NEEGAN BURNSIDE

National Assessment of First Nations Water and Wastewater Systems

National Roll-Up Report
FINAL

Department of Indian Affairs and Northern Development

April 2011

Neegan Burnside Ltd.
15 Townline
Orangeville, Ontario
L9W 3R4
1-800-595-9149
www.neeganburnside.com

National Assessment of First Nations Water and Wastewater Systems

National Roll-Up Report
Final

Department of Indian and Northern Affairs Canada

Prepared By:

Neegan Burnside Ltd.
15 Townline Orangeville ON L9W 3R4

Prepared for:

Department of Indian and Northern Affairs Canada

April 2011

File No: FGY163080.7

Statement of Qualifications and Limitations for National Roll-Up Report

This National Roll-Up report has been prepared by Neegan Burnside Ltd. and a team of sub-consultants (Consultant) for the benefit of Indian and Northern Affairs Canada (Client). The National Regional Roll-Up Report is prepared to facilitate planning and budgeting on both a regional and national level to address water and wastewater system deficiencies and needs.

The material contained in this National Roll-Up Report is:

- preliminary in nature, to allow for high level budgetary and risk planning to be completed by the Client on a national level.
- based on a compilation of the data and findings from the individual regional reports.
- not proposing to identify the preferred solution to address deficiencies for each community. Rather this report will identify possible solution(s) and probable preliminary costs associated with solution(s) presented in greater detail in the community reports. Community specific studies including more detailed evaluation will be required to identify both preferred solutions and final costs.
- based on existing conditions observed by, or reported to the Consultant. This assessment does not wholly eliminate uncertainty regarding the potential for costs, hazards or losses in connection with a facility. Conditions existing but not recorded were not apparent given the level of study undertaken.
- to be read in the context of its entirety.
- not to be used for any purpose other than that agreed to with the Client. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Any other user specifically denies any right to claims against the Consultant, Sub-Consultants, their Officers, Agents and Employees.

Risk as it pertains to health and safety issues and building code compliance is based upon hazards readily identifiable during a simple walk through of the water and wastewater facilities, and does not constitute a comprehensive assessment with regard to health and safety regulations and or building code regulations.

The Consultant accepts no responsibility for any decisions made or actions taken as a result of this report.

Executive Summary

The purpose of the *National Assessment* is to define current deficiencies and operational needs of water and wastewater systems, to identify long-term water and wastewater needs for each community and to review sustainable, long-term infrastructure development strategies for the next ten years. The recommendations are grouped according to infrastructure needs, operations and capacity, and reflections on regulations and guidelines.

Nationally, 571 of 587 First Nations (97%) participated in the study. Four First Nations chose not to participate, while 12 First Nations have no active infrastructure on reserve lands, in some cases as a result of recent or ongoing land claim settlements.

Water Systems

There are a total of 807 water systems serving 560 First Nations. The remaining 11 First Nations are serviced solely by individual water supplies. The following summarizes the level of service provided to the homes within the First Nation communities:

- 72% of the homes (81,026) are piped
- 13.5% of the homes (15,451) are on truck delivery
- 13% of the homes (14,479) are serviced by individual wells
- 1.5% of the homes (1,880) are reported to have no water service.

Overall, 52% of the systems rely on groundwater, 19% rely on a Municipal Type Agreement and 29% rely on surface water. Direct use of raw water is the most common in British Columbia, where it is the case for 40% of the systems.

Wastewater Systems

There are a total of 532 wastewater systems serving 418 First Nations. The remaining 153 First Nations are serviced solely by individual septic systems. Facultative lagoons are the most common type of treatment followed by Municipal Type Agreement systems. The following summarizes the level of wastewater service provided:

- 54% of the homes (61,395) are piped
- 8% of the homes (8,861) are on truck haul
- 36% of the homes (40,803) are serviced by individual wastewater systems
- 2% of the homes (1,777) are reported to have no service.

Individual Systems

An assessment was completed for approximately 5% of the individual well and septic systems. 36% of the individual wells sampled did not meet the requirements of the GCDWQ for a health related parameter (i.e. arsenic, barium, bacteriological, etc.) and 75% did not meet the GCDWQ for an aesthetic parameter (i.e. hardness, sodium, iron, manganese, etc.). Approximately 47% of the septic systems assessed had operational concerns identified, which were usually attributed to limited maintenance (not pumping out septic tank 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 referred to as a "shoot-out."

Risk Analysis

A risk assessment has been completed for each water and wastewater system according to the INAC Risk Level Evaluation Guidelines. The overall risk for each system is based on a weighted average of the following components: source – 10%, design – 30%, operations – 30%, reporting – 10% and operators – 20%.

Of the 807 water systems inspected:

- 314 (39%) are categorized as high overall risk
- 278 (34%) are categorized as medium overall risk
- 215 (27%) are categorized as low overall risk.

Although 39% of the systems are high risk, this represents only 25% of the population, as the majority of high risk systems tend to serve a small population. The greatest percentage of high risk systems are found in British Columbia (53%) followed by Ontario (46%).

Small water systems are generally found to have a higher risk rating than larger water systems. In many cases, these small facilities were not designed to meet current protocols and do not have the same level of resources available for operation as larger systems. In addition, the overall risk of a system appears to increase with remoteness.

Of the high risk systems, 150 systems serving 16% of the on-reserve population are flagged as high risk as a result of a bacteriological exceedance. Failure to meet a bacteriological Maximum Acceptable Concentration automatically results in high system risk using the risk tool provided. Other health related and aesthetic exceedances increase risk but do not automatically result in an overall high risk score.

Of the 532 wastewater systems inspected:

- 72 (14%) are categorized as high overall risk
- 272 (51%) are categorized as medium overall risk
- 188 (35%) are categorized as low overall risk.

It is noted that the current risk tool is not well equipped to assess the risk associated with a Municipal Type Agreement system, nor is it designed to assess the risk associated with residents relying on individual services or houses with no servicing. To be applied effectively and consistently by a variety of parties it is imperative that clear and suitable guidance materials are developed and the assumptions revisited on a regular basis.

Upgrade to Meet Protocol

One of the objectives of this study was to review the existing water and wastewater infrastructure, and to identify the potential upgrade costs to meet INAC's Protocols, and federal and provincial guidelines, standards and regulations.

The total estimated construction cost to meet protocol is $1.08 billion. This includes requirements that are considered to be related to health and safety, providing minimum levels of treatment, providing firm capacity, standby power and best management practices. Although the cost to upgrade systems is significantly higher in more remote communities, the extent of the needs was not significantly greater than in more accessible communities.

The total estimated non-construction cost is $79.8 million. This includes operator training, undertaking GUDI studies, and development of Source Water Protection Plans, Maintenance Management Systems, O&M manuals, Emergency Response Plans and other studies.

While the cost to meet protocol covers many items, some items will provide a more immediate impact as far as reducing system risk. For water supply, the provision of the required minimum level of treatment (in particular adequate disinfection) and operator training and support are both key as is, providing a reduction in risk at a relatively low cost.

New Servicing

An analysis was completed for each community to evaluate future servicing alternatives for a 10-year design period. The analysis considers a variety of alternatives, including centralised systems (expanding existing systems, developing new systems, connecting to nearby municipal systems through a Municipal Type Agreement) and the use of decentralised systems (individual wells and septic systems) as appropriate for each community.

These options were then evaluated based on estimated capital and operating and maintenance costs. Nationally, the capital cost associated with this servicing is $4.7 billion or approximately $29,600 per connection. The new servicing cost includes the cost of the upgrades necessary for systems to meet INAC's Protocol, if applicable (i.e. for servicing alternatives that include continued use of the existing system).

The use of centralised treatment systems and/or the use of Municipal Type Agreements is generally the most cost effective means of providing treatment at the required level of service. Extending piped servicing provides a high level of service with efficient operations and maintenance costs; however, it relies on a relatively compact layout to be cost effective. For communities with suitable soils and groundwater resources, individual wells and septic systems are an economical solution. Many of the communities are located in geographically remote areas, often in challenging terrain for typical servicing approaches. For very small communities, and those with a high servicing cost per connection, it is recommended that alternative servicing options be investigated.

Summary of Recommendations

A recent CD Howe Institute report, Safe Drinking Water Policy for Canada, Turning Hindsight into Foresight, by Steve Hrudey, dated February 2011, indicates the need to focus more on operational competence and support as well as a few key parameters that are known to pose a serious human health risk, such as bacteriological contamination. The report specifically mentions the benefits of the Circuit Rider Training program to provide hands on training and operator support, and identifies the need for increased support.

Moving forward, it is recommended that action be taken to address the issues identified within this National Assessment report, including:

Infrastructure

- works and measures associated with ensuring current systems meet the requirements of the various protocols, thereby reducing the risk associated with these systems
- the approach to addressing future servicing needs associated with the projected growth in First Nation communities.

Capacity and Operations

- increased support of Circuit Rider Training Program
- ensure systems have a certified primary and backup operator
- enhance awareness and follow-up to encourage adequate monitoring and record keeping
- develop and promote templates for source water protection plans, emergency response plans and maintenance management plans.

Standards and Regulations

It is recommended that INAC review and clarify some of the tools including the protocols and design guidelines, and the risk analysis system, including:

- clarification and harmonization of protocol and guidelines
- establishment of a regulatory framework for water and wastewater systems
- provide support to increase community and First Nation leadership awareness of water related issues (e.g. disinfection)
- modification of the INAC risk assessment tool
- update Asset Condition Reporting System to reflect current technology
- implement Full Cost Accounting.

Table of Contents

Tables

Figures

Appendix

1.0 Introduction

The Government of Canada is committed to providing safe, clean drinking water in all First Nations communities, and to ensuring that wastewater services in all First Nations communities meet acceptable effluent quality standards. As part of this commitment, the Government announced the First Nations Water and Wastewater Action Plan (FNWWAP). The plan funds the construction and renovation of water and wastewater facilities, operator training, and public health activities related to water and wastewater on reserves. It also provided for a national, independent assessment – *The National Assessment of First Nations Water and Wastewater Systems* – which will inform the Government's future, long-term investment strategy. This assessment was also recommended by the Senate Standing Committee on Aboriginal Peoples.

The purpose of the *National Assessment* is to define current deficiencies and operational needs of water and wastewater systems, to identify long-term water and wastewater needs for each community and to recommend sustainable, long-term infrastructure development strategies for the next ten years.

The objectives of the *National Assessment* are to:

- Identify which upgrades will be required for existing public systems to meet INAC's Level of Service Standards; INAC's Protocol for Safe Drinking Water in First Nations Communities; INAC's Protocol for Wastewater Treatment and Disposal in First Nations Communities; and applicable provincial regulations, codes, and standards

- Complete the Annual Inspection, Risk Assessment and Asset Condition Reporting System (ACRS) assessment for water and wastewater assets

- Conduct an overall community serviceability assessment of private, on-site communal and/or central systems

- Prepare Class "D" cost estimates for each of the communities visited. Class "D" estimates are preliminary, and are based on available site information. They indicate the approximate magnitude of the cost of the recommended actions, and they may be used to develop long-term capital plans. In addition, these estimates may be used in preliminary discussions of proposed capital projects.

This assessment involved collecting background data and information about each community, undertaking a site visit, and preparing individual community reports for each participating First Nation. Neegan Burnside and its sub-consultants conducted an assessment for each of the eight regions. This report summarizes the findings for all regions.

1.1 Site Visits

Neegan Burnside Ltd. and its sub-consultants visited 571 First Nations in Canada during 2009 and 2010. In addition to the consultant staff, additional participants including the Circuit Rider Trainer (CRT), INAC Representative, Environmental Health Officer (EHO) from Health Canada and Tribal Council Representative were invited to attend the site visits. The assessments represent the conditions in the community at the time of the inspection. It is understood that conditions may have changed over the duration of the study.

1.2 Reporting

Nationally, 571 of 587 First Nations (97%) participated in the study. In cases where the First Nation consists of multiple communities that are located in geographically distinct areas, a separate report was prepared for each community, which resulted in the preparation of 641 individual community reports. Those First Nations listed as having no assets have no active infrastructure on reserve lands, in some cases as a result of recent or ongoing land claim settlements.

Regional Roll-Up reports were prepared for each of eight regions which summarized the information provided in the individual community reports. Each regional report includes:

- a summary of risks associated with each water and wastewater system based on INAC risk assessment guidelines
- estimated capital costs associated with recommendations to meet departmental, federal and provincial protocols
- estimated capital costs associated with providing servicing for a 10 year growth period
- estimated annual O&M costs for future servicing to meet departmental protocols.

The appendices of each regional report also include overall water and wastewater system summaries and a risk evaluation summary for the region.

Table 1.1 - First Nations by Region

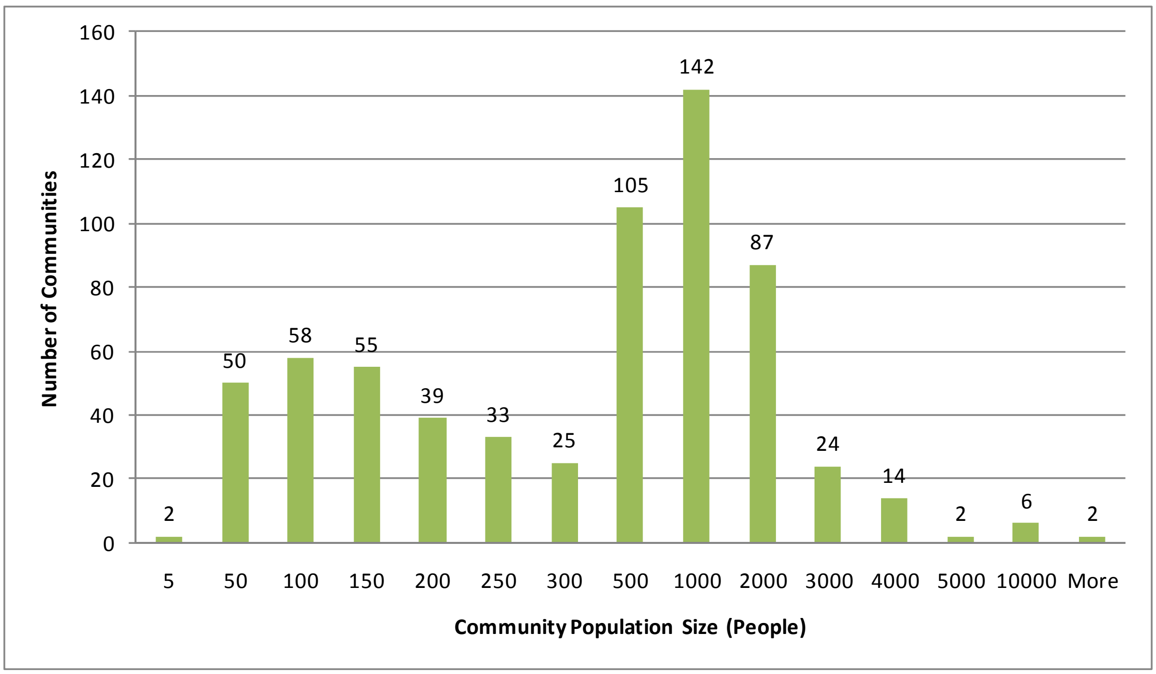
Region	Number of First Nations	Non - Participating First Nations	First Nations with No Assets	First Nations Visited	Reports Issued
Atlantic	33	0	0	33	35
Quebec	38	0	1	37	39
Ontario	122	1	1	120	122
Manitoba	63	0	1	62	62
Saskatchewan	70	0	1	69	86
Alberta	44	0	1	43	54
British Columbia	198	3	7	188	223
Northwest Territories	2	0	0	2	2
Yukon	17	0	0	17	18
Total	**587**	**4**	**12**	**571**	**641**

2.0 National Overview

First Nation communities are generally relatively small. For the 571 First Nations, the community population (both member and non-member) ranges from 13 to 11,449 people. Approximately 79% of the communities have a population of less than 1,000 people, and 57% have a population of less than 500 people. The average First Nation community population across the country is 751 people and the median population is 406.

The total on-site population is estimated to be 484,321 and the number of dwellings is estimated to be 112,836, which gives a national average household size of 4.3 persons per unit (ppu).

Figure 2.1 - National Community Population Size



2.1 Water Systems

There are a total of 807 water systems serving 560 First Nations. The remaining 11 First Nations are serviced solely by individual water supplies. The following summarizes the level of service being provided to the homes within the First Nation communities:

- 72% of the homes (81,026) are piped
- 13.5% of the homes (15,451) are on truck delivery
- 13% of the homes (14,479) are serviced by individual wells
- 1.5% of the homes (1,880) are reported to have no water service.

For the purposes of the assessment, homes without water service are defined as those without plumbing within the house. Table 2.1, below, provides an overview of the water systems by system classification, source type, storage type and treatment type.

The prevalence of piped wastewater service varies across the country, and is most common in the Atlantic, Quebec and British Columbia regions where more than 94% of homes have piped service. Piped service is least common in Alberta (38%) and the Yukon (31%) regions.

Similarly, the incidence of truck haul systems varies across the country. Truck haul systems are most common in the Yukon region (51%). Truck haul is significant in Alberta (31%), Manitoba (31%) and Saskatchewan (21%). Truck haul is uncommon in Ontario (10%). The Atlantic, British Columbia and Quebec regions have no systems with truck haul service.

The incidence of homes with no water service is highest in Manitoba (6%) although the number of houses with no service is similar in Manitoba and Ontario.

Table 2.1 - Water Overview - No. of Systems

System Classification	ATL	QB	ON	MB	SK	AB	BC	NWT	YK	Total	%
None	18	0	3	0	2	2	58	0	0	**83**	**11%**
Small System	1	1	24	12	8	7	122	0	5	**180**	**22%**
Level I	2	12	45	7	48	18	8	0	7	**147**	**18%**
Level II	5	12	62	32	36	19	20	0	2	**188**	**23%**
Level III	0	6	12	18	0	11	9	0	0	**56**	**7%**
Level IV	0	0	0	0	0	0	1	0	0	**1**	**0%**
MTA	9	8	12	5	9	25	72	2	10	**152**	**19%**
Total	**35**	**39**	**158**	**74**	**103**	**82**	**290**	**2**	**24**	**807**	**100%**

Source Type	ATL	QB	ON	MB	SK	AB	BC	NWT	YK	Total	%
Groundwater	20	19	39	32	70	29	155	0	11	**375**	**46%**
Groundwater GUDI	3	1	13	0	7	5	15	0	1	**45**	**6%**
Surface Water	3	11	94	37	17	23	48	0	2	**235**	**29%**
MTA	9	8	12	5	9	25	72	2	10	**152**	**19%**
Total	**35**	**39**	**158**	**74**	**103**	**82**	**290**	**2**	**24**	**807**	**100%**

Storage	ATL	QB	ON	MB	SK	AB	BC	NWT	YK	Total	%
None	15	5	47	11	11	20	96	2	14	**221**	**27%**
Elevated	5	4	14	0	0	0	24	0	1	**48**	**6%**
Standpipe	5	0	7	0	0	3	46	0	0	**61**	**8%**
Grade level	4	5	10	3	6	5	36	0	5	**74**	**9%**
Underground	6	25	80	60	86	54	88	0	4	**403**	**50%**
Total	**35**	**39**	**158**	**74**	**103**	**82**	**290**	**2**	**24**	**807**	**100%**

Treatment Type	ATL	QB	ON	MB	SK	AB	BC	NWT	YK	Total	%
None - Direct Use	2	1	4	6	4	1	115	0	2	**135**	**17%**
Disinfection Only	16	8	28	8	4	17	55	0	2	**138**	**17%**
Greensand Filtration	4	2	6	5	37	8	2	0	0	**64**	**8%**
Activated Carbon Only	0	0	0	1	0	0	0	0	0	**1**	**0%**
Slow Sand	1	1	19	1	2	1	29	0	0	**54**	**7%**
Conventional	1	16	46	34	21	24	12	0	3	**157**	**19%**
Membrane Filtration	2	3	43	14	26	6	5	0	7	**106**	**13%**
MTA	9	8	12	5	9	25	72	2	10	**152**	**19%**
Total	**35**	**39**	**158**	**74**	**103**	**82**	**290**	**2**	**24**	**807**	**100%**

The system classifications are split equally among Small, Level I, Level II and Municipal Type Agreement (MTA) systems, while the remaining 18% of systems are classified as Level III, Level IV or are unclassified. The majority of the unclassified treatment systems are located in British Columbia and the Atlantic regions; typically these systems are groundwater systems that serve a relatively small population. In British Columbia and the Atlantic, these systems are given a distribution classification only. In British Columbia, 20% of the systems are unclassified and 42% of the systems are classified as Small systems. In Alberta, Manitoba and Ontario, Level II systems are the most common. In Quebec, Level I and Level II systems are the most common. MTA's are the most common in the Yukon.

