levels on Great Slave Lake were the highest on record, which created elevated flows on the Mackenzie River during the winter of 2020-2021. These conditions contributed to flooding during the 2021 breakup period, which resulted in the evacuation of several communities.
- Ice jams and overland flooding impacted the Prairie region from April through to late July in 2020. The city of Fort McMurray declared a state of emergency resulting in evacuation orders issued in low-lying areas of the city. ECCC's Water Survey of Canada recorded some of the highest water levels on record.
- As an example of support for open information sharing, ECCC worked closely with British Columbia on the development of a website for the water quality agreement to bring together water quality and biomonitoring information, data, status, and trend results through a single ArcGIS* online tool.

*An online geographic information system service

3 Freshwater monitoring

Environment and Climate Change Canada (ECCC), in collaboration with provincial and territorial governments and others*, conducted 3 types of monitoring in fresh water across Canada to obtain information on:

- water quantity
  - National Hydrometric Program (National Hydrometric Monitoring Network)
- freshwater quality
  - physical-chemical parameters (Long-Term Freshwater Quality Monitoring Network)
- biological condition
  - benthic macroinvertebrate communities (Canadian Aquatic Biomonitoring Network (CABIN))

*In a few cases, Indigenous Peoples, institutions or volunteers assist with monitoring.

3.1 Water quantity monitoring

The National Hydrometric Program (NHP), a partnership between federal, provincial and territorial governments, is responsible for providing critical hydrometric data, information, and knowledge that Canadians and their institutions need to make informed water management decisions to protect and provide stewardship of fresh water in Canada. These data are available on ECCC's Wateroffice website. 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.

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 1 national administrator designated by Canada. Both groups met regularly throughout 2020-2021 to discuss program issues. Regular input from both groups and an annual survey of NAT partner satisfaction provided valuable input on program operations, documentation and dissemination practices, and available training resources for the NHP.

ECCC has hydrometric agreements with 9 provinces, Yukon and Northwest Territories, and with Crown-Indigenous Relations and Northern Affairs Canada for Nunavut for the collection, analysis, interpretation, and dissemination of water quantity data. These agreements have been administered cooperatively since 1975 and, with the exception of Newfoundland and Labrador, New Brunswick, and Saskatchewan, have been renewed since 2008. In addition,

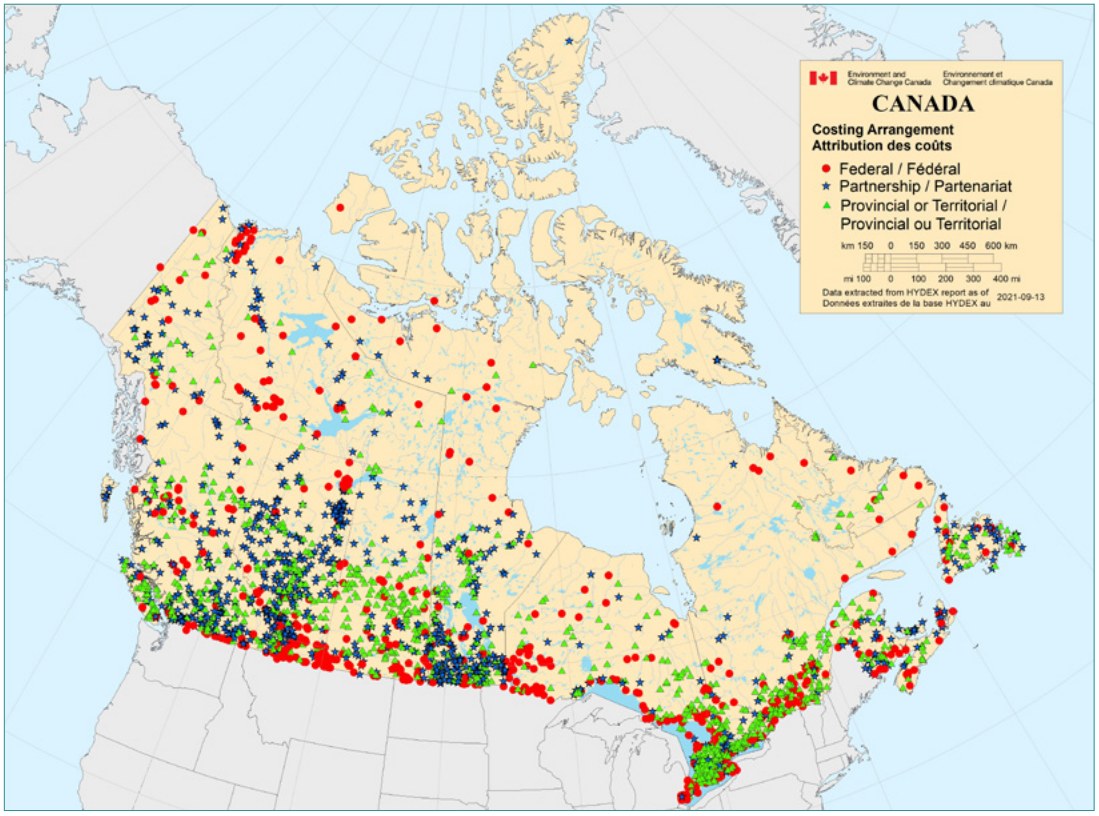
NHS is a co-signee of the annual Memorandum of Agreement on Water with the province of Prince Edward Island. The intent of the Agreement is to coordinate the efforts of the provincial and federal governments to monitor the health of aquatic ecosystems, including water quantity, on PEI to ensure that the sustainability of the province's water resources is maintained for environmental, social and economic benefit.

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.

3.1.1 National hydrometric monitoring network

During 2020-2021, there were no significant changes to the size of the national hydrometric monitoring network, but a number of small adjustments were made. The national hydrometric monitoring network of the NHP in Canada consisted of 2826 hydrometric monitoring stations (see Table 1 and Figure 1).

Figure 1: National Hydrometric Monitoring Network



During this period, ECCC operated 2263 of these hydrometric stations. Of the ECCC-operated stations, 1096 were fully or partially federally funded.

The remaining stations were operated by ECCC on behalf of provincial and territorial governments or a third-party interest, and cost-sharing was based on 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.

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
Alberta	81	158	161	38	18	**456**
British Columbia	49	184	213	0	6	**452**
Manitoba	20	90	108	5	174	**397**
New Brunswick	14	16	27[c]	7	4	**68**
Newfoundland & Labrador	16	32	64	1	0	**113**
Nova Scotia	10	6	15	0	0	**31**
Northwest Territories	42	23	21	18	0	**104**
Nunavut	6	2	13	4	0	**25**
Ontario	78	65	326	88	7	**564**
Prince Edward Island	0	5	5	0	0	**10**
Quebec	16	0	0	0	227	**243**
Saskatchewan	95	51	11	7	127	**291**
Yukon	9	24	28	11	0	**72**
Total	**436**	**656**	**992**	**179**	**563**	**2826**

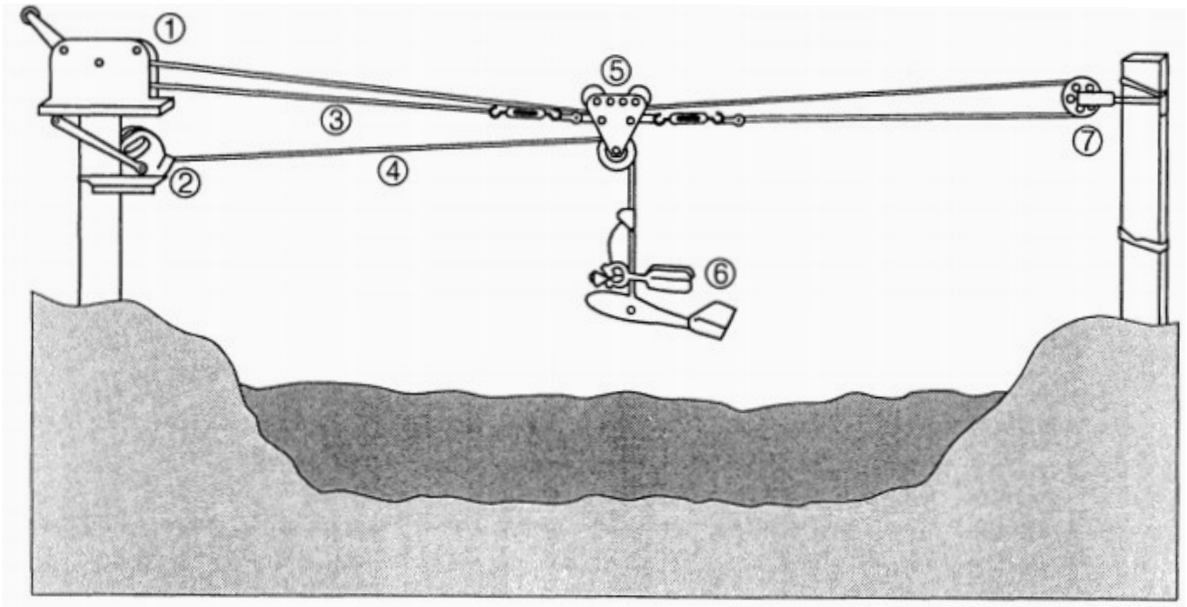
[a] Hydrometric monitoring stations located within the boundaries of each province, no matter which office operates them.

[b] Stations that are partially funded by the federal government, provincial/territorial governments, and third parties. The cost-share ratio varies by station.

[c] Nine of these stations are groundwater stations.

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 2020-2021, only 28 cableways were addressed throughout the country as COVID-19 had major impacts on the national work plan delivery. With the previous year's repair, a total of 183 cableways have been either repaired, repurposed or replaced with alternative technologies through renewal investment. At the beginning of the project in July 2018, there were 350 cableways that needed to be addressed. Therefore, 52% of construction work on cableways is completed.



Schematic of a cableway system with sounding reel and current meter in use
(1) near post with pulley drive housing; (2) sounding reel; (3) cableway cable; (4) sounding reel cable; (5) traveling block; (6) current meter; (7) tailhold on far post

COVID-19 has not only impacted the scheduled work on cableways, but created delays for the entire infrastructure workplan, including decommissioning and stilling wells projects. Approximately 40% of the 200 infrastructure projects planned for 2020-2021 had to be postponed to subsequent years. It is important to note that none of the 15 projects planned for the Northern region have been addressed. In total, 118 infrastructure projects were completed, including work on cableways.

3.1.2 Data dissemination

After-hour support was provided during the 2020 spring freshet to ensure real-time hydrometric data were available 24/7 during high water periods.

The uploading process was automated to retrieve approved daily data from the data production system and upload them into the National Archive database. This new process enabled the data uploading on a daily basis and greatly improved the efficiency of data publishing.

The daily data (2013 to 2020) of the Quebec-operated hydrometric stations were updated in the National Archive database.

The newly uploaded data facilitate the development of the Canada-wide Water Quantity Indicator under the Canadian Environmental Sustainability Indicators program.

The offline historical databases of the National Archive were released 4 times: April 2020, July 2020, October 2020, and January 2021.

3.2 Freshwater quality monitoring

Freshwater quality monitoring has been a core ECCC program 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, in addition to fulfilling federal domestic and international commitments and legislative obligations. Data are also used to support the water quality indicator developed under the Canadian Environmental Sustainability Indicators program (see Section 4).

Water quality monitoring efforts were significantly impacted over 2020-2021 due to the COVID-19 pandemic, with field activities limited to varying degrees across Canada. Continuity in monitoring opportunities was facilitated, in part, through leveraging of partnerships with provinces and territories. Future reporting on 2020-2021 data will need to account for these changes.

Lake Berg, British Columbia

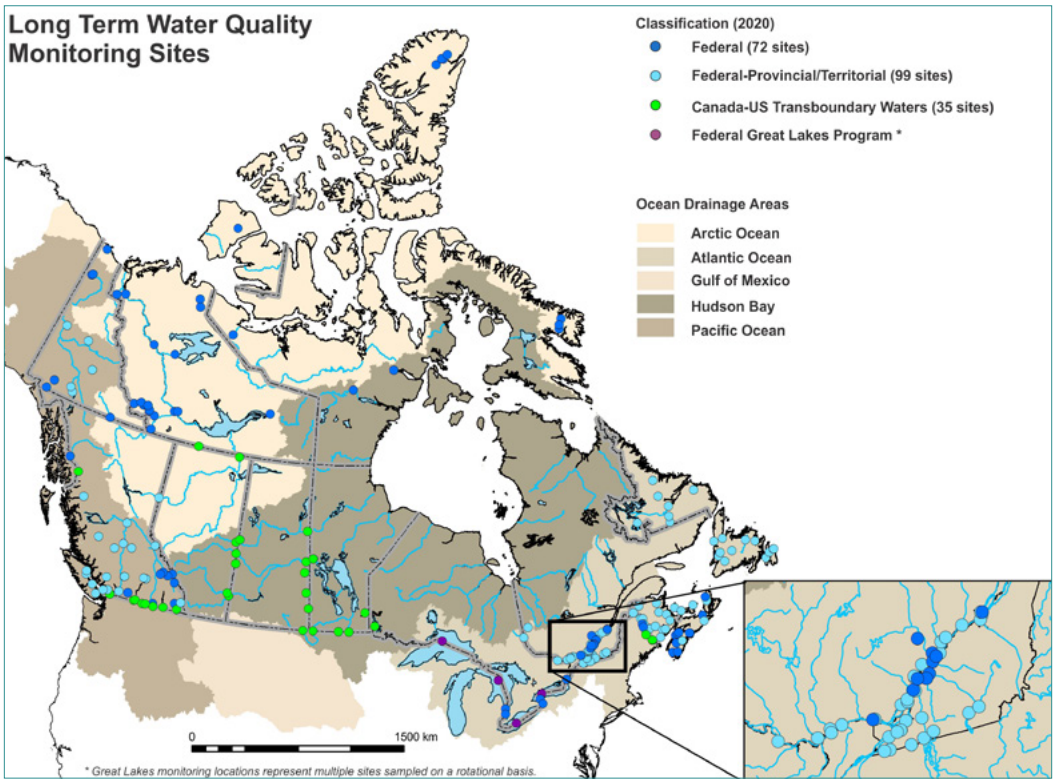
Much of the program's monitoring is carried out through federal-provincial/territorial agreements, ensuring cost-effective and non-duplicative program delivery. ECCC has water quality monitoring agreements with British Columbia, Yukon, Manitoba, Quebec, Prince Edward Island, New Brunswick, and Newfoundland and Labrador.

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
- obtain comparable, scientifically sound water quality data that are reliable to inform water resource management
- disseminate water quality information in a timely manner to the public, government agencies, industry and the scientific community

The Long-Term Freshwater Quality Monitoring Network consists of 171 federal, federal-provincial and federal-territorial sampling sites across Canada (see Figure 2). The map also displays 35 sites that are monitored in Canada-US Transboundary Waters, as well as the location of sites monitored at various times under the Federal Great Lakes Program. Water quality samples are routinely collected at these sites for physical and chemical water quality parameters such as temperature, pH, alkalinity, turbidity, major ions, nutrients and metals. Pesticides, bacteria and additional parameters of concern are also monitored where site-specific water quality issues exist. The National Long-Term Water Quality Monitoring Data are published online.

