OFFICE OF THE
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CANADA

# Budget Sufficiency for First Nations Water and Wastewater Infrastructure

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The Parliamentary Budget Officer (PBO) supports Parliament by providing analysis, including analysis of macro-economic and fiscal policy, for the purposes of raising the quality of parliamentary debate and promoting greater budget transparency and accountability.

This report responds to a request by Mr. Charlie Angus, the member for Timmins-James Bay, to estimate the costs of upgrading water and wastewater infrastructure on First Nations reserves, in order to eliminate long-term boil water advisories, and to compare these estimates with the funding announced in Budget 2016.

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# Executive Summary

In Canada, water and waste water (W&WW) is largely a provincial domain. However, the responsibility for First Nations communities living on reserve falls squarely with the Crown, specifically the Minister of Indigenous and Northern Affairs (INAC). The Government's 2015 Speech from the Throne promised a renewal of the relationship between Canada and Indigenous peoples[1] and the Government's first budget proposed an end to long-term boil water advisories on reserves within five years by investing an additional $1.8 billion over five years, starting in 2016-17[2].

Importantly, this federal commitment only relates to those systems financially supported by INAC. While INAC financially supports most systems on reserve, it does not support all systems. As such, even if the federal commitment is fulfilled, there may remain inadequate infrastructure.

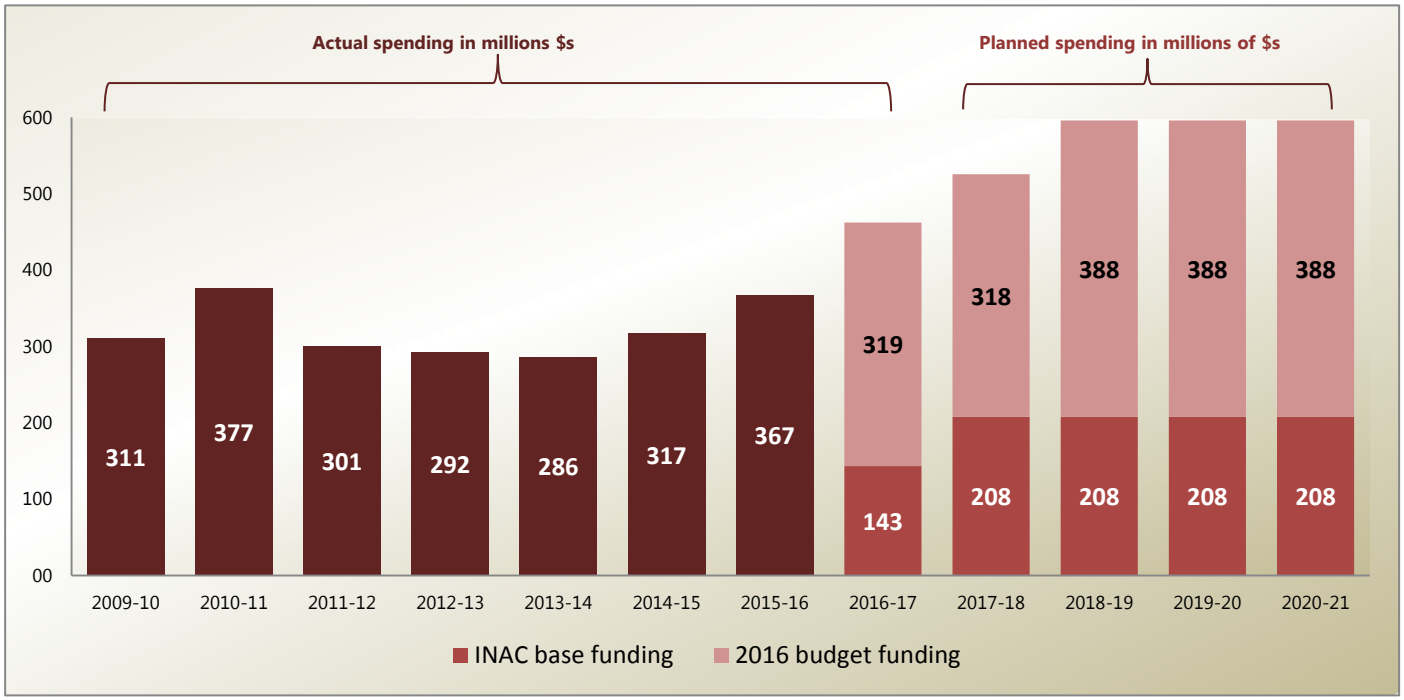
This report analyzes federal spending on W&WW treatment on First Nations reserves. Using data collected from the W&WW National Assessment undertaken in 2011[3], along with other socio-economic, demographic and W&WW system data, PBO has estimated the costs of upgrading water and wastewater systems (referred to as "investment needs") on First Nation reserves. The report also examines the evolution of expenditures over the past decade and where possible, explains how INAC allocates funds.

### Box 1: Water and wastewater systems on First Nations Reserves 2010-11

- 484,000 indigenous people living in 112,800 houses, across 571 First Nations.
- 807 drinking water systems serving 560 First Nations. The remaining 11 First Nations were serviced solely by individual water supplies.
- 532 wastewater systems serving 418 First Nations. The remaining 153 First Nations were serviced solely by individual septic systems.
- 314 (39%) of the drinking water systems were categorized as high risk and 278 (34%) were categorized as medium risk.
- 72 (14%) of 532 inspected sewer systems were categorized as high overall risk, 272 (51%) as medium overall risk, and 188 (35%) as low overall risk.

The nominal value of INAC spending on the W&WW systems on reserves was $2.25 billion from 2009 to 2016, an average annual amount of $322 million.[4] Figure 1 shows the actual and planned spending from 2009 to 2020.[5]

## Summary Figure 1: Actual and planned INAC spending on W&WW systems on reserves




Sources: Treasury Board of Canada Secretariat, INAC Administrative Data, Department of Finance, Budget 2016, PBO Calculations. All figures in millions of dollars.

PBO has identified other potential funding sources, in addition to the INAC budget. These include transfers from provincial and territorial governments and revenues (taxes on production, products and imports) of Aboriginal governments. PBO estimates this funding to be $66 million, on average, per year.

PBO has constructed a range of estimates of the cost of improving W&WW systems on First Nations reserves to the point where residents can enjoy drinking water and wastewater services comparable to non-First Nations communities of comparable size, and which would eliminate long-term boil water advisories by 2020.

### Box 2: Boil water advisories (BWAs) on First Nations Reserves

- The David Suzuki Foundation and the Council of Canadians (2017) found that 151 drinking water advisories were in effect in First Nations across Canada in the last half of 2016.
- Health Canada indicates that there were 100 long-term drinking water advisories and 47 short-term DWAs in 102 First Nations communities south of the 60th parallel as of October 31, 2017.
- INAC indicates that there were 69 long-term drinking water advisories remaining in effect on public systems financially supported by it as of September 30, 2017.
- The divergence between the Health Canada and INAC data could be mainly explained by the difference in the measure used to classify the drinking water systems under DWAs.

Using data from the Neegan Burnside (NB) reports, PBO estimates the minimum capital investment required to meet actual W&WW objectives until 2020 at $3.2 billion, with drinking water systems accounting for 57% ($1.8 billion) and wastewater systems accounting for the rest ($1.4 billion).

The total needed capital investment is broken down as follows:

$1.2 billion to upgrade existing W&WW systems such that they meet existing W&WW safety protocol as defined by INAC.[6] This protocol is a set of standards and codes to be followed for the design, construction, operation, maintenance, and monitoring of water and wastewater systems.[7] The on-reserve drinking water system accounts for 73% ($846 million) of the INAC protocol cost. The rest goes to the wastewater infrastructure.

$2 billion for the future capital investment required to accommodate replacement of systems as they near the end of life, and to accommodate projected population growth on reserves. The on-reserve drinking water system accounts for 48% ($962 million) of the future cost, with the remainder going to the wastewater infrastructure.

PBO's estimate of the annual operating and maintenance needs is $361 million. Of this total, $218 million is allocated to drinking water and the remaining amount is for wastewater systems.

PBO analysis indicates that total historical spending (federal + others) since 2011-2012 and the planned spending announced in Budget 2016 will only cover 70% of the total investment needs. The estimated capital and operating and maintenance (O&M) costs are considerably more than the actual and planned Aboriginal governments' funding for First Nations W&WW infrastructure.

PBO's estimate is sensitive to assumptions about population growth and other demographic factors, as well as a variety of capital investment options.

PBO identifies and estimates two other scenarios based on various assumptions (Summary Table 1). PBO uses two principal sources of data: The NB reports and the R.V. Anderson Associates (ARV) Ltd studies.

For example, the NB projection of the on-reserve population is higher than the INAC projection. PBO uses the population growth rate included in the registry group data of INAC. Hence, the NB scenario projects total future investment needs that are higher than the PBO baseline estimate.

In another case, a decision to switch from individual W&WW systems to communal systems (the "switching option") can have a significant impact on investment costs. This option is motivated by the fact that the septic systems have been known to contaminate groundwater sources, and many wells are affected by surface water. Also, because the maintenance cost of the individual systems is borne by the First Nations Communities, this may cause a significant challenge for the communities in the long run.

For example, if PBO keeps the NB projection of the on-reserve population, then the total spending since 2011-2012 will only cover 54% of the total investment needs.