Nationally, 46% of the systems rely on a groundwater source, 6% rely on a groundwater under the direct influence (GUDI) source, 19% rely on a Municipal Type Agreement and 29% rely on surface water. Groundwater sources are most common in Saskatchewan (68%), Atlantic (57%) and Quebec (49%), whereas surface water is most common in Ontario (59%) and Manitoba (50%).

Water storage is provided for 73% of the systems. Underground storage is the most common, representing 50% of all types of storage systems.

Direct use of raw water is the most common in British Columbia, where it is the case for 40% of the systems. In Quebec, Ontario, Manitoba and Alberta, the most common form of treatment is conventional filtration. In the Yukon, the most common form of treatment is membrane filtration. Membrane filtration is also common in Ontario (27%). In Saskatchewan the most common form of treatment is for iron and manganese removal (36%). Nationally, direct use of raw water, disinfection only, conventional filtration and Municipal Type Agreement's are equally common at 17 to 19%.

2.2 Wastewater Systems

There are a total of 532 wastewater systems serving 418 First Nations. The remaining 153 First Nations are serviced solely by individual wastewater systems (septic systems and shoot-outs). The following is a summary of the level of wastewater service being provided to the homes within the First Nation communities:

- 54% of the homes (61,395) are piped
- 8% of the homes (8,861) are on truck haul
- 36% of the homes (40,803) are serviced by individual wastewater systems
- 2% of the homes (1,777) are reported to have no service.

Homes without wastewater service typically do not have indoor plumbing and often service is provided by the use of pit privies. Table 2.2 below, provides an overview of the wastewater systems by system classification and treatment type.

The prevalence of piped wastewater service varies across the country, and is the most common in the Atlantic and Quebec where more than 90% of homes have piped service. Piped service is the least common in Ontario (35%), Alberta (32%) and the Yukon (28%).

Similarly, the incidence of truck haul systems varies across the country. Truck haul systems are most common in the Yukon region (99%). Truck haul is uncommon in Ontario (5%) and Saskatchewan (7%). The Atlantic, British Columbia and Quebec regions have no systems with truck haul service.

The incidence of homes with no wastewater service is highest in Manitoba (5%) although the number of homes with no service is similar in Manitoba and Ontario.

Across the country, Level I is the most common wastewater system classification (49%) and the second most common system classification is Municipal Type Agreement (22%). This pattern holds for all regions except British Columbia, where both Small Systems (39%) and MTA systems (39%) are more common than Level I systems (11%). The incidence of systems without a classification is the highest in British Columbia (6%).

Nationally, wastewater systems which provide treatment using facultative lagoons are the most common (41%) and MTA's are the second most common (22%). There is considerable variation on a regional basis. Facultative lagoons are the most common form of treatment in Ontario, Saskatchewan and Alberta, whereas aerated lagoons are the most common in Quebec. MTA's are most common in British Columbia, the Yukon and the Atlantic. In Manitoba, mechanical treatment is the most common approach (40%).

The systems in British Columbia identified as having "None" for a treatment type describe situations where there is no treatment prior to a marine discharge. "Other" refers to systems such as solids removal in septic tanks followed by direct discharge, rapid infiltration basin, etc.

Table 2.2 - Wastewater Overview - No. of Systems

System Classification	ATL	QB	ON	MB	SK	AB	BC	NWT	YK	Total	%
None	0	0	0	0	0	1	9	0	0	**10**	**2%**
Small System	1	2	7	4	0	6	60	0	1	**81**	**15%**
Level I	10	23	46	28	83	51	17	0	1	**259**	**48%**
Level II	7	4	17	20	0	1	7	0	0	**56**	**11%**
Level III	1	0	1	5	0	1	1	0	0	**9**	**2%**
MTA	9	10	6	4	5	13	59	2	9	**117**	**22%**
Total	**28**	**39**	**77**	**61**	**88**	**73**	**153**	**2**	**11**	**532**	**100%**

Treatment Type	ATL	QB	ON	MB	SK	AB	BC	NWT	YK	Total	%
Aerated Lagoon	7	22	1	10	2	2	15	0	0	**59**	**11%**
Facultative Lagoon	6	0	37	22	81	52	16	0	2	**216**	**41%**
Mechanical Treatment	5	5	27	24	0	3	11	0	0	**75**	**14%**
MTA	9	10	6	4	5	13	59	2	9	**117**	**22%**
None	0	0	0	0	0	0	2	0	0	**2**	**0%**
Other	0	1	2	0	0	2	8	0	0	**13**	**3%**
Septic System	1	1	4	1	0	1	42	0	0	**50**	**9%**
Total	**28**	**39**	**77**	**61**	**88**	**73**	**153**	**2**	**11**	**532**	**100%**

2.3 Individual Systems

2.3.1 Individual Wells

Nationally, there are approximately 14,479 homes serviced by individual wells. For each community an assessment was completed for approximately 5% of the individual wells for a national total of 757 individual wells. The following summarizes the type of individual wells that were assessed within the First Nation communities:

- 73% were drilled wells
- 7% were bored wells
- 13% were dug wells
- 7% of wells were with unknown construction.

The assessment included sampling for bacteriological contaminants and other typical indicators of contamination, interviewing residents regarding operational and water quality concerns, and a visual assessment of the well. The water quality results for each community were presented in the individual community reports. Table 2.3 summarizes the number of individual wells assessed in each region, the percentage of wells that had quality concerns (health and aesthetic related) and the percentage of wells that met the *Guidelines for Canadian Drinking Water Quality* (GCDWQ).

Table 2.3 - Individual Well Summary

Region	Number of Individual Wells Assessed	Individual Wells Assessed with Health Concerns	Individual Wells Assessed with Aesthetic Concerns	Individual Wells Assessed that Meet Guidelines
Atlantic	30	23%	53%	40%
Quebec	57	32%	58%	32%
Ontario	164	48%	97%	1%
Manitoba	147	26%	74%	16%
Saskatchewan	51	45%	82%	12%
Alberta	237	38%	78%	19%
British Columbia	52	27%	38%	44%
Yukon	19	5%	37%	63%
Total	**757**	**36%**	**75%**	**19%**

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. In many cases, it was recommended that Point of Use (POU) treatment be installed to ensure safe drinking water quality for individual wells with quality concerns. Approximately 19% of the individual wells sampled met the requirements of the GCDWQ for health and aesthetic related parameters.

2.3.2 Community Building Wells

Nationally, an assessment was completed for a total of 94 community building wells, which serve public buildings within the communities including schools, band offices, daycares, health centres, libraries, fire halls and public works buildings. The assessment included sampling for bacteriological contaminants and other typical indicators of contamination, interviewing staff regarding operational and water quality concerns, and a visual assessment of the well. The water quality results for each community were presented in the individual community reports. Table 2.4 summarizes the number of community building wells assessed in each region, the percentage of wells that had quality concerns (health and aesthetic related) and the percentage of wells that met the *Guidelines for Canadian Drinking Water Quality* (GCDWQ).

Table 2.4 - Community Building Wells

Region	Number of Community Building Wells Assessed	Community Building Wells Assessed with Health Concerns	Community Building Wells Assessed with Aesthetic Concerns	Community Building Wells Assessed that Meet Guidelines
Atlantic	6	33%	83%	17%
Quebec	1	0%	0%	100%
Ontario	38	39%	97%	0%
Manitoba	15	40%	60%	13%
Saskatchewan	7	43%	86%	14%
Alberta	12	50%	58%	17%
British Columbia	3	33%	67%	33%
Yukon	12	17%	75%	17%
Total	**94**	**37%**	**80%**	**11%**

Nationally, 37% of the community building wells sampled did not meet the requirements of the GCDWQ for health related parameters (i.e. arsenic, barium, bacteriological, etc.) and 80% did not meet the GCDWQ for aesthetic related parameters (i.e. hardness, sodium, iron, manganese, etc.). Wellhead integrity or well construction issues are likely causes of contamination. In many cases, it was recommended that Point of Use (POU) treatment be installed to ensure safe drinking water quality for wells with quality concerns. Approximately 11% of the community building wells sampled met the requirements of the GCDWQ for health and aesthetic related parameters.

2.3.3 Private Surface Water Intakes

Nationally, an assessment was completed for a total of 13 private surface water intakes, of which 12 are located in Ontario and one in British Columbia. The water quality results for each community were presented in the individual community reports. Table 2.5 summarizes the number of private surface water intakes assessed in each region, the percentage of intakes with quality concerns (health and aesthetic related) and the percentage of intakes that met the *Guidelines for Canadian Drinking Water Quality* (GCDWQ).

Table 2.5 - Private Surface Water Intakes

Region	Number of Private Surface Water Intakes Assessed	Private Surface Water Intakes Assessed with Health Concerns	Private Surface Water Intakes Assessed with Aesthetic Concerns
Ontario	12	50%	92%
British Columbia	1	100%	0%
Total	**13**	**54%**	**85%**

Nationally, 54% of the surface water intakes sampled did not meet the requirements of the GCDWQ for health related parameters (i.e. arsenic, barium, bacteriological, etc.) and 85% did not meet aesthetic related parameters (i.e. hardness, sodium, iron, manganese, etc.). In many cases, the main cause of contamination is a direct result of having improper treatment for a surface water source. Approximately 46% of the surface water intakes sampled met the requirements of the GCDWQ for health and aesthetic related parameters.

2.3.4 Private Septic Systems

Nationally, there are approximately 40,803 homes serviced by individual wastewater systems, typically septic systems. For each community, an assessment was completed for 5% of the individual wastewater systems for a total of 1,960 systems nationally. The assessment included interviewing the residents regarding operational and environmental concerns and a visual assessment of the wastewater system. Table 2.6 summarizes the number of individual wastewater systems assessed in each region and the percentage of these systems that discharge septage waste to the surface.

Table 2.6 - Individual Wastewater Systems Summary

Region	Number of Septics Assessed	Systems with Surface Discharge	Operational Concerns
Atlantic	45	4%	20%
Quebec	60	10%	32%
Ontario	551	2%	28%
Manitoba	184	15%	62%
Saskatchewan	317	40%	68%
Alberta	520	42%	65%
British Columbia	226	3%	27%
Northwest Territories	7	0%	0%
Yukon	50	0%	4%
Total	**1960**	**20%**	**47%**

Approximately 47% of the individual wastewater systems assessed had operational concerns identified, which were usually attributed to limited maintenance (not pumping out septic tank 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.

3.0 Final Results and Trends

3.1 Per Capita Consumption and Plant Capacity

For communal water systems, the average per capita demand ranges from 30 L/p/d to 986 L/p/d, with an average per capita demand of approximately 306 L/p/d.[1]

The distribution of per capita flow is outlined in Table 3.1.

Table 3.1 - Range of Per Capita Water Usage Rates

Region	Less than 250 L/p/d	250 L/p/d to 375 L/p/d	Greater than 375 L/p/d
Atlantic	3%	91%	6%
Quebec	28%	38%	34%
Ontario	25%	64%	11%
Manitoba	51%	46%	3%
Saskatchewan	41%	45%	14%
Alberta	51%	42%	7%
British Columbia	9%	73%	18%
Northwest Territories	50%	50%	0%
Yukon	63%	29%	8%
National (Weighted Average)	**27%**	**60%**	**13%**

Generally, the western and northern regions are observed to more likely have a lower per capita water demand than other regions. British Columbia is a notable exception to this. The higher per capita demands are more likely to be found in British Columbia and Quebec than in the other regions. These regions have relatively high percentages of piped water service.

The historical wastewater flow data available for most of these systems was very limited. Therefore, to evaluate the ability of the existing infrastructure to meet the current and projected needs, an average daily flow was calculated based on the actual or assumed per capita water consumption, plus an infiltration allowance of 90 L/c/d for piped servicing.

The following figure provides a summary of the treatment capacity for the water and wastewater systems:

- over capacity: the existing system is unable to meet the current needs
- at capacity: the existing system is able to meet the current needs
- available capacity: the existing system has sufficient capacity to meet more than the current needs
- not enough data: insufficient data to determine the actual system capacity.

[1] By comparison, according to Environment Canada data (2004), the average per capita consumption across Canada, is 329 L/c/d.

Figure 3.1 - Water Treatment Capacities

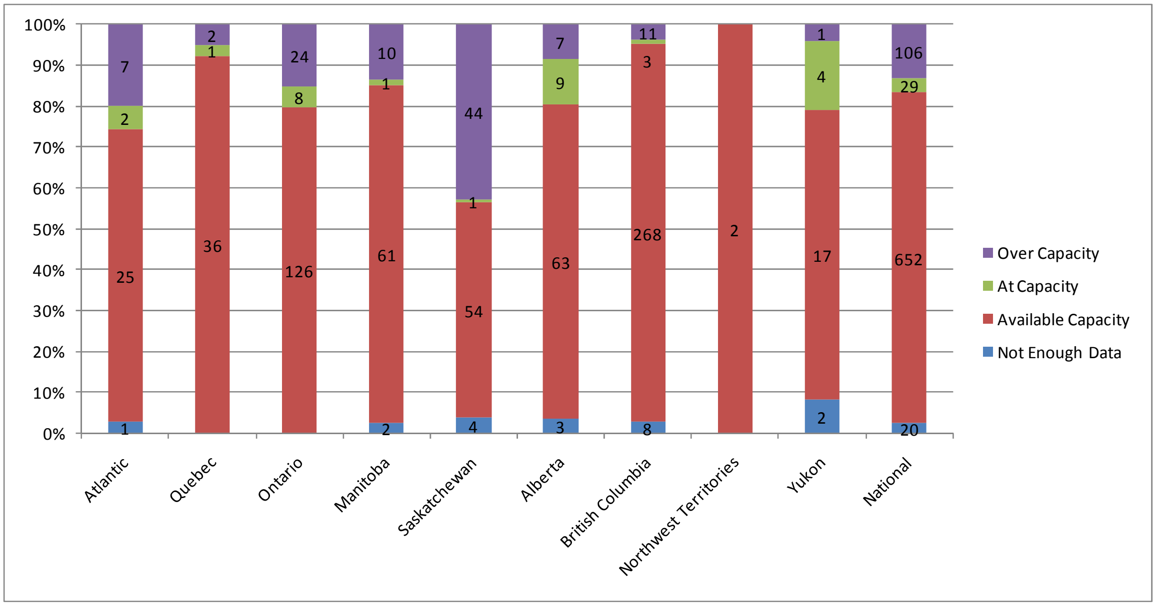
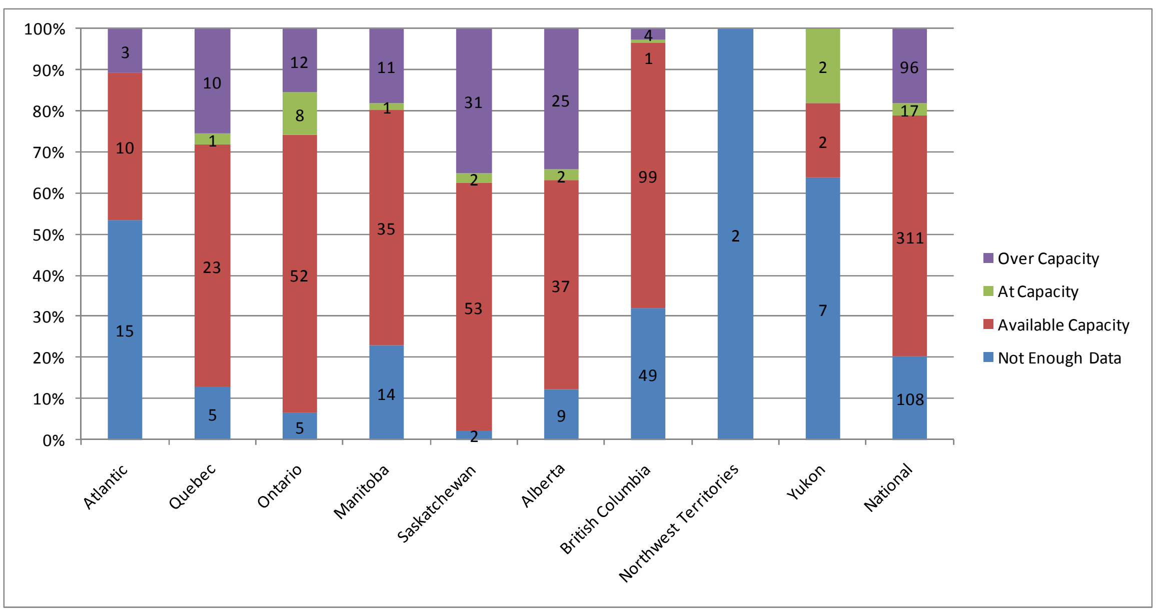


Figure 3.2 - Wastewater Treatment Capacities



The data shows that 135 water systems (17%) and 113 wastewater systems (21%) are operating at or beyond their estimated capacities. The incidence of water systems at or over capacity is highest in Saskatchewan (44%), followed by the Atlantic region (26%). The incidence of wastewater systems at or over capacity is highest in Saskatchewan (38%) followed closely by Alberta (37%).

3.2 Distribution and Collection

The total number of piped connections is 81,026 for water and 61,395 for wastewater. The average length per connection of water main is approximately 58 m and for sewer main is approximately 32 m. The regional variation is presented for water and wastewater in Table 3.2. Alberta region has the highest average length of water main and sewer main per connection, followed by Saskatchewan. Seven of eight regions have an average water main length per connection greater than 30 m and five regions have an average sewer main length greater than 30 m.

