PART II

Chapter 5

Urban wastewater management

This chapter examines urban wastewater management policies in Canada over the last decade. It discusses recent developments that have strengthened the policy framework. These include the Canada-wide Strategy for the Management of Municipal Wastewater Effluent and the first national regulation for wastewater treatment. The chapter highlights some of the most salient challenges that still need to be tackled, including the detrimental situation of Indigenous peoples, the lack of a sustainable financing strategy and the need to swiftly adapt to a changing climate and precipitation patterns. It suggests areas for improvement in the use of pricing instruments and of incentives to explore innovative approaches to manage waste- and rainwater, among others.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

1. Introduction

Freshwater plays a crucial role in Canada's society and economy, and wastewater management is an essential driver of water's availability and quality. Water is abundant nationally and generally of good quality, even though some areas of concern remain in urban environments or agricultural areas. Wastewater discharges represent one of the largest emissions by volume into the Canadian environment. Significant investment is required to provide access to appropriate levels of treatment across provinces and territories, to renew existing infrastructures and to adapt to a changing climate. Indigenous communities remain in a disadvantageous position. Energy production, urbanisation and, to a lesser extent, agriculture have increased tensions on water quantity and quality. Climate change is adding more uncertainty about future water availability and needs.

In that context, policy responses to urban wastewater challenges have changed markedly. This is most clearly illustrated by the 2009 Canada-wide Strategy for the Management of Municipal Wastewater Effluent and the 2012 Wastewater Systems Effluent Regulation. More recently, the 2015 mandate letter to the Minister of the Environment and Climate Change included an explicit reference to "investments in the best wastewater treatment technologies" in pursuit of freshwater protection and stewardship. This testifies that urban wastewater collection and treatment ranks high on the federal policy agenda.

2. Status and trends in urban wastewater management

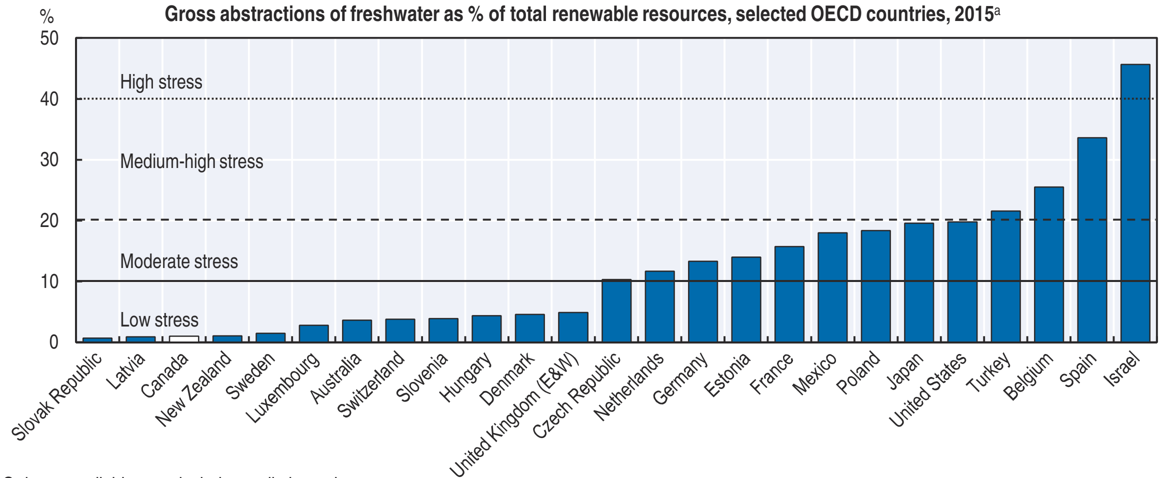
2.1. Urban wastewater in the context of water management in Canada

Canada has about 7% of the world's renewable water. Water stress, defined as the ratio of water abstraction on renewable resources, is among the lowest in OECD member countries (Figure 5.1). Aggregate figures, however, mask significant regional disparities: much of Canada's renewable water supply is out of reach for the general population. Renewable water available in the most populated areas of the country dropped by 8.5% between 1971 and 2004 (Statistics Canada, 2010). Episodes of drought are experienced across Canada, particularly affecting the interior of British Columbia, the Prairies, as well as southern Ontario and southern Quebec. The Great Lakes area is affected by variable water levels, which impair capacity to absorb and dilute nutrients. Further, Canada is among the OECD member countries with the highest freshwater abstraction per capita (Figure 5.2). This is putting pressure on freshwater supply in some urban areas.

Overall, freshwater quality of Canadian rivers and lakes is fair to good and remained relatively stable between 2003-05 and 2010-12. At the regional level, water quality is a concern, however, particularly near city centres and in agricultural areas (Wood, 2013). Key pollution sources include excess nutrients (phosphorous and nitrogen) from agricultural and wastewater sources, persistent toxic substances (from industrial or domestic uses), and emerging chemicals of concern from urban and industrial sources. The application of nitrogen fertilisers increased twice as fast as agricultural production since 2000 (Chapter 1). With improved control of source pollution, the control of diffuse pollution, such as urban

Figure 5.1. **Canada experiences no water stress at national level**

Gross abstractions of freshwater as % of total renewable resources, selected OECD countries, 2015[a]



a) Or latest available year, includes preliminary data.
Source: OECD (2017), "Freshwater Resources (long term annual average)" and "Water: Freshwater Abstractions", *OECD Environment Statistics* (database).

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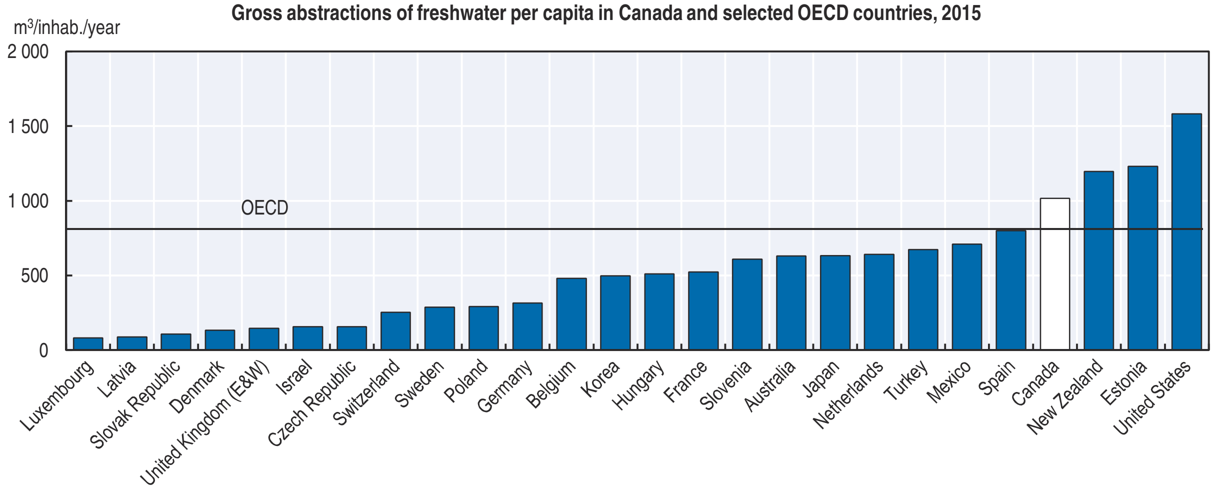
Figure 5.2. **Canadians are profligate water users**

Gross abstractions of freshwater per capita in Canada and selected OECD countries, 2015



Note: Includes provisional data. Data referring to years before 2010 have not been included.
Source: OECD (2017), "Water: Freshwater Abstractions", *OECD Environment Statistics* (database).

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or agricultural run-off, is likely to be a more efficient and effective way to improve water quality in Canada (see OECD, 2017a).

Effluent from wastewater systems represents one of the largest sources of pollution in Canadian waters, by volume. Municipalities released 6.4 billion cubic metres (m^3) of wastewater in 2006. Manufacturing and mineral extraction released another 4.2 billion m^3 and thermal-electric power generation industries another 25.2 billion m^3 of wastewater in 2013 (Statistics Canada, 2017). Most of this undergoes some type of treatment before it is released. However, an estimated 205 million m^3 of untreated wastewater was released into Canadian rivers and oceans in 2015 (CBC, 2016).

The impact of urban wastewater effluent on water quality varies across the country, reflecting the large variation in treatment levels (Section 2.2 and Table 5.1). Monitoring

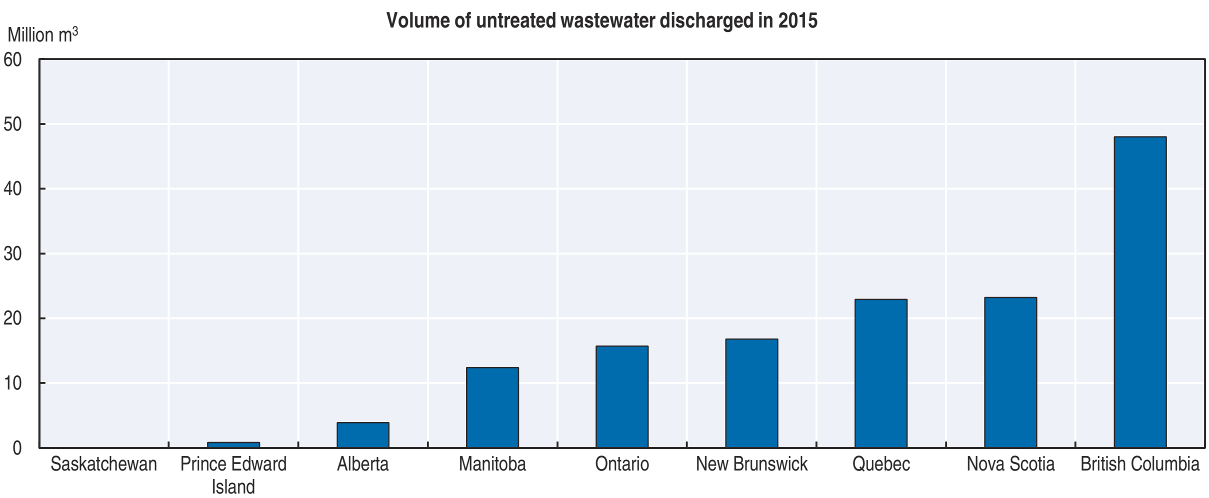
Table 5.1. **Overview of water quality that relates to wastewater**