## Summary Table 1 Investment needs for FN W&WW Infrastructure from 2010 to 2020

| ($ millions) | PBO Base Case | With "Switching Option" | Using NB Population Growth Forecast |
|---|---|---|---|
| **Drinking water systems** | | | |
| **Immediate refurbishment** | 846 | 846 | 846 |
| **Future needs** | 962 | 1337 | 1804 |
| **Additional O&M** | 218 | 190 | 253 |
| **Total estimated capital cost** | **1,808** | **2,184** | **2,650** |
| | | | |
| **Wastewater systems** | | | |
| **Immediate refurbishment** | 316 | 316 | 316 |
| **Future needs** | 1,052 | 2,039 | 1,704 |
| **Additional O&M** | 144 | 105 | 166 |
| **Total estimated capital cost** | **1,368** | **2,356** | **2,020** |
| **Grand total of capital cost** | **3,176** | **4,539** | **4,670** |
| **Grand total of O&M cost** | **362** | **295** | **419** |

Sources: INAC Administrative Data, PBO calculations. All spending in millions of dollars.

Note: PBO's estimate assumes that this "switching option" is exercised when it is possible to connect all the houses that use the individual systems to the existing communal systems.

# 1. Introduction

Many First Nations do not have access to safe drinking water. A study by the David Suzuki Foundation and the Council of Canadians (2017)[8] found that 151 drinking water advisories were in effect in First Nations across Canada in the last half of 2016.

Health Canada's website indicates that there were 100 long-term drinking water advisories (DWAs) and 37 short-term DWAs in 89 First Nations communities south of the 60th parallel as of March 31, 2017.[9] McClearn (2016)[10] reports that one-third of First Nations people living on reserves use drinking water systems that threaten their health and that some First Nations have lived under drinking water advisories for nearly 20 years.

It is important to keep in mind that First Nations reserves own the W&WW assets on their respective reserves, and any capital and O&M expenditures must be approved and overseen by the governing councils of those reserves. However, the federal government is responsible for ensuring safe drinking water on most First Nations reserves.

Since the 1960s, the federal government has undertaken a number of initiatives to address on-reserve water quality issues with the objective of ensuring that "on-reserve residents had access to water facilities comparable with those for other Canadians living in communities of a similar size and location."

Three federal government departments are primarily responsible for water quality issues on reserves: the Department of Indigenous and Northern Affairs (INAC), Health Canada (HC), and the Department of Environment and Climate Change (ECC).

INAC provides funding for construction and upgrades (capital investment) and 80% of operating and maintenance expenses to First Nations for the provision of water services to their communities. It also oversees the design, construction, and maintenance of these water facilities through the approval process for capital investment, and through its funding of the Circuit Rider Training Program.[11,12]

Health Canada is responsible for the delivery of drinking water monitoring programs on reserves located south of the 60th parallel, either directly or in an oversight role.

ECC is involved in source water protection through its powers to regulate waste water discharge into federal waters or into water generally where water quality has become a matter of national concern, and to enforce effluent discharge standards into water throughout Canada.[13]

Other entities may contribute, at much lower levels, to the on-reserve W&WW management. For example, Aboriginal governments receive transfers from provincial and territorial governments, in addition to the federal transfers.[14] PBO assumes that a portion of these revenues could be used as funding for on-reserve W&WW systems.[15]

Drinking water treatment cannot be considered independently from wastewater treatment. Discharging untreated or inadequately treated wastewater can negatively affect the use of water for drinking. Thus, a successful plan to improve the drinking water quality also includes efficient wastewater treatment.

This report analyzes federal spending on water and wastewater treatment on First Nations reserves. Using data collected from the W&WW National Assessment undertaken in 2011 (see below) along with other socio-economic, demographic and W&WW system data, PBO has estimated the costs of upgrading water and wastewater systems (referred to as 'investment needs') on First Nation reserves. It examines the evolution of expenditures over the past decade and where possible, explains how INAC allocates funds.

# 2. Background

## 2.1. Drinking and wastewater systems: A primer

There are three main ways of delivering drinking water: piped systems, where water is treated at a main treatment plant and then piped directly to people's homes; water truck deliveries, where drinking water is delivered to individual residences, and water wells, which serve individuals or groups of residences.

A water distribution system which relies on pipes to convey water through pumping or elevated storage to the end user is different from trucked distribution in that a trucked distribution system delivers water to end users in batch quantities to individual holding tanks (cisterns), usually placed above the ground.[16]

In the same way, the collection of the wastewater is mainly conducted by three mechanisms: piped systems, through which the wastewater is collected from individual buildings and homes for treatment and disposal at a public facility; truck haul, as the piped systems, is used to transport the collected wastewater to a sewage treatment plant; and individual septic systems, which is a combination of underground pipe(s) and holding tank(s) which are used to hold, decompose and clean wastewater for subsurface disposal.

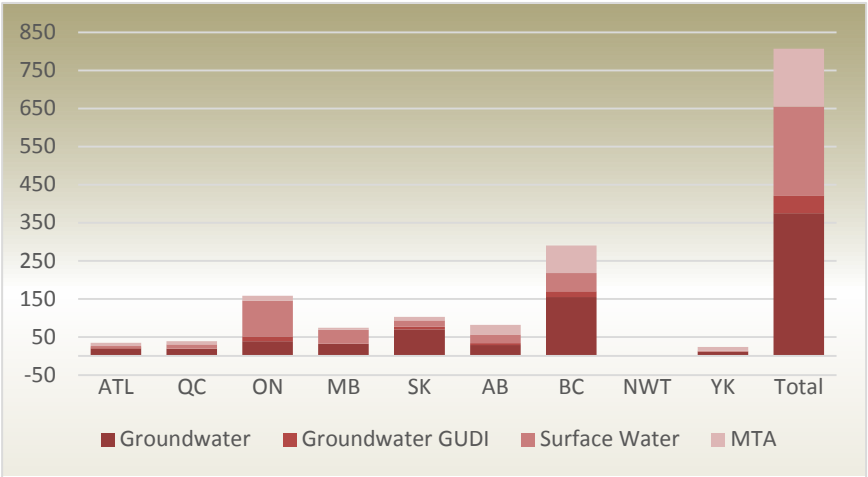
## 2.2. Existing drinking water systems on reserve

In this section, we describe the state of the on-reserves water and sewer systems, their current deficiencies, and their ability to respond to the First Nations community W&WW needs. PBO relies heavily on the 2011 W&WW National Assessment of First Nations Water and Wastewater Systems: 2009-2011 for much of this analysis.

The PBO finds that this assessment, which was conducted from 2009 to 2011, is a rigorous and comprehensive assessment of water and wastewater systems serving 571 participating First Nations. Prepared by Neegan Burnside Ltd. (NB), this study assessed the condition of the W&W assets, identified the capital and operation and maintenance needs, and recommended future servicing options for the period 2010-2020. The methodology involved collecting background data and information about each community, undertaking a site visit, and preparing individual community reports for each participating First Nation. NB and its sub-consultants conducted an assessment for each of the eight regions.[17]

At the national level, 571 of 587 First Nations (97%) participated in the 2011 W&WW National Assessment, which is equivalent to 112,836 houses. Four First Nations chose not to participate, while 12 First Nations have no current infrastructure on reserve lands. A total of 560 First Nations are served by 807 water systems. The rest of the reported First Nations were entirely serviced by individual water supplies.

Figure 2-1 On-reserve source-water classification




Source: INAC Administrative Data

At the national level, 81,026 (72%) on-reserve homes are served by piped systems, 15,451 (13.5%) homes are serviced with water truck deliveries, and 14,479 are serviced by individual wells or systems serving less than five homes. The remaining homes (1.5%) had no water service.

About 46% of the on-reserve water systems use a groundwater source, 6% rely on ground water under the direct influence of surface water (GUDI) source, and 29% used surface water. The remaining systems (19%) relied on a Municipal Type Agreement (MTA). The latter was mostly used in Yukon (42% of the drinking water systems on local reserves), Alberta (30%), Atlantic (26%) and British Columbia (25%). (See Figure 2.1)

### Municipal Type Agreement (MTA)

An MTA is a mechanism for water treatment on FN Reserves. Lipka and Deaton (2015) defined the MTAs as partnerships of First Nations with neighboring non-First Nation communities for the provision of drinking water services on their reserves. These partnerships take the form of a contract between a First Nation Band and the local government of a neighboring municipality or township.

### Box 2-1: Ground Water Under the Direct Influence of Surface Water (GUDI)

1. A drinking water system that obtains water from a well that is not a drilled well or from a well that does not have a watertight casing that extends to a depth of 6 m below ground level.

2. A drinking-water system that obtains water from an infiltration gallery.

3. A drinking-water system that is not capable of supplying water at a rate greater than 0.58 L/s and that obtains water from a well, any part of which is within 15 m of surface water.

4. A drinking-water system that is capable of supplying water at a rate greater than 0.58 L/s and that obtains water from an overburden well, any part of which is within 100 m of surface water.

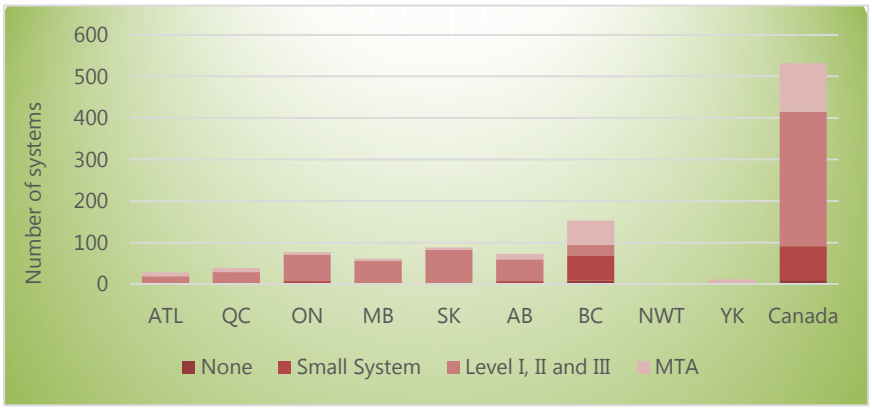
5. A drinking-water system that is capable of supplying water at a rate greater than 0.58 L/s and that obtains water from a bedrock well, any part of which is within 500 m of surface water.