Table 3.2 - Average Water Distribution and Wastewater Collection Pipe Lengths

	Water (Distribution)	Wastewater (Collection)
Region	**Avg. Length per Connection (m)**	**Avg. Length per Connection (m)**
Atlantic	33	26
Quebec	22	20
Ontario	52	30
Manitoba	56	33
Saskatchewan	72	43
Alberta	136	54
British Columbia	60	33
Yukon	47	35
National (Weighted Average)	**58**	**32**

Water main is typically a higher number than sewer main. Water main typically included transmission mains and raw water feedermains in the total lengths, while forcemains from pumping stations to wastewater treatment facilities are typically funded as part of the pumping station and does not have a separate asset code in ACRS.

3.3 Risk Evaluation

A risk assessment has been completed for each water and wastewater system according to the INAC Risk Level Evaluation Guidelines.

The overall risk level of the system is ranked numerically from 1 to 10. Low, medium and high risks are defined as follows:

- **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 water (in particular, the Guidelines for Canadian Drinking Water Quality (GCDWQ)).
- **Medium Risk (4.1 to 7.0):** These are systems with deficiencies, which—individually or combined—pose a medium risk to the quality of water and to human health. These systems do not generally require immediate action, but the deficiencies should be corrected to avoid future problems.
- **High Risk (7.1 to 10.0):** These are systems with major deficiencies, which—individually or combined—pose a high risk to the quality of water. These deficiencies may lead to potential health and safety or environmental concerns. They could also result in water quality advisories against drinking the water (such as, but not limited

to, boil water advisories), repetitive non-compliance with guidelines, and inadequate water supplies. Once systems are classified under this category, regions and First Nations must take immediate corrective action to minimize or eliminate deficiencies.

3.3.1 National Risk Summary:

Of the 807 water systems inspected:

- 314 (39%) are categorized as high overall risk
- 278 (34%) are categorized as medium overall risk
- 215 (27%) are categorized as low overall risk.

Table 3.3 - Summary of Overall Risk Levels by Region - Water

Region	High	Medium	Low	Total
Atlantic	6	19	10	**35**
Quebec	7	12	20	**39**
Ontario	72	61	25	**158**
Manitoba	21	32	21	**74**
Saskatchewan	27	47	29	**103**
Alberta	21	48	13	**82**
British Columbia	154	52	84	**290**
Northwest Territories	0	2	0	**2**
Yukon	6	5	13	**24**
Total	**314**	**278**	**215**	**807**

Figure 3.3 provides a geographical representation of the final risk for the water systems that were inspected.

Although 39% of the systems are high risk, this represents 25% of the population, as the majority of high risk systems tend to serve a small population. The greatest percentage of high risk systems are found in British Columbia (53%) followed by Ontario (46%). The incidence of low risk systems is greatest in the Yukon (54%), closely followed by Quebec (52%).

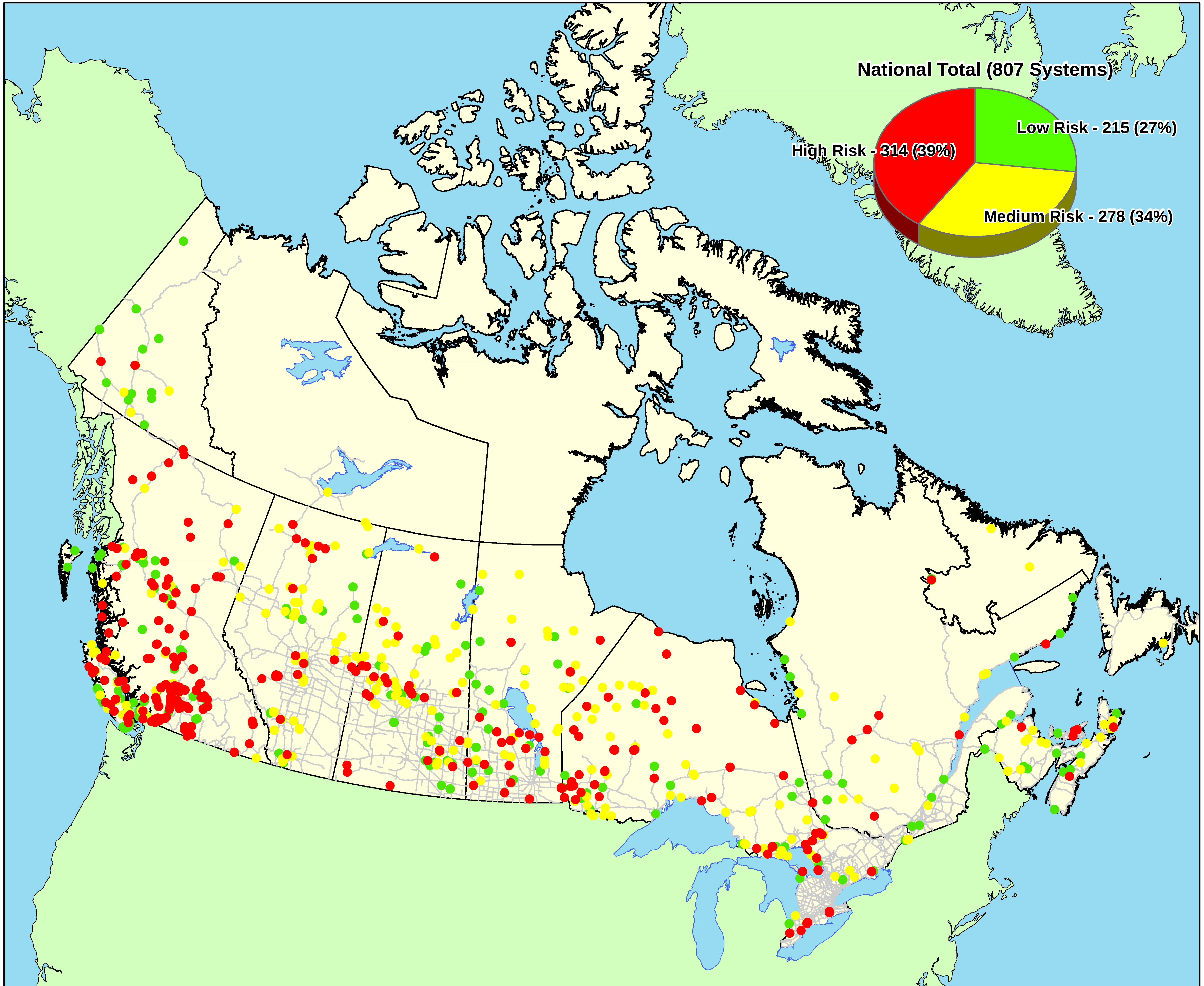
The overall risk for each system consists of five components. Each component is given a risk score between 1 and 10 and the overall system risk is then calculated based on a component weighting of source – 10%, design – 30%, operations – 30%, reporting – 10% and operators – 20%.

Nationally, the component scores for source, operation and reporting risk are similar at 6.1 to 6.3, design risk is approximately 5.3 and operator risk is the lowest at 2.6. Regionally, all component risk scores for Quebec and the Yukon are lower than the national average. Figure 3.4 illustrates both national and regional water risk scores.

Indian and Northern Affairs Canada / Affaires indiennes et du Nord Canada

NATIONAL ASSESSMENT OF FIRST NATION WATER AND WASTEWATER SYSTEMS

Figure 3.3
Community Water Systems By Risk



Water System Risk Level

- High
- Medium
- Low
- Major Roads
- Major Lakes

NOTES

This map has been compiled with data of varying scale and accuracy.
This is not a plan of survey.

SOURCES

DISCLAIMER

Neegan Burnside Ltd. and the above mentioned sources and agencies are not responsible for the accuracy of the spatial, temporal, or other aspects of the data represented on this map. It is recommended that users confirm the accuracy of the information represented.

Project: FGY16308
Drawn By: B. Goll

Projection: Canada LCC
Datum: NAD83

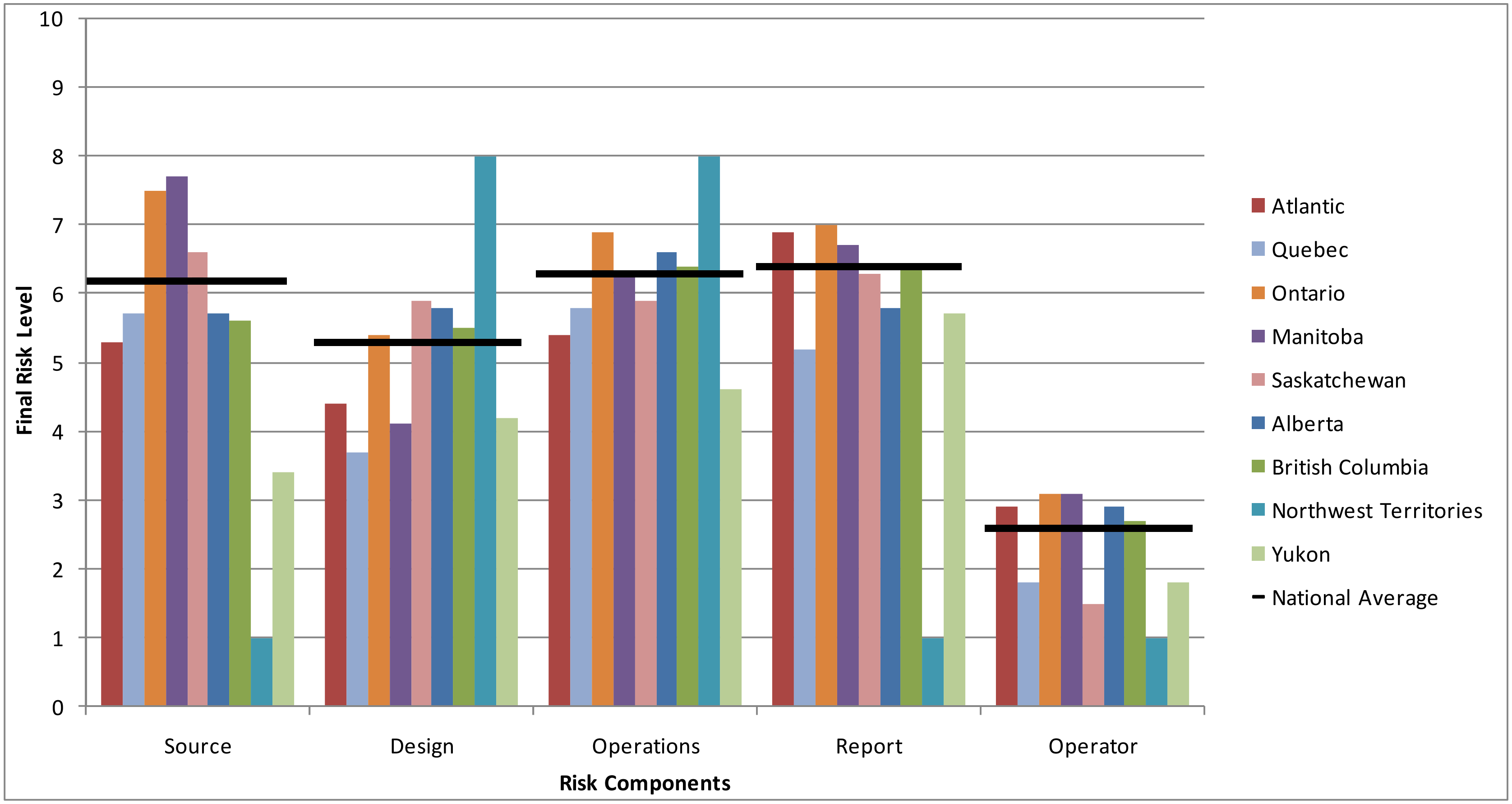
N

0 200 400 600 800 1,000
Kilometres

NEEGAN BURNSIDE

P:_FGY16308\Maps\Risk\National_Water_Systems

Figure 3.4 - Water: Risk Profile Based on Risk Components by Region



The following table illustrates the relationship between remoteness and risk. Nationally, the overall risk of a water system appears to increase with remoteness, where, as defined by the INAC remoteness factor, Zone 1 is the most readily accessible and Zone 4 is the least accessible. In Zone 1 the systems are evenly distributed between low, medium and high risk, whereas in Zone 4 the water systems are 2.5 times more likely to be high risk than low risk.

Table 3.4 - Summary of Overall Risk Levels by Zone: Water

	Population	No. of Systems	High	Medium	Low	Total
Zone 1	136,683	261	34%	34%	32%	**100%**
Zone 2	186,362	386	40%	38%	22%	**100%**
Zone 3	16,840	37	41%	35%	24%	**100%**
Zone 4	71,559	123	49%	33%	19%	**100%**
Total	**411,444**	**807**	**40%**	**36%**	**25%**	**100%**

Of the 532 wastewater systems inspected:

- 72 (14%) are categorized as high overall risk
- 272 (51%) are categorized as medium overall risk
- 188 (35%) are categorized as low overall risk.

Table 3.5 - Summary of Overall Risk Levels by Region - Wastewater

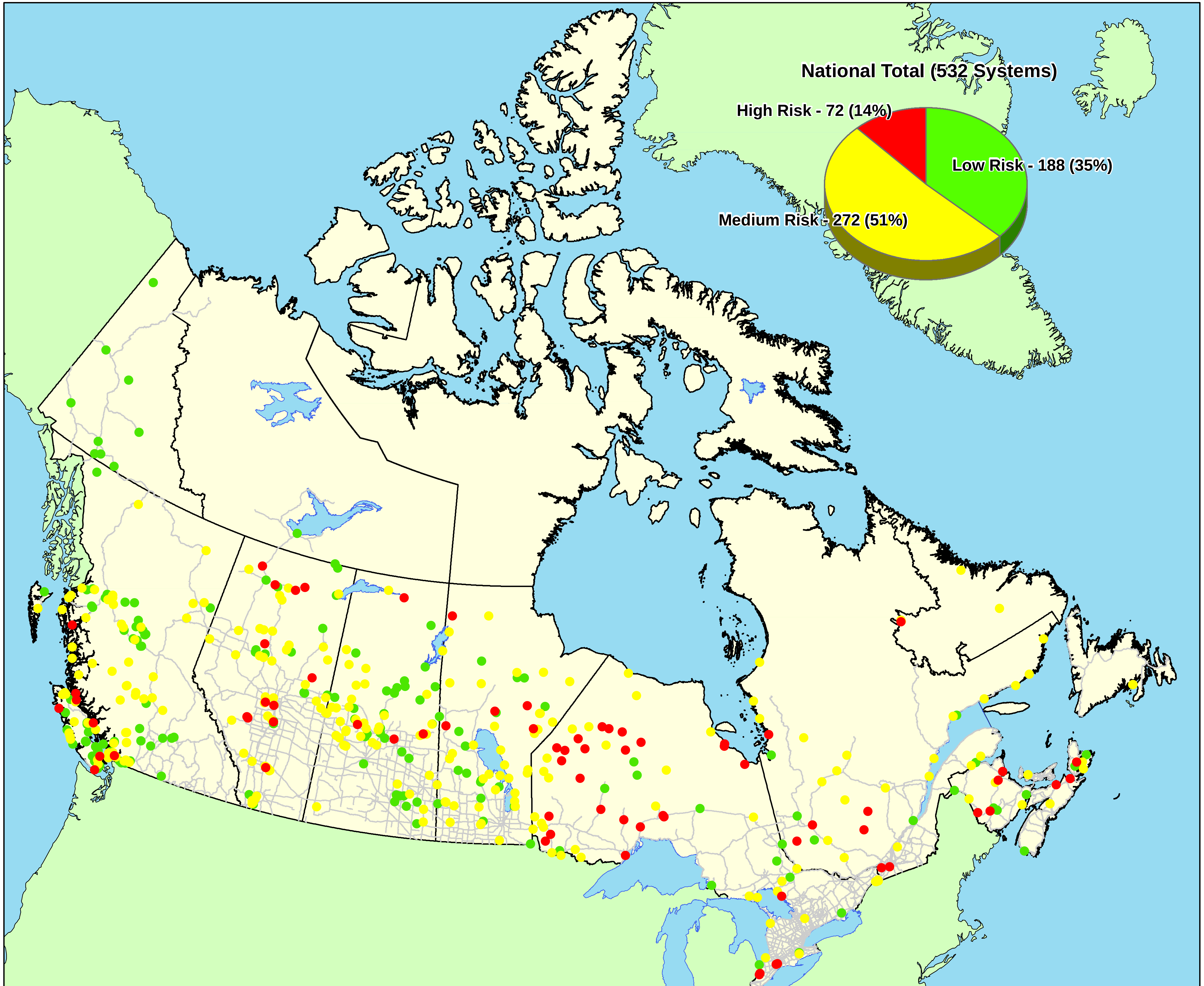
Region	High	Medium	Low	Total
Atlantic	7	12	9	**28**
Quebec	7	26	6	**39**
Ontario	28	38	11	**77**
Manitoba	6	38	17	**61**
Saskatchewan	4	44	40	**88**
Alberta	12	44	17	**73**
British Columbia	8	69	76	**153**
Northwest Territories	0	0	2	**2**
Yukon	0	1	10	**11**
Total	**72**	**272**	**188**	**532**

Figure 3.5 provides a geographical representation of the final risk for the wastewater systems that were inspected. Figure 3.6 illustrates both national and regional wastewater risk scores.

Indian and Northern Affairs Canada
Affaires indiennes et du Nord Canada

NATIONAL ASSESSMENT OF FIRST NATION WATER AND WASTEWATER SYSTEMS

Figure 3.5
Community Wastewater Systems
By Risk



Wastewater System Risk Level

- High
- Medium
- Low
- Major Roads
- Major Lakes

NOTES

This map has been compiled with data of varying scale and accuracy.
This is not a plan of survey.

SOURCES

DISCLAIMER

Neegan Burnside Ltd. and the above mentioned sources and agencies are not responsible for the accuracy of the spatial, temporal, or other aspects of the data represented on this map. It is recommended that users confirm the accuracy of the information represented.