British Columbia	A resource-based economy (including mining, pulp and paper) has put pressure on water resources. Levels of many pollutants have decreased over the past few decades due to government regulatory actions. Tertiary treatment of wastewater has reduced phosphorus loads in rivers and lakes (Lake Osoyoos, Columbia River). Metro Vancouver deserves further attention, as it suffers from an ageing infrastructure not up to current and future challenges (in particular). Levels of faecal coliforms still increase at places (although below guidelines for recreational use). The construction and expansion of combined sewers is not permitted under existing provincial regulation and existing combined sewers must be separated upon repair or renewal.
Alberta	The level of water quality is very good and was stable between 1996 and 2009, although Alberta is the fastest growing province in terms of population and the home of Canada's oil extraction industry, which uses water and produces large amounts of wastewater. Improvements to wastewater treatment plants have reduced nutrients and bacteria in rivers and lakes. Alberta claims that provincial wastewater effluent standards are more stringent than the national ones established in 2012; this is debatable in selected areas; for instance, Alberta has no effluent quality standards for lagoons without aeration. The construction of combined sewers overflows has not been allowed since the mid-1980s.
Saskatchewan	91 municipal wastewater treatment plants discharge treated effluent to natural waterways. Approximately 98% of these systems use lagoons as the treatment method, with another 2% having systems that use mechanical treatment plants. Trends of water quality are not well documented or publicised, except for nutrients. Nutrient flow (naturally high in the province) shows contrasted trends across rivers. Combined sewers are prohibited in the province.
Manitoba	Manitoba had established effluent standards prior to the 2009 Canada-wide Strategy for the Management of Municipal Wastewater Effluent that are considered to be as or more stringent than the national performance standards. The population is almost entirely served by secondary-mechanical treatment. Mediocre water quality in Lake Winnipeg and Lake Manitoba. The construction of combined sewer has not been permitted for decades.
Ontario	Some persistent, bio accumulative and toxic substances (PBTs) have declined substantially since the 1980s, but some remain at concentrations that still pose a threat to human health and the environment. Phosphorus concentrations have decreased in many rivers and lakes since the 1970s, as illustrated by Lake Simcoe. They have also decreased in the offshore waters of most of the Canadian Great Lakes. Conversely, there are excess nutrients in many nearshore areas. While a certain level of nutrients is good, too much may lead to the development of nuisance and harmful algal blooms. Pharmaceuticals in drinking water are not at levels that create concerns for human health. Ontario does not allow the construction of new combined sewers. For existing combined sewer systems, Ontario policy requires capture and treatment of wet weather flow, and prohibits dry weather overflows. The city of Ottawa is building a combined sewer storage tunnel to reduce the frequency of sewage overflows during storms from entering the Ottawa River. The CSST project is a CAD 232.3 million investment. The government of Canada and province of Ontario are each providing CAD 62.1 million. In addition, the city has committed CAD 108 million.[3]
Quebec	The St. Lawrence River is affected by municipal wastewater from urban communities. The situation is improving, due to improvements in municipal wastewater treatment. Bacterial contamination increased in 2004/05 as wastewater treatment plants in Montreal, Longueuil and Repentigny do not disinfect effluents. The failure to adequately maintain urban water infrastructure results in increased operational costs for water and wastewater systems due to non-revenue water or the infiltration of storm water into sewers (Baltutis and Shah, 2012).
New Brunswick	The province has generally very good quality surface water, although bacteria levels in the Saint John River remain high and above the guidelines for recreational use. New Brunswick requires overflow management plans for upgraded pumping stations associated with new development. All municipalities were required to develop long-term plans to reduce combined sewer overflows and reduce overflows from infiltration by 1 January 2016.
Nova Scotia	Phosphorus is increasing in several rivers. Nitrate exceeds guidelines for protection of aquatic life in the Mersey River. Monitoring capacity has improved with the development of an automated network of monitoring devices. The province is affected by ageing and inadequately maintained storm water and wastewater infrastructure (Baltutis and Shah, 2012)
Prince Edward Island	Nitrogen levels are high and rising in this small, agriculture-centred province. Regulation allows for the construction of combined sewers, even though the province has not approved any new ones for many years. A programme to eliminate combined sewer overflows in the sole remaining community with combined sanitary-storm sewers is nearing completion.
Newfoundland and Labrador	Water quality is rated fair or above. Nutrient levels are decreasing, except near St John's.
Yukon	Yukon does not have combined sewer systems.
Northwest Territories	Extreme climate conditions make standard wastewater collection and treatment systems inappropriate. Difficult road transportation hinder operation and maintenance. No Northwest Territories communities have combined sewer and storm water systems.

systems also vary, reflecting the size and diversity of the country, and the specificities of local situations. The fragmented (and at places incomplete) monitoring systems impair a comprehensive assessment of the performance of wastewater treatment systems. No source of information compiles data on the performance of wastewater systems nationally.

Discharged wastewater needs to be managed in conjunction with urban run-off, which is caused by heavy rains. Where waste- and rainwater are conveyed in the same sewer, heavy rains can lead to sewer overflow and release of untreated wastewater into the environment. Environment and Climate Change Canada (ECCC) inventories 268 systems (out of more than 3 000) that generate overflows in Canada, and 2 933 points of overflow (one system can generate overflows in several points). In 2015, these systems released 144 million m^3 of untreated wastewater (Figure 5.3); Quebec alone hosts 178 such systems. Combined sewers are largely a legacy of early settlements. Their construction is banned in all Canadian provinces, but retrofitting existing systems is costly and takes time. In Quebec, for example, the cost of minimising combined sewer overflows is estimated at CAD 6.2 billion (Gouvernement du Québec, 2013). Changing precipitation patterns, coupled with the extension of sealed surfaces, increase run-offs in urban areas, putting existing infrastructures that collect and treat rain water to their limit.

Figure 5.3. **Combined sewers released 144 million m^3 of untreated sewerage in 2015**



Source: Environment Canada, personal communication based on summary of the information submitted by owners and operators of wastewater systems for the year 2015.

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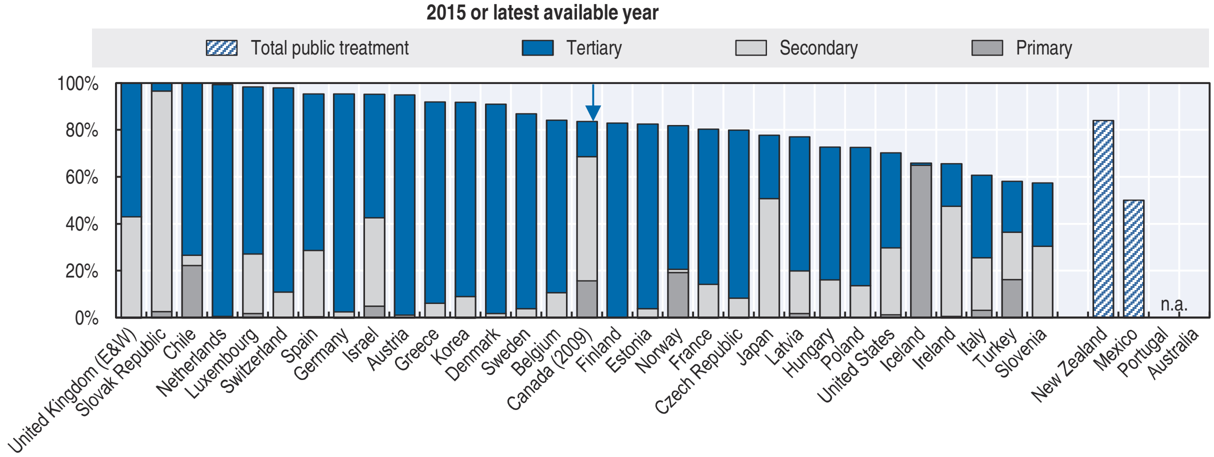
Organic micro-pollutants, such as pharmaceuticals and pesticides, can have detrimental effects on water quality even in trace concentrations. However, wastewater containing such pollutants is particularly difficult to treat. In May 2016, the government of Canada (in a joint action with the United States) identified eight new Chemicals of Mutual Concern, under the Great Lakes Water Quality Agreement. All designated Chemicals of Mutual Concern are listed under the List of Toxic Substances under the Canadian Environmental Protection Act, and, as such, are subject to federal risk management. Environment and Climate Change Canada (ECCC) is working with the US Environmental Protection Agency to develop binational strategies to address these eight chemicals, which may include additional research, monitoring, surveillance and pollution prevention and control measures. Quebec sees such substances as a potential threat, but not an immediate risk, as their presence is still below the provincial threshold. The province organises surveillance on drinking water at wastewater treatment plants.

2.2. Access to wastewater collection and treatment

More than 3 000 wastewater systems operate in Canada. The 2009 Municipal Water and Wastewater Survey indicates that 87% of the population is served by sewers; the remaining population uses private septic systems (12%) or sewage haulage (less than 0.5%). Of the population served by sewers, 3% receives no or only preliminary treatment (ECCC, 2011a).[1] More than half of the population was served with secondary treatment, which removes most conventional pollutants.[2] Another 15% of the population are served with tertiary treatment, which aims to remove such harmful elements as suspended solids, phosphorus or specific compounds (e.g. pesticides or metals). This is a relatively low share compared to most other OECD member countries (Figure 5.4). All told, 15% of Canadians receive primary treatment, which is rather large in international comparison.

Figure 5.4. **A comparatively large share of Canadian population still relies on primary wastewater treatment**

Share of population connected to public wastewater treatment plants by type of treatment, 2015 or latest available year



Note: Includes preliminary data. Data earlier than 2010 have not been considered except for Canada.
Source: OECD (2017), "Water: Wastewater Treatment (% Population Connected)", *OECD Environment Statistics* (database).

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Access to, and level of, wastewater treatment varied widely between provinces (ECCC, 2011a). Primary treatment was prominent in Newfoundland and Labrador, Nova Scotia, Quebec and, to a lesser extent, British Columbia; in Quebec, 81 municipalities released untreated wastewater and 14 wastewater treatment plants only provided primary treatment; Montreal, which accounts for half of wastewater released in the province, provided primary treatment only. Similarly, much of Vancouver's population is served by primary treatment only. The populations of Ontario and Manitoba are almost entirely served by secondary-mechanical treatment, while 78% of Alberta's population is served by tertiary-level wastewater treatment. The contrasted situation across the country requires policy instruments and governance structures that are targeted to local circumstances. Federal regulations and standards need to provide provinces and municipalities with flexibility on how to improve performance.