The dataset provided in the NB report is the only comprehensive data available. See Section 5, for a more detailed discussion of data sources and methodologies.

## 2.3. Existing wastewater systems

There are a total of 532 wastewater systems serving 418 First Nations.[18] The remaining 153 First Nations are serviced solely by individual septic systems. The total number of on-reserve houses connected to a piped system is 61,395 (54%). The number of houses maintained by truck haul is 8,861(8%). There are approximately 40,803 homes (36%) serviced by individual wastewater systems, typically septic systems. Finally, 1,777 houses (2%) had no sewer service.

Figure 2-2 On-reserve wastewater classification by treatment system




Source: INAC Administrative Data

## 2.4. INAC Risk Assessment

Between 2009 and 2011, INAC had completed a risk assessment for each water and wastewater system in accordance with the INAC Risk Level Evaluation Guidelines (see Appendix A).

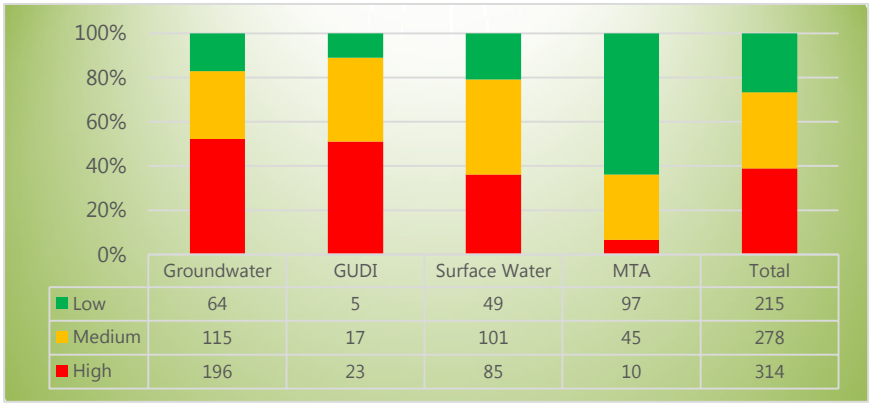
Across the country, INAC classified 314 (39%) of the water systems as high overall risk, 278 (34%) as medium overall risk, and 215 (27%) as low-risk systems. About 25% of the on-reserve population was found to be served by high-risk water systems, as the majority of high-risk systems tend to serve small communities. Regionally, the largest share of high-risk systems is in British Columbia (53%) and Ontario (45%). The low-risk systems were the most common in Yukon (54%) and Quebec (51%).

INAC reports that "a system with a high-risk ranking under INAC's management evaluation, because of its multiple deficiencies, is likely to be unable to cope with problems that may occur in the system that result in a DWA. This means that DWA are likely to occur more frequently and have a longer-term duration on a high-risk system. On the other hand, while problems can and do occur in low-risk systems, because of better overall risk management, these systems are more likely to address the problem in the short term, resulting in the rapid removal of problems and DWA."[19]

By water source classification, 64% of MTA systems were categorized as low-risk systems, and only 7% of MTA systems were classified as high risk. However, more than half of the groundwater and GUDI systems were classified as high risk.

MTA systems generally have lower overall risk than other systems because they operate in compliance with provincial legislation. As mentioned previously, MTA is the most used in Yukon, which explains the predominance of the low-risk systems. The majority of systems in British Columbia are classified as a high overall risk because groundwater and GUDI source systems are the most common sources of drinking water.

## Figure 2-3 Overall risk levels by water source




| | Groundwater | GUDI | Surface Water | MTA | Total |
|---|---|---|---|---|---|
| Low | 64 | 5 | 49 | 97 | 215 |
| Medium | 115 | 17 | 101 | 45 | 278 |
| High | 196 | 23 | 85 | 10 | 314 |

Source: INAC Administrative Data

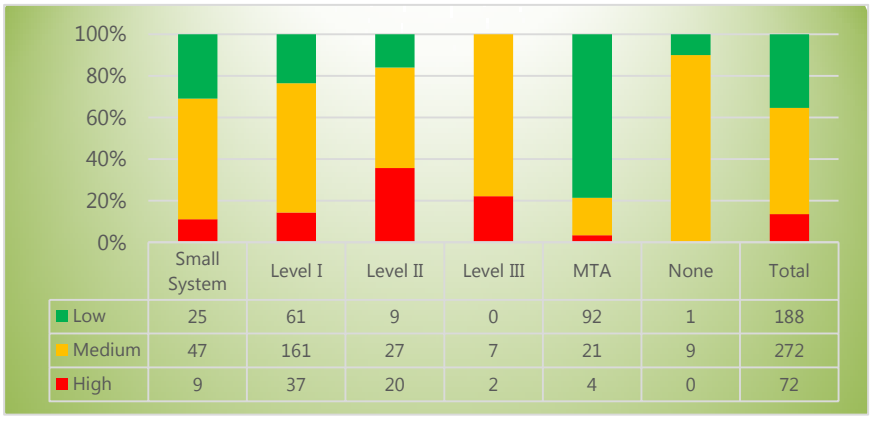
Nationally, 72 (14%) of the 532 inspected sewer systems are categorized as high overall risk, 272 (51%) as medium overall risk, and 188 (35%) as low overall risk. PBO estimates that almost 18% of the on-reserve population and 17% of households are served by high-risk wastewater systems, and 49% of the on-reserve population and 47% of households are served by medium-risk systems.

At the regional level, medium-risk systems are most common in Quebec (67%), Manitoba (62%), and Alberta (60%). In Yukon, 91% of the wastewater systems are categorized as low overall risk. Ontario (36%) and the Atlantic region (25%) have the largest share of high-risk systems.

Wastewater systems are classified differently than drinking water. This classification includes five groups: Level I, II, and III wastewater systems, the small (individual) systems, and the systems that are maintained through a Municipal Type Agreement (MTA). Level I wastewater systems are described as a group or groups of on-site waste treatment systems, including septic tanks and disposal fields, centrally operated and maintained by the First Nation in accordance with the criteria set out in the Decentralised Systems Protocol.[20] The sewage in the Level II wastewater systems is retained in holding tanks at the home, and is regularly removed and is transported to a central treatment plant or other disposal facility, and Level III of service can be realized using a community piped collection, treatment and disposal system.[21]

At the national level, the wastewater systems classified at levels I, II, and III are the most common (61%). The MTA is the second most used (22%). The on-reserve sewer systems classified as small systems (15%) come in third place. At the regional level, only British Columbia and Yukon use MTA (39% and 82%).

**Figure 2-4 Overall risk levels by wastewater treatment classification**




| | Small System | Level I | Level II | Level III | MTA | None | Total |
|---|---|---|---|---|---|---|---|
| Low | 25 | 61 | 9 | 0 | 92 | 1 | 188 |
| Medium | 47 | 161 | 27 | 7 | 21 | 9 | 272 |
| High | 9 | 37 | 20 | 2 | 4 | 0 | 72 |

Source: INAC Administrative Data

Level II wastewater systems contain the largest share of high-risk systems (36% of these systems are considered at high risk), while 78% of Level III and 62% of Level I systems are considered medium risk. About 58% of small wastewater systems are classified at medium risk. MTA systems are most likely to be low-risk (79% are classified as low-risk) because in this system, First Nations benefit from a system that is compliant with provincial regulations. (See figure 2.4)

## 2.5. Federal government expenditures

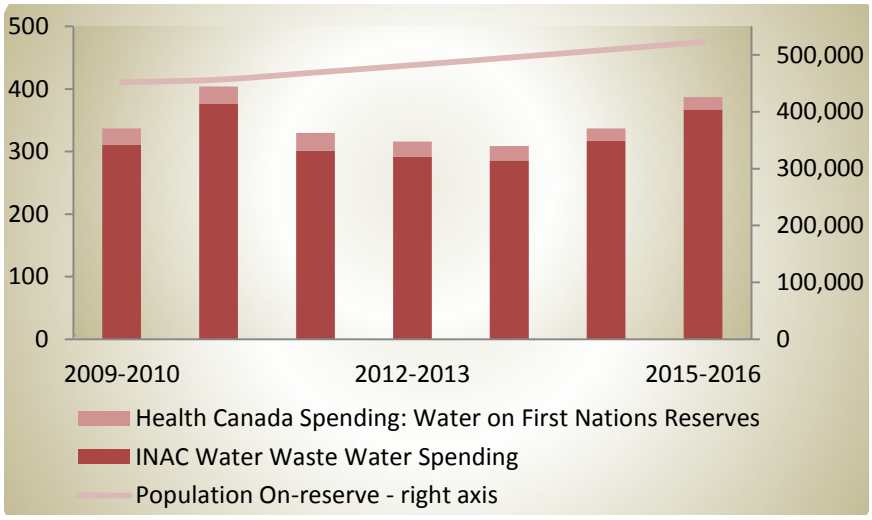
Federal government spending on W&WW systems comes mainly from two federal programs: INAC's Capital Facilities and Maintenance Program and Health Canada's Drinking Water Safety Program.