Project: FGY16308
Drawn By: B. Goll

Projection: Canada LCC
Datum: NAD83

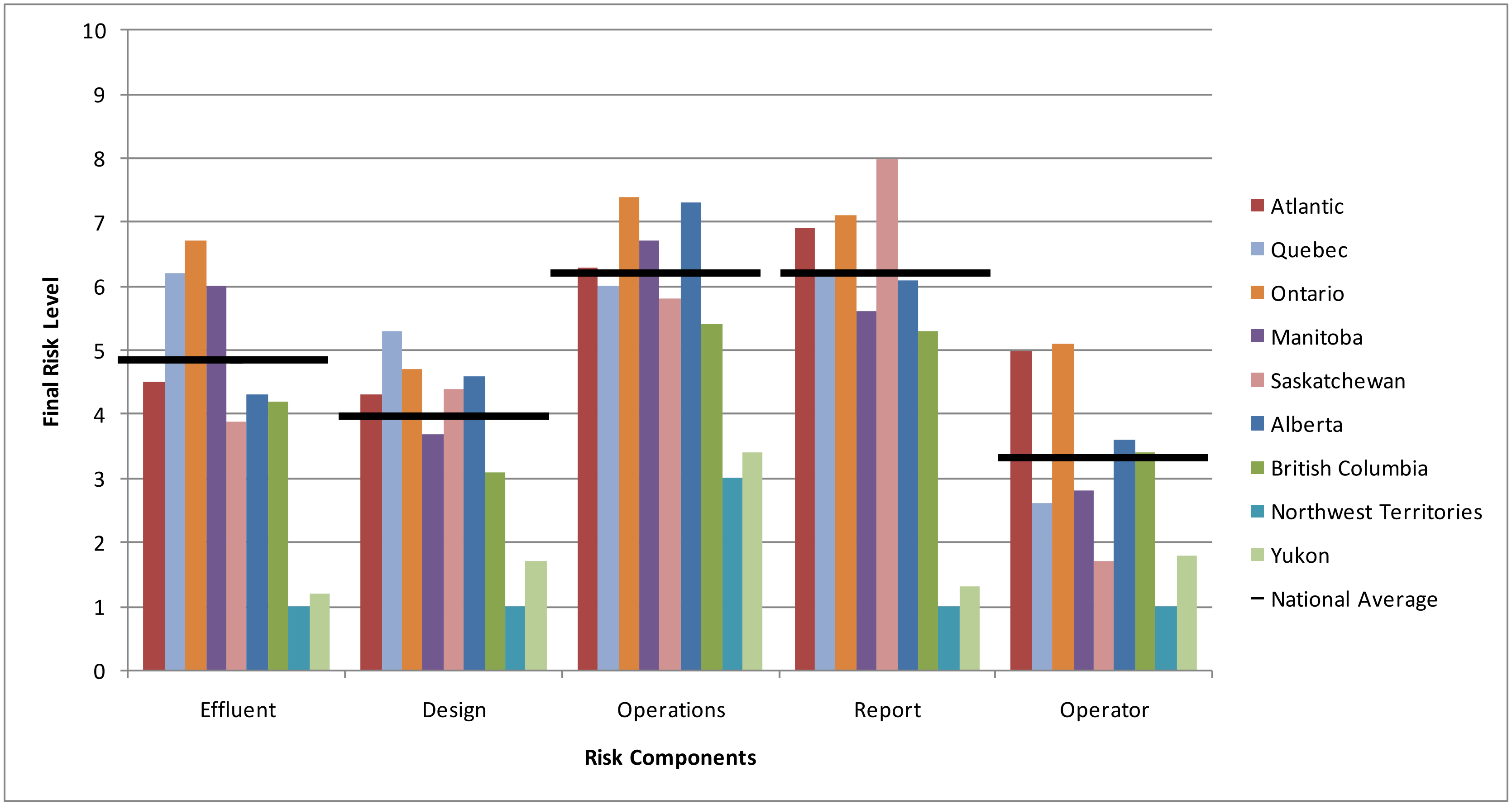
N

0 200 400 600 800 1,000
Kilometres

NEEGAN BURNSIDE

P:_FGY16308\Maps\Risk\National_Wastewater_Systems

Figure 3.6 - Wastewater: Risk Profile Based on Risk Component by Region



The greatest percentage of high risk systems are found in Ontario (36%) followed by the Atlantic (25%). The incidence of low risk systems is greatest in the Northwest Territories (100%), Yukon (91%) and British Columbia (50%).

The overall risk for each system consists of five components. Each component is given a risk score between 1 and 10 and the overall system risk is then calculated based on a component weighting of effluent – 20%, design – 25%, operations – 25%, reporting – 10% and operators – 20%.

Table 3.6 - Risk By Zone: Wastewater

	Population	No. of Systems	High	Medium	Low	Total
Zone 1	95,212	177	12%	44%	44%	**100%**
Zone 2	127,587	238	9%	56%	35%	**100%**
Zone 3	13,558	24	4%	58%	38%	**100%**
Zone 4	68,522	93	29%	57%	14%	**100%**
Total	**304,879**	**532**	**14%**	**52%**	**34%**	**100%**

3.3.2 Overall System Risk by Source

The following table summarizes the overall system risk by water source. In general, it is assumed that MTA systems would have a lower overall risk than other systems because they operate in accordance with provincial legislation. Nationally, 52% of the groundwater systems, 51% of the GUDI systems, 36% of the surface water systems and 7% of the MTA systems are high risk systems. 17% of the groundwater systems, 11% of the GUDI systems, 21% of the surface water systems and 64% of the MTA systems have a low overall risk.

In British Columbia, 99 or 64% of the groundwater systems do not provide any treatment including disinfection and therefore scored as high risk systems.

Table 3.7 - Summary of Overall Risk Levels by Water Source

Overall Risk Level	Groundwater	GUDI	Surface Water	MTA	Total
High	196	23	85	10	**314**
Medium	115	17	101	45	**278**
Low	64	5	49	97	**215**
Total	**375**	**45**	**235**	**152**	**807**

3.3.3 Overall System Risk by Treatment Classification - Water

The following table summarizes the overall system risk by the classification level of the treatment system. System classification is based on a number of factors, among them service population and treatment complexity. It was generally observed that the simpler the facility the more likely the facility was to have medium or high overall risk, and that the incidence of high overall risk was greatest for systems which are not classified. The simpler and smaller systems are often riskier as they are more likely to lack suitable treatment and resources.

Table 3.8 - Summary of Overall Risk Levels by Treatment Classification - Water

Overall Risk Level	Small System	Level I	Level II	Level III	Level IV	MTA	None	Total
High	126	57	44	16	0	10	61	**314**
Medium	31	65	96	24	0	45	17	**278**
Low	23	25	48	16	1	97	5	**215**
Total	**180**	**147**	**188**	**56**	**1**	**152**	**83**	**807**

3.3.4 Overall System Risk by Treatment Classification - Wastewater

The following table summarizes the overall system risk by the classification level of the treatment system. For MTA systems, it was assumed that the municipality operates their system in accordance with provincial legislation, which contributes to a lower overall risk for these systems. For wastewater treatment systems, it appears that a higher plant classification is positively correlated with the incidence of a facility having a medium or high overall risk. MTA systems are the most likely to be low risk.

Table 3.9 - Summary of Overall Risk Levels by Treatment Classification - Wastewater

Overall Risk Level	Small System	Level I	Level II	Level III	MTA	None	Total
High	9	37	20	2	4	0	**72**
Medium	47	161	27	7	21	9	**272**
Low	25	61	9	0	92	1	**188**
Total	**81**	**259**	**56**	**9**	**117**	**10**	**532**

3.4 Water Quality

Of the 314 water systems classified as high risk, 192 are identified as not meeting a health related parameter in the Guidelines for Canadian Drinking Water Quality (GCDWQ). There are an additional 120 systems that did not meet the GCDWQ for a health related parameter but are not classified as high risk.

Of the 192 high risk systems, 150 are flagged as high risk as a result of a bacteriological exceedance; 59 as a result of system design, 58 as a result of operation and 33 attributed to both design and operation. Failure to meet a bacteriological Maximum Acceptable Concentration automatically results in high system risk using the risk tool provided. Other health related and aesthetic exceedances increase risk but do not automatically result in an overall high risk score.

There are 158 water systems identified as making direct use of raw water, of these 135 are classified as high risk using the tool provided and 65 of these are identified as failing to meet the GCDWQ for a health related parameter.

Nationally, a total of 278 water systems are identified as not meeting the limits for an aesthetic parameter in the GCDWQ. These include 139 high risk systems.

3.5 Operators

The following tables summarize the operator status for water and wastewater systems. For both water and wastewater systems, less than 5% of the systems did not have a primary operator. However, only 54% of water systems and 49% of wastewater systems have a fully certified primary operator. For water systems approximately 81% of the systems had a backup operator and for wastewater systems approximately 74% of the systems had a backup operator.

For both water and wastewater systems, the percentage of certified operators is considerably lower in Zone 4 than in Zone 1. This may be because there is easier access to training for operators in Zones 1, 2 and 3.

Table 3.10 - Water: Operator Status by Zone - Treatment

	No. of Systems that Require Operators	Operators Certified (Primary)	Systems without Primary Operator	Systems without Backup Operator
Zone 1	118	67%	2%	16%
Zone 2	314	59%	4%	20%
Zone 3	32	47%	3%	97%
Zone 4	108	26%	1%	15%
Total	**572**	**54%**	**3%**	**19%**

Table 3.11 - Wastewater: Operator Status by Zone - Treatment

	No. of Systems that Require Operators	Operators Certified (Primary)	Systems without Primary Operator	Systems without Backup Operator
Zone 1	96	51%	5%	20%
Zone 2	207	56%	3%	29%
Zone 3	19	63%	10%	26%
Zone 4	83	27%	6%	26%
Total	**405**	**49%**	**4%**	**26%**

The ability to develop and retain suitable certified operators is critical to having a well run water or wastewater system. Certified operators are more likely to operate facilities in compliance with applicable guidelines and legislation. The absence of a certified operator may impact other issues such as monitoring, reporting and record keeping, and increases the risk associated with these components. The percentage of certified operators is generally higher for water systems than for wastewater systems.

3.6 Plans

Information was collected regarding the availability of various documents, including Source Water Protection Plans (SWPP), Maintenance Management Plans (MMP), and Emergency Response Plans (ERP).

The following tables provide a summary of the percentages of First Nations that have plans in place.

Table 3.12 - Plans Summary: Water

Region	*Percentage of Water Systems that have a (an)…*		
	Source Water Protection Plan	**Maintenance Management Plan**	**Emergency Response Plan**
Atlantic	15%	3%	17%
Quebec	39%	62%	33%
Ontario	11%	24%	25%
Manitoba	4%	7%	1%
Saskatchewan	7%	52%	40%
Alberta	0%	23%	11%
British Columbia	10%	28%	39%
Northwest Territories	0%	0%	0%
Yukon	64%	29%	21%
National Weighted Average	**11%**	**28%**	**28%**

Table 3.13 - Plans Summary: Wastewater

Region	*Percentage of Wastewater Systems that have a (an)…*	
	Maintenance Management Plan	**Emergency Response Plan**
Atlantic	4%	18%
Quebec	59%	18%
Ontario	8%	6%
Manitoba	5%	2%
Saskatchewan	40%	33%
Alberta	10%	19%
British Columbia	31%	31%
Northwest Territories	0%	0%
Yukon	0%	18%
National Weighted Average	**23%**	**21%**

The above tables reflect the percentages of First Nations that have an approved Emergency Response Plan (ERP) that is existing and in use. An additional 18% of First Nations have an approved ERP that is not in use or a generic ERP that is being used.

3.6.1 Source Water Protection Plans

Source water protection planning is one component of a multi-barrier approach to providing safe drinking water. Source Water Protection Plans seek to identify threats to the water source. They also establish policies and practices to prevent contamination of the water source and to ensure that the water service provider is equipped to take corrective action in the event of water contamination. Source water protection is appropriate for groundwater and surface water sources.

Source Water Protection Plans are uncommon, with only 11% of water systems having a plan in place. Quebec (39%) and the Yukon (64%) had a significantly above average number of systems with Source Water Protection Plans in place, whereas Manitoba (4%), Saskatchewan (7%) and Alberta (0%) had very low incidence of Source Water Protection Planning.

3.6.2 Maintenance Management Plans

Maintenance management plans are intended to improve the effectiveness of maintenance activities. They focus on planning, scheduling and documenting preventative maintenance activities, and they document unscheduled maintenance efforts. The plans represent a change from reactive to proactive thinking and, when executed properly, optimize maintenance spending, minimize service disruption, and extend asset life.

Nationally, 28% of water systems had a Maintenance Management Plan in place. However, the incidence of these was highly varied across the regions ranging from Quebec (62%) to very low in Manitoba (7%) and the Atlantic (3%).

Nationally, 23% of wastewater systems had a Maintenance Management Plan in place. Quebec had the highest incidence at 59%. Six of eight regions had an incidence of 10% or less.

3.6.3 Emergency Response Plans

Emergency Response Plans (ERPs) are intended to be a quick reference to assist operators and other stakeholders in managing and in responding to emergency situations. Emergency Response Plans should be in place for both water and wastewater systems. They include key contact information for those who should be notified and who may be of assistance in case of emergency (agencies, contractors, suppliers, etc.), and they provide standard communication and response protocols. Emergency Response Plans identify recommended corrective actions for foreseeable emergencies, and they establish methodologies for addressing unforeseen situations. They are essentially the last potential barrier in a multi-barrier approach to protecting the drinking water supply and the natural environment, and they guide activities to mitigate damages.

Nationally, 28% of water systems had an Emergency Response plan in place. Saskatchewan and British Columbia had the highest incidence at 40% and 39% respectively. Manitoba and Northwest Territories had very low incidences.

Nationally, 21% of wastewater systems had an Emergency Response Plan. The incidence of these plans was lowest in Ontario, Manitoba and the Northwest Territories.

4.0 Cost Analysis

In 2006, INAC began to develop a series of Protocol documents for centralised and decentralised water and wastewater systems in First Nation communities. The Protocols contain standards for the design, construction, operation, maintenance, and monitoring of these systems.

One of the objectives of this study was to review the existing water and wastewater infrastructure, and to identify the potential upgrade costs to meet INAC's Protocols, and federal and provincial guidelines, standards and regulations.

4.1 Upgrade to Meet INAC's Protocol: Water

Table 4.1 is a summary of the estimated construction, non-construction and additional annual O&M costs for water system upgrades to meet the INAC Protocol by region.

Table 4.1 - Summary of Protocol Estimated Costs: Water

Region	Construction Costs	Non-Construction Costs	Additional Annual Water O&M Costs
Atlantic	$28,427,950	$2,717,500	$1,049,000
Quebec	$14,930,600	$775,000	$145,650
Ontario	$228,111,450	$13,578,000	$4,036,050
Manitoba	$52,467,450	$4,482,500	$362,500
Saskatchewan	$137,099,800	$11,345,000	$1,854,500
Alberta	$103,628,800	$6,625,000	$2,720,350
British Columbia	$208,887,600	$22,592,000	$3,896,000
Northwest Territories	$0	$35,000	$13,500
Yukon	$9,338,000	$1,222,500	$665,100
Total Estimate	**$782,891,650**	**$63,372,500**	**$14,742,650**

The total estimated construction cost is $783 million and includes a 25% allowance for engineering and contingencies. This includes requirements that are considered to be related to health and safety, providing minimum levels of treatment, providing firm capacity, and best management practices. The cost to upgrade similar systems is significantly higher in the more remote communities, however, the extent of the needs was not significantly higher in remote areas than in more accessible communities. Other factors such as source type had more influence on the extent of the needs.

The total estimated non-construction cost is $63.4 million. This includes operator training, undertaking GUDI studies, development of Source Water Protection Plans, Maintenance Management Systems, O&M manuals, Emergency Response Plans and other studies.

The total estimated additional annual operation and maintenance cost is $14.7 million. This annual cost is for activities that are not currently being undertaken but are required to meet protocols, such as calibrating monitoring equipment, additional sampling, cleaning the reservoir, and providing a backup operator.

Nationally, there are 209 groundwater systems that may be under the direct influence of surface water (GUDI). Upgrade costs for these systems have been estimated assuming they will prove to be secure groundwater supplies. Recommendations for GUDI studies have been included in the above costs to confirm the status of the wells.

If the GUDI studies indicate these supplies should be considered to be surface water *rather than* groundwater, then additional upgrade requirements will be necessary for these systems to meet INAC's Protocols. It is estimated that, depending on system capacity and site indices, an additional $1.0 to $2.5 million will be required for each system that needs to be upgraded to surface water treatment.

4.2 Upgrade to Meet Protocol: Wastewater

Table 4.2 is a summary of the estimated construction, non-construction and additional annual O&M costs for wastewater system upgrades to meet the INAC Protocol by region.

Table 4.2 - Summary of Protocol Estimated Costs: Wastewater

Region	Construction Costs	Non-Construction Costs	Additional Annual Wastewater O&M Costs
Atlantic	$10,369,000	$740,000	$340,000
Quebec	$12,205,300	$325,000	$298,500
Ontario	$63,729,150	$3,247,500	$1,455,400
Manitoba	$24,634,950	$727,500	$392,800
Saskatchewan	$52,395,700	$2,205,500	$185,200
Alberta	$49,958,550	$1,832,500	$378,500
British Columbia	$86,014,650	$7,298,000	$948,700
Yukon	$616,000	$50,000	$110,000
Total Estimate	**$299,923,300**	**$16,426,000**	**$4,109,100**

The total estimated construction cost for wastewater system upgrades to meet INAC Protocol is $300 million and includes a 25% allowance for engineering and contingencies. This includes requirements that are considered to be related to health (environmental protection) and safety, capacity, standby power and other needs to address best management practices.

The total estimated non-construction cost is $16.4 million. This includes operator training, development of Maintenance Management Systems, O&M manuals, Emergency Response Plans and other studies.

The total estimated additional annual operation and maintenance cost is $4.1 million. This includes annual costs for activities that are not currently being undertaken but are required to meet protocol, such as calibrating monitoring equipment, additional sampling and providing a backup operator.

4.3 Upgrade Cost Summary

The following tables present a breakdown of the estimated upgrade costs to meet INAC Protocols by overall risk level and timing.

Table 4.3 - Total Construction and Non-Construction Protocol Estimated Cost: Water

Risk Level	Short Term	Long Term	Total
High	$385,330,855	$5,960,695	**$391,291,550**
Medium	$359,682,357	$3,938,243	**$363,620,600**
Low	$88,572,511	$2,779,489	**$91,352,000**
Total	**$833,585,723**	**$12,678,427**	**$846,264,150**

Table 4.4 - Total Construction and Non-Construction Protocol Estimated Cost: Wastewater

Risk Level	Short Term	Long Term	Total
High	$79,505,060	$80,540	**$79,585,600**
Medium	$199,924,596	$409,204	**$200,333,800**
Low	$35,778,964	$650,936	**$36,429,900**
Total	**$315,208,620**	**$1,140,680**	**$316,349,300**

4.4 Asset Condition and Reporting System Needs

Asset Condition and Reporting System (ACRS) inspections were completed for all water and wastewater related assets. The following Table 4.5 provides a summary of the repairs required for both water and wastewater.

Table 4.5 - Asset Condition and Reporting System Identified Operation & Maintenance (Needs) Estimated Costs: Water and Wastewater

Region	Water	Wastewater	Total
Atlantic	$2,213,175	$1,866,650	**$4,079,825**
Quebec	$827,125	$748,275	**$1,575,400**
Ontario	$5,596,970	$4,733,285	**$10,330,255**
Manitoba	$1,960,700	$1,920,200	**$3,880,900**
Saskatchewan	$2,478,845	$4,016,700	**$6,495,545**
Alberta	$6,918,916	$5,473,793	**$12,392,709**
British Columbia	$7,467,095	$3,625,825	**$11,092,920**
Yukon	$298,000	$111,200	**$409,200**
Total	**$27,760,826**	**$22,495,928**	**$50,256,754**

4.5 Community Servicing

An analysis was completed for each community to evaluate future servicing alternatives for a 10-year design period. The analysis considers a variety of alternatives, including centralised systems (expanding existing systems, developing new systems, connecting to nearby municipal systems through a Municipal Transfer Agreement if applicable) and the use of decentralised systems (individual water and wastewater systems) as appropriate for each community.

These options were then evaluated based on estimated capital costs and operating and maintenance costs, in the form of a 30-year life cycle cost.