Most Indigenous and northern communities rely on secondary-level wastewater treatment systems, such as lagoons that discharge treated effluent into designated natural receivers. All treatment systems are subject to applicable provincial and federal requirements. Continued research is needed to better understand the treatment efficacy of natural systems and the impact on ecosystem health. Better knowledge will also help determine potential design parameters for northern wetlands. These are a key component in developing northern performance standards that the governments of Northwest Territories, Nunavut, Quebec, and Newfoundland and Labrador have committed to develop in the context of the Canada-wide Strategy for the Management of Municipal Wastewater Effluent.

2.3. Wastewater treatment and Indigenous communities

Access to wastewater treatment in Indigenous and northern communities is unsatisfactory. Access to safe water and wastewater services is generally lower than other populations. According to an assessment conducted between 2009 and 2011 of 532 community wastewater systems, 14% posed high overall risk to the community members they serve, 51% posed medium overall risk and 35% low overall risk (INAC, 2011). It concluded that substantial investment in infrastructure for wastewater systems in First Nations communities was required, along with investments in capacity building for operation and maintenance, and operator qualification. The situation of Métis people is more favourable, as a large majority of Métis people lives in urban areas. Some observers contend that the lasting unequal access of Indigenous peoples to safe water, wastewater services and water security in general results from 140-year-old biased social-political dynamics, which fail to acknowledge Indigenous knowledge of land, resources and water management (Castleden et al., 2017).

Between 2006 and 2015, the government of Canada invested around CAD 3.1 billion in water and wastewater infrastructure and related public health activities in First Nations communities (INAC, 2016). Federal funding is mostly allocated under the 2008 First Nations Water and Wastewater Action Plan (FNWWAP), which is co-ordinated by Indigenous and Northern Affairs Canada (INAC), in with support from Health Canada. Indigenous communities also invest in water and wastewater systems and activities through their own revenues and various other government sources at the local, provincial and federal level. Indigenous communities commit to cover 20% of the operation and maintenance costs of on-reserve water supply and sanitation systems. As a result of investments, the 2015/16 annual inspection of federally funded water and wastewater treatment systems shows marked reduction of exposure to risk, compared to the 2009-11 situation (Table 5.2).

Table 5.2. **Risk exposure from wastewater systems in First Nations communities**

Percentage of community wastewater systems posing an overall risk to the community members they serve

Level of risk	2009-11 %	2015/16 %
High overall risk	14	3
Medium overall risk	51	52
Low overall risk	35	45

Source: INAC (2016); INAC (2011).

The third Federal Sustainable Development Strategy (FSDS) 2016-19 sets targets that relate to wastewater collection and treatment in Indigenous communities. It aims to increase the share of on-reserve First Nations drinking water systems with low risk ratings from 27% in 2011 to 65% by 2019. It also seeks to increase the percentage of on-reserve First Nations wastewater systems with low risk ratings from 35% in 2011 to 65% by 2019. While the realisation of these objectives would constitute a marked improvement in the situation of Indigenous peoples, the objectives look minimal compared to standard performance in Canada. The FSDS 2016-19 aims to resolve 60% of long-term drinking water advisories affecting First Nations supported by INAC by March 2019; 100% should be resolved by March 2021.

The focus on financial support to infrastructure development continues, accompanied by skills development and the establishment of technical hubs to support operation and maintenance of existing systems. Starting in 2016/17 and over a five-year period, Budget 2016 is investing CAD 1.8 billion for on-reserve water and wastewater infrastructure through INAC's programmes (INAC, 2017). The effectiveness and efficiency of such federal spending will depend on the capacity of INAC and Infrastructure Canada to select and support projects that improve the situation on the ground. The selection procedure to access funds managed by Infrastructure Canada urges municipalities to prioritise wastewater in their investment portfolio; it does not necessarily ensure the best value for public moneys (see also Section 5). Effective public spending will also depend on minimising the impacts on water resources of developments on Indigenous land. New developments or transport infrastructures that affect the quality of groundwater on which Indigenous communities depend can result in water scarcity or more expensive treatment.

The 2013 Safe Drinking Water for First Nations Act enabled the federal government, in partnership with First Nations, to develop enforceable federal regulations to ensure access to safe, clean and reliable drinking water, the effective treatment of wastewater and the protection of sources of drinking water on First Nations lands. INAC, in consultation with Health Canada, has established non-binding water and wastewater protocols that aim to help ensure that residents on First Nations lands enjoy standards of health and safety comparable to other Canadians. However, no enforceable standards have been developed to date. Many First Nations do not support the act and INAC is currently reviewing its approach. Wastewater systems on First Nations lands that meet the threshold of the WSER are required to meet its effluent quality standards.

A challenge remains to fully engage with Indigenous peoples. Although First Nations, Métis and Inuit communities differ, in particular as regards the nature and legal definition of rights to land and water, they are best characterised as *right holders*, and not mere *stakeholders* (see also Chapter 2). These rights can compete with federal, provincial or private ambitions to develop energy (i.e. hydropower) or to transport fossil fuel across Indigenous territories. The Site-C dam illustrates a situation where a valley was flooded in contradiction with existing treaties (see Box 2.7 in Chapter 2).

Canada's adherence to the UN Declaration on the Rights of Indigenous Peoples (UNDRIP) in May 2016 is an important step forward. It will materialise when pending issues are addressed, in particular the practical definition of "consultation" and an agreement on the definition of free, prior and informed consent. The question of whether the right to oppose a project constitutes a veto remains subject to debate. While Indigenous communities are more routinely consulted, these consultations essentially focus on the impacts of specific projects, with a view to reach a compensation agreement. However, O'Faircheallaigh (2010) notes that such agreements also raise major issues for Indigenous peoples' relations with other actors and institutions, including government, environmental groups and the judicial system. Typically, most agreements require that Indigenous peoples either support the project or refrain from opposing it in environmental assessment and regulatory proceedings (Salée, 2005). Similarly, confidentiality provisions can limit communication options.

A step change would base consultations on rights, with a view to mitigate the environmental impacts of projects and regulations on Indigenous land. The Species at Risk Act, developed in the 1990s, is considered good practice. The revision of the Act on Environmental Impact Assessment provides an opportunity to replicate the former.

Innovative approaches being explored in New Zealand may be a source of inspiration, while acknowledging that legal statuses of Indigenous peoples and rights may differ (see Box 5.1). This step change also requires that Indigenous peoples streamline their organisation and clearly identify who should be consulted: discussions with leaders may not reflect a community's opinion, putting implementation at risk.

Box 5.1. **New Zealand iwi rights to water**

The Freshwater Iwi Leaders Group, established in 2007, is proceeding to resolve with the Crown how to recognise iwi proprietary rights in freshwater quantity and quality. One avenue being explored is a nationwide recognition of iwi interests in the form of an equitable, permanent share of water entitlements and discharge allowances allocated for commercial use. A permanent allocation of water to iwi would not be the first time a mechanism has been considered that simultaneously recognises the commercial value of a natural resource to iwi, and a societal need for more clarity around interests in that resource. For example, the Fisheries Quota Management System in 1992 was used to recognise iwi proprietary rights in fisheries and to revolutionise management of the fishery resource for the benefit of New Zealand.

Another option explored by the Leaders Group to provide recognition of Māori water is to introduce a resource rental (or royalty) regime under which Māori would be paid for the commercial use and pollution of their waters. There are already some forms of resource rentals in New Zealand, particularly in relation to the extraction of coal, precious metals, oil and gas, geothermal energy, sand and gravel, and more recently coastal space. Charging resource rent on the commercial use of freshwater resources and paying those rentals to Māori who have proprietary interests would be one way for the Crown to meet its Treaty obligations.

Alternative forms of recognition of Māori rights in freshwater bodies could be considered, such as granting legal personhood to a water body, or granting ownership of the bed and water column of a water body to a Māori trust. For example, the Te Awa Tupua [River with Ancestral and Extraordinary Power] framework for the Whanganui River affords the highest level of protection – legal personality – to Te Awa Tupua. It aligns with a Māori world view that has always regarded rivers as containing their own distinct life forces. Another example is the granting of ownership of the bed and the water column of Lake Taupō and its tributaries to Tūwharetoa Māori Trust Board.

Source: OECD (2017b), *OECD Environmental Performance Review of New Zealand.*

2.4. How a changing climate affects wastewater management

Climate change is adding distinctive pressures on wastewater management in Canada. First, more frequent thaw increases cold run-off, affecting biological nitrogen removal and the efficiency of secondary treatment. Debris can block flows and trigger local flooding.

Second, precipitation has increased by approximately 17% for the 1948-2015 period. The biggest increases have been observed in the North (e.g. annual precipitation in northern Canada has increased 33%, compared to 8% in southern Canada). Precipitation in southern Canada is increasingly falling as rain (as opposed to snow), while in northern Canada, precipitation is increasingly falling as snow (NRCan, 2008). Heavier rains, coupled with the extension of sealed surfaces, increase run-offs in urban areas. These put existing infrastructures that collect and treat rain water to their limit, increasing risk of combined sewer overflows. They also increase energy cost of pumping water through the networks.

Third, the frequency and severity of storms are increasing across the country. From 1900 to 1990, for example, Newfoundland and Labrador was hit by about six hurricanes and tropical storms per decade. Between 1990 and 2015, this ratio has more than doubled. Moreover, these storms are now extending from the July and August timeframe to as late as October. Extreme storms, which result in storm surge, and over-land and coastal flooding, affect emergency and disaster planning, public health, infrastructure planning and water management. Yukoners as well are experiencing more extreme weather events, including lightning storms and flash floods.

These impacts are projected to accelerate in the future. In the North, warming will affect the amount and distribution of rain, snow and ice, as well as the risk of extreme weather events (e.g. heat waves, heavy rainfalls and related flooding, dry spells or droughts, and forest fires). Precipitation is projected to increase in the future, with annual total precipitation increases in the range of 0-10% in southern Canada in 2080, and up to 40-50% in the North. Storm frequency is expected to increase, with subsequent increases in storm surges, coastal flooding and coastal erosion (NRCan, 2008).

Alberta Government (2009) signals some of the main impacts of climate change on municipal wastewater management:

- Increased evaporation in lakes and reservoirs leads to decreased assimilative capacity of water bodies for municipal wastewater effluent.
- Droughts will have negative effects on water quality and will decrease a river's capacity for wastewater assimilation.
- Higher intensity of precipitation events will increase the amount of storm water that needs to be treated. Storm water in urban environments can be heavily polluted, as water picks up contaminants ranging from sediment, nutrients, hydrocarbons, heavy metals, road salt, pesticides and animal waste. This polluted water is mainly discharged into a water body untreated. In the case of combined sewers, large storms can result in raw sewage and polluted storm water bypassing the wastewater treatment facility.