The nominal value of INAC spending on the W&WW systems on reserves amounted to about $2.25 billion from 2009-10 to 2015-16; an average annual value of $322 million, but it has fluctuated considerably since 2009. From 2009-2011, INAC spending grew by almost 21%from $311 million to $377 million. From 2012-2014, spending declined on average by 3% per year, and between 2014 and 2016, spending increased by 13% annually to reach $288 million. (Figure 2.5)

Health Canada spent $169 million on water monitoring for the period of 2009 to 2016, which is equivalent to an average annual spending of $24

million. Health Canada spending has remained relatively stable at $27 million per year from 2009-10 to 2011-12, but declined from 2012-13 to 2015-16 by 31% to $20 million. (Figure 2.5)

## Figure 2-5 FN W&WW action plan expenditures

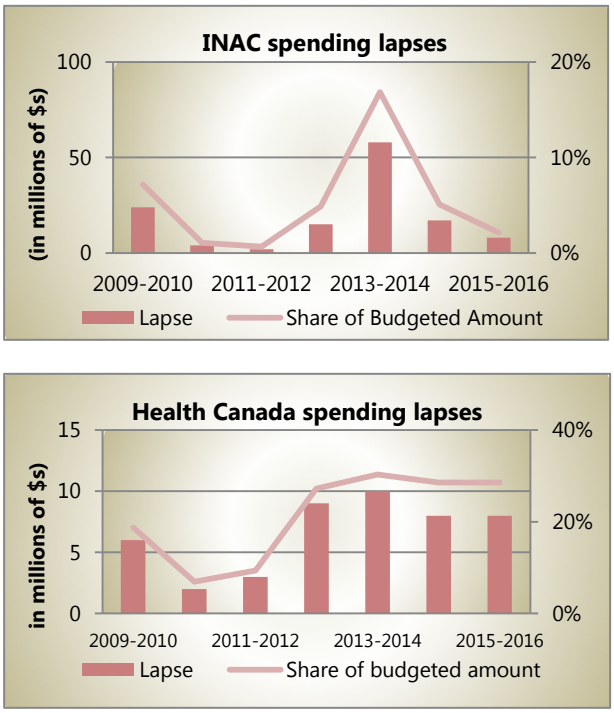



Sources: Treasury Board of Canada Secretariat, INAC Administrative Data, PBO calculations.

Note: There is some divergence between the INAC spending values provided by the Water and Wastewater Infrastructure reports and those provided by Treasury Board of Canada Secretariat. This report uses the data included in INAC reports.

Figure 2.6 compares the actual federal expenditures on the W&WW systems with the planned spending for the period 2010-11 to 2015-16. The INAC and Health Canada expenditures were below planned spending throughout the whole period.

## Figure 2-6 Federal spending and lapse




Sources: Treasury Board of Canada Secretariat, INAC administrative data, PBO calculations.

The INAC program is divided into two categories: Capital spending and Operational and Maintenance (O&M) spending:

**Capital spending** includes the capital cost of upgrading existing facilities to comply with Indigenous and Northern Affairs Canada (INAC) protocol, and the capital cost to expand facilities and the construction of additional facilities to meet the demand forecasted over the specified 10-year window (until 2020)**.** This includes funding for a wide variety of items including construction of new water plants or wastewater treatment plants; feasibility studies for future projects; design work for future projects; repairs and expansion of water and sewer systems; installation of new pipes or pumping stations; service hookups for new housing developments; running of a cleaning and disinfection project on existing pipes; replacement of valves on fire hydrants; buying water or septic trucks; payment of loans for water trucks; etc.[22]

Total capital spending on W&WW systems on FN reserves for the period of 2010-11 to 2014-15 was $905 million (58% of the total INAC expenditure on W&WW systems).[23] Capital investment on W&WW infrastructure varied between $146 million and $250 million per year between 2010-11 and 2014-15.[24, 25]

**Operational and Maintenance (O&M) spending** includes the cost of the operator training and the performance of the monitoring, and recording requirements, and sampling program. This funding could be used for activities such as salaries for plant operators or water and septic truck drivers; employee benefits; chemical supplies; hardware; uniforms; equipment; laboratory testing of samples; freight and delivery of supplies; minor repairs to water or wastewater treatment systems; insurance; telephone; travel; training and development; utilities (e.g. electricity, waste collection); fuel for vehicles (e.g. water or septic trucks) and miscellaneous expenses.[26]

Total O&M expenditure was $667 million for the period between 2010-11- and 2014-15 (42% of total spend).[27] O&M spending was much less variable than the capital investment, fluctuating between $126 million and $142 million for the period.

## 2.6. Additional funding from Budget 2016

Budget 2016 allocates close to $2 billion over five years towards improving First Nations W&WW delivery, with $1.83 (93%) billion for infrastructure and $142 million (7%) to improve the monitoring and testing of on-reserve community drinking water.

Importantly, this federal commitment only relates to those systems financially supported by INAC. While INAC financially supports most systems on reserve, it does not support all systems. As such, even if the federal commitment is fulfilled, there may remain inadequate infrastructure as described in subsequent sections.

The actual and planned INAC spending including the additional funding from budget 2016 represents an increase of 78% over 5 years from 2016-17 to 2020-21 . The budget allocation includes the renewal of $690 million for existing INAC programs and $118 million in existing Health Canada programs. About $1.17 billion can be considered "new money". (See table 2.1)

## Table 2-1 Budget 2016 funding for W&WW Infrastructure on Reserve

| ($ millions) | 2016-17 | 2017-18 | 2018-19 | 2019-20 | 2020-21 | Total |
|---|---|---|---|---|---|---|
| **INAC – water and wastewater infrastructure** | 158 | 184 | 263 | 267 | 271 | **1,143** |
| **Health Canada – Water Monitoring** | 3.3 | 3.3 | 5.3 | 5.3 | 5.3 | **22.5** |
| **Sub-Total Budget 2016 funds** | **161.3** | **187.3** | **268.3** | **272.3** | **276.3** | **1,165.5** |
| **Renewal of Budget 2014 INAC funding*** | 138 | 138 | 138 | 138 | 138 | **690** |
| **Renewal of Budget 2014 Health Canada funding*** | 23.7 | 23.7 | 23.7 | 23.7 | 23.7 | **118.5** |
| **Sub-Total Renewal of 2014 funds** | **161.7** | **161.7** | **161.7** | **161.7** | **161.7** | **808.5** |
| **Total** | **323** | **349** | **430** | **434** | **439** | **1,975** |

Source: Finance Canada,

Notes:: * These amounts are from the First Nations Water, and Wastewater Action Plan announced in Budget 2014 and scheduled to sunset in 2016-2017.

Totals do not add due to rounding

# 3. Methodology

PBO has created a basecase estimate of capital and O&M investment required to bring First Nations W&WW infrastructure to the point where long-term boil water advisories will be eliminated. This basecase estimate relies on data and cost estimates from the NB report and adjusts this data with more recent demographic data from the R.V. Anderson Associates Limited (RVA) report.[28] See Appendix A for a detailed description of this methodology.

Key cost drivers to the basecase estimate include:

- **Baseline population**: the NB report of 2011 identified 484,321 people living in 112,836 on-reserve units in the period between 2010 and 2011. However, the RVA uses the INAC 2015 estimate of the on-reserve population at 444,000 living in 111,340 homes (the "INAC registry"). PBO assumes that RVA demographic data is based on the registry group data.[29] The registry data "does not include all persons who are entitled to be registered according to the Indian Act, only those who have applied to be registered and whose entitlement has been verified."[30] Therefore, data from the Indian Registration System (IRS) may not be fully appropriate for our estimates. Because of difficulties in validating INAC's demographic data, PBO has chosen to use the figures from the NB report.

- **Population growth:** PBO's model uses an annual population growth rate of 1.7%, which was the same rate used in the RVA report of 2016. The NB report forecasts a population growth rate of 2.8%. PBO chose the RVA growth rate because this forecast is more current and corresponds more to the recent historical growth rate estimated by INAC for the on-reserve registry groups.[31]

- **Switching option:** Switching from private wells/septic systems to communal, public drinking water systems requires a larger upfront capital investment but can result in lower operating and lifecycle costs in the longrun.[32] PBO's basecase estimate assumes that this "switching option" is exercised when it is possible to connect all the houses that use the individual systems to the existing communal systems.

### Box 3-1 Individual systems

- **NB (2011) mentions that "Nationally, 36% of the individual wells sampled did not meet the requirements of the GCDWQ for health related parameters (i.e. arsenic, barium, bacteriological, etc.) and 75% did not meet the GCDWQ for aesthetic related parameters (i.e. hardness, sodium, iron, manganese, etc.). In many cases, wellhead integrity or well construction issues are likely causes of contamination. Typically, dug wells are under the direct influence of surface water, which increases the probability of contamination. Approximately 19% of the individual wells sampled met the requirements of the GCDWQ for health and aesthetic related parameters."**
- **Regarding the wastewater treatment, NB reports that "Approximately 47% of the individual wastewater systems assessed had operational concerns identified, which were usually attributed to limited maintenance (not pumping out septic tanks regularly), leaching beds installed in inappropriate soils and age of the system. Approximately 20% of the systems assessed had septage waste discharging directly to the ground surface. These systems are referred to as a "shoot-out." The incidence of this is highest in Alberta (42%) and Saskatchewan (40%). Shoot-outs usually occur as a result of cases where the leaching beds had failed. This type of surface discharge of untreated wastewater is considered a health risk. The servicing recommendations for communities with shoot-outs, included either that these systems be upgraded to include raised leaching beds, connected to a piped system, or serviced by truck haul as appropriate."**

- **Fixed costs:** The construction cost represents the largest proportion of the total investment value. Many components of these fixed costs (disinfection station, storage reservoirs, pumping systems, etc.) are directly related to the population size. However, PBO adjusted the total cost using a unit price per household, using data from the NB reports. Capital and operating cost are subject to economies of scale. As mentioned in the first point, PBO uses a population growth rate of 1.1% lower than the one estimated by NB. The cost per household generally should increase with decreasing scale because fixed costs are spread out over fewer houses. If PBO takes this into account in its estimates, the total capital cost could be higher than the reference value.

The following section of the report describes the results of the base case cost estimate, along with adjustments reflecting changes in assumptions about these key cost drivers.