The operations and maintenance costs for truck haul and individual systems were calculated based on the requirements in the INAC Protocol for Decentralised Water and Wastewater Systems, as listed below. The costs carried for managing individual systems includes costs for both proposed individual systems to service new growth and the costs associated with managing individual systems serving existing development such that new and existing users would receive similar levels of service.

Water - Trucked water supply with cisterns and individual wells:

- annual cistern cleaning
- water quality monitoring and sampling (cisterns and wells)
- maintaining individual water pumps (cisterns and wells)
- future replacement costs of individual water pumps (cisterns and wells)
- hydro costs for individual water pumps (cisterns and wells)
- well maintenance (flushing and cleaning every 10 years)
- annual well head inspections
- operation and maintenance of Point of Use treatment systems (wells).

Wastewater - Trucked wastewater and individual septic systems:

- holding tank pumpouts
- septic tank pumpouts
- tank replacement (every 15 years)
- pump maintenance, replacement and hydro (raised beds).

The following tables provide a summary of the estimated costs to complete the upgrades to meet Protocol, recommended servicing and projected annual operation and maintenance costs by region for water and wastewater. The table also provides the average per connection costs for each region for Protocol upgrades based on the current number of connections, and for recommended servicing and annual operation and maintenance costs based on the projected total connections. It is important to note that the cost of the upgrades that are necessary for systems to meet INAC's Protocol is included in the new servicing cost, if appropriate (i.e. for new servicing alternatives that include continued use of the existing system).

Table 4.6 - Future Servicing Costs - Water

Region	Current Population	Current Homes	Forecast Homes	Population Forecast	Upgrade To Protocol	Average Per Lot Upgrades to Protocol (Current Homes)	Recommended Servicing	Average Per Lot Recommended Servicing (Forecast Homes)	Recommended O&M	Average Per Lot O&M (Forecast Homes)
Atlantic	25,856	6,838	9,278	33,460	$31,145,500	$4,600	$110,000,000	$11,900	$9,000,000	$1,000
Quebec	54,667	14,535	18,932	67,825	$15,705,600	$1,100	$210,000,000	$11,100	$13,800,000	$700
Ontario	93,559	23,732	32,179	121,078	$241,689,500	$10,200	$700,000,000	$21,800	$51,100,000	$1,600
Manitoba	88,478	15,661	22,627	115,946	$56,950,000	$3,600	$390,000,000	$17,200	$33,900,000	$1,500
Saskatchewan	70,696	14,248	21,525	97,779	$148,444,800	$10,400	$400,000,000	$18,600	$37,500,000	$1,700
Alberta	74,411	14,503	20,969	98,877	$110,253,800	$7,600	$410,000,000	$19,600	$50,300,000	$2,400
British Columbia	71,125	21,505	29,261	92,792	$231,479,600	$10,800	$400,000,000	$13,700	$50,200,000	$1,700
Northwest Territories	314	117	235	716	$35,000	$300	$10,000,000	$42,600	$500,000	$2,200
Yukon	5,215	1,697	2,096	6,192	$10,560,500	$6,200	$30,000,000	$14,300	$6,700,000	$3,200
Total	**484,321**	**112,836**	**157,102**	**634,665**	**$846,264,300**		**$2,660,000,000**		**$253,000,000**	

Table 4.7 - Future Servicing Costs - Wastewater

Region	Current Population	Current Homes	Forecast Homes	Population Forecast	Upgrade To Protocol	Average Per Lot Upgrades to Protocol (Current Homes)	Recommended Servicing	Average Per Lot Recommended Servicing (Forecast Homes)	Recommended O&M	Average Per Lot O&M (Forecast Homes)
Atlantic	25,856	6,838	9,278	33,460	$11,109,000	$1,600	$100,000,000	$10,700	$8,800,000	$900
Quebec	54,667	14,535	18,932	67,825	$12,530,300	$900	$170,000,000	$9,100	$8,900,000	$500
Ontario	93,559	23,732	32,179	121,078	$66,976,700	$2,800	$440,000,000	$13,600	$42,200,000	$1,300
Manitoba	88,478	15,661	22,627	115,946	$25,362,500	$1,600	$300,000,000	$13,200	$22,600,000	$1,000
Saskatchewan	70,696	14,248	21,525	97,779	$54,601,200	$3,800	$280,000,000	$13,100	$21,200,000	$1,000
Alberta	74,411	14,503	20,969	98,877	$51,791,100	$3,600	$390,000,000	$18,500	$26,300,000	$1,300
British Columbia	71,125	21,505	29,261	92,792	$93,312,700	$4,300	$310,000,000	$10,500	$31,600,000	$1,100
Northwest Territories	314	117	235	716	$0	$0	$10,000,000	$24,900	$600,000	$2,500
Yukon	5,215	1,697	2,096	6,192	$666,000	$400	$20,000,000	$8,500	$3,900,000	$1,900
Total	**484,321**	**112,836**	**157,102**	**634,665**	**$316,349,500**		**$2,020,000,000**		**$166,100,000**	

Table 4.8 - Future Servicing Costs - Combined (Water and Wastewater)

Region	Current Population	Current Homes	Forecast Homes	Population Forecast	Upgrade To Protocol	Average Per Lot Upgrades to Protocol (Current Homes)	Recommended Servicing	Average Per Lot Recommended Servicing (Forecast Homes)	Recommended O&M	Average Per Lot O&M (Forecast Homes)
Atlantic	25,856	6,838	9,278	33460	$42,254,500	$6,200	$210,000,000	$22,600	$17,800,000	$1,900
Quebec	54,667	14,535	18,932	67825	$28,235,900	$2,000	$380,000,000	$20,200	$22,700,000	$1,200
Ontario	93,559	23,732	32,179	121078	$308,666,200	$13,000	$1,140,000,000	$35,400	$93,300,000	$2,900
Manitoba	88,478	15,661	22,627	115946	$82,312,500	$5,200	$690,000,000	$30,400	$56,500,000	$2,500
Saskatchewan	70,696	14,248	21,525	97779	$203,046,000	$14,200	$680,000,000	$31,700	$58,700,000	$2,700
Alberta	74,411	14,503	20,969	98877	$162,044,900	$11,200	$800,000,000	$38,100	$76,600,000	$3,700
British Columbia	71,125	21,505	29,261	92792	$324,792,300	$15,100	$710,000,000	$24,200	$81,800,000	$2,800
Northwest Territories	314	117	235	716	$35,000	$300	$20,000,000	$67,500	$1,100,000	$4,700
Yukon	5,215	1,697	2,096	6192	$11,226,500	$6,600	$50,000,000	$22,800	$10,600,000	$5,100
Total	**484,321**	**112,836**	**157,102**	**634665**	**$1,162,613,800**		**$4,680,000,000**		**$419,100,000**	

Predominantly, it was found that to accommodate future growth, the life cycle costs for extending piped water and wastewater servicing was the most cost effective solution. This solution assumes that future homes would be constructed in a compact subdivision type setting adjacent to an existing serviced area and would meet INAC Level of Service Standards for piped water and sewer servicing. These assumptions, however, will need to be confirmed through detailed studies for each community. Some residents, for example, may choose to continue to build homes in outlying areas where individual wells or truck haul servicing may be more appropriate.

The decision on where to develop clearly impacts which servicing approach is most efficient. Initiatives that encourage consolidated development can be accompanied by community education and awareness outlining the trade-offs that must be made between spread out development on individual services or more dense development on piped services. For isolated dwellings, with poor soil conditions, alternative technologies such as composting toilets may be an alternative to holding tanks or septic systems.

In areas with existing piped servicing, infilling on either existing serviced lots, or on new lots adjacent to existing trunk mains is a cost effective approach to reducing the future servicing costs. In addition, it was found that there is significant savings if the First Nation is able to share water or wastewater servicing with a nearby municipality through an MTA, or Municipal Type Agreement, where this option is appropriate.

Nationally, based on the 10 year projected populations, the combined water and wastewater servicing needs are estimated to be $4.7 billion plus a projected operating and maintenance budget of $419 million per year. The projected future servicing cost per dwelling unit is estimated to average $29,600 per unit with an annual operating and maintenance cost of $2,700 per unit.

5.0 Review of National Issues

5.1 Study Summary

Between June 2009 and December 2010, Neegan Burnside Ltd., with the support of several sub-consultants, completed an assessment of the water and wastewater systems servicing First Nations across the country. A total of 571 First Nations participated in the study. In cases where the First Nation consists of multiple communities that are located in geographically distinct areas, a separate report was prepared for each community.

A total of 641 community reports were prepared which addressed the water and wastewater servicing issues in each community. The total on-reserve population across the country is estimated to be 484,321 residing in 112,836 dwellings. The average household size is 4.3 persons per household. There are a total of 807 communal water systems and 532 communal wastewater systems. A total of 86% of the dwellings are served by the communal water systems and 63% are served by the communal wastewater systems.

Municipal Type Agreements, where a nearby municipality or neighbouring First Nation or corporate entity provides the water or wastewater service, are used as a servicing arrangement for 19% of water systems and 22% of wastewater systems.

Each community report identifies the cost to upgrade each facility to comply with current applicable guidelines, protocols and legislation, establishes the risk associated with each communal system and identifies the cost to service the needs of the community over a 10 year design period.

5.1.1 Cost to Comply with Guidelines, Protocols and Legislation

The assessment includes estimates for upgrades necessary to comply with currently applicable guidelines, protocols and legislation. The requirements for water and wastewater systems are continuously evolving and have changed significantly over the last decade. As a result, most systems are in need of upgrading to comply with current best management practices. The total cost (both construction and non-construction) associated with upgrading water systems to comply with applicable guidelines, protocols and legislation is estimated to be $846 million. In addition, there are estimated to be 209 water systems which are potentially under the direct influence of surface water (GUDI). An additional $1.0 to $2.5 million will be required in additional upgrades for each system that proves to be under the influence of surface water. For wastewater systems, the total cost (construction and non-construction) is estimated to be $316 million.

For water systems, significant portions of the cost are associated with ensuring the systems are upgraded to provide the minimum required level of treatment equipment, including such items as additional disinfection facilities, additional chlorine contact time, the provision of standby power, improvements to chemical storage facilities and the provision of an additional well, or an additional treatment train.

Similarly, for wastewater systems, significant upgrade costs include improving capacity and providing standby power.

5.1.2 System Risk

Each water and wastewater system was classified according to INAC's risk scoring system to establish an overall risk for each system. It is noted that the current risk tool is not well equipped to assess the risk associated with a Municipal Type Agreement system, nor is it designed to assess the risk associated with residents relying on individual services.

Across Canada, 39% of the water systems and 14% of the wastewater systems are identified as high risk. The high risk water systems affect 25% of the population base. The incidence of high risk water systems is the greatest in British Columbia. Small water systems are generally found to have a higher risk rating than larger water systems. In many cases, these small facilities are not designed to meet current protocols and do not have the same level of resources available for operation as larger systems.

The overall risk score is based upon a weighted evaluation of the component risk scores. Nationally, for water systems, the component scores for Source, Operation and Reporting risk are the highest at approximately 6.3, Design risk is lower at 5.3 and Operator risk is the lowest at 2.6. Regionally, the Yukon and Quebec have lower than average risk scores, whereas Ontario and Alberta's risk scores are generally slightly above the average. The high risk systems typically require upgrades or improved operational procedures to meet the guidelines for treated water quality.

There was found to be some inconsistency in the risk guideline with respect to disinfection. There is a question for disinfection under both the design and operations components. The wording of the question for operations leads the entire system to be rated high risk if there is no disinfection installed and in operation, regardless of whether the system was actually designed for it or not. However, there is some indication that it may have been the original intention for the system to override to high risk only if the system was originally designed to have disinfection, and not in the case of a pristine raw water source that had not been designed for disinfection.

If the system risk override is not considered for those systems not originally designed to provide disinfection, the number of high risk systems is reduced by 64, to a total of 250 high risk systems or 31% of the systems. The majority of the systems impacted are located in British Columbia.

Based on the data collected, only 54% of water systems and 49% of wastewater systems have a fully certified primary operator. These percentages drop as remoteness increases. In the most remote communities, only 26% of systems meet operator certification requirements. The risk rating of many systems could be reduced significantly by ensuring that operators are fully certified and trained in system operation, monitoring and record keeping.

While the risk ranking in the "operator" category was the lowest of all categories, operator training also has an indirect impact on other sources of risk. For example, if the operator is well-supervised and trained to take samples and keep adequate records, the "reporting" risk will be lower. If the operator is trained in the operation of the system and has access to a Circuit Rider Trainer (CRT) or other expert, there will be fewer exceedances of parameters that can be attributed to operation. In selected remote areas, direct third-party oversight has generally resulted in improved operations and record keeping.

Improvement in this area has already been identified as a priority in previous reports, and the findings of this study confirm the need for sustained effort and continued improvement. Current initiatives, particularly the Circuit Rider Trainer program, have been a valuable resource for system operators. Circuit Rider Trainers have been able to provide ongoing training and assistance with system operation, maintenance, repairs, and record keeping.

Another area to be addressed is the lack of planning and reference tools, including Source Water Protection Plans (SWPPs), Operation & Maintenance (O & M) Manuals, and Emergency Response Plans (ERPs). In some regions, Tribal Councils or Circuit Rider Trainers are able to assist in the preparation and implementation of these tools.

The comments received from individual First Nations note a general feeling among First Nation communities that current Operation & Maintenance budgets are often insufficient to retain operators, to provide ongoing component replacement, and to perform all of the monitoring and recording requirements. Many site inspectors saw missing equipment or equipment in disrepair and were informed that repairs have not been completed because of a lack of funding. The study included an ACRS assessment of the maintenance needs for the water and wastewater infrastructure. This work identified a set of needs of $28 million for water infrastructure and $22 million for wastewater infrastructure. These needs do not overlap with the identified protocol related upgrades.

Wastewater sampling prior to effluent discharge appears to be another area to be addressed in order to reduce the overall risk significantly. Sampling, testing and recording the effluent quality and volumes prior to and during discharge would reduce the reporting risk for these systems.

5.1.3 Future Servicing Needs

Each community report includes an evaluation of servicing alternatives to address water and wastewater needs for the community over a 10 year period. Where the anticipated servicing approach makes use of the existing facilities, the upgrades to meet protocol are carried forward into the servicing estimates. Nationally, the costs associated with this servicing totals $4.7 billion or approximately $29,600 per connection. In order to complete this evaluation a number of assumptions were required. It is important to note that the cost of the upgrades necessary for systems to meet INAC’s Protocol is included in the new servicing cost, if appropriate (i.e. for new servicing alternatives that include continued use of the existing system).

A life cycle cost was developed for each alternative, including the capital cost of upgrading existing facilities to comply with protocol and the capital cost to expand facilities and/or the construction of additional facilities to meet the demand forecasted over the specified ten year window. In addition, any necessary capital improvements to existing decentralised systems were included in the capital portion of the life cycle cost. Examples include providing Point of Use (POU) treatment systems and replacement of septic systems where they are needed. The annual cost associated with maintaining and operating both the centralised systems and the decentralised systems (individual servicing) was estimated. The life cycle cost for each solution includes the capital cost described above and the present value of 30 years of maintenance and operating costs. Future cash flows were discounted at the rate of 3.5%. An increase in the assumed discount rate would reduce the life cycle cost of solutions with high operating costs such as trucked water delivery and sewage collection.

The infrastructure requirements are driven by the population projections provided by INAC. The typical community growth is approximately 30% over the ten year period. The housing occupancy rate assumed for future housing ranges from the existing occupancy rate in the community to a maximum of 4 people per future household.

The national cost estimate represents the sum of the individual estimates prepared for each community. In some cases, there are multiple systems, and therefore multiple studies recommended within one community. It may be feasible to realize economies of scale by undertaking some works or measures on a community, sub regional, regional or national basis. On a national basis, examples might include templates for GUDI studies, Source Water Protection Studies and emergency response plans or even basic groundwater pumphouse layout and specifications. Some studies might be contracted out and completed on a regional or sub-regional basis.

The estimates include rounding, and engineering and contingencies of 25% as appropriate for a level D estimate, with a cumulative accuracy of +/- 40%. The future servicing costs do not include the costs associated with roads, electrical servicing, or the dwellings themselves.

The servicing costs presented generally represent the options with lowest life cycle cost in comparison to the other options considered for each community. In many cases, the proposed growth requires an expansion of existing facilities to accommodate the growth. Where this is necessary, this dramatically increases the cost per household. Some cost savings may be possible by ensuring that non-structural solutions to increase servicing capacity, such as water conservation, leakage and infiltration management, and plant optimization are fully considered as an alternative to increasing supply or treatment capacity in an effort to reduce costs per household.

In the majority of cases, the extension of existing piped communal systems to service new growth is anticipated to be the servicing solution with the lowest lifecycle cost. However, to maintain this efficiency the proposed development is required to occur in subdivision format with well controlled lot sizes. Piped communal solutions are not generally cost effective for semi urban or rural development with large lots or large separation. For development which is not in a subdivision setting, typically individual servicing is more cost effective provided the groundwater aquifer and soils conditions are acceptable. In order to maintain a similar level of service between communal and individual servicing, the assessment follows the recommendations presented in the Protocol for Decentralised Systems, which includes central management of the individual systems, including labour, maintenance, cleaning, testing, etc. There is an opportunity to enhance community awareness and understanding regarding development planning and its impact on servicing options.

At a certain point, the cost of providing water and wastewater servicing meeting the requirements of the protocol exceeds the value of the service being provided and additional consideration should be given to evaluation of solutions which provide some level of service at a lower overall cost. Small communities with fewer than 50 houses, perhaps located in areas difficult to service because of geological conditions, and/or located in remote areas, can lead to significantly higher than average per connection servicing costs. It is recommended that alternative servicing approaches be investigated. Some examples might include the use of non treated water through individual wells or intakes for non-potable water use and delivery of water jugs for drinking water use. The use of a small diameter low pressure piped delivery system may also be considered. These systems are generally designed to deliver water at a slower rate, with storage provided at the dwelling or cluster of dwellings, and are not intended to provide fire protection. The use of composting toilets in combination with a grey water treatment system may also prove a solution in challenging wastewater servicing situations.

The study identified that providing future servicing to some First Nation communities may be a very expensive proposition on a per connection basis. A total of 569 communities, or 89.5% of the total and 97% of the population, were identified as having a combined future water and wastewater servicing cost of less than $60,000 per connection prior to adjustments to the cost, where necessary, to account for the remoteness of the site. With increasing per connection cost, the merit of investigating alternative servicing strategies grows. The study identified 67 communities, or 10.5% of the total with a per connection future servicing cost in excess of the $60,000 for a total of $0.5 billion. Investigation, identification and implementation of alternative servicing strategies, which hold the per connection cost below $60,000 represents an opportunity for savings as high as $0.2 billion over the currently identified cost for these communities. The threshold of $60,000 is somewhat arbitrary, but serves to illustrate the point that there is a small subset of communities with per lot costs that are atypical and warrant further investigation or modification to the servicing criteria with the goal of reducing overall project cost and still providing benefit to the community.