Adaptation to climate change has, however, been slow across the country. Most sub-national governments have either a climate change adaptation strategy or plan, or take climate change adaptation into account in their water strategies or plans. However, the 2016 Canadian Infrastructure Report Card estimates that only 16% of municipalities have formally factored climate change adaptation into decision- making practices for wastewater.

3. The institutional framework

Fragmented governance is a recurring theme in water governance in Canada (Renzetti and Dupont, 2017). Powers to control water pollution are shared between federal and provincial governments, while the delivery of water and wastewater services is shared between provinces and municipalities. Several platforms exist to co-ordinate initiatives, share knowledge and raise awareness. Notwithstanding, marked discrepancies in policy objectives and wastewater services performance can be found across the Canadian territory. More systematic use of incentives could help align initiatives across levels of government. Multi-level governance contracts have delivered in several OECD member countries and could be considered, supported by strategic uses of federal or provincial funds. Incentives could also be set up to expedite the development of federal-provincial or federal-territorial bilateral agreements for wastewater standards.

3.1. Division of powers and responsibilities

The main federal legislation governing water resources management is the 1970 Water Act, revised in 1985. The act provides that provinces manage wastewater, including issuing permits or licences for the construction and operation of wastewater treatment plants, using their own legislative and regulatory or non-regulatory frameworks. The federal government is responsible for water issues associated with federal lands, fisheries, oceans, shipping, navigation, criminal law, international relations, and boundary and transboundary waters. The federal government also regulates pollution from wastewater effluent under the Fisheries Act (see below). Powers to manage water and water pollution are hence shared between the federal and provincial governments and – to a certain extent – overlap.

In Yukon and the Northwest Territories, land, water and resource management falls under the responsibility of the territorial government. In Nunavut, management responsibility lies with the federal government, while the negotiations of a devolution Agreement-in-Principle are ongoing.

River basin (or watershed) authorities are in charge of catchment protection, monitoring of river flows and water quality. They are not decision-making bodies, however.

The overall responsibility for the delivery of water and wastewater services is shared among the provincial governments and municipalities (in Canada, municipalities are features of the provinces; see Chapter 2). Municipalities are the primary owners of the vast majority of water systems in Canada. They also make front-line decisions on current and future water management challenges. Further, they bear financial responsibility for their systems, although federal and provincial government grants and programmes support a number of activities.

Indigenous communities own, manage and operate their water and wastewater systems. INAC provides funding and advice with regards to the design, construction, operation and maintenance of treatment infrastructure. In addition, it provides protocols, and funding and training for water treatment plant staff. ECCC regulates treatment of wastewater discharged to receiving water bodies. In First Nations reserves south of the 60th parallel, the management of drinking water quality and wastewater is a shared responsibility among Indigenous communities and the federal government (INAC and Health Canada). As for north of the 60th parallel, territorial governments are responsible for safe drinking water in all communities in their territories, including Indigenous communities.

3.2. A complex system of involved institutions require extensive co-ordination

The fragmented governance for water and wastewater management makes inter-governmental co-operation a necessity. At federal level, ECCC sets standards for wastewater systems effluent (see Section 4). Health Canada works with ECCC to assess the potential risks to human health posed by new and existing substances in Canada under the 1999 Canadian Environmental Protection Act (CEPA). The Ministry of Infrastructure and Communities delivers significant volumes of funding to provinces, territories and municipalities.[4] The Ministry of Fisheries, Oceans and the Canadian Coast Guard and ECCC are involved in protecting the Great Lakes, the St. Lawrence River Basin and the Lake Winnipeg Basin. INAC works with Indigenous communities to improve their essential physical infrastructure in collaboration with the Ministry of Infrastructure and Communities, and other stakeholders.

The federal government supports the work of the International Joint Commission (IJC) between Canada and the United States. It also manages and helps resolve disputes regarding boundary and transboundary waters.[5]

Platforms are in place to make governance for urban wastewater management more coherent. These include the Canadian Council of Ministers of the Environment (CCME) and the National Advisory Committee (NAC) – the two key forums for federal-territorial-provincial collaboration for environmental policy (see Chapter 2). In addition, the Federation of Canadian Municipalities (FCM) and the Canadian Water and Wastewater Association (CWWA) represent the interests of Canada's municipalities and public sector municipal water and wastewater services, respectively. River basin or watershed bodies facilitate consultation of stakeholders; they are also active in outreach, awareness raising and education. The Association of River Basin Organizations of Quebec (ROBVQ), for instance, has structured its experience in engaging with stakeholders around five levels of engagement (see OECD, 2015a).

These platforms facilitate information sharing and co-ordination. However, they do not provide concrete incentives to align initiatives across levels of governments. International experience with multi-level governance contracts can inspire further co-ordination mechanisms for urban wastewater management in Canada (see Box 5.2).

Box 5.2. **Multi-level governance contracts in Brazil, Italy and the Netherlands**

OECD (2015b) has characterised arrangements to co-ordinate policies across ministries and public agencies: inter-governmental councils or special commissions, regional agencies, contracts and conditionalities.

The national pact for water management in Brazil

In 2011, the Brazilian National Water Agency designed the Water Management Pact to enhance integration between federal and state water resources systems, to foster convergence across states' performance and to reduce regional discrepancies in water governance. The pact, which all states adhered to, clearly defined federal and state targets. States were clustered into homogeneous categories according to their degree of water management complexity to better address specific needs in terms of legal, planning, information and operational instruments, human resources and governance. In addition, the pact included a financial incentive mechanism called Progestão to accelerate implementation. The mechanism allocated BRL 100 million (approximately CAD 40 million) for water management over five years, distributing funds equally to states that reach established goals. Rewards are based on progress in achieving targets rather than on specific outputs.

While it faces some challenges, the pact promotes consistency, integration and dialogue across levels of government, with capacity building and support to decentralised water policy. Goals set in the pact contribute to reducing asymmetries of information between federal and state institutions. The pact reflects the subsidiarity principle, which preserves the autonomy of states while engaging them towards shared responsibility to reach common goals.

Framework programme agreements in Italy

The *Accordi di Programma Quadro* (APQs) are frequently used as multi-level governance instruments for regional development policies in Italy, including natural resources and infrastructure areas. They rely on strong co-operation between sub-national governments, the Ministry of Economic Development and relevant central administrations. For each region and infrastructure sector (e.g. water), an APQ is signed when the projects and the necessary funding resources are identified. Beneficiaries and needs are identified based on

Box 5.2. **Multi-level governance contracts in Brazil, Italy and the Netherlands** *(cont.)*

regions' selection of priority sectors. AQPs pool multiple sources of financing (ordinary and additional public resources, EU funding and private resources) that are allocated by the Inter-ministerial Committee for Economic Planning. APQs include a programming section and an implementation section. The former lists interventions that are in accordance with the general objectives, but for which the required technical and financial conditions are not satisfied. For each intervention, APQs indicate needed tasks, as well as actors responsible for implementation, procedures, and monitoring and evaluation of outcomes. Implementation of APQs is monitored.

A successful example is the APQ signed between Apulia, Basilicata and the Ministry of Infrastructure and Transportation (in 1999) to address water shortage in Apulia. It committed the two regions to recover 20% of the resources by 2015 through water savings, planning and control of consumption, modernisation of irrigation systems, metering, monitoring of leakages and non-conventional resources. The first APQ came to an end in 2015 and a new one came into force for 2016-30.

Administrative agreement of water affairs in the Netherlands

The Administrative Agreement on Water Affairs (2011) was signed between the Ministry of Infrastructure, the Ministry of Environment and the main stakeholders in the Netherlands. These included the national water authority, the association of (12) provinces, the association of (408) municipalities, the association of (23) jurisdictional water authorities and the association of (10) drinking water companies. The agreement promoted important developments in the allocation of roles and responsibilities, as well as cross-sectoral planning integration between central and provincial authorities (water, environment and spatial planning). Savings of EUR 750 million annually by 2020 are expected across the water chain through reducing the control and supervision functions, learning and knowledge-sharing, clear agreements about the division of tasks and reallocation of roles and responsibilities when organisations can perform the same tasks better and cheaper.

The Dutch government contracts directly with cities as well. The Climate Adaptation City Deal was signed in 2016 between the Ministry of Infrastructure and the Environment, three jurisdictional water authorities, five cities and seven partners (research centres and companies). It aims to create a learning environment for climate adaptation at urban level for the next four years, fostering co-operation and complementarities across water and spatial planning (see Charbit and Romano, forthcoming).

Source: OECD (2015b) (Brazil); OECD (2014) (Netherlands), OECD (2007) (Italy), Venanzi and Gamper (2012).

Prevailing institutional arrangements may be challenged by evolutions of the workforce in Canadian municipalities. CWWA notes that demographic shifts in retirements compared with new entries to the workforce and changing career habits may affect the expertise and skills of people in charge of wastewater management. New skills are also required to deal with the increasing complexity of regulations and policies, as municipalities need to reconcile the management of assets, plans and risks that have historically been dealt with separately.

4. The policy framework

The large variation in the regulatory and policy frameworks across provinces has prompted the federal government to develop a Canada-wide strategy for municipal wastewater management. As part of the strategy, the government has also created a set of effluent regulations that would bring all wastewater treatment plants to secondary treatment. In line with the OECD Council Recommendation on water (OECD, 2016a), the federal government takes a risk-based approach. It mandates provinces to assess their own risk, set priorities and address high-risk areas. Work is underway to assess how provincial standards align with federal ones. Additional measures are needed to ensure that all water users contribute to policy objectives and that urban water management in all areas contributes to wider policy objectives of environmental health.

4.1. The Fisheries Act, a distinct perspective

The legislative and regulatory basis for federal wastewater effluent regulation is unique, as it derives from the Fisheries Act (1985). This act prohibits the deposit of deleterious substances into waters frequented by fish, unless authorised by regulations under the Fisheries Act or other federal legislation. Wastewater regulations are therefore based on a responsibility to not harm fisheries, rather than protecting human health or ecosystem health. This approach may lead to inefficiencies. For example, the Fisheries Act does not consider rainwater. This means the regulatory architecture managing rainwater is separated from the management of wastewater effluent, hampering a co-ordinated or integrated approach.