Figure 2: Long-term water quality monitoring sites



Since 2010, ECCC's Water Quality Monitoring and Surveillance Division has utilized the Risk Based Adaptive Management Framework (RBAMF) to optimize its monitoring activities. The RBAMF is defined through a set of established pillars that guide its various components. These pillars include defining monitoring responsibilities, identifying risks to water quality at monitoring sites and across Canada's drainage basins, optimizing monitoring operations, and ensuring data quality and data access, all of which improves reporting outcomes.

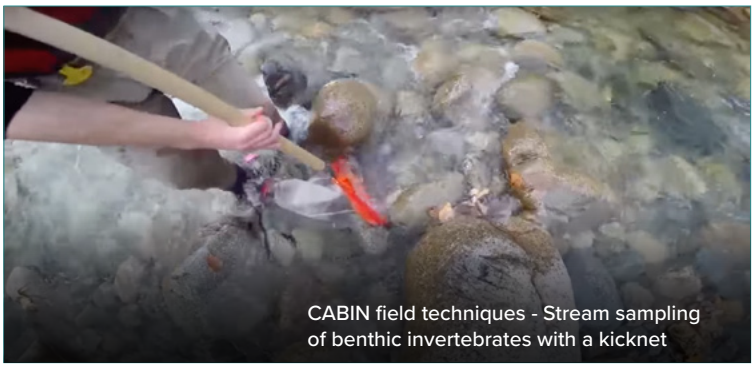
Existing long-term monitoring sites have been classified under a series of national scale networks, namely Large Rivers, Large Lakes Priority, Transboundary Rivers, Reference, and High Stress where each network included a set of specific national monitoring objectives. Each network was developed to improve comparability of monitoring data.

ECCC's Freshwater Quality Monitoring Program is aligned with Canada's major watersheds (Pacific, Arctic/Athabasca, Hudson Bay and Atlantic watersheds)(see Figure 2). This program promotes robust water resource management across Canada.

For more information, please consult the ECCC Freshwater Quality Monitoring website.

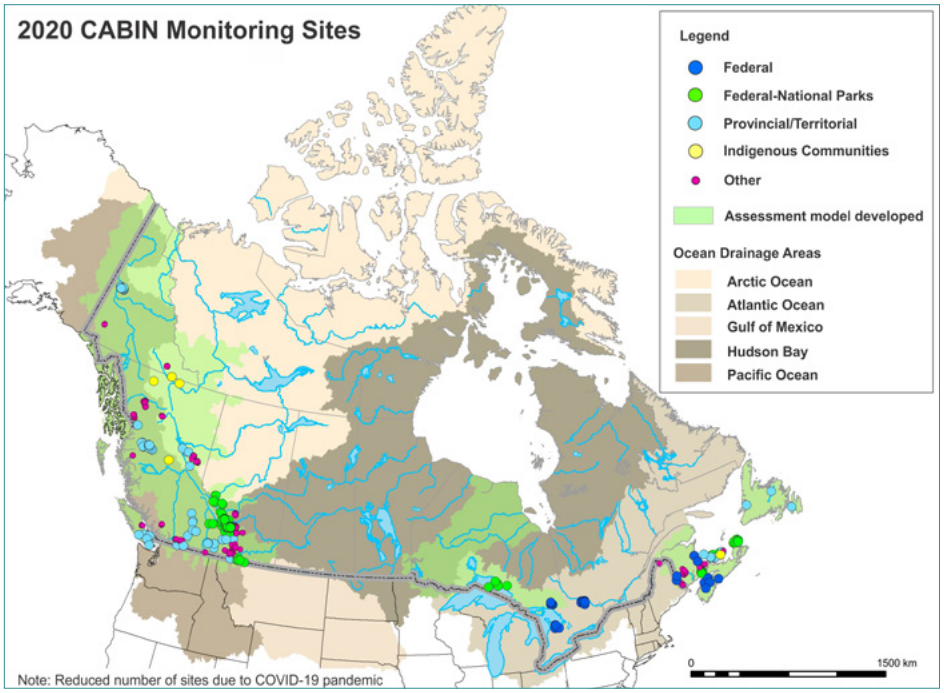
3.3 Biological monitoring

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



CABIN field techniques - Stream sampling of benthic invertebrates with a kicknet

Figure 3: CABIN monitoring sites



The Canadian Aquatic Biomonitoring Network (CABIN) is a component of the Freshwater Quality Monitoring Program for assessing the biological condition of freshwater ecosystems in Canada using standardized data collection and analysis methods. This component, based on decades of research and development in many countries, has been adopted by multiple organizations across Canada. ECCC's National CABIN Team 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 nongovernmental organizations such as community watershed groups. The CABIN Science Team, consisting of ECCC and external scientists with expertise in large-scale ecological monitoring, provides science advice and recommendations. Data from over 10 000 locations across the country are represented in the CABIN database, since the early development of nationally standardized biological monitoring programs in the 1990s.

Due to COVID-19 restrictions, limited sampling was conducted during CABIN sampling season of 2020. In 2020-2021, data were collected at 502 sites in various sub-basins across the country, primarily by non-federal government organizations (see Figure 3). Although federal and federal-provincial/territorial sampling was decreased in 2020 due to the COVID-19 pandemic, the flexible program design meant that a number of CABIN sites were still safely monitored by local academic and community organizations.

3.4 Monitoring information by region

Summaries of the monitoring conducted in the various regions across Canada are discussed below on a region by region basis (with Yukon overlapping both the Pacific Coast and Northern Canada regions), as follows:

- water quantity monitoring
- water quality monitoring
- CABIN monitoring

3.4.1 Pacific coast

Water quantity monitoring

In British Columbia (BC), during the April 2020 to March 2021 period, annual streamflow volumes ranged near normal (relative to the 1980-2019 time period).

The Alsek River, Yukon, drains into the Pacific Ocean

The water quantity monitoring network in BC (452 stations) was adjusted as follows:

- Eight stations were added to the network:
  - Capilano River at Canyon (08GA031)
  - Kitwanga River near Kitwanga (08EB007)
  - Nation River near Fort St James (07ED001)
  - Pearson Creek near the mouth (08NM172)
  - Ryan River near the mouth (08MG028)
  - Southgate River above Elliot Creek (08GD010)
  - Tahltan River at the mouth (08CE005)
  - Thompson River at Savona (08LF033)
- Cableway and monitoring well infrastructure was removed, repaired or rebuilt:
  - 2 cableways were removed
  - 14 cableways were repaired or rebuilt
  - 75 cableways remain out of service
  - 5 creosote wells were removed

Water quality monitoring

Water quality monitoring was conducted in the Pacific watershed (which includes parts of BC and Yukon) under the *Canada-British Columbia Water Quality Monitoring Agreement* and under the *Canada-Yukon Agreement on Water Quality and Ecosystem Monitoring*.

In the area of Yukon that drains westward to the Pacific Ocean, 2 sites on the Alsek and Dezadeash Rivers were monitored in collaboration with Parks Canada and ECCC. The other water quality monitoring sites in Yukon, which drain to the Bering Sea and were previously assigned as part of the Pacific drainage basin, are included in the report section on Northern Canada (see Section 3.4.2).

In BC, ECCC conducted joint monitoring with the provincial Ministry of Environment and Climate Change Strategy at 37 sites in total, which includes 1 automated station (described below). Fifteen of these sites are co-located with ECCC gauging stations.

- The annual water monitoring activities were negotiated and documented in the *Canada-British Columbia Water Quality Monitoring Agreement Business Plan (2020-2021*).
- Sampling operations in BC were suspended from April to October 2020 due to the COVID-19 pandemic.
- One real-time automated monitoring buoy is located at the mouth of the Fraser River (main arm of the Fraser River Estuary) providing real-time water quality data meteorological data, as well as grab-sample water quality data. The data is available to the public through ECCC's Freshwater Quality Monitoring and Surveillance website (Canada-BC).
- Water quality data collected under the *Canada-British Columbia Water Quality Monitoring Agreement* is also available through a joint ECCC-British Columbia website hosted by British Columbia. This website aims to bring together water quality and biomonitoring information including data, status and trend results through a single ArcGIS Online tool.

In 2020-2021, ECCC, in cooperation with Parks Canada, also operated 5 long-term water quality monitoring sites in the Glacier, Yoho, Mount Revelstoke and Kootenay National Parks in BC and Kluane National Park in the Yukon. These relatively pristine sites 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.

CABIN monitoring

In BC, CABIN monitoring is jointly conducted under the *Canada-British Columbia Water Quality Monitoring Agreement*.

In 2020-2021, ECCC was unable to collect data for the assessment of biological conditions at long-term physical-chemical monitoring sites in BC due to the COVID-19 pandemic. However, significant efforts were spent working with British Columbia on the development of a webpage for the water quality agreement to bring together water quality status and trends and biomonitoring information at long-term water quality sites.

There are 9 reference models available to all CABIN users to conduct biological assessments in nearly all watersheds across BC that were developed collaboratively by federal and provincial agencies (i.e. ECCC, Parks Canada, British Columbia Ministry of Environment and Climate Change Strategy). Models are available for the Fraser River, Skagit River Basin, Okanagan Basin, BC (updated in 2020), Central/North Coast, Northeastern BC, Peace Basin, Columbia Basin, Rocky Mountains national parks, and the preliminary BC South Coast model (currently being revised).

3.4.2 Northern Canada

Water quantity monitoring

In 2020-2021, snowpack in the western portion of the Northwest Territories and the southern portion of the Yukon were well above normal (188% in southern Yukon). Water levels on Great Slave Lake were the highest on record, which created elevated flows on the Mackenzie River during the winter of 2020-2021. These conditions contributed to flooding during the 2021 breakup period, which resulted in the evacuation of several communities. The villages of Hay River, Jean Marie River, Fort Simpson and Fort Good Hope all had evacuation orders issued. Downstream communities, such as Aklavik, also had voluntary evacuation notices.

Mackenzie River, Yukon

Kluane Lake in the Yukon continues to experience significantly lower peak water levels as a result of a 2016 river piracy event, where the Slims River, which drains into Kluane Lake, had its flow diverted as a result of the retreat of the Kaskawulsh Glacier. To better describe and capture the change in flow characteristics, the Kluane River at the outlet of Kluane Lake was re-established as an annual discharge station, with operating costs being shared between the Yukon Government and the Water Survey of Canada since in 2019.

The water quantity monitoring network in this region was adjusted as follows:

- **Yukon** (72 stations)
  - No new stations were added in 2020-2021
  - Yukon based Water Survey staff operated 9 gauges in northern BC for operational efficiencies as part of the *British Columbia Hydrometric Agreement*.
- **Northwest Territories** (104 stations)
  - One new station was added to the Northwest Territories network in 2020:
    - Buffalo River at Highway No. 5 (07PA001)
  - Northwest Territories Water Survey staff continue to operate 1 station in northeastern BC (Petitot River below Highway No. 7 – 10DA001) and 13 stations within the Peace-Athabasca Delta in Northeastern Alberta for operational efficiencies. In December 2020, 11 of those stations reverted back to the responsibility of the Alberta NHS staff.
- **Nunavut** (25 stations)
  - No new stations were added to the Nunavut network in 2020
  - Within Nunavut, the 25 hydrometric stations are run by ECCC in accordance with the established cost-share agreement between ECCC, CIRNAC, Parks Canada Agency and the City of Iqaluit

Water quality monitoring

Many of the High Arctic sites are considered relatively pristine and 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 associated with transboundary basins (e.g. Mackenzie River, Slave River, Liard River, Yukon River) or are significant northern watersheds (e.g. Coppermine River, Thelon River, Great Bear Lake/River).

ECCC monitored 39 sites within the Arctic watershed and across the North: 19 in the Northwest Territories, 6 in Nunavut, 11 in Yukon, and 3 in Northern Alberta. Many of these sites were operated under agreement with Nahanni

National Park. Many of these sites were also co-located with ECCC's gauge stations. Twelve sites that are typically sampled under agreements with 6 other National Parks in Northwest Territories, Yukon, and Nunavut were not sampled in 2020-2021 due to the COVID-19 pandemic.

Water quality monitoring was conducted in the Yukon under the *Canada-Yukon Agreement on Water Quality and Ecosystem Monitoring.* Eleven river sites were monitored in collaboration with Environment Yukon, including 1 automated site. Sampling operations under the *Canada-Yukon Agreement* were suspended from April to October 2020 due to the COVID-19 pandemic. Eight sites are co-located with ECCC's gauge stations.

CABIN monitoring

In 2020-2021, ECCC was unable to collect data for the assessment of biological condition at long-term physical-chemical monitoring sites in the Yukon due to the COVID-19 pandemic. Northern bioassessment models are available for site assessment of CABIN samples collected in the Yukon River Basin and are also available to other government organizations conducting biomonitoring programs, including the Department of Fisheries and Oceans and the Government of Yukon. A bioassessment model is also available for the South Nahanni Basin in the Northwest Territories, which is primarily used by Parks Canada.

3.4.3 Prairie region

Water quantity monitoring

Ice jams and overland flooding impacted several stations from April through to late July in 2020. The city of Fort McMurray declared a state of emergency resulting in evacuation orders issued in low-lying areas of the city. ECCC's Water Survey of Canada recorded some of the highest water levels on record. Higher than normal precipitation in June and July of 2020 in the Peace, Athabasca, and North Saskatchewan River basins resulted in high water events in several areas of the province. Water survey staff documented some of the highest water levels on record once again at several stations related to the flooding that had occurred.

High Streamflow and Flood Watch advisories continued in the Peace River, Athabasca, North Saskatchewan, Red Deer, and Oldman River Basins of the province throughout June and July of 2020.

Saskatchewan River, Saskatchewan

Flows on the Athabasca River were much higher than normal throughout the summer of 2020. In addition, flows on the Peace River were much higher than average between July and September 2020, with these flows exceeding the 75th percentile for much of the summer of 2020.

The global COVID-19 pandemic affected operations and the delivery of the program in 2020-2021. Minimal field operations continued with the necessary protective measures, only when responding to critical situations.

- **Alberta** (456 stations)
  - The operation of 11 Peace Athabasca Delta stations in the Mackenzie River basin were transferred from NWT to Alberta (Edmonton Office) in January 2021.
  - Peace River at Peace Point (07KC001) Station suffered damage by spring ice jam/boulders. A temporary gauge has been deployed and rebuild of a permanent gauge is planned for 2021-2022.
  - Athabasca River Upstream of Grande Rapids (07CC908) was destroyed by ice jams. Real-time data transmission was lost at the site until a temporary gauge was installed.
  - Bountiful Coulee Inflow near Cranford (05AG026) Gauge was relocated upstream of the existing gauge.