5.2 Reflection on Assessment Tools

5.2.1 Protocol and Design Guidelines

A set of three documents comprise the newly developed INAC water and wastewater system protocol:

- Protocol for Centralised Drinking Water Systems in First Nations Communities
- Protocol for Centralised Wastewater Systems in First Nations Communities
- Protocol for Decentralised Water and Wastewater Systems in First Nations Communities.

The purpose of these protocol documents is to define the standards and codes to be followed for the design, construction, operation, maintenance, and monitoring of water and wastewater systems. Although these documents contain some specific standards, such as the minimum level of free chlorine residual for water in the distribution system, there are also many references to established standards that provide greater technical detail. For example, for centralised wastewater system design, the Protocol cites the Recommended Standards for Wastewater System Design (Ten State Standards) and, for centralised drinking water system design, it cites the Design Guidelines for First

Nation Water Works (Design Guidelines) adapted by INAC from the Ten State Standards.

The Protocol also states that in the event that provincial requirements are more stringent than the Protocol, system design must comply with the provincial requirements in addition to those of the Protocol. Therefore, designers must consult the Protocol, standards referenced in the Protocol, and provincial standards when designing water and wastewater infrastructure on First Nations. This also means different standards may apply to different First Nations, depending on which province they are in.

There are some references in the Design Guidelines to provincial standards and regulations which are assumed to be unintentional. For instance, the guidelines state that all wells are required to be constructed by BC registered drillers, which is not applicable for communities in other regions.

To ensure a more consistent interpretation of the protocols, it would be helpful if the various guidelines and protocol documents be consolidated. Clarity would ensure all parties recognize what is required, and make it more likely that requirements would be met. In addition, it would be helpful if caveats and exceptions to the requirements are minimized.

In recent years, particularly since the Walkerton incident, the requirements for water treatment in federal and provincial regulations and guidelines have grown more stringent. The new INAC Protocol and Design Guidelines fit that trend. As a consequence, most water systems designed more than ten years ago do not meet the new Protocol, which is reflected in the high cost of recommendations for new capital expenditures.

The following list notes several key items in the Protocol and Design Guidelines which were frequently deficient in existing systems, and would require significant capital expenditure to address:

- The Design Guidelines require multiple filtration units for conventional gravity filters capable of meeting the plant design capacity with one of the filter units out of service (4.3.2.1.3). With this requirement, most surface water treatment plants require an additional filter train to meet the Protocol. A building expansion is often required to accommodate the new filter train.
- Water treatment systems using slow sand filtration are required by the Design Guidelines to have a minimum of two units, though there is no requirement to meet design capacity with one unit out of service, and it is noted that this requirement may be waived by the reviewing authority (4.3.2.3.2).
- The Design Guidelines recommend a minimum of two sources for groundwater systems (3.2.1.2). Based on this recommendation, many small groundwater systems require an additional well for redundancy, even if the existing well has sufficient capacity.
- The Design Guidelines require a separate room for chemical storage and feed equipment (2.3.j). Most First Nation water treatment plants do not have such a room, and therefore require a building retrofit.
- The Design Guidelines recommend spare chlorine feed equipment. It is not clear if this is to be interpreted as a requirement for a redundant mixing tank, injection line,

and plumbed dosing system with automatic switchover, or a standby chemical feed pump (Page 4-3, Disinfection Synopsis). Very few systems have a redundant mixing tank and feed line, and many do not have a standby pump.

- The Design Guidelines recommend a minimum of two fire pumps in systems that provide fire protection (6.4.4). Many systems that provide fire protection have only one fire pump and would require the installation of a backup pump.
- The Design Guidelines state that standby power may be required by the reviewing authority, depending on the history of power outages, system storage, and water consumption (2.6). As the power supply on many First Nations was reported to have at least minor reliability concerns, many recommendations for standby power units are included in the reports.
- The Design Guidelines recommend against the use of potassium permanganate as an oxidization agent in First Nation iron and manganese removal plants. However, greensand filtration using potassium permanganate is the most common system for groundwater treatment plants on First Nations in several regions. Reconsideration of this recommendation may be warranted.

5.2.2 Risk

The INAC Risk Level Evaluation system is a tool used to assess communal water and wastewater systems. Using this evaluation tool, each system is assigned a risk ranking from 1 to 10. The risk ranking of each water system is based on criteria in five categories:

- water source (water)/effluent receiver (wastewater)
- design
- operation
- reporting
- operators.

The overall risk ranking provides a numerical score which provides a general indication of the severity of the deficiencies for each system. While the overall ranking is useful for identifying high risk systems to be singled out for scrutiny, it is necessary to consider which of the criteria is contributing to the risk of each system.

There are certain concerns that automatically trigger a high risk ranking, either in a certain category or for the entire system. For example, exceedance of an aesthetic or health-based GCDWQ limit for treated water quality causes an automatic high risk score in Design or Operation or both, depending on where the responsibility for the exceedance lies. However, there is no differentiation between a low or high magnitude exceedance, or between parameters of serious or minor concern. Therefore, a minor exceedance of total dissolved solids attributable to both design and operation problems, may lead to a higher risk score than a high magnitude exceedance of lead or arsenic that is due only to design.

An exceedance of bacteriological maximum allowable concentration (MAC) automatically triggers a high risk ranking for the entire system. However, it is not clear how many bacteriological exceedances must occur before the system is defined as a high risk system. If there is a single exceedance in a year from one point in the distribution system, and it is retested and found to be safe, it is not clear if this constitutes a “yes” answer for the question, automatically making the system high risk. While it is understandable that the risk evaluation system highlights bacteriological exceedances as a serious health risk, other contaminants such as lead, arsenic, antimony, or uranium may be just as harmful with prolonged exposure at levels above the GCDWQ limits. The risk assessment system does not currently weight the risk from these contaminants at an equivalent level to bacteriological exceedances.

It should be noted that certain regions apply different criteria to the risk assessment process. For example, in the Saskatchewan region any MAC exceedance triggers a high risk ranking, not just for bacteriological parameters. A review of regional differences in the risk evaluation algorithms is recommended to standardize interpretations of the system across Canada.

The risk evaluation system is currently not set up to evaluate certain situations such as the typical Municipal Type Agreement (MTA) system where the First Nation has an agreement with a nearby municipality to provide water or wastewater services, nor is it designed to assess the risk associated with communities that rely on individual servicing or houses with no servicing.

Other items to be reviewed:

- design – flexibility to meet future requirements – this is an unclear requirement
- design – system reliability – more detail required to promote consistent application
- operations – unclear wording of SCADA question
- operations/maintenance logs under operations and record keeping under reporting, the differentiation is not always clear, and as a result, it may not be applied consistently
- review of risk related to no design for disinfection.

The risk assessment system is a useful tool for identifying some high risk sites to ensure that they are investigated more thoroughly. However, it should be kept in mind that this risk score is based upon a set of assumptions. To be applied effectively and consistently by a variety of parties it is imperative that clear and suitable guidance materials are developed and the assumptions revisited on a regular basis.

5.2.3 Asset Condition Reporting System (ACRS)

The Asset Condition Reporting System (ACRS) is a means of recording necessary repairs, component replacement, or maintenance work, referred to generically as “needs.” The ACRS system is used for all INAC funded assets on the First Nation, although this study only considers those assets that are part of water and wastewater systems.

In this study, ACRS is used to identify what is required to maintain the existing infrastructure. ACRS is a pragmatic tool that can serve to ensure investments already made in First Nation infrastructure are not lost due to preventable deterioration.

The ACRS structure can be used to identify deficiencies in meeting the Protocol on an ongoing basis for water and wastewater assets, and to recommend upgrades to address those deficiencies. It may be necessary to emphasize the requirement to do so in the generic Terms of Reference (ToR) for ACRS inspections.

The identification of needs through the ACRS assessments is only valuable when the needs are funded and the repairs are completed. In most regions the ACRS assessments are undertaken in each community every three years. Follow-up work in many communities is required to ensure needs are addressed. In an incentive/disincentive system, INAC could, for example, insist that critical ACRS work from previous inspections be completed before any additional minor capital funds are released in the coming year.

It may be beneficial to update the ACRS system to reflect current technology. For example, the system does not provide direction on how UV disinfection is to be included. For a system with chlorination only, for instance, the chlorination is included with the well asset. It is not clear if UV disinfection should be considered as part of the well asset, or whether a separate treatment unit asset should be created. For wastewater, asset codes exist for Rotating Biological Contactor and Extended Aeration but not for other treatment types such as a Sequencing Biological Reactor (SBR) or a combination of mechanical treatment with sand filter, UV disinfection and/or final settling.

5.2.4 Full Cost Accounting

Municipal governments, through the Public Sector Accounting Board, have recently been required to ensure that their investment in water and wastewater infrastructure, and the full costs of providing this service, is fully recognized from an accounting perspective. It is understood there is a move toward First Nations meeting these same requirements. This process helps to identify that these assets have value, this value depreciates over time, and life spans are impacted by the amount and effectiveness of operations and maintenance spending. A thorough understanding of the value and lifespan of these assets will help to quantify issues with “rust-out” and permit for the orderly planning of replacement facilities and the costs associated with this.

5.2.5 Sharing of Information and Resources

It was noted that there are various levels of communication and interaction between government agencies and support organizations across the regions. In some regions, agencies such as Health Canada, INAC and the Circuit Rider Trainers interact more closely than other regions, sharing information and working together on a regular basis to assist communities. The different agencies keep separate digital systems that record some of the same information. There may be a benefit to creating a shared digital system to store and share vital information such as water quality data, boil water advisories, design drawings, design briefs, annual inspections, etc. Much of this information was not readily available for review and what was available was obtained from a variety of sources.

5.3 Summary of Recommendations

It is recommended that action be taken to address the issues identified within this report. These recommendations can be grouped into three broad categories, as follows:

- works and measures associated with closing the gap between current conditions and the requirements of the various applicable protocols, thereby reducing the risk associated with these systems
- approach to addressing future servicing needs associated with the projected growth in First Nation communities
- further refinement of the various tools used for the assessment of these systems.

5.3.1 Infrastructure and Design

Design upgrades for water systems not meeting Guidelines for Drinking Water Quality, are considered to be the highest priority, followed by systems not meeting protocol. The following are some of the upgrades required to obtain a reduction in design related risk:

- provide minimum required level of treatment including disinfection and adequate contact time as required
- provide basic service level for existing non serviced homes
- conduct GUDI investigations where necessary
- provide required monitoring equipment and alarm systems
- provide standby power
- provide identified backup equipment to improve system reliability
- all other identified works and measures.

5.3.2 Capacity and Operations

In addition to the design issues, the following support is recommended for operations:

- increase support of Circuit Rider Training Program
- ensure systems have a certified primary and backup operator
- enhance awareness and follow-up to encourage adequate monitoring and record keeping
- develop and promote templates for source water protection plans, emergency response plans and maintenance management plans.

With respect to future servicing, the use of centralised treatment systems and/or the use of Municipal Type Agreements is generally the most cost effective means of providing treatment at the required level of service. Extending piped servicing, although providing a high level of service with efficient operations and maintenance costs, relies on a relatively compact layout to be cost effective. For communities with suitable soils and groundwater resources, individual wells and septic systems are an economical solution. For very small communities, and those with a high servicing cost per connection, it is recommended that alternative servicing options be investigated. Co-ordination with the INAC housing program is recommended to ensure best efficiency in infrastructure servicing.

5.3.3 Standards and Regulations

Thirdly, it is recommended that INAC review and clarify some of the tools used in assessment of the water and wastewater systems, including the protocols and design guidelines, and the risk analysis system. The suggested refinements include:

- clarification and harmonization of protocol and guidelines with respect to mandatory items and discretionary items, such as:
  - required minimum level of treatment
  - monitoring requirements
  - equipment redundancy
  - consistency of system classification.
- consideration of application of the protocol to different users
  - large residential
  - small residential
  - community buildings
  - systems serving sensitive populations (elders centre, school and day care)
  - commercial establishments
  - individual systems.
- establishment of a regulatory framework for water and wastewater systems
  - approvals
  - operator certification
  - water quality testing.
- provide support to increase community and First Nation leadership awareness of water related issues (e.g. disinfection)
- ensure commissioning and training is undertaken following capital works and upgrade projects
- modification of the INAC risk assessment tool
  - review of rules which automatically trigger risk “overrides”
  - update of guidance materials to support consistent application of the tool
  - modifications to appropriately score systems operating under a municipal transfer agreement
  - modifications to reflect risk associated with communities and or users on individual systems
  - review weightings of questions and categories to most appropriately reflect risk
  - evaluation of merit of integrating system monitoring data and operator status on a real time basis.
- Asset Condition Reporting System
  - update codes to reflect current technology.
- Full Cost Accounting
  - to support recognition of existing assets and to plan for their orderly replacement.

Appendix A

Glossary

Appendix A: Glossary of Terms and Acronyms

Aeration (see also lagoon): The process of bringing air into contact with a liquid (typically water), usually by bubbling air through the liquid, spraying the liquid into the air, allowing the liquid to cascade down a waterfall, or by mechanical agitation. Aeration serves to (1) strip dissolved gases from solution, and/or (2) oxygenate the liquid. (Gowen Environmental)

Aesthetic Objective (AO): Aesthetic objectives are set for drinking water quality parameters such as colour or odour, where exceeding the objective may make the water less pleasant, but not unsafe. (INAC *Protocol for Decentralised Water and Wastewater*)

Ammonia (See also: Potable water; Effluent quality requirements): A pungent colorless gaseous alkaline compound of nitrogen and hydrogen (NH_3) that is very soluble in water and can easily be condensed to a liquid by cold and pressure (*Merriam-Webster*). Ammonia is used in several areas of water and wastewater treatment, such as pH control. It is also used in conjunction with chlorine to produce potable water. The existence of ammonia in wastewater is common in industrial sectors as a by-product of cleaning agents. This chemical impacts both human and environmental conditions. Treatment of ammonia can be completed in lagoon systems and mechanical plants.
(R.M. Technologies)

Arsenic: A metallic element that forms a number of compounds. It is found in nature at low levels, mostly in compounds with oxygen, chlorine, and sulphur; these are called inorganic arsenic compounds. Organic arsenic in plants and animals combines with carbon and hydrogen. Inorganic arsenic is a human poison. Organic arsenic is less harmful. High levels of inorganic arsenic in food or water can be fatal.
(Medicinenet.com)

Aquifer (confined): A layer of soil or rock below the land surface that is saturated with water. There are layers of impermeable material both above and below it, and it is under pressure so that when the aquifer is penetrated by a well, the water will rise above the top of the aquifer. (INAC *Protocol for Decentralised Water and Wastewater Systems*)

Aquifer (unconfined): An unconfined aquifer is one whose upper water surface (water table) is at atmospheric pressure, and thus is able to rise and fall. (INAC *Protocol for Decentralised Water and Wastewater Systems*)

As-built/record drawings: Revised set of drawing submitted by a contractor upon completion of a project or a particular job. They reflect all changes made in the specifications and working drawings during the construction process, and show the exact dimensions, geometry, and location of all elements of the work completed under the contract. Also called as-built drawings or just as-builts.

ACRS Inspection (Asset Condition Reporting System Inspection): For centralised water and wastewater systems, an ACRS (asset condition reporting system) inspection of the system is to be performed once every three (3) years by a qualified person (consulting engineer, Tribal Council engineer), who is not from the First Nation involved, to assess the condition of the asset, adequacy of maintenance efforts, and need for additional maintenance work. The ACRS inspection report will be discussed with, and submitted to, the First Nation council and the INAC regional office. Inspections will be conducted in accordance with the ACRS Manual, a copy of which can be obtained from the INAC regional office.

Bacteria (plural) bacterium (singular): Microscopic living organisms usually consisting of a single cell. Bacteria can aid in pollution control by consuming or breaking down organic matter in sewage and/or other water pollutants. Some bacteria may also cause human, animal, and plant health problems. Bacteria are predominantly found in the intestines and feces of humans and animals. The presence of ***coliform*** bacteria in water indicates the contamination of water by raw or partially treated sewage. (INAC ***Protocol for Decentralised Water and Wastewater Systems***)

Baffle (concrete and/or curtain): Vertical/horizontal impermeable barriers in a pond or reservoir. Baffles direct the flow of water into the longest possible path through the reservoir in order to eliminate short-circuiting in the water treatment system. In potable water treatment, short-circuiting can reduce the effectiveness of disinfectants. In effluent treatment, short-circuiting may result in an increase of pollutants at the outlet. Short-circuiting occurs when water flows directly from the inlet to the outlet across a pond or reservoir. (Layfield)

BOD_5 (Biochemical Oxygen Demand): The most widely used parameter of organic pollution applied to both wastewater and surface water is the 5-day BOD (BOD_5). This determination involves the measurement of the dissolved oxygen used by microorganisms in the biochemical oxidation of organic matter. BOD test results are used to: determine the approximate quantity of oxygen that will be required to biologically stabilize the organic matter present; to determine the size of waste treatment facilities; to measure the efficiency of some treatment processes; and to determine compliance with wastewater discharge permits. (Metcalf & Eddy)

Capacity (actual vs. design): Refers to the capacity of the treatment system, with the "design capacity" being the flow rate proposed by the designer or manufacturer. If the system is not operating to design levels, the "actual capacity" could be limited by failing pumps, clogged filters or not meeting the Protocol (i.e. Protocol requires two filter trains such that one could operate while another is being cleaned/repaired and this was previously not explicitly required; therefore, the actual capacity is half of the design capacity).

Chemical feed equipment: All equipment associated with introducing chemicals to the raw water as part of the treatment process including coagulants, coagulant aids, disinfectants, etc.

Chlorine: A disinfectant used in either gas or liquid from gas that is added to water to protect the consumer from bacteria and other micro-organisms. It is widely used because it is inexpensive and easily injected into water. Because of its concentration, a gallon can treat a large amount of water. However, chlorine use does have drawbacks: when chlorine is used as a disinfectant it combines with naturally occurring decaying organic matter to form Trihalomethanes (THMs). (Vital Life Systems)

Chlorination: The application of chlorine to water, sewage or industrial wastes for disinfection (reduction of pathogens) or to oxidize undesirable compounds. (City of Toronto)

Chlorine Residual: The chlorine level in potable water immediately after it has been treated. (Ontario Ministry of the Environment)

Circuit Rider (see also Circuit Rider Training Program): Under the department's Circuit Rider Trainer Program (CRTP) INAC provides funds to engage circuit riders (third party water and wastewater system experts who provide water and wastewater system operators with on-site, mentoring, training, and emergency assistance). The third-party service providers that provide circuit rider services also provide operators with a 24/7 emergency hotline. (INAC *Protocol for Centralised Wastewater Systems in First Nations Communities*)

Circuit Rider Training Program: The main vehicle by which most First Nations operators receive the required training to operate their systems. This program provides qualified experts who rotate through a circuit of communities, providing hands-on training for the operators on their own system. Circuit rider trainers also help the First Nations with minor troubles and issues of operation and maintenance of their systems. (INAC *Plan of Action*)

Cistern: A tank for storing potable water or other liquids, usually placed above the ground. (Bow River Basin Council, cited in Alberta Environment *Glossary*)

Class "D" Cost Estimates: A preliminary estimate, for each community visited, based on available site information, which indicates the approximate magnitude (+/- 40%) of the cost of the actions recommended in the report, and which may be used in developing long-term capital plans and for a preliminary discussion of proposed capital projects.