At the provincial level, regulatory provisions stem from other origins. In Quebec, for instance, wastewater management is regulated from an environmental perspective. Different origins of regulations translate into different levels of ambition or assessment of appropriate levels of water quality. Federal standards do not consider the dilution capacity of receiving water bodies: the same level of effluents may be safe for the environment in a water-abundant river or lake, but harmful where water is scarce. The ongoing revision of environmental licences in Quebec provides for local adjustment of standards: effluent levels account for the dilution capacity of the milieu. Differences in approaches explain the lack of consistency of federal and provincial regulations as regards wastewater management.

4.2. The Canada-wide Strategy for the Management of Municipal Wastewater Effluent

The Canada-wide Strategy for the Management of Municipal Wastewater Effluent was endorsed by the CCME in 2009. It aims to facilitate a harmonised approach to wastewater management across governments and provide regulatory certainty to municipal wastewater facility owners. The strategy requires that all municipal, community and government wastewater facilities achieve minimum national performance standards – minimal requirements for effluent quality, equivalent to secondary treatment of wastewater streams. The strategy further requires facilities to develop site-specific effluent discharge objectives to address specific substances that are of concern to a particular discharge or environment. The strategy foresaw that its requirements would be incorporated into federal, provincial and territorial regulatory frameworks. Three provinces/territories did not endorse the strategy: Newfoundland and Labrador, Quebec and Nunavut. Quebec, for example, helped draft the strategy and shares the objectives. However, it is concerned about financial implications and encroachment on provincial affairs. Municipalities have not been directly involved in the development of the strategy.

The Municipal Wastewater Effluent Coordinating Committee, established in 2009, is a forum to discuss long-term planning, co-operative work and issues related to the implantation of the strategy. The committee includes a representative from each jurisdiction, as well as an observer from the Table of Provincial/Territorial Deputy Ministers Responsible for Local Government.

4.3. National standards for wastewater treatment

Under the framework of the Canada-wide strategy, the federal government adopted Canada's first-ever national standards for wastewater treatment: the Wastewater Systems Effluent Regulations (WSER) in 2012. These regulations, established under the pollution prevention provisions of the Fisheries Act, set national baseline effluent quality standards on carbonaceous biochemical oxygen demand (CBOD), suspended solids, residual chlorine and un-ionised ammonia. These standards are achievable through secondary wastewater treatment. The WSER benefited from wide consultations with provinces, territories, municipalities, Indigenous communities and other interested parties.

The WSER include risk-based compliance timelines for those systems requiring upgrades to achieve secondary treatment. Deadlines to comply are quite generous for lower risk systems: some systems have until 31 December 2040 to meet effluent quality standards for CBOD and suspended solids. Such delays may, however, imply continued pressure on water quality in receiving water bodies. The regulations specify requirements for monitoring, record-keeping, reporting and toxicity testing. Regulatory reporting information from wastewater system owners and operators is housed in the Effluent Regulatory Reporting Information System (ERRIS), an electronic reporting system. Municipalities that do not comply are subject to penalties.

The WSER apply to owners and operators of wastewater systems that discharge effluent to fish-bearing waters and that collect an average annual daily volume of influent of 100 m^3 or greater (including municipal, private and federal wastewater systems). It also applies to systems owned or operated by Indigenous communities. Overall, some 2 560 of the 3 000+ wastewater treatment systems in Canada are subject to the WSER.

WSER do not apply to small systems under the 100 m^3 threshold. Nor do they apply to systems operating under extreme conditions, including in the Northwest Territories, Nunavut, or north of the 54th parallel in Quebec, Newfoundland and Labrador. Finally, they do not apply to wastewater systems that are located on the site of an industrial, commercial or institutional facility if the wastewater system is designed to collect influent whose volume consists of less than 50% blackwater and greywater combined. Deposits from wastewater systems not subject to the WSER may be regulated by provinces, or the federal government under the Fisheries Act. Quebec, for example, regulates systems above 10 m^3, anticipating shifts towards small-scale, decentralised systems.

Progress towards compliance has been slow. This mirrors the scale of the challenge and, possibly, the reliance of progress on access to federal funding. Hundreds of wastewater systems are thought to require upgrades to meet the requirements of the WSER. The cost of compliance is estimated at CAD 5.5 billion (in present value terms); ECCC estimates the monetary benefits of the regulation – essentially avoided health and environmental costs – at CAD 16.5 billion (in present value terms). The WSER have therefore triggered financing requests from municipalities. Recent increases in federal budgets for infrastructure development can accelerate progress (see Section 5).

Some progress has been made towards a harmonised framework. The WSER have strengthened the policy framework, yet the adoption of the standard has been slow in some jurisdictions. Further, the WSER have created some duplication and misalignments with existing provincial and territorial regulation. A 2014 progress report of the Canada-wide Strategy showed that initial risk assessments are well underway and commitments to phase out sewer overflows have been implemented (Table 5.3). However, review of how provincial

Table 5.3. **Implementation of the strategy for management of municipal wastewater effluent**

	Assessing initial risk level for non-complying facilities	Overflows due to development will not increase	Harmonised requirements are incorporated into regulatory frameworks	Bilateral agreements are completed
Alberta	Yes	Yes	Ongoing	Ongoing
British Columbia	partially	Yes	Ongoing	Ongoing
Manitoba	partially	Yes	Yes	Ongoing
New Brunswick	Yes (some issues)	Yes	Yes	Draft
Northwest Territories	na	Yes	na	na
Nova Scotia	Yes	Ongoing	Ongoing	Ongoing
Ontario	Yes	Yes	Yes	Ongoing
Prince Edward Island	Yes (full compliance)	Yes	Ongoing	Ongoing
Quebec[1]				Ongoing
Saskatchewan	Yes (some issues)	na	Ongoing	Draft
Yukon	Yes (full compliance)	na	Ongoing	Draft

1. Quebec has not signed onto the strategy, but adheres to its objectives.

regulations align with the new federal standard is time-consuming and progressing only slowly. This impacts the establishment of bilateral agreements between federal and sub-national jurisdictions. The possibility of "equivalency agreements" has provided an incentive for provinces to develop regulations that match federal ambitions, and thus can substitute for federal standards.[6] In addition, bilateral agreements can be reached to reduce administrative burden and set out procedures for co-operation between federal and provincial regulators. To date, agreements have been established with New Brunswick (2014), Yukon (2014) and Saskatchewan (2015). Discussions are ongoing with most interested provinces; an agreement with Quebec was drafted in 2015, but has yet to be finalised.

In addition to the strategy and new regulation, specific actions target selected lakes and rivers (e.g. Lake Winnipeg basin, Canadian Great Lakes, St. Lawrence River) in partnerships with provinces or with the United States. In 2005, Quebec, Ontario and the eight US Great Lakes states signed the Great Lakes–St. Lawrence River Basin Sustainable Water Resources Agreement. It has been an important regional and international initiative led by provinces.

4.5. *Urban wastewater in the context of adaptation to climate change*

The federal government supported the development of a guide for municipal climate adaptation, as well as a risk-based guide for local governments in 2010 to help local governments address climate change. In addition, Budget 2016 provides CAD 75 million to the FCM for municipally-led projects that support the assessment of local climate risks and the integration of these impacts into asset management plans[7], as well as to identify and implement greenhouse gas (GHG) reduction strategies (GoC, 2016). In so doing, Canada is well-aligned with most OECD member countries, where policy responses to adaptation to climate change are often limited to mapping risks and raising awareness. Much more could be done, in particular to finance investments in water security in the context of adaptation to a changing climate. The Pan-Canadian framework on Clean Growth and Climate Change (Chapter 3) also supports investment in climate-resilient infrastructure, which includes wastewater. Box 5.3 highlights selected international experience with promoting adaptation of storm and wastewater management to a changing climate.

Box 5.3. **Adapting storm and wastewater management to a changing climate**

Several OECD member countries are providing adaptation guidance to local governments, businesses and the general public. This has been a particular focus for countries taking a decentralised approach to adaptation.

In ***Denmark***, for example, all 98 municipalities were required to conduct a climate change adaptation plan before the end of 2013. This plan contains a risk-mapping of the entire surface area in each municipality for flood events from all water sources. Flood risk mappings from rain events, sewer systems, creeks, sea and groundwater will be merged with a value-distribution mapping to generate the local risk-map. The Danish government released the tools needed to conduct the mapping for the disposal of the municipalities in January 2013. In addition, a law passed in 2012 allows municipalities to ban construction in certain areas solely due to climate change adaptation reasons. As such, it provides municipalities with a legislative foundation for local city planning directly connected to climate change adaptation.

In ***Norway***, the Oslo Water and Wastewater Department developed the "Midgard Snake" project to address pressure on the water mains and increased risks of flooding and water damage resulting from increased urban development and increasing precipitation due to climate change. The Midgard Snake (finished in 2014) functions as an interruptive drainage system, preventing polluted water from reaching the Oslo Fjord. The tunnel (with a capacity of 50 000 m^3) is both a transport route and a retention reservoir, storing water if the purifying plant lacks capacity. The project is designed to improve water quality in the fjord, address climate change impacts and reduce energy consumption (because the water is not being transported as far as it was previously).

The Climate Ready Water Utilities Initiative in the **United States** was developed by the US Environmental Protection Agency to assist water and utilities in becoming "climate ready". It supports implementation of plans and adaptation strategies at water and wastewater utilities that account for potential climate change impacts and build water sector resilience. In **New Zealand**, the government provides technical manuals, summary publications and guidance to inform local governments, businesses and individuals. Japan, Spain, Sweden and the United Kingdom take a similar approach.

Source: OECD (2013). Country profiles are available at *www.oecd.org/environment/resources/water-and-climate-change-adaptation-9789264200449-en.htm*

5. Financing investment in urban wastewater management

Urban wastewater management needs substantial and long-term financing to upgrade existing systems and adapt to forthcoming challenges. To date, prevailing sources of finance have relied heavily on federal and provincial programmes. A stronger reliance on predictable sources of finance such as tariffs for wastewater collection and treatment, and secured funding for storm water management, would put the sector on a more robust financial path. Economic instruments can also minimise investment needs in the future by promoting water-wise behaviour from water users, water utilities, property developers and city planners.

5.1. *Investment is needed to renew ageing infrastructure and adjust to new regulation*

Infrastructure for urban water management in Canada is publicly owned. Storm and wastewater management infrastructure represents the second largest category of capital investment in Canada (NRCan, 2008). In 2012, the Canadian Infrastructure Report Card estimated the current value of Canadian water assets to be CAD 362 billion. Municipalities account for more than 80% of capital spending in environment and water systems. As of 2000, water and wastewater systems made up approximately 30% of Canada's municipal infrastructure stock (Mirza, 2007).