- Fish Creek Above Little Fish Lake (05CG006) Gauge was relocated to higher ground due to frequent flooding and to address an occupational health and safety issue, data collection and integrity.
- Eymundson Creek near the Mouth (07DA041) needed re-installation of a tilting mast and cabinet shelter, as the original was lost in June high water.
- Station decommissioning and upgrades to replace aging infrastructure, improve safety, record quality and operational efficiencies continue. The following stations were upgraded:
  - Berland River Near The Mouth (07AC007)
  - Berry Creek near The Mouth (05CH007)
  - Blindman River near Blackfalds (05CC001)
  - Bow River Below Carseland Dam (05BM002)
  - Bow River Development Drain D near Vauxhall (05BN008)
  - Clearwater River at Draper (07CD001)
  - Clearwater River Near Dovercourt (05DB006)
  - Crowsnest River At Frank (05AA008)
  - Eastern Irrigation District Main Branch Canal near Headgate (05BM020)
  - Eymundson Creek near the Mouth (07DA041)
  - Manyberries Creek at Brodins Farm (05AF010)
  - Mcleod River Near Whitecourt (07AG004)
  - Medicine River Near Eckville (05CC007)
  - North Saskatchewan River at Whirlpool Point (05DA009)
  - Oldman River Near The Mouth (05AG006)
  - Pyami Drain near Picture Butte (05AD037)
  - Red Deer River near Bindloss (05CK004)
  - Rush Lake Drain near New Dayton (05AF031)
  - Twelve Mile Creek near Cecil (05BN002)
- Seven stations were upgraded to Geostationary Operational Environmental Satellites (GOES) from cellular modem or land line communications to improve data collection:
  - Atimoswe Creek near Elk Point (05ED002)
  - Monitor Creek near Monitor (05GA003)
  - Simonette River near Goodwin (07GF001)
  - Babette Creek near Colinton (07CA008)
  - Parlby Creek at Alix (05CD007)
  - Pembina River at Jarvie (07BC002)
  - North Saskatchewan River at Edmonton (05DF001)
- Various levels of decontamination measures continued at all stations in the province to deal with whirling disease[1]. A construction project was initiated to build the capacity for a decontamination space at the Edmonton Warehouse.
- ECCC's Water Survey of Canada North's newly opened office in Edmonton continues to expand with new staff to support the consolidation of northern operations. The transition over the next few years will result in operational efficiencies for the northern region of Alberta.

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

- **Saskatchewan** (291 stations)
  - Pre-runoff conditions ranged from below normal to normal for southern and northern Saskatchewan. Spring snowmelt-runoff was generally normal to below normal.
  - High water on the Saskatchewan River system began moving through Saskatchewan in early July. Record high rainfall in the summer in northern Saskatchewan resulted in very high water levels and flows in the Churchill River basin and Lake Athabasca Basin. Many stations experienced historic stage (water level) and discharge. All time high flow was observed on the Reindeer River. Two sites were inundated and had emergency shelters installed.
  - Fall conditions were generally below normal in southern Saskatchewan and well above normal in northern Saskatchewan heading into freeze up.
  - Ninety stations were changed from 8-month operation to 12-month operation: 53 federal, 31 federal/provincial, and 6 provincial stations.
  - Three new stations were installed:
    - Reindeer River at Southend (06DB004)
    - Saskatchewan River Old Channel (05KH009)
    - Crean Lake at the Warden Station (06CA008)
  - One station was discontinued:
    - Shepherd Ditch near Consul – Irrigation ditch/structures removed (11AB020)
  - Facilities/Construction:
    - Repairs: 1 v-notch weir, 3 bank-operated cableways (BOC) upgraded
    - Decommissioning: 3 wells, 2 shelters, and 2 metering bridges
    - Installation: 1 narrow well
- **Manitoba** (397 stations)
  - Pre-runoff conditions ranged from normal to above normal for southern and northern Manitoba, with central Manitoba having normal conditions. Spring snowmelt-runoff was generally normal to below normal.
  - Rainfall (up to 150 mm) in early June in southeast Manitoba led to overland flooding and very high water in the area. Local states of emergency were declared and some homes required sandbagging and evacuating.
  - In southwest Manitoba another event in late June resulted in approximately 200 mm of rain over 72 hours. This led to unprecedented water levels on Lake Wahtopanah (part of the Little Saskatchewan River system) and the integrity of the Rivers Dam was under scrutiny by Manitoba Infrastructure and high water warnings and evacuations took place downstream of the structure. This was identified by Manitoba Infrastructure as a 1/1000 year event.
  - High water levels were experienced throughout northern Manitoba with many stations recording historic stage (water level) and discharge. Two sites were inundated and had emergency shelters installed.
  - Fall conditions were generally below normal in southern Manitoba and well above normal in northern Manitoba heading into freeze up.
  - Facilities/Construction:
    - Decommissioned: 1 cableway, 10 wells, and 12 shelters which were replaced with tilting mast shelters

Water quality monitoring

Lower Athabasca, Peace and Slave River Watershed

Sampling operations in the Athabasca, Peace and Slave river watersheds were reduced in 2020-2021 due to the COVID-19 pandemic. ECCC collected approximately 40 samples from 7 of 13 stations during the fall and winter. All but 3 of these stations are monitored under the Oil Sands Monitoring Program in partnership with Alberta Environment and Parks. The monitoring work done under this plan was designed to track the cumulative effects of oil sands development in air, water, wildlife, and biodiversity to help inform government and industry decision-making processes.

Hudson Bay Watershed

As part of the National Long-Term Freshwater Quality 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 past year only 4 out of 12 samples were collected for rivers in this network.

Data from this monitoring is used to support annual reporting on water quality objectives for nutrient, metal, major ion, and pesticide parameters established by Canada, Alberta, Saskatchewan, and Manitoba and to support the Lake Winnipeg Basin Program.

ECCC worked 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*. Key transboundary monitoring sites are located on the Red River, Pembina River, Winnipeg River, and Souris River. The Red River and Souris River, 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) (see section 6.5).

All of the transboundary rivers in the watershed are usually monitored 8 to 12 times per year. Due to the COVID-19 pandemic, monitoring activity was reduced to 4 to 8 times depending on the river.

Finally, under a Memorandum of Understanding with Parks Canada, sites in Banff, Jasper, and Waterton National Parks were only sampled twice due to the COVID-19 pandemic. These sites provided water quality information to Parks Canada and were used as reference sites as part of ECCC's Long-Term Water Quality Monitoring Program.

CABIN monitoring

Lower Athabasca, Peace and Slave River Watersheds

In the Athabasca, Peace and Slave River Watersheds, under the Oil Sands Monitoring Program, no CABIN sampling was conducted at any sites in 2020-2021 due to the COVID-19 pandemic. CABIN is conducted by Parks Canada at other long-term physical-chemical monitoring sites. There is a reference model available to all CABIN users to conduct biological assessments in the Rocky Mountain Parks watersheds developed by Parks Canada which overlaps the BC-Alberta border.

3.4.4 Ontario region

Water quantity monitoring

There were few high water events during 2020-2021 across Ontario, with the exception of localized flooding due to ice jamming in some northern locations. High water levels in the Great Lakes continued to contribute to extended periods of shore flooding and in-land flooding in that area.

Beginning in March 2020, the global COVID-19 pandemic affected operations and the delivery of the program. In some cases, station visits did not take place, and data uncertainty caused the suppression of realtime data. At the peak, on July 24th 2020, 95 stations had suppressed water level and discharge data. This number was reduced gradually until November 4, 2020, when all data suppression alerts were lifted. Part of this activity involved constant communication with all data users and funding partners.

Lake Erie, Ontario

- **Ontario** (564 stations)
  - Two gauges were discontinued: Pine River at Lurgan (02FD001) and Wawa Creek at Wawa.
  - A gauging station on the Amable Du Fond River at Kiosk (02JE027) was temporarily discontinued pending final decision making in 2021-2022.
  - New stations were added in 2 locations: the Wanapitei River at Highway 637 (02DB008) and Pickerel River above Cantin Lake (02DD028).
  - Operations of 34 stations in northwestern Ontario are now conducted from the Manitoba offices, with the bulk of stations supporting the Lake of the Woods Control Board included in that group.
  - Infrastructure and life cycle management activities were curtailed due to the pandemic, but several historic wells were decommissioned and decontamination activities related to historic mercury useage were undertaken.

Water quality monitoring

In Ontario, federal-provincial and Canada-United States water quality monitoring is supported through the *Canada-Ontario Agreement on Great Lakes Water Quality and Ecosystem Health* and the *Great Lakes Water Quality Agreement (GLWQA) between Canada and the United States.*

Monitoring results generated by ECCC contribute to indicators assessing the status of the Great Lakes ecosystem for toxic chemicals in water, sediments and fish, as well as indicators on the status of nutrients, water quality and algae; however, in 2020-2021, ECCC did not conduct any water quality monitoring due to the COVID-19 pandemic.

CABIN monitoring

Previously collected CABIN data was reported as part of work for Great Lakes Areas of Concern (AOC's) detailed in the Great Lakes Protection Initiative section of this report. Additional samples collected in Ontario were part of Department of National Defense monitoring initiatives on Canadian Forces Base Borden and Petawawa, and CFTA Burwash. No other work was conducted in Ontario in 2020-2021 due to the COVID-19 pandemic.

3.4.5 Quebec region

Water quantity monitoring

- **Quebec** (243 stations)
  - One-hundred-fifty-three flow stations and 56 water level stations are run by the provincial government and data are provided to the NHP database.
  - An additional 11 flow stations and 5 water level stations are run by ECCC in Quebec to address federal data requirements.
  - Thirteen of these stations are located in the Montreal area and are operated from the Montreal office.
  - One located in the Gatineau area and 2 located in the Abitibi-Témiscamingue are operated by the ECCC Ontario district.

Boat crossing St. Lawrence River, Quebec

Water quality monitoring

In 2020-2021, due to the COVID-19 pandemic restrictions, no samples were collected at federal sites in the St. Lawrence River Basin. However, the program benefited from that pause for a review and update initiative that will inform future monitoring activities.

Quebec's activities were also impacted by the COVID-19 pandemic. The 39 sites in the St. Lawrence River and its tributaries were still monitored according to the *Canada-Quebec Water Quality Monitoring Agreement* (2017-2022), but fieldwork stopped during the months of April and May 2020. It gradually resumed and was back to normal in June. The stations were sampled monthly for physical parameters, nutrients, chlorophyll and fecal coliforms. During the summer months, metals were measured monthly at 9 of those stations.

CABIN monitoring

No sampling was done in 2020 given the restrictions due to the COVID-19 pandemic. In the St. Lawrence River Priority Ecosystem and La Mauricie National Park, no biomonitoring sampling was done in 2020-2021 given the restrictions due to the COVID-19 pandemic.

3.4.6 Atlantic region

In the Atlantic region, the COVID-19 epidemiology and regional public health management measures allowed ECCC and its partners to achieve approximately 75% of planned monitoring and surveillance sampling. This was in part achieved through continued collaboration with provincial partners and amendments to federal/provincial agreements under the *Canada Water Act*.

Water quantity monitoring

- **Atlantic region** (222 stations)
  - No major changes to the network in New Brunswick, Newfoundland and Labrador, Nova Scotia and Prince Edward Island.

Meduxnekeag River, New Brunswick,
Photo: Jennifer Calhoun

Water quality monitoring

In the Atlantic watershed, federal-provincial water quality monitoring is supported through:

- Canada-Prince Edward Island Memorandum of Agreement on Water
- *Canada-Newfoundland and Labrador Water Quality Monitoring Agreement*
- *Canada-New Brunswick Water Quality Monitoring Agreement*

In 2020-2021, 3 federal-provincial and 8 provincial sites were monitored under the *Canada-Prince Edward Island Memorandum of Agreement*, including 1 real-time (automated) site on the Wilmot River. In addition, pesticide surveillance was conducted during the growing season. The sites are distributed across the province, with data available on the Government of Prince Edward Island's website.

In 2020-2021, 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. No samples were collected in the spring and summer months due to COVID-19 restrictions; however, sampling in the fall and winter was possible due to the lower health risks in the province at that time.

In Newfoundland and Labrador, 24 federal-provincial and 56 provincial sites across the major drainage areas were sampled 4 to 6 times in 2020-2021. No samples were collected from the first quarter (April – June) due to COVID-19; however, the Water Quality Monitoring Agreement facilitated local sampling within the province where health risks were lower. Data and station information from the sites are available on the Newfoundland and Labrador Water Resources website.

Under the *Canada-New Brunswick Water Quality Agreement* during 2020-2021, 10 federal-provincial sites were monitored on international and interprovincial transboundary rivers or their tributaries in the Saint John River (Wolastoq) and Restigouche River watersheds. Three additional real-time automated sites in the Saint John River (Wolastoq) watershed were also maintained by ECCC at the borders of the transboundary Big Presque Isle Stream, Aroostook River and Meduxnekeag River. Maintenance of those real-time stations was limited due to COVID-19, so some data gaps exist in the data for 2020-2021.

CABIN monitoring

In the Atlantic provinces, 97 stream and river sites were monitored by ECCC and certified partners in 2020. Out of this total, 9 were monitored by ECCC, 49 by other federal departments or Parks Canada, 10 by provincial governments, 14 by academics, 14 by non-governmental organizations and 1 site by an Indigenous organization. This work supported federal-provincial water quality monitoring agreements with New Brunswick, Newfoundland and Labrador, and Prince Edward Island. The monitoring allowed partners to conduct assessments in trans-boundary watersheds (such as Saint Croix) and federal lands (national parks and Indigenous communities).

Sea ice on Hudson Bay near Churchill, Manitoba

4 Water Quality and Quantity Indicators

The Canadian Environmental Sustainability Indicators (CESI) program provides data and information to track Canada's performance on key environmental sustainability issues including climate change and air quality, water quality and availability, and protecting nature. The water quality and water quantity in Canadian Rivers indicators are usually highlighted in this section; however, these 2 indicators were not published during 2020-2021. Updated water quality data were published on the Open Data platform during 2020-2021 as part of other water-related indicator updates. Indicators for phosphorus loadings in Lake Winnipeg and Lake Erie were released November and October 2020, respectively (see Section 7.1, Figure 6 and Section 7.2, Figure 7).