Collection piping: Sanitary sewer collecting wastewater from individual buildings and homes, for treatment and disposal at a public facility.

Component risk / component risk factors: The overall risk is determined by five component risks: water source/effluent, design, operation, reporting, and operator.

Community Health Representatives (CHRs): Health Canada's local health representatives. They undertake bacteriological and chlorine residual sampling of distributed water within most First Nation communities.

Contact piping: Dedicated watermain to provide chlorine contact time before potable water is distributed to the first user.

Containment liners (for on-site fuel storage): A form of secondary containment used for diesel driven generators or fire pumps.

Continuous discharge to a receiving body: The release of treated wastewater effluent to a lake, river, stream, etc. where the rate of release is continuous (i.e. not batch discharge).

Conventional Wastewater Treatment: Consists of preliminary processes, primary settling to remove heavy solids and floatable materials, secondary biological aeration to metabolize and flocculate colloidal and dissolved organics, and secondary settling to remove additional solids. Tertiary treatment such as disinfection or filtration to further treat the wastewater depending on the level of treatment required for discharge. Waste sludge drawn from these operations is thickened and processed for ultimate disposal, usually either land application or landfilling. Preliminary treatment processes include coarse screening, medium screening, shredding of solids, flow measuring, pumping, grit removal, and pre-aeration. Chlorination of raw wastewater sometimes is used for odor control and to improve settling characteristics of the solids.

Conventional Water Treatment: Consists of a combination of coagulation (adding chemicals called coagulants), flocculation (particles binding together with coagulants) and sedimentation (settling of particles) to remove a large amount of organic compounds and suspended particles, filtration (water passing through porous media) to remove bacteria protozoa and viruses (slow sand filtration) or suspended particles (rapid sand filtration), and disinfection to ensure all the bacteria protozoa and viruses are removed, and provide safe drinking water.

Cross connections: A cross connection is a link between a possible source of pollution and a potable water supply. A pollutant may enter the potable water system when a) the pressure of the pollution source exceeds the pressure of the potable water source or b) when a sudden loss of pressure occurs in the water system and "backflow" occurs. The flow through a water treatment plant should have no instances of treated water coming into contact with raw or wastewater. Backflow preventers should be tested regularly and any actual physical links should be removed.

Decentralized System: A group or groups of communal (as opposed to private) on-site water or wastewater systems. (INAC *Protocol for Decentralised Water and Wastewater Systems*)

Dedicated transmission main: A length of watermain which has no service connections or hydrants; can refer to the length of raw watermain from a raw water source to the water treatment plant or in the distribution system where there are larger distances between homes.

Discharge Frequency: The frequency in which treated wastewater is discharged; could be continuous, seasonal, annual, etc.

Discharge quality data: Data acquired through the completion of a laboratory analysis of treated wastewater effluent prior to obtaining permission to discharge. Relevant parameters for testing include: 5 day Biochemical Oxygen Demand, Suspended Solids, Fecal Coliforms, pH, Phenols, Oils & Greases, Phosphorus and Temperature.

Disinfectant: A disinfectant is a chemical (commonly chlorine, chloramines, or ozone) or physical process (e.g., ultraviolet light) that inactivates or kills microorganisms such as bacteria, viruses, and protozoa. (INAC *Protocol for Decentralised Water and Wastewater Systems*)

Disinfection: A process that has as its objective destroying or inactivating pathogenic micro-organisms in water. (Government of Alberta, *Environmental Protection and Enhancement Act*, cited in Alberta Environment *Glossary*)

Disinfection By-products: Disinfection by-products are chemical, organic and inorganic substances that can form during a reaction of a disinfectant with naturally present organic or anthropogenic matter in the water. (Lenntech)

Distribution Classification > piped / trucked: Refers to the classification of the delivery of potable water leaving the water treatment plant. This can be either piped (via watermain) or trucked (via truck delivery to individual homes/cisterns). The level of classification involves the number of house connections (population served).

Domestic flows: All demands in the water system excluding fire flows.

Drinking Water: Water of sufficiently high quality that can be consumed or used without risk of immediate or long term harm.

Drinking Water Advisory (DWA): Drinking Water Advisories (DWAs) are preventive measures that are regularly issued in municipalities and communities across Canada; they protect public health from waterborne contaminants that can be present in drinking water. A DWA can be issued in any community and may include *boil water advisories, do not consume advisories* and *do not use advisories.* (INAC "Fact Sheet")

Effluent: 1. The liquid waste of municipalities/communities, industries, or agricultural operations. Usually the term refers to a treated liquid released from a wastewater treatment process. (Bow River) 2. The discharge from any *on-site sewage* treatment component. (Alberta Municipal Affairs; cited in Alberta Environment *Glossary*)

Effluent quality data: Any test results or monitoring data that describes the condition of treated wastewater effluent.

Effluent Quality Requirements: All effluents from wastewater systems in Canada must comply with all applicable federal legislation including the *Canadian Environmental Protection Act, 1999* and the *Fisheries Act,* as well as any other applicable legislation, including provincial, depending on the geographical location of the system.
In addition, all discharges from First Nations wastewater systems shall meet the quality requirements found in the *Guidelines for Effluent Quality and Wastewater Treatment at Federal Establishments* - EPS 1-EC-76-1 (1976 Guidelines).

For the purposes of determining effluent quality related to ammonia and chlorine, the *Notice Requiring the Preparation and Implementation of Pollution Prevention Plans for Inorganic Chloramines and Chlorinated Wastewater Effluents* and the *Guideline for the Release of Ammonia Dissolved in Water Found in Wastewater Effluents* contain additional and/or updated information to the requirements provided in the 1976 Guidelines.

A copy of the *Guideline for the Release of Ammonia Dissolved in Water Found in Wastewater Effluents* can be found at Environment Canada's website. (INAC *Protocol for Centralised Wastewater Systems in First Nations Communities*)

Effluent Receiver (also referred to as the receiving body; the receiving environment; the receiver) (see also Effluent and Component risks): The environment that receives treated wastewater, including lakes, rivers, wetlands, sub-surfaces, title fields, open marines, and enclosed bays. It may also refer to a community's method for dealing with wastewater (e.g. Municipal Type Agreements or evaporation).

Elevated Storage: A water tower, which is a reservoir or storage tank mounted on a tower-like structure at the summit of an area of high ground in a place where the water pressure would otherwise be inadequate for distribution at a uniform pressure. (Collins)

Emergency Response Plan (ERP): Emergency response plans for water and wastewater systems are intended to be a quick reference to assist operators and other stakeholders in managing and responding to emergency situations. They include key contact information for persons to be notified and for persons who may be of assistance (e.g. agencies, contractors, suppliers, etc.), as well as standard communication and response protocols. Emergency response plans identify recommended action for "foreseeable" emergencies, and provide methodologies for unforeseen situations.

Facultative Lagoon: The most common type of wastewater treatment lagoon used by small communities and individual households. Facultative lagoons rely on both aerobic and anaerobic decomposition of waste, can be adapted for use in most climates and require no machinery to treat wastewater.

Filter: A device used to remove solids from a mixture or to separate materials. Materials are frequently separated from water using filters. (Edwards Aquifier)

Filter train equipment: Includes all components that form part of the water filtration process from where the raw water enters the filter process to where the filtered water leaves the treatment unit. This does not refer to the disinfection equipment.

Filtration: The mechanical process which removes particulate matter by separating water from solid material, usually by passing it through sand. (Edwards Aquifier)

Fire pump tests: A monthly test for the basic operation and functionality of the fire pump.

Grade Level Storage: A treated water storage reservoir that is constructed at grade, typically with earth mounded on top to provide some frost protection.

GPS: Global Positioning System (GPS) - A navigational system involving satellites and computers that can determine the latitude and longitude of a receiver on Earth by computing the time difference for signals from different satellites to reach the receiver.

Groundwater: Groundwater is any water that is obtained from a subsurface water-bearing soil unit (called an aquifer). 1) Water that flows or seeps downward and saturates soil or rock, supplying springs and wells. The upper surface of the saturate zone is called the water table. 2) Water stored underground in rock crevices and in the pores of geologic materials that make up the Earth's crust. (INAC, *Protocol for Decentralised Water and Wastewater Systems*)

Groundwater, confined: Groundwater that is under pressure significantly greater than atmospheric, with its upper limit the bottom of a bed with hydraulic conductivity distinctly lower than that of the material in which the confined water occurs. (INAC, *Protocol for Decentralised Water and Wastewater Systems*)

Groundwater, unconfined: Water in an aquifer that has a water table that is exposed to the atmosphere. (INAC *Protocol for Decentralised Water and Wastewater Systems*)

Groundwater under the direct influence of surface water (GUDI): This term refers to groundwater sources (e.g., wells, springs, infiltration galleries, etc.) where microbial pathogens are able to travel from nearby surface water to the groundwater source. (Government of Nova Scotia)

Guidelines: Guidelines as referred to in this Assessment include all federal and provincial water and wastewater guidelines for domestic potable water and household sanitary waste. These guidelines include the "Guidelines for Canadian Drinking Water Quality" and all its recommended health and aesthetic guidelines for water quality.

Guidelines for Canadian Drinking Water Quality (GCDWQ): Water quality guidelines developed by the Federal-Provincial-Territorial Committee on Drinking Water and have been published by Health Canada since 1968.

Canadian drinking water supplies are generally of excellent quality. However, water in nature is never "pure." It picks up traces of everything it comes into contact with, including minerals, silt, vegetation, fertilizers, and agricultural run-off. While most of these substances are harmless, some may pose a health risk. To address this risk, Health Canada works with the provincial and territorial governments to develop guidelines that set out the maximum acceptable concentrations of these substances in drinking water. These drinking water guidelines are designed to protect the health of the most vulnerable members of society, such as children and the elderly. The guidelines set out the basic parameters that every water system should strive to achieve in order to provide the cleanest, safest and most reliable drinking water possible.

The Guidelines for Canadian Drinking Water Quality deal with microbiological, chemical and radiological contaminants. They also address concerns with physical and aesthetic characteristics of water, such as taste and odour. (Health Canada)

Guidelines for Effluent Quality and Wastewater Treatment at Federal Establishments, April 1976: The purpose of these guidelines is to indicate the degree of treatment and effluent quality that will be applicable to all wastewater discharged from existing and proposed Federal installations. Use of these guidelines is intended to promote a consistent wastewater approach towards the cleanup and prevention of water pollution and ensure that the best practicable control technologies used. (Government of Canada)

Highlift Pumping: Refers to pumps installed that provide treated water into the water distribution system at pressure; either directly or via water tower.

Hydrant Flushing (see line flushing and swabbing)

Influent: Water, wastewater, or other liquid flowing into a reservoir, basin or treatment plant. (Gowen)

Lagoon: A shallow pond where sunlight, bacterial action, and oxygen work to purify wastewater. Lagoons are typically used for the storage of wastewaters, sludges, liquid wastes, or spent nuclear fuel. (Edwards Aquifier)

Lagoon, aerated: See Aeration

Lagoon, facultative: See Facultative Lagoon.

L/c/d: Measurement of daily water usage as Litres per capita, per day.

Level of Service Standards (INAC): The Level of Service Standards (LOSS), determined on a national basis, are the levels of service that the Department of Indian Affairs and Northern Development (DIAND) is prepared to financially support to assist First Nations in providing community services comparable to the levels of service that would generally be available in non-native communities of similar size and circumstances.

The Level of Service Standards provide a description of criteria which will be used to establish the level of funding for safe, cost-effective, domestic water supply and wastewater disposal systems for on-reserve housing units and administrative, operative, institutional and recreational buildings. (INAC "Water and Sewage Systems")

Lift Station (also Pumping Station): A point in the sewer system where the wastewater needs to be pumped (lifted) to a higher elevation so that gravity can be used to bring the wastewater to the treatment plant. (Hailey City Hall Public Works)

Line flushing and swabbing (also referred to as watermain swabbing and flushing): Watermain swabbing entails inserting a soft material shaped like a bullet into the watermain through a fire hydrant. The diameter is slightly larger than the watermain and the bullet (swab) is pushed along the watermain by water pressure. As it passes through the watermain, the swab executes a scouring action on the sediment inside the watermain.

During watermain flushing, high velocity water flowing from hydrants is used to remove loose sediment from watermains. (City of Guelph)

L/p/d: Measurement of daily water usage as Litres per person, per day.

MAC (Maximum acceptable concentration): In the Guidelines for Canadian Drinking Water Quality (GCDWQ), Maximum Acceptable Concentrations (MACs) have been established for certain physical, chemical, radiological and microbiological parameters or substances that are known or suspected to cause adverse effects on health. For some parameters, Interim Maximum Acceptable Concentrations (IMACs) are also recommended in the guidelines.

Drinking water that continually has a substance at a greater concentration than the specified MACs will contribute significantly to consumer exposure to the substance and may, in some instances, produce harmful health effects. However, the short-term presence of substances above the MAC levels does not necessarily mean the water constitutes a risk to health. (INAC, *National Assessment Summary Report*)

Maintenance Management Plan (MMP): Maintenance management plans apply to both water and wastewater systems. They are intended to improve the effectiveness of maintenance activities and are focused on planning, scheduling, and documenting preventative maintenance activities and on documenting unscheduled maintenance.

Manganese: Manganese is a mineral that naturally occurs in rocks and soil and is a normal constituent of the human diet. In some places, it exists in well water as a naturally occurring groundwater mineral, but may also be present due to underground pollution sources. Manganese may become noticeable in tap water at concentrations greater than 0.05 milligrams per liter (mg/L) of water by imparting a colour, odour, or taste to the water. However, health effects from manganese are not a concern until concentrations are approximately 10 times higher. (Conneticut Dept. of Health)

Mechanical Plant/ Mechanical Treatment: Refers to any type of wastewater treatment plant including treatments systems consisting of rotating biological contactors (RBC), sequencing batch reactors (SBR), extended aeration (EA), etc. It does not include natural forms of wastewater treatment like lagoons or septic systems.

Metals Scan (Full): A full metal scan refers to what laboratories call Inductively Coupled Plasma Mass Spectrometry (ICP-MS) analysis for the evaluation of trace metals in water samples. This test covers a complete scan of over 20 trace metals in a single analysis.

Municipal Type Agreement (MTA): The situation where First Nations are supplied with treated water from or send their wastewater to a nearby municipality, as outlined in a formal agreement between the two parties. The term is also used in this report to describe a system where the First Nation is supplied with treated water or wastewater treatment services by another First Nation or other independent body such as a corporate entity such as a Casino etc.

Multi-Barrier Approach: Approach used to ensure that drinking water is safe. In the past, the term ‘multi-barrier’ referred only to the barriers involved in the actual treatment of raw water to provide quality drinking water. This approach has now been expanded to include a number of key elements that are an integral part of a drinking water program to ensure delivery of safe, secure supplies of drinking water. Barriers may be physical (eg: filter) or administrative (eg: planning) in nature. (Alberta Environment, *Glossary* & *Alberta’s Drinking Water Program*)

None: Indicates that the treatment and/or distribution/collection system has not been classified.

O & M: Operation and Maintenance.

Operational Plan (OP): An Operational Plan is the primary instrument for communicating the Community’s quality management system (QMS) from the public works departments (water and wastewater) to Chief and Council, and from Council to INAC, Health Canada and the community members.

Phosphorus: A non-metallic element of the nitrogen family that occurs widely especially as phosphates (*Merriam-Webster*). Phosphorus occurs naturally in rocks, soil, animal waste, plant material, and even the atmosphere. In addition to these natural sources, phosphorus comes from human activities such as agriculture, discharge of industrial and municipal waste, and surface water runoff from residential and urban areas. Nutrients held in soil can be dissolved in water and carried off by leaching, tile drainage or surface runoff.

Phosphorus does not pose a direct threat to human health; it is an essential component of all cells and is present in bones and teeth. It does, however, pose an indirect threat to both aesthetics and to human health by affecting source waters used for drinking and recreation. For example, excessive nutrients can promote the growth of algal blooms, which can contribute to a wide range of water quality problems by affecting the potability, taste, odour, and colour of the water. (Canadian Council of Ministers of the Environment)

Piped Distribution System: A water distribution system which relies on pipes to convey water through pumping or elevated storage to the end user. Different from trucked distribution in that a trucked distribution system delivers water to end users in batch quantities to individual holding tanks (cisterns).

Potable water: Potable water is water that is destined for human consumption.
For the purposes of the *Protocol for Centralised Drinking Water Systems in First Nations Communities*, water destined for human consumption is water that is consumed directly as drinking water, water that is used in cooking, water that is used to wash food, and water that is used for bathing infants (individuals under 1 year in age). (INAC, *Protocol for Centralised Drinking Water Systems in First Nations Communities*)

PPU: People per unit. Measurement to describe housing density.

Primary Operator: The main operator of a water or wastewater system. The primary operator must be certified to the level of the treatment and distribution/collection system.

Primary Wastewater Treatment: Removal of particulate materials from domestic wastewater, usually done by allowing the solid materials to settle as a result of gravity. Typically, the first major stage of treatment encountered by domestic wastewater as it enters a treatment facility. Primary treatment plants generally remove 25 to 35 percent of the *Biological Oxygen Demand (BOD)* and 45 to 65 percent of the total suspended matter. Also, any process used for the decomposition, stabilization, or disposal of sludges produced by settling. (North American Lake Management Society; cited in Alberta Environment *Glossary*)

Protocol for Safe Drinking Water in First Nations Communities: **S**tandards 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 Indian and Northern Affairs Canada (INAC) staff, Public Works and Government Services Canada (PWGSC) 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. (INAC *Protocol*)

Quality Assurance/Quality Control (QA/QC): A quality management system that focuses on fulfilling quality requirements and providing confidence that quality requirements will be fulfilled.

Reporting Risk: The Reporting risk level is the risk inherent with the operational method of recording data and providing the required reports. This would include both manual and automatic methods of record keeping. The reporting risk ranking is based on the adequacy of the operational records and the number of reports submitted during the year compared to the total number of records and reports required according to the appropriate legislation, standards, and operation procedures of the system in question.

Reservoir: A man-made lake that collects and stores water for future use. During periods of low river flow, reservoirs can release additional flow if water is available. (Government of Alberta, *Water for Life*, cited in Alberta *Glossary*)

Reservoir Cleaning: This involves the pump-down, clean-out, removal of settled material, disinfection and refill of a water storage reservoir. This activity requires confined space entry equipment and training.

Retrofit: 1. To furnish with new or modified parts or equipment not available or considered necessary at the time of manufacture; 2. To install (new or modified parts or equipment) in something previously manufactured or constructed; 3**.** To adapt to a new purpose or need**:** modify. (*Merriam-Webster*)

Rotating Biological Contactor (RBC): A technology used to treat wastewater classified as mechanical treatment.

Risk (Management Risk Level/Management Risk Score): Risk is defined in INAC's *Management Risk Level Evaluation Guidelines for Water and Wastewater Systems in First Nations Communities* (Revised 2010). These guidelines follow the Multi-Barrier Approach for water management. This approach, developed by the Federal-Provincial-Territorial Committee on Drinking Water and the Canadian Council of Ministers of the Environment (CCME) Water Quality Task Group, is intended to prevent the presence of water-borne contaminants in drinking water by ensuring effective safeguards are in place at each stage of a drinking water system.