The state of wastewater and rainwater collection and treatment infrastructure has improved significantly compared to the mid-1990s. At that time, two-thirds of sanitary and combined sewers and a majority of sewerage treatment plants and storm sewers were not operating at an acceptable level (Mirza and Haider, 2003). Twenty years later, the situation has improved, but remains fragile. On the one hand, the 2016 Canadian Infrastructure Report Card estimates that two-thirds of Canada's urban wastewater infrastructure is in very good (39%) or good (26%) physical condition. The remainder is estimated to be in fair (24%), poor (8%) or very poor (3%) condition, and requires upgrade and replacement. On the other hand, estimated annual reinvestment levels range from 0.7% to 1.4% of current assets. At such rates, it would take between 71 and 140 years to renew existing assets. This far exceeds the life expectancy of many pipes and appliances and will result in wastewater assets decaying over time (CIRC, 2016).

ECCC estimates that compliance with the WSER will cost CAD 5.5 billion. Operators in Quebec, British Columbia and Atlantic Canada are expected to shoulder the largest share. This figure does not include investments to accommodate population growth, adapt to climate change or improve service. The five largest infrastructure projects underway or in planning represent over CAD 2 billion in investment in wastewater management upgrades (CIRC, 2012). In Quebec alone, the cost for addressing sewer overflow and treating effluents is projected to be CAD 9.5 billion over the next 30 years (CAD 6.2 billion for the former, and CAD 3.2 billion for the latter) (Gouvernement du Québec, 2013).

5.2. Local funding: Tariffs and fees for water services

Most provinces levy licence fees to major water users to access the resource. However, these fees are not set in accordance with any pricing principles, but rather derive from the cost of administering the licensing programme. As such, they cannot promote efficient water use.

The use of pricing instruments for urban wastewater management – notably tariffs for wastewater services – is widespread. All municipalities levy charges to water users, with an increasing number applying volumetric charges. This has helped reduce residential water consumption, which nonetheless remains one of the highest in the OECD (see Chapter 1). A large heterogeneity in tariffs exists for water services across provinces and territories. A 2009 survey on municipal water pricing indicates that (ECCC, 2011b):

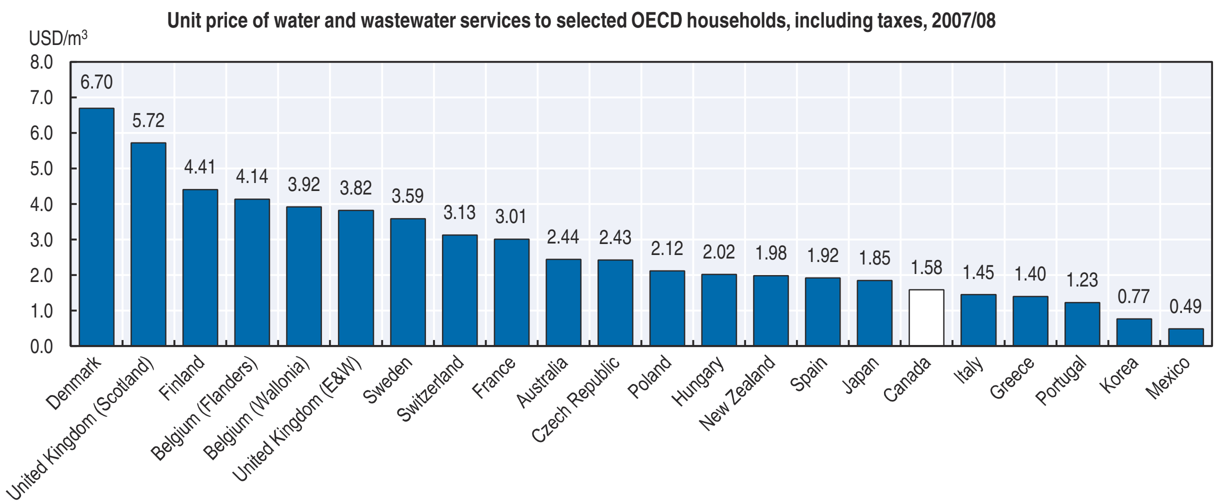
- Residential metering increased from 63% to 72% over 2006-09.
- An estimated 80% of residential clients pay for water through volumetric rates (up from some 55% in 1991). But there are large variations across provinces: for example, in Newfoundland and Labrador, most residents pay a flat charge (Renzettti and Dupont, 2017).
- The most common volumetric rate is a constant unit charge. The use of increasing block tariff (where unit cost increases by tranche) has decreased since 2004, essentially as Toronto shifted from a block tariff to constant unit charge.
- Average residential volumetric rates for water and sewer increase with levels of consumption. A three-person household consuming 25 m^3/month would pay about CAD 53 in 2009 (up 24% since 2006). Average monthly bills range from CAD 22 in Quebec to nearly

CAD 75 in New Brunswick. The result for New Brunswick reflects higher level of per capita consumption.

- As in most OECD member countries, sewer charges represent approximately half of the total charge for water and sewer services. Their share is higher in larger municipalities. This may reflect the higher cost for more advanced treatment in larger municipalities.

The level of tariffs for wastewater services is too low to generate the revenues needed to cover the cost of urban wastewater management, or to provide incentives to minimise future infrastructure needs. Canadian municipalities are far from recovering the full cost of the service and the full environmental cost through prices (ECCC, 2011b). Affordability is not the main obstacle to robust pricing strategies, as Canada ranks at the low end of water rates in OECD member countries (Figure 5.5). With the exception of Ontario, Canadian provinces lack regulation to promote recovery of costs for municipal water supply and sanitation services through tariffs (Renzetti and Dupont, 2017).

Figure 5.5. **Canada ranks at the low end of water rates among OECD member countries**



Note: OECD estimates based on country repllies to the 2007-08 survey or public sources validated by the countries; see OECD (2010), "*Pricing Water Resources and Water and Sanitation Services.*

StatLink http://dx.doi.org/10.1787/888933566039

In June 2015, CCME identified a set of options to guide a jurisdiction if it chooses to develop a water pricing framework. Governments can use these water pricing principles to develop or improve their policies in light of their particular circumstances and objectives. The options are listed under two themes: Influencing the Behaviour of Water Users and Generating Public Revenue.

Asset management plans are increasingly popular among Canadian municipalities, and have increased knowledge of infrastructure needs and costs. This has led to growing use of mechanisms that allow municipalities to allocate revenues to cover associated costs of services more fairly and accurately. Several municipalities have set up specific instruments to finance storm water collection and treatment. These include specific user fees levied on property owners based on the amount of rainwater run-off generated by their property (or on the surface of the property). Such fees can discourage constructions that increase run-off, while securing revenues for municipalities to build and operate storm water management systems. In combination with green infrastructure, they provide a cost-efficient option to manage rainwater in a resilient way. The growing use of storm water user fees partly results from the diffusion of asset management plans among Canadian municipalities.

The increase of wastewater tariffs to cost-recovery level and the diffusion of storm water management fees can remedy the decline of revenues of water utilities in Canada, which occurred along with the decline in domestic water consumption. They are part of a menu of options to secure revenues for water services, decoupled from the volume of water sold (OECD, 2015c).

5.3. *Federal and provincial investment*

As the level of cost recovery through tariffs is low, governments (co-)finance a significant part of operation and maintenance costs of water infrastructure, as well as investment in water infrastructure renewal or expansion. Such high reliance on federal or provincial funding could generate risks of underfunding if public finance becomes scarce and contested. In addition, it provides no incentive to local governments to harness additional sources of finance (e.g. through tariffs) and to manage assets properly.

Public funds for urban wastewater management

Several federal programmes channel public funds to investment in urban water management. Such fragmentation, however, encourages an opportunistic approach from provinces and municipalities. It does not guarantee the most efficient contribution of public budgets to national priorities. Some of these programmes are described below.

The Gas Tax Fund (GTF) provides CAD 2 billion annually in funding for Canadian municipalities to build and revise local public infrastructure, including for water and wastewater. Funding is provided up-front to provinces and territories, which forward it to municipalities to pool, bank and borrow against. As of March 2016, CAD 2.5 billion had been spent towards wastewater infrastructure projects, about 15% of total investment under the GTF. Wastewater infrastructure is also eligible under several of Infrastructure Canada's programmes. Since 2002, it has provided almost CAD 3.3 billion for wastewater infrastructure projects across the country. The Great Lakes Sustainability Fund provides technical and financial support (up to one-third of the total cost of projects) to complete the clean-up and restoration of locally degraded areas, including support to innovative approaches to improve municipal wastewater effluent quality.

Through Budget 2016, the federal government began providing CAD 5 billion over five years for investments in water, wastewater and green infrastructures. This includes the creation of a new CAD 2 billion Clean Water and Wastewater Fund for provinces, territories and municipalities to spend on immediate improvements. The Lions Gate Wastewater Treatment Plant, for example, received CAD 212 million to upgrade secondary treatment standards and make them more climate-resilient. In addition, Budget 2016 provides CAD 3.4 billion over five years for social infrastructure, including water efficiency of social housing. These levels of funding signal an effort to accelerate the improvement of wastewater collection and treatment, after the adoption of the WSER.

The Green Municipal Fund (CAD 550 million) provides loans and grants through the FCM to finance upfront costs of municipal projects, including urban water management. It also provides knowledge services. Typical expenditures cover feasibility studies, pilot or small-scale developments. In 2016, the federal government added CAD 125 million to the fund. According to the fund's database, 150 wastewater and storm water projects have been completed or are ongoing since 2000. This includes 68 feasibility studies.

Provinces also develop investment support programmes that benefit wastewater treatment, often in conjunction with the federal budget. Under Alberta's Specified Gas Emitter Regulation, for example, wastewater treatment plants can apply for carbon offset credits using the Quantification Protocol for Anaerobic Treatment of Wastewater Projects. The Canada-Quebec agreement on the fund for water supply and wastewater treatment (FEPTEU, in French) allocates CAD 364 million of federal funding; Quebec is expected to contribute CAD 300 million. The fund supports projects listed in the provincial infrastructure plan for 2016-26.