Clams

5 Shellfish Water Classification Program

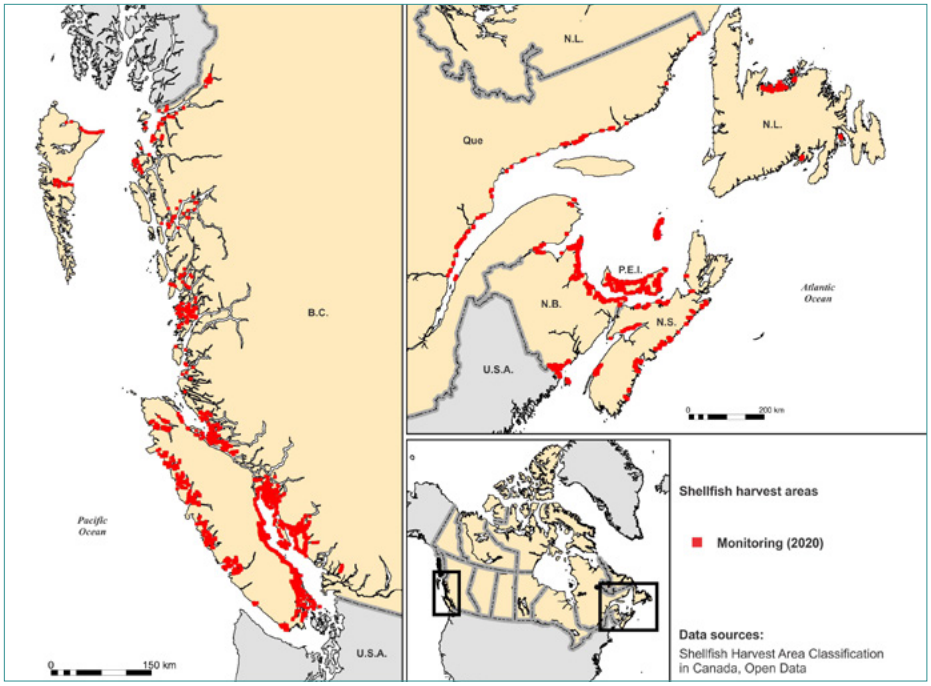
The Shellfish Water Classification Program (SWCP) is run by ECCC as part of the Canadian Shellfish Sanitation Program (CSSP). The CSSP is a federal program administered jointly pursuant to a Memorandum of Understanding (MOU) between the Canadian Food Inspection Agency, ECCC, and the Department of Fisheries and Oceans (DFO).

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 Canadian tidal waters. The mutual concerns of Canada and the United States to protect the public from the consumption of contaminated bivalve molluscs led to the signing of the Canada-United States Bilateral Agreement on Shellfish Sanitation on April 30, 1948, to deal with sanitary practices in the shellfish industries of both countries. This agreement remains in effect to maintain open trade with the United States, and is a cornerstone in allowing exports to other foreign countries. As a result, Canada is subject to periodic audits by other countries, including the United States.

Data are collected by ECCC for the purpose of making applicable classification recommendations on the basis of sanitary and water quality survey results. There are 5 classification categories of marine bivalve shellfish harvest areas (Approved; Conditionally Approved; Restricted; Conditionally Restricted; and Prohibited) under the CSSP. ECCC recommendations are reviewed and adopted by Regional Interdepartmental Shellfish Committees prior to regulatory implementation by DFO.

The SWCP field operations, including water quality monitoring, pollution source surveys and wastewater system assessments were significantly affected by the COVID-19 pandemic in 2020-2021. The accomplishment of workplan objectives varied considerably from province to province, largely due to differences in regional outbreaks of COVID-19 and public health measures. Completion of monitoring objectives ranged from 10% in Nova Scotia to 100% in Prince Edward Island. Overall, approximately 60% of monitoring objectives were achieved, despite challenges posed by the COVID-19 pandemic.

Figure 4: Monitored shellfish growing areas



In 2020-2021, 394 shellfish growing areas were monitored in Canada (see Figure 4 and Table 2). Marine water sampling was undertaken 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 under the CWA, and voluntary agreements with First Nations and stakeholders. Analyses for fecal coliform and salinity content determination were performed in ISO 17025 accredited laboratories. Across Canada, 16 136 marine water samples were collected at 5245 stations in the Atlantic region, Quebec and BC (see Table 2).

Table 2: Number of shellfish growing areas, stations and marine water samples taken in the Atlantic region, Quebec and British Columbia

Region	Shellfish growing areas	Stations	Marine water samples
Atlantic	167	2676	8538
Quebec	92	728	2119
British Columbia	135	1841	5479
Total	**394**	**5245**	**16 136**

In addition to marine water quality determinations, sanitary shoreline investigations of point and non-point pollution sources were performed within 49 shellfish growing areas (Atlantic - 0, BC - 49, Quebec - 0). As part of the waste water treatment plant assessments, 3 wastewater systems (Atlantic - 2, BC - 0, Quebec - 1) were evaluated or re-evaluated. In addition, 2135 (Atlantic 860, BC 1136, Quebec 139) environmental emergency events were reviewed and significant incidents were assessed to determine the need for emergency harvest area closures.

For more information, consult the CSSP.

6 Inter-jurisdictional water boards

Inter-jurisdictional water boards have been established to focus on specific water issues that have implications for more than 1 province or territory. Domestic inter-jurisdictional boards include the Mackenzie River Basin Board (MRBB), the Prairie Provinces Water Board (PPWB), the Lake of the Woods Control Board (LWCB) and the Ottawa River Regulation Planning Board (ORRPB). The 2020-2021 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 International Joint Commission (IJC). While the work of the IJC is not pursuant to the CWA, ECCC reports on progress under the *Environment and Climate Change Canada-International Joint Commission Memorandum of Understanding*.

6.1 Mackenzie River Basin Board

Agreement: *Mackenzie River Basin Transboundary Waters Master Agreement*, signed in July 1997 (Master Agreement).

Signatory Governments: Canada, British Columbia, Alberta, Saskatchewan, the Northwest Territories, and Yukon

Board: Mackenzie River Basin Board (MRBB)

The Master Agreement states that the waters of the Mackenzie River Basin should be managed to preserve the ecological integrity of the aquatic ecosystem and to facilitate reasonable, equitable, and sustainable use of this resource for present and future generations. It contains provisions for 7 bilateral agreements between adjacent jurisdictions in the basin. As of March 31, 2021 bilateral agreements had been completed between:

- British Columbia and the Northwest Territories
- Alberta and the Northwest Territories
- the Northwest Territories and Yukon
- British Columbia and Yukon

The MRBB represents all parties to the Master Agreement and administers the provisions of the Master Agreement. Federal members include representatives from ECCC and Crown-Indigenous Relations and Northern Affairs Canada. Representatives from the Parks Canada Agency joined the board in 2020. Ten members represent the 3 provinces and 2 territories in the basin, including an appointee from each provincial and territorial government, and an Indigenous board member representing Indigenous Peoples in each of the 5 jurisdictions.

The MRBB currently has 2 active committees and 1 task team that support work on duties and priorities: the State of the Aquatic Ecosystem and the Traditional Knowledge and Strengthening Partnerships Steering Committees, and the Water Quality Task Team.

Activities and accomplishments of the MRBB and the comittees and task team that supported MRBB work in 2020-2021 include the following:

- The MRBB advanced work on a 2-year interim Strategic Plan. MRBB members confirmed support for the existing goals, and provided feedback and direction on the 2020 Strategic and Operational Report recommendations. The interim plan will consider resources and data gaps identified in the State of the Aquatic Ecosystem Report (SOAER), and move the MRBB towards examining its practices and policies through the lens of reconciliation.
- The MRBB completed a contract to develop a web-based SOAER. This report blends together publicly available Indigenous knowledge and science of 4 aquatic indicators for each of the 6 sub-regions in the Mackenzie River Basin. The report was a major focus for both the State of the Aquatic Ecosystem Steering Committee and the Traditional Knowledge and Strengthening Partnerships Steering Committee. The report will undergo a final review and be formatted for mobile devices before going live in 2021-2022.
- The Water Quality Task Team (WQTT) advanced work that will support a consistent approach to water quality trend analysis, and setting water quality triggers and objectives for the Mackenzie River Basin. This work will support the implementation of the Bilateral Water Management Agreements (BWMAs) and could link to future versions of the SOAER.

ECCC's Science and Technology Branch and National Hydrometric Service collect and share data important to the MRBB and its members. That work is highlighted in sections 3.1 and 3.2

A summary of ECCC monitoring operations in the Mackenzie River Basin from provincial and territorial jurisdictions follows:

Saskatchewan (9 stations)

Saskatchewan experienced high spring flows, especially north of Lake Athabasca. High flows were also experienced from summer through fall due to rainfall. Flows remained high going into winter. While measures to deal with COVID-19 resulted in schedule changes, as of September, all stations in the Mackenzie River Basin area had been visited. Discharge measurements were collected, discharge rating curves have been validated and all stations are transmitting data.

Alberta (185 stations)

Ice jams and overland flooding impacted several stations from April through to late July. ECCC recorded some of the highest water levels on record in this period. Flows on the Athabasca River were much higher than normal throughout the summer of 2020. Flows on the Peace River were much higher than average between July and September 2020 and exceeded the 75th percentile for much of the summer. The COVID-19 pandemic affected operations and the delivery of the program in 2020-2021. Minimal field operations continued, with the necessary protective measures, only when responding to critical situations.

BC (45 stations)

BC experienced a wet summer in 2020 and high flows were recorded during the summer as a result. The wettest August on record was experienced in the town of Smithers. Above normal flows were experienced at most stations in 2020. Nation, Parsnip, Halfway and Pine Rivers experienced particularly high flows. Despite COVID-19 constraints on technician mobility, hydrometric stations were effectively managed through the spring freshet and summer.

Northwest Territories and Yukon (101 stations)

Entering the spring of 2020, snowpack in the eastern and southern portions of the Yukon, and western portion of the NWT were above, or well above, normal. Ice jams occurred at Hay River and a minor jam occurred at Fort Simpson during the 2020 freshet. Water levels on Great Slave Lake were record high in 2020-2021. Tributaries in the southern part of the basin experienced record high flows in the fall of 2020 and winter of 2021. The COVID-19 pandemic, and associated border restrictions, impacted operations for stations operated in BC by Yukon-based staff throughout 2020-2021. Remote control boats were used during high flows to conduct discharge measurements. NuPoint satellite cameras were also used to capture daily images at select locations. Image frequency was also increased during critical periods.

6.2 Prairie Provinces Water Board

Agreement: Master Agreement on Apportionment (MAA) signed October 30, 1969

Signatory Governments: Canada, Alberta, Saskatchewan, and Manitoba

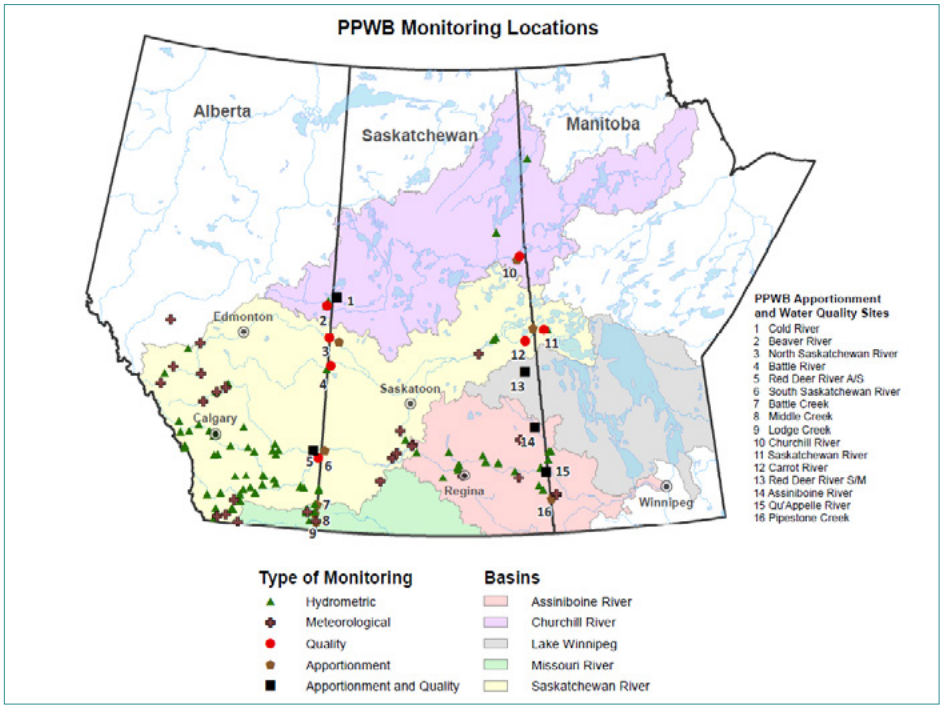
Board: Prairie Provinces Water Board (PPWB)

The purpose of the MAA is to apportion water between the provinces of Alberta, Saskatchewan, and Manitoba, and to protect surface water quality and transboundary aquifers. It also provides for cooperation among governments with respect to transboundary water management and for the establishment of the PPWB and its responsibility to administer the Agreement.

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 lakes that cross provincial boundaries. The Schedules to the Agreement describe the role of the PPWB and stipulate the amount and quality of water that shall pass from Alberta to Saskatchewan and from Saskatchewan to Manitoba.

In support of the MAA, ECCC monitors stream flows, water quality and meteorological conditions on eastward flowing streams on the provincial borders (see Figure 5). The PPWB computes apportionable flows based on the natural flow of a river, as if that river had never been affected by human activity. Excursions (i.e. deviations) to the MAA water quality objectives are calculated annually.

Figure 5: PPWB water quantity and quality monitoring stations and basins for 2020



Activities and accomplishments of the PPWB and its 4 standing technical committees on hydrology, water quality, groundwater, and flow forecasting in 2020-2021 include:

- Work continued on the formal basin review for the Qu'Appelle River Basin at the Saskatchewan-Manitoba boundary and will be completed in 2021. This review is looking at all aspects of the apportionable flow calculation and options for improvements.
- The initial review of the Assiniboine River Basin on the Saskatchewan-Manitoba boundary which began in 2019 was placed on hold until the Qu'Appelle River Basin Review is completed.
- Progress was made on an initial review and assessment of apportionment needs for the South Saskatchewan River Basin leading to a formal multi-year basin review, which is scheduled to begin in 2021-2022.
- Work continued towards developing a methodology for estimating the consumptive use by Alberta water users from the Lodge and Middle Creeks.
- The PPWB approved the 2019 Water Quality Excursion Report. The overall adherence to Interprovincial Water Quality Objectives was on average 97.6% in 2019, such that water quality continues to be protected in the 12 transboundary rivers monitored under the MAA. The adherence rate was based on the comparison of 5361 water quality results to water quality objectives for a range of water quality parameters, including nutrients, metals, major ions, pesticides, and bacteria.
- From April to September 2020, the water quality-monitoring program was suspended due to the COVID-19 pandemic. Monitoring resumed from October 2020 to December, but was suspended again in January 2021 due a surge in COVID-19 cases.
- In November 2020, the 2021 Water Quality Monitoring Program was approved. The most significant change to the monitoring program was the addition of pesticide monitoring to the rivers that were not monitored in 2020. Pesticides on the transboundary rivers are monitored on a rotational basis and, hence, the 2021 monitoring program included both the rivers for 2020 and 2021 to address the pesticide data gap caused by the COVID-19 pandemic.
- The review of the Interprovincial Water Quality Objectives for the 12 transboundary rivers was completed. Following Ministerial approval, these updated objectives be adopted by the PPWB in 2021.
- An analysis of the non-compliance patterns in 2015 to interprovincial water quality objectives in the Red Deer River, on the Alberta/Saskatchewan Boundary, was prepared by Alberta Environment and Parks and approved as a PPWB technical report. The report concluded that the majority of the excursions on the Red Deer River in 2015 were attributable to 2 runoff events in the Red Deer-Drumheller and upstream Red Deer areas.
- An integrated hydrologic and water quality study of the Carrot River and the Red Deer River located on the Saskatchewan-Manitoba boundary was begun.
- Work continued on developing a method to classify transboundary aquifers according to the Risk Informed Management document.
- Initial assessment work identifying options for harmonizing Spring Runoff Potential maps across the 3 provinces was completed.
- A validation of the MESH (Modélisation Environmentale Communautaire - Surface and Hydrology) hydrological land surface forecasting model for the South Saskatchewan River Basin was initiated.
- For 2020-2021, all PPWB meetings of the Board and its 4 standing committees were held virtually due to COVID-19 restrictions.