# 4. Results

## 4.1. What is the cost of improving the W&WW infrastructure on reserves?

PBO has constructed a range of estimates of the cost of improving W&WW systems on First Nations reserves to the point where residents there can enjoy drinking water and wastewater services comparable to non-First Nations communities of comparable size, and which would eliminate long-term boil water advisories by 2020.

PBO's baseline costing methodology estimates the capital investment required to meet actual and future W&WW needs at $3.2 billion, with drinking water systems accounting for 57% ($1.8 billion) and wastewater systems accounting for the rest ($1.4 billion).

Annual operating and maintenance needs are estimated at $361 million, with $218 million for drinking water and the balance for wastewater systems.

The estimate of the capital investment needs is broken down as follows:

- $1.2 billion to upgrade existing W&WW systems such that they meet INAC's existing W&WW safety protocol (as described above).[33]
- $2 billion for future capital investment required to accommodate replacement of systems as they near the end of life, and to accommodate projected population growth on FN Reserves. The on-reserve drinking water system accounts for 73% ($846 million) of the INAC Protocol cost and 48% ($962 million) of the future value. The rest goes to the wastewater infrastructure.

Table 4-1 describes the base cost as well as two other scenarios derived from adjustments to the underlying assumptions and type of infrastructure.

Table 4-1 Investment needs for FN W&WW infrastructure from 2010 to 2020

| ($ millions) | PBO Base Case | With Switching Option | NB Population Growth Forecast | + Switching Option |
|---|---|---|---|---|
| **Drinking Water Systems** | | | | |
| **Immediate refurbishment** | 846 | 846 | 846 | 846 |
| **Future needs** | 962 | 1337 | 1804 | 2180 |
| **Additional O&M** | 218 | 190 | 253 | 225 |
| **Total Estimated Capital Cost** | **1,808** | **2,184** | **2,650** | **3,026** |
| | | | | |
| **Wastewater Systems** | | | | |
| **Immediate refurbishment** | 316 | 316 | 316 | 316 |
| **Future needs** | 1,052 | 2,039 | 1,704 | 2,691 |
| **Additional O&M** | 144 | 105 | 166 | 127 |
| **Total Estimated Capital Cost** | **1,368** | **2,356** | **2,020** | **3,007** |
| **Grand Total of Capital Cost** | **3,176** | **4,539** | **4,670** | **6,033** |
| **Grand Total of O&M Cost** | **362** | **295** | **419** | **352** |

Sources: INAC Administrative Data, PBO calculations. All spending in millions of dollars.

A description of the sensitivity analysis follows:

- **Population growth:** Using the population size and growth assumptions from the Neegan Burnside report, NB's capital cost estimate is $4.7 billion, an increase from the PBO reference value of 47%, with a corresponding increase in the annual O&M costs of 16% as well.

- **Switching option**: This entails the replacement of existing individual systems by one common public system.[34] PBO uses the median value of all alternative investments given in the Alberta community data included in the NB report, which includes the expansion of the piped systems for drinking water distribution and wastewater collection. This value could be an approximation of the minimum investment required to consider the switching cost.[35] Under this scenario, the capital cost estimate is $4.5 billion, an increase from the reference value of 43%, with a corresponding decrease of 19% in O&M costs.

## 4.2. Funding gap

Depending on the scenario, PBO analysis indicates that total historical spending since 2011-2012 and the planned spending announced in budget 2016 plus other potential funding[36] only cover between 50% and 70% of the total investment needs. The recommended capital and O&M costs are considerably more than the actual and planned funding for First Nations W&WW infrastructure.

### Table 4-2 Comparison between current and required funding levels

| ($ millions) | Base Case | Scenario 1 | Scenario 2 | Scenario 3 |
|---|---|---|---|---|
| **Capital Required** | 3,176 | 4,539 | 4,670 | 6,033 |
| **Current Budget allocation** | 2,505 | 2,505 | 2,505 | 2,505 |
| **Difference** | 671 | 2,034 | 2,165 | 3,528 |
| **Average Annual O&M Required** | 362 | 295 | 419 | 352 |
| **Average Annual O&M Available** | 183 | 183 | 183 | 183 |
| **Difference** | 179 | 112 | 236 | 169 |
| **Potential annual additional funding (Other sources)** | 66 | 66 | 66 | 66 |
| **Overall Gap (%)**[(1;2)] | 30% | 37% | 46% | 50% |

Sources: INAC Administrative Data, PBO calculations. All spending in millions of dollars.

Notes: The gap is calculated using the real value of 2016-17 and based on the ratio of the total spending to the total costs for the ten- year period.

PBO does not take into account the asset deteriorations to calculate the gap. Including the changing state of the W&WW systems, the costing may increase, as well as the gap.

The federal budget does not describe how the planned funding will be distributed between the capital investment and the O&M investment. PBO uses the actual allocation since 2010 (the INAC assessment period) to estimate the future funding allocated to each investment categories. INAC allocates annually between 33% and 49% of the total expenditure to the O&M costs, which represents an average annual share of 41%. PBO assumes that INAC will continue to allocate 41% of the announced budget to the O&M cost. The remaining funds will be allocated to future capital costs.

# 5. Alternative analyses

As discussed previously, PBO's analysis relies primarily on the 2009-11 National Assessment Reports prepared by Neegan Burnside Ltd. The report assessed the condition of the W&WW assets on FN Reserves, identified the capital and operation and maintenance needs, and recommended future servicing options to 2020. The methodology involved collecting background data and information about each community, undertaking a site visit, and preparing individual community reports for each participating First Nation.

The NB report recommended capital and O&M investments well beyond INAC's planned spending levels. Subsequently, INAC commissioned a workshop team involving participants from R.V Anderson Associates Ltd. (RVA) and Morrison Hershfield, to review the recommended amounts and find alternative approaches that could be more affordable than what was recommended in the NB report.

## 5.1. RV Anderson Approach

The NB report recommended a capital investment of $4.68 billion ($2011), including $1.16 billion to upgrade the existing systems and provide service to currently un-serviced populations and $3.52 billion to meet projected future needs until 2020. The NB report forecast an additional 44,266 new homes (to account for population growth from 2010-2020), resulting in an average future investment of $79,460 per home. The RVA consultants compared this amount against a sample population of comparable urban and suburban communities in the USA and Canada, and concluded that a $60,000 capital investment per new household should be considered as a sufficient upper limit. Capping the maximum investment at $60,000 per new household would reduce the total investment required from $4.68 billion to $2 billion.

PBO has considered this approach, but has nevertheless maintained its reliance on the NB report for the following reasons:

1. **Duration and scope of the study**: Neegan Burnside Ltd. and its subcontractors visited 571 First Nations in Canada over a 2 year period. The RVA report is based on a 3-day workshop held in Gatineau, QC. PBO considers the Neegan Burnside Ltd. studies to be a more reliable representation of the existing condition of W&WW infrastructure on reserve.
2. **The accuracy of the studies:** Each visit of NB included at least two team members. Additional participants including the Circuit Rider Trainer (CRT), an INAC Representative, an Environmental Health Officer (EHO) from Health Canada and a Tribal Council Representative were invited to attend. This assessment involved collecting background data and

information about each community (demographic data, geographic data, elevation, system design, etc.), undertaking a site visit, and preparing individual community reports for each participating First Nation. The RVA analysis is based on comparative approach with average per-household data from other remote and small rural communities, and relies on an average 20-year capital water need per household published by the U.S. Environmental Protection Agency (EPA). This approach is useful to compare between communities, but it cannot be an alternative to the NB report because it does not consider the specificity of each reserve's W&WW infrastructure. The RVA report qualifies its conclusions with the following statement: "At a high level, it should be recognized that different practices and approaches are already in use in various Regions and by different First Nations and that any recommendation put forward in the present report should be scrutinized in terms of the local impact. The intent here is to provide focus on Best Practices and new tools where needed, not to impair programs and approaches which have proven to work well in various regions and First Nation communities."

3. **Operation and maintenance costs and life cycle costs:** The RVA consultants do not give a precise estimate of the O&M costs and the life cycle cost of the alternative assets that they suggest. Again, the report uses data from the Ontario Municipal CAO's Benchmarking Initiative (2008), which finds that O&M costs for W&WW infrastructure are in the range of $750 and $1,250 per household per year. This data has no connection to the capital investment that is being proposed, and the report does not explain how this finding could be applied in the on-reserve communities. Using the demographic data from the NB report, capping capital investments at $60,000 per new household, and maintaining the investment required to bring existing W&WW infrastructure to compliance with the INAC Protocol, the total capital investment required would be about $3.5 billion. Furthermore, using the $750 to $1,250 O&M cost per household per year as described above, the total annual O&M cost would be between $126 million and $210 million, compared to the NB estimate of $418 million annually.

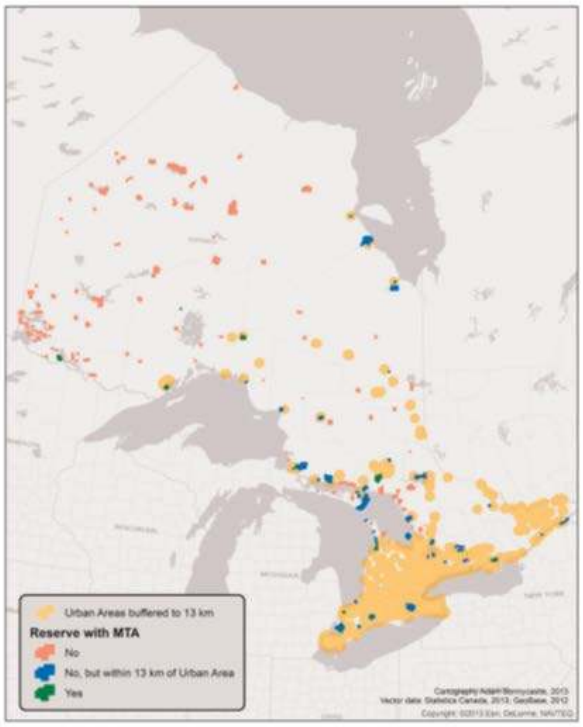
## 5.2. Municipal Type Agreements

A Municipal Type Agreement (MTA) can be an efficient way to reduce the risk to drinking water and waste water risk on reserves. As mentioned previously, MTA systems have a lower overall risk than other systems. Nationally, 64% of MTA drinking water systems and 79% of MTA wastewater systems were categorized as low risk.[37] PBO found that the First Nations communities that use MTA systems enjoy a low overall risk of W&WW treatment (see above, section 2.2). Another study by Lipka and Deaton[38] has shown that participation in an MTA significantly reduces by 11% the likelihood that a First Nations' water system will be under a boil water advisory. The study also shows that MTA participation reduces by 40% the probability of a system having a high-risk ranking, and by 38% for a system failing the

aesthetic guidelines of the Guidelines for Canadian Drinking Water Quality (CGDWQ).