Following that approach, INAC assesses five main components of a system to determine an overall system management risk score:
-Source Water (drinking water systems) or Effluent Receiver (wastewater systems)
-System Design
-Operation and Maintenance
-Records and Reporting
-Operator Training and Experience

Each of these components is assigned a risk score, which are then weighed to determine the overall management risk score of a system. The resulting score will then result in the management of the system as being classified as either high risk, medium risk, or low risk.

-High Risk: Major deficiencies in most of the components. Should a problem arise, the system and management as a whole is unlikely to be able to compensate, thus there is a high probability that any problem could result in unsafe water. Issues should be addressed as soon as possible.

-Medium Risk: Minor deficiencies in several components, or major deficiencies in one or two components. Should a problem arise, the system and management can probably compensate for the problem, but the noted deficiencies makes this uncertain, thus there is a medium probability that any problem could result in unsafe water. Issues need to be addressed.

-Low Risk: Minor or no deficiencies with the system or management. Should a problem occur, it is likely that the system and management as a whole will be able to compensate and continue to provide safe water while the issue is being resolved.

It is important to distinguish between INAC's system management risk level and drinking water quality. The actual quality of the water produced by a system is but one part of determining the overall system management risk level.

Unsafe drinking water is noted through the implementation of Drinking Water Advisories (DWA), not by the management risk level of the system. DWA come in multiple forms, the most common being the boil water advisory.

A system with a high-risk ranking under INAC's management evaluation is, because of its multiple deficiencies, 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 to 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.

This means that a high-risk drinking system can still produce perfectly safe and potable water. Deficiencies should be addressed as quickly as possible, however, before any issues arise with the water quality. (INAC, *Management Risk Level Evaluation Guidelines*)

SCADA (Supervisory Control and Data Acquisition) system: Refers to a control and/or computer system that can monitor, record and control infrastructure, or facility-based processes.

Screened reservoir vents: Reservoir vents should be screened to allow air movement and to prevent vermin from entering.

Seasonal discharge: Discharge of wastewater at times of maximum or substantial stream flow. This may vary from location to location.

Secondary containment for treatment chemicals: Secondary containment is required for the storage of all regulated hazardous materials. Secondary containment must be constructed using materials capable of containing a spill or leak for at least as long as the period between monitoring inspections. A means of providing overfill protection for any primary container may be required. This may be an overfill prevention device and/or an attention getting high level alarm. Materials that in combination may cause a fire or explosion, the production of a flammable, toxic, poisonous gas, or the deterioration of a primary or secondary container will be separated in both the primary and secondary treatment containment so as to avoid intermixing.

Secondary Treatment: involving the biological process of reducing suspended, colloidal, and dissolved organic/inorganic matter in effluent from primary treatment systems and which generally removes 80 to 95 percent of the *Biochemical Oxygen Demand (BOD)* and suspended matter. Secondary wastewater treatment may be accomplished by biological or chemical-physical methods. Activated sludge and trickling filters are two of the most common means of secondary treatment. (North American Lake Management Society, cited in Alberta *Glossary*)

Septic tank: A tank used to detain domestic wastes to allow the settling of solids prior to distribution to a leach field for soil absorption. Septic tanks are used when a piped wastewater collection system is not available to carry them to a treatment plant. A settling tank in which settled sludge is in immediate contact with sewage flowing through the tank, and wherein solids are decomposed by anaerobic bacterial action. (INAC *Protocol for Centralised Wastewater*)

Septic system: A combination of underground pipe(s) and holding tank(s) which are used to hold, decompose, and clean wastewater for subsurface disposal. (Bow River, cited in Alberta *Glossary*)

Sequencing Batch Reactor (SBR): A treatment technology used to treat wastewater classified as mechanical treatment.

Sewage treatment plant (STP) (also known as Wastewater Treatment Plant (WWTP) or Water Pollution Control Plant (WPCP)): Facility designed to treat wastewater (sewage) by removing materials that may damage water quality and threaten public health. (Ontario Ministry of Environment)

Sewage treatment systems: Facility or system designed to treat wastewater (sewage) by removing materials that may damage water quality and threaten public health. (Ontario Ministry of Environment)

Shoot-out: A septic system consisting of a septic tank with untreated wastewater effluent being discharged to the surface; this poses a health risk.

Sludge: The accumulated wet or dry solids that are separated from wastewater during treatment. This includes precipitates resulting from the chemical or biological treatment of wastewater. (Government of Alberta, *Activities*, cited in Alberta *Glossary*)

Source Classification: The determination of the water source classification in this assessment includes the options of: surface water, groundwater, GUDI or MTA. Surface water includes water from lakes or rivers; groundwater includes any well water that is not influenced by surface water infiltration; GUDI is any groundwater source under the direct influence of surface water; MTA as a source refers to the community acquiring the treated water from a municipality.

Source risk: The risk inherent in the quality and quantity of the raw source water prior to treatment.

Source Water Protection: 1. The prevention of pollution of the lakes, reservoirs, rivers, streams, and groundwater that serve as sources of drinking water. Wellhead protection would be an example of a source water protection approach that protects groundwater sources, whereas management of land around a lake or reservoir used for drinking water would be an example for surface water supplies. Source water protection programs typically include: delineating source water protection areas; identifying sources of contamination; implementing measures to manage these changes; and planning for the future. (North American Lake Management Society, cited in Alberta *Glossary*)

2. Action taken to control or minimize the potential for introduction of chemicals or contaminants in source waters, including water used as a source of drinking water (Alberta Environment, *Standards and Guidelines*, cited in Alberta *Glossary*).

SPS: An abbreviation of the term sewage pumping station.

Standard Operating Procedures (SOPs): An SOP is a written document or instruction detailing all steps and activities of a process or procedure. This would include all procedures used in water/wastewater treatment processes that could affect the quality.

Standpipe Storage: An above-grade storage facility where the storage volume is contained within the entirety of the structure. This type of storage is most feasible for use where there is sufficient change in the topography to allow for maximum usable volume in the standpipe.

Storage Type: Refers to whether the community water storage is via grade-level, below-grade or elevated storage (including standpipes and towers). In some cases there is no storage thus the storage type would be considered "direct pump."

Surface water: Surface water is any water that is obtained from sources, such as lakes, rivers, and reservoirs that are open to the atmosphere. (INAC, *Protocol for Centralised Drinking Water*)

System Designer: A system designer is a person, such as a professional engineer, who is qualified to design a water or wastewater systems. (INAC, *Protocol for Centralised Drinking Water*)

System Operator: A system operator is a First Nation employee or third party under contract to a First Nation who is tasked with managing a water or wastewater system. (INAC, *Protocol for Centralised Drinking Water*)

System Manager: A system manager is a First Nation employee or third party under contract to a First Nation who is tasked with managing a water or wastewater system. (INAC, *Protocol for Centralised Drinking Water*)

Tertiary Treatment: Selected biological, physical, and chemical separation processes to remove organic and inorganic substances that resist conventional treatment practices. *Tertiary Treatment* processes may consist of flocculation basins, clarifiers, filters, and chlorine basins or ozone or ultraviolet radiation processes. Tertiary techniques may also involve the application of wastewater to land to allow the growth of plants to remove plant nutrients. Can include advanced nutrient removal processes. (North American Lake Management Society, cited in Alberta *Glossary*)

Trihalomethanes (THMs): Chemical compounds that can be formed when water is disinfected using chlorine or bromine as the chemical disinfection agent. These chemical compounds are formed when organic material present in the raw source water reacts with chlorine or bromine. Therefore, THMs are classified as disinfection by-products (DBPs). The primary source of organic material comes from decaying vegetation found in lakes, rivers and streams and for this reason, THMs are more commonly observed in water systems that use a surface water source. The four chemical compounds that are measured and used to calculate total THMs are: chloroform, bromoform, bromodichloromethane (BDCM) and chlorodibromomethane (CDBM). THMs are a concern in potable water because there is scientific evidence that they may pose a risk in the development of cancer.

Treatment Certification: The treatment level to which an operator is certified for water treatment and distribution and wastewater treatment and collection systems (see Treatment Classification).

Treatment Classification: The size (flow) and complexity of a water or wastewater system is used to determine the Class of a system using a point template. The knowledge and experience it takes to operate a system is closely related to its classification and is reflected in the level of certification of the operator. Systems that are small and relatively simple, are classified as Small Water or Wastewater Systems. Larger or more complex systems are ranked as Class I, II, III, and IV with the highest being Class IV. Systems should be operated under the supervision of an operator certified to at least the same level of the facility.

TSS (Total Suspended Solids): Measure of the amount of non-dissolved solid material present in water or wastewater. Total suspended solids (TSS) can cause: a) interference with light penetration (in UV applications), b) build-up of sediment and c) can carry nutrients and other toxic pollutants that cause algal blooms and potential reduction in aquatic habitat (wastewater).

Underground Storage: A water storage facility (reservoir/clearwell) which is located 100% below-grade. Often located below the water treatment plant.

Waste: Any solid or liquid material, product, or combination of them that is intended to be treated or disposed of or that is intended to be stored and then treated or disposed. This does not include recyclables. (Government of Alberta, Activities Designation Regulation, cited in Alberta *Glossary*)

Waste management plan: A Waste Management Plan identifies and describes types of waste generated during operations and how they are managed and disposed of.

Wastewater (*Industrial Wastewater, Domestic Wastewater)*: A combination of liquid and water-carried pollutants from homes, businesses, industries, or farms; a mixture of water and dissolved or suspended solids. (North American Lake Management Society, cited in Alberta *Glossary*)

Wastewater System: an organized process and associated structures for collecting, treating, and disposing of wastewater. For the purposes of this report, it is a system serving five or more houses. It includes any or all of the following:
1. Sewers and pumping stations that make up a wastewater collection system.
2. Sewers and pumping stations that transport untreated wastewater from a wastewater collection system to a wastewater treatment plant.
3. Wastewater treatment plants.
4. Facilities that provide storage for treated wastewater.
5. Wastewater sludge treatment and disposal facilities.
6. Sewers that transport treated wastewater from a wastewater treatment plant to the place where it is disposed of.
7. Treated wastewater outfall facilities, including the outfall structures to a watercourse or any structures for disposal of treated wastewater to land or to wetlands. (Government of Alberta, *Environmental Protection and Enhancement Act*, cited in Alberta *Glossary*)

Wastewater Treatment: Any of the mechanical, chemical or biological processes used to modify the quality of wastewater (sewage) in order to make it more compatible or acceptable to man and his/her environment. (North American Lake Management System, cited in Alberta *Glossary*)

Wastewater Treatment Plant: Any structure, thing, or process used for the physical, chemical, biological, or radiological treatment of wastewater before it is returned to the environment. The term also includes any structure, thing, or process used for wastewater storage or disposal, or sludge treatment, storage, or disposal. (Government of Alberta, *Activities,* cited in Alberta *Glossary*)

Watermain: A principal pipe in a system of pipes for conveying water, especially one installed underground. (*American Heritage Dictionary*)

Water quality: The term used to describe the chemical, physical, and biological characteristics of water, usually with respect to its suitability for a particular purpose. (INAC, *Protocol for Centralised Drinking Water*)

Water use: The term water use refers to water that is used for a specific purpose, such as for domestic use, irrigation, or industrial processing. Water use pertains to human interaction with and influence on the hydrolic cycle, and includes elements, such as water withdrawal from surface- and ground-water sources, water delivery to homes and businesses, consumptive use of water, water released from wastewater-treatment plans, water returned to the environment, and in-stream uses, such as using water to produce hydroelectric power. (INAC, *Protocol for Centralised Drinking Water*)

Water Well: An opening in the ground, whether drilled or altered from its natural state, that is used for the production of groundwater, obtaining data on groundwater, or recharging an underground formation from which groundwater can be recovered. By definition in the provincial Water Act, a water well also includes any related equipment, buildings, and structures. (Government of Alberta, *Water for Life*, cited in Alberta, *Glossary*)

Wellhead Protection Area: A protected surface and subsurface zone surrounding a well or well field supplying a public water system to keep contaminants from reaching the well water. (Edwards Aquifier)

Wellhead Protection Plan: A wellhead protection plan defines the wellhead protection area, identifies potential sources of contamination, manages the potential contaminant sources including properly decommissioning abandoned wells, identifies emergency and contingency plans (i.e. what to do if the well becomes contaminated or requires additional capacity) and provides overall public awareness.

Zone: Geographic areas developed and utilized by INAC to estimate average unit costs based on location and remoteness.

Zone	**Description**	**No. of First Nations**
Zone 1	First Nations located within 50 km of the nearest service centre with year-round road access.	187
Zone 2	First Nations located between 50 and 350 km from the nearest service centre with year-round road access.	275
Zone 3	First Nations located over 350 km from the nearest service centre with year-round road access.	27
Zone 4	First Nations that have no year-round road access to a service centre and, as a result, experience a higher cost of transportation.	97

References

Alberta Environment. *Alberta's Drinking Water Program: A 'Source to Tap, Multi-barrier'* Approach, 2008. Unpublished

Alberta Environment, Partnerships and Strategies Section. *Glossary of Terms Related to Water and Watershed Management in Alberta.* 1st Edition. November 2008. http://environment.gov.ab.ca/info/library/8043.pdf

Alberta Environment. *Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems*, 2006. http://environment.gov.ab.ca/info/library/6979.pdf

Alberta Municipal Affairs. *Alberta Private Sewage Systems Standard of Practice Handbook*, 2000. http://www.municipalaffairs.gov.ab.ca/Handbook_index.cfm

The American Heritage® Dictionary of the English Language, Fourth Edition copyright ©2000 by Houghton Mifflin Company. Updated in 2009.

Bow River Basin Council. *Guidebook to Water Management: Background Information on Organizations, Policies, Legislation, Programs, and Projects in the Bow River Basin*, 2002. http://www.brbc.ab.ca/pdfs/Guidebook.pdf

Canadian Council of Ministers of the Environment. "Phosphorous." http://www.ccme.ca/sourcetotap/phosphorus.html

City of Guelph. "Watermain Cleaning Program Frequently Asked Questions." http://guelph.ca/living.cfm?itemid=68203&smocid=1791#3.%20What%20is%20watermain%20swabbing%20and%20flushing

City of Toronto. *Biosolids and Residuals Masterplan.* http://www.toronto.ca/wes/techservices/involved/wws/biosolids/pdf/meeting_5_nov6_glossary.pdf

Collins English Dictionary - Complete & Unabridged 10th Edition
2009 © William Collins Sons & Co. Ltd. 1979, 1986 © HarperCollins
Publishers 1998, 2000, 2003, 2005, 2006, 2007, 2009.

Conneticut Department of Health, Drinking Water Section. *Fact Sheet: Manganese in Drinking Water*. http://www.ct.gov/dph/lib/dph/drinking_water/pdf/manganese.pdf

Edwards Aquifer Website: Glossary of Water Resource Terms. http://www.edwardsaquifer.net/glossary.html

Government of Alberta. *Activities Designation Regulation*, 2003. http://www.qp.gov.ab.ca/documents/Regs/2003_276.cfm?frm_isbn=0779750616

Government of Alberta. *Environmental Protection and Enhancement Act*, 2000. http://www.qp.gov.ab.ca/documents/Acts/E12.cfm?frm_isbn=0779717287

Government of Alberta. *Water for Life: Alberta's Strategy for Sustainability.*, 2003. http://www.waterforlife.gov.ab.ca

Government of British Columbia, Environmental Protection Division. *Glossary of Water Terms.* http://www.env.gov.bc.ca/wat/wq/reference/glossary.html

Government of Canada. *Guidelines for Effluent Quality and Wastewater Treatment at Federal Establishments, April 1976*. http://www.ec.gc.ca/eu-ww/0FB32EFD-73F9-4360-95EE-CB856FB4D971/1976_Guidelines_En.pdf

Government of Nova Scotia. Government of Nova Scotia. "Protocol for Determining Groundwater Under the Direct Influence of Surface Water." http://www.gov.ns.ca/nse/water/docs/MunWaterGUDI.pdf

Gowen Environmental Ltd. "Contaminated and Hazardous Waste Site Management Glossary I." http://www.contaminatedsite.com/glossary/glossary%20-%20i.htm

Hailey City Hall, Public Works. http://www.haileycityhall.org/publicworks/wastewater/glossary.asp

Health Canada. *Canadian Drinking Water Guidelines*. http://www.hc-sc.gc.ca/ewh-semt/water-eau/drink-potab/guide/index-eng.php

INAC. "Fact Sheet: Water Quality." http://www.ainc-inac.gc.ca/enr/wtr/fs_wtr-eng.asp

—*Management Risk Level Evaluation Guidelines for Water and Wastewater Systems in First Nations Communities*. July 14, 2010.

—*National Assessment of Water and Wastewater Systems in First Nations Communities Summary Report.* http://www.ainc-inac.gc.ca/enr/wtr/pubs/watw/watw-eng.asp

—*Plan of Action for Drinking Water in First Nations Communities - Progress Report January 17, 2008*. http://www.aincinac.gc.ca/enr/wtr/pubs/prpf/pad08/pad08-eng.asp

—*Protocol for Centralised Drinking Water Systems in First Nations Communities*. April 2010. http://www.ainc-inac.gc.ca/enr/wtr/index-eng.asp

—*Protocol for Centralised Wastewater Systems in First Nations Communities*. April 2010. http://www.ainc-inac.gc.ca/enr/wtr/index-eng.asp

—*Protocol for Decentralised Water and Wastewater Systems in First Nations Communities*. April 2010. http://www.ainc-inac.gc.ca/enr/wtr/index-eng.asp

—"Water and Sewage Systems." http://www.ainc-inac.gc.ca/ih/ci/pubs/wat/wat-eng.asp#chp9

Layfield Environmental Systems. "AquaGuide Floating and Fixed Baffles." http://www.layfieldenvironmental.com/pages/Products/default.aspx?id=3094

Lenntech Water Treatment Solutions. "Disinfection By-Products." http://www.lenntech.com/processes/disinfection/byproducts/disinfection-byproducts.htm

Medicinenet.com. "Definition of Arsenic." http://www.medterms.com/script/main/art.asp?articlekey=14947

Merriam-Webster Dictionary. http://www.merriam-webster.com/dictionary/

Ontario Ministry of the Environment. Technical Report: Drinking Water System at the Kashechewan First Nation. November 10, 2005.

North American Lake Management Society. *Water Words Glossary*. http://www.nalms.org/Resources/Glossary.aspx

R.M. Technologies. "Water Treatment." http://www.rmtech.net/Water%20Treatment.htm

UNEP (2000) *International source book on environmentally sound technologies for wastewater and stormwater management*. http://www.unep.or.jp/ietc/Publications/TechPublications/TechPub-15/2-4/4-2-3.asp

Vital Life Systems. "Water Treatment Terminology." http://vital-lifesystems.com/sitebuildercontent/sitebuilderfiles/watertreatmentterm.pdf

Waterwiki http://waterwiki.net/index.php/Glossary/Facultative_lagoon