6.3 Lake of the Woods Control Board

Authority: defined by concurrent Canada-Ontario-Manitoba legislation (*Lake of the Woods Control Board Act*; 1921, 1922, 1958)

Cooperating Governments: Canada, Ontario, Manitoba

Board: Lake of the Woods Control Board (LWCB)

International Agreement: Canada-U.S. treaty (*Convention and Protocol for Regulating the Level of the Lake of the Woods, 1925*)

International Board: International Lake of the Woods Control Board (ILWCB)

The LWCB does not fall under the CWA since it pre-dates the Act, but it is included in this report to provide a more complete picture of federal-provincial water management in Canada. The LWCB is responsible for the regulation of the water levels of Lake of the Woods and Lac Seul, as well as the flows in the Winnipeg and English Rivers downstream of these lakes to their junction for the benefit of all users and interests.

The LWCB has 4 members, each with an alternate. Order-in-Council appointments for these positions are made by Canada (1 member), Ontario (2 members), and Manitoba (1 member). Provincial and federal legislation require members and alternate members to be duly qualified engineers. The LWCB had a full complement for 2020.

The level of Lake of the Woods is normally regulated solely by this board. However, its decisions are subject to the approval of the ILWCB whenever the level of the lake rises above or falls below certain levels specified in the Lake of the Woods Convention and Protocol.

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.

The effects of exceptionally wet conditions in the fall of 2019 carried on through the winter of 2019-2020, with water levels remaining higher than normal throughout this period across most of the basin. The remainder of 2020 was, on average, much drier than normal, resulting in lower than normal water levels for Lake of the Woods, Lac Seul and the Winnipeg and English Rivers for most of the year as drought conditions developed and worsened.

The Board has not met in person since March 2020 due to the COVID-19 pandemic. Regulation meetings to set operating strategy were held remotely in June and October with invitations to First Nations, Specific Interest Groups and Resource Agencies. Typical annual outreach activities such as visits to areas of the basin and public open houses were canceled due to COVID-19.

6.4 Ottawa River Regulation Planning Board

Agreement: *Agreement Respecting Ottawa River Basin Regulation (1983)*

Signatory Governments: Canada, Quebec, and Ontario

Board: Ottawa River Regulation Planning Board (the Planning Board)

The Planning Board was constituted to ensure the integrated management of the flows from the 13 principal reservoirs of the Ottawa River basin in order to minimize the impacts of floods and droughts along the Ottawa River and in the Montreal region, while maintaining beneficial water uses within the watershed. Under the 1983 Agreement, the governments also established 2 other entities that report to the Planning Board, namely the Ottawa River Regulating Committee (the Regulating Committee) and the Ottawa River Regulation Secretariat (the Secretariat), which is housed by ECCC. Integrated management of the principal reservoirs is done throughout the year; however, it is during the spring and periods of extreme flow conditions (floods and droughts) that this management approach results in the most apparent benefits.

The 2020 spring freshet was characterized by an early start, intermittent snowmelt, and a moderate intensity with a peak flow approximately 10% higher than average.

At the beginning of March, the snow cover was well above normal in most areas of the watershed. The freshet started early in mid-March with a sudden thaw in the Rideau River and South Nation River sub-basins. At the end of March, spring runoff increased rapidly in the south and central parts of the watershed due to a low-pressure system that brought warmer temperatures and up to 40 mm of rainfall. In the following 2 weeks, flows and levels increased gradually on the Ottawa River and reached a peak in mid-April. A significant snow cover remained in the northern portion of the watershed at that time. At the end of April, warmer temperatures combined with up to 40 mm of rainfall in the Abitibi-Timiskaming area caused spring runoff to increase again, with flows and levels on the Ottawa River rising again into a second peak in early May. The freshet ended around mid-May when most of the snow in the northern portion of the watershed had melted.

Like other years, dam operators undertook flood reduction measures in preparation for the spring runoff. Typically, this involves emptying the principal reservoirs during the winter period with reservoirs being at their lowest levels before the spring snowmelt begins. This available storage volume is then used as the spring melt progresses to reduce downstream flows. Throughout the 2020 spring freshet, the Regulating Committee, which is made up of representatives from the major dam operators in the Ottawa River Basin, held frequent conference calls to perform integrated management of the system, wherein the observed and forecast hydrological conditions are analyzed, and a regulation strategy to use the available storage volume to reduce flood risk is developed.

Apart from ensuring the integrated management of the system, the Planning Board also ensures that the hydrological forecasts are made available to government agencies that are involved in issuing flood-related messages and, when necessary, the deployment of emergency measures. As such, the Regulating Committee worked closely with provincial agencies and the Secretariat participated in many conference calls with responsible authorities.

Also, flows of the Ottawa River can have a considerable effect on the flows of the St. Lawrence River in the vicinity of the Montreal Archipelago. This is why provision of hydrological forecasts on the Ottawa River is important to the Great Lakes-St. Lawrence Regulation Office, which is responsible for carrying out the day-to-day regulation activities for the International Lake Ontario - St. Lawrence River Board.

The Planning Board uses its website as the main tool for issuing hydrological forecasts to the public. It launched a new website in March 2020 prior to the beginning of the freshet, providing hydrological information at additional locations and graphic view of the river conditions. To better communicate conditions to the public, the Regulating Committee published for the first time 2 bulletins, 1 in March and 1 in April, that provided an overview of spring conditions with details about current snow conditions and the reservoir regulation strategy. The Regulating Committee issued 2 press releases in 2020, 1 on March 29 to announce the start of the freshet, and 1 on April 9 to inform residents about the risk of minor flooding in some locations. Press releases and bulletins are still available on the Planning Board website (see ORRPB Archives).

6.5 ECCC support of international water boards

Agreement: *Environment and Climate Change Canada-International Joint Commission Memorandum of Understanding (consistent with the Government of Canada's commitments under the Department of Environment Act and the Boundary Waters Treaty)*

Signatory Agencies: ECCC and the IJC

Boards: All transboundary Boards and Committees under the jurisdiction of the IJC

ECCC, primarily through NHS, contributes to the management of international transboundary water by carrying out the orders of the IJC under the Boundary Waters Treaty as per the Department of Environment Act. In 2020-2021, ECCC continued to provide engineering and technical support to the many IJC water boards and committees across the international border, including from west to east: the International Osoyoos Lake Board of Control; International Columbia River Board of Control; International Kootenay Lake Board of Control; Accredited Officers for St. Mary-Milk; International Souris River Board; International Red River Board; International Rainy-Lake of the Woods Watershed Board; International Lake Superior Board of Control; International Niagara River Board of Control; International Lake Ontario-St. Lawrence River Board; Great Lakes-St. Lawrence River Adaptive Management Committee; and the International St. Croix River Watershed Board.

The MOU also obligates ECCC to provide engineering and technical support for special IJC studies. In 2020-2021, ECCC supported IJC reference studies for the Lake Champlain-Richelieu River and the Souris River. This included the development, testing and implementation of hydrologic scenario modelling, simulation testing of alternative strategies, iterative review and selection of performance indicators to assess outcomes and development of socio-economic and environmental assessment tools for providing decision support for evaluating flood mitigation measures. These 2 special studies are due for completion at the end of 2021-2022.

ECCC continued to support the IJC's International Lake Ontario-St. Lawrence River Board in the operation of Plan 2014, which was implemented in January 2017 and is designed to provide for more natural variations of water levels of Lake Ontario and the St. Lawrence River to restore ecosystem health. Record high water levels in 2017 and again in 2019 on Lake Ontario and the St. Lawrence River caused concern that these high water levels could continue for some time given more record or near record-high water levels in 2020 on all the Great Lakes. As a result, the IJC requested an expedited review of Plan 2014 by their Great Lakes-St. Lawrence River Adaptive Management Committee. ECCC provided considerable support to this effort, leading efforts in the generation of plausible extreme hydrologic supply scenarios, designing and simulating alternative outflow management strategies, consolidating information to assess potential impacts under different water level and flow scenarios, and guiding the evolution of a decision support tool to reflect critical priorities and for assessing lake regulation strategies during extreme conditions for Lake Ontario-St. Lawrence River. Efforts also focused on the development of a short and long-term adaptive management strategy for the ongoing review of lake regulation plans for the outflows from Lake Superior and Lake Ontario.

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 7 stations in the watershed and real time (automated) water quality at 2 stations and provided input to the Board's 2020 annual report.

Three fishermen on Lake Erie

7 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. While not all of these initiatives are formalized under the Act, they do contribute to the objectives of the Act through improving the management of water resources in Canada.

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.

7.1 Lake Winnipeg Basin Program

The Lake Winnipeg Basin Program (LWBP) (2017-2022) is the Government of Canada's response to addressing water quality issues in Lake Winnipeg. The LWBP aims to engage citizens, scientists, and domestic and international partners in actions to restore the ecological health of Lake Winnipeg, reduce nutrient pollution and improve water quality. It does this through the following 3 program priorities: collaborative governance, Indigenous engagement and nutrient reduction.

Collaborative Governance

The *Canada-Manitoba Memorandum of Understanding Respecting Lake Winnipeg and the Lake Winnipeg Basin*, signed under the *Canada Water Act* facilitates a cooperative and coordinated approach between Canada and Manitoba to improve the ecological health of Lake Winnipeg and its basin. As the Memorandum of Understanding expired in September 2020, Canada and Manitoba have initiated the development of a new Memorandum of Understanding.

Indigenous engagement

The water quality in Lake Winnipeg and its basin affects the cultural, social, spiritual, and economic well-being of Indigenous Peoples. The LWBP supports opportunities to build capacity and increase engagement of Indigenous governments, organizations and communities on Lake Winnipeg basin water quality issues, including community-based monitoring and incorporation of traditional knowledge in discussions on the ecosystem health of Lake Winnipeg.

Nutrient reducing actions

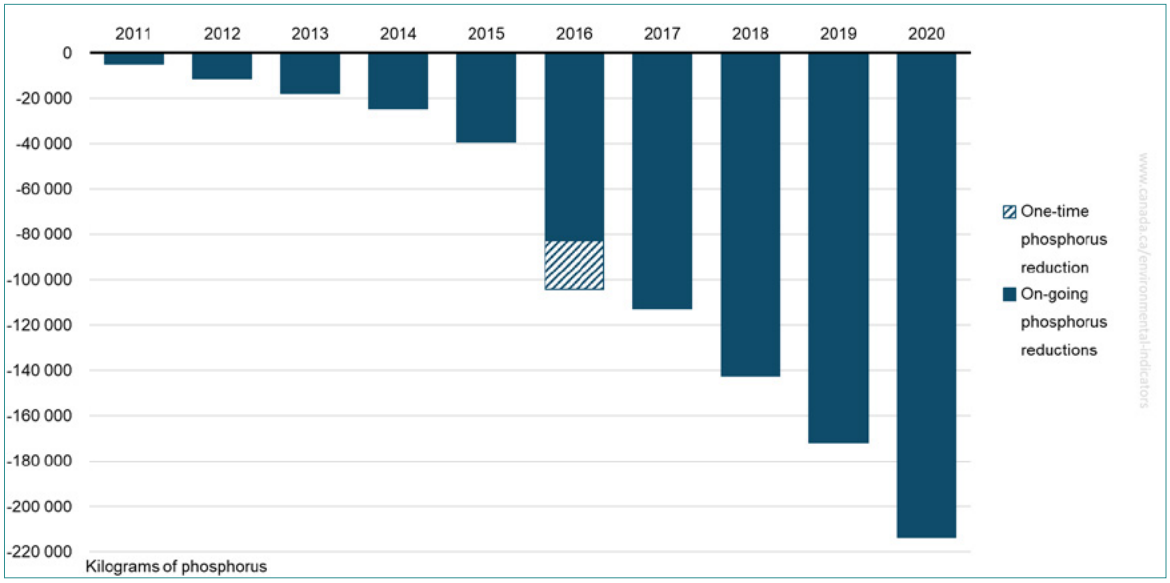
Lake Winnipeg experiences large and frequent algal blooms due to high nutrient levels from multiple trans-boundary sources, including agriculture, industry, municipal wastewater and surface runoff. ECCC, the Manitoba government and other partners are engaging citizens in nutrient reducing activities in several ways, including funding provided through the LWBP.

Through application-based funding, the LWBP continued to support targeted stakeholder-driven projects in 2020-2021 that demonstrate an effective means of reducing phosphorus loading, while also increasing public knowledge and engagement on water quality issues within the basin. This includes activities such as:

- building retention ponds that intercept water flow across the landscape and capture nutrients
- stabilizing river banks and lake shorelines
- restoring wetlands
- using natural infrastructure and innovative technologies to reduce nutrient loading

Projects funded by ECCC and completed between 2010 and 2021 have prevented 270 215 kilograms of phosphorus from reaching Lake Winnipeg.

Figure 6: Estimated cumulative reduction in the amount of phosphorus reaching Lake Winnipeg, April 2010 to March 2021



Source: Environment and Climate Change Canada (2020) Lake Winnipeg Basin Program

Note: The estimated reduction in phosphorus load is based on the results of LWBP funded projects completed between April 2010 and March 2021. Estimated phosphorus reductions for each project are summed to calculate the total. Year refers to fiscal year, which runs from April 1 to March 31. The year 2021 therefore refers to April 1, 2020 to March 31, 2021.

Lake Winnipeg Basin Program Science Plan

The LWBP Science Plan builds upon previous science efforts that characterized the state of Lake Winnipeg. Research is aimed at improving knowledge of nutrient export to streams and understanding impacts of climate variability and invasive species on the lake. The science plan has 4 priority areas:

- reporting on progress towards restoring a healthy Lake Winnipeg
- monitoring to assess status and track changes
- research on nutrient sources and transport pathways to the lake
- research on lake ecosystem components to achieve a sustainable nutrient balance

The LWBP also supports the Lake Winnipeg Research Consortium, which operates and maintains an in-lake science platform on Lake Winnipeg, and the Canadian Watershed Information Network (CanWIN), a web-based open access data and information network.