INAC participates with Federation of Canadian Municipalities in negotiating MTA's for First Nations. However, despite the relevance of the MTA mechanism, only 19% of the drinking water systems and 22% of the wastewater systems rely on an MTA[39]. There are two main reasons for this. The first is the geographic proximity of a First Nations' reserve to a potential MTA partner. The distribution cost of the drinking water systems is positively correlated with their proximity. The Lipka and Deaton study finds that First Nations reserves in remote areas are far less likely to participate in MTAs. However, the authors identify 25 First Nations with reserves in Ontario that fall within a feasible distance to a potential MTA partner but do not have an existing MTA (see Figure 4.2.1). The second reason is due to the transaction costs of coordinating an MTA. The report shows that a history of cooperation between the residents of the concerned municipality and those of the nearby First Nations reserve will generally result in a reduced transaction cost.

**Figure 5-1: First Nations' reserves in Ontario (MTA participants and non-participants) and their proximities to population centers**




Source: Lipka and Deaton (2015).

## 5.3. On-reserve infrastructure: condition and replacement needs

A more recent R.V. Anderson Associates[40] study describes an alternative estimate of the capital investment needs for the on-reserve W&WW. This estimate is based on the replacement costs of all W&WW assets that were reported in poor condition or were closed in 2015. The total replacement cost is calculated based on data from INAC's asset condition reporting system (ACRS) 2015 consolidated at the national level.

RVA divides its estimate into two elements: an estimate based on the current physical condition of the W&WW infrastructure and facilities (from the ACRS data), and the new infrastructure needed over a 5-year time frame (to 2020).

This estimate could reasonably represent the lower bound of the real costs for the reasons set out below:

- The investment to provide services to the portion of the population currently with no access to the W&WW systems are not a part of the study.

- Other performance criteria such as current system capacity are not included in the analysis.
- The estimates are less likely to include a remoteness factor when considering location and access.
- The estimates focus on major capital investments and do not include investments needed for operations, maintenance and (minor) repairs.

The RVA (2016) study estimates capital investment needs for drinking water systems at $626 million and wastewater systems at $214 million. Investments needed to accommodate population growth on-reserve (using a population growth rate of 1.7%, and a 2015 population of 440,000) are estimated at $473 million for drinking water and $476 million for wastewater. Using this methodology, the total capital investment amounts to $1.8 billion, equal to the amount set aside in Budget 2016. However, it is important to remember that Budget 2016 funding was intended to cover both capital and O&M expenditures.

# Appendix A: Costing Methodology

PBO uses the cost estimate included in the NB report, and it adjusts these values using the more recent demographic growth rate included in the R.V. Anderson Associates Limited (RVA) report. PBO calculates the Total Servicing Costs (TSC)[41] for each province using this formula:

TSC_{PBO, j}=[ (TSC_{NB estimate, 2011 value, j}-PC_{NB estimate, j}]/{Forecast Homes_national assessment, j})* {Forecast Homes_PBO, j}+ PC_{NB estimate, j}.

With,

TSC_{PBO, 2015 value, j} representing the total servicing cost in province j∈{ ON, MB, SK, AB, QC, BC, YK } estimated by PBO.

TSC_{NB estimate, j} is the total servicing cost in province j included in the NB reports.

PC_{NB estimate, j} is the INAC Protocol cost in province j.

{Forecast Homes_national assessment, j} is the total number of the forecast homes on reserve in region j estimated by the NB consultants.

{Forecast Homes_PBO, j} is the total number of the forecast homes on reserve in region j estimated by PBO using the growth of the population included in the RVA report (2016).

The forecast homes in province j are estimated using the population growth in this region between 2010 and 2020 and assuming that each new home will be occupied by four people (The same assumption made by NB). The 2020 on-reserve population size in province j is estimated by using the weight of their population at the national level calculated from the 2009-11 national INAC assessment and the annual growth population of 1.7%.

The same methodology is applied to the annual O&M cost.

**Population growth**: PBO uses the annual population growth rate of 1.7% from the RVA report to estimate future investment needs until 2020. This rate is much lower than the one based on NB report. RVA (2016) mentions that INAC estimated an on-reserve population of 444,000 living in 111,340 houses in 2015. However, the 2009-2011 national assessment identified 484,321 people living in 112,836 on-reserve units in the period between 2010 and 2011. INAC's demographic projections show a significant decrease in the population living on reserve and assume that native people leaving the reserves will continue to exceed the number of new births. Different

assumptions of population growth result in significant differences in estimated investment costs.

**Switching option**: Most of the NB recommended capital investment options assume the maintenance and/or expansion of existing private wells and septic systems. This can be problematic in the long run, because septic systems have been known to contaminate groundwater sources, and many wells are affected by surface water.[42] Also, because the maintenance cost of the individual systems is by policy borne by the First Nations Communities, this may cause a significant challenge for the communities in the long run. This option will likely be less efficient in the long run.[43] Hence, these social and environmental externalities warrant serious consideration for replacing private wells with public drinking water systems and individual septic systems with common wastewater systems. This switching option would increase the capital cost in the short run.

Table A.1: Comparison of the life cost between the individual W&WW systems and the piped systems on Alberta's reserves

| Drinking water systems | | Upgrade and/or expansion of the existing piped systems | | | Upgrade and/or expansion of the existing individual systems | | |
|---|---|---|---|---|---|---|---|
| Community | Option number (*) | 30 year life cost | Total Serviced households | 30 year life cost per household | 30 year life cost | Total Serviced households | 30 year life cost per household |
| Siksika No. 146 | 1 | 12,673 | 860 | 15 | 17,158 | 325 | 53 |
| Samson | 1 | 28,710 | 1,013 | 28 | 48,620 | 926 | 53 |
| | 2 | 33,680 | 833 | 40 | 49,140 | 926 | 53 |
| Big Horn No. 144A | 1 | 1,140 | 21 | 54 | 1,327 | 25 | 53 |
| | 2 | 1,024 | 16 | 64 | 1,327 | 25 | 53 |
| Duncan No. 151A | 2 | 492 | 35 | 14 | 1,547 | 28 | 55 |
| Saddle Lake No. 125 | 1 | 7,940 | 522 | 15 | 3,260 | 64 | 51 |
| | 3 | 990 | 178 | 6 | 29,890 | 408 | 73 |
| Stony Plain No. 135 | 1 | 3,070 | 221 | 14 | 3,710 | 92 | 40 |
| | 2 | 5,060 | 221 | 23 | 3,710 | 92 | 40 |
| Horse Lake No. 152B | 1 | 2,226 | 150 | 15 | 1,087 | 20 | 54 |
| | 2 | 717 | 91 | 8 | 5,964 | 79 | 75 |
| Wabamun No. 133A | 1 | 3,067 | 128 | 24 | 7,040 | 147 | 48 |
| Ermineskin No. 138 | 1 | 3,290 | 225 | 15 | 29,020 | 488 | 60 |
| | 2 | 8,260 | 225 | 37 | 29,020 | 488 | 59 |
| | 3 | 11,800 | 400 | 30 | 16,870 | 331 | 51 |
| Montana No. 139 | 1 | 2,180 | 151 | 14 | 4,820 | 76 | 63 |
| | 2 | 4,520 | 151 | 30 | 4,820 | 76 | 63 |
| O'Chiese First Nation | 1 | 3,067 | 99 | 31 | 8,932 | 193 | 46 |
| | 2 | 881 | 34 | 26 | 14,169 | 274 | 52 |
| Louis Bull Tribe No. 138B | 1 | 3,700 | 240 | 15 | 8,800 | 149 | 59 |
| | 2 | 6,180 | 240 | 26 | 8,800 | 149 | 59 |
| Pigeon Lake. 138A | 1 | 2,000 | 39 | 51 | 3,200 | 123 | 26 |