Ensure high returns on public money

The benefit of public expenditure depends on how investment projects are selected and how opportunities to harness other sources of finance have been explored. OECD (2016b) highlights four inter-connected sets of actions that can increase the scale and effectiveness of investment in water security:

1. Maximise the value of existing assets for water security investments. The operational efficiency and effectiveness of existing infrastructure and service providers postpone investment needs and are a requisite to further investment. It is not clear how public financing schemes in Canada ensure that new projects have been assessed against the potential benefits of improved operation and maintenance. Nor is it clear how they factor in the capacity to adequately operate and maintain new developments.
2. Select investment pathways that maximise the performance of urban wastewater management returns over time. This requires performing rigorous triple bottom line analysis on sequences of projects and carefully considering how pursuing a specific project may foreclose future options. Such analysis is best performed at watershed level. CWWA reports that this may not happen in Canada; available funding is not always apportioned by asset classes and prioritised by impacts and risks. Some municipalities address highly visible projects such as transit and may not focus enough on wastewater infrastructure.
3. Ensure synergies with investments in other sectors. In particular, investment in urban wastewater management needs to be harmonised with urban development, land use and related policies at watershed level. In that perspective, regional land-use planning in Alberta is an interesting approach that could inspire other provinces. The province's regional plans use environmental management frameworks to manage the cumulative effects of development. These, in turn, manage air, water and biodiversity to established thresholds and help build relationships with Indigenous peoples.
4. Scale-up financing through improved risk-return frameworks. Governments can help by enabling public and private actors (including water users) to earn returns commensurate to the risks they take. There is little evidence of attempts to attract private finance in Canada (be it revenues from water tariffs, or contributions from property developers). Anecdotal indication suggests that municipalities only consider action when federal and provincial funds are secured. There is a risk that such a financing strategy crowds out other sources of finance.

Some stakeholders reported limitations of the prevailing use of public money for urban wastewater management in Canada under current disbursement procedures for

Infrastructure Canada's funds. In Quebec, for example, the Ministry of Environment reviews plans and budgets submitted by municipalities, but the Ministry of Municipal Affairs (MAMOT) provides access to federal financial support. While the two ministries collaborate on accessing Infrastructure Canada funding, ECCC is not directly consulted on project selection (neither are regional watershed organisations). Projects selected by MAMOT therefore do not necessarily reflect the Ministry of Environment's priorities. MAMOT has set priorities; water supply and sanitation comes first: a municipality can only access financial assistance for projects in other domains (e.g. transportation) when water supply and sanitation objectives are met. These rules allow ranking priorities for each municipality, but not across municipalities, which would allow for channelling resources to where they would yield the largest environmental benefits. Municipalities have access to funds on a first come, first served basis. The process does not necessarily rewards projects with best value for money or those that accrue the most to the community. These deficiencies create a risk that selected projects may not align with federal priorities and may not fit into a co-ordinated approach at watershed level.

6. A role for innovation

Business-as-usual solutions have limited capacities to deliver reliable wastewater treatment under conditions of a changing climate in Canada. In response, some provinces and cities are exploring more innovative options. For instance, Alberta is drafting a Reuse and Storm Water Use Policy, expected to be completed by Fall 2017. However, the diffusion of innovative options seems limited. The 2011 Municipal Water Pricing Report indicates that less than 20% of the Canadian population lives in municipalities that reuse waste- or storm water (ECCC, 2011b).

Jurisdictions in charge of urban wastewater management would benefit from systematically exploring approaches that combine technical and non-technical innovations, from apartment to municipal scale and beyond, for storm and wastewater management. In relevant contexts, and when properly managed, these approaches can achieve high performance and adapt to a changing climate at least cost for the community. Such innovations can scale up to needs, minimise investment needs and avoid technical path dependency.

Localised, on-site systems, for example, can collect, treat and reuse wastewater at plot level, for both individual or small groups of properties. They require less up-front investment than larger, centrally piped infrastructures and are more effective at coping with the need to expand services (USEPA, 2002). They can also recover nutrients and energy (Matsui et al., 2001). Another option is the growing use of "source control" technologies that handle storm water near the point of generation. For instance, green roofs or pervious surfaces capture rainwater before it runs on polluted pavements and streets. Localised rainwater collection can be combined with grey water recycling, and even recycling of sewage water at source.

Innovation need not be high-tech. Proven technologies can change the way urban water is managed in cities, potentially contributing to higher levels of security, at least cost for society. They operate best when combined with non-technical innovation related to business models or design. Water-sensitive urban design, for example, considers how to enhance water security and access to water services at minimal cost for the community, including financial, social and environmental costs. Sustainable urban drainage systems (SUDS), for example, disconnect storm-water drainage from the sewer system and use the green infrastructure of the urban landscape to store, filter and evaporate the storm water within the local catchment area (Mguni et al., 2015). In practice, SUDS supplement existing sewer system capacity, address flood risks and increase resilience in the face of climate change. This approach is gaining traction in selected municipalities in Canada.

Table 5.4. **Green infrastructure solutions for water resources management**

	WSS[1]	Water quality regulation			Moderation of floods			Protection of ecosystems
		Water purification	*Biological control*	*Water temperature control*	*Riverine flood control*	*Urban storm-water runoff*	*Coastal flood (storm) control*	
Green infrastructure solution								
Demand management	x							x
Local processing of black or grey water	x	x	x					
Wetlands restoration/ conservation	x	x	x	x	x			x
Constructing wetlands	x	x	x	x	x			x
Water harvesting	x					x		
Green spaces	x	x		x		x		x
Permeable pavements	x	x				x		x
Green roofs						x		x
Protecting/restoring mangroves, coastal marshes, dunes, reefs							X	x
Corresponding grey infrastructure (primary service level)								
Dams, groundwater pumping	x			x				
Dams, levees				x	x			
Water distribution systems	x							
Water treatment plant		x	x					
Urban storm water infrastructure						x		
Sea walls							X	

1. WSS = Water supply and sanitation. Includes drought.
Source: adapted from UNEP (2014), OECD (2013b).

In Canada, Ontario and Alberta are paving the way. Alberta is developing regulations, technical standards and guidelines to facilitate the safe use of reclaimed wastewater, in particular for fracking. It is thus creating a market (and a demand) for reclaimed water. Ontario supports demonstration projects to prove concepts and innovative technologies (Box 5.4). Other instruments include financial incentives for water users or property developers, and regulation through building and construction codes that mandate rainwater collection and minimising run-off at lot level.

Innovative solutions face a number of barriers. For example, even though the WSER do not prescribe specific technologies, federal funding schemes implicitly favour centrally piped infrastructure; these are accessible to municipalities. It is more difficult to finance a myriad of small-scale initiatives, under the remit of individual water users or property developers, such as green roofs to minimise run-off, or rainwater harvesting. Such barriers must be overcome to allow more innovative options to be systematically adopted. The case study of San Francisco illustrates how decentralised water management best materialises when combined with a series of adjustments (see Box 5.5).

OECD cities that have overcome barriers to the dissemination of alternative urban wastewater management have usually combined several initiatives:

- A long-term vision of water challenges and opportunities for urban development, combining policies beyond urban wastewater management. For instance, in Germany, municipalities

Box 5.4. **Stimulating innovative storm water management in Ontario**

The traditional approach to storm water management in Ontario is an efficient underground storm sewer network to convey urban run-off as quickly as possible to a nearby water body. In older parts of some cities such as Toronto's downtown core, storm water is conveyed with raw sewage in a combined sewer network to a wastewater treatment plant. The increase in impervious surfaces, combined with traditional storm water management, has significantly altered the movement of water in urban areas. The changes in the total volume, frequency and duration of rain events and the peak flow rate of storm water have increased erosion of river banks, as well as the potential for floods.

In response, Ontario's approach to storm water management now focuses on flood control: it addresses run-off volume, peak flow and quality, and factors such as temperature control, infiltration, water budget and fish habitat. Some practices also address run-off duration and frequency, considering Ontario's seasonal challenges such as spring snowmelt. The use of a "treatment train approach", which incorporates source (e.g. disconnected downspouts, rain barrels, rain gardens), conveyance (e.g. swales, exfiltration systems) and end of pipe control (ponds, engineered wetlands) to manage storm water, is encouraged. Sixteen storm water projects in Ontario received funding under the Showcasing Water Innovation programme to stimulate innovative research, and ultimately to help municipalities manage storm water better. For example, Lake Simcoe Region Conservation Authority was awarded a grant to retrofit existing storm-water ponds to include quality control. This will yield important information to other municipalities, as storm-water ponds are extensively used throughout Ontario.

The city of Toronto encourages green infrastructure through several instruments, including a green roof by-law, an eco-roof incentive programme, a green standard for sustainable site and building design, a Wet Weather Flow Master Plan and a downspout disconnection programme.

Source: WaterTAP (2013).

Box 5.5. **Decentralised water management in San Francisco**

As with many other US cities, San Francisco also faces dwindling water supplies, long-lasting droughts and extreme weather events. Most of its options for new water supplies and control strategies tend to be controversial and expensive, urging the city to evaluate new ways to collect, treat and reuse local water resources. The San Francisco Public Utilities Commission (SFPUC) is therefore embracing decentralised water treatment systems to provide supplemental water and wastewater services.

It launched the Non-potable Water Program, a local programme for regulating on-site water use (there are no national standards for on-site systems using alternate water sources such as rainwater, storm water, grey water and black water in the United States). The programme creates a streamlined process for new developments to collect, treat and reuse alternate water sources for toilet flushing, irrigation and other non-potable uses. Additionally, the programme establishes guidelines for developers interested in installing non-potable water systems in buildings and local regulations to ensure appropriate water quality standards.

Subsequently, the SFPUC realigned governmental policies and created a new regulatory framework. It collaborated with the city's Departments of Building Inspection and Public Health to develop a permitting, review and approval process for on-site system installation

Box 5.5. **Decentralised water management in San Francisco** *(cont.)*

and operation. SFPUC served as: a) programme administration (providing outreach, technical and financial assistance); b) cross connection control (protecting the public water supply, including backflow prevention, testing, certification and tracking); and c) a water use calculator to help developers estimate the volume of the on-site non-potable supplies and demand available for their project.

The Non-potable Water Program allowed for micro-markets to emerge when two or more buildings share, buy or sell water without the public agency providing the service. The programme shifts the burden of operation, maintenance and water quality compliance to the private sector. At the same time, the public sector maintains oversight to ensure the protection of public health and the public water system. The move towards smaller on-site water systems holds great promise for reducing fresh water demands, aiming to building a more resilient and sustainable city.

Source: OECD (2015c).

combine responsibilities for spatial planning and development control for the provision of water services, including surface water drainage.