A significant amount of planned field work could not proceed and new sampling could not be completed by ECCC in 2020-2021 due to COVID-19 restrictions. However, data collected by partners along with historical data and existing models enabled work on scientific projects in 2020-2021 to focus on the following:

- Advancements on the Assiniboine and Red River watershed modeling work included the development of:
  - decision support systems using large scale watershed and site-specific models for the Red and Assiniboine Rivers
  - downscaled climate data for assessing the historical and projected changes in the basin
  - a new process based snow model to assess the snowpack response in the Red and Assiniboine River basin to projected global warming scenarios
  - a high resolution lake model and validation of a hydrodynamic model with historical and recent in-situ and remote sensing data
- Scientific analyses based on data obtained prior to the pandemic included:
  - the quantification of nutrient sources and transport processes to Lake Winnipeg tributaries
  - the development of in-stream biological indicators to track nutrient loading to streams
  - the quantification of in-lake processes affecting lake ecology
  - the evaluation of food web structures using stable isotopes
- In April 2020, the Governments of Canada and Manitoba released the second edition of the State of Lake Winnipeg Report. By leveraging data from partners as well as ECCC historical and recent data, significant progress has been made to quantify nutrient sources and transport processes to Lake Winnipeg tributaries; in particular, for evaluating the efficacy of BMPs in priority watersheds to reduce nutrient loads to Lake Winnipeg.
- Assessments of algal blooms in Lake Winnipeg using satellite remote sensing were reported through the EOLakeWatch portal. On this site, daily imagery and historical indices for Lake Winnipeg are made available, including algal bloom severity index. The annual algal bloom reports can also be accessed via the portal.
- A special issue of the Journal of Great Lakes Research was published and included studies on the emerging view of Lake Winnipeg after 15 years of whole-lake, whole-ecosystem science.

Some key program highlights from 2020-2021 include the following:

- Fifteen new contribution agreements were signed with funding recipients to provide $1.2 million in financial support for nutrient-reducing actions, advancements in science, information sharing, Indigenous engagement, and collaboration. All of the projects being funded will be completed by March 31, 2022.
- A total of $1.2 million was expended on stakeholder-led projects.

- Publication of a 2020 Algal Bloom Report to provide information on the algal bloom extent, duration, and severity for Lake Winnipeg. Assessments of algal blooms in Lake Winnipeg using satellite remote sensing were reported through the EOLakeWatch portal.
- Four Indigenous students were employed to build capacity in water quality expertise and support Indigenous engagement on Lake Winnipeg water quality issues. These students provided valuable science and policy support.

7.2 Great Lakes Protection Initiative

The Great Lakes Protection Initiative is ECCC's primary regional program targeting federal water quality and aquatic ecosystem priorities in the Great Lakes. Through the Initiative, ECCC combines science and action to address the most significant threats to Great Lakes water quality and ecosystem health. Its current priorities for action include: working with others to protect the Great Lakes, restoring water quality and ecosystem health in Areas of Concern, preventing toxic and nuisance algae, improving the health of coastal wetlands, identifying at-risk nearshore waters, reducing releases of harmful chemicals, engaging Indigenous Peoples in addressing Great Lakes issues, and engaging the public through citizen science.

Freshwater management of the Great Lakes is a responsibility shared by multiple levels of government. To coordinate efforts on water management, restoration and protection, ECCC works in close collaboration with other implicated federal departments, the governments of Ontario and the United States, local governments, Indigenous partners and many other organizations, and individuals. This is accomplished through leading and coordinating implementation of the:

- *Canada-Ontario Agreement on Great Lakes Water Quality and Ecosystem Health* (COA)(2014), an instrument under the *Canadian Environmental Protection Act, 1999*, provides the governments of Canada and Ontario with a shared short-term (5-year) action plan for achieving Canada's commitments under the GLWQA. A draft 2020 *Canada-Ontario Agreement on Great Lakes Water Quality and Ecosystem Health* (COA) was published for public comments in 2019 and was expected to be finalized in mid-2021.
- *2012 Canada-U.S. Great Lakes Water Quality Agreement* (GLWQA), which establishes long-term binational objectives for the restoration and protection of the Great Lakes.

Key actions completed for the reporting period include:

- Canada, in cooperation with the province of Ontario and other partners, continued to implement the Lake Erie Action Plan to reduce phosphorus loads to Lake Erie from Canadian sources.
- Canada and the United States finalized the Binational Screening Criteria for Nominated Chemicals of Mutual Concern (CMCs). Screening Criteria were developed to provide a consistent framework for reviewing nominated CMCs under the GLWQA.
- In 2020-2021, the Canadian assessment was completed for Lake Superior under the Great Lakes Nearshore Framework, which is a systematic, integrated and comprehensive approach for assessing the nearshore health of the Great Lakes and identifying and communicating cumulative impacts and stresses.
- ECCC continued to assess the vulnerability of coastal wetlands to future climate change.

Preventing toxic and nuisance algae in Lake Erie

Lake Erie frequently experiences both toxic and nuisance algae due to excess phosphorus loading resulting from a combination of physical characteristics and surrounding land use. The situation is further complicated by a changing climate, hydrological patterns and invasive species, all of which are contributing to shifting ecological systems.

The Government of Canada, the province of Ontario, and other partners are taking action to address harmful algal blooms and improve the health of the lake through the implementation of the Canada-Ontario Lake Erie Action Plan. This 5-year action plan was established in 2018 to reduce phosphorus loadings; ensure effective policies, programs and legislation; improve knowledge; educate and build awareness; and strengthen leadership and coordination.

Through the Great Lakes Protection Initiative, ECCC provides funding for partner-led projects that increase participation in the application of phosphorus load reduction measures in the Lake Erie basin by demonstrating innovative approaches and best management practices, and promoting their broad uptake and application. In 2020-2021, the initiative provided $1 million over 2 years to support 5 new partner-led phosphorus reduction projects that would implement activities such as:

- constructing wetlands in priority areas to capture and store nutrient runoff from upstream agricultural land;
- implementing agricultural best management practices, such as cover crops;
- applying innovative nutrient recovery technology; and
- communicating results of projects with other farmers to promote broader uptake.

Projects supported through the Great Lakes Protection Initiative resulted in a 20-tonne reduction in total annual phosphorus from Canadian sources to Lake Erie in 2020-2021.

Restoring water quality and ecosystem health in Great Lakes Areas of Concern

Areas of Concern (AOCs) are specific locations, such as rivers, 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 designated 43 AOCs, 12 of which were in Canada and 5 of which are shared between Canada and the United States. Three Canadian AOCs have since been restored through the implementation of individual Remedial Action Plans for each AOC.

There are 14 beneficial use impairments (BUIs) that are assessed in each AOC. Environmental studies and monitoring determine whether beneficial uses in an AOC are impaired and require restoration. Remedial Action Plans to restore beneficial uses are developed and implemented in cooperation with the province of Ontario, with input from First Nations, Métis, municipal governments, watershed management agencies and other local public agencies, and the public. Canada removes a BUI designation when delisting criteria established in the Remedial Action Plan have been met.

Environmental quality in all of Canada's Great Lakes Areas of Concern has improved since the restoration program began. To date, of the 157 BUIs initially identified for remedial actions or further study, 90 have been resolved and removed from the list. Efforts continue to restore and assess the remaining 67.

Canada, in cooperation with the province of Ontario and other partners, continued to restore beneficial uses in AOCs and removed the following BUIs in 2020-2021 in:

- Spanish Harbour – restrictions on dredging activities
- Thunder Bay – degradation of phyto- and zooplankton populations
- Toronto and Region – degradation of aesthetics
- Detroit River– fish tumours and other deformities, degradation of benthos
- Bay of Quinte – restrictions on drinking water consumption, taste/odour problems

As of March 31, 2021, Canada formally removed the AOC designation from Collingwood Harbour, Severn Sound, and Wheatley Harbour – 3 of the original 17 AOCs. In addition, all beneficial uses have been restored in the Nipigon Bay AOC and it will be removed from the list upon final approval of its completion report.

Through the Great Lakes Protection Initiative, Canada provides funding and technical support to partners at the local level to implement remedial and monitoring actions to advance the restoration of beneficial uses in AOCs.

Examples of activities in 2020-2021 which Canada, through ECCC or others, led or supported to restore water quality and ecosystem health in Canadian AOCs include:

- In the Hamilton Harbour AOC, as part of the Randle Reef Sediment Remediation Project, Canada and partners dredged approximately 254 000 cubic metres of severely contaminated sediment from the bottom of the harbour and placed it into a 6.2 hectare double-walled engineered containment facility. As of March 31, 2021 dredging was 83% complete, with a total of 503 000 cubic metres now contained.
- In the Thunder Bay AOC, a multi-stakeholder working group provided their recommended option for managing contaminated sediment in Thunder Bay North Harbour, which is now under review by federal and provincial authorities.
- In the Toronto and Region AOC, the naturalization of the mouth of the Don River and transformation of the industrial Port Lands of Toronto continued. This project, which began in 2018, involves creating a new natural river channel to mitigate flooding. Significant riparian habitat, 10 hectares of wetlands, 4 hectares of terrestrial habitat and 1000 metres of new natural river channel and flood plain will be created. Excavation of this river channel continued in 2020 and 2 fish habitat coves were created.
- On the Canadian side of the Detroit River AOC, construction of the Peche Island habitat project started. This project will create 7.6 hectares of new fish habitat. Restoration of another 30.3 hectare of wetland is also underway with the installation of infrastructure to optimize water levels and the removal of invasive aquatic plants to rejuvenate native plant growth.
- On the Canadian side of the Niagara River AOC, a 2-year project is nearing completion to restore up to 10 km of habitat by planting native vegetation along the Niagara River. The project will add to the 2 km already naturalized between 2018 and 2019. Also, the Town of Niagara-on-the-Lake completed remedial actions including the installation of a stormwater bioswale (channel) that successfully reduced bacterial levels at the local beach.
- On the Canadian side of the St. Clair River AOC, engineering design work continued for the management of mercury-contaminated sediment in 3 priority areas.
- In the Toronto Region and Hamilton Harbour AOCs, major infrastructure project construction continued to improve effluent quality and wet weather management at wastewater treatment plants. These projects will reduce the need for sewage bypasses and lead to improved water quality and ecosystem health in these AOCs. The city of Hamilton's Woodward Avenue Wastewater Treatment Plan Upgrade is nearing completion. The plant will provide tertiary level of treatment.
- In the St. Lawrence River (Cornwall) AOC, a nearshore eutrophication strategy was completed and 5 rural best management practices implemented to reduce phosphorus and sediment loading to the river.

Scientific research and monitoring

ECCC undertakes research, modelling and monitoring to support decision-making in the Great Lakes. In 2020-2021, typical monitoring science activities in the Great Lakes and connecting channels were not completed due to restrictions in place to deal with the COVID-19 pandemic. Science-related work included ongoing water quality assessments in the Great Lakes, the review and update of binational Lakewide Action and Management Plans, and ongoing data collection and analysis to support binational State of the Great Lakes environmental indicators and reporting.

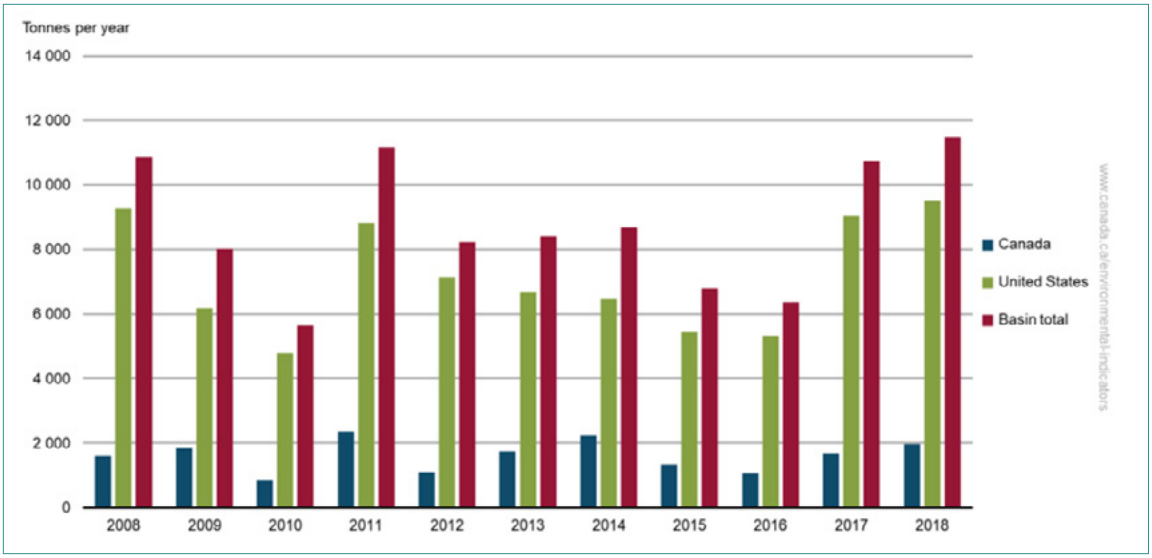
In addition, Canada studied plankton, fish, wildlife, and habitat to assess the current status of BUIs within Canadian AOCs. These assessments help with the design of effective remedial actions and confirm when delisting criteria have been met and beneficial uses have been restored.

Assessments contributed in several other areas, with recent examples including:

- Scientific assessments recommended a “not impaired” status for the: Detroit River AOC Degradation of Phyto-Zooplankton Populations BUI; St. Clair River AOC Fish Tumours and Other Deformities BUI; and the Bay of Quinte AOC Degradation of Aesthetics BUI. Future engagement with communities will seek input for these decisions.
- In Niagara River, St. Clair River, Detroit River, Hamilton Harbour and Toronto and Region AOCs, surveys were underway to determine fish consumption habits of each AOC community and Indigenous communities to assist in progress on the Restrictions on Fish Consumption BUIs in each AOC.
- In the St Lawrence River (Cornwall) AOC, a fish contaminant study was initiated with Mohawks of Akwesasne to assess the status of the Restrictions on Fish and Wildlife Consumption BUI.
- In Jackfish Bay, Spanish Harbour, Niagara River and St. Lawrence River (Cornwall) AOCs, assessment of natural recovery of sediments continued.
- In the Bay of Quinte AOC, development of a long term phosphorus management strategy continued with enhanced modelling work on phosphorus loads for to address harmful algal blooms.
- Analysis of existing data was undertaken for:
  - water quality, plankton and algae in Hamilton Harbour, Lake Erie, Lake St. Clair and Thames River
  - groundwater nutrient fluxes in the Thames basin
  - phosphorus levels in Lake Ontario
  - water quality and sediment chemistry in the St. Clair River and Niagara River
- Joint assessment of Lake St. Clair water quality (2016 to 2019) continued in partnership with the Ontario Ministry of Environment, Conservation and Parks.

Canada undertook numerous scientific activities in 2020-2021 in partnership with the Governments of Ontario and the United States to support implementation of the Canada-Ontario Lake Erie Action Plan with the goal of reducing annual phosphorus loading into Lake Erie by 40% from a 2008 baseline. This included improved calculation of phosphorus loads from Canadian sources and, in October 2020, issuing of the first annual Canadian Environmental Sustainability Indicators (CESI) report on phosphorus loadings (Figure 7). Lake Erie phosphorus loads are publicly reported annually through various mechanisms.