| Wastewater systems | | Upgrade and/or expansion of the existing piped systems | | | Upgrade and/or expansion of the existing individual systems | | |
|---|---|---|---|---|---|---|---|
| Community | | 30 year life cost | Total Serviced households | 30 year life cost per household | 30 year life cost | Total Serviced households | 30 year life cost per household |
| Siksika No. 146 | 2 | 16,381 | 829 | 20 | | | |
| | 3 | 35,197 | 829 | 42 | 8,991 | 413 | 22 |
| Samson | 3 | 9,600 | 833 | 12 | 33,170 | 926 | 36 |
| Whitefish Lake No. 128 | 3 | 4,770 | 271 | 18 | 7,240 | 193 | 38 |
| | 4 | 760 | 117 | 6 | 15,290 | 347 | 44 |
| Big Horn No. 144A | 3 | 61 | 5 | 12 | 960 | 41 | 23 |
| Duncan No. 151A | 3 | 1,190 | 63 | 19 | 625 | 14 | 45 |
| | 4 | 805 | 42 | 19 | 2,158 | 35 | 62 |
| Saddle Lake No. 125 | 4 | 8,110 | 447 | 18 | 12,780 | 582 | 22 |
| Frog Lake First Nation | 3 | 3,171 | 110 | 29 | 9,470 | 239 | 40 |
| | 4 | | 22 | 0 | 14,746 | 327 | 45 |
| Heart lake No. 167 | 3 | 492 | 6 | 82 | 2,924 | 56 | 52 |
| | 4 | 2,492 | 57 | 44 | 451 | 15 | 30 |
| Stony Plain No. 135 | 5 | 3,480 | 233 | 15 | 6,100 | 180 | 34 |
| | 6 | 760 | 110 | 7 | 12,510 | 303 | 41 |
| Horse Lake No. 152B | 3 | 2,795 | 159 | 18 | 408 | 11 | 37 |
| | 4 | 759 | 100 | 8 | 3,673 | 70 | 52 |
| Kapawe'no First Nation | 2 | 383 | 40 | 10 | 164 | 4 | 41 |
| Kehewin Cree Nation | 3 | 2,740 | 142 | 19 | 9,100 | 232 | 39 |
| | 4 | 700 | 70 | 10 | 12,820 | 304 | 42 |
| Wabamun No. 133A | 1 | 2,890 | 110 | 26 | 5,676 | 176 | 32 |
| | 2 | 5,159 | 110 | 47 | 5,676 | 176 | 32 |
| Cold Lake First Nations No. 149 | 1 | 5,260 | 204 | 26 | 7,740 | 212 | 37 |
| | 2 | 3,490 | 115 | 30 | 12,340 | 300 | 41 |
| | 3 | 1,180 | 27 | 44 | 16,890 | 388 | 44 |
| Driftpile First Nation | 3 | 4,456 | 223 | 20 | 5,160 | 116 | 44 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| No. 150 | | | | | | | |
| | 4 | 1,951 | 124 | 16 | 10,653 | 215 | 50 |
| Ermineskin No. 138 | 1 | 4,440 | 400 | 11 | 21,590 | 372 | 58 |
| | 2 | 4,480 | 400 | 11 | 21,590 | 372 | 58 |
| | 3 | 6,700 | 400 | 17 | 13,480 | 372 | 36 |
| Montana No. 139 | 3 | 2,800 | 151 | 19 | 3,310 | 101 | 33 |
| | 4 | 680 | 73 | 9 | 6,030 | 179 | 34 |
| O'Chiese First Nation | 1 | 5,404 | 94 | 57 | 6,573 | 181 | 36 |
| | 2 | 369 | 34 | 11 | 10,259 | 262 | 39 |
| Louis Bull Tribe No. 138B | 3 | 3,930 | 246 | 16 | 6,200 | 151 | 41 |
| Sawridge 150G | 1 | 1,292 | 26 | 50 | 137 | 4 | 34 |
| Loon Lake No. 235 | 5 | 1,582 | 90 | 18 | 7,641 | 152 | 50 |
| | 6 | 5,600 | 193 | 29 | 1,943 | 49 | 40 |
| Pigeon Lake. 138A | 3 | 2,650 | 39 | 68 | 4,600 | 123 | 37 |

Sources: INAC Administrative Data, PBO Calculations from Alberta's community reports. All values in thousands of 2015

*: NB sets options as service opportunities available in the community to meet future needs in water and wastewater.

**Fixed costs**: The construction cost represents the largest proportion of the total servicing costs. INAC estimated that this cost covered more than 90% of the needed investment to upgrade existing water and wastewater systems to meet the INAC Protocol. The construction cost includes a significant part of the fixed costs. Many components of these fixed costs (disinfection station, storage reservoirs, pumping systems, etc.) are directly related to the population size. However, PBO adjusted the total servicing costs using a unit price by household, implicitly assuming only a fixed average value by family. Capital and operating costs are subject to economies of scale. As mentioned above (population), PBO anticipated on-reserve population from 2010 to 2020 lower than the one estimated by NB. If this were the case, the cost per household would increase because fixed costs are spread over fewer houses. Taking this into account, the total capital cost could be higher than the reference value.

**Calculation of the Switching Option:**

PBO estimates of this option include the cost of expanding an existing piped system to houses with individual wells, which are not currently connected to the existing piped system. The NB report included costs for expanding piped systems to new homes. PBO was only able to get this detailed data for reserves located in Alberta. PBO then scaled these costs to include all applicable FN reserves, and used this figure to represent the lower bound of drinking water switching costs for all FN reserves. The same calculation was done for the expansion of sewage pipelines to homes currently using septic systems.

The costs of distributing piped drinking water and collecting piped wastewater are proportional to the density of the reserve population density. Because households using individual wells and septic systems are usually remote, PBO considers the median value of the average expansion cost per household as the lower bound of its estimates of capital and O&M costs.

The median values of the average switching cost per household for the W&WW systems were used as an approximation because they provide a better fit than the average values.

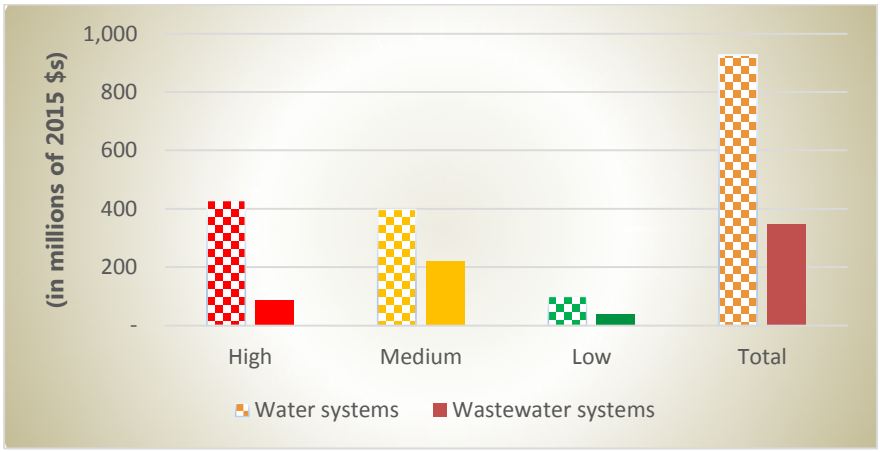
# Appendix B: Costing by overall risk level

INAC only classifies the Protocol costs by immediate overall risk level. This classification does not consider the investment required to increase the capacity of the water and wastewater systems to meet the future needs. This assumes no correlation between the two kinds of investments.

Based on the 2011 assessment, PBO estimates the 2015 present value of upgrade costs to meet INAC Protocols of the drinking water systems classified as high risk at $428 million, which is about 46% of the total Protocol cost. The investments required to update the on-reserve water system that INAC classified as medium and low risk are $398 million (43%) and $100 million (11%) respectively. The investment needs for high-risk systems comprise the biggest part of the total cost of meeting the INAC Protocol. (See figure B.1)

Regarding the on-reserve wastewater, INAC attributed $87 million (25%) of the Protocol cost to high-risk systems, $219 million (63) to those with medium risk, and $40 million (12%) to those with low-risk. The high and medium risk systems had the biggest share of the needed investment. (See Figure B.1)

Figure B.1: Total Construction and Non-Construction Protocol Estimated Cost by Risk Level

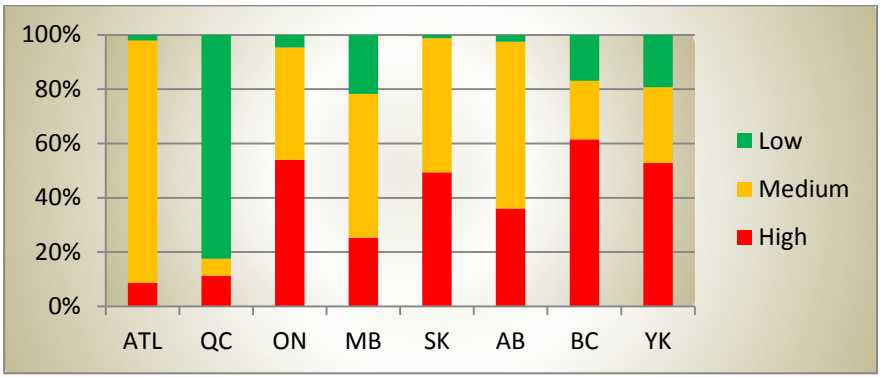



Sources: INAC Administrative Data, PBO Calculations.

At the regional level, INAC attributed the biggest portion of the investment needs to the high-risk drinking water systems in British Columbia (61%), Ontario (54%), Yukon (53%), and Saskatchewan (49%). These four provinces accounted for almost 50% of the on-reserve total population and 54% the on-reserve households in 2011. A significant share of the INAC Protocol cost was assigned to the medium-risk water systems in Atlantic (89%), Alberta (61%), and Manitoba (53%). The on-reserves population (households) in

these three provinces accounted for 39% (33%) of the total at the national level. INAC allocated the biggest portion of its Protocol cost of the low-risk system (82%) to Quebec. (See Figure B.2)

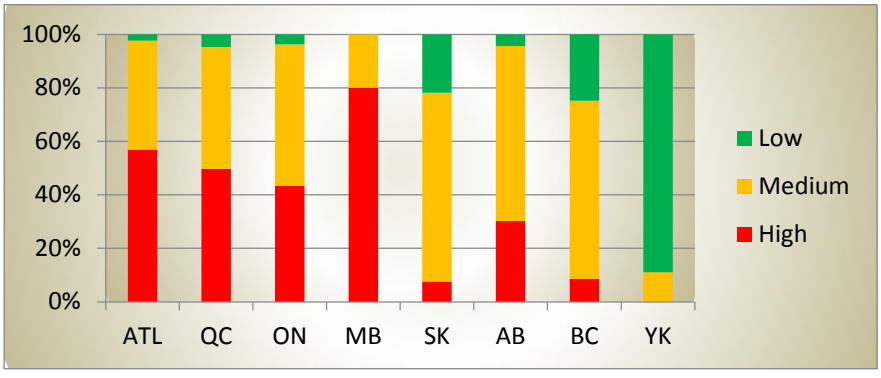
Figure B.2: Breakdown of Protocol Estimated Costs by Risk Level and by Region: Water




Sources: INAC Administrative Data, PBO Calculations.