- Economic instruments and business models for water utilities and land development that factor in externalities related to water security. Well-designed tariffs can reflect some of the benefits of enhanced water security and improved water services.
- Governance structures that favour a whole-of-government approach to urban water management and reach beyond city limits. Canadian metropolitan areas provide opportunities to manage water at the appropriate scales.
- Information campaigns to raise city dwellers' awareness of water-related risks and the costs of liabilities that result from short-term visions.

In Canada, federal and provincial governments would benefit from joining forces in encouraging municipalities to systematically explore alternative ways to manage water, including urban wastewater. They could:

- Ensure that regulation and financing schemes do not prescribe any technology, or contribute to technological path dependency.
- Use regulation to encourage exploration of innovative (technical and non-technical) approaches. Land use, urban policies are particularly appropriate. Reflecting the full cost of water, including the opportunity cost of using freshwater, would create demand for reclaimed water. Clear quality standards for secondary uses of reclaimed water would eliminate regulatory uncertainty.
- Build confidence in green infrastructure. The government of Quebec proposes that green infrastructures benefit from the Environmental Technology Verification programme (ETV), just as grey ones have.
- Share information and award innovative cities. The federal government, together with partners such as the Canadian Water and Wastewater Association, developed and distributed materials to support education and encourage consumers to adopt sustainable water use practices. Such material could include reference to product stewardship. This would enable users to understand the costs associated with the release of harmful substances into domestic water flows. Additional action could be targeted towards the engineering community to promote green infrastructures.

Infrastructure finance can play an important part in the process. It can select projects that contribute to urban water security and adapt to a changing climate at the least cost. Infrastructure finance can contribute to water-sensitive urban design, attaching financial support to long-term, horizontal development plans that factor in climate change.

Recommendations on urban wastewater management

- Complete monitoring of the performance of wastewater management, and impacts on water quality, in places where information is lacking; improve consistency of monitoring frameworks across the country with a view to better identify hotspots and rank priorities.
- Invest in research to better understand the treatment efficacy of alternative technologies (including natural systems and wetlands), as well as the impact of effluent releases on wetlands' ecosystem health, under both normal and extreme climatic conditions. Build on that research to explore the possibility of expanding the coverage of the Wastewater Systems Effluent Regulations (WSER), across Canada, including northern territories.
- Expedite discussions on bilateral agreements between the federal government and provinces for the WSER as one possible way to trigger policy responses and adjust regulatory frameworks at provincial and territorial level; systematically explore opportunities to streamline and speed up negotiations.
- Ensure that conditions attached to provincial and federal infrastructure funds for urban wastewater management bring about the best value for money by incentivising municipalities to: i) make the best use of existing assets; ii) develop investment pathways that maximise water security returns over time; iii) ensure synergies and complementarities with investments in other sectors, especially urban development, land use, rainwater management or energy; and iv) scale-up their own financing capacities, for instance by harnessing water users (with tariffs for wastewater and rainwater services) or property developers (with taxes that capture some of the rent accrued from improved water security).
- Increase tariffs for water and/or wastewater services to at least recover the operation and maintenance cost of wastewater collection and treatment.
- Systematically reflect the impacts of climate change on water availability and demand in all urban water management plans, infrastructure design and investment programmes across levels of government. Risks of heavy rains and urban floods deserve particular attention.
- Encourage innovative approaches to urban water management, by ensuring that financial support and regulation are not technology-prescriptive and can actively contribute to the diffusion of innovative and green infrastructure solutions, as appropriate; use federal funding to encourage cities to explore water-wise urban development (such as green roofs or permeable pavements) as potentially cost-effective, climate-resilient responses to heavier storms triggered by a changing climate.
- Further study risks associated with emerging pollutants, and explore cost-effective policy responses, including by raising public awareness on their effect on wastewater streams, with a view to avoid dumping. Other options build on new developments in monitoring techniques, such as effect-based monitoring.

Notes

1. The authors of the survey note that, because of sampling biases, this figure may be an underestimate. They also note that comparison with previous surveys is inappropriate because of changes in methods.
2. Secondary treatment removes over 95% of the total mass of conventional pollutants in wastewater (i.e. carbonaceous biochemical oxygen demand, suspended solids and nutrients). Significant amounts of non-conventional pollutants and bacteria that are present may also be removed through such treatment. Secondary treatment suffices to meet standards for wastewater effluents.
3. See *http://ottawa.ca/en/city-hall/planning-and-development/construction-and-infrastructure-projects/sewers-water-and/under-2* for more information.
4. The Ministry of Infrastructure and Communities develops a ten-year plan to deliver significant new funding to provinces, territories and municipalities. The plan focuses on green infrastructure (including investments in local water and wastewater facilities), clean energy, climate-resilient infrastructure like flood mitigation systems, and infrastructure to protect against changing weather.
5. Budget 2016 proposes to provide up to CAD 19.5 million over five years, starting in 2016-17, to facilitate Canada's portion of funding regarding the response to several studies on bilateral water issues.
6. Under the federal Fisheries Act, the federal government can agree *not* to apply its regulations in a province or territory, if it agrees that provincial regulations in that province provide "equivalent" protection.
7. CWWA projects that within ten years, every municipality in Canada will likely have an asset management plan in place. Some provinces, such as Ontario, already require all their municipalities to have one.

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ANNEX 5.A

Canadian and EU water framework directive guidelines for water quality

The European Water Framework Directive (WFD) sets an objective of good ecological status of water bodies. This compares with the Canadian definition of water quality guidelines for the protection of aquatic life.[1] Some comments apply before the two standards can be compared.

Water quality essentially is a provincial jurisdiction in Canada: provinces have their own regulations and standards. To measure water quality, the federal government uses the Canadian Water Quality Guidelines (CWQGs) for the protection of aquatic life. The CWQGs provide science-based goals for the quality of aquatic habitats. Water quality is good when water quality measurements never or rarely exceed water quality guidelines and, when they do, it is usually by a narrow margin. Poor water quality is found when water quality measurements usually exceed water quality guidelines or exceed the guidelines by a considerable margin.

The European regulation endeavours to measure biological quality. It considers physicochemical and hydromorphological elements and takes undisturbed conditions as a reference. The Canadian standards measure whether physical and chemical characteristics of freshwaters are acceptable for aquatic life. Generic CWQGs figures set at national level may not capture local variation in water quality due to geography.

Another difference is that the European classification considers that if a water body does not meet one parameter, it fails ("One out, All out"). The Canadian policy considers the percentage of cases of non-compliance. It is usually considered that the "One out, All out" rule leads to an underestimation of the good ecological status in Europe. CWQGs tends to underestimate problems in some areas and overestimate problems in others. Table 5.5 compares the two standards.

Note

1. The characterisation of Canadian standards in this section owes to Martha Guy, ECCC (personal communication), who is gratefully acknowledged.

Comparison of Canadian and EU Water Framework Directive guidelines for water quality

	WFD ECOLOGICAL STATUS CLASSES Normative definitions (Annex V)		CANADA ATTRIBUTE STATES Attribute tables – narrative attribute states
High	The values for the biological quality elements reflect those normally associated with undisturbed conditions for that type and show no, or only very minor, evidence of distortion. There must be no, or only very minor, alterations to the values of the physicochemical (and hydromorphological) elements from those normally associated with undisturbed conditions for the type. Example – lake algae/plants and nutrients The taxonomic composition and abundance of phytoplankton, macrophytes and phytobenthos correspond totally or nearly totally to undisturbed conditions. The average phytoplankton biomass is consistent with the type-specific physicochemical conditions and is not as such to significantly alter the type-specific transparency conditions. There are no detectable changes in the average macrophytic and the average phytobenthic abundance. Planktonic blooms occur at a frequency and intensity consistent with the type-specific physicochemical conditions. Nutrient concentrations remain within the range normally associated with undisturbed conditions.	Excellent	Water quality measurements never or very rarely exceed water quality guidelines.
Good	There are low levels of distortion to the biological elements due to human activity, but the values must deviate only slightly from those associated with undisturbed conditions. The physicochemical conditions must support the biological values and ecosystem functioning. Example – lake algae/plants and nutrients There are slight changes in the composition and abundance of planktonic, macrophytic and phytobenthic taxa compared to the type-specific communities. Such changes do not indicate any accelerated growth of algae resulting in undesirable disturbance to the balance of organisms present in the water body or to the physicochemical quality of the water or sediment. A slight increase in the frequency and intensity of the type specific planktonic blooms may occur. The phytobenthic community is not adversely affected by bacterial tufts and coats present due to anthropogenic activity. Nutrient concentrations do not exceed the levels established so as to ensure the functioning of the ecosystem and the achievement of the values specified above for the biological quality elements. **WFD default objective is Good/Moderate boundary. A less stringent objective – the highest achievable – can be set based on disproportionate cost or technical infeasibility**.	Good	Water quality measurements rarely exceed water quality guidelines and, if they do, it is usually by a narrow margin.
Moderate	There are moderate levels of distortion to the biological elements due to human activity, and the values deviate moderately from those associated with undisturbed conditions. The physicochemical conditions are consistent with the biological values. Example – lake algae/plants and nutrients The composition and abundance of planktonic taxa differ moderately from the type-specific communities. Phytoplankton biomass is moderately disturbed and may be such as to produce a significant undesirable disturbance in the condition of other biological quality elements and the physicochemical quality of the water or sediment. A moderate increase in the frequency and intensity of planktonic blooms may occur. Persistent blooms may occur during summer months. The composition of macrophytic and phytobenthic taxa differ moderately from the type-specific communities and are significantly more distorted than those observed at good quality. Moderate changes in the average macrophytic and the average phytobenthic abundance are evident. The phytobenthic community may be interfered with, and, in some areas, displaced by bacterial tufts and coats present as a result of anthropogenic activities. Nutrient conditions consistent with the achievement of the values specified above for the biological quality elements.	Fair	Water quality measurements sometimes exceed water quality guidelines and may do so by a wide margin.
Poor	Waters showing evidence of major alterations to the values of the biological quality elements for the surface water body type and in which the relevant biological communities deviate substantially from those normally associated with the surface water body type under undisturbed conditions, shall be classified as poor.	Marginal	Water quality measurements often exceed water quality guidelines and/or exceed the guidelines by a considerable margin.
Bad	Waters showing evidence of severe alterations to the values of the biological quality elements for the surface water body type and in which large portions of the relevant biological communities normally associated with the surface water body type under undisturbed conditions are absent, shall be classified as bad.	Poor	Water quality measurements usually exceed water quality guidelines and/or exceed the guidelines by a considerable margin.