Figure 7: Total estimated phosphorus loadings to Lake Erie, 2008 to 2018



Source: Environment and Climate Change Canada (2020)

Note: Basin total values include loadings from runoff and tributaries in Canada and the United States, flows from Lake Huron and atmospheric sources of phosphorus. Half of the total phosphorus loadings from atmospheric sources and from Lake Huron were allocated to each country.

Research tools were developed to provide daily satellite imagery to map the extent of algal blooms and for assessing the spatial/temporal trends of these blooms in Lake Erie. Studies using remote sensing and in situ observations were conducted to further develop satellite chlorophyll-retrieval algorithms.

Three-dimensional modelling of in situ contaminant distributions was completed for a St. Mary's River sediment deposit, confirming a consistent improvement in sediment quality over time.

In 2020-2021, with the COVID-19 pandemic leading to the suspension of monitoring activities related to the abundance of benthis algae and dreissenid mussels, the focus shifted to analysis and interpretation of existing data collected to investigate the factors contributing to excessive algal growth in the nearshore areas of Lakes Erie and Ontario. Data and syntheses were used to improve and refine integrated watershed-lake models and informed binational task teams assessing current nutrient targets developed to control the extent of hypoxia and the wash-up of algae on shorelines.

Research efforts advanced the development of new modelling capability for understanding the effect of catchment inputs on local water quality and benthic algae (*Cladophora*) and improving our understanding of major drivers of variation. Improved modelling efforts were conducted to assist the development of east basin nutrient objectives.

Integrated watershed-lake models were implemented for Lake Erie to improve understanding of the factors responsible for hypoxia and periodic wash-up of algae on shorelines.

In 2020-2021, an ECCC contribution agreement with Swim Drink Fish Canada allowed them to engage Canadians in a citizen science project to conduct water quality monitoring of beaches and other recreational waters and to educate citizens about the significance of water, where water comes from and how to use it sustainably.

Swim Drink Fish Canada has established several monitoring hubs in the Great Lakes. In 2020, a fourth hub was added in Kingston on Lake Ontario. Previous monitoring hubs were established in downtown Toronto through its Lake Ontario Waterkeeper Initiative; on Manitoulin Island hosted by Zhiibaahaasing First Nation; and on the eastern shores of Lake Erie in the Niagara Region. Volunteers help hub coordinators collect water samples in places where people swim, boat, and hold ceremonial activities.

In 2020-2021, volunteer training curriculum was developed and the citizen science data collected was made available to the public through an Open Data Portal. In Toronto, the hub engaged 233 youth through a collaboration with Harbourfront Centre Camps.

7.3 St. Lawrence Action Plan

The St. Lawrence Action Plan is a platform for collaboration between the Canadian and Quebec governments intended to strengthen collective efforts for the integrated management of the St. Lawrence Basin, and to carry out joint actions to conserve and enhance its ecosystem. These efforts focus on 3 priorities:

- biodiversity conservation
- improved water quality
- sustainable use

The *Canada-Quebec Agreement on the St. Lawrence 2011-2026* allows for implemention of the St. Lawrence Action Plan that covers a span of 15 years, with 5-year planning cycles.

This multi-year program, which has been renewed 5 times since it was first signed in 1988, has helped produce concrete results through cooperative efforts from the private sector, universities, research centres, Areas of Prime Concern committees (zones 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 Overview of the State of the St. Lawrence River 2019 was published in November 2020.

The last fact sheets released in March 2021 were related to:

- Shellfish water quality in the Estuary and Gulf of St. Lawrence
- St. Lawrence Estuary beluga whale;
- Phytoplankton, toxic algae and zooplankton in the estuary and Gulf of St. Lawrence
- Oceanographic processes: Temperatures, dissolved oxygen and acidification

In 2020-2021, work on 37 projects identified in the annual report for 2019-2020 continued, 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 re-establishing the functional connectivity of biodiversity hotspots in the St. Lawrence lowlands, including tools for knowledge transfer
- wetland rehabilitation guidance for the St. Lawrence
- the promotion of recreational fishing along the St. Lawrence, including the implementation of an incentive program
- 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 eco-toxicological effects of sewage discharge from the city of Montreal after its disinfection treatment by ozonation (tertiary wastewater treatment)
- a study of the risk associated with the presence of the cytostatics (new pharmaceutical products/anti-cancer substances) in the St. Lawrence river

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. Some research activities such as the fluvial transport of contaminants in water, benthic communities in Lake Saint-Pierre, wetland vegetation in Lake Saint-Pierre and Boucherville Islands were postponed due to the exceptional circumstances of the COVID-19 pandemic.

Activities under the St. Lawrence Action Plan's numerical environmental predictions working group continued in 2020-2021. These activities are done through federal-provincial collaboration under the St. Lawrence Action Plan. The main activities of the group were:

- 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

Community involvement and awareness

Under the St. Lawrence Action Plan, ECCC and Quebec's Ministry of Sustainable Development, Environment and Fight against Climate Change (Ministère de l'Environnement et de la Lutte contre les changements climatiques du Québec) are implementing the Community Interaction Program (CIP), which provides funding to non-governmental organizations and Indigenous communities for projects that aim to conserve and enhance the ecosystem of the St. Lawrence.

In 2020-2021, ECCC distributed $376,249 in funding for 12 projects. These projects involved riverside communities, including municipalities, First Nations, and relevant provincial and federal departments. Specifically, the projects funded were intended to:

- restore waterways in agricultural areas
- restore habitats for fish in Lake St-Paul and for turtles in the Montreal Archipelago
- raise public awareness of the problem of microplastics and solutions to reduce them at the source
- promote the voluntary conservation of natural environments and habitats of migratory marine birds
- control the invasion of exotic plant species in wetlands

Moreover, the Areas of Prime Concern Program supports Stratégies Saint-Laurent and its 12 CIP committees in their cohesive actions to engage and support local stakeholders working to improve the quality of the surrounding environment.

7.4 Atlantic Ecosystems Initiatives

The Atlantic Ecosystems Initiatives (AEI) 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 collaboration and cooperative action resulting in positive environmental impacts throughout Atlantic Canada. The program funds Atlantic Canadian organizations, including nongovernment organizations, coalitions and networks of organizations, research and academic institutions, and Indigenous governments and organizations to deliver projects that address integrated ecosystem planning and decision-making, coordinated science and action initiatives.

In 2020-2021, ECCC committed over $1.1M in funding for 6 new multi-year AEI projects to enhance integrated ecosystem planning and decision-making, increase ecosystem knowledge and science, and undertake actions to conserve, restore, and enhance the Wolastoq/Saint John River Watershed and the Southern Gulf of St. Lawrence Watershed ecosystems.

The following projects received funding:

- In both the Wolastoq/Saint John River and the Southern Gulf of St. Lawrence Watersheds:
  - Eastern Charlotte Waterways Inc. is working to create a map of scientifically determined watercourse buffer widths in priority watersheds in Prince Edward Island and New Brunswick using existing environmental data to determine the site specific factors to be considered in buffer design and GIS (Geographic Information System) to create the maps
  - Bluenose Coastal Action Foundation is taking action to determine levels of microplastics in priority areas and their impact on commercially and environmentally important species, using the blue mussel (*Mytilus edulis*) as an indicator species
- In the Wolastoq/Saint John River Watershed:
  - The Atlantic Coastal Action Program (ACAP) Saint John Inc. will inform water managers and policy makers on water threats and the effects of nutrients to better regulate water quality and inform the public. This will include identification of high nutrient concentrations sites where site health will be investigated by assessing water quality and fish health. A computer model will be created using water quality data to predict ways to protect ecosystems, as well as how animal and plant communities change in response to excess nutrients.
  - Researchers at the University of New Brunswick will generate information about the DNA (deoxyribonucleic acid) of toxic blue-green algal mats in the Wolastoq/Saint John River Watershed in order to understand and predict changes to the algal mats in space and time. Researchers will investigate the factors associated with the presence and rapid increase of blue-green algal mats.
  - Researchers at the University of New Brunswick will also assess factors affecting water quality and nutrient transport in the Upper Wolastoq/Saint John River basin. A comprehensive examination of in-water nutrient concentrations will be completed. Water quality maps and results generated with models for both current

and future climatic conditions will help inform and focus planning in-field remediation efforts to improve water quality. The proposed modelling system will have multiple uses long-term, including modelling of nutrient flow dynamics in other priority watersheds across Atlantic Canada as well as climate change adaptation planning in flood- and drought-prone areas.

- In the Southern Gulf of St. Lawrence Watershed:
  - The Coalition-Southern Gulf of Saint Lawrence will track the effects of bacteria and nutrient contamination from stressors such as development, agriculture and industry on water quality in estuaries. Levels and locations of contaminants and their impact on 6 estuaries with both ecologic and economic importance will be examined. In partnership with local watershed groups, data will be collected to inform resource managers, jurisdictional agencies and watershed organizations about potential remediation projects that could decrease contaminant levels. Data will also be made accessible and usable for long-term trend analyses.

7.5 Wolastoq (Wəlastəkw) / Saint John River Watershed in New Brunswick

In 2020-2021, ECCC continued to focus on 4 key commitments for the Wolastoq/Saint John River watershed under the Freshwater Action Plan:

- increased coordination and cooperation among orders of government
- enhanced Indigenous and stakeholder engagement
- coordinated freshwater science and assessments
- strengthened information sharing

Activities were undertaken to advance a coordinated and integrated management approach for the watershed. ECCC initiated meetings and discussions with other partners (Canadian and United States governments, provincial and state governments, non government institutions and groups, and Indigenous Peoples) to advance shared priorities such as water quality monitoring, data management and access, freshwater assessment, citizen science, and information sharing.

Progress continued under the Wəlastəkw River Interim Statement of Cooperation signed in 2017 by ECCC, the Department of Fisheries and Oceans, Wolastoqey (Maliseet) Chiefs, and several U.S. Federal Agencies (U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, U.S. Geological Survey, U.S. Department of the Interior (Bureau of Indian Affairs)). Although International Summits were not held this year due to the COVID-19 pandemic, the partners continued discussions to advance a watershed governance model and organizational structure going forward.

ECCC funded economic study of the Wolastoq/Saint John River to identify and quantify key economic sectors within the watershed, uses of the watershed, and to identify risks or costs associated with potential changes in environmental quality. The study also identified natural assets such as forests, water supply, wetlands and estuaries, and the ecosystem goods and services they provide, such as recreation (fishing, boating, swimming, and ecotourism) and climate change mitigation.

8 Research and development

8.1 Research on the impacts of climate change on aquatic systems

In 2020-2021, 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:

- continued assessment of hydro-climatic and ecological impacts of river ice jams, with focus on the Peace-Athabasca Delta ecosystem and the Wood Buffalo National Park Action Plan
- planning of Community Based Monitoring activities and analysis of data collected in the past decade
- developing information that will help determine the effectiveness and economic viability of potential climate change adaptation strategies in the most vulnerable regions in western Canada; included water-storage/release approaches using surface dams and groundwater aquifers, and assessing future agricultural irrigation potential
- investigating the implications of potential changes in basin integrated snow water equivalent (SWE) and mean spring temperature/precipitation on Annual Peak Flow (APF) over western Canada
- assessing the vulnerability of western Canadian watersheds reliant on water from mountain headwaters to increasing drought risk and diminishing snow packs, in collaboration with international and national academic organizations
- developing and implementing a scheme to assess the hydrological and water chemistry resilience of northern Canadian watersheds to forest fire
- assessing changes to the spatial and temporal features (such as growth, persistence, retreat, spatial extent) of future severe droughts across the Canadian Prairies
- assessing the climate variability and change on prairie wetlands and hydrology including resultant impacts on the water quality in the Prairie's watershed
- examining the synergistic effects of climate change and resource development on environmental water needs in key Pan-Canadian hydrological systems
- examining the linkage between terrestrial flow pathways and sediment sources with changes in moisture content or condition (permafrost thaw, rainfall)
- conducting research to evaluate the impact of permafrost degradation on water cycling and chemistry in the Arctic and subarctic Canadian Shield
- investigating knowledge gaps and cumulative impacts understanding the impacts of climate change on Arctic freshwater watersheds, in collaboration with universities, provincial and territorial agencies, and Indigenous organizations
- contributing to the Arctic Marine Assessment Report on Freshwater and Cryosphere in a Changing Climate

In addition, ECCC contributed to the editing and publication of the book "Arctic Hydrology, Permafrost and Ecosystems"[2] with 30 chapters by 86 authors from 12 countries. The book provides a comprehensive, up-to-date assessment of the key terrestrial components of the Arctic system (i.e. hydrology, climatology, permafrost, and ecology across the circumpolar regions).

2 Yang, D. and Kane, D.L. 2020. Aquatic Hydrology, Permafrost and Ecosystems. Springer. https://doi.org/10.1007/978-3-030-50930-9

8.2 Technology development

National Hydrological Service's Renewal Initiative and the Innovation Component

The National Hydrological Service's Renewal initiative was launched in the summer of 2018. This initiative involves an $89.7M investment in the NHS in 4 areas or components: forecasting water quantity, infrastructure, rebuilding capacity, and innovation. The broad objective of the innovation component is to enhance monitoring and hydrological services by evaluating and testing innovations in measurement technology and data quality management. This component has $15.5M and 21 full-time equivalent positions invested over 5 years (2018-2023).

In 2020-2021 (third year), the focus of the innovation component was establishing new hydrometric test sites, through careful site selection, planning and instrumentation and equipment installations. Despite restrictions due to COVID-19 limiting some access to the field, 35 new test stations were established (across 7 provinces), which exceeded the goal of establishing 20 test stations in 2020-2021.

Hydrometric instrumentation, data collection and data production

At the operational level, the NHP continued investment in field technologies, including hydroacoustic equipment and advanced deployment platforms, such as bank-operated cableway systems and remote control boats, as manned cableways across the country are being decommissioned. Routine instrument quality assurance testing of hydroacoustic devices continues, but a need for a national database or system to track this information is becoming ever more apparent. Defining requirements for tracking such non-station based capital assets will be a priority in 2021-2022.

Investments also continue in the use of site cameras for monitoring site conditions, including the ice effected period. The NHP now operates more than 90 transmitting cameras (including predominately satellite cameras and a handful of cell modem cameras), typically transmitting 1 image a day, along with more than 200 time-lapse cameras, from which images are downloaded periodically at the time of a field visit. Images from transmitting cameras are now available in real-time to partners via the login side of the Wateroffice website.

The use of electronic Hydrometric Survey Notes (eHSN) to document and upload field visit information and data has become routine, and greatly improves the quality and standardization of how we document and record field visit activities. The percentage of eHSN uploads increased from 26% of all field visits uploaded in 2017 to 59% in 2018 and 94% in 2020.

Through innovative project work, the NHP is also exploring the possibility of using non-contact technology, such as radars and cameras (using images from both drones and fixed stations cameras), for improved water level and flow monitoring. In 2020-2021, 2 camera-based image velocimetry and 5 surface velocity radar test sites were established across Canada.