Regarding the on-reserve wastewater treatment, the investment needs of the high-risk systems were found in Manitoba (80%), Atlantic (57%), and Quebec (50%). Accordingly, INAC attributed 37% of the total INAC Protocol cost of high-risk systems to the 35% (33%) of the total on-reserve population (household). INAC allocated the biggest portion of its Protocol cost of the medium-risk system to Saskatchewan (71%), British Columbia (67%), Alberta (65%), and Ontario (53%). By implication, 91.7% of the total INAC Protocol cost of the medium-risk system was attributed to 64% (65%) of the on-reserve population (household). Finally, 98% of the total protocol cost in Yukon was assigned to the low-risk system. (See figure B.3)

Figure B.3: Breakdown of Protocol Estimated Costs by Risk Level and by Region: Wastewater




Sources: INAC Administrative Data, PBO Calculations.

# Appendix C: INAC Risk Level Analysis

INAC rates the water and wastewater systems in First Nations communities from 1 (lowest risk) to 10 (highest risk). Risk level is assigned for each of the elements of the system and the overall system rank is calculated using a weighted value for each category as shown in the following table:

Table C.1: Weighting applied to each component in calculation of system management risk scores

| Water system's component | Percentage weighting for water systems | Percentage weighting for wastewater systems |
|---|---|---|
| Water source/ Wastewater effluent receiver | 10% | 20% |
| System's design | 30% | 25% |
| Operation and maintenance | 30% | 25% |
| Operator training and certification | 20% | 10% |
| Reporting and record keeping | 10% | 20% |

Source: INAC Administrative Data.

INAC categorizes the risk assigned to each component and the overall risk as:[44]

- **Low risk (1.0 to 4.0):** These are systems that operate with minor deficiencies. Low-risk systems usually meet the water quality parameters that are specified by the appropriate guidelines (such as the Guidelines for Canadian Drinking Water Quality).

- **Medium Risk (4.1 to 7.0):** These systems have deficiencies that, individually or combined, pose a medium risk to the quality of water and human health. These systems do not generally require immediate action, but the deficiencies should be corrected to avoid future problems.

- **High Risk (7.1 – 10.0):** These are systems with significant deficiencies that may, individually or combined, pose a high risk to the quality of water. While these deficiencies may lead to potential health and safety or environmental concerns, in many cases, systems identified as high risk are providing safe water to communities. The systems may be considered high risk for several reasons, ranging from insufficient record keeping to not having an operator with the proper certification.

# Appendix D: Protocol for Safe Drinking Water in First Nations Communities

The Protocol for Safe Drinking Water in First Nations Communities contains standards for design, construction, operation, maintenance, and monitoring of drinking water systems and is intended for use by First Nations staff responsible for water systems. It is also intended for use by Indigenous and Northern Affairs Canada (INAC) staff, Public Services and Procurement Canada (PSPC) for INAC staff, and all others involved in providing advice or assistance to First Nations in the design, construction, operation, maintenance, and monitoring of their drinking water systems in their communities, in accordance with established federal or provincial standards, whichever are the most stringent.

Any water system that produces drinking water destined for human consumption that is funded in whole or in part by INAC, and that serves five or more households or a public facility, must comply with the requirements of this protocol.[45]

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# Notes

[1] http://www.speech.gc.ca/en/content/making-real-change-happen#Clean-Environment-Strong-Economy, accessed June 12 2017

[2] http://www.budget.gc.ca/2016/docs/plan/ch3-en.html, accessed June 12 2017

[3] Neegan Burnside Ltd. (2011). National Assessment of First Nations Water and Wastewater Systems- National Roll-Up Report. Retrieved from Department of Indian and Northern Affairs Canada: http://www.aadnc-aandc.gc.ca/DAM/DAM-INTER-HQ/STAGING/texte-text/enr_wtr_nawws_rurnat_rurnat_1313761126676_eng.pdf

[4] Adjusted for inflation, INAC spending during the same period was about $1.9 billion in 2002 dollars, an average annual deflated value of $265 million.

[5] Note: The renewal funding is the renewal money of programs that were sunsetting

The incremental funding is the new money added to the current budget.

[6] Indigenous and Northern Affairs Canada. (2017). Protocols and guidelines for water systems. Retrieved from https://www.aadnc-aandc.gc.ca/eng/1100100034988/1100100034989?=undefined&wbdisable=true#chp1

[7] More details will be found further in the document.

[8] David Suzuki Foundation. (2017). Glass Half Empty? Resolving Drinking Water Advisories in Ontario. Retrieved from http://www.davidsuzuki.org/publications/DWA%20report%20-%20Feb%209.pdf

[9] Drinking water advisories: First Nations south of 60. (n.d.). Retrieved from https://www.canada.ca/en/health-canada/topics/health-environment/water-quality-h

[10] McClearn, M. (2016). Investigation: Water systems at risk. Retrieved from *The Globe and Mail*: https://www.theglobeandmail.com/news/national/indigenous-water/article31589755/

[11] According to Bill S-8 of the safe drinking water for first Nations act, first Nations communities are responsible for the remaining 20% of the O&M costs.

[12] Bill S-8: The Safe Drinking Water for First Nations Act. (n.d.). Retrieved from http://www.lop.parl.gc.ca/content/lop/LegislativeSummaries/41/1/s8-e.pdf

[13] Ibid. note 12..

[14] Statistics Canada. (2017). CANSIM - 380-0080 - Revenue, expenditure and budgetary balance - General governments. Retrieved from http://www5.statcan.gc.ca/cansim/a47

[15] PBO considers this additional money as a potential financial resource used by the first Nations communities to fund the remaining 20% of costs mentioned in Bill S-8.

[16] Ibid. note 3.

[17] Ibid. note 3.

[18] Some of these reserves are serviced by more than one wastewater system.

[19] Ibid. note 3.

[20] Decentralized management of wastewater is defined as the collection, treatment, and reuse of wastewater at or near the point of generation. Most of this wastewater is treated at the household, although small systems that serve clusters or housing developments are becoming more common (Nelson, 2005).

[21] Indigenous and Northern Affairs Canada. (2011). Water and Wastewater Policy and Level of Services Standards (Corporate Manual System). Retrieved from https://www.aadnc-aandc.gc.ca/eng/1312228309105/1312228630065

[22] Water and Wastewater Infrastructure Investment Report: April 2012 - March 2013. Retrieved from https://www.aadnc-aandc.gc.ca/eng/1403198954861/1403199074561.

[23] The total expenditure includes the capital and O&M spending.

[24] Treasury Board of Canada Secretariat. (2015). *First Nations Water and Wastewater Action Plan [successor to the joint First Nations Water Management Strategy (2003-2008) and the AANDC Plan of Action for Drinking Water (2006-2008)]*. Retrieved from http://www.tbs-sct.gc.ca/hidb-bdih/initiative-eng.aspx?Org=2&Hi=82

[25] Indigenous and Northern Affairs Canada. (2012). Water and Wastewater Infrastructure Reports. Retrieved from https://www.aadnc-aandc.gc.ca/eng/1352911655513/1352911698648

[26] Ibid. note 22.

[27] Ibid. notes 24 and 25.

[28] R.V. Anderson Associates Limited. (2016). On-Reserve Infrastructure: Condition and Replacement Needs.

[29] According to INAC definition, a registry group is an administrative term applied to a group of Indian register individuals who have membership in a particular Indian band, or, are descendants from members of that band.

[30] Indigenous and Northern Affairs Canada. (2012). Registered Indian Population by Sex and Residence 2011. Retrieved from https://www.aadnc-aandc.gc.ca/DAM/DAM-INTER-HQ-AI/STAGING/texte-text/rs_st_pubs_rip2011_pdf_1349278787966_eng.pdf

[31] Ibid. note 30.

[32] Table A.1 in Appendix A compares the life costs of the individual systems with those of the piped systems on some reserves in Alberta.

[33] More details will be found in Appendix D.

[34] This is an alternative approach recommended in the Anderson report

[35] The estimation methodology of switching option is described in Appendix C.2.

[36] Other entities may contribute, at much lower levels, to the on-reserve W&WW investments. For example, the Aboriginal general governments receive some revenue transfers from provincial and territorial general governments, in addition to the federal transfers. PBO calculates the portion of these

revenues that could be used as funding for on-reserve W&WW systems by projecting the INAC expense share assigned to the W&WW systems in the other aboriginal general government revenues. These additional funding may be used by the First Nations to finance their part of W&WW investments as defined in Bill S-8.

[37] Ibid. note 3.

[38] Lipka and Deaton (2015)

[39] INAC administrative data

[40] Ibid. note 28.

[41] The total servicing cost is the sum of the capital investment needed to upgrade the existing W&WW systems to meet the INAC's Protocol and the capital investment required to meet the future needs.

[42] Ibid. note 3.

[43] Table A.1 compares the life costs of the individual systems with those of the communal systems on some reserves in Alberta.

[44] Fact Sheet - Risk Assessment of Water and Wastewater. (n.d.). Retrieved from https://www.aadnc-aandc.gc.ca/eng/1313687144247/1313687434335

[45] https://www.aadnc-aandc.gc.ca/eng/1100100034913/1100100034920, accessed June 16 2017