Developing resiliency in data telemetry is critical, and in 2020-2021, the NHP committed to continue work in 2 main areas of focus for telemetry modernization: 1) continue transitioning any remaining land-based telecommunications systems to cellular or satellite services, which will reduce dependency on aging hardware and increasingly unreliable land-lines, and 2) inviting proposals for installing 2 Direct Readout Ground Stations (DRGS) for receiving Geostationary Operational Environmental Satellites (GOES) Data collection System (DCS) messages directly from GOES East and West satellites. NHS is currently totally reliant on terrestrial internet links to United States DRGS sites for over 1400 hydrometric stations. This work will diversify means of accessing data and increasing system resilience overall.

In 2020-2021, a site characterization survey was completed for all active hydrometric stations in the network (about 2200 stations). This survey has yielded important information to be used to optimize various aspects of the day-to-day operations of the network.

Surface Water Ocean Topography (SWOT) Mission Preparation

ECCC continued collaboration on the development of space-based monitoring technologies for hydrological monitoring in Canada with the Canadian Space Agency (CSA), the National Aeronautics and Space Administration (NASA), the University of Sherbrooke, the University of California, Los Angeles and other organizations in the United

States. Work focused on the Surface Water Ocean Topography (SWOT) hydrology mission, scheduled for launch by NASA in 2022.

NHS has been working in collaboration with ECCC's Water Science and Technology Directorate and the University of Saskatchewan, to complete development of a new facility, designed to develop and test new water sensors and drones for improved monitoring of Canadian water resources. In 2020-2021, many activities involving field work were unachievable due to the COVID-19 pandemic. However, SWOT team members made significant progress on several fronts including model development and hydrodynamic modelling runs at several test sites, the analysis of data collected for the North Saskatchewan River, and analysis of AirSWOT data collected in the Peace-Athabasca Delta (PAD) among others.

8.3 Program development

Quality assurance

Improvements to the quality of real-time data have been established through the adoption of new Continuous Data Production procedures. Starting in June 2020, a process involving faster integration of field observations, and a frequent monitoring of data quality and station performance now ensures that users have access to better data faster. This innovative approach is also a component of the investment in the NHP.

Updating of ECCC's Water Survey of Canada Standard Operating Procedures (SOPs) continued in 2020-2021 in an effort to keep pace with changes in methods and technologies. Investments focused on, and will continue towards procedures for auditing; the estimation of discharge when conditions do not permit the use of the usual hydrometric model; as well as streamlining aspects of data approval to validate data computation conclusions.

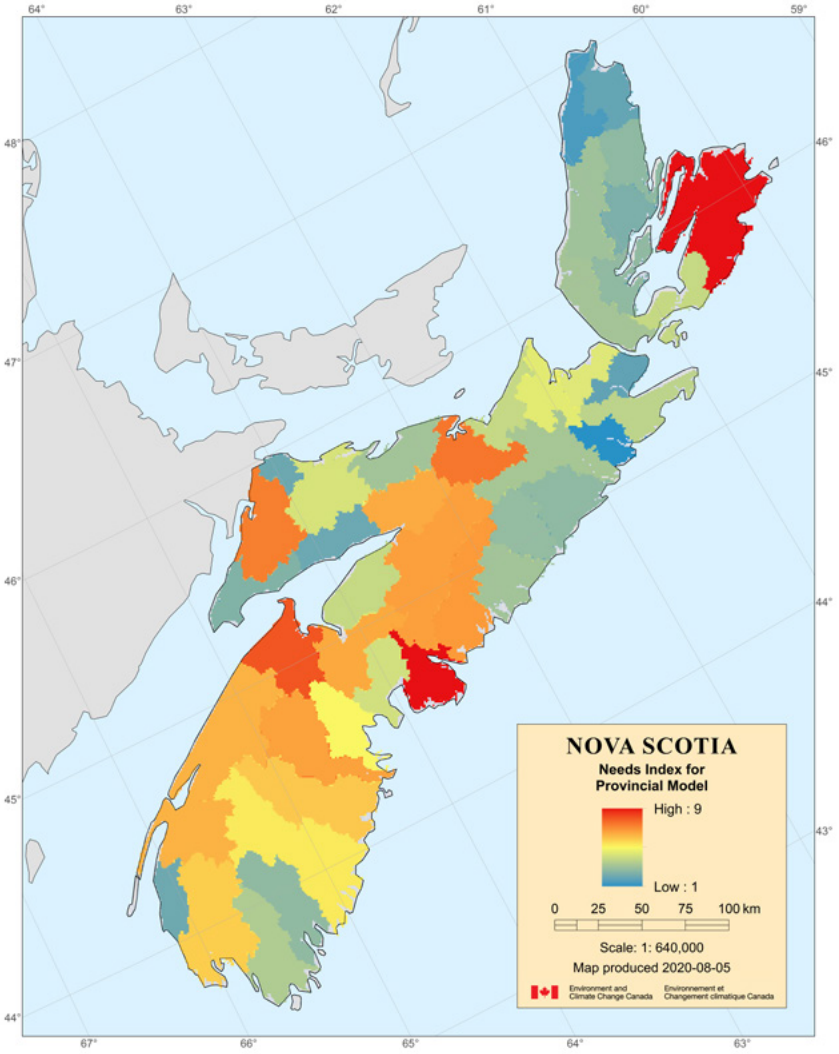
Hydrometric science and development

ECCC, through its NHS, continued to collaborate with internal ECCC partners as well as external government and academic partners to improve flow prediction capability under the auspices of its federal obligations related to transboundary water management. In addition, operationalization of hydrodynamic and ecohydraulic models in rivers of federal significance continued through collaborations with university colleagues in Quebec (L'Institut national de la recherche scientifique).

ECCC is working in partnership with provinces and territories to develop and/or improve flow prediction systems. The "Second Annual Canadian Flood Forecasting Forum" was virtually held on February 22-24, 2021 by ECCC, in cooperation with Global Water Futures (GWF). Attendance was exceptional, peaking at 187 concurrent attendees from across Canada, the United States, and Europe on day 1, with over 100 participants remaining connected throughout the forum. The forum continued efforts to foster more communication and collaboration between provincial and territorial governments, ECCC, academia, and their partners nationwide towards the establishment of a "National Flood Forecasting Community of Practice", for which there was widespread support. Some key findings from the forum included that forecasting is truly a global effort, and that Canada has unique challenges with international and inter-provincial transboundary agreements and complex water systems. There are a wide variety of approaches across the country for dealing with flood forecasting and many elements as well. Many jurisdictions use ECCC products, such as our deterministic numerical forecasts, ensemble forecasts and the Canadian Precipitation Analysis (CaPA) for their forecasting needs.

ECCC continued development of water quantity prediction capacity in 5 of Canada's major water basins: the Great Lakes-St. Lawrence River Basin, the Saskatchewan-Nelson River Basin, the Mackenzie River Basin, the Columbia River Basin, and the Churchill River Basin. This capacity allows ECCC to offer different prediction products and services to assist the provinces and territories, and thereby local governments with their flood and/or drought forecasting. The hydrometric data collected by ECCC, through its National Hydrological Service, continues to be of critical importance to any flood or drought forecasting performed by the provinces, territories and local governments.

Figure 8: Example of Hydrometeric Needs Index, Nova Scotia



The Hydrometric Needs Index (HNI) is a tool developed by NHS to represent the spatial gradient of hydrometric monitoring needs across a defined space (such as, Canada or a specific province or territory). Preliminary results of this tool were presented to NHP partners in 2020-2021. The first step for developing the index was to identify the hydrometric monitoring mandates of the NHP partners (federal, provincial, and territorial governments) and represent them through geospatial data sets. Second, these data sets were normalized and used to generate a numerical index score, between 0 and 9, for each sub-sub drainage areas (SSDA) in Canada. Finally, the resulting index score for each SSDA was plotted spatially, representing the sum of monitoring needs in an area. The index score is an indicator for network evaluation and future design. Areas with the highest score have the highest density of monitoring mandate requirements and may require a dense network of hydrometric stations. An example of the index developed for Nova Scotia is provided in Figure 8.

Outreach

NHS supports openness and interoperability of information and data access across various systems. NHS is working with ECCC's Geospatial Web Service team to make real-time hydrometric data available in Open Geospatial Consortium compliant standards. Real-time data is now available via the MSC GeoMet web service on the staging system and it will go operational in 2021-2022.

8.4 Modelling and studies

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 hydrometeorological modelling can help improve water resources management.

Great Lakes

ECCC collaborates with the United States Army Corps of Engineers (USACE), the National Oceanographic and Atmospheric Administration (NOAA), and the U.S. Geological Survey (USGS) to operationalize various modelling systems for historical analysis of the water balance in the upper Great Lakes.

In 2020-2021, ECCC continued to improve methods for coupled hydrometeorological 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. After years of development by NOAA, in consultation with ECCC, a statistical model that determines the most likely values for the water balance components is now run every month using input from ECCCMSC and other Canadian and U.S. agencies. Research is continuing so that this technique will lead to improved coordinated values of the components of the Great Lakes net basin supply, increase our understanding of the hydrological functions and improve forecasting of Great Lakes water levels. As well, research to examine methods for using a combination of the ECCC Canadian Precipitation Analysis (CaPA) and various NOAA precipitation analyses to replace the currently coordinated precipitation product has begun.

ECCC continues to provide support in verification of flows through the Great Lakes connecting channels in collaboration with USACE and USGS. Binational field verification measurements in the St. Marys, St. Clair, Detroit, Niagara and St. Lawrence Rivers were limited due to restrictions on travel across the U.S. – Canada border in 2020-2021, however verification analysis of past measurements continued. ECCC efforts continued to ensure quality assurance and Canada-U.S. coordination of connecting channels hydrometric station measurements. Measurement accuracy of Great Lake connecting channel flows continue to support development of water balance prediction models and accounting for binational water use.

Under the Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data, a comprehensive plan to update the International Great Lakes Datum of 1985 (vertical datum) for the Great Lakes-St. Lawrence system was developed. An extensive binational field survey that was planned for 2020 was postponed until 2022 due to travel restrictions in place to respond to COVID-19. The update is still anticipated to be completed by 2025.

International rivers

ECCC played a lead role in the Lake Champlain-Richelieu River Study, with the completion in 2020-2021 of a high-resolution 2D hydrodynamic model of Lake Champlain - Richelieu River, which includes the integration of the wind effect on the lake level and river discharge, and the development of mitigation solutions with the objective of reducing flood peaks. Major efforts were invested in finalizing and using an integrated modelling tool (ISEE-Integrated Socio-Economic and Environmental system) that allows for a robust quantitative analysis of mitigation solutions for both sides of the US and Canada border. During 2020-2021, multiple flood mitigation measures were developed and analyzed, and ECCC contributed to the flood forecasting and real-time mapping effort of the Lake Champlain-Richelieu River Study.

ECCC continues to play a key role in the Souris River Study to examine potential improvements to the operation of several dams in Saskatchewan and North Dakota for both flood control and water supply purposes. The study created and analyzed alternative simulations for reservoir operations to optimize flood control and water supply while also considering the interests of other stakeholders and rights-holders in the basin (e.g. recreation, water quality, fish and wildlife, culture). In 2020-2021, work also continued on the climate change component of the study whereby the impacts of a changing climate was tested through global climate models, and trend and non-stationarity analysis. The study held a number of workshops and meetings with the public, regulatory agencies and First Nations. The study strengthened a process with the IJC to develop long-term relationships with First Nations with interests in the basin. Dam safety continues to be a major issue that will complicate the management of the reservoirs as well as the development of recommendation for improved operations going forward.

Arctic

ECCC leads the Arctic Hydrological Cycle Observing System (HYCOS) initiative, which focuses on assessing freshwater flux into the Arctic Ocean. In 2020-2021, work continued to finalize the public web portal to allow the users to display, filter and download streamflow and other data for all hydrometric stations in the Arctic-HYCOS network, according to extended metadata criteria. The first phase of the Arctic-HYCOS Project is complete. Planning for the second phase has commenced and a work plan will be developed in 2021-2022. Canada continues to chair and provide secretariat services for the project.

Global

ECCC supported the restructuring of the World Meteorological Organization (WMO) in 2020-2021. NHS reviewed the development of 2 new WMO commissions which have replaced the previous 8 scientific and technical commissions (including the former Hydrologic Commission). In addition, WMO has formed a Hydrological Coordination Panel to better integrate hydrology into WMO activities; and to develop a Vision, Strategy and Action Plan for WMO Hydrology. NHS leads a pan-Canadian, multi-expert working group, including scientists, policy experts, and academia to consider global hydrology issues, the impacts of new WMO initiatives on Canada, and Canada's role in supporting the global hydrology agenda.

9 Water data online

The Government of Canada's Water website 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.

Unfortunately, the government's web analytics software crashed and statistics regarding the data accessed in 2020-2021 (number of hits, visits and data downloaded) could not be developed for the sites below.

ECCC's Wateroffice website provides public access to real-time and archived hydrometric data collected in Canada. ECCC's Meteorological Services of Canada Datamart provides access to weather, climate and water data as static files using open file formats.

Federal Water Quality Monitoring and Surveillance data is available through various mechanisms:

1) Freshwater quality data collections on the Government of Canada Open Data Portal:
   - National scope
     - National Long-term Water Quality Monitoring Data
     - Automated Fresh Water Quality Monitoring and Surveillance Data
     - CABIN Canadian Aquatic Biomonitoring Network
   - Regional scope
     - Great Lakes Water Quality Monitoring and Aquatic Ecosystem Health Data
     - Surface Water Quality and Benthic Invertebrates, Oil Sands Region
     - Freshwater Quality Surveillance Data – Pacific Basin
     - Field data for the mapping of wetlands of the St. Lawrence River between Cornwall and Trois-Pistoles, of the Lake St. Pierre wetlands and of the Boucherville Islands area.
     - Clean Air Regulatory Agenda Freshwater Inventory and Surveillance of Mercury (CARA FISHg)
     - Great Lakes Fish Contaminants Monitoring and Surveillance Data

2) Two internal interactive websites allow search and extraction of freshwater quality monitoring and surveillance regional data that can easily be shared as required:
   - Envirodat-PYR Web data extraction – provides data for the Pacific and Yukon watershed.
   - Fresh Water Quality Monitoring and Surveillance web mapping – provides data for the Great-Lakes, St. Lawrence and Atlantic watersheds.

3) The Gordon Foundation's DataStream integrates federal datasets with community based water quality monitoring data. ECCC has provided technical advice and expertise (with respect to water quality data) to support the expansion of and improvements in the platforms for Lake Winnipeg DataStream, Mackenzie DataStream and Atlantic DataStream.

10 Additional information

To obtain further information or publications and to submit questions or comments concerning the *Canada Water Act*, please contact ECCC's Inquiry Centre.

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Toll Free: 1-800-668-6767 (in Canada only)
Email: enviroinfo@ec.gc.ca

The following media relations contact is also available to provide information.
Environment and Climate Change Canada
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Toll-free within Canada: 1-888-908-8